Final Report

THESIS FINAL REPORT

Ramy Labna – CM Option
4/09/2014
Advisor: Prof. Sowers

2B + G + M + 7 Development At Mansoura

Doha, Qatar

Function: Office & Retail
Size: 106,000 GSF
Stories: 9 Stories above grade & 2 Stories below
Construction Dates: 4/13 - 4/15
Total Project Cost: $7M

Delivery Method: Lump Sum Method
Owner: Mrs. Fakhriya Ismail Radhwani
Architect: Petra Design
Contractor: Commitment Construction

Architecture

- Mansoura area is currently a mixed-use development, consisting of low-end residential apartments, offices & retail stores
- Rectangular building plan
- Curtain wall system on all facades of building
- Ground & Mezzanine floors are for commercial use
- Aluminum tubular decorative ornaments used on façade

Structural

- Cast in Place Concrete (serves as exterior & interior walls)
- Boundary wall is 8" thick
- Powder coated finish Aluminum frame for the curtain wall

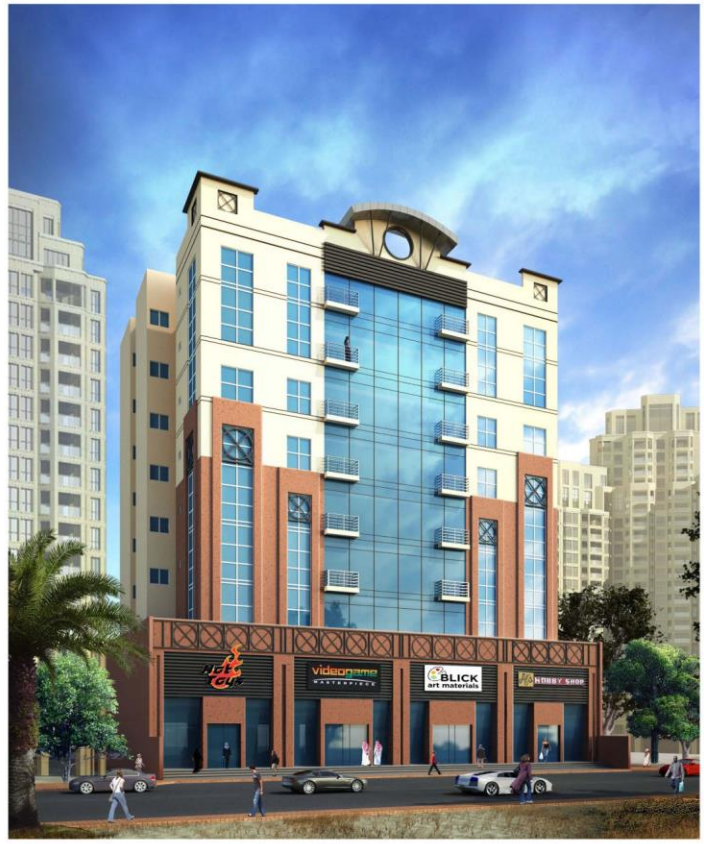
Mechanical

- DX Split type Air Conditioning Unit
- Impulse jet fans, smoke extract fans & fresh air fans used for basement parking
- All fans provided with emergency power
- Sprinklers are utilized throughout the building

Electrical

- Total connected load: 1466.40 KW
- Maximum load for building: 1128.52 KW
- Transformer provided: 1600 KVA
- Main switchboard at 2500 A

Special Thanks to: Petra design



South Elevation

North Elevation

Executive Summary

The following Senior Thesis Report is the conclusion of a year-long study and research of multiple analyses developed through the knowledge encompassed through the Architectural Engineering curriculum at the Pennsylvania State University. This report is on the construction of 2B + G + M + 7 Mansoura Development, located in Doha, Qatar. Three analyses were conducted in order to provide and target problematic and acceleration schedule concerns through the use of Precast Concrete construction, implementation of different construction practices and lastly through field labor management and different scheduling techniques.

Analysis 1: Construction of Precast Concrete vs. Cast in Place Concrete

The first analysis focuses on the feasibility of replacing the exterior cast in place wall with precast concrete wall panels. Through the use of precast concrete modules, the schedule benefited from schedule reductions. In addition, the panels were tested to explore the structural and mechanical effects it would have on the building and was compared with the current cast in place system. After conducting this analysis, the overall schedule was reduced by 9 days, with an added cost of $459,729, however there was potential cost savings through resizing of mechanical equipment and structural slab and foundation thickness.

Analysis 2: Comparison of Construction Practices between the US & Qatar though the Assessment of the HHD project (Penn State) & the Mansoura Development

The second analysis investigated the different construction practices that were implemented between both the US & Qatar. It was to identify the differences and see what could be improved with the current construction process for the Mansoura Development, to create the opportunity to improve the schedule, cost of the project and general quality of the final product. The three main topics compared were Labor wages, Safety Programs/Procedures and Quality Control Programs. The results of the analysis proved that having higher/trained skilled labors, OSHA trained personnel and a better quality control program like the HHD project was in the best interest to reduce project cost and schedule.

Analysis 3: Field Labor Management and Alteration

The third analysis aimed to find schedule saving scenarios, in order to by-pass the halt of construction during the hot summer months in Qatar, where temperatures reach over 122 ^{o}F. The primary concern was to build the superstructure before the summer months therefore re-sequencing activities was important. The use of a short interval prediction schedule (SIPS) proved to be very successful, with the implementation of a Man Power Loaded Schedule to portray the man power on the site at all times and make sure SIPS was a feasible option. This analysis estimated over 3 months of schedule savings.

Credits/Acknowledgements

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Project Overview

Project Summary

2B + G + M + 7 is a 9 story residential building that is around 106, 000 square feet. The building is located in the Mansoura region in Doha, Qatar. It is comprised of mainly residential apartments with retail stores on the ground floor. The Mansoura area is an up and coming renovated region, targeting high end retail stores in order to bring in more attraction and business to the area.

Fig. 1.1 – Rendering of Building (Courtesy of Petra Design)

The building is of a rectangular shape, with a curtain wall system in its façade. The building contains many aluminum tubular decorative ornaments that help make the building aesthetically pleasing. The boundary wall is made up of Cast in Place Concrete that is 10" thick, and acts as both the exterior and interior walls of the building. Paint is directly applied onto the concrete walls as a decorative finish. The roofing is made up of concrete slab with a waterproofing membrane and solar shield protection due to the intensity of the sunlight given throughout the year in Qatar, especially in the summer months.

The development of the project is located between Al Mansoura Street and Al Salhiya Street in Doha, Qatar, where an existing office building stood. Demolition was not included in the contractual agreement. There are no zoning restrictions in the Mansoura Area of Qatar and no building codes are required.

The $7M Lump Sum contract was granted to Commitment Construction, who is the sole contractor on the project, with no sub-contractors. The start of construction began on April 15, 2013, with an estimated time for completion of 24 months.

The project delivery method is Design-Bid-Build and the schedule of construction is broken down into a floor-by-floor sequence rather than by trades. The structure is comprised of cast in place concrete, which is the structural support of the building. A curtain wall system is used partly on all facades of the building, and is comprised of powder coated finish aluminum frame and double pane glazing.

Client Information

The client for this project is Mrs. Fakhriya Ismail Radhwani, who is a Qatari real estate investor, who is constantly on the lookout for new ventures to increase her capital. She has been in the real estate business for many years and has proven to be very successful. One of the main reasons Ms. Fakhriya had studied and entered the real estate market was due to Qatar being heavily populated with expats who only have the right to rent property throughout the country. This is a huge advantage, as she can benefit from buying property and make some profit through renting it out.

Her main objective for the construction of this project is for the potential for financial gain, since the location of the project is located in an up and coming renovated region, targeting high end retail stores, this will help attain higher asking prices for the spaces. Mrs. Fakhriya has put an emphasis on the quality and schedule of completion of the project, to ensure a rapid time for her clients to occupy the building. Some actions were taken to ensure these expectations were met, which included stringent qualifications for the contractor and design firm to ensure experience and ability to perform.

Existing Conditions

The development of the project is located between Al Mansoura Street and Al Salhiya Street in Doha, Qatar, as shown below in Fig.1.2. There was a prior office building on the site, however demolition was not included in the contractual agreement. The area around the site is very congested due to it being a residential and office region. Extensive underground utilities run along both Al Salhiya and Al Mansoura Street, which the building will tie in to.

***See Appendix A-1 for further detail of existing conditions plan**

Fig 1.2 – Project Site Location (Courtesy of Bing Maps)

Excavation

Since demolition was completed before the contractor was selected, Commitment Construction Contractors can set up their site trailer. The major activity here is the excavation of earthwork and preparation for underground foundation of the basement floors. Referencing Appendix D, the site logistics in this phase include site fencing, excavation of support, flaggers to direct traffic, and action of mid-stage of site excavation.

All that is needed during site excavation are the front-end loaders, excavators and dumpster trucks to carry the earthwork away from the site. A ramp made of the excavated earth work is constructed to allow the excavators and trucks the ability to get down the site. In looking at this plan, there is a possibility to get more dumpster trucks in order for the excavation to progress more efficiently. This can be executed by creating two ramps instead of the one, to ease access and exit.

***See Appendix A-2 for further detail of the excavation plan.**

Concrete Placing

The major activity here is the pouring of the concrete. Starting at the basement, the floors will be poured one after the other similar to what was mentioned in the Detailed Structural Schedule. As the floors increase, assistance will be needed in order to form and place the concrete. The use of a crane will assist with this matter (crane shown on finishes plan: C-3). To increase productivity, pump trucks will be utilized after one another in order to complete this task in a timely manner. A storage area and dumpster will be located on site for further assistance. Both gates will be utilized in this phase, in order for better functionality.

***See Appendix A-3 for further detail of the Concrete Placing plan.**

Exterior/Interior Finishes

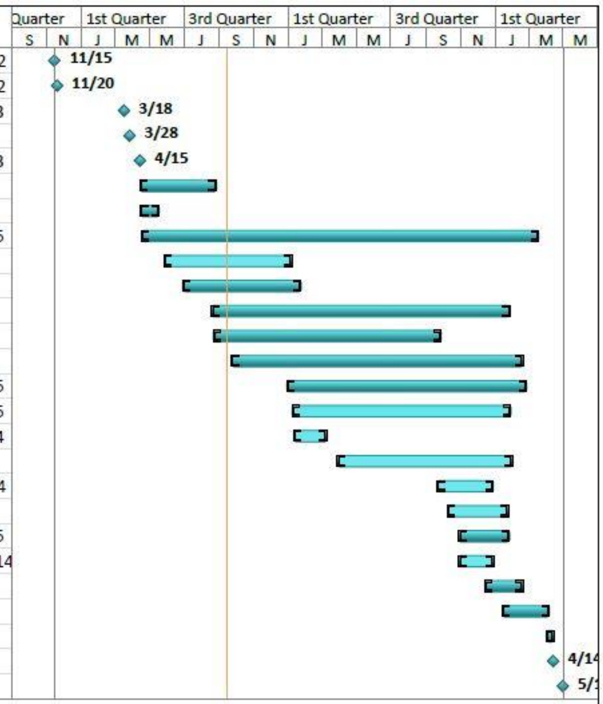
This is one of the last phases of the project. Having a crane in the elevator shaft prevents the need to move the crane, as it can build and reach the entire perimeter of the building from the same point. The crane will then be dismantled once the elevator is ready to be installed, as mentioned before in the Detailed Project Schedule. The use of scaffolding and hoist helps to haul up material and laborers to their respected floors. As in the previous plan, both gates will be utilized, in order for material delivery trucks to transport the materials to their respected storage areas.

***See Appendix A-4 for further detail of the Exterior/Interior Finishes plan.**

Project Schedule Summary

The project started on 15th November, 2012 when Petra Design (Architectural Firm) was hired to design the building. Commitment Construction (Contractor) was selected after construction drawings were completed. Project construction commenced on 15th April, 2013 and a summary of the schedule can be seen below in Fig. 1.3. The work was phased floor by floor which is why Electrical, Plumbing and HVAC have long durations. The 24-month construction schedule seemed a little long for this building type, since floors 1-7 are all typical. Therefore there was an opportunity for schedule acceleration scenarios to be analyzed and implemented on the project. This could provide the prospect of saving money and help generate profit to the owner if the project can be completed at an earlier date by allowing for tenants to move in earlier.

ID	Task Name	Duration	Start	Finish
1	Architect Hired	0 days	Thu 11/15/12	Thu 11/15/12
2	Design Phase	0 days	Tue 11/20/12	Tue 11/20/12
3	Construction Drawings	0 days	Mon 3/18/13	Mon 3/18/13
4	Contractor Selected	0 days	Thu 3/28/13	Thu 3/28/13
5	Project Commencement	0 days	Mon 4/15/13	Mon 4/15/13
8	Foundation	97 days	Mon 4/15/13	Tue 8/27/13
6	Hoarding (Fencing)	25 days	Tue 4/16/13	Sat 5/18/13
7	Site Facilities & Offices	500 days	Thu 4/18/13	Wed 3/18/15
9	Basement Level -2	162 days	Tue 5/28/13	Wed 1/8/14
10	Basement Level -1	150 days	Sat 6/29/13	Thu 1/23/14
12	Plumbing Installation	377 days	Mon 8/19/13	Tue 1/27/15
11	Superstructure	288 days	Thu 8/22/13	Sat 9/27/14
13	Enclosure Installation	369 days	Mon 9/23/13	Thu 2/19/15
14	Electrical Installation	303 days	Mon 12/30/13	Wed 2/25/15
15	Ventillation & AC	276 days	Wed 1/8/14	Wed 1/28/15
16	Substation Construction	42 days	Sat 1/11/14	Mon 3/10/14
17	Fire Safety	222 days	Sat 3/29/14	Sat 1/31/15
18	External Façade Finishes	72 days	Sun 9/21/14	Sun 12/28/14
19	Elevator Installation	78 days	Thu 10/9/14	Sat 1/24/15
20	Curtain Wall Framing	64 days	Wed 10/29/14	Mon 1/26/15
21	External Works Around Building	44 days	Wed 10/29/14	Mon 12/29/14
22	Final External Finish	50 days	Sun 12/14/14	Thu 2/19/15
23	Testing & Comissioning Phase	59 days	Wed 1/14/15	Mon 4/6/15
24	Project Demobilization	9 days	Thu 4/2/15	Tue 4/14/15
25	Substantial Completion	0 days	Tue 4/14/15	Tue 4/14/15
26	Owner Move In	0 days	Fri 5/1/15	Fri 5/1/15



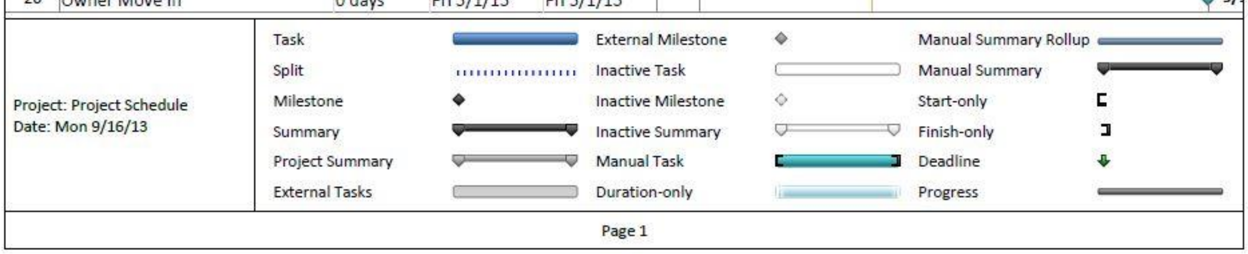


Fig 1.3 – Summary of Project Schedule

Project Delivery & Staffing Plans

Analysis of the project delivery system and staffing plans were performed to further understand the responsibilities of the parties within the project. The delivery method for the project is Design-Bid-Build with a Lump Sum payment method, since it was easier to manage the project, control the cash flow and gives an extra benefit for the contractor to try and complete the project faster, which in turns helps residents occupy the building earlier. In addition it simplifies financing, and since commitment construction are the sole contractors on the project, with no subs included, they can estimate exactly how much the project will cost, and be able to finish the project at an accelerated pace, resulting in greater profits. The contractor was required to provide a performance bond before any work can begin, to assure that the contractor completes the project according to the contract. In the case that the contractor fails to do so, the owner can make a claim to keep from losing money as the performance bond covers 100 percent of the contract price. An advance payment bond was also issued in conjunction with the performance bond for the protection of the owner in case the contractor fails to abide by contractual agreement.

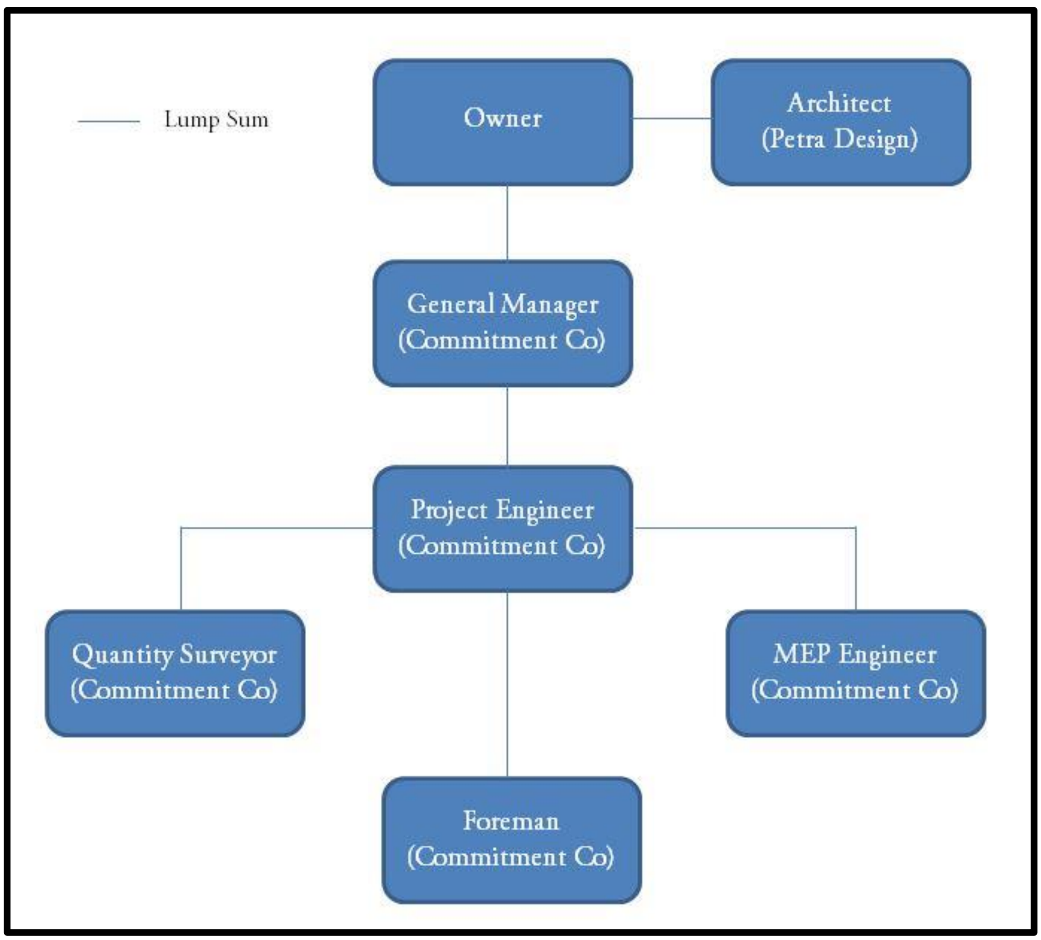


Fig 1.4 – Project Delivery Layout

Staffing Plan

Since the project is performed solely by Commitment Construction, the staffing plan is quite similar to the Organizational Chart of the project. As shown below in Fig. 1.5, the General Manager was heavily involved in the early stages of the project in order to get the project underway and make any important decisions regarding changes for any information given by the architect in the construction drawings. Once the project had commenced, responsibilities were then passed down to the Sr. Project Manager who was in charge of the Contracts Manager and Quantity Surveyor and dealt with all the contractual agreements and Sr. Project Engineer who was in charge of the Project Engineer and MEP Coordinator and dealt with the coordination of the construction of the building.

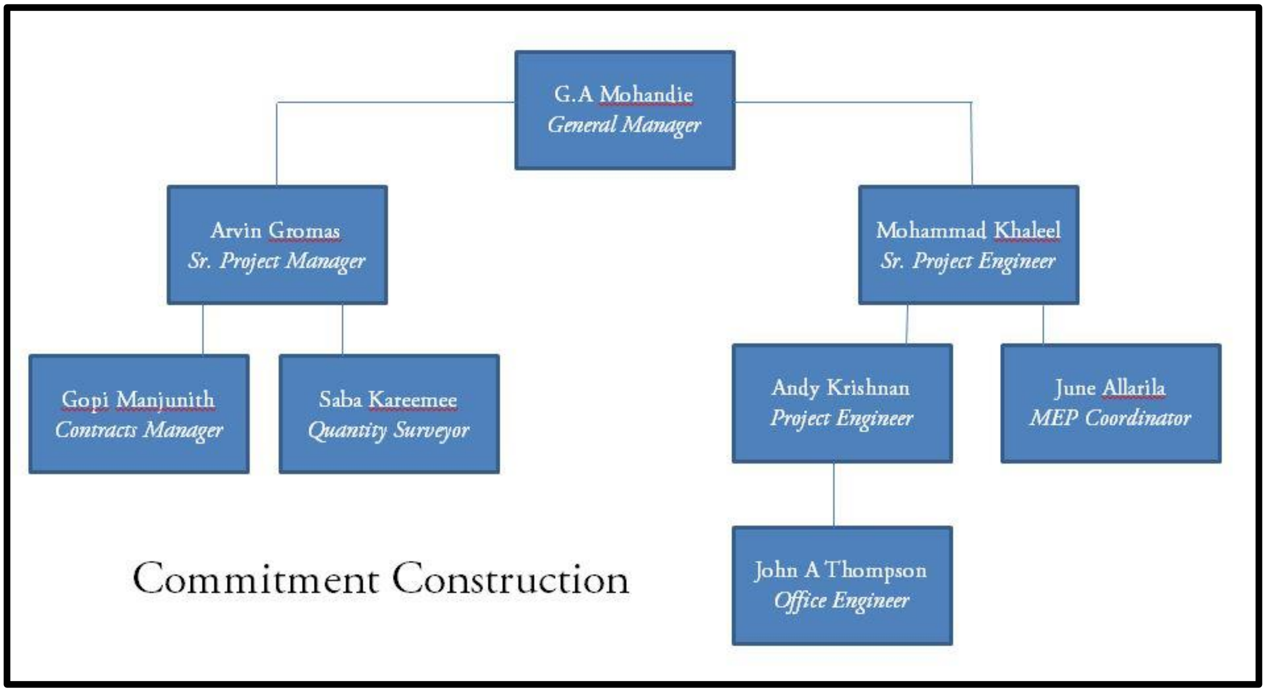


Fig 1.5 – Project Delivery Layout

Building Systems Summary

The buildings system summary was looked into with detail, to understand the key aspects of the design and construction of the building.

Yes	No	Work Scope
	X	Demolition Required
	X	Structural Steel Frame
X		Cast in Place Concrete
	X	Precast Concrete
X		Mechanical System
X		Electrical System
	X	Masonry
X		Curtain Wall
	X	Support of Excavation

Table 1.1 – Required Building Systems

Cast in Place Concrete

The whole building is structured using Cast in Place Concrete. It is the structural support acting as beams, columns, floors, walls and roof. It serves the exterior façade and interior walls. The reason for the use of this system is due to its long term durability and structural support. The cast in place concrete is transported in an unhardened, ready-mix state, where the concrete is delivered to the site in a cement truck and placed in forms. Pre formed steel forms and wood forms were used as formwork for the placement of the concrete.

Mechanical System

The mechanical system being used is a DX Split Type Air Conditioning Unit. It is a direct expansion HVAC system which uses the same coil system to expand the refrigerant and cool the air. The components of the refrigeration loop are split apart, allowing for increased flexibility in the system design, which helps achieve the desired performance. The reasons this was chosen over a chilled water system was because it had lower installation cost, requires less labor and fewer materials to install. The basement areas are ventilated with impulse jet fans, smoke extract fans and fresh air fans, to reduce the level of polluted air and assist with the extraction of smoke in an event of a fire. This type of ventilation helps reduce operation cost, noise and eliminates bulky ductwork. The residential apartments are ventilated using exhaust fans and wall mounted propeller fans to help move air out of the enclosure. The staircase and lobby are pressurized with emergency ventilation fans, which are roof mounted and have a fire rating of 2 hours. All fans are provided with emergency power and the ducts constructed with fire resistant material. Most assemblies will have a fire rating of two hours as a minimum and sprinklers will also be utilized throughout the building.

Electrical System

The total connected load provided by KAHRAMAA is 1466.40 KW, with the maximum demand load for the building being 1128.52 KW. The transformer provided by the utility company is at 1600 KVA. The main switchboard at 2500A feeds the entire building via a bus bar (power concentrated for distribution). The current flows through the main switchboard and is then split into 17 breakers plus 1 spare to be distributed throughout the whole building. Sub main switch boards (SMDB) are used throughout each breaker. The SMDB feeds the final distribution board, which then feeds electrical energy to the end user. Two of the breakers further split into 2 similar bus bars rated at 630A to feed the apartments starting on the fourth floor, continuing on to the seventh floor. The reason to use other bus bars is to improve reliability, eliminate wiring errors and reduce system costs in general.

Curtain Wall

A curtain wall system is used partly on all façades of the building. Installation is identical throughout the building and is comprised of powder coated finish aluminum frame and double pane glazed window with reflected glass on the outer pane and clear glass on the inner pane with an air gap, as shown in Fig. 6 on the right.

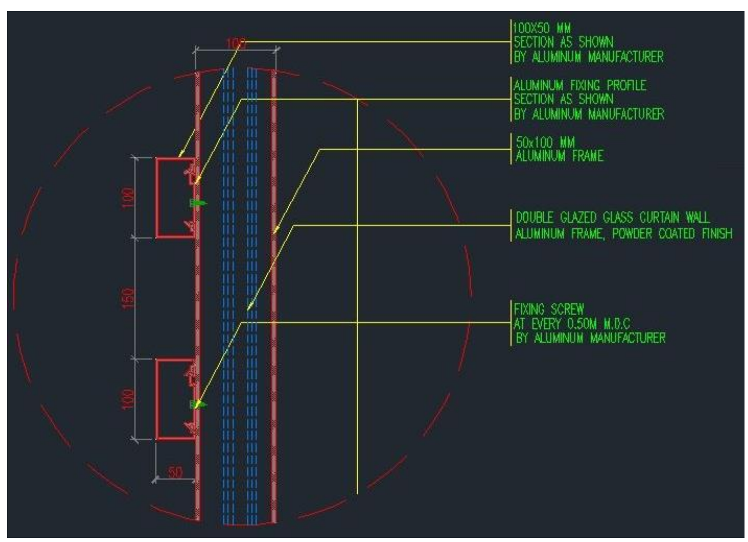


Fig 1.6 – Curtain Wall Cutout

Project Cost Evaluation

Overall Project Cost: $7,000,000

Size: 106,000 Gross Square Feet

Number of Stories: 9 stories above grade and 2 stories below grade for parking

Square Foot Estimate

The cost breakdown for the systems was compared to the square foot estimates obtained from RS Means, as it can be seen in Fig. XX below. Since the building included Residential, Retail and Underground Parking, the estimate had to be split up in to three different sections in order to get an accurate result. The residential portion made up 58% of the building, while retail and underground parking made up 19% and 23% respectively. It was found that the estimate came in higher than the actual cost due to many reasons such as, the project being located outside the US, where materials, utilities and labor costs would be drastically different, since there are different government regulations. When picking the location factor for RS Means, Philadelphia was picked as it portrayed a more neutral cost than New York where construction would be very expensive.

***See Appendix B for the full RSMeans CostWorks Square Foot Estimate**

Building Cost Summary				
System	Actual		SF Estimate	
	Cost	Cost/SF	Cost	Cost/SF
Actual Building Construction Cost (CC)	$ 5,997,443.10	$ 56.58	$ 12,647,791.60	$ 131.80
Strcutural System Cost	$ 3,236,701.38	$ 30.54	$ 2,860,627.22	$ 29.81
Electrical System Cost	$ 531,506.85	$ 5.01	$ 260,057.02	$ 2.71
Plumbing & Drainage System Cost	$ 282,898.63	$ 2.67	$ 867,496.48	$ 9.04
Air Conditioning & Ventillation Cost	$ 302,780.82	$ 2.86	N/A	N/A
General Conditions	$ 728,000.00	$ 6.87	N/A	N/A
Total Project Cost (TC)	$ 7,000,000.00	$ 66.04	$ 16,733,853.56	$ 174.38

Table 1.2 – Building Cost Summary

Detailed Estimate

A quantity takeoff of the structural system was performed in order to get a more accurate estimate of the project. Values were taken off RS Means Cost works Data from the RS Means web source. The location factor I chose to match closely to Doha, Qatar was Philadelphia, Pennsylvania. The reason I chose this location was because it would be a more neutral cost than New York, where construction will be very expensive, and so I would be able to compare it to my square foot estimate which was completed in Tech 1.

The building was made up of cast-in-place structural concrete. The concrete columns, slabs, footings and reinforcing were taken off using the method of a "typical bay". This bay was assumed to be similar on select floors. Due to the similarity of beams and columns, I chose to proceed using this method. This procedure provided an efficient way to calculate the total quantities of the remaining floors, however will create a larger chance for error. Since the Basements and Ground Floor had similar structural plans, they were assumed a like. Therefore after one floor was calculated, the values were multiplied by three in order to get the total value for all those floors. Meanwhile Floors Mezzanine to 7 had similar structural plans too, so as mentioned before; one floor was calculated, and then multiplied by 7 to get the total value for all those floors. The "typical bay" method could have affected the outcome of the estimate, however I would not be able to compare my actual cost values accurately, as the prices for labor, equipment and material would differ greatly in different countries.

***See Appendix C-1, C-2 & C-3 for the Detailed Structural Estimate**

Foundation & Retaining Wall

The retaining walls found on this project ran along the perimeter on the foundation (building) footprint. It is 10' high (3.3m) and is reinforced using #4 Rebars. There is a mat foundation made up of 3000 psi normal weight concrete, extending over the footprint of the building and is 4' thick.

***See Appendix C-1 for the Detailed Col/Wall/Slab & Reinforcing Estimate**

Concrete Columns & Beams

The columns and beams support the elevated slab. All beams were individually taken off, unlike the columns which was taken off using the "typical bay" method. The columns and beams are made up of 4000 psi normal weight concrete with various rebar sizes (typical bay method used).

***See Appendix C-2 for Beams.**

Cost Summary

System	Detailed Estimate	SF Estimate	Actual Cost
Structural	$ 3,340,134.59	$ 2,860,627.22	$ 3,236,701.39

Table 1.3 – Detailed Structural System Cost Comparison

As seen in Table 1.3 above, my estimate came really close to the actual cost of the structural portion of my building. There are a few reasons why this estimate came to be very close to my actual cost even though they are both priced at different locations.

Labor rates in the US are much higher compared to Qatar; however material pricing, renting of equipment, etc. can be valued at a much higher rate in Qatar in comparison to the US. This can therefore cancel each other out and reach a value that is quite similar.

Assemblies MEP Estimate

The MEP assemblies system totals $5,126,234.04. This estimate isn't very accurate as I had to use substitutes to some of the equipment included in the contract documents as it wasn't included in the RS Means Cost Works data (Web Source). The actual MEP Cost is $1,117,186.30. Even though there is a great difference between the estimate and the actual cost, it is understandable as different equipment, pricing, etc. is being used within different countries.

The mechanical estimate totals at $691,711 in comparison to the actual of $302,780. This inaccuracy can be understood due to the substitution of select fans and exhaust systems as the ones included in the contract document were not available in RS Means.

The electrical estimate totals at $3,157,345 in comparison to the actual of $531,506.85. This is due to RSMeans system limitation in calculating, as it includes generic information which makes it hard to apply into the estimate with multiple systems. Added to these limitations is the fact that the actual values are not prices with the US standards, therefore the inaccuracy can be understood.

Lastly the Plumbing estimate totals at $1,277,178.54 in comparison to the actual $282,900. Similar to the electrical estimate description, the values of the estimate will be completely off due to the generic information provided by RS Means and the difference in pricing within the two countries.

***See Appendix D for Assemblies MEP Estimate**

Detailed Project Schedule

The Mansoura Development detailed project schedule begins on November 15, 2012, when Petra Design Architecture Firm was hired to take on the project. The Contractor was selected after construction drawings were produced, on March 28, 2013. The construction schedule lasts 24 months. The schedule is broken down into a floor to floor sequence rather than by trades. The following table gives a summary of the major design and construction phases:

Detailed Schedule Summary			
Phase Description	Start Date	End Date	Dur. (Days)
Design & Pre-Construction	11/15/2012	5/8/2013	128
Sub Structure Structural	4/15/2013	1/23/2014	199
Super Structure Structural	8/22/2013	9/26/2014	284
Plumbing Installation	8/19/2013	1/27/2015	374
Arch Rough-ins	9/23/2013	2/19/2015	359
Electrical Installation	12/30/2013	2/25/2015	303
Fire Safety	1/2/2014	1/30/2015	282
Ventilation & AC	1/8/2014	1/28/2015	276
External Façade Finishes	9/22/2014	2/19/2015	109
Elevator Installation	10/9/2014	1/23/2015	77
External Site Work (Landscape)	10/29/2014	12/29/2014	44
Testing & Closeout	1/14/2015	5/1/2015	81

Table 1.4 – Key Schedule Phase Summary

***See Appendix E for the Detailed Project Schedule**

General Conditions Estimate

The general conditions estimate was done with the assistance of RS Means Cost Works database (Web source) and Commitment Construction Percentages for Insurance work. The total estimated cost for General Conditions is $1,095,111.08, which can be seen in detail in Appendix D. This cost was grouped into 5 sub categories, which included, Project Management, Field Operations, Field Office, Testing & Inspections and Insurance. There will be a difference in values when comparing the estimate to the actual, as both are based on pricing and evaluation of different countries. The summary of the schedule breakdown can be seen on Table 3 and Figure 2 below.

Project Management costs that were included for Commitment Construction staff were taken from the project organizational chart submitted in Tech 1. All members but one in project team was assumed to have spent the entire 24 months of the project on the site.

Field Operation costs included items like fencing, signage, temporary power, water supply and site cleanup. All items are used at different phases of the project, however were all important to include in the estimate.

Field Office costs included items related to the office trailer on site. Items that are included in the costs are trailer rental and office facilities. Items such as office supplies and equipment are included under office facilities. The trailer was assumed to only last 12 months, as after erection of the structure, they would be move into the building, to make more space on site for other equipment and storage.

Testing & Inspections included testing the building services after the completion of the building, right before the owner move-in date.

Lastly Insurance was included in the estimate. This consisted of a Performance Bond, Insurance of Work, Third Party Insurance and Workmen Insurance. All these items were based off a percentage of the entire building construction cost ($12,647,791.60). The building construction cost was taken off the SF Estimate value and not the actual cost because it would more likely match the previous values taken from RS Means.

Table 3 and Figure 2 on the next page provide a summary of the General Conditions Estimate as a percentage of the entire estimate.

***See Appendix F for General Conditions Estimate**

Category	Project Cost	% of GC
Project Management	$ 662,100.00	60%
Field Operations	$ 86,443.95	8%
Field Office	$ 9,070.00	1%
Testing & Inspections	$ 6,125.60	1%
Insurance	$ 331,372.26	30%
Total	$ 1,095,111.81	100%

Table 1.5 – General Conditions Estimate Summary

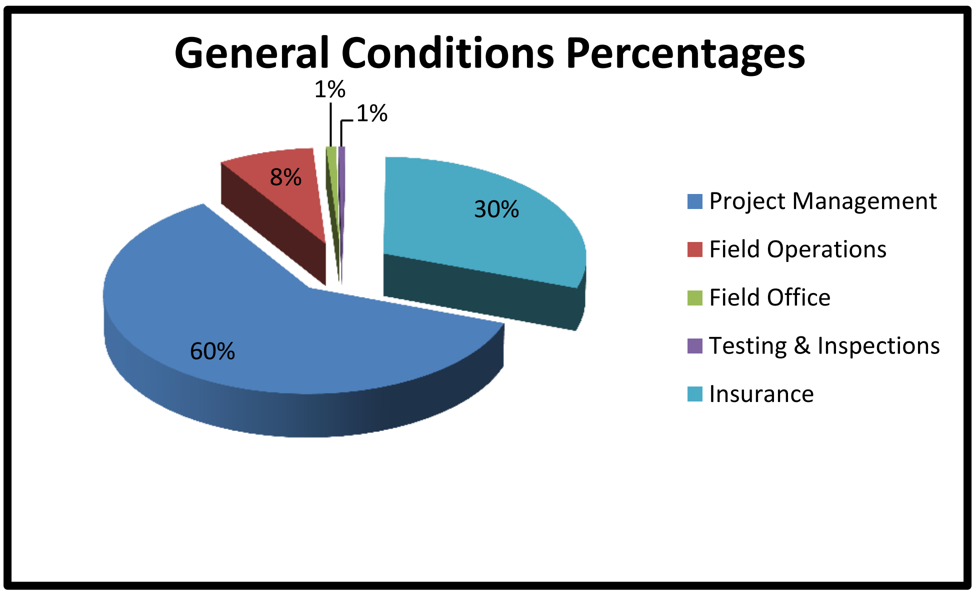


Figure 1.7 – General Conditions Estimate Graph

Analysis 1 – Construction of Precast Vs. Cast in Place Concrete

Opportunity Identification

It is seen that the schedule and construction techniques are the main issues holding back the completion date for the Mansoura Project. The owner is very particular in having the completion date for the project to be accomplished as soon as possible in order for her tenants to move in and she can start generating some profit. Since cast-in place concrete can take time for the concrete to set and place, another option could be researched, which can be seen as a faster installation alternative. This could help with schedule savings and allow for a faster completion of the overall project.

Background Research Performed

After some preliminary research, a faster and cheaper alternative to cast in place could be using precast concrete. This alternative method can be analyzed to further understand how it would affect the structure of the building with the addition of schedule and cost reduction. The areas that are of concern with precast concrete are how it will be transported and installed on site. However since precast is manufactured in a controlled casting environment, quality can be controlled and monitored easily. Weather does not come into a factor since it is manufactured in a closed environment. Less labor will be required to install and it does not require skilled labor, which in turn can decrease the overall project cost. The greatest advantage to precast is that it can be installed immediately with no weight needed for it to gain strength and modularity unlike cast in place. Furthermore it's easy to make copies of the same precast by maximizing the repetition of using the same mold. This will allow for a faster construction process and substantial completion date. In addition modularization was a key topic during the 22nd Annual PACE Roundtable, which noted that several projects found significant reduction in the construction schedule with the use of this method.

Potential Solutions

When analyzing the schedule, a lot of time is wasted waiting for the concrete to set and cure in place; therefore, a potential solution can include using precast concrete. This will help create a much easier system to construct and procure while reducing the overall cost and schedule duration of the project. Since the precast modules would be ready made before coming to the site, installation would be the only step for this process. The proposed system would be concrete floor slabs with precast wall panels for the exterior. In addition to using precast, the matt foundation used for this project can be re-evaluated due to the decrease in weight of the structure from using the precast panels instead of cast in place. This can generate costs and schedule reductions.

Solution Method

- The study will initially be performed on a typical bay that can be expanded to the entire area of the building.
- Analyze the cost of switching from cast in place to precast concrete. This will include:
    - Immediate actual cost of both systems
    - Long term cost of both systems
    - Construction cost of each system
        - Equipment used
        - Material used
        - Machinery needed
        - Storage area cost
        - Labor cost
        - Laydown area
        - Transportation cost of both systems
- Analyze Structural Load.
- Analyze Mechanical Load.
- Compare duration impacts of both systems on the project schedule. The factors included:
    - Labor differences
    - Placing time (installation)
    - Efficiency of workers
- Analyze other factors such as safety concerns, logistics and sequencing of both systems.

Resources

~ Relative Project Documents
~ Commitment Construction Project Team Members
~ Industry Professionals and AE Faculty Members
~ Jason Lien of Encon United Precast Company

Expected Outcome

The initial schedule of casting concrete seemed extensive, therefore it allowed for a different construction method to be analyzed. Through the use of precast concrete modules, the schedule is expected to be reduced significantly through the increase in productivity. Additionally it can reduce site traffic however increase cost of transportation and erection.

Existing System (Cast in Place Concrete)

The existing structural system in place is cast in place concrete. The concrete is transported in an unhardened state, as ready-mix to be placed in forms using specialized paving equipment to spread the concrete for pavement. The reason for the use of this system was for its long-term durability and structural support.

Design

In order for the precast to provide a better alternative than the cast in place concrete, the design of the panels must be researched and appropriate to the building in production. This process began with contacting Jason Lien of EnCon United, to further help my understanding of the manufacturing process and details of precast concrete panels. After much research it was evident that the use of repetitive sizes would be the best strategy when implementing the use of precast. With using repetitive sizes, it helps cut down on coordination and costs, since the same concrete mold would be used for the manufacturing process.

Since the current façade of the building stretched to nine floors above grade, another design item that had to be considered is the size of the panels. The main aim would be to reduce the amount of panels used in order to reduce the costs of crane pickups, panel connections and sealing the joints. Since each floor beam and columns would be cast in place, the wall panels would be designed to fit directly between both floor beams. Since each floor would be repetitive, the same concrete mold can be used for numerous panels, which would reduce the manufacturing process.

To have a more efficient structural system, the exterior wall panels are load bearing. The load bearing panels are components that transfer gravitational and vertical loads from other elements and contribute to the strength and stability of a structure.

After talking with Jason Lien of EnCon United, I was told that the wall panels can be designed to the dimensions of 12ft either in the horizontal or vertical directions, and 20-44ft in the opposite direction. However the delivery of the panels must be taken into account in order to be able to fit on the delivery trucks. When connecting the panels to the concrete foundation and floors, a bar will be projected out of the concrete, and a sleeve which is located in the actual wall panel will allow for a grouted connection. Using the guidelines recommended, I designed and conducted a panel designation and takeoff for a typical bay on the building and multiplied it by the amount of floors of the project.

After conducting the takeoff, the building had many design elements that allowed numerous panels to be shared. There were a total of 33 different layouts for the panels for the entire building, which seemed suitable for a residential tower of this many floors.

*** See Appendix G for the design take off for the entire precast system.**

After formulating and finalizing the panel sizes and quantities, it was essential to consider what type and thickness the panel would be. Since the original cast in place system consisted of a 10" thick concrete, with no insulation and had paint as its finish; I tried to replicate this same sort of idea with the precast. Referring back to Jason Lien, he informed me that they manufacture sandwich panels, which consists of a layer of insulation sandwiched between two layers of concrete. They also provided different architectural finishes, however since the original system just included paint; I decided I would opt out and just keep a painted finish, which could help reduce any extra costs for finishes.

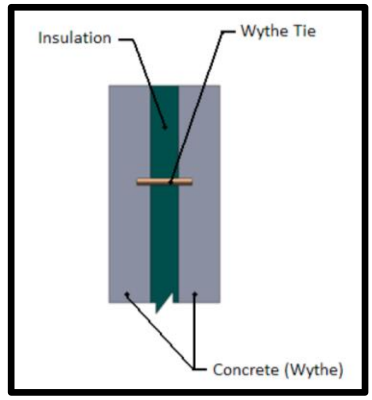


Figure 2.1 – Section of Precast Panel (Courtesy of Encon United)

Manufacturing

One of the biggest advantages of using precast concrete wall panels is moving from on-site construction into a manufacturing facility, which can help further reduce the project's schedule. Using precast panels also quickens up on-field construction for enclosing the building. Other added benefits of manufacturing in a facility is the shortened duration of the work involved, creating a better efficiency since it is a repetitive process. All equipment is available and since it is a repetitive process the work flow is more consistent and faster. Unlike on-field construction where there can be deviations in work, inconsistent measurements and lack of proper or missing equipment, leading to schedule delays.

When manufacturing at a factory, less material is wasted and the material can be delivered as needed, which reduces the chance of the material being damaged on site. In addition it promotes a more productive work environment, which reduces the chances of working in harmful conditions such a bad weather. The structural erection becomes concerning during the hot summer month when weather in Qatar can reach over 120^{o}F and construction is halted by the government. The heat can be detrimental to the productivity of the laborers and can be a setback to the overall project schedule.

Overall the factory setting promotes better safety practices and overall quality of the product since the working environment involves perfect conditions with a large work space, perfect lighting and less equipment needed.

Quality Control

EnCon United's plants are PCI certified and their production is monitored by PCI Certified quality control inspectors. All PCI members must pass two unannounced inspections each year in order to maintain their certification. This ensures all precast factories are producing quality work. The factory has precisely controlled air entrainment and curing procedures which results in reduced cracking and surface scaling. Having repetitive work also leads to a steady work flow, resulting in a better and more consistent quality of work.

Delivery

The most important item to consider after the completion of the walls panels is the size of the panel, which is a maximum of 12 feet in width and 44 feet in length, according to Jason Lien of EnCon United. This consideration was used when designing the precast panels, in order to fit a typical truck bed. The panels should be shipped on non-staining, shock absorbing materials to ensure that the panels do not get damaged through the process of delivery. Since the price Jason Lien provided included materials, labor, and transportation; the actual cost for transportation was not needed.

Erection

With cast in place construction, many issues can be faced during the erection of the structural stage, mainly with the coordination of the concrete trucks and timing for the concrete to set. By using the precast concrete wall panels, the coordination and wait times can be completely eliminated. Furthermore, the duration of erection is significantly reduced, due to having all the material on site ready to be erected, with no wait time for any concrete to set. This too results in fewer clashes with any work and laborers on other trades. Precast panels help minimize coordination issues, as they reduces the amount of machinery, laborers and materials on site, making it a smoother process for construction. The only aspect of using this installation method is that it needs to be carefully planned and managed as 'just-in-time' deliveries. This is so the material is available only when needed, to reduce congestion in the construction site.

Schedule Analysis

The main driving force for experimenting with structural precast panels for the Mansoura Development was for the potential of accelerating the schedule. Since the cast in place construction took a huge amount from the project schedule to complete, using the precast panels created a chance to cut down in schedule time. With switching the procurement method, the schedule was able to be cut down by a drastic amount. Table 2.1 below, shows the 122 day duration for casting the walls of the structure, and how it was possible to reduce to 11 days. This resulted in savings of 111 days for the entire enclosure. Other activities such as waterproofing works, and cement sand screed would typically be interchanged with sealing joints and cleaning the precast panels.

With the new activities implemented for erecting the precast panels, a new schedule was built which reflected the same sequence as the current cast in place system. Table 2.1 below portrays the resulted savings from using the proposed system over the current cast in place. A total of 145 work days were saved simply by utilizing the new activities.

Building Enclosure Activity	
Activity	**Duration**
Cast in Place Concrete Wall	
Formwork/Reinforcement/Concrete Casting	122
Waterproofing & Cement Sandscreed	74
Total	196
Precast Panels	
Erect Panels	11
Seal Joint/Clean Panels	40
Total	51
Days Saved on Enclosure	**145**

Table 2.1 – Time savings for building enclosure

When revising the schedule to implement the precast panels into the original schedule, certain assumptions had to be made as the original schedule had grouped the 'Columns and Walls' together as an activity as it can be seen in the original project schedule in Appendix C. Therefore to portray the schedule as accurate as possible, I split the 'Columns and Walls' activity separately and assumed that the columns took up approximately 30% of that activity. The 'Precast Panel Erection' activity was then added as a sole activity after the columns were cast. Furthermore I assumed that the activity consisting of 'Waterproofing' and 'Cement sand screed' could compute as the sealing and cleaning of joints and decided not to change the duration of those activities as it would pan out to be similar or just a bit less than the original duration. The last assumption made was that the sequencing of activities would stay the same; therefore durations between certain activities did not change.

*** See Appendix H for the revised schedule and activities using precast panels.**

As it can be seen in Appendix H, the superstructure was completed on Sept 17th, 2014, which is 9 days ahead of schedule, of the original date, Sept 25, 2014. The reason for this minimal difference in schedule completion is due to the sequencing and coordination of the current schedule. Since the point of this analysis was to demonstrate the difference between precast and cast in place construction, re-sequencing of activities was not taken into consideration. If re-sequencing was implemented, a larger difference in the schedule completion would be portrayed, with a possibility of completing the superstructure months ahead of time. This can be seen in analysis 3, where a SIPS schedule is implemented, having a re-sequenced list of activities.

Cost Analysis

Since precast concrete companies and factories were not available in Qatar, and the majority of production is of cast in place construction; it was very hard to compare prices retrieved from Commitment Construction with the prices retrieved from Jason Lien of Encon United Precast Panels. The comparison of both would be meaningless as each country has different prices for certain resources, therefore this comparison would not be accurate. Therefore I compared prices of both the precast panels and cast in place concrete within the US, to get a more realistic idea of what the difference of both systems would be.

The current cast in place system for the superstructure created a lot of coordination issues on site, however did not accumulate to a heavy cost, as it was worth $656, 416.20 which accounted for the material, erection and delivery of the concrete. This cost was retrieved by RSMeans and primarily accounts for the area where the precast wall panel would replace the cast in place concrete walls and does not count for the slabs, foundation, columns, etc.

The precast concrete cost information was retrieved from Jason Lien. The average cost for each panel would be $25/SF without an architectural finish, and $30/SF with an architectural finish. These prices accounted for material, transportation, insulation and erection. Since the Ground and Mezzanine floors would have an architectural finish, both prices had to be considered during the cost take-offs. After completing the costs for the precast panel build-out, it turned out to be $1,116,145.20.

When comparing both systems, using the precast panels would accumulate to $459,729 in extra costs. However, the possible benefits from using precast panels are much larger than using cast in place. As mentioned before, with the consideration of re-sequencing of activities, there is the possibility to reduce the schedule much more. Therefore with the added cost there is the added benefit of completing the project faster.

*** See Appendix I for the cost take off from the precast panels.**

Breadth #1: Structural Analysis

To further enhance and provide a thorough analysis of the use of precast concrete panels, it was essential to explore the structural effects on the buildings structure. The existing enclosure of the Mansoura Development consists of 10" thick, cast in place concrete. The concrete makes up the entirety of the structure and serves as the structural support for the building. To get a better understanding of the current building, an exterior wall section of the building can be seen in the Fig. 2.2 on the right.

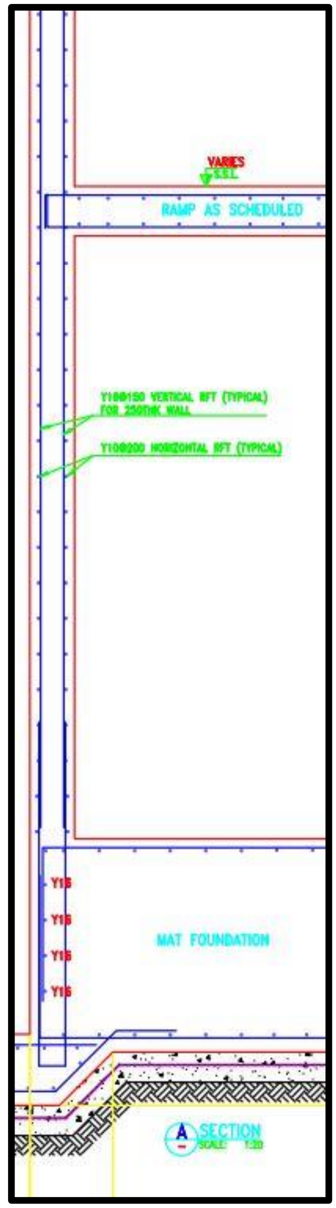


Figure 2.2 – Section of Concrete Cast in Place

This analysis consisted of checking the panels internal reinforcing of the slab, to see if any savings can be done through resizing the rebar since the load on the slab and foundation minimized with the use of the proposed precast panel system. Although it would have also been beneficial to see whether there was a possibility to decrease the thickness of both the slab of the floors and the matt foundation; it would however require more intense structural analysis, which was found to be beyond the scope of my understanding.

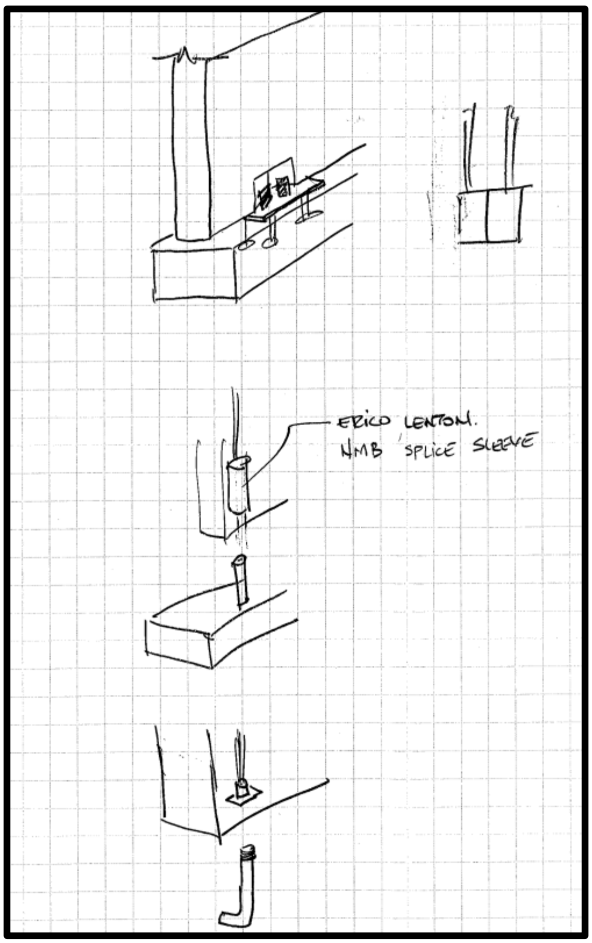


Figure 2.3 – How the Precast would connect to the Slabs and Foundation

Before calculating the loads of the panels, it was important to understand how the proposed precast concrete panels would be connected to the foundation and slabs. As seen in Fig. 2.3 on the left, it was noted that the panels would connect in such a way that it acted like a sleeve. The rebar would project out of the foundation and slab and would connect into a hole in the wall panel which allowed for a grouted connection. This would be similar to the connection from floor to floor, since all panels were designed to be the height of the floor.

In addition, the panels would have to be tied back to the columns for wind and overturning. This would be made possible by using a slotted insert that goes into the panel which would allow movement in one direction (horizontal slot) so the panel will have give and flexibility.

Lastly in order to treat the moment forces, 2 bolts would have to be inserted into the precast panel, 2 on the top and one on the bottom. As seen in Fig. 2.4, Halfen inserts that have teeth would lock on to the T-bolt (also with teeth) to hold the vertical panel without it twisting.

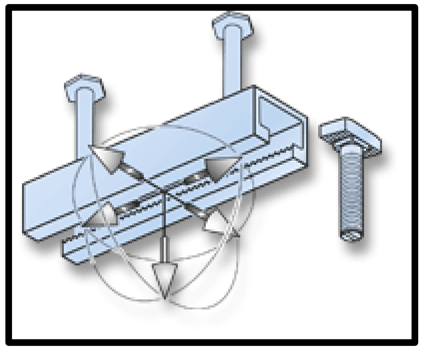


Figure 2.4 – Halfen Insert (Courtesy of halfenusa.com)

Using the desired panel thickness of 8" (consisting of 2" of insulation sandwiched between two 3" of concrete slabs) with the 5000 psi concrete recommendation from Jason Lien, the panel was designed for flexure and reinforced. The next step was to analyze both the current and proposed systems in order to compare and calculate if any changes could be made.

***See Appendix J for the Structural calculations.**

The results in Appendix J show that with the decrease in load, there was a possibility to decrease the rebar size from #8 to #7. This could result in further reductions to the slabs and foundation thickness. This decrease in weight can produce saving in cost and schedule. The difference in rebar sizes can be seen in the figures below.

Imperial Bar Size	"Soft" Metric Size	Weight per unit length (lb/ft)	Mass per unit length (kg/m)	Nominal Diameter (in)	Nominal Diameter (mm)	Nominal Area(in^2)	Nominal Area (mm^2)
#7	#22	2.044	3.049	0.875	22.225	0.6	387

Table 2.2 - #7 Rebar Information (Courtesy of harrissupplysolutions.com)

Imperial Bar Size	"Soft" Metric Size	Weight per unit length (lb/ft)	Mass per unit length (kg/m)	Nominal Diameter (in)	Nominal Diameter (mm)	Nominal Area(in^2)	Nominal Area (mm^2)
#8	#25	2.67	3.982	1.000	25.4	0.79	509

Table 2.3 - #8 Rebar Information (Courtesy of harrissupplysolutions.com)

As it can be seen, in the tables above, there is a difference in weight, and size of the rebars. The difference is approximately 25% lighter per unit length. This concludes that it would be a good idea to consider resizing the slab and foundation thickness, which would in turn help decrease the overall project cost and potentially accelerate the schedule.

From the results portrayed in this breadth, it can be seen that the precast panel system has many advantages over the fully cast in place concrete structure system. The reduction in rebar size and weight, promoted the consideration of resizing the thickness of the slabs and foundation, which could in turn help with schedule and cost reductions. The resizing of the slabs and foundations were considered but not implemented in the breadth due to it being out of my scope if understanding.

Breadth #2: Mechanical Analysis

Since the design of the building enclosure impacts a number of items which is important to the users that occupy the space when the development is complete, they must be taken into consideration when a different system is proposed. The thermal properties of the building is very important, as it affects the users comfort level and calculates how the building energy is changing, whether it gets better or worse. It was necessary to conduct a mechanical analysis to find the difference in heating and cooling loads and note the disparity of energy efficiency between both concrete-placing methods, using a computer program called H.A.M Toolbox (Heat, Air and Moisture Toolbox).

This program helps to design energy efficient walls for hot, cold, humid or dry climates and computes the condensation accumulated with the specific materials. The exact weather data of where the building is located is taken into account, therefore the analysis can be seen as an accurate setting. Since the program did not have the geographical location and weather data for Doha, Qatar; I researched and computed the daily averages of weather conditions for the winter and summer online and manually entered them into the system. The indoor temperatures were kept at 70 ^{o}F during winter and summer, with a Relative Humidity of 25% during winter and 50% during summer. Table 2.4 below includes the weather information for a typical winter and summer in Doha, Qatar.

Qatar Climate		
	Winter	Summer
Temperature (^{o}F)	59	122
Relative Humidity	50	80

Table 2.4 – Qatar Weather Conditions

The next category was to find and enter information regarding the proposed system, which are the precast wall panels. As described earlier in this analysis, the thickness of the proposed precast panel as a whole is 8 inches. It is comprised of a rigid insulation, sandwiched between two 3 inch layers of concrete. There is a connector (Wythe Tie) which creates a thermal bridge because it crosses the continuous layer of insulation. Non-thermally conductive materials are used for these connectors in order not to degrade the R-value. The best materials are in the carbon fiber composite family.

Concrete Wythe Tie Image Non-Conductive Tie Image

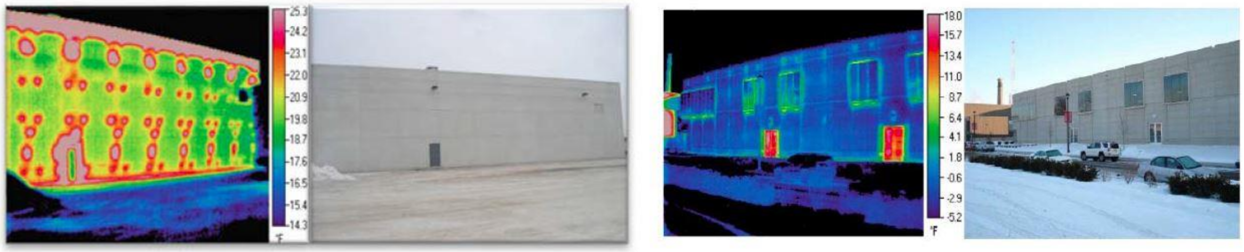


Fig. 2.5 – Thermal Image of panel with concrete tie vs. one with non-conductive Wythe-tie

As can be seen in Fig 2.5 above, the panel with the uniform light color and red spots indicates the maximum heat loss. The panel that is fully blue is completely isolated from the temperature inside the structure, which promotes minimum heat loss.

In comparison to the actual cast in place system that is comprised of 10" of concrete with no insulation, the typical cutout of the precast wall panel and what it is comprised of can be seen in Fig. 2.6 below.

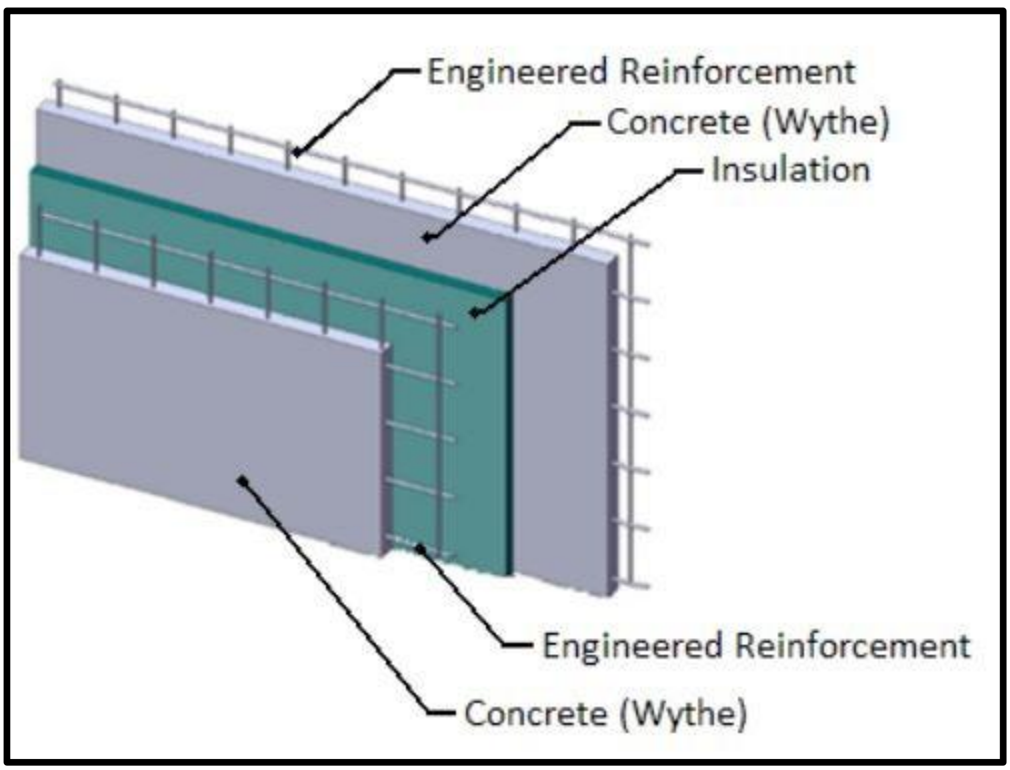


Fig. 2.6 – Cutout of Precast Concrete Panel

One of the benefits of using precast concrete is its thermal mass. As concrete has a high specific heat, high product density, and conductivity, large amount of heat energy can be absorbed and released in the surrounding environment, which in turn reduces the fluctuations of the indoor temperatures. The thermal storage of the concrete wall panels reduces energy requirements through the ability of the concrete to absorb, store and release heat as needed.

After entering all the relevant information into the program, I was able to obtain a report for the R-Value analysis and Condensation analysis for both the winter and summer months. This was done for both systems in order to be able to compare and contrast between them, and see if the new system performs better.

***See Appendix K for the R-Value reports using H.A.M. Toolbox**

R-Value Analysis

Furthermore I manually calculated for the R-Value for both systems, to make sure that the system had the correct results. The R-value analysis checks to see the performance of the system in terms of heating and cooling. The following tables on the next page show the results of the analysis.

Actual System						
Material	Thickness		Conductivity	Conductance	Thermal Resistance	
	In	m			RSI	Imperial
Exterior Film	N.A	N.A	N.A	34	0.02941	0.166382
Cast-in-Place Concrete	10	0.25	1.8	7.2	0.13889	0.785694
Interior Film	N.A.	N.A	N.A	8.3	0.12048	0.681566
Thickness Total	10	0.25	R-Total		0.28878	1.633643

Table 2.5 – Actual System R-Value Analysis

Proposed System						
Material	Thickness		Conductivity	Conductance	Thermal Resistance	
	In	m			RSI	Imperial
Exterior Film	N.A	N.A	N.A	34	0.02941	0.166382
Precast Concrete	3	0.0762	1.8	23.62204724	0.04233	0.23948
Rigid Insulation	2	0.0508	0.034	0.669291339	1.49412	8.452224
Precast Concrete	3	0.0762	1.8	23.62204724	0.04233	0.23948
Interior Film	N.A.	N.A	N.A	8.3	0.12048	0.681566
Thickness Total	8	0.2032	R-Total		1.72868	9.779131

Table 2.6 – Proposed System R-Value Analysis

As it can be seen, the thermal resistance of the proposed system is much more efficient, since the precast system yields a higher R-value than the cast in place system. When comparing both systems, the proposed system appears to be 6 times greater or 83% more efficient than the actual system. This is due to the rigid insulation that is placed within the wall panel. To further highlight the difference in both systems, the following tables on the next page provide the change in heat transfer for both summer and winter.

Summer Loads				
System	R-value	Change in Temp	Area (sqft)	Heat Transfer (BTU/hr)
Proposed	9.777913	52	4237.3	22,534.42
Current	1.63333	52	4237.3	134,902.07
Difference				(112,367.65)

Winter Loads				
System	R-value	Change in Temp	Area	Heat Transfer (BTU/hr)
Proposed	9.777913	11	4237.3	4,766.90
Current	1.63333	11	4237.3	28,536.98
Difference				(23,770.08)

Table 2.7 & 2.8 – Summer & Winter Loads Comparisons

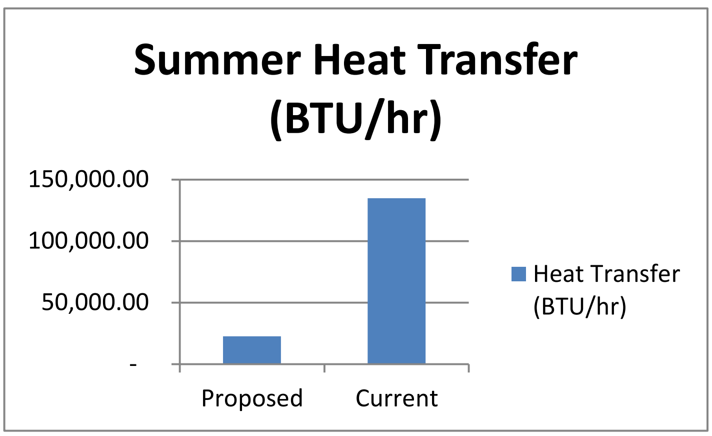


Fig. 2.7 – Summer Heat Transfer Graph

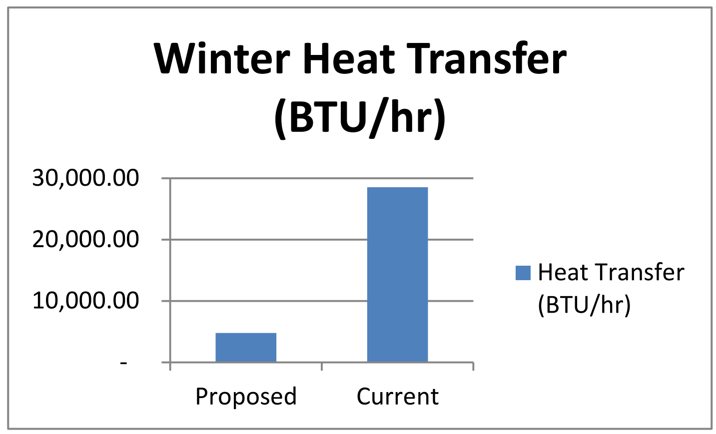


Fig. 2.8 – Winter Heat Transfer Graph

As it can be seen in the tables and graphs above, the red value indicates the difference of heat transfer when comparing both systems. The proposed system has an ability to keep a lot of heat from travelling to the outside, which in turn can help with energy savings. In addition, due to this large disparity of heat loads, mechanical systems can be sized down which can further incur savings to the overall project cost.

Condensation Analysis

Condensation is one of the most common causes form dampness in buildings. It is associated with mold growth. Condensation happens when moisture-laden air comes into contact with a cold surface. This might not be seen as an issue on water-resistant surfaces, however on permeable surfaces condensing water is absorbed into the material. Therefore it was important to analyze the condensation for both systems and compare the findings. The condensation reports can be seen in the Figures below.

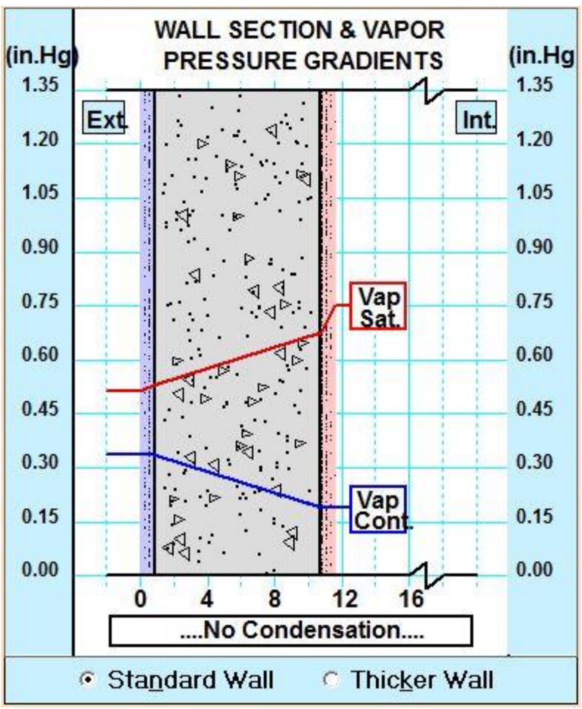


Fig. 2.9 – Condensation of Actual System during Winter

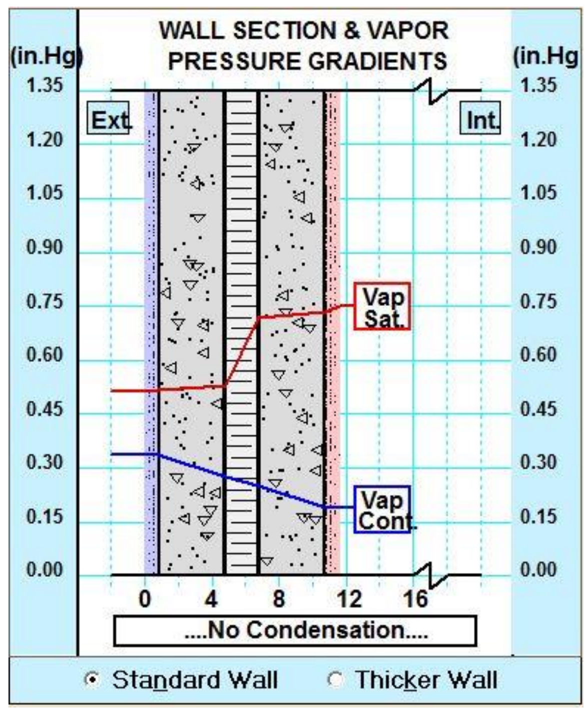


Fig. 2.10 – Condensation of Proposed System during Winter

The results show that the cast in place concrete system shows no signs of condensation and the precast concrete wall panel will perform very well during the winter months. However in the summer there is potential for condensation to enter the precast wall panel, as seen in Fig. 2.12 on the next page.

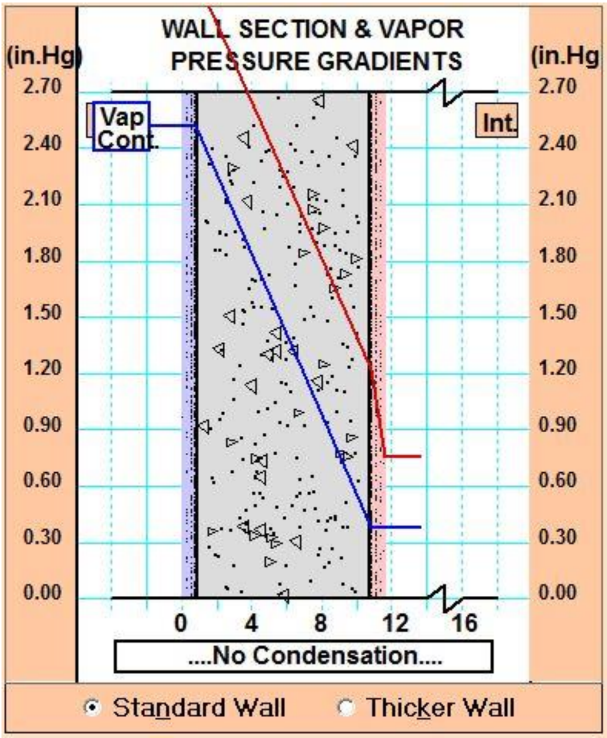


Fig. 2.11 – Condensation of Actual System during Summer

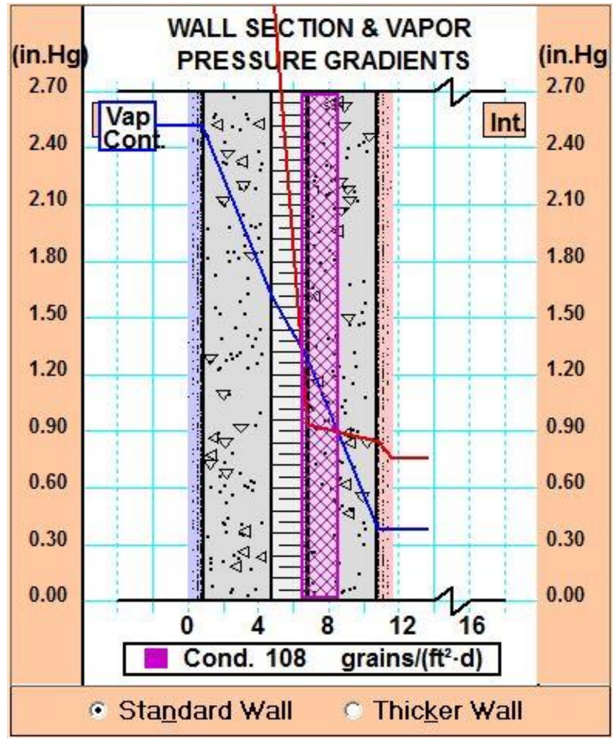


Fig. 2.12 – Condensation of Proposed System during Summer

Careful consideration must be made in order to ensure that no moisture is exposed to the insulation. After understanding my findings, I decided to speak to Jason Lien, representative of Encon United, manufacturers for precast panels. I was told that usually there was not a concern for condensation in previous projects, however since the weather was very humid and hot during the summer months in Qatar, a vapor barrier can be the solution to this matter. I then took it upon myself to research possible ways to control the condensation and came up with many solutions. Some include improving ventilation. This can be achieved by installing air vents and using extractor fans. Another solution would be using a humidistat controlled unit, which would allow the occupants not to worry about operating the fan and controls the indoor climate automatically.

To solve this issue the addition of a vapor barrier seemed feasible. Additional costs will have to be added towards the precast panel overall system. After online research and talking to the precast manufacturers, the cost per square feet of adding the vapor barrier was averaged at $0.1 per square feet. With summing up all areas of the precast panels used, there would be a total of 40,244.44 SF of Vapor barrier to be added. This created an additional cost of $4,024.44 which is not a large cost impact to the project. Adding this will lower the chances of condensation from occurring, and it can also be seen as a cheaper rather then if problems arose after tenants accommodated the building.

From the results portrayed in this breadth, it is evident that the precast system is the favorable choice, since the energy impact shows a huge disparity between both systems. The precast system shows better thermal properties and can prove that resizing of mechanical system can be considered, which could then reduce costs and impact the overall cost of the project. Resizing of equipment was considered however is out of my scope of knowledge.

Recommendation & Conclusions

The use of the precast concrete panels is usually targeted for schedule acceleration scenarios; however it showed to be useful in other areas too. The overall reduction in schedule turned out to be 9 days, however it was found out that there was a potential for large savings from having lower loads on the slabs and foundation. A different rebar size could be implemented that promoted the consideration of resizing the thickness of the slabs and foundation, which could in turn help with schedule and cost reductions. Furthermore the precast showed a much better efficiency in its thermal properties, and possible resizing of mechanical equipment can be considered, which could reduce costs even further. After conducting this analysis it would be recommended to use precast panels if there is availability of such a product in Qatar.

Analysis 2 – Comparison of Construction Practices between the US & Qatar through Assessment of the HHD project (Penn State) and the Mansoura Development

Opportunity Identification

Since construction practices are different in each country, material, labor and construction techniques must be evaluated to understand the differences between costs and procedure between both Qatar and the USA. These differences can help identify what can be improved with the current construction process for the Mansoura Development. This can create an opportunity to improve the schedule, the cost of the project and general quality of the final product.

Background Research

There is a slight difference between the construction industries in Qatar in comparison to the USA. Labor wages and labor hours are different, which could affect the duration of when projects are completed. Labor hours and practices could yield to different results, and either help or hinder the project completion date. Other than workforce, material availability can also affect when a product can be completed and either increase or decrease the project by a substantial amount. The usual method of construction in Qatar is cast in place concrete, which is a very lengthy process; therefore reasons for this use must be researched and understood.

Potential Solutions

Since cast in place concrete is the usual method of construction in Qatar, further research must be completed in order to understand the reasons for using this method over others. Labor information regarding both countries will be collected and compared to one another. Information associated with the USA will be assessed through the evaluation of the HHD (Human Health Development) Project located in Penn State. The HHD project is of similar size to the Mansoura Development, therefore it will be beneficial to understand how their differences affect the construction practices, and how it lengthens or shortens the time in contrast to one another. Material availability will also be researched in this analysis, to further understand how it affects the duration of construction. Information such as where material is shipped from and how it is used will be taken into account. The three main topics to be compared will be Labor wages, Safety Programs/Procedures and Quality Control Programs for both Projects. The successful practices will be implemented and tested in order to see how it could improve the Mansoura Development.

<u>Solution Method</u>

- Research information regarding Qatar & USA labor wages through the comparison of the Mansoura Development and HHD Project.
- Research information regarding common construction practices in Qatar.
    - Why is cast in place method most popular?
- Material availability in Qatar
    - What material is readily available?
    - Where is material shipped from?
- Compare information retrieved about Qatar (Mansoura Development) with the HHD Project statistics.
- What construction methods can be used in Qatar to improve their construction practice?
- Conclusion and Recommendation based on Findings.

Resources

~ Commitment Construction Project Team Members
~ Industry Professionals and AE Faculty Members
~ Individual research performed online
~ Tim Jones of Massaro Corporation

<u>Expected Outcome</u>

There is potential to cut down on the schedule of duration for the project, if some construction practices were performed similar to the USA. Cost of construction will be exponentially cheaper in Qatar than in the USA, largely due to the difference in labor wages and material availability.

Common Construction Practices in Qatar

After intensive research and many meetings with different construction companies in Qatar, it was very evident that cast in place construction was the favored practice of construction in Qatar. The reason for using this procurement method over precast is because it is mainly cheaper and readily available unlike precast concrete, which needs advanced construction practices to be made, even though it might be easier to be installed over cast in place. Most materials are shipped from other countries close to Qatar like the United Arab Emirates and Saudi Arabia; this is because Qatar does not have any natural resources to manufacture the material. Material is usually readily available as neighboring countries are only hours away by vehicle, therefore material can be retrieved at any time if needs be. However if the client needs specific material that is not usually used in that region close to Qatar, ordering of the material can be a timely process, since import and customs can cause a delay with the shipment from arriving to its specific destination within Qatar.

Labor Wages in Qatar vs. USA

Labor rates in Qatar are very different in contrast to the US. As per labor laws, Qatar has not set a minimum wage rate, which means companies do not have to abide by a labor law. This in turn can give those companies an advantage of a permissive environment of labor protection and enforcement, which is what creates a large disparity between labor laws of Qatar and the US. After speaking with a representative from Commitment Construction, I found out that on average the hourly rate for a construction worker is around $2, which is very low to any standard and is seen by many as worker abuse. Furthermore this cannot be challenged by workers since Qatari Laws prohibit workers from unionizing or striking, which can cause some construction issues on jobs, since workers can be dissatisfied, resulting them to not put their full effort into their jobs, hence affecting the quality of the final project and even cause delays on the schedule from mistakes and lack of effort.

In comparison to Qatar, the median salary for a general construction worker in the US is around $40,000 a year. When converting that into an hourly rate, it turns out to be around $20. This shows a huge gap and disparity between both countries and this is what can separate the quality of work output between both labor forces.

Comparison of construction practices of HHD Project vs. Mansoura Development

I will assess and compare a current project in the US with my thesis project from Qatar to further help portray the difference in the construction industry of both countries. I chose the HHD (Human Health Development) Project in Penn State due to it being of similar size to the Mansoura Development. This comparison will help find ways that lengthens or shortens the time of construction in contrast to one another. I was able to get in contact with Tim Jones, who is the project Manager for Massaro CM Services in order to compile as much information as I can about the HHD project. I was told that the HHD development is the second phase of a two phase project for the College of Health and Human Development. The new academic/research building is around 93,000 square feet of new construction with an anticipated completion by spring 2015. The three main topics to be compared will be Labor wages, Safety Programs/Procedures and Quality Control Programs for both Projects. The successful practices will be implemented and tested in order to see how it could improve the Mansoura Development.

Labor Wages

HHD Project

The first thing to understand about the HHD is that it is a state funded job, and offers a state prevailing wage rate, which is derived by the union. The contractors provide certified payrolls in order to abide by the union. Each profession is paid differently, and is calculated with regard to when the work is completed. The contract is a multiple prime contract with Massaro acting as the owner's representative. Massaro helps with controlling all these contracts, and assign the job to the lowest bidder for each subcontractor. To show the large disparity on labor wages between the both countries, I have chosen to analyze the wages of 7 different jobs on site in order to get an understanding of the different skills involved and how important each on is to the construction industry. These will include Laborers, Masons, Plumbers, Carpenters, Operators, Electricians and lastly Painters. Since on the HHD project, different phases were completed at specific times, different skilled workers were needed at specific times or more than once, and due to the project being of long duration, wages tend to change from year to year. However I will include the wages of each job from the last 3 years to give a perspective of how much changes.

Job	Effective Date	Hourly Rate	Fringe Benefits	Total
Carpenters	6/1/12	$25.98	$11.67	$37.65
	6/1/13	$26.09	$12.51	$38.60
	6/1/14	$26.21	$13.35	$39.56
Electricians	12/23/11	$35.76	$21.10	$60.81
	12/21/12	$37.71	$21.10	$58.81
	12/21/13	$39.71	$21.10	$60.81
Painters	6/1/11	$25.72	$14.09	$39.81
	6/1/12	$26.25	$14.56	$40.81
	6/1/13	$26.78	$15.03	$41.81
Plumbers	5/1/11	$31.92	$20.56	$52.48
	5/1/12	$32.67	$20.81	$53.48
Masons	1/1/12	$30.85	$13.60	$44.45
	1/1/13	$31.45	$14.10	$45.55
Operators	1/1/11	$27.68	$15.74	$43.42
	1/1/12	$28.08	$16.44	$44.52
	1/1/13	$28.48	$17.14	$45.62
Laborers	1/1/11	$18.27	$10.27	$28.41
	1/1/12	$18.27	$10.87	$28.54

Table 3.1 – HHD Project Wages

Table 3.1 shows the different wages for each profession and how it fluctuates yearly.

Mansoura Development

On the other hand the Mansoura Development does not need to abide by any minimum wage, since there are no government regulations set. They do not include any fringe benefits, as the country provides free medical service to all residents and living there is tax free. The following wages that are shown on the next page are set by the contractor themselves and do not really change much from year to year.

Job	Effective Date	Hourly Rate	Fringe Benefits	Total
Carpenters	1/1/13	$2.40	N/A	$2.40
Electricians	1/1/13	$3.08	N/A	$3.08
Painters	1/1/13	$2.74	N/A	$2.74
Plumbers	1/1/13	$2.40	N/A	$2.40
Masons	1/1/13	$2.05	N/A	$2.05
Operators	1/1/13	$2.43	N/A	$2.43
Laborers	1/1/13	$1.37	N/A	$1.37

Table 3.2 – Mansoura Development Wages

As seen in Table 3.2 the comparison of the labor wages to the HHD project is drastic. Even though the labor is very cheap for the Mansoura Development, the skill level is not very high. This can negatively impact the project by causing several delays on the jobsite. It is more effective to have fewer workers that are skilled, rather than more workers that are not skilled. The cost to having higher skilled workers equates to a better quality end product.

Safety Programs/Procedures Implemented

HHD Project

Further talking with the project manager of Massaro, I was able to understand what types of safety programs were implemented throughout the construction industry in the US. For the HHD project there were many procedures to follow to ensure that safety was one of the key components when construction began. He mentioned that they required all contractors on the jobsite to have OSHA 30, which is a 30 hour safety course that covers everything from Electrical Hazard Safety to Fall Protection. It is devised for safety directors, foremen and field supervisors and includes information on safety compliance issues, to train on recognition, avoidance, abatement and prevention of safety and health hazards in the workplace. Having employees understand and follow the OSHA accreditation allows the company to be able to protect their workers from danger, holds the companies accountable if any accidents were to occur, and help pass OSHA inspection when an OSHA representative visits the construction site at random, usually once every three months. In addition to having OSHA accredited foremen, meetings are held on a daily basis to highlight any safety issues, whether it is to inform workers about the cold weather and protecting from frost bites or how to keep hydrated during the hotter months. In addition, at the start of every week on Monday, a meeting about safety toolbox topics is held in order to go through the safety and right use of different tools on site, as an example ladder safety. Having all these safety programs and procedures help the process of construction move swiftly with minimizing the chance of delay. It primarily helps save workers, who are the most important part of any project, since having any injuries would be detrimental to the project as each person is not interchangeable, therefore will slow down the production quality and flow of the project. As of yet, the HHD project has been fortunate enough through upfront safety focus have zero recordable or lost time accidents on site. The project goal is to have zero recordable accidents. A recordable accident would be any incident that seeks medical attention.

Mansoura Development

In comparison, with the Mansoura Development, Mohammed, the Project manager for Commitment Construction informed me that they follow and abide by a Safety and Health Policy that they had put together and implement on all their construction projects. In Qatar there are not really any safety administration enforcing safe practices like OSHA in the Unites States. However Commitment Construction Co. believes that no job or task is more important than worker health and safety, therefore they have come up with a safety program to ensure shortcuts in safety is not tolerated. They plan to achieve worker safety and health through using a qualified safety person, who will perform the following:

1. Make regular job site inspections
   Observe potential safety hazards and develop a plan for safeguarding the laborers. This will include providing personal protective equipment and enforcing its use, and training workers on safe practices.

2. Enforce the use of safety equipment
   Ensures all PPE (Personal Protective Equipment) areas are marked and enforced. Head protection, eye protection, protective footwear and gloves are all worn before entering the site to protect against any hazards. Lastly harnesses and lanyards shall be utilized for fall protection.

3. Follow safety procedures
   All safety rules must be obeyed and failure to do so will result in suspension of the following worker. Common sense should be the key to avoid precarious situations.

4. Provide on-going safety training
   Safety person should identify and evaluate all potential hazards on jobsite. Hazards will be pointed out, necessary precautions will be explained and the greater the hazard the more detailed the training should be.

If the aforementioned is not complied by, the following actions below will be taken to ensure the workers comply with the safety rules:

- **First violation:** Oral warning
- **Second violation**: Written warning
- **Third violation**: Written warning, one say suspension without pay.
- **Fourth violation**: Written warning and one-week suspension with possibility of being terminated.

With having this safety program implemented it does somewhat provide workers and the jobsite with a sense of security, however safety can still be cut short in order to complete a project faster. This in turn can create more complications and inefficiencies if workers are injured and hurt. The reason why this could happen is because there is no safety administration that can come and shut down the project if jobsite safety is not enforced. With their current regular scheduled safety inspections, workers will only be forced to implement safety procedures on those specific inspection days, and then continue on the regular unsafe ways after inspections are completed. After some research online, I learnt that a total of 1200 laborers have died during the construction of projects since Qatar had been awarded the 2022 FIFA world cup. This is due to not having a safety administration that can regulate workers wellbeing. This information supports the critical need to having a safety control program, not only on the Mansoura Development, but on all projects in Qatar as a whole. As of yet, the Mansoura Development have a recorded 8 accidents on the project so far. A recordable accident is similar to the HHD project, where any incident that seeks medical attention is recorded.

Quality Control Programs Implemented

HHD Project

I was able to understand that they implemented a Quality Assurance and Control Program to all their projects in order to deliver the owner the best possible job. I was informed that before any quality checks can be implemented, the most important thing is to understand what type of quality is expected by the owner and architect. This information would be retrieved from the Design and Specifications material, in order to be able to understand what to check for when quality control procedures are taking place. After understanding the type of quality intended for the project, Massaro have a Three-Phase Control System that is implemented in order to achieve the goal of the project. The three phases include:

1. Preparatory Phase
   This phase includes reading the documents and having the contractor refer to submittals in order to portray the plan for installment of specific features on the project. This is primarily to develop a plan before construction, and have it checked to comply with Design and Specifications. All results of this phase should be documented by separate meeting minutes.

2. Initial Phase
   This phase includes meeting with the workers (foremen) at the beginning before construction begins to verify the work that was planned in the "preparatory phase" be implemented and performed to the level of workmanship agreed to. The work should be completed through a sequence of actions, which include:

   - Review minutes of Preparatory Meeting.
   - Check preliminary work.
   - Establish level of workmanship.
   - Resolve all differences.
   - Check safety to include compliance with the safety plan. Review the activity hazard with workers.

The owner and architect should be notified when this phase begins and all results of this phase should be documented by separate meeting minutes, and shall be repeated for each new crew that work onsite, or level of workmanship is not met.

3. Follow-Up Phase
   As the work is being performed and completed, daily checks of quality work will be implemented until the completion of the specific feature. This information will be documented and communicated to the Owner and Architect to assure them that they will be receiving quality work. Final check-ups will be conducted to all deficiencies corrected prior to the start of additional features of work. Personnel will continually refer back to the standards set in the previous two phases to assure quality is met.

The reason for all these quality checks is to ensure that the owner receives a quality product. If proper time and attention is not taken on early in the project, future problems can arise, which will erode the profits for the contractor if the work is not done correctly the first time. The typical lifetime of a building in Penn State is around 100 years, which stresses that quality must be of the greatest standards in order to last that many years. Therefore having a quality product the first time around is in the contractor's interest.

Mansoura Development

In comparison, with the Mansoura Development, Mohammed informed me that there is no actual quality control program that is followed, instead they have the engineer on the site at each specific time to go around and check the current work that is being completed and make sure it is up to a good standard. The problem with this is that not all engineers will have the same standard of approval as each other; good work to one person might be viewed differently to the other person. This also doesn't provide harmony with the work done by the workers, as they do not know what standards should be met when construction is in process. Not having a quality control program can create many issues on the site for all parties involved in the project. One of the biggest issues would be redoing specific features, which in turn would delay the project schedule and accumulates extra cost for the contractor as they did not abide by the owners expectations. In comparison to the Penn State, a typical lifetime goal for buildings in Qatar is around 50-70 years, which still stresses that quality must be taken care of first time around in order for the building to last that entire duration and to reduce any defects in the future.

<u>Recommendation & Conclusion</u>

Although Commitment Construction has had much success in the construction industry in Qatar, with completing many prestigious developments around the city of Doha; the Mansoura Development acts as the perfect candidate in order to try and improve construction practices and implement successful programs learnt from in the US in order to have a quality fast-built production, whilst still keeping all the workers and environment safe of any hazards. A few recommendations to improve the Mansoura Development and create a better construction practice industry within the country of Qatar would be as follows:

1. Either to train or acquire more experienced workers and skilled tradesmen to complete a job. Having cheap labor might be a primary advantage before construction begins, however if and when mistakes do occur, it will negatively impact the construction flow and will accumulate to more money paid for both acquiring more labor for longer hours and to fix the specific feature that had been constructed poorly. In addition, investing in the company's workforce and having a key group of laborers that complete the projects

will result in a higher production rate, through experience and training. Furthermore, with having more experienced and skilled workers, it allows for a higher quality end product, which further enhances my third recommendation below about implementing a quality control program. As mentioned earlier in this analysis, it is more effective to have fewer workers that are skilled, rather than more workers that are not skilled. The cost to having higher skilled workers equates to a better quality end product and less re-work on features and mistakes.

2. It would be beneficial to have a few OSHA trained personnel in the field when construction is in process, in order to ensure that safety is being met at the construction site. It would be hard to suggest having the equivalent of OSHA to be established in Qatar as it is not part of their regulation, however by acquiring OSHA trained personnel; it could help strengthen the safety of the site in general. Having an employee who is only in charge of safety practice and has nothing associated with the specific project can yield to a more strict construction site. In addition, having regular unscheduled safety inspections could also help keep the laborers in constant alarm that safety should be the primary concern in the construction site. This should greatly reduce injuries on site.
3. Implementing a quality control program much like in the HHD project would benefit both the owners and contractors, as it would allow for the best standard of construction to be met and delivered. If quality can be set right from the design phase, it will make it easier for all laborers and engineers to understand what is to be expected by the designers and owners right from the specifications on the drawings. This will allow some sort of harmony for the workers during the construction process. In addition this will also help prevent any re-work on specific features as the quality can be met first time around.

With all these recommendations, I believe there is the potential to cut down on the overall cost of the project, and specifically help save and deliver the project before or on time, since the owner's primary concern for the project is the schedule. More importantly, there is a huge potential to improve the safety of the construction site, as caring for the workers is of primary concern.

Analysis 3 – Field Labor Management & Alteration

Problem identification

Due to the intense heat of the summer months in Qatar, weather can reach over 122 ^{o}F. This can cause a delay in the project schedule, due to a halt of construction during the day, which is primarily done for safety issues regarding the laborers. As mentioned in technical report 3, this pause in construction comes with direct enforcement from the Ministry of Labor and has to be abided by. This can create some delays in the schedule, which in turn could affect the project completion date.

Background Research

With the project under construction, there is a need to understand the situation that will be encountered during the warm months in Qatar. As a result, this analysis will focus on the critical activities of the schedule and possible scenarios to by-pass this construction delay and have it not affect the project schedule in a negative way. The project schedule can be analyzed and evaluated to find any critical areas that can be improved. This will help improve the lessons learned from past situations in previous projects, or previous delays, and institute the best possible sequencing for the schedule.

Potential Solutions

When analyzing this possible project delay, some potential solutions come to play and can include re-evaluating/re-considering certain schedule of events. Certain critical milestones in the schedule, like exterior finishes, or construction of exterior structure can be rescheduled to prior months before summer, so to not delay critical events in the schedule and still have the project completion date on time. Increasing labor force during the non-summer months can also be evaluated to see if it could affect countering the delay of construction during summer. Therefore, halting construction during the summer would not have any negative effects in the overall project hand in date. Additionally a Manpower Loaded schedule can be established to systematically assign the appropriate personnel to specific tasks in an efficient and effective manner. This can help improve efficiency and decrease any delays with errors and weather delays. In addition SIPS (Short Interval Production Schedule) implementation can be utilized so the tasks and crews can be broken down and can be more detailed. Coordination of the crews can be used to help optimize and increase efficiency of work. By having better coordination, it will help eliminate any deficiencies with wasting crew members in any specific area. The process of construction will be much smoother and with higher quality, as each crew will be designated a specific area, while repeating the tasks multiple times.

Solution Method

- Gather all information regarding the outlined schedule and relevant durations.
- Re-evaluate/re-schedule critical events in schedule
  - Determine different possibilities of changing certain events and how it could affect schedule delays.
- Utilize background research to increase workforce prior to summer months.
  - Determine cost analysis of increasing labor.
  - Evaluate possibility of schedule of reduction.
- Develop a sequence of work and balance crews with consideration to the project schedule. (SIPS)
- Identify respective durations, tasks and designate crews.
- Develop a Man Power Loaded Schedule
- Analyze each method to quantify the best potential outcomes.
- Develop process for implementation.
- Critique potential outcome.

Resources

~ Commitment Construction Project Team Members
~ Industry Professionals and AE Faculty Members
~ Scheduling Software
~ Relative Project Documents
~ AE 473 Course – SIPS Project

Expected Outcome

The schedule delays that this can bring to the project can be detrimental to the contractor and owner; therefore different methods must be taken to overcome this projected schedule delay. Through the re-scheduling of events, and increasing labor force, the schedule should not be negatively affected by the halt of construction during the summer months. Additionally, Due to the length of construction and repetitive nature of the building, SIPS may allow for many opportunities for improvement. Since the owner's main priority is schedule acceleration, coordinating the tasks and crews by implementing new production sequencing can substantially reduce the project schedule. Also, a schedule reduction can be expected if summer months turn out to be more workable then what is suggested.

Evaluating Current Schedule

With the current schedule under way, there are definitely a few concerns regarding specific activities which continue on during the hot summer months, where construction must be shifted to different hours, in order to abide by the government regulations of worker safety. The main issue in place is the construction of the superstructure, which poses possible delays since its duration clashes within the hot summer months of 2014. This is due to the sequencing of work, where they have decided to phase the construction of this building floor by floor. This means that once each floor's structure is completed, MEP work can begin. With this type of sequencing, the overall structure of the remaining floors will take time to complete, as the task force will be split into completing the individual floors first. Since the current government regulation for the summer is withholding all laborers from working during the day during the month of July and most of August, there must be a different solution in order to by-pass these laws and have a more productive project site.

Possible Solutions to Current Schedule

When looking at the current schedule, floors 5-7, the roof deck and Upper roof seem to conflict with the hot summer months, therefore the proposed solution is to try and complete the entire cast in place structure before the month of July 2014. Since the current work sequence is floor by floor phasing, I propose phasing the entire project by trade, in order to complete the exterior of the structure before the summer of 2014. With completing this task, all other trades such as the mechanical, electrical and plumbing, work can be done during regular hours throughout the summer since they could work inside the structure, and not be exposed to the sun for long hours. With phasing the work by trade, it creates more emphasis on the specific task, which could possibly complete each phase quicker, if man power is distributed and allocated correctly. SIPS and a man power loaded schedule can help achieve the goal of completing each phase in time, and eventually create time savings for both the owner and construction company on the project. While increasing the man power can result in additional costs, the cost of time saving is far larger and more important to the owner, as tenants can therefore move in earlier, which creates an earlier net income flow for the owner.

Cost Analysis of Increasing Labor

Currently the cost for each laborer is $1.37. After talking with Mohammed, the project manager for Commitment Construction; I was informed that it would be quite difficult to increase labor by a vast amount since the site is very small which could lead to congestion, therefore it would negatively affect the productivity rate. In addition to the site, continuing on from analysis 2, the laborers are not very skilled, therefore bringing in more unskilled workers will not solve the issue, but rather negatively affect and lead to further problems on site. Increasing the labor through cost analysis is not difficult as labor costs are very cheap, however it would not benefit the project, but rather hinder the overall schedule completion. Thus re-sequencing certain activities appears to be the best option, as well as distributing the laborers throughout the site to increase the productivity rate and reduce congestion on site. A total of 13 laborers were added to the 53 laborers that made up for superstructure crew. The addition of 13 laborers accounted for an increase in monthly cost, however showed an overall reduction of $22,906.40 in total labor cost at the completion of the superstructure, as it can be seen in table 4.1 below.

Cost Analysis of Labor Increase					
	# of Laborers	Hourly Rate	Monthly Cost	Months to complete superstructure	Total Cost
Original Crew	53	$1.37	$12,779.36	13	**$166,131.68**
Proposed Crew	66	$1.37	$15,913.92	9	**$143,225.28**

Table 4.1 – Analysis of labor Increase

SIPS

Short Interval Production Schedule typically is man and material loaded schedule displaying shorter durations, since the schedule is composed of less work. Best for repetitive sequence, however does not maintain consistent time segments, therefore requires greater dedication to management. Using SIPS helps increase the productivity, since workers don't have to waste time in not knowing where and when to be. It helps maintain crew sizes, which keeps the workers focused in their area of need. Areas of concern can be addressed more quickly and at a timely manner, in order to reduce wasted time on the schedule. This added benefit of coordination helps with on time material deliveries, and decreases congestion on site, since it designates a time and instance for each material and crew member.

Mansoura Activity Analysis

Since the main goal is to complete the construction of the enclosure before the summer months of 2014 (July-August), I will focus my SIPS analysis on the superstructure of the building. The first step is to identify all the activities that will be used in the SIPS schedule for the construction of the Mansoura Development. The schedule will mainly focus on the concrete casting of the superstructure of the building, as the activities for each of the floors are similar and repetitive. Since the ground and mezzanine floors have a different layout, they will have different durations in comparison to floors 1-7 which are completely identical. Figure 4.1 below shows a typical floor construction.

Ground Floor	98	22-Aug-13	09-Jan-14
Beams & Slabs/Ramp Formwo	18	22-Aug-13	17-Sep-13
Columns & Walls Reinforceme	13	18-Sep-13	04-Oct-13
Waterproofing Works Above S	15	18-Nov-13	09-Dec-13
Cement Sand Screed Above W	11	09-Dec-13	23-Dec-13
Hollow Block	12	24-Dec-13	09-Jan-14
Mezz. Floor	82	07-Oct-13	30-Jan-14
Typ as Ground Floor	82	07-Oct-13	30-Jan-14
First Floor	219	11-Nov-13	15-Sep-14
Typ as Ground Floor	219	11-Nov-13	15-Sep-14

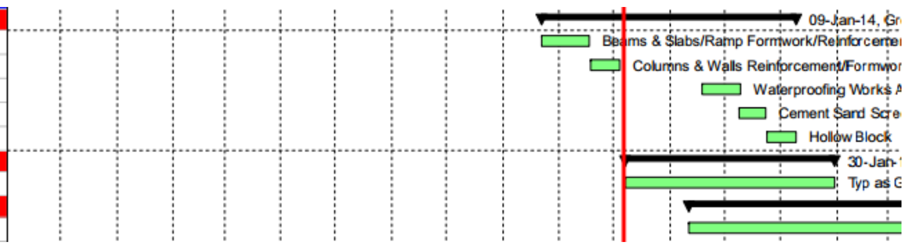


Fig 4.1 – Excerpt of the Ground Floor Structural Construction

As you can see from Figure 4.1 there is a large gap between the end of "Columns & Walls Reinforcement" activity and the "Waterproofing works above Slab & Ramp" activity. This is due to the fact that other trades start their work whilst the structural work on the following floor "Mezzanine" begins. This prolongs the construction of the building enclosure adding an extra month or so for completion of each structural floor. I will propose completing the entirety structure of the floor, before the other trades can begin work on that same floor. The SIPS schedule will be completed for all 5 activities proposed on each floor, however instead of starting construction on the 22nd August, 2013, which is a Thursday, it will start on the following Monday, 26th August, 2013. All activities from the other trades also have the potential to utilize SIPS; however this analysis will only focus portray the structural portion of the building.

Since there are only 5 activities, and the building footprint is relatively small, the work will not be separated by zones, but rather by the majority completion of each activity. The Ground & Mezzanine floors have an area of 9,900 GSF each, whilst Floors 1-7 have an area of 7,900 GSF each. All trades will be able to utilize this same plan from SIPS in order to help with distributing the crews on their specific activities in order to make the project flow more smoothly.

The tables provided on the next page, are the list of the 5 activities from the original structural construction of the superstructure, along with their original durations, and how they will be adjusted to fit the SIPS schedule. The Ground and Mezzanine floors will be grouped separately from Floor 1-7 because their layouts are different.

Original Superstructure Constr. (G&M)		
Activity	Crew (Laborers)	Duration (Days)
Beams & Slabs/Ramp - Formwork/Reinforcement/Concrete Casting	20	18
Columns & Walls Reinforcement/Formwork/Concrete Casting	20	13
Waterproofing works above Slab & Ramp	4	15
Cement sand screed above water proofing	4	11
Hollow Block	5	12

Table 4.2 – Original Crews and Duration Designation (G&M)

Proposed Superstructure Constr. (G&M)		
Activity	Crew (Laborers)	Duration (Days)
Beams & Slabs/Ramp - Formwork/Reinforcement/Concrete Casting	20	18
Columns & Walls Reinforcement/Formwork/Concrete Casting	20	13
Waterproofing works above Slab & Ramp	8	8
Cement sand screed above water proofing	8	6
Hollow Block	10	6

Table 4.3 – Proposed Crews and Duration Designation (G&M)

Original Superstructure Constr. (1-7)		
Activity	Crew (Laborers)	Duration (Days)
Beams & Slabs/Ramp - Formwork/Reinforcement/Concrete Casting	20	13
Columns & Walls Reinforcement/Formwork/Concrete Casting	20	10
Waterproofing works above Slab & Ramp	4	12
Cement sand screed above water proofing	4	9
Hollow Block	5	15

Table 4.4 – Original Crews and Duration Designation (1-7)

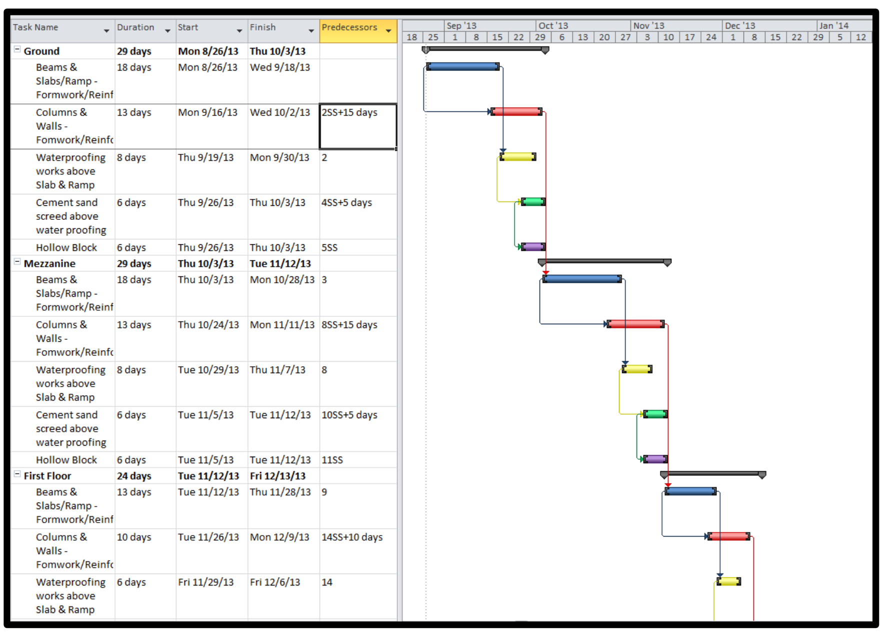
Proposed Superstructure Constr. (1-7)		
Activity	Crew (Laborers)	Duration (Days)
Beams & Slabs/Ramp - Formwork/Reinforcement/Concrete Casting	20	13
Columns & Walls Reinforcement/Formwork/Concrete Casting	20	10
Waterproofing works above Slab & Ramp	8	6
Cement sand screed above water proofing	8	5
Hollow Block	10	8

Table 4.5 – Proposed Crews and Duration Designation (1-7)

As seen from the tables above, the number of laborers is not drastically changing from the original crew size intended by Commitment Construction. The aim was to re-sequence the activities in order to make it flow better without having to add as much labor, in order not to congest the site or add extra costs to the project. I decided to split the laborers into 5 crews, one crew for each activity. I thought it would more beneficial to split the crews into 5, in order for the workers to focus on one certain type of activity and be able to repeat it as many times, to eventually become more efficient and have the work flow more smoothly. The first step was to figure out and decide when the latest the superstructure can be built in order to size up the crews in that matter. Since the aim was to complete the superstructure before summer months of July & August, there was a 10 month duration that I would have to work with, starting with the construction on the 26th of August, 2013.

Different crew sizes were then tested in order to get the right duration for each activity and be able to achieve the completion aim. As seen on the tables above, those were the final Crew Sizes and durations calculated. With that came the re-sequencing of the superstructure schedule. Since there were 5 crews, it was more efficient to have them keep flowing onto the next floors to make it more efficient and more likely to achieve the target completion date. With that in mind, each crew would move onto the next floor right after their work is done on the current floor, which creates a nice flow to construction. Fig. 4.2 below shows a small snapshot of what the re-sequenced schedule (SIPS) looks like on a typical floor.

***See Appendix L for full version of SIPS Schedule.**



Task Name	Duration	Start	Finish	Predecessors
Ground	29 days	Mon 8/26/13	Thu 10/3/13	
Beams & Slabs/Ramp - Formwork/Reinf	18 days	Mon 8/26/13	Wed 9/18/13	
Columns & Walls - Fomwork/Reinfc	13 days	Mon 9/16/13	Wed 10/2/13	2SS+15 days
Waterproofing works above Slab & Ramp	8 days	Thu 9/19/13	Mon 9/30/13	2
Cement sand screed above water proofing	6 days	Thu 9/26/13	Thu 10/3/13	4SS+5 days
Hollow Block	6 days	Thu 9/26/13	Thu 10/3/13	5SS
Mezzanine	29 days	Thu 10/3/13	Tue 11/12/13	
Beams & Slabs/Ramp - Formwork/Reinf	18 days	Thu 10/3/13	Mon 10/28/13	3
Columns & Walls - Fomwork/Reinfc	13 days	Thu 10/24/13	Mon 11/11/13	8SS+15 days
Waterproofing works above Slab & Ramp	8 days	Tue 10/29/13	Thu 11/7/13	8
Cement sand screed above water proofing	6 days	Tue 11/5/13	Tue 11/12/13	10SS+5 days
Hollow Block	6 days	Tue 11/5/13	Tue 11/12/13	11SS
First Floor	24 days	Tue 11/12/13	Fri 12/13/13	
Beams & Slabs/Ramp - Formwork/Reinf	13 days	Tue 11/12/13	Thu 11/28/13	9
Columns & Walls - Fomwork/Reinfc	10 days	Tue 11/26/13	Mon 12/9/13	14SS+10 days
Waterproofing works above Slab & Ramp	6 days	Fri 11/29/13	Fri 12/6/13	14

Fig 4.2 – Snapshot of SIPS Schedule

The figure above portrays a typical sequencing of the superstructure. The Ground, Mezzanine and part of the first floor are portrayed in Fig. 4.2 above, and as it can be seen, each activity has a different crew. Furthermore a few days before the 'Beams & Slabs' are constructed, the next activity with the new crew begins. There are a total of 5 crews, 1 for each activity.

After re-sequencing the schedule and applying the possible crew size to each activity, the end date for the construction of the superstructure came out to be the 30th May, 2014, which is one month ahead of the target schedule of July 1st, 2014, which is when the summer months begin. If more crews were added, there is still a possibility of decreasing the duration of construction even more, however since I was able to achieve my goal, without having to add much to the crew sizes, I decided re-sequencing would be more than adequate.

Culture Adjustment

As the majority of the Qatar population is made up of Expats (People of different nationalities), the culture is more open to new ideas, therefore I think the implementation of SIPS would be highly accepted if it helps speed up and improve the process of construction. Having a diverse culture, makes it easier to adjusting to new things which further enhances acceptance of different technologies and ways of thinking. SIPS would be greatly accepted and liked by the laborers, as it will give them a chance to become more skilled and efficient at one type of activity. It would further help them get a sense of direction and knowledge of where to be at all times during the project. As described in my second analysis, the laborers are not very skilled; therefore the learning curve would be steep since they would be able to learn a lot in a small amount of time, as they are only focusing on one specific activity. By repeating the same activity many times, this will help with speeding up the process of construction and make the laborers more efficient. Lastly, using SIPS will promote a safer site, since all individuals know where they have to be at all times during the construction, which helps reduce congestion and hazard from being on site.

From the results and information portrayed above, it can be concluded that SIPS implementation can be feasible and beneficial to the project. Furthermore the superstructure can be constructed before the summer months, which will help by-pass the halt in construction during those months. However, since many of the tasks are simultaneously working at the same time, an analysis of the man power must be take into consideration in order to make sure that none of the laborers are being over-allocated and that the site is no congested with workers, which could have a negative effect on the productivity of the other trades working too. A man power loaded schedule can be implemented to check for this, and the results are portrayed in the following pages.

Man Power Loaded Schedule

Man Power or Resource loading involves assigning the laborers with a task or percentage of a project. The goal is to balance the demands for the resources with the available crews that are adjusted based on the start and finish dates. I performed this based on the SIPS schedule, previously completed in this analysis above. This study was to understand and ensure that the SIPS schedule was indeed feasible, and the construction site was not congested with too many workers. Since some activities on the schedule were started simultaneously, it was essential to understand that if extra labor is needed, that they would be available, and not be working on 2 different tasks at the same time, which would result in having the tasks rescheduled sequentially to manage the specific constraint.

Man Power Loading	
Activity	Crew (Laborers)
Beams & Slabs/Ramp - Formwork/Reinforcement/Concrete Casting	20
Columns & Walls Reinforcement/Formwork/Concrete Casting	20
Waterproofing works above Slab & Ramp	8
Cement sand screed above water proofing	8
Hollow Block	10

Table 4.6 – Man Power Loaded Crews

Continuing on with the SIPS analysis, the crews were split up into 5 groups as shown in the Table 4.6 above. Having one crew on each activity forces the laborers to focus on working on that one activity, many times. This repeat in construction would strengthen the laborers skills, and help them become more efficient, eventually increasing the productivity rate on site.

Resource leveling helps solves any conflicts that arise and can be used to balance the workload over the course of the project. Conflicts usually mean over-allocated workers, and this will help show if any conflicts will arise with the implementation of the SIPS schedule. Many types of software can be used to create a man power loaded schedule, such as Microsoft Project, Primavera and many more. These project softwares are able to calculate delays and update the specific tasks automatically, since leveling requires delaying tasks until resources (laborers) are available to work on those specific tasks. For this analysis, Primavera was used and Fig. 4.3 below shows the final representation of what the schedule turned out to be.

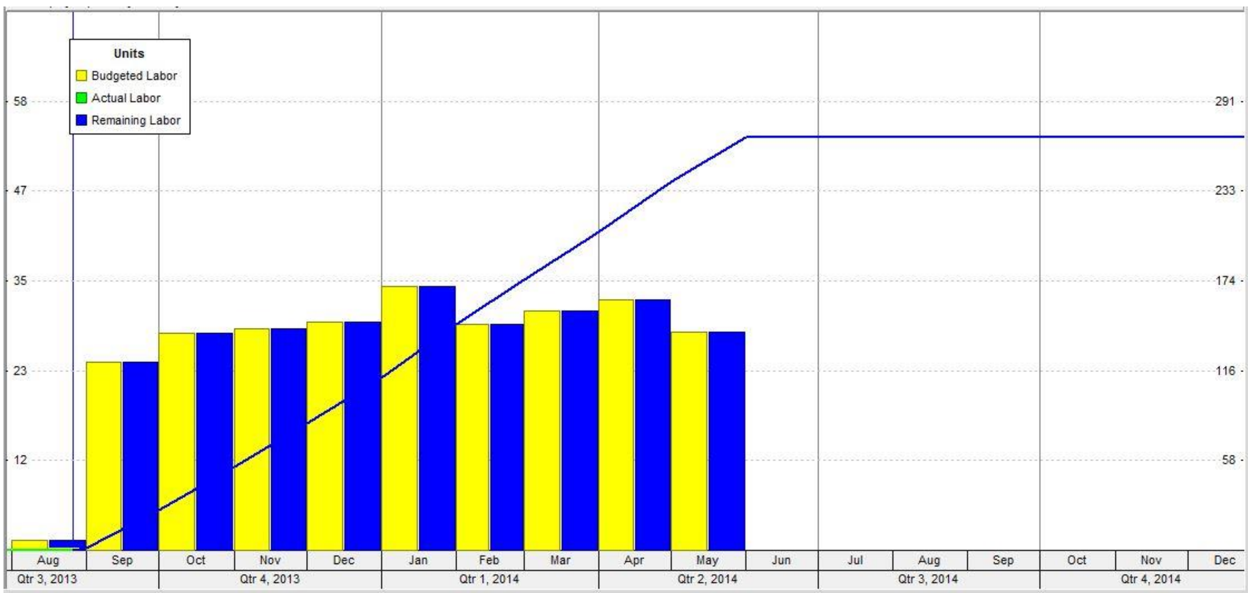


Fig. 4.3 – Man Power Loaded Schedule

As it can be seen with Fig. 4.3 above, there are no over-allocated units, which means that the resource allocations were correct, and will not result in any delays as the project finish date stayed the same. The number of laborers working on the superstructure does not exceed 35, which can be seen during the month of January, where workload is at its maximum output.

Recommendation & Conclusions

From the results shown above, it is clear that the SIPS implementation is the favorable choice over the original schedule, since the schedule for the superstructure was cut by more than 3 months. Due to this difference, further consideration can be taken to include and implement SIPS to the entire project and on all trades, as this will help complete the entire project at a faster and shorter duration. Even though cost was not taken into consideration for this analysis, increasing the labor deemed very minimal to the overall project cost. Since the owner's primary concern was to have a completed project as soon as possible, it is strongly recommended to proceed with SIPS, as it will be beneficial for both the owner and contractor.

Final Recommendation & Conclusions

Throughout the academic year, the Mansoura Development has been thoroughly analyzed in order to identify all the potential areas of construction that have an opportunity to enhance the project, whether to reduce costs, accelerate schedule or improve the quality and design. After much research and guidance by Penn State faculty and industry professionals, three areas were selected in order to investigate further and find potential improvements. This report provides the opportunities, approaches and results of the three main areas: feasibility of precast panels over cast in place concrete, implementation of different construction practices and finally the application of different schedule techniques through field labor management. These three investigation areas provided the largest opportunity for improvement.

Analysis 1: Construction of Precast Concrete vs. Cast in Place Concrete
The first analysis focused on the feasibility of replacing the exterior cast in place wall with precast concrete wall panels. The proposed system decreased the overall project schedule by 9 days but increases overall project cost by $459,729. However with the added cost, came the benefit of schedule reductions, and possible cost reductions with re-sizing the mechanical equipment and re-sizing of the concrete slabs and matt foundations. Through re-sequencing of the activities, using precast has the potential to portray larger schedule savings, similar to the re-sequencing of SIPS schedule that can be seen in the third analysis.

Analysis 2: Comparison of Construction Practices between the US & Qatar though the Assessment of the HHD project (Penn State) & the Mansoura Development
The second analysis investigated the different construction practices that were implemented between both the US & Qatar. Different practices were analyzed to see what could be improved with the current construction process for the Mansoura Development, to create the opportunity to improve the schedule, reduce the cost of the project and general improve the quality of the final product. Through the three main topics of Labor wages, Safety Program and Quality Program, the results showed that much can be improved. With the addition of more skilled and trained laborers would subsequently lead to reduction in laborers which in turn reduces congestion on the project site, improve productivity rate and improve the quality of the construction. Furthermore having OSHA trained employees and laborers proved to be beneficial to the job site in reducing injuries and improve construction practices. Lastly the implementation of a quality control program similar to the HHD project proved to reduce waste on the construction site from any rework from occurring, as all workers know beforehand what is expected. Even though these results did not provide actual figures of how much would the schedule or cost is reduced by, a great potential of the reductions can be seen by the examples and solutions provided.

Analysis 3: Field Labor Management and Alteration

The third analysis aimed to find schedule saving scenarios, in order to by-pass the halt of construction during the hot summer months in Qatar, where temperatures reach over 122 ^{o}F. As the primary concern was the completion of the superstructure before the summer months, re-sequencing was essential to achieving this goal. With the increase of 13 laborers, it added $3,134.56 to monthly labor cost, however showed an overall reduction of $22,906.40 in total labor cost at the completion of the superstructure. After re-evaluating the schedule and implementing SIPS, there was an approximate of over 3 months saving to the super structure schedule. Furthermore the man power loaded schedule further enhanced the SIPS analysis, by showing how congested the site is at specific times during the project and that none of the laborers were over allocated, which could have created possible delays on the project.

These analyses were all determined to be advantageous to the Mansoura Development, specifically in regards to scheduling concerns and accelerations, which was the primary concern for the owner, Ms. Fakhriya. In addition, this report demonstrated the ability to apply knowledge learnt through the Architectural Engineering curriculum to provide possible alternatives to current building systems and techniques. With analyzing a project from a different country, another perspective was gained by understanding the different means and methods of construction being implemented. It portrayed how specific resources were used in different countries and how it drove their construction industry. Furthermore it also displayed how different approaches to certain activities can yield to different results. A lot of experience was gained through the process of this report, which will be beneficial when entering the construction industry.

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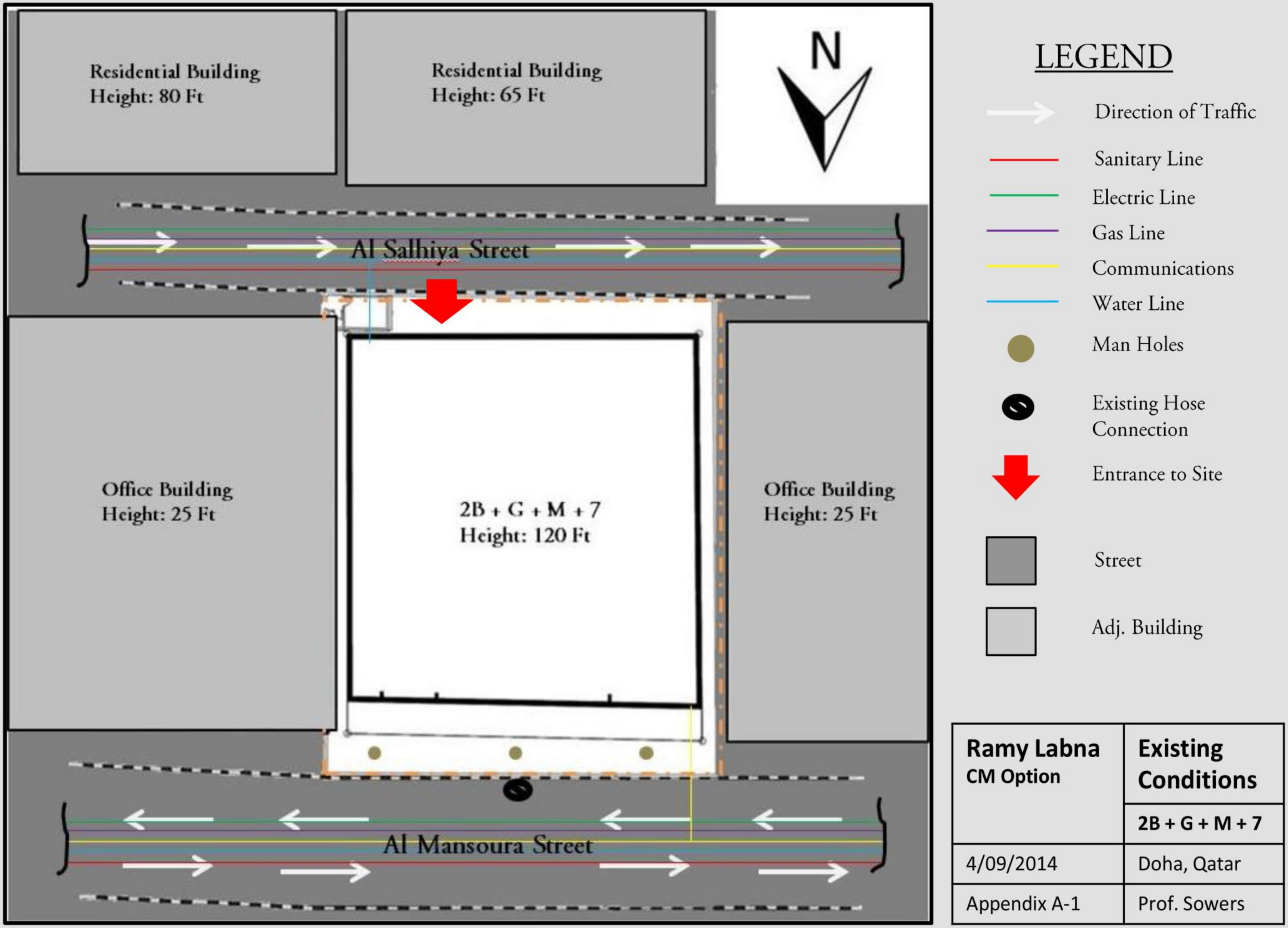
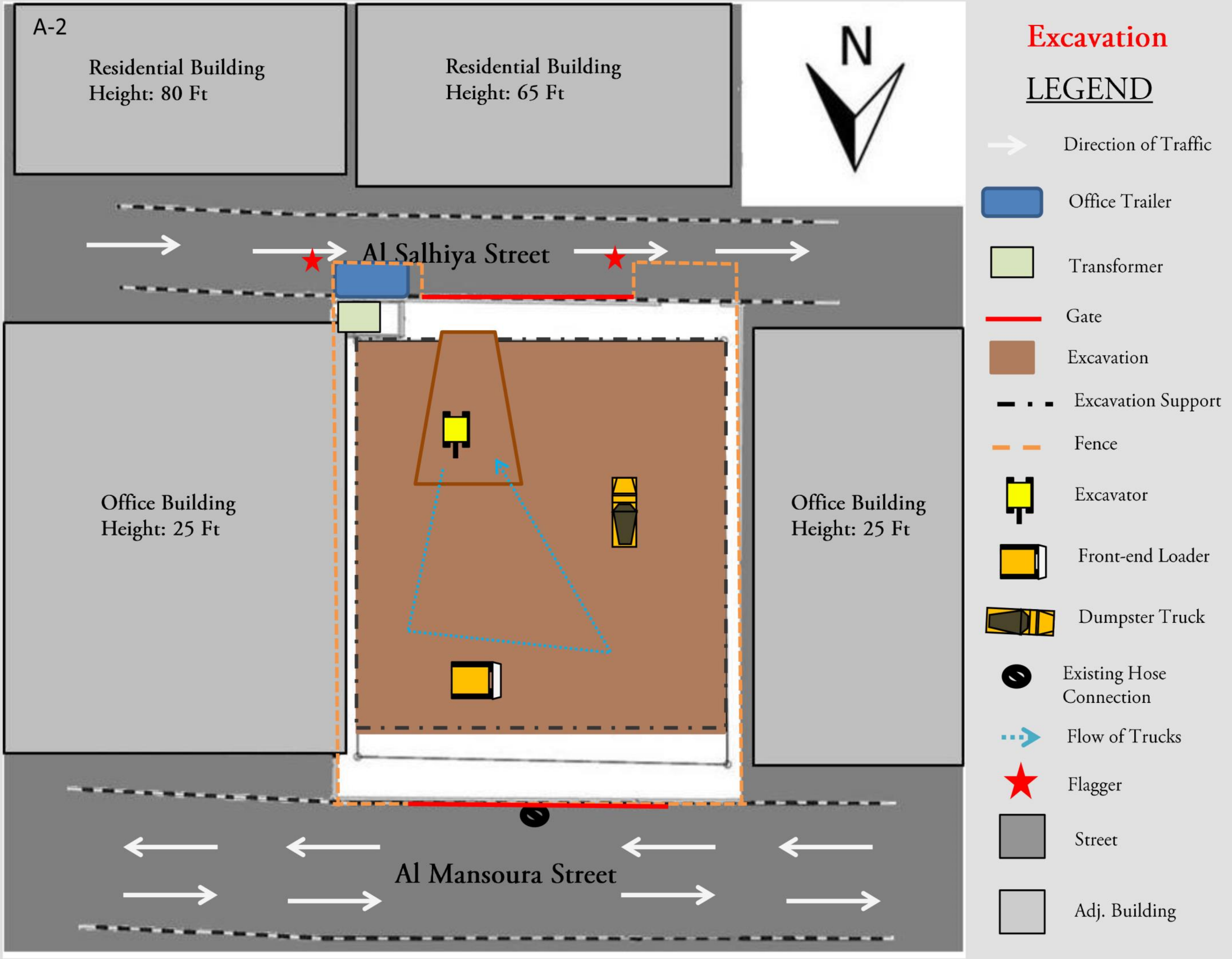
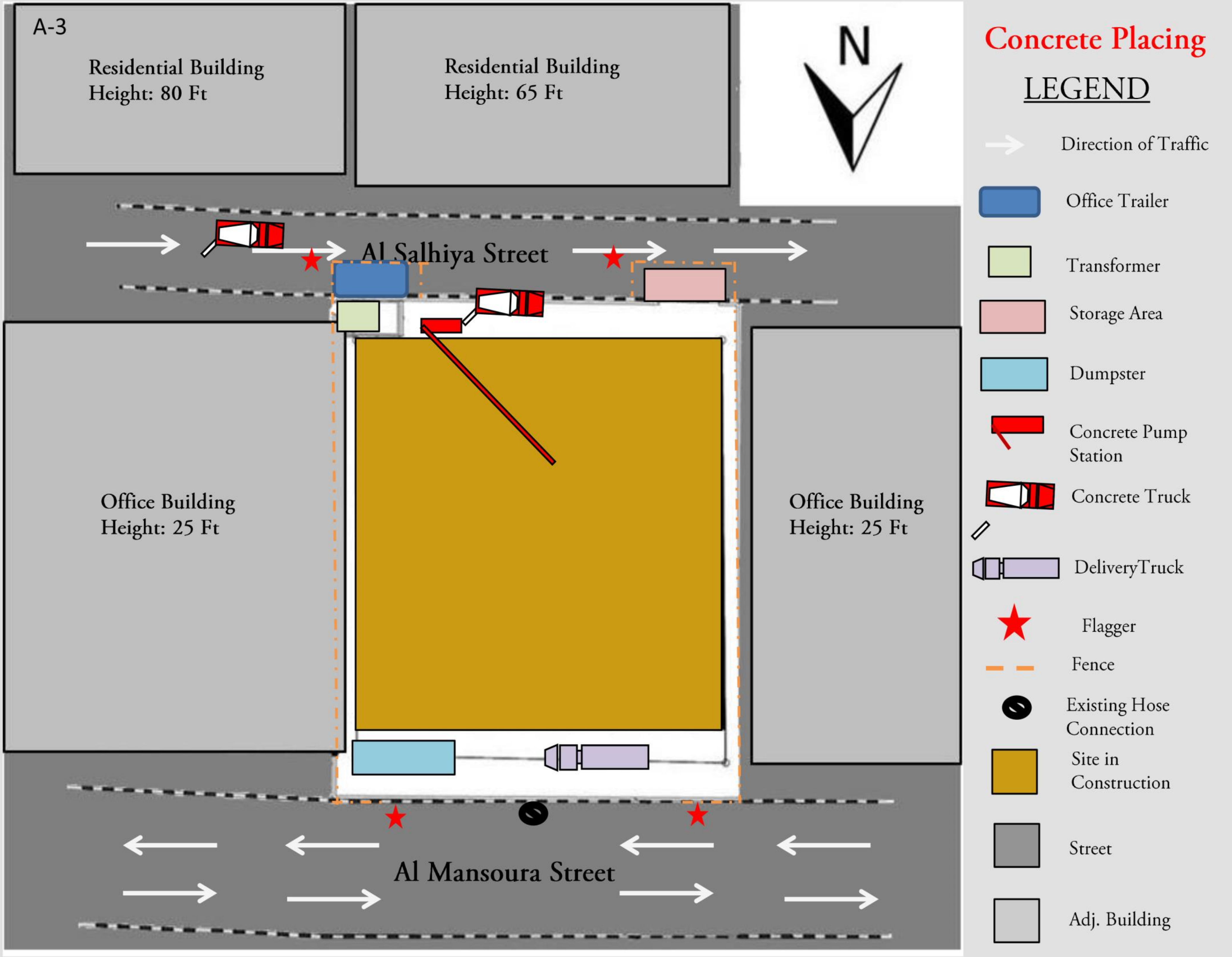
Appendix A – Detailed Site Layout Plans

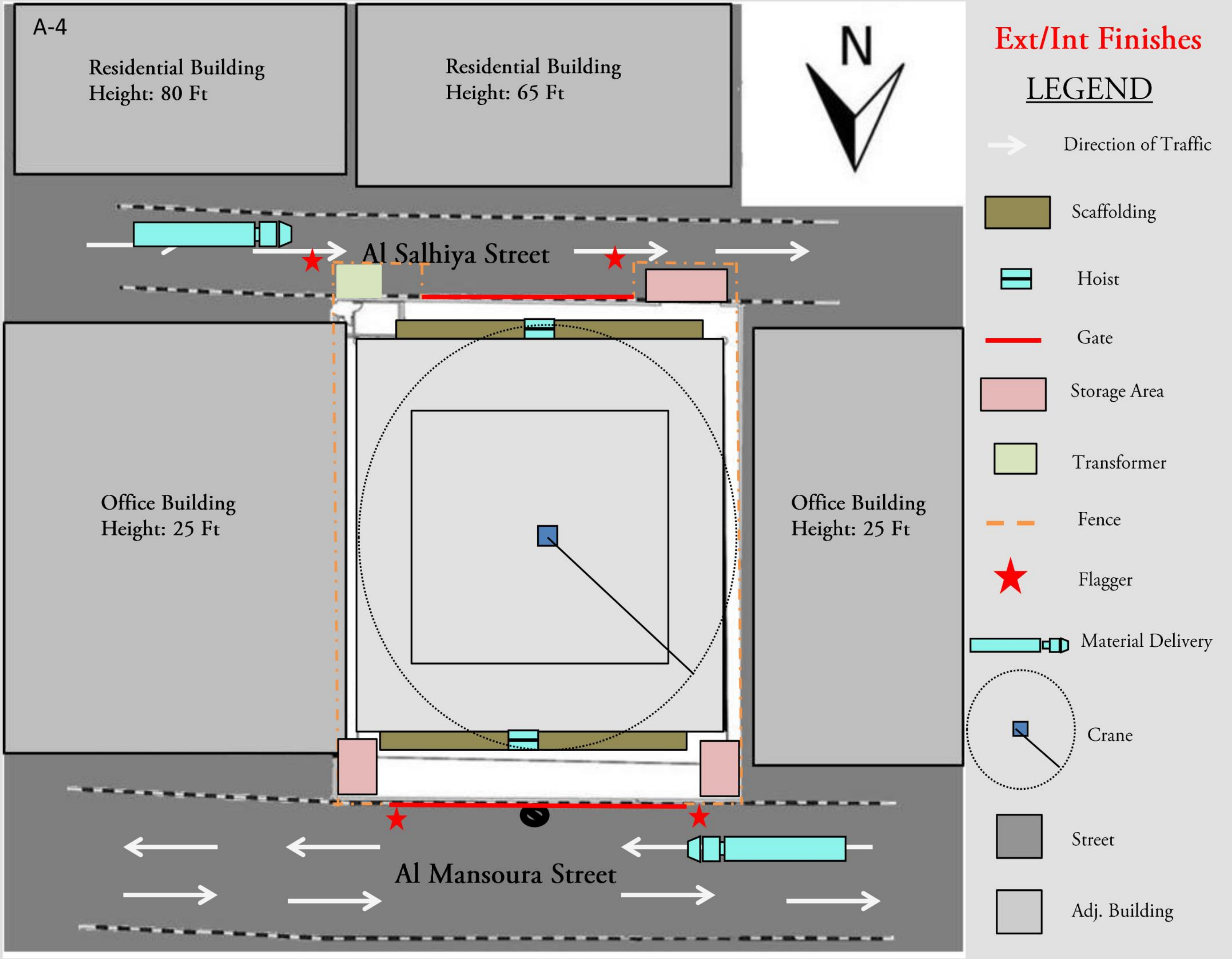


Ramy Labna CM Option	**Existing Conditions**
	2B + G + M + 7
4/09/2014	Doha, Qatar
Appendix A-1	Prof. Sowers


A-2
Residential Building
Height: 80 Ft
Residential Building
Height: 65 Ft
N
Al Salhiya Street
Office Building
Height: 25 Ft
Office Building
Height: 25 Ft
Al Mansoura Street
Excavation
LEGEND
Direction of Traffic
Office Trailer
Transformer
Gate
Excavation
Excavation Support
Fence
Excavator
Front-end Loader
Dumpster Truck
Existing Hose Connection
Flow of Trucks
Flagger
Street
Adj. Building



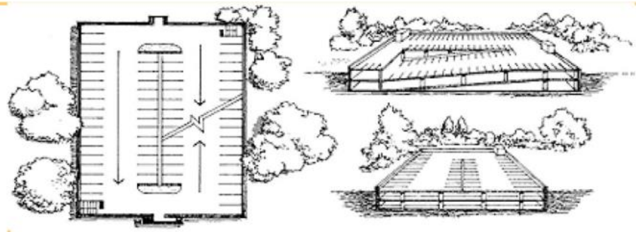
A-3
Residential Building
Height: 80 Ft
Residential Building
Height: 65 Ft
N
Concrete Placing
LEGEND
Direction of Traffic
Office Trailer
Transformer
Storage Area
Dumpster
Concrete Pump Station
Concrete Truck
DeliveryTruck
Flagger
Fence
Existing Hose Connection
Site in Construction
Street
Adj. Building
Al Salhiya Street
Office Building
Height: 25 Ft
Office Building
Height: 25 Ft
Al Mansoura Street


A-4
Residential Building
Height: 80 Ft
Residential Building
Height: 65 Ft
N
Al Salhiya Street
Office Building
Height: 25 Ft
Office Building
Height: 25 Ft
Al Mansoura Street
Ext/Int Finishes
LEGEND
Direction of Traffic
Scaffolding
Hoist
Gate
Storage Area
Transformer
Fence
Flagger
Material Delivery
Crane
Street
Adj. Building

Appendix B – Square Foot Estimates

Square Foot Cost Estimate Report

Estimate Name:	**2B + G + M + 7** Mansoura, Doha Qatar , Philadelphia , PA , 19019
Building Type:	**Garage, Underground Parking with Reinforced Concrete / R/Conc. Frame**
Location:	**PHILADELPHIA, PA**
Story Count:	**2**
Story Height (L.F.):	**10.2**
Floor Area (S.F.):	**22155**
Labor Type:	**STD**
Basement Included:	**No**
Data Release:	**Year 2013 Quarter 3**
Cost Per Square Foot:	**$115.08**
Building Cost:	**$2,549,500.00**



Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

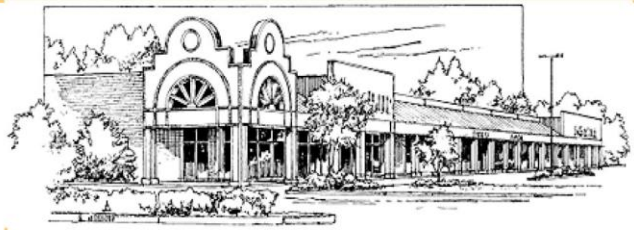
		% of Total	Cost Per S.F.	Cost
A Substructure		22.95%	19.75	437500
A1010	**Standard Foundations**		8.82	195500
	KSF, 12" deep x 24" wide			
	8' -6" square x 20" deep			
	10' - 6" square x 25" deep			
	Foundation dampproofing, asphalt with fibers, 1/8" thick, 8' high			
A1030	**Slab on Grade**		3.93	87000
	Slab on grade, 5" thick, light industrial, reinforced			
A2010	**Basement Excavation**		7	155000
	site storage			
B Shell		52.23%	44.93	995500
B1010	**Floor Construction**		16.86	373500
	1000K load, 10'-14' story height, 740 lbs/LF, 4000PSI			
	35'x35' bay, 200 PSF superimposed load, 355 PSF total load			
	superimposed load, 165 PSF total load			
B1020	**Roof Construction**		15.55	344500
	deep beam, 9" slab, 209 PSF total load			
B2010	**Exterior Walls**		9.55	211500
	Concrete wall, reinforced, 8' high, 8" thick, plain finish, 4000 PSI			
B2030	**Exterior Doors**		0.2	4500
	hardware, 6'-0" x 10'-0" opening			
	0" opening			
B3010	**Roof Coverings**		2.78	61500
	Vinyl and neoprene membrane traffic deck			
C Interiors		7.24%	6.23	138000
C1010	**Partitions**		4.74	105000
	Concrete block (CMU) partition, light weight, hollow, 8" thick, no finish			
	8" concrete block partition			
C1020	**Interior Doors**		0.47	10500

	3'-0" x 7'-0" x 1-3/8"			
C2010	**Stair Construction**		**0.41**	**9000**
	Stairs, CIP concrete, w/landing, 16 risers, with nosing			
C3010	**Wall Finishes**		**0.61**	**13500**
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
D Services		**17.05%**	**14.67**	**325000**
D1010	**Elevators and Lifts**		**1.81**	**40000**
	Hydraulic passenger elevator, 2500 lb., 2 floor, 125 FPM			
D2010	**Plumbing Fixtures**		**0.07**	**1500**
	Water closet, vitreous china, bowl only with flush valve, floor mount			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
D2020	**Domestic Water Distribution**		**0.11**	**2500**
	GPH			
D2040	**Rain Water Drainage**		**2.48**	**55000**
	Roof drain, steel galv sch 40 threaded, 3" diam piping, 10' high			
	foot add			
D3050	**Terminal & Package Units**		**0.18**	**4000**
	16000 CFM, 5 HP vane axial fan			
D4010	**Sprinklers**		**4.94**	**109500**
	Dry pipe sprinkler systems, steel, ordinary hazard, 1 floor, 50,000 SF			
	50,000 SF			
D4020	**Standpipes**		**0.18**	**4000**
	Dry standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor			
	floors			
D5010	**Electrical Service/Distribution**		**0.16**	**3500**
	phase, 4 wire, 120/208 V, 200 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 200 A			
	V, 1 phase, 400 A			
D5020	**Lighting and Branch Wiring**		**4.45**	**98500**
	Receptacles incl plate, box, conduit, wire, 2.5 per 1000 SF, .3 watts per SF			
	Miscellaneous power, to .5 watts			
	fixtures @32 watt per 1000 SF			
D5030	**Communications and Security**		**0.23**	**5000**
	detectors, includes outlets, boxes, conduit and wire			
	conduit			
D5090	**Other Electrical Systems**		**0.07**	**1500**
	gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 11.5 kW			
E Equipment & Furnishings		**0.52%**	**0.45**	**10000**
E1030	**Vehicular Equipment**		**0.45**	**10000**
	way			
	economy			
	computing			
E1090	**Other Equipment**		**0**	**0**
F Special Construction		**0%**	**0**	**0**
G Building Sitework		**0%**	**0**	**0**

SubTotal	**100%**	**$86.03**	**$1,906,000.00**
Contractor Fees (General Conditions,Overhead,Profit)	**25.0 %%**	**$21.51**	**$476,500.00**
Architectural Fees	**7.0 %%**	**$7.54**	**$167,000.00**
User Fees	**0.0 %%**	**$0.00**	**$0.00**
Total Building Cost		**$115.08**	**$2,549,500.00**

Square Foot Cost Estimate Report

Estimate Name:	2B + G + M + 7 Mansoura, Doha Qatar , Philadelphia , PA , 19019
Building Type:	Store, Retail with Face Brick on Concrete Block / Steel Joists
Location:	PHILADELPHIA, PA
Story Count:	1
Story Height (L.F.):	15
Floor Area (S.F.):	17892
Labor Type:	STD
Basement Included:	No
Data Release:	Year 2013 Quarter 3
Cost Per Square Foot:	$136.23
Building Cost:	$2,437,500.00



Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per S.F.	Cost
A Substructure		10.67%	10.87	194500
A1010	Standard Foundations		1.51	27000
	KSF, 12" deep x 24" wide			
	- 0" square x 12" deep			
A1030	Slab on Grade		6.06	108500
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	Basement Excavation		0.42	7500
	storage			
A2020	Basement Walls		2.88	51500
	thick			
B Shell		30.64%	31.22	558500
B1020	Roof Construction		8.13	145500
	wall, 25'x25' bay, 20" deep, 40 PSF superimposed load, 60 PSF total load			
	wall, 25'x25' bay, 20" deep, 40 PSF superimposed load, 60 PSF total load,			
B2010	Exterior Walls		12.74	228000
	Concrete wall, reinforced, 8' high, 8" thick, rubbed 1 side, 3000 PSI			
B2020	Exterior Windows		2.43	43500
	intermediate horizontals			
	Glazing panel, insulating, 1/2" thick, 2 lites 1/8" float glass, clear			
B2030	Exterior Doors		0.73	13000
	0" opening			
	0" opening			
B3010	Roof Coverings		7.13	127500
	mopped			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Gravel stop, aluminum, extruded, 4", mill finish, .050" thick			
B3020	Roof Openings		0.06	1000
	steel, 165 lbs			

C Interiors		16.65%	16.96	303500
C1010	Partitions		1.31	23500
	gypsum board, 2-1/2" @ 24", same opposite face, no insulation			
C1020	Interior Doors		2.21	39500
	3'-0" x 7'-0" x 1-3/8"			
C3010	Wall Finishes		2.15	38500
	2 coats paint on masonry with block filler			
	primer & 2 coats			
C3020	Floor Finishes		2.49	44500
	Vinyl, composition tile, maximum			
C3030	Ceiling Finishes		8.8	157500
	channel grid, suspended support			
D Services		42.03%	42.81	766000
D2010	Plumbing Fixtures		3.91	70000
	Water closet, vitreous china, tank type, 2 piece close coupled			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, vanity top, PE on CI, 20" x 18"			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 24" x 20"			
	Water cooler, electric, wall hung, dual height, 14.3 GPH			
D2020	Domestic Water Distribution		2.54	45500
	Gas fired water heater, commercial, 100< F rise, 500 MBH input, 480 GPH			
D2040	Rain Water Drainage		1.96	35000
	Roof drain, CI, soil,single hub, 4" diam, 10' high			
	Roof drain, CI, soil,single hub, 4" diam, for each additional foot add			
D3050	Terminal & Package Units		9.59	171500
	ton			
D4010	Sprinklers		5.53	99000
	Wet pipe sprinkler systems, steel, ordinary hazard, 1 floor, 10,000 SF			
D4020	Standpipes		1.17	21000
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor			
D5010	Electrical Service/Distribution		1.51	27000
	phase, 4 wire, 120/208 V, 400 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 400 A			
	V, 1 phase, 400 A			
D5020	Lighting and Branch Wiring		14.34	256500
	Receptacles incl plate, box, conduit, wire, 8 per 1000 SF, .9 watts per SF			
	Miscellaneous power, 1.5 watts			
	Central air conditioning power, 4 watts			
	fixtures @32watt per 1000 SF			
D5030	Communications and Security		2.01	36000
	detectors, includes outlets, boxes, conduit and wire			
	conduit			
D5090	Other Electrical Systems		0.25	4500
	gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 15 kW			
E Equipment & Furnishings		0.00%	0	0
E1090	Other Equipment		0	0
F Special Construction		0%	0	0

G Building Sitework	**0%**	**0**	**0**
SubTotal	**100%**	**$101.86**	**$1,822,500.00**
Contractor Fees (General Conditions,Overhead,Profit)	**25.0 %%**	**$25.46**	**$455,500.00**
Architectural Fees	**7.0 %%**	**$8.91**	**$159,500.00**
User Fees	**0.0 %%**	**$0.00**	**$0.00**
Total Building Cost		**$136.23**	**$2,437,500.00**

Square Foot Cost Estimate Report

Estimate Name:	2B + G + M + 7 Mansoura, Doha Qatar , Philadelphia , PA , 19019	
Building Type:	Apartment, 4-7 Story with Precast Concrete Panels / R/Conc. Frame	
Location:	PHILADELPHIA, PA	
Story Count:	6	
Story Height (L.F.):	11.81	
Floor Area (S.F.):	55915	
Labor Type:	STD	
Basement Included:	No	
Data Release:	Year 2013 Quarter 3	Costs are derived from a building model with basic components.
Cost Per Square Foot:	$213.68	Scope differences and market conditions can cause costs to vary significantly.
Building Cost:	$11,948,000.00	

		% of Total	Cost Per S.F.	Cost
A Substructure		2.33%	3.73	208500
A1010	Standard Foundations		1.79	100000
	KSF, 16" deep x 48" wide			
	9' - 6" square x 30" deep			
A1030	Slab on Grade		1.23	69000
	Slab on grade, 4" thick, light industrial, reinforced			
A2010	Basement Excavation		0.06	3500
	site storage			
A2020	Basement Walls		0.64	36000
	thick			
B Shell		28.29%	45.2	2527500
B1010	Floor Construction		20.33	1137000
	height, 140 lbs/LF, 4000PSI			
	30'x35' bay, 40 PSF superimposed load, 158 PSF total load			
	30'x35' bay, 125 PSF superimposed load, 254 PSF total load			
B1020	Roof Construction		3.93	220000
	deep beam, 8" slab, 158 PSF total load			
B2010	Exterior Walls		15.67	876000
	Exterior wall, precast concrete, flat, 4" thick, 8' x 8', white face, low rise			
B2020	Exterior Windows		3.69	206500
	Windows, aluminum, sliding, standard glass, 5' x 3'			
B2030	Exterior Doors		0.46	26000
	0" opening			
	hardware, 6'-0" x 7'-0" opening			
B3010	Roof Coverings		1.11	62000
	mopped			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Flashing, aluminum, no backing sides, .019"			
	Gravel stop, aluminum, extruded, 4", mill finish, .050" thick			

C Interiors		**25.28%**	**40.39**	**2258500**
C1010	**Partitions**		**10.21**	**571000**
	gypsum board, 2-1/2" @ 24", same opposite face, no insulation			
	1/2" fire rated gypsum board, taped & finished, painted on metal furring			
C1020	**Interior Doors**		**8.12**	**454000**
	Door, single leaf, wood frame, 3'-0" x 7'-0" x 1-3/8", birch, solid core			
	Door, single leaf, wood frame, 3'-0" x 7'-0" x 1-3/8", birch, hollow core			
C1030	**Fittings**		**3.79**	**212000**
	Cabinets, residential, wall, two doors x 48" wide			
C2010	**Stair Construction**		**3.26**	**182500**
	Stairs, steel, cement filled metal pan & picket rail, 12 risers, with landing			
C3010	**Wall Finishes**		**3.62**	**202500**
	primer & 2 coats			
	Vinyl wall covering, fabric back, medium weight			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		**5.88**	**329000**
	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 24 oz			
	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 35 oz			
	Carpet, padding, add to above, minimum			
	Carpet, padding, add to above, maximum			
	Vinyl, composition tile, minimum			
	Vinyl, composition tile, maximum			
	Tile, ceramic natural clay			
C3030	**Ceiling Finishes**		**5.5**	**307500**
	textured finish, 7/8"resilient channel furring, 24" OC support			
D Services		**44.09%**	**70.44**	**3938500**
D1010	**Elevators and Lifts**		**8.33**	**465500**
	200 FPM			
D2010	**Plumbing Fixtures**		**16.19**	**905000**
	Kitchen sink w/trim, countertop, PE on CI, 24" x 21", single bowl			
	Laundry sink w/trim, PE on CI, black iron frame, 24" x 20", single compt			
	Service sink w/trim, PE on CI, corner floor, 28" x 28", w/rim guard			
	Bathroom, lavatory & water closet, 2 wall plumbing, stand alone			
	bathtub, stand alone			
D2020	**Domestic Water Distribution**		**5.37**	**300000**
	Gas fired water heater, residential, 100< F rise, 30 gal tank, 32 GPH			
D2040	**Rain Water Drainage**		**0.28**	**15500**
	Roof drain, DWV PVC, 4" diam, diam, 10' high			
	Roof drain, DWV PVC, 4" diam, for each additional foot add			
D3010	**Energy Supply**		**9.8**	**548000**
	30,000 SF area,300,000 CF vol			
D3030	**Cooling Generating Systems**		**11.23**	**628000**
	93.33 ton			
D4010	**Sprinklers**		**3.43**	**192000**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF			
	10,000 SF			
D4020	**Standpipes**		**1.07**	**60000**

	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, 1 floor			
	floors			
	Fire pump, electric, with controller, 4" pump, 30 HP, 500 GPM			
D5010	**Electrical Service/Distribution**		**2.62**	**146500**
	phase, 4 wire, 120/208 V, 1600 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 1600 A			
	V, 1600 A			
D5020	**Lighting and Branch Wiring**		**9.73**	**544000**
	Receptacles incl plate, box, conduit, wire, 10 per 1000 SF, 1.2 watts per SF			
	Wall switches, 2.5 per 1000 SF			
	Miscellaneous power, 2 watts			
	Central air conditioning power, 3 watts			
	Motor installation, three phase, 200 V, 15 HP motor size			
	fixtures per 1000 SF			
D5030	**Communications and Security**		**2.17**	**121500**
	detectors, includes outlets, boxes, conduit and wire			
	Fire alarm command center, addressable with voice, excl. wire & conduit			
	Internet wiring, 2 data/voice outlets per 1000 S.F.			
D5090	**Other Electrical Systems**		**0.22**	**12500**
	gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 11.5 kW			
	engine with fuel tank, 30 kW			
E Equipment & Furnishings		**0.00%**	**0**	**0**
E1090	**Other Equipment**		**0**	**0**
F Special Construction		**0%**	**0**	**0**
G Building Sitework		**0%**	**0**	**0**

SubTotal	**100%**	**$159.76**	**$8,933,000.00**
Contractor Fees (General Conditions,Overhead,Profit)	**25.0 %%**	**$39.94**	**$2,233,500.00**
Architectural Fees	**7.0 %%**	**$13.98**	**$781,500.00**
User Fees	**0.0 %%**	**$0.00**	**$0.00**
Total Building Cost		**$213.68**	**$11,948,000.00**

Appendix C – Detailed Project Estimates

Appendix C-1

Code	Description (Typ. Bay)	Quantity	# Bays	Total/Floor	Unit	# of Floors	Total (All Floors)	Crew	Extended Total	Extended Total O&P
Columns, Walls, Slabs & Reinforcing										
Foundation										
0.033053406250	Retaining Wall (Typ Bay)	27	4	108	CY	1	108	C14D	$ 24,296.76	$ 31,321.08
0.033053404050	Spread Footings	381.25	4	1525	CY	1	1525	C14C	$ 432,856.00	$ 553,986.75
0.032110600550	#4 (#12 Metric) Rebar	0.13	4	0.52	Tons	1	0.52	4 Rodman	$ 863.16	$ 1,107.86
2 Basements & Ground Floor										
0.033053400700	Column C1a	2.43	4	9.72	CY	3	29.16	C14 A	$ 41,713.67	$ 58,576.32
0.033053400700	Column C3	2.14	4	8.56	CY	3	25.68	C14 A	$ 36,735.50	$ 51,585.32
0.033053400700	Column C4	1.88	4	7.52	CY	3	22.56	C14 A	$ 32,272.31	$ 45,318.30
0.033053400700	Column C5a	1.22	4	4.88	CY	3	14.64	C14 A	$ 20,942.67	$ 29,408.69
0.033053400700	Column C9	3.5	4	14	CY	3	42	C14 A	$ 60,081.42	$ 84,369.18
0.033053400700	Column C10	0.43	4	1.72	CY	3	5.16	C14 A	$ 7,381.43	$ 10,365.36
0.033053401900	Elevated Slab	40	4	160	CY	3	480	C14B	$ 281,558.40	$ 379,612.80
0.032110600200	#3 (#10 Metric) Rebar	0.038	4	0.152	Tons	3	0.46	4 Rodman	$ 1,166.26	$ 1,629.01
0.032110600200	#4 (#12 Metric) Rebar	0.00167	4	0.00668	Tons	3	0.02	4 Rodman	$ 50.71	$ 70.83
0.032110600250	#8 (#25 Metric) Rebar	0.47	4	1.88	Tons	3	5.64	4 Rodman	$ 11,402.22	$ 15,280.45
0.032110600250	#10 (#32 Metric) Rebar	1.28	4	5.12	Tons	3	15.36	4 Rodman	$ 31,052.85	$ 41,614.85
Floors M-7										
0.033053400700	Column C1a	3	4	12	CY	8	96	C14A	$ 137,328.96	$ 192,843.84
0.033053400700	Column C3	2.34	4	9.36	CY	8	74.88	C14A	$ 107,116.59	$ 150,418.20
0.033053400700	Column C4	2.1	4	8.4	CY	8	67.2	C14A	$ 96,130.27	$ 134,990.69
0.033053400700	Column C5a	1.14	4	4.56	CY	8	36.48	C14A	$ 52,185.00	$ 73,280.66
0.033053400700	Column C10	0.85	4	3.4	CY	8	27.2	C14A	$ 38,909.87	$ 54,639.09

0.033053401900	Elevated Slab	40	4	160	CY	8	1280	C14B	$ 750,822.40	$ 1,012,300.80
0.032110600200	#3 (#10 Metric) Rebar	0.03	4	0.12	Tons	8	0.96	4 Rodman	$ 2,433.94	$ 3,399.68
0.032110600200	#4 (#12 Metric) Rebar	0.001625	4	0.0065	Tons	8	0.052	4 Rodman	$ 126.77	$ 177.07
0.032110600250	#8 (#25 Metric) Rebar	0.35	4	1.4	Tons	8	11.2	4 Rodman	$ 22,642.70	$ 30,344.16
0.032110600250	#10 (#32 Metric) Rebar	1.19	4	4.76	Tons	8	38.08	4 Rodman	$ 76,985.19	$ 103,170.14
Subtotal									**$ 2,303,790.55**	**$ 3,111,396.45**

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Beams Take-off								
Code	**Item**	**Quantity**	**Unit**	**Amouont**	**Subtotal**	**Crew**	**Extended Total**	**Extended Total O&P**
Basements								
0.033053400300	BB1	1.4	CY	1	1.4	C14A	$ 1,575.39	$ 2,218.23
0.033053400300	BB2	0.56	CY	1	0.56	C14A	$ 630.16	$ 887.29
0.033053400300	BB3	2.78	CY	2	5.56	C14A	$ 6,256.56	$ 8,809.54
0.033053400300	BCB 1	0.44	CY	1	0.44	C14A	$ 495.12	$ 697.16
0.033053400300	BCB 2	0.3	CY	1	0.3	C14A	$ 337.58	$ 475.34
0.033053400300	TB 1	0.94	CY	1	0.94	C14A	$ 1,057.76	$ 1,489.38
0.033053400300	TB 2	0.19	CY	3	0.57	C14A	$ 641.41	$ 903.14
Subtotal					**9.77**	-	**$ 10,993.98**	**$ 15,480.08**
Ground								
0.033053400300	GB1	0.53	CY	3	1.59	C14A	$ 1,789.20	$ 2,519.28
0.033053400300	GB2	2.07	CY	1	2.07	C14A	$ 2,329.33	$ 3,279.81
0.033053400300	GB3	3.71	CY	2	7.42	C14A	$ 8,349.58	$ 11,756.62
0.033053400300	GB4	2.13	CY	3	6.39	C14A	$ 7,190.54	$ 10,124.64
0.033053400300	GB5	0.67	CY	1	0.67	C14A	$ 753.94	$ 1,061.58
0.033053400300	GB6	5	CY	2	10	C14A	$ 11,252.80	$ 15,844.50
0.033053400300	GB7	0.53	CY	3	1.59	C14A	$ 1,789.20	$ 2,519.28
0.033053400300	GB8	1.3	CY	1	1.3	C14A	$ 1,462.86	$ 2,059.76
0.033053400300	GB9	3.15	CY	1	3.15	C14A	$ 3,544.63	$ 4,991.02
0.033053400300	GB10	1.53	CY	2	3.06	C14A	$ 3,443.36	$ 4,848.42
0.033053400300	GB11	4.97	CY	1	4.97	C14A	$ 5,592.64	$ 7,874.72
0.033053400300	GB12	2.41	CY	2	4.82	C14A	$ 5,423.85	$ 7,637.05
0.033053400300	TB 1	0.94	CY	1	0.94	C14A	$ 1,057.76	$ 1,489.38
0.033053400300	TB 2	0.19	CY	2	0.38	C14A	$ 427.61	$ 602.09
0.033053400300	RMB 1	0.89	CY	2	1.78	C14A	$ 2,003.00	$ 2,820.32
0.033053400300	RMB 2	3.15	CY	1	3.15	C14A	$ 3,544.63	$ 4,991.02
Subtotal					**35.81**	-	**$ 59,954.93**	**$ 84,419.49**
Mezzanine								
0.033053400300	MB1	0.69	CY	15	10.35	C14A	$ 11,646.65	$ 16,399.06
0.033053400300	MB2	0.69	CY	8	5.52	C14A	$ 6,211.50	$ 8,746.16

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0.033053400300	MB3	1.4	CY	1	1.4	C14A	$	1,575.39	$	2,218.23
0.033053400300	MB4	0.68	CY	2	1.36	C14A	$	1,530.38	$	2,154.85
0.033053400300	MB5	0.7	CY	1	0.7	C14A	$	787.70	$	1,109.12
0.033053400300	TB 1	0.94	CY	2	1.88	C14A	$	2,115.53	$	2,978.77
0.033053400300	TB 2	0.19	CY	2	0.38	C14A	$	427.61	$	609.02
Subtotal					**21.59**	-	**$**	**24,294.76**	**$**	**34,215.21**
1st Floor										
0.033053400300	FB1	1.05	CY	12	12.6	C14A	$	14,178.53	$	19,964.07
0.033053400300	FB2	1.67	CY	6	10.02	C14A	$	11,275.31	$	15,876.19
0.033053400300	FB3	1.26	CY	1	1.26	C14A	$	1,417.85	$	1,996.41
0.033053400300	FB4	0.98	CY	2	1.96	C14A	$	2,205.55	$	3,105.52
0.033053400300	FB5	1.4	CY	4	5.6	C14A	$	6,301.57	$	8,872.92
0.033053400300	FB6	0.8	CY	2	1.6	C14A	$	1,800.45	$	2,535.12
0.033053400300	FB7	0.44	CY	3	1.32	C14A	$	1,485.37	$	2,091.47
0.033053400300	FCB 5	0.16	CY	1	0.16	C14A	$	180.04	$	253.51
0.033053400300	FCB 7	0.24	CY	2	0.48	C14A	$	540.13	$	760.54
0.033053400300	TB 1	0.94	CY	2	1.88	C14A	$	2,115.53	$	2,978.77
0.033053400300	TB 2	0.19	CY	2	0.38	C14A	$	427.61	$	602.09
Subtotal					**37.26**	-	**$**	**41,927.94**	**$**	**59,036.61**
2nd - Roof										
0.033053400300	TB 1	0.94	CY	16	15.04	C14A	$	16,924.21	$	23,830.13
0.033053400300	TB 2	0.19	CY	16	3.04	C14A	$	3,420.85	$	4,816.73
Subtotal					**18.08**	-	**$**	**20,345.06**	**$**	**28,646.86**
Machine Room										
0.033053400300	MRB 1	0.39	CY	8	3.12	C14A	$	3,510.87	$	4,943.48
0.033053400300	MRB 2	0.39	CY	2	0.78	C14A	$	877.72	$	1,235.87
0.033053400300	MRB 3	0.48	CY	1	0.48	C14A	$	540.13	$	760.54
Subtotal					**4.38**	-	**$**	**4,928.72**	**$**	**6,939.89**
Total Calculated (CY)					**126.89**	-	**$**	**162,445.39**	**$**	**228,738.14**

Appendix C-3

Total Structural Estimate		
Col/Wall/Slabs & Reinf.	$	3,111,396.45
Beams	$	228,738.14
Subtotal	**$**	**3,340,134.59**

Appendix D – MEP Assemblies Estimate

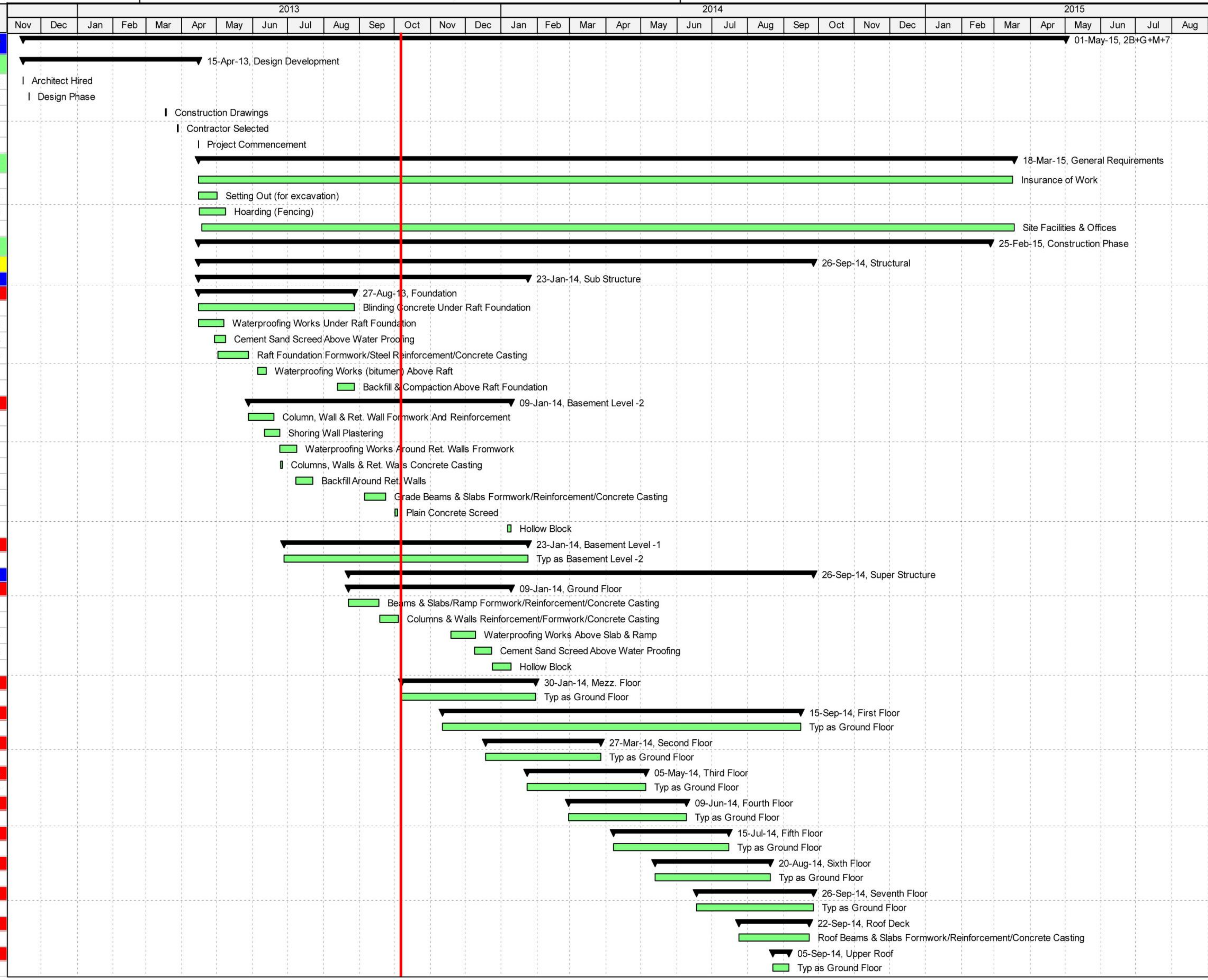
2B+G+M+7 Assemblies Estimate					
Data Release :Year 2013 Quarter 3					
Quantity	Assembly Number	Description	Unit	Total O&P	Ext. Total O&P
3	D30903101040	Fume hood exhaust system, 6 FT long, 5000 CFM	Ea.	$ 40,183.58	$ 120,550.74
1	D30903101050	Fume hood exhaust system, 10 FT long, 8000 CFM	Ea.	$ 53,461.35	$ 53,461.35
9	D30903201600	Garage, single exhaust, 5" outlet, diesel trucks, 1 bay	Ea.	$ 6,855.43	$ 61,698.87
80000	D30501701280	Split system, air cooled condensing unit, apartment corridors, 1,000 SF, 1.83 ton	S.F.	$ 5.70	$ 456,000.00
99	D20101101880	Water closet, vitreous china, tank type, wall hung, close coupled 2 piece	Ea.	$ 2,456.63	$ 243,206.37
46	D20101101920	Water closet, vitreous china, tank type, floor mount, 1 piece	Ea.	$ 2,457.11	$ 113,027.06
40	D20105102000	Bathtub, recessed, PE on CI, 48" x 42"	Ea.	$ 4,621.01	$ 184,840.40
22	D20107101560	Shower, stall, baked enamel, molded stone receptor, 30" square	Ea.	$ 2,791.46	$ 61,412.12
24	D20402101880	Roof drain, DWV PVC, 2" diam, piping, 10' high	Ea.	$ 1,019.28	$ 24,462.72
147	D20202101820	Electric water heater, residential, 100< F rise, 20 gallon tank, 7 GPH	Ea.	$ 2,353.43	$ 345,954.21
1	D40104100620	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF	S.F.	$ 3.76	$ 3.76
90000	D40104100740	Wet pipe sprinkler systems, steel, light hazard, each additional floor, 10,000 SF	S.F.	$ 2.85	$ 256,500.00
1	D40203100600	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, 1 floor	Floor	$ 14,325.83	$ 14,325.83
9	D40203100620	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, additional floors	Floor	$ 3,716.23	$ 33,446.07

1	D50102400620	Switchgear installation, incl switchboard, panels & circuit breaker, 277/480 V, 2000 A	Ea.	$ 56,035.40	$ 56,035.40
17	D50102504080	Panelboard, 4 wire w/conductor & conduit, NEHB, 277/480 V, 100 A, 10 stories, 75' horizontal		$ 11,788.76	$ 200,408.92
20000	D50202181000	Fluorescent high bay-4 lamp, 8'-10' above work plane, 2.5 watt/SF, 162 FC, 11 fixtures per 1000 SF	S.F.	$ 11.53	$ 230,600.00
405	D50201250680	Toggle switch single pole, 15 A with box, plate, 3/4" EMT & wire	Ea.	$ 319.37	$ 129,344.85
225	D50201250760	3 way switch, 15 A with box, plate, 3/4" EMT & wire	Ea.	$ 336.55	$ 75,723.75
20000	D50202080560	Fluorescent fixtures, type A, 11 fixtures per 600 SF	S.F.	$ 11.80	$ 236,000.00
30000	D50202140400	Incandescent fixtures recess mounted, 100 FC, type A, 34 fixtures per 400 SF	S.F.	$ 40.73	$ 1,221,900.00
734	D50201250560	Receptacle duplex 120 V grounded, 20 A with box, plate, 3/4" EMT & wire	Ea.	$ 335.08	$ 245,948.72
100000	D50303100680	Telephone systems, conduit system with floor boxes, high density	S.F.	$ 6.07	$ 607,000.00
1	D50309100440	Communication and alarm systems, fire detection, non-addressable, 100 detectors, includes outlets, boxes, conduit and wire	Ea.	$ 74,793.90	$ 74,793.90
100	D50309200102	Internet wiring, 2 data/voice outlets per 1000 S.F.	M.S.F.	$ 795.89	$ 79,589.00

Total	**$5,126,234.04**

Appendix E – Detailed Project Schedule

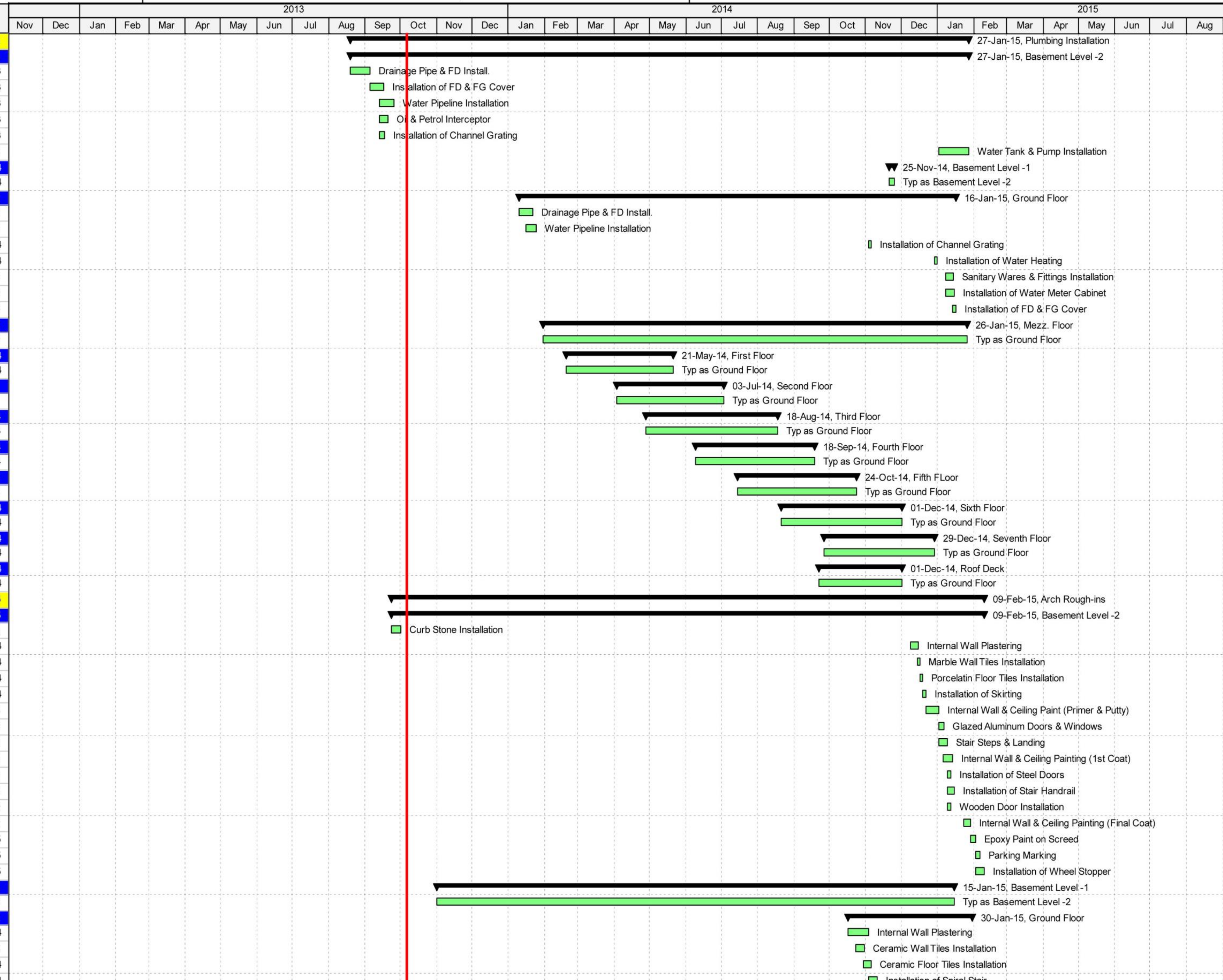
#	Activity Name	Original Duration	Start	Finish
1	2B+G+M+7	634	15-Nov-12	01-May-15
2	Design Development	105	15-Nov-12	15-Apr-13
3	Architect Hired	1	15-Nov-12	15-Nov-12
4	Design Phase	1	20-Nov-12	20-Nov-12
5	Construction Drawings	1	18-Mar-13	18-Mar-13
6	Contractor Selected	1	28-Mar-13	28-Mar-13
7	Project Commencement	1	15-Apr-13	15-Apr-13
8	General Requirements	498	15-Apr-13	18-Mar-15
9	Insurance of Work	496	15-Apr-13	16-Mar-15
10	Setting Out (for excavation)	13	15-Apr-13	01-May-13
11	Hoarding (Fencing)	17	16-Apr-13	08-May-13
12	Site Facilities & Offices	495	18-Apr-13	18-Mar-15
13	Construction Phase	483	15-Apr-13	25-Feb-15
14	Structural	375	15-Apr-13	26-Sep-14
15	Sub Structure	199	15-Apr-13	23-Jan-14
16	Foundation	95	15-Apr-13	27-Aug-13
17	Blinding Concrete Under Raft F	95	15-Apr-13	27-Aug-13
18	Waterproofing Works Under R	17	15-Apr-13	07-May-13
19	Cement Sand Screed Above W	8	29-Apr-13	08-May-13
20	Raft Foundation Formwork/Ste	18	02-May-13	28-May-13
21	Waterproofing Works (bitumen	6	05-Jun-13	12-Jun-13
22	Backfill & Compaction Above R	11	13-Aug-13	27-Aug-13
23	Basement Level -2	159	28-May-13	09-Jan-14
24	Column, Wall & Ret. Wall Form	17	28-May-13	19-Jun-13
25	Shoring Wall Plastering	10	11-Jun-13	24-Jun-13
26	Waterproofing Works Around F	10	24-Jun-13	08-Jul-13
27	Columns, Walls & Ret. Walls C	2	25-Jun-13	26-Jun-13
28	Backfill Around Ret. Walls	11	08-Jul-13	22-Jul-13
29	Grade Beams & Slabs Formwo	13	05-Sep-13	23-Sep-13
30	Plain Concrete Screed	3	01-Oct-13	03-Oct-13
31	Hollow Block	4	06-Jan-14	09-Jan-14
32	Basement Level -1	146	28-Jun-13	23-Jan-14
33	Typ as Basement Level -2	146	28-Jun-13	23-Jan-14
34	Super Structure	284	22-Aug-13	26-Sep-14
35	Ground Floor	98	22-Aug-13	09-Jan-14
36	Beams & Slabs/Ramp Formwo	18	22-Aug-13	17-Sep-13
37	Columns & Walls Reinforceme	13	18-Sep-13	04-Oct-13
38	Waterproofing Works Above S	15	18-Nov-13	09-Dec-13
39	Cement Sand Screed Above W	11	09-Dec-13	23-Dec-13
40	Hollow Block	12	24-Dec-13	09-Jan-14
41	Mezz. Floor	82	07-Oct-13	30-Jan-14
42	Typ as Ground Floor	82	07-Oct-13	30-Jan-14
43	First Floor	219	11-Nov-13	15-Sep-14
44	Typ as Ground Floor	219	11-Nov-13	15-Sep-14
45	Second Floor	71	18-Dec-13	27-Mar-14
46	Typ as Ground Floor	71	18-Dec-13	27-Mar-14
47	Third Floor	73	23-Jan-14	05-May-14
48	Typ as Ground Floor	73	23-Jan-14	05-May-14
49	Fourth Floor	72	28-Feb-14	09-Jun-14
50	Typ as Ground Floor	72	28-Feb-14	09-Jun-14
51	Fifth Floor	72	07-Apr-14	15-Jul-14
52	Typ as Ground Floor	72	07-Apr-14	15-Jul-14
53	Sixth Floor	72	13-May-14	20-Aug-14
54	Typ as Ground Floor	72	13-May-14	20-Aug-14
55	Seventh Floor	73	18-Jun-14	26-Sep-14
56	Typ as Ground Floor	73	18-Jun-14	26-Sep-14
57	Roof Deck	43	24-Jul-14	22-Sep-14
58	Roof Beams & Slabs Formwor	43	24-Jul-14	22-Sep-14
59	Upper Roof	11	22-Aug-14	05-Sep-14
60	Typ as Ground Floor	11	22-Aug-14	05-Sep-14



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

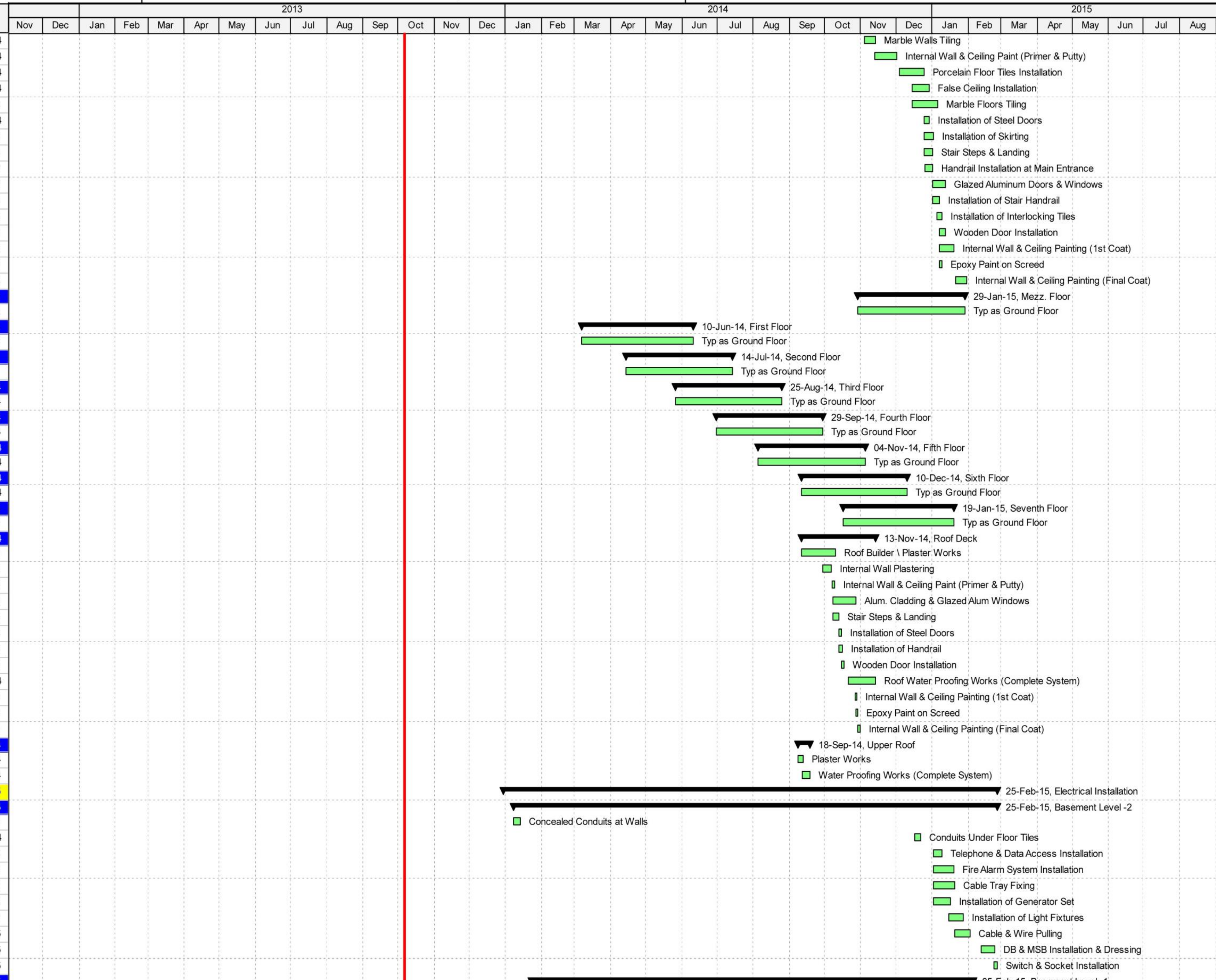
#	Activity Name	Original Duration	Start	Finish
61	**Plumbing Installation**	374	19-Aug-13	27-Jan-15
62	**Basement Level -2**	374	19-Aug-13	27-Jan-15
63	Drainage Pipe & FD Install.	13	19-Aug-13	05-Sep-13
64	Installation of FD & FG Cover	8	05-Sep-13	16-Sep-13
65	Water Pipeline Installation	9	13-Sep-13	25-Sep-13
66	Oil & Petrol Interceptor	6	13-Sep-13	20-Sep-13
67	Installation of Channel Grating	3	13-Sep-13	17-Sep-13
68	Water Tank & Pump Installation	18	02-Jan-15	27-Jan-15
69	**Basement Level -1**	3	21-Nov-14	25-Nov-14
70	Typ as Basement Level -2	3	21-Nov-14	25-Nov-14
71	**Ground Floor**	266	10-Jan-14	16-Jan-15
72	Drainage Pipe & FD Install.	8	10-Jan-14	21-Jan-14
73	Water Pipeline Installation	7	16-Jan-14	24-Jan-14
74	Installation of Channel Grating	3	03-Nov-14	05-Nov-14
75	Installation of Water Heating	3	29-Dec-14	31-Dec-14
76	Sanitary Wares & Fittings Installat	5	08-Jan-15	14-Jan-15
77	Installation of Water Meter Cabinet	6	08-Jan-15	15-Jan-15
78	Installation of FD & FG Cover	3	14-Jan-15	16-Jan-15
79	**Mezz. Floor**	258	30-Jan-14	26-Jan-15
80	Typ as Ground Floor	258	30-Jan-14	26-Jan-15
81	**First Floor**	66	19-Feb-14	21-May-14
82	Typ as Ground Floor	66	19-Feb-14	21-May-14
83	**Second Floor**	66	03-Apr-14	03-Jul-14
84	Typ as Ground Floor	66	03-Apr-14	03-Jul-14
85	**Third Floor**	81	28-Apr-14	18-Aug-14
86	Typ as Ground Floor	81	28-Apr-14	18-Aug-14
87	**Fourth Floor**	74	09-Jun-14	18-Sep-14
88	Typ as Ground Floor	74	09-Jun-14	18-Sep-14
89	**Fifth FLoor**	74	15-Jul-14	24-Oct-14
90	Typ as Ground Floor	74	15-Jul-14	24-Oct-14
91	**Sixth Floor**	73	21-Aug-14	01-Dec-14
92	Typ as Ground Floor	73	21-Aug-14	01-Dec-14
93	**Seventh Floor**	67	26-Sep-14	29-Dec-14
94	Typ as Ground Floor	67	26-Sep-14	29-Dec-14
95	**Roof Deck**	51	22-Sep-14	01-Dec-14
96	Typ as Ground Floor	51	22-Sep-14	01-Dec-14
97	**Arch Rough-ins**	359	23-Sep-13	09-Feb-15
98	**Basement Level -2**	359	23-Sep-13	09-Feb-15
99	Curb Stone Installation	7	23-Sep-13	01-Oct-13
100	Internal Wall Plastering	5	09-Dec-14	15-Dec-14
101	Marble Wall Tiles Installation	3	15-Dec-14	17-Dec-14
102	Porcelain Floor Tiles Installation	3	17-Dec-14	19-Dec-14
103	Installation of Skirting	2	19-Dec-14	22-Dec-14
104	Internal Wall & Ceiling Paint (Prim	10	22-Dec-14	02-Jan-15
105	Glazed Aluminum Doors & Windo	3	02-Jan-15	06-Jan-15
106	Stair Steps & Landing	6	02-Jan-15	09-Jan-15
107	Internal Wall & Ceiling Painting (1s	6	06-Jan-15	13-Jan-15
108	Installation of Steel Doors	2	09-Jan-15	12-Jan-15
109	Installation of Stair Handrail	5	09-Jan-15	15-Jan-15
110	Wooden Door Installation	2	09-Jan-15	12-Jan-15
111	Internal Wall & Ceiling Painting (Fi	5	23-Jan-15	29-Jan-15
112	Epoxy Paint on Screed	3	29-Jan-15	02-Feb-15
113	Parking Marking	5	02-Feb-15	06-Feb-15
114	Installation of Wheel Stopper	6	02-Feb-15	09-Feb-15
115	**Basement Level -1**	313	01-Nov-13	15-Jan-15
116	Typ as Basement Level -2	313	01-Nov-13	15-Jan-15
117	**Ground Floor**	76	17-Oct-14	30-Jan-15
118	Internal Wall Plastering	12	17-Oct-14	03-Nov-14
119	Ceramic Wall Tiles Installation	6	23-Oct-14	30-Oct-14
120	Ceramic Floor Tiles Installation	5	30-Oct-14	05-Nov-14
121	Installation of Spiral Stair	6	03-Nov-14	10-Nov-14



Actual Level of Effort | Remaining Work | ◆ ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

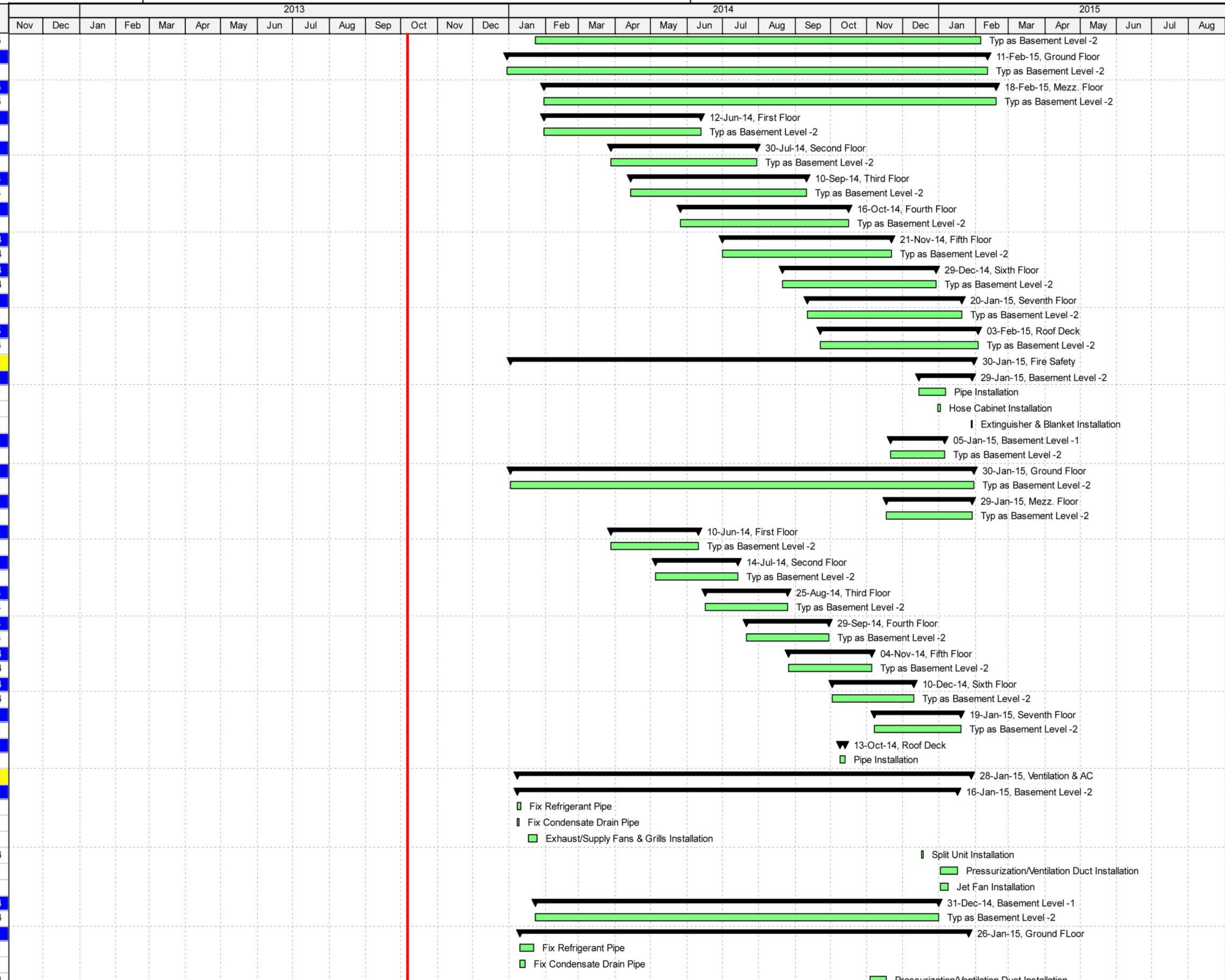
#	Activity Name	Original Duration	Start	Finish
122	Marble Walls Tiling	8	04-Nov-14	13-Nov-14
123	Internal Wall & Ceiling Paint (Prim	13	13-Nov-14	01-Dec-14
124	Porcelain Floor Tiles Installation	16	04-Dec-14	25-Dec-14
125	False Ceiling Installation	11	15-Dec-14	29-Dec-14
126	Marble Floors Tiling	16	15-Dec-14	05-Jan-15
127	Installation of Steel Doors	3	25-Dec-14	29-Dec-14
128	Installation of Skirting	7	25-Dec-14	02-Jan-15
129	Stair Steps & Landing	6	25-Dec-14	01-Jan-15
130	Handrail Installation at Main Entra	5	26-Dec-14	01-Jan-15
131	Glazed Aluminum Doors & Windo	8	01-Jan-15	12-Jan-15
132	Installation of Stair Handrail	5	01-Jan-15	07-Jan-15
133	Installation of Interlocking Tiles	5	05-Jan-15	09-Jan-15
134	Wooden Door Installation	4	07-Jan-15	12-Jan-15
135	Internal Wall & Ceiling Painting (1s	9	07-Jan-15	19-Jan-15
136	Epoxy Paint on Screed	3	07-Jan-15	09-Jan-15
137	Internal Wall & Ceiling Painting (Fi	8	21-Jan-15	30-Jan-15
138	**Mezz. Floor**	67	29-Oct-14	29-Jan-15
139	Typ as Ground Floor	67	29-Oct-14	29-Jan-15
140	**First Floor**	68	07-Mar-14	10-Jun-14
141	Typ as Ground Floor	68	07-Mar-14	10-Jun-14
142	**Second Floor**	66	14-Apr-14	14-Jul-14
143	Typ as Ground Floor	66	14-Apr-14	14-Jul-14
144	**Third Floor**	66	26-May-14	25-Aug-14
145	Typ as Ground Floor	66	26-May-14	25-Aug-14
146	**Fourth Floor**	66	30-Jun-14	29-Sep-14
147	Typ as Ground Floor	66	30-Jun-14	29-Sep-14
148	**Fifth Floor**	66	05-Aug-14	04-Nov-14
149	Typ as Ground Floor	66	05-Aug-14	04-Nov-14
150	**Sixth Floor**	65	11-Sep-14	10-Dec-14
151	Typ as Ground Floor	65	11-Sep-14	10-Dec-14
152	**Seventh Floor**	67	17-Oct-14	19-Jan-15
153	Typ as Ground Floor	67	17-Oct-14	19-Jan-15
154	**Roof Deck**	46	11-Sep-14	13-Nov-14
155	Roof Builder \ Plaster Works	22	11-Sep-14	10-Oct-14
156	Internal Wall Plastering	6	29-Sep-14	06-Oct-14
157	Internal Wall & Ceiling Paint (Prim	3	07-Oct-14	09-Oct-14
158	Alum. Cladding & Glazed Alum Wi	14	08-Oct-14	27-Oct-14
159	Stair Steps & Landing	4	08-Oct-14	13-Oct-14
160	Installation of Steel Doors	3	13-Oct-14	15-Oct-14
161	Installation of Handrail	4	13-Oct-14	16-Oct-14
162	Wooden Door Installation	3	15-Oct-14	17-Oct-14
163	Roof Water Proofing Works (Com	18	21-Oct-14	13-Nov-14
164	Internal Wall & Ceiling Painting (1s	2	27-Oct-14	28-Oct-14
165	Epoxy Paint on Screed	2	28-Oct-14	29-Oct-14
166	Internal Wall & Ceiling Painting (Fi	3	29-Oct-14	31-Oct-14
167	**Upper Roof**	9	08-Sep-14	18-Sep-14
168	Plaster Works	5	08-Sep-14	12-Sep-14
169	Water Proofing Works (Complete	5	12-Sep-14	18-Sep-14
170	**Electrical Installation**	303	30-Dec-13	25-Feb-15
171	**Basement Level -2**	296	08-Jan-14	25-Feb-15
172	Concealed Conduits at Walls	4	08-Jan-14	13-Jan-14
173	Conduits Under Floor Tiles	4	17-Dec-14	22-Dec-14
174	Telephone & Data Access Installa	6	02-Jan-15	09-Jan-15
175	Fire Alarm System Installation	12	02-Jan-15	19-Jan-15
176	Cable Tray Fixing	13	02-Jan-15	20-Jan-15
177	Installation of Generator Set	11	02-Jan-15	16-Jan-15
178	Installation of Light Fixtures	9	15-Jan-15	27-Jan-15
179	Cable & Wire Pulling	10	20-Jan-15	02-Feb-15
180	DB & MSB Installation & Dressing	8	12-Feb-15	23-Feb-15
181	Switch & Socket Installation	3	23-Feb-15	25-Feb-15
182	**Basement Level -1**	271	23-Jan-14	05-Feb-15



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

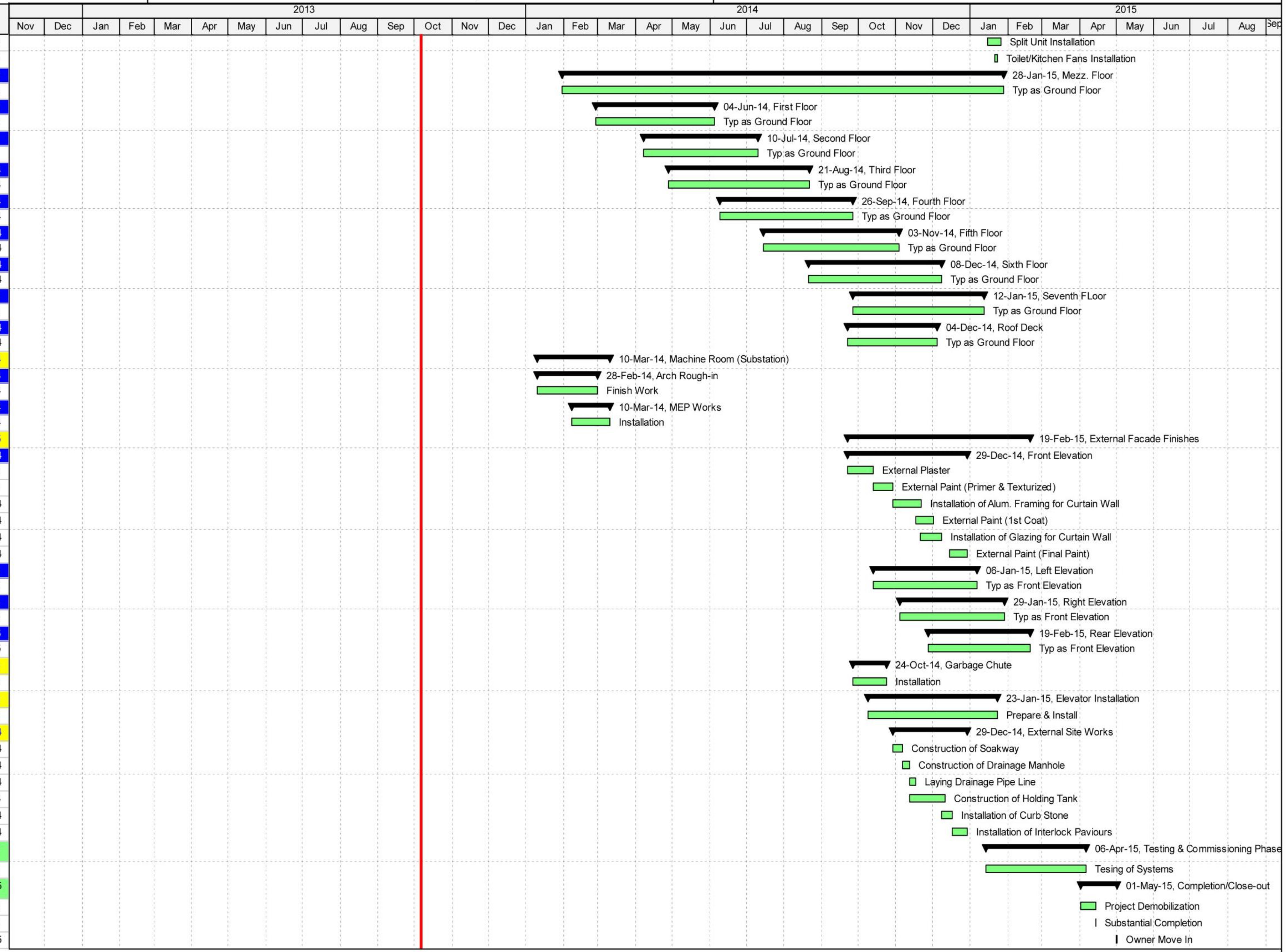
#	Activity Name	Original Duration	Start	Finish
183	Typ as Basement Level -2	271	23-Jan-14	05-Feb-15
184	**Ground Floor**	293	30-Dec-13	11-Feb-15
185	Typ as Basement Level -2	293	30-Dec-13	11-Feb-15
186	**Mezz. Floor**	275	30-Jan-14	18-Feb-15
187	Typ as Basement Level -2	275	30-Jan-14	18-Feb-15
188	**First Floor**	96	30-Jan-14	12-Jun-14
189	Typ as Basement Level -2	96	30-Jan-14	12-Jun-14
190	**Second Floor**	89	28-Mar-14	30-Jul-14
191	Typ as Basement Level -2	89	28-Mar-14	30-Jul-14
192	**Third Floor**	108	14-Apr-14	10-Sep-14
193	Typ as Basement Level -2	108	14-Apr-14	10-Sep-14
194	**Fourth Floor**	104	26-May-14	16-Oct-14
195	Typ as Basement Level -2	104	26-May-14	16-Oct-14
196	**Fifth Floor**	104	01-Jul-14	21-Nov-14
197	Typ as Basement Level -2	104	01-Jul-14	21-Nov-14
198	**Sixth Floor**	93	21-Aug-14	29-Dec-14
199	Typ as Basement Level -2	93	21-Aug-14	29-Dec-14
200	**Seventh Floor**	94	11-Sep-14	20-Jan-15
201	Typ as Basement Level -2	94	11-Sep-14	20-Jan-15
202	**Roof Deck**	97	22-Sep-14	03-Feb-15
203	Typ as Basement Level -2	97	22-Sep-14	03-Feb-15
204	**Fire Safety**	282	02-Jan-14	30-Jan-15
205	**Basement Level -2**	34	15-Dec-14	29-Jan-15
206	Pipe Installation	17	15-Dec-14	06-Jan-15
207	Hose Cabinet Installation	3	31-Dec-14	02-Jan-15
208	Extinguisher & Blanket Installation	2	28-Jan-15	29-Jan-15
209	**Basement Level -1**	32	21-Nov-14	05-Jan-15
210	Typ as Basement Level -2	32	21-Nov-14	05-Jan-15
211	**Ground Floor**	282	02-Jan-14	30-Jan-15
212	Typ as Basement Level -2	282	02-Jan-14	30-Jan-15
213	**Mezz. Floor**	54	17-Nov-14	29-Jan-15
214	Typ as Basement Level -2	54	17-Nov-14	29-Jan-15
215	**First Floor**	53	28-Mar-14	10-Jun-14
216	Typ as Basement Level -2	53	28-Mar-14	10-Jun-14
217	**Second Floor**	51	05-May-14	14-Jul-14
218	Typ as Basement Level -2	51	05-May-14	14-Jul-14
219	**Third Floor**	51	16-Jun-14	25-Aug-14
220	Typ as Basement Level -2	51	16-Jun-14	25-Aug-14
221	**Fourth Floor**	51	21-Jul-14	29-Sep-14
222	Typ as Basement Level -2	51	21-Jul-14	29-Sep-14
223	**Fifth Floor**	51	26-Aug-14	04-Nov-14
224	Typ as Basement Level -2	51	26-Aug-14	04-Nov-14
225	**Sixth Floor**	50	02-Oct-14	10-Dec-14
226	Typ as Basement Level -2	50	02-Oct-14	10-Dec-14
227	**Seventh Floor**	52	07-Nov-14	19-Jan-15
228	Typ as Basement Level -2	52	07-Nov-14	19-Jan-15
229	**Roof Deck**	3	09-Oct-14	13-Oct-14
230	Pipe Installation	3	09-Oct-14	13-Oct-14
231	**Ventilation & AC**	276	08-Jan-14	28-Jan-15
232	**Basement Level -2**	268	08-Jan-14	16-Jan-15
233	Fix Refrigerant Pipe	3	08-Jan-14	10-Jan-14
234	Fix Condensate Drain Pipe	2	08-Jan-14	09-Jan-14
235	Exhaust/Supply Fans & Grills Inst	6	17-Jan-14	24-Jan-14
236	Split Unit Installation	2	17-Dec-14	18-Dec-14
237	Pressurization/Ventilation Duct Ins	11	02-Jan-15	16-Jan-15
238	Jet Fan Installation	5	02-Jan-15	08-Jan-15
239	**Basement Level -1**	245	23-Jan-14	31-Dec-14
240	Typ as Basement Level -2	245	23-Jan-14	31-Dec-14
241	**Ground FLoor**	272	10-Jan-14	26-Jan-15
242	Fix Refrigerant Pipe	8	10-Jan-14	21-Jan-14
243	Fix Condensate Drain Pipe	3	10-Jan-14	14-Jan-14
244	Pressurization/Ventilation Duct Ins	11	03-Nov-14	17-Nov-14



Actual Level of Effort | Remaining Work | ◆ ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

#	Activity Name	Original Duration	Start	Finish
245	Split Unit Installation	8	15-Jan-15	26-Jan-15
246	Toilet/Kitchen Fans Installation	3	21-Jan-15	23-Jan-15
247	**Mezz. Floor**	260	30-Jan-14	28-Jan-15
248	Typ as Ground Floor	260	30-Jan-14	28-Jan-15
249	**First Floor**	70	27-Feb-14	04-Jun-14
250	Typ as Ground Floor	70	27-Feb-14	04-Jun-14
251	**Second Floor**	69	07-Apr-14	10-Jul-14
252	Typ as Ground Floor	69	07-Apr-14	10-Jul-14
253	**Third Floor**	84	28-Apr-14	21-Aug-14
254	Typ as Ground Floor	84	28-Apr-14	21-Aug-14
255	**Fourth Floor**	80	09-Jun-14	26-Sep-14
256	Typ as Ground Floor	80	09-Jun-14	26-Sep-14
257	**Fifth Floor**	80	15-Jul-14	03-Nov-14
258	Typ as Ground Floor	80	15-Jul-14	03-Nov-14
259	**Sixth Floor**	78	21-Aug-14	08-Dec-14
260	Typ as Ground Floor	78	21-Aug-14	08-Dec-14
261	**Seventh FLoor**	77	26-Sep-14	12-Jan-15
262	Typ as Ground Floor	77	26-Sep-14	12-Jan-15
263	**Roof Deck**	54	22-Sep-14	04-Dec-14
264	Typ as Ground Floor	54	22-Sep-14	04-Dec-14
265	**Machine Room (Substation)**	42	10-Jan-14	10-Mar-14
266	**Arch Rough-in**	36	10-Jan-14	28-Feb-14
267	Finish Work	36	10-Jan-14	28-Feb-14
268	**MEP Works**	22	07-Feb-14	10-Mar-14
269	Installation	22	07-Feb-14	10-Mar-14
270	**External Facade Finishes**	109	22-Sep-14	19-Feb-15
271	**Front Elevation**	71	22-Sep-14	29-Dec-14
272	External Plaster	16	22-Sep-14	13-Oct-14
273	External Paint (Primer & Texturize	13	13-Oct-14	29-Oct-14
274	Installation of Alum. Framing for C	18	29-Oct-14	21-Nov-14
275	External Paint (1st Coat)	11	17-Nov-14	01-Dec-14
276	Installation of Glazing for Curtain \	12	21-Nov-14	08-Dec-14
277	External Paint (Final Paint)	11	15-Dec-14	29-Dec-14
278	**Left Elevation**	62	13-Oct-14	06-Jan-15
279	Typ as Front Elevation	62	13-Oct-14	06-Jan-15
280	**Right Elevation**	63	04-Nov-14	29-Jan-15
281	Typ as Front Elevation	63	04-Nov-14	29-Jan-15
282	**Rear Elevation**	61	27-Nov-14	19-Feb-15
283	Typ as Front Elevation	61	27-Nov-14	19-Feb-15
284	**Garbage Chute**	21	26-Sep-14	24-Oct-14
285	Installation	21	26-Sep-14	24-Oct-14
286	**Elevator Installation**	77	09-Oct-14	23-Jan-15
287	Prepare & Install	77	09-Oct-14	23-Jan-15
288	**External Site Works**	44	29-Oct-14	29-Dec-14
289	Construction of Soakway	7	29-Oct-14	06-Nov-14
290	Construction of Drainage Manhole	5	06-Nov-14	12-Nov-14
291	Laying Drainage Pipe Line	4	12-Nov-14	17-Nov-14
292	Construction of Holding Tank	22	12-Nov-14	11-Dec-14
293	Installation of Curb Stone	8	08-Dec-14	17-Dec-14
294	Installation of Interlock Paviours	9	17-Dec-14	29-Dec-14
295	**Testing & Commissioning Ph**	59	14-Jan-15	06-Apr-15
296	Tesing of Systems	59	14-Jan-15	06-Apr-15
297	**Completion/Close-out**	22	02-Apr-15	01-May-15
298	Project Demobilization	9	02-Apr-15	14-Apr-15
299	Substantial Completion	1	14-Apr-15	14-Apr-15
300	Owner Move In	1	01-May-15	01-May-15



Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

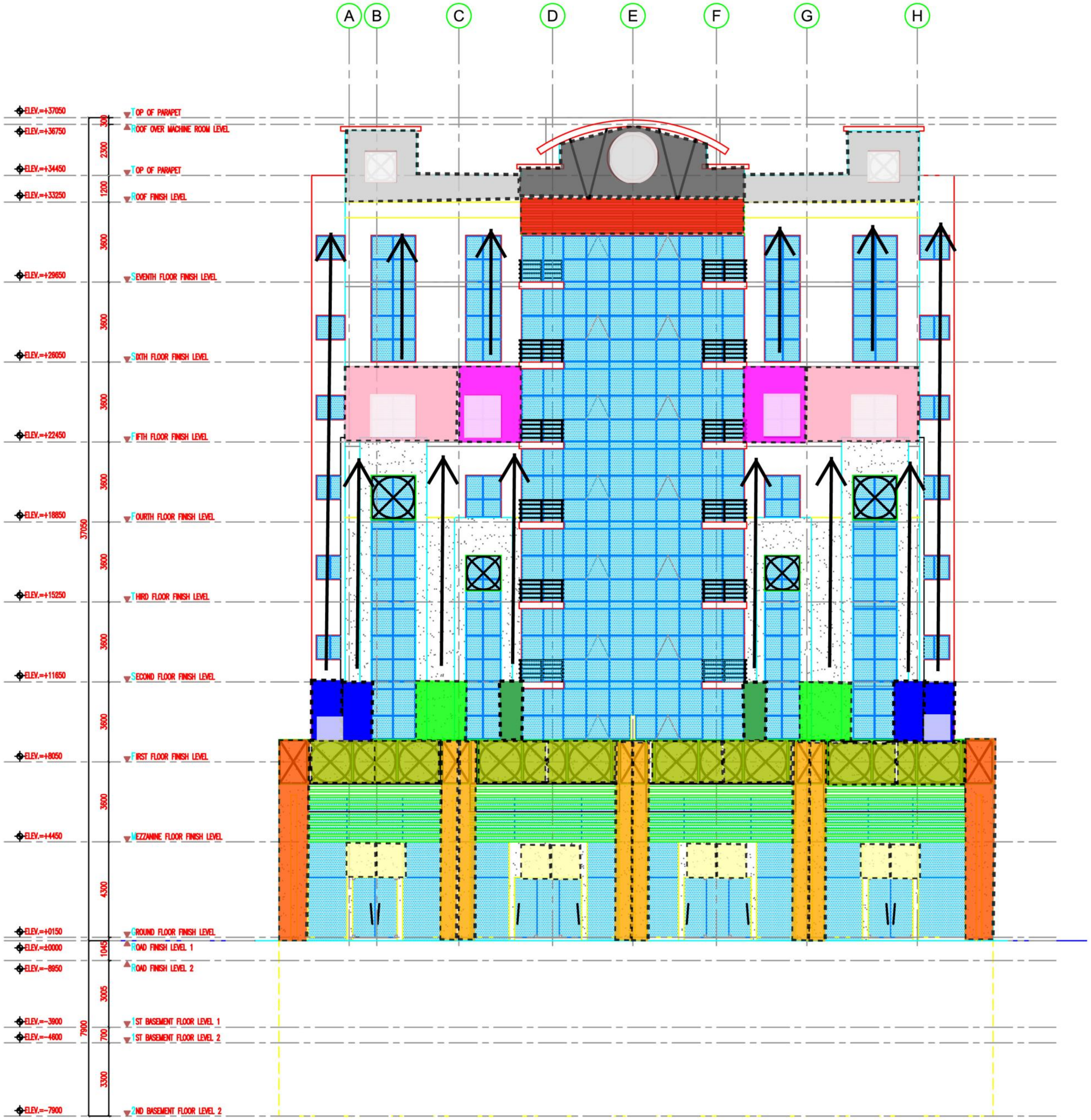
Appendix F – General Conditions Estimate

Appendix F

General Conditions Estimate				
Item	**Unit**	**Quantity**	**Cost/Unit**	**Total**
Project Management				**$ 662,100.00**
General Manager	Weeks	12	$ 2,525.00	$ 30,300.00
Project Engineer	Weeks	104	$ 2,225.00	$ 231,400.00
MEP Engineer	Weeks	104	$ 1,925.00	$ 200,200.00
Quantity Surveyor	Weeks	104	$ 1,925.00	$ 200,200.00
Field Operations				**$ 86,443.95**
Perimeter Fencing	L.F.	443	$ 23.85	$ 10,565.55
Project Sign Board	S.F.	500	$ 31.50	$ 15,750.00
Safety Handrails (For all Floors)	Months	12	$ 1,200.00	$ 14,400.00
Temp Power, 400A	EA.	1	$ 2,625.00	$ 2,625.00
Lighting	Months	24	$ 152.00	$ 3,648.00
Water Supply	Months	24	$ 63.00	$ 1,512.00
Site Cleanup	%	0.3	$ 12,647,791.60	$ 37,943.40
Field Office				**$ 9,070.00**
Site Office Trailer	Months	14	$ 305.00	$ 4,270.00
Site Office Facilities	Months	24	$ 200.00	$ 4,800.00
Testing & Inspections				**$ 6,125.60**
Testing Service	EA.	1	$ 5,566.05	$ 6,125.60
Insurance				**$ 331,372.26**
Performance Bond	%	0.6	$ 12,647,791.60	$ 75,886.70
Insurance Work (Commitment Co.)	%	0.02	$ 12,647,791.60	$ 2,529.56
Third Party Insurance (Commitment Co.)	%	1	$ 12,647,791.60	$ 126,478.00
Workmen Insurance (Commitment Co.)	%	1	$ 12,647,791.60	$ 126,478.00
Subtotal				**$ 1,095,111.81**

Appendix G – Precast Panel Design Take-Off

**Note: West Façade is identical to East Façade therefore only one plan was included.*



A
A14
NORTH (FRONT) ELEVATION
SCALE: 1:100MTS.

NOTES

1) ALL DRAWINGS ARE STATED IN MILLIMETERS, AND METERS AS INDICATED IN ROOM SIZES.

2) DRAWINGS SHALL NOT BE SCALED. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.

REF.	DATE	REVISIONS	BY
1	07.06.12	ISSUED FOR DC-2 APPROVAL	RBR
0	22.10.11	ISSUED FOR DC-1 APPROVAL	RBR

U.D.D STAMP

MUNICIPALITY STAMP

MAIN CONSULTANT		SUB-CONSULTANT	
CONSULTANT REG. NO: m55	GRADE : A	CONSULTANT REG. NO:	GRADE : A
TECHNICAL MANAGER : MAHMOUD S. SALTI		TECHNICAL MANAGER :	
REGISTRATION NO : 306		REGISTRATION NO :	

بترا للتصميم
Petra design
consulting architects, engineers
TELEPHONE: 44664396 - 44664350 FAX: 44664943
P.O.BOX: 1151, DOHA-QATAR, 305 "C"RING ROAD
www.petradesign.com

ISO 9001 : 2008 C : 376
MGMT. SYS CERTIFIED

PROJECT:
2B+G+M+7 DEVELOPMENT

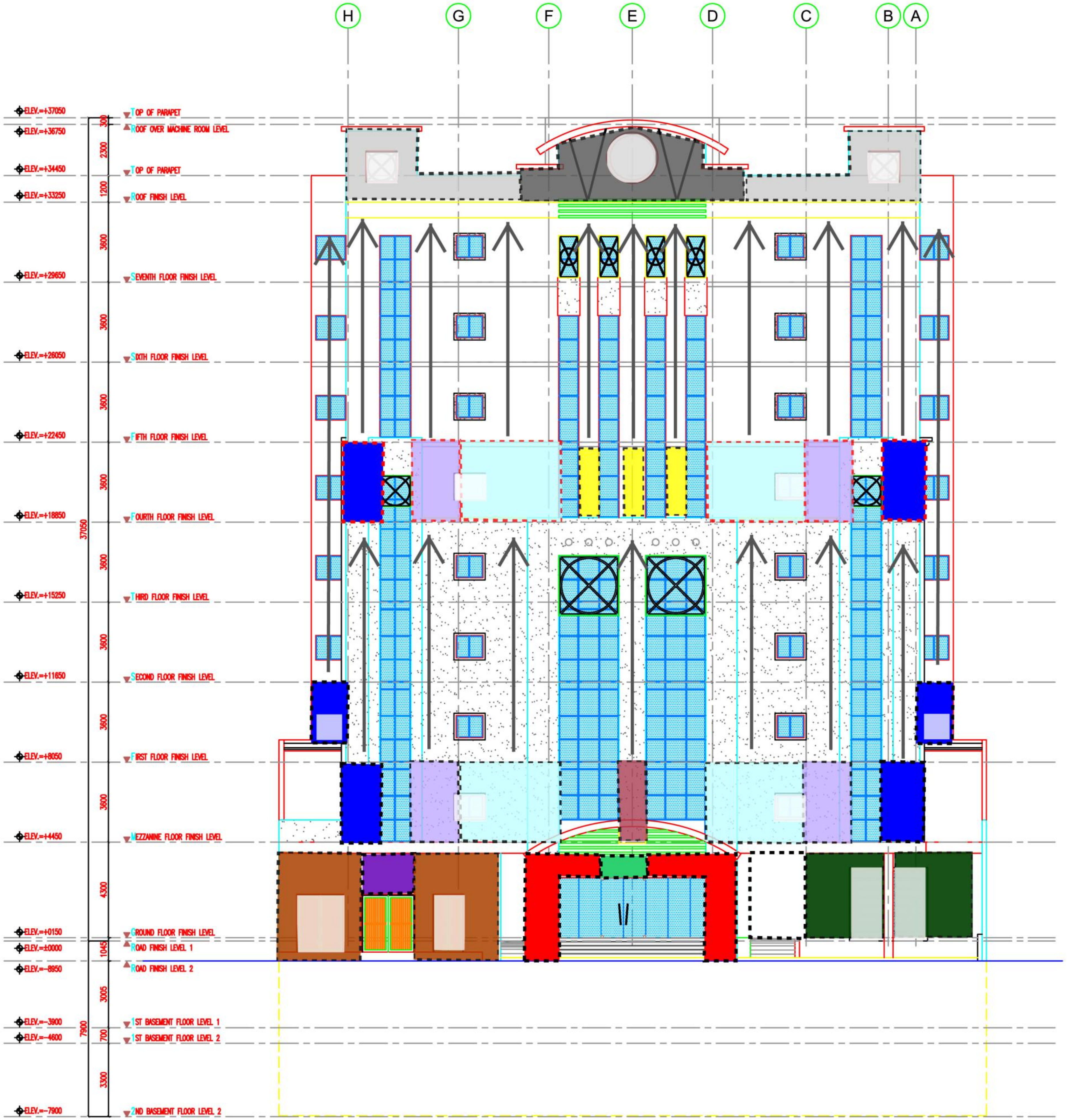
LOCATION : MANSOURA

CLIENT :
MRS. FAKHRIYA ISMAIL RADHWANI

JOB NO : 2011139 | REVISION : 1

DRG. TITLE :
NORTH (FRONT) ELEVATION

DRAWING NO: A14	SCALE : 1:100	PAPER SIZE: A1
DRAWN BY: RBR	DESIGNED BY: MSS	CHECKED BY: EMB



A A17 SOUTH (REAR) ELEVATION
SCALE: 1:100MTS.

NOTES

1) ALL DRAWINGS ARE STATED IN MILLIMETERS, AND METERS AS INDICATED IN ROOM SIZES.

2) DRAWINGS SHALL NOT BE SCALED. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.

REF.	DATE	REVISIONS	BY
1	07.06.12	ISSUED FOR DC-2 APPROVAL	RBR
0	22.10.11	ISSUED FOR DC-1 APPROVAL	RBR

U.D.D STAMP

MUNICIPALITY STAMP

MAIN CONSULTANT		SUB-CONSULTANT	
CONSULTANT REG. NO: m55	GRADE : A	CONSULTANT REG. NO:	GRADE : A
TECHNICAL MANAGER : MAHMOUD S. SALTI		TECHNICAL MANAGER :	
REGISTRATION NO : 306		REGISTRATION NO :	

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www.petradesign.com

ISO 9001 : 2008 C : 376
MGMT. SYS CERTIFIED

PROJECT: 2B+G+M+7 DEVELOPMENT

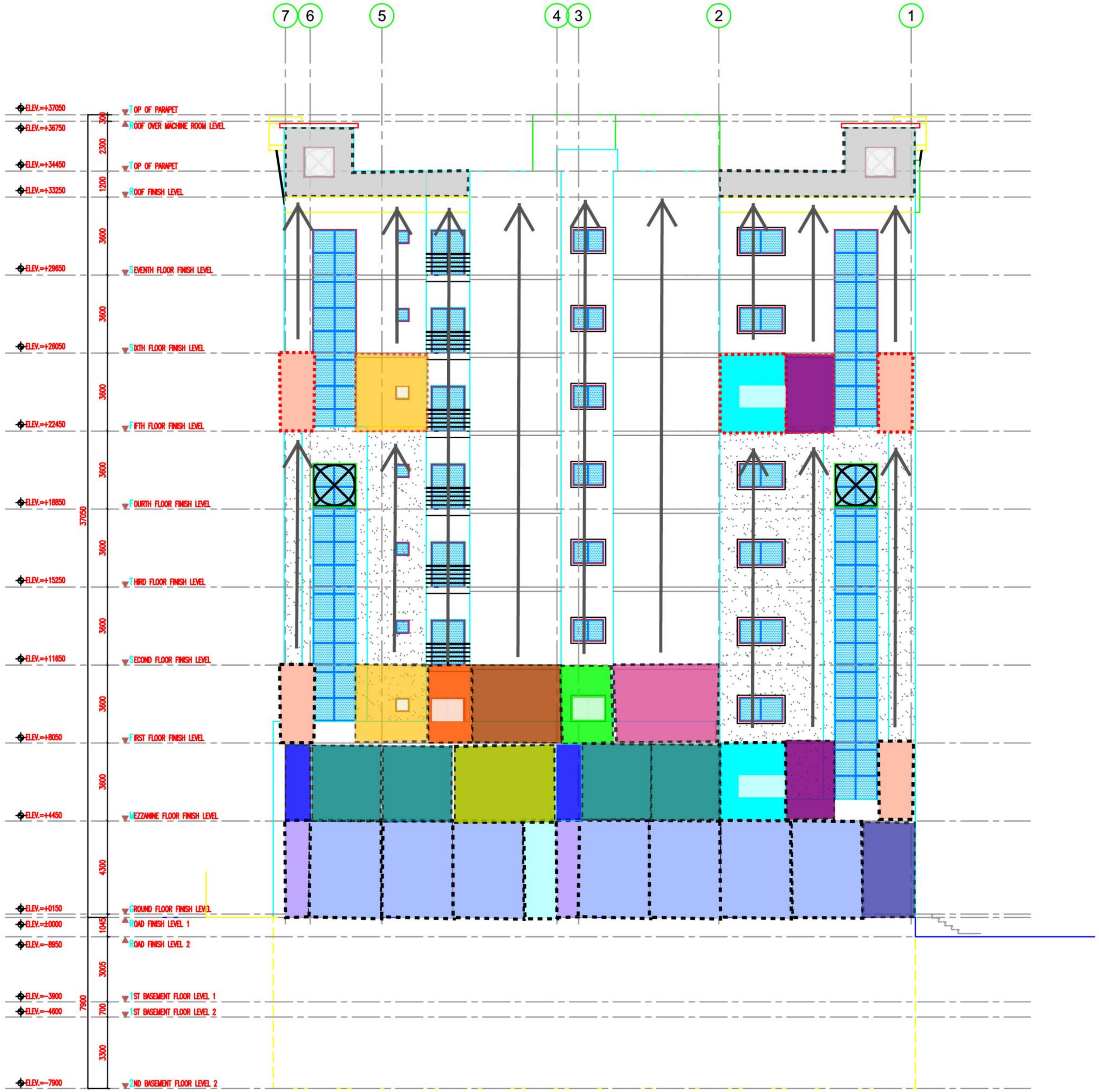
LOCATION : MANSOURA

CLIENT : MRS. FAKHRIYA ISMAIL RADHWANI

JOB NO : 2011139 — REVISION : 1

DRG. TITLE : SOUTH (REAR) ELEVATION

DRAWING NO: A17	SCALE : 1:100	PAPER SIZE: A1
DRAWN BY: RBR	DESIGNED BY: MSS	CHECKED BY: EMB



A
A14
WEST (RIGHT-SIDE) ELEVATION
SCALE: 1:100MTS.

NOTES

1) ALL DRAWINGS ARE STATED IN MILLIMETERS, AND METERS AS INDICATED IN ROOM SIZES.

2) DRAWINGS SHALL NOT BE SCALED. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.

REF.	DATE	REVISIONS	BY
0	07.06.12	ISSUED FOR DC-2 APPROVAL	RBR

U.D.D STAMP

MUNICIPALITY STAMP

MAIN CONSULTANT		SUB-CONSULTANT	
CONSULTANT REG. NO: m55	GRADE : A	CONSULTANT REG. NO:	GRADE : A
TECHNICAL MANAGER : MAHMOUD S. SALTI		TECHNICAL MANAGER :	
REGISTRATION NO : 306		REGISTRATION NO :	

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www.petradesign.com

ISO 9001 : 2008 C : 376
MGMT. SYS CERTIFIED

PROJECT: 2B+G+M+7 DEVELOPMENT

LOCATION : MANSOURA

CLIENT : MRS. FAKHRIYA ISMAIL RADHWANI

JOB NO : 2011139 | REVISION : 0

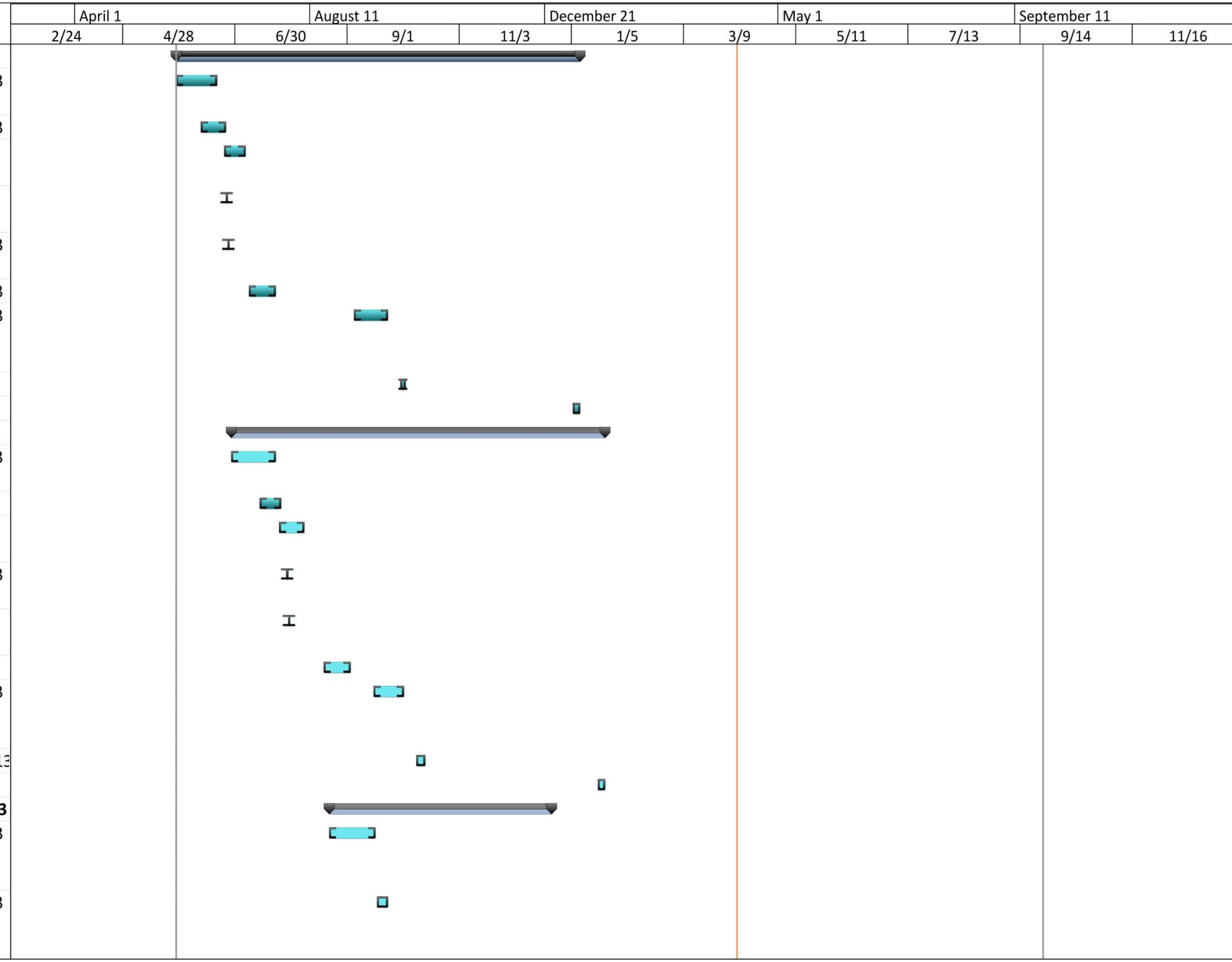
DRG. TITLE : WEST (RIGHT SIDE) ELEVATION

DRAWING NO: A15	SCALE : 1:100	PAPER SIZE: A1
DRAWN BY: RBR	DESIGNED BY: MSS	CHECKED BY: EMB

Appendix H – Revised Precast Schedule

Mansoura Development

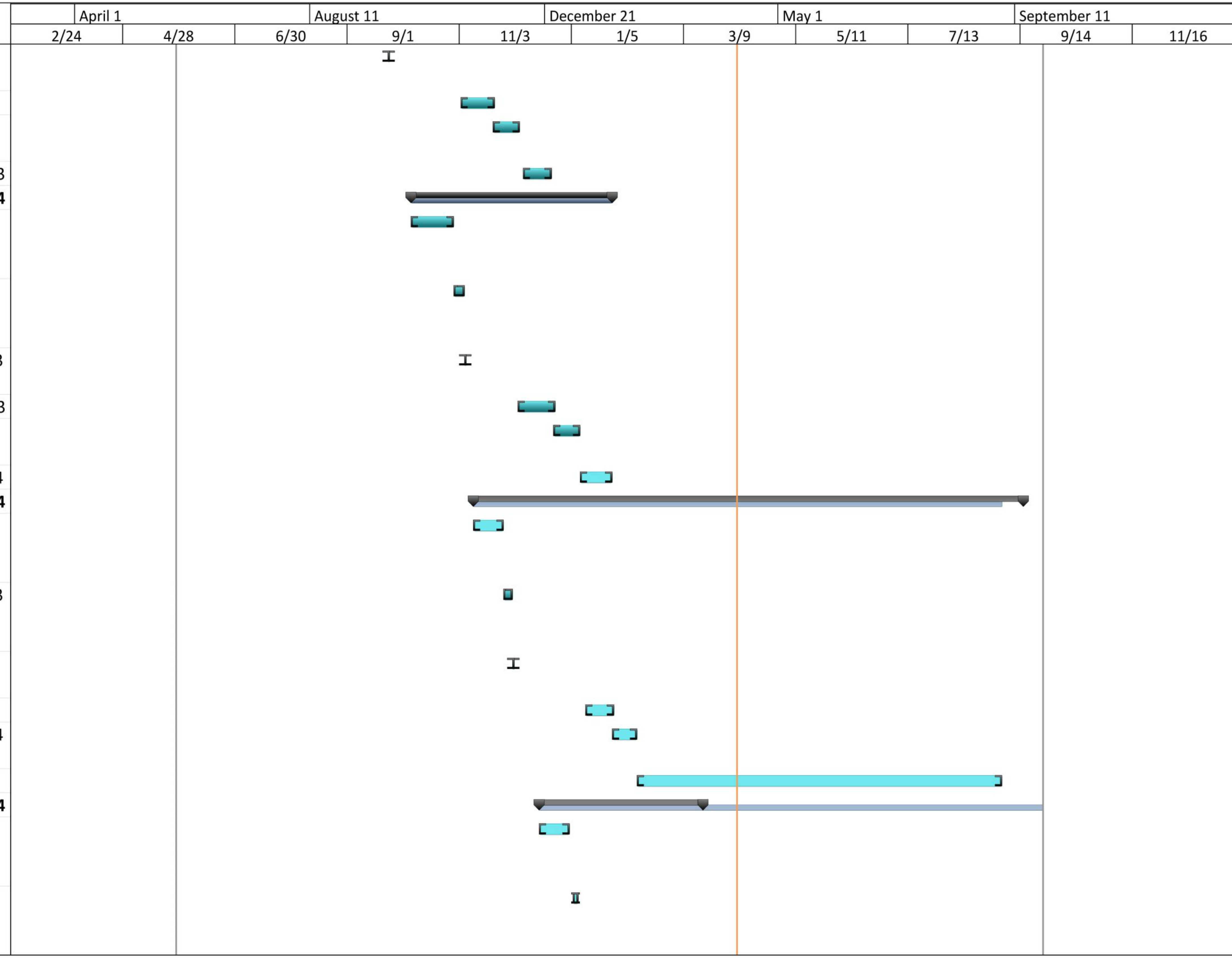
ID	Task Mode	Task Name	Duration	Start	Finish
1		**Basement 2**	**163 days**	**Tue 5/28/13**	**Thu 1/9/14**
2		Column & Wall Formwork/Reinforceme	17 days	Tue 5/28/13	Wed 6/19/13
3		Shoring Wall Plastering	10 days	Tue 6/11/13	Mon 6/24/13
4		Waterproofing work around walls	10 days	Mon 6/24/13	Fri 7/5/13
5		Column concrete casting	1 day	Tue 6/25/13	Tue 6/25/13
6		Precast Panel Erection	1 day	Wed 6/26/13	Wed 6/26/13
7		Backfill around walls	11 days	Mon 7/8/13	Mon 7/22/13
8		Beams and slabs formwork/reinforcemer casting	13 days	Thu 9/5/13	Mon 9/23/13
9		Plain Concrete Screed	3 days	Tue 10/1/13	Thu 10/3/13
10		Hollow Block	4 days	Mon 1/6/14	Thu 1/9/14
11		**Basement 1**	**150 days**	**Fri 6/28/13**	**Thu 1/23/14**
12		Column & Wall Formwork/Reinforceme	17 days	Fri 6/28/13	Mon 7/22/13
13		Shoring Wall Plastering	10 days	Sun 7/14/13	Thu 7/25/13
14		Waterproofing work around walls	10 days	Thu 7/25/13	Wed 8/7/13
15		Columns concrete casting	1 day	Mon 7/29/13	Mon 7/29/13
16		Precast Panel Erection	1 day	Tue 7/30/13	Tue 7/30/13
17		Backfill around walls	11 days	Mon 8/19/13	Mon 9/2/13
18		Beams and slabs formwork/reinforcemer casting	13 days	Mon 9/16/13	Wed 10/2/13
19		Plain Concrete Screed	3 days	Thu 10/10/13	Mon 10/14/13
20		Hollow Block	4 days	Mon 1/20/14	Thu 1/23/14
21		**Ground Floor**	**89 days**	**Thu 8/22/13**	**Tue 12/24/13**
22		Beams and slabs formwork/reinforcemer casting	18 days	Thu 8/22/13	Mon 9/16/13
23		Columns formwork/reinforcemer casting	4 days	Wed 9/18/13	Mon 9/23/13



Project: proposed
Date: Tue 4/8/14

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

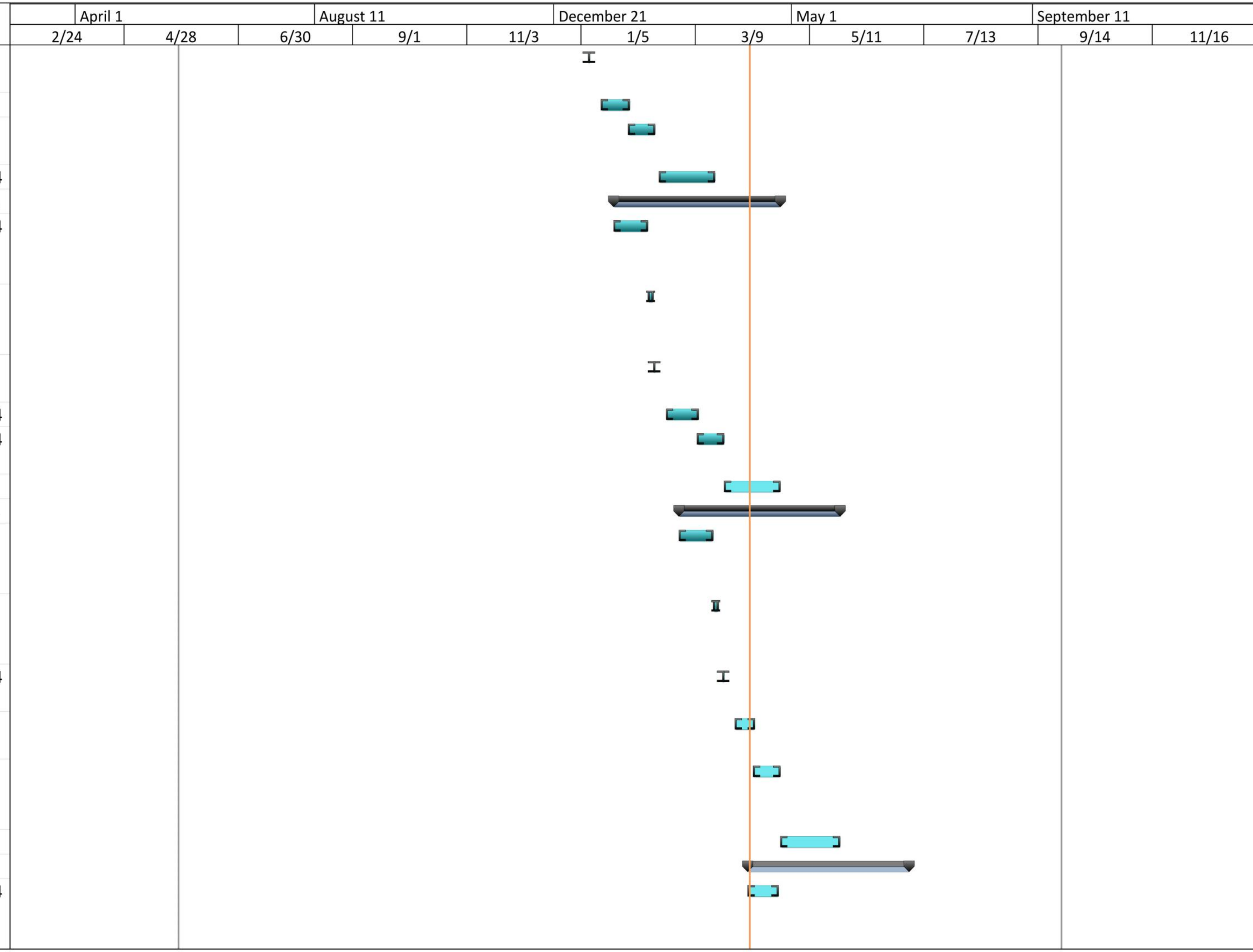
ID	Task Mode	Task Name	Duration	Start	Finish
24		Precast Panel Erection	1 day	Tue 9/24/13	Tue 9/24/13
25		Waterproofing works	15 days	Mon 11/4/13	Fri 11/22/13
26		Cement sand screed above waterproofing	11 days	Fri 11/22/13	Fri 12/6/13
27		Hollow Block	12 days	Mon 12/9/13	Tue 12/24/13
28		**Mezzanine Floor**	**81 days**	**Mon 10/7/13**	**Mon 1/27/14**
29		Beams and slabs formwork/reinforcemer casting	18 days	Mon 10/7/13	Wed 10/30/13
30		Columns formwork/reinforcemer casting	4 days	Thu 10/31/13	Tue 11/5/13
31		Precast Panel Erection	1 day	Wed 11/6/13	Wed 11/6/13
32		Waterproofing works	15 days	Fri 12/6/13	Thu 12/26/13
33		Cement sand screed above waterproofing	11 days	Thu 12/26/13	Thu 1/9/14
34		Hollow Block	12 days	Fri 1/10/14	Mon 1/27/14
35		**First Floor**	**221 days**	**Mon 11/11/1:**	**Mon 9/15/14**
36		Beams and slabs formwork/reinforcemer casting	13 days	Mon 11/11/13	Wed 11/27/13
37		Columns formwork/reinforcemer casting	3 days	Thu 11/28/13	Mon 12/2/13
38		Precast Panel Erection	1 day	Tue 12/3/13	Tue 12/3/13
39		Waterproofing works	12 days	Mon 1/13/14	Tue 1/28/14
40		Cement sand screed above waterproofing	10 days	Tue 1/28/14	Mon 2/10/14
41		Hollow Block	147 days	Tue 2/11/14	Wed 9/3/14
42		**Second Floor**	**66 days**	**Wed 12/18/1:**	**Wed 3/19/14**
43		Beams and slabs formwork/reinforcemer casting	13 days	Wed 12/18/13	Fri 1/3/14
44		Columns formwork/reinforcemer casting	3 days	Mon 1/6/14	Wed 1/8/14



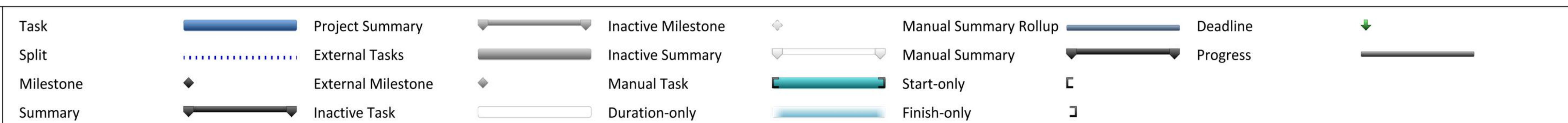
Project: proposed
Date: Tue 4/8/14

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

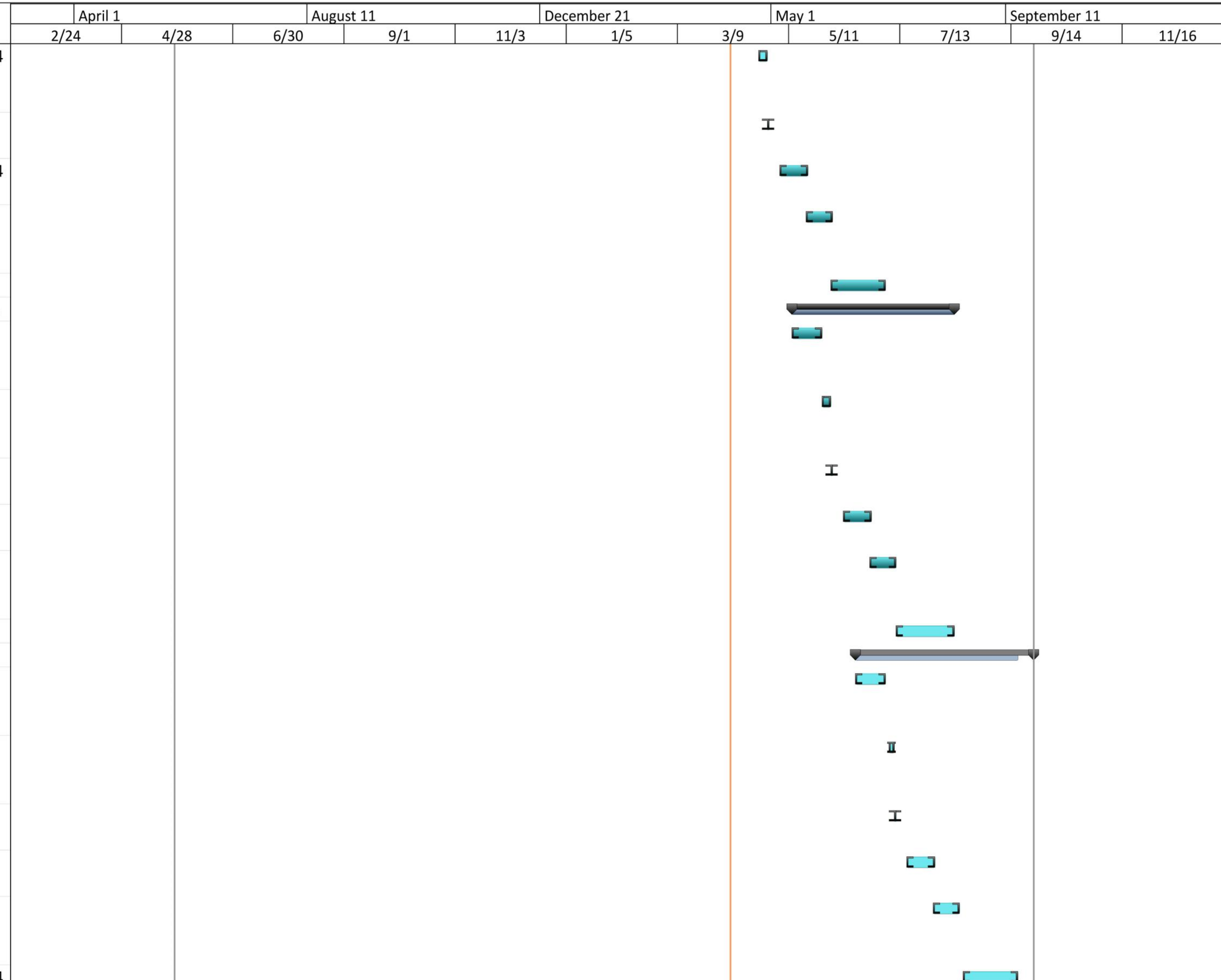
ID	Task Mode	Task Name	Duration	Start	Finish
45		Precast Panel Erection	1 day	Thu 1/9/14	Thu 1/9/14
46		Waterproofing works	12 days	Thu 1/16/14	Fri 1/31/14
47		Cement sand screed above waterproofing	11 days	Fri 1/31/14	Fri 2/14/14
48		Hollow Block	23 days	Mon 2/17/14	Wed 3/19/14
49		**Third Floor**	**66 days**	**Thu 1/23/14**	**Thu 4/24/14**
50		Beams and slabs formwork/reinforcem casting	13 days	Thu 1/23/14	Mon 2/10/14
51		Columns formwork/reinforcem casting	3 days	Tue 2/11/14	Thu 2/13/14
52		Precast Panel Erection	1 day	Fri 2/14/14	Fri 2/14/14
53		Waterproofing works	12 days	Fri 2/21/14	Mon 3/10/14
54		Cement sand screed above waterproofing	11 days	Mon 3/10/14	Mon 3/24/14
55		Hollow Block	23 days	Tue 3/25/14	Thu 4/24/14
56		**Fourth Floor**	**63 days**	**Fri 2/28/14**	**Tue 5/27/14**
57		Beams and slabs formwork/reinforcem casting	13 days	Fri 2/28/14	Tue 3/18/14
58		Columns formwork/reinforcem casting	3 days	Wed 3/19/14	Fri 3/21/14
59		Precast Panel Erection	1 day	Mon 3/24/14	Mon 3/24/14
60		Waterproofing works	9 days	Mon 3/31/14	Thu 4/10/14
61		Cement sand screed above waterproofing	11 days	Thu 4/10/14	Thu 4/24/14
62		Hollow Block	23 days	Fri 4/25/14	Tue 5/27/14
63		**Fifth Floor**	**65 days**	**Mon 4/7/14**	**Fri 7/4/14**
64		Beams and slabs formwork/reinforcem casting	13 days	Mon 4/7/14	Wed 4/23/14



Project: proposed
Date: Tue 4/8/14



ID	Task Mode	Task Name	Duration	Start	Finish
65		Columns formwork/reinforcem casting	3 days	Thu 4/24/14	Mon 4/28/14
66		Precast Panel Erection	1 day	Tue 4/29/14	Tue 4/29/14
67		Waterproofing works	12 days	Tue 5/6/14	Wed 5/21/14
68		Cement sand screed above waterproofing	11 days	Wed 5/21/14	Wed 6/4/14
69		Hollow Block	23 days	Wed 6/4/14	Fri 7/4/14
70		**Sixth Floor**	**66 days**	**Tue 5/13/14**	**Tue 8/12/14**
71		Beams and slabs formwork/reinforcem casting	13 days	Tue 5/13/14	Thu 5/29/14
72		Columns formwork/reinforcem casting	3 days	Fri 5/30/14	Tue 6/3/14
73		Precast Panel Erection	1 day	Wed 6/4/14	Wed 6/4/14
74		Waterproofing works	12 days	Wed 6/11/14	Thu 6/26/14
75		Cement sand screed above waterproofing	11 days	Thu 6/26/14	Thu 7/10/14
76		Hollow Block	23 days	Fri 7/11/14	Tue 8/12/14
77		**Seventh Floor**	**73 days**	**Wed 6/18/14**	**Fri 9/26/14**
78		Beams and slabs formwork/reinforcem casting	13 days	Wed 6/18/14	Fri 7/4/14
79		Columns formwork/reinforcem casting	3 days	Mon 7/7/14	Wed 7/9/14
80		Precast Panel Erection	1 day	Thu 7/10/14	Thu 7/10/14
81		Waterproofing works	12 days	Thu 7/17/14	Fri 8/1/14
82		Cement sand screed above waterproofing	11 days	Fri 8/1/14	Fri 8/15/14
83		Hollow Block	23 days	Mon 8/18/14	Wed 9/17/14



Project: proposed
Date: Tue 4/8/14

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

Appendix I – Precast Panel Cost Take-Off

Precast Panel Takeoffs													
Panel Designation	Panel Width (Ft.)	Panel Height (Ft.)	Openings (Qty. & Type)	Total Opening Area (SF)	Joint Sealant (LF)	North Façade	South Façade	West Façade	East Façade	Total Quantity	Total Panel Area (SF)	Average Cost/SF	Total Cost
A	4	26	-	-	60	2	-	-	-	2	104	$ 30.00	$ 6,240.00
B	1.6	26	-	-	55.2	6	-	-	-	6	41.6	$ 30.00	$ 7,488.00
C	10	6.5	-	-	33	8	-	-	-	8	65	$ 30.00	$ 15,600.00
D	4	12	-	-	32	8	8	2	2	20	48	$ 30.00	$ 28,800.00
D-1	4	12	1 x W1	12.8	32	28	28	-	-	56	35.2	$ 25.00	$ 49,280.00
D-2	4	12	-	-	32	-	8	-	-	8	48	$ 25.00	$ 9,600.00
E	6	12	-	-	36	8	-	-	-	8	72	$ 30.00	$ 17,280.00
F	2.2	12	-	-	28.4	8	-	-	-	8	26.4	$ 30.00	$ 6,336.00
G	16	12	1 x W2	39	56	6	-	-	-	6	153	$ 25.00	$ 22,950.00
H	7.5	12	1 x W3	31.2	39	6	-	-	-	6	58.8	$ 25.00	$ 8,820.00
I	23.5	11.5	1 x T1	20.25	70	2	2	2	2	8	250	$ 25.00	$ 50,000.00
J	33	11.5	1 x T2	34	89	1	1	-	-	2	345.5	$ 25.00	$ 17,275.00
K	33	5	-	-	76	1	-	-	-	1	165	$ 25.00	$ 4,125.00
L	6.5	12	-	-	37	-	8	-	-	8	78	$ 30.00	$ 18,720.00
L-1	6.5	12	-	-	37	-	8	-	-	8	78	$ 25.00	$ 15,600.00
M	10	12	1 x W4	15.12	44	-	8	-	-	8	104.88	$ 30.00	$ 25,171.20
M-1	10	12	1 x W4	15.12	44	-	8	-	-	8	104.88	$ 25.00	$ 20,976.00
N	3.3	12	-	-	30.6	-	4	-	-	4	39.6	$ 30.00	$ 4,752.00
N-1	3.3	12	-	-	30.6	-	12	-	-	12	39.6	$ 25.00	$ 11,880.00
O	4	14	-	-	36	-	-	2	2	4	56	$ 30.00	$ 6,720.00
P	11	14	-	-	50	14	14	21	21	70	154	$ 30.00	$ 323,400.00
Q	5	14	-	-	38	-	-	1	1	2	70	$ 30.00	$ 4,200.00
R	11	12	-	-	46	-	-	4	4	8	132	$ 30.00	$ 31,680.00
S	16	12	-	-	56	-	-	1	1	2	192	$ 30.00	$ 11,520.00
T	9.5	12	1 x W5	23.4	43	-	-	5	5	10	90.6	$ 30.00	$ 27,180.00
T-1	9.5	12	1 x W5	23.4	43	-	-	3	3	6	90.6	$ 25.00	$ 13,590.00
U	8	12	-	-	40	-	-	5	5	10	96	$ 30.00	$ 28,800.00
U-1	8	12	-	-	40	-	-	3	3	6	96	$ 25.00	$ 14,400.00
V	5	12	-	-	34	-	-	9	9	18	60	$ 30.00	$ 32,400.00
V-1	5	12	-	-	34	-	-	6	6	12	60	$ 25.00	$ 18,000.00
V-2	5	12	1 x W6	35.36	34	-	-	7	7	14	24.64	$ 25.00	$ 8,624.00
W	9	12	-	-	42	-	-	4	4	8	108	$ 30.00	$ 25,920.00
X	15	12	-	-	54	-	-	7	7	14	180	$ 25.00	$ 63,000.00
Y	11.5	12	1 x W1	12.8	47	-	-	7	7	14	125.2	$ 25.00	$ 43,820.00
Z	20	12	-	-	64	-	-	7	7	14	240	$ 25.00	$ 84,000.00
AA	8	5	-	-	26	8	-	-	-	8	40	$ 30.00	$ 9,600.00
BB	11	14	1 x D1	57.8	50	-	2	-	-	2	96.2	$ 30.00	$ 5,772.00
CC	7	5.5	-	-	25	-	1	-	-	1	38.5	$ 30.00	$ 1,155.00
DD	10	14	-	-	48	-	2	-	-	2	140	$ 30.00	$ 8,400.00
EE	6.5	5	-	-	23	-	1	-	-	1	32.5	$ 30.00	$ 975.00
FF	8	14	-	-	44	-	1	-	-	1	112	$ 30.00	$ 3,360.00
GG	12	14	1 x W7	22.4	52	-	2	-	-	2	145.6	$ 30.00	$ 8,736.00

Total	1830.8	106	118	96	96	416	-	-	$ 1,116,145.20

Opening	W1	W2	W3	W4	W5	W6	W7	D1	T1	T2
Area (SF)	12.8	39	31.2	15.12	23.4	35.36	22.4	57.8	20.25	34

Appendix H-2

CIP Take-OFF				
Panel Designation	**Area (SF)**	**Area (Cu.Ft.)**	**Area (CY)**	**Total Cost**
A	208	Thickness of concrete = 10"		$550.50/CY
B	249.6			
C	520			
D	960			
D-1	1971.2			
D-2	384			
E	576			
F	211.2			
G	918			
H	352.8			
I	2000			
J	691			
K	165			
L	624			
L-1	624			
M	839.04			
M-1	839.04			
N	158.4			
N-1	475.2			
O	224			
P	10780			
Q	140			
R	1056			
S	384			
T	906			
T-1	543.6			
U	960			
U-1	576			
V	1080			
V-1	720			
V-2	344.96			
W	864			
X	2520			
Y	1752.8			
Z	3360			
AA	320			
BB	192.4			
CC	38.5			
DD	280			
EE	32.5			
FF	112			
GG	291.2			
Total	40,244.44	32,195.55	1192.4	**$ 656,416.20**

Appendix J – Structural Analysis Calculations

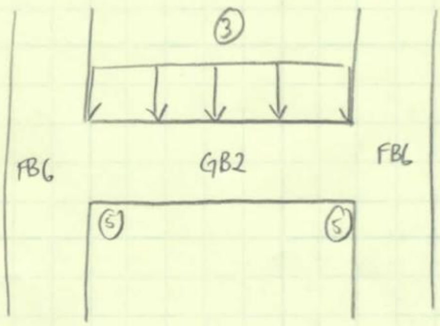
Structural Breadth Analysis

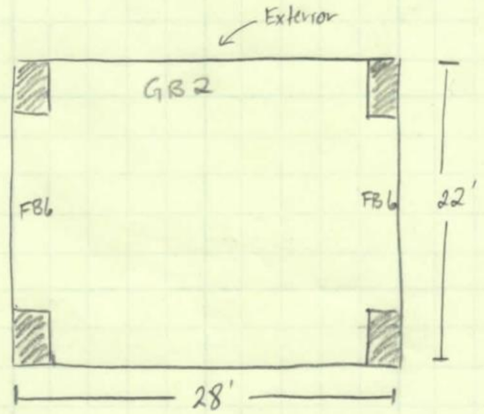
weight of conc. = 150 pcf

Existing Conditions (Cast-in-Place Concrete)

* info retrieved from AE 404 notes

Examining a typical bay:





$③ = +\frac{W_u l_n^2}{16}$ $⑤ = \frac{-W_u l_n^2}{11}$

$(W_{Trib} = \frac{1}{2} \times 22')$

$W_u = 1.2D + 1.6L$ ⟹ Retrieved from IBC [part of AE 404 notes]

L = Live Load ⟹ 40 psf (ASCE-7) + 20 psf (partition)

$= 60 \text{ psf} \left(0.25 + \frac{15}{\sqrt{22' \times 28'}}\right)$

$= 60\,(0.85) \doteq 51.26 \text{ psf} \times W_{Trib} = \underline{563.86 \text{ plf}}$

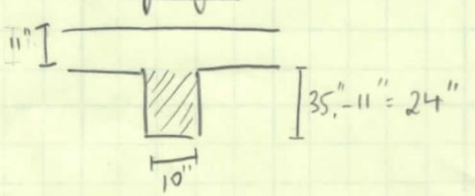
D = Dead Load ⟹ Slab selfwgt $= \frac{11''}{12''} \times 15 \text{ pcf} = 13.75 \text{ psf}$

superimposed = 10 psf (Assume)

> 23.75 psf

$23.75 \text{ psf} \times W_{Trib} = 23.75\left(\frac{1}{2} \times 22'\right) = \underline{261.25 \text{ plf}}$

Girder Selfweight



$\Longrightarrow \frac{24'' \times 10''}{144 \text{ in}^2/\text{ft}^2} \times 150 \text{ pcf} = \underline{250 \text{ plf}}$

Wall ⟹ $\frac{10''}{12''} \times 12' \times 150 \text{ pcf} = \underline{1500 \text{ plf}}$

$\therefore W_u = 1.2(\underbrace{261.25}_{\text{Slab + Super DL}} + \underbrace{250}_{\text{Girder SW DL}} + \underbrace{1500}_{\text{wall DL}}) + 1.6(\underbrace{563.86}_{\text{LL}})$ = 2413.5 + 902.176

= 3315.676 lbs

= **3.3156 Kips**

Proposed Conditions (Pre-cast Concrete)

$W_u = 1.2(261.25 + 250 + \text{Wall DL}) + 1.6(563.86)$

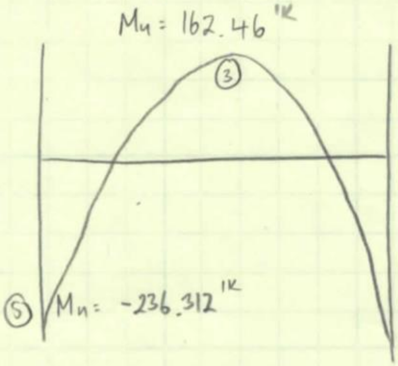
$\text{Wall DL} = 75.26 \text{ psf} \times 12' = 903.12 \text{ plf}$

$\therefore \quad W_u = 1697.244 + 902.176$

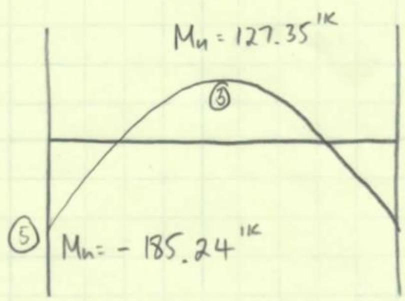
$= 2599.42 \text{ lbs}$

$= \boxed{2.599 \text{ Kips}}$

Existing — Vs. — Proposed



Vs.

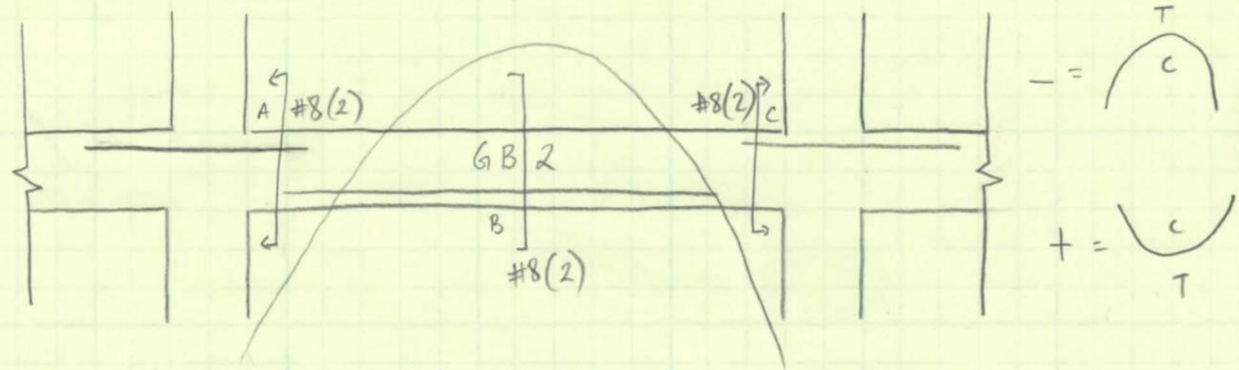


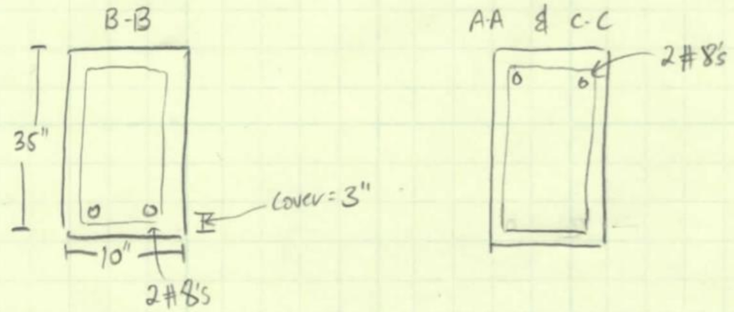
$③ = \dfrac{3.3156(28^2)}{16} = 162.46'^K$

$⑤ = -\dfrac{3.3156(28^2)}{11} = -236.312'^K$

$③ = \dfrac{2.599 \times (28^2)}{16} = 127.35'^K$

$⑤ = -\dfrac{2.599(28^2)}{11} = 185.24'^K$





Check $M_u \leq \phi M_n$ [Flexural Strength]

For B-B

$M_u = 127.35$ Kips

$h = 35" - 3" = 32"$

$$\phi M_n = 0.9 \times A_s \times 60 \times \left(d - \frac{1.96 A_s}{2}\right)$$

$$127.35\,(12') = 0.9 \times A_s \times 60 \times \left(32" - \frac{1.96 A_s}{2}\right)$$

↳ $A_s \geq 0.91$ ∴ ✓✓

∴ #7 @ 7½" ⇒ Need 2!

* Since A-A & C-C are identical to B-B, no further calculation was needed.

As for this composition will be : 0.96 in/in.

↳ Retrieved from ACI Rebar Spacing Chart

ACI – Rebar Spacing

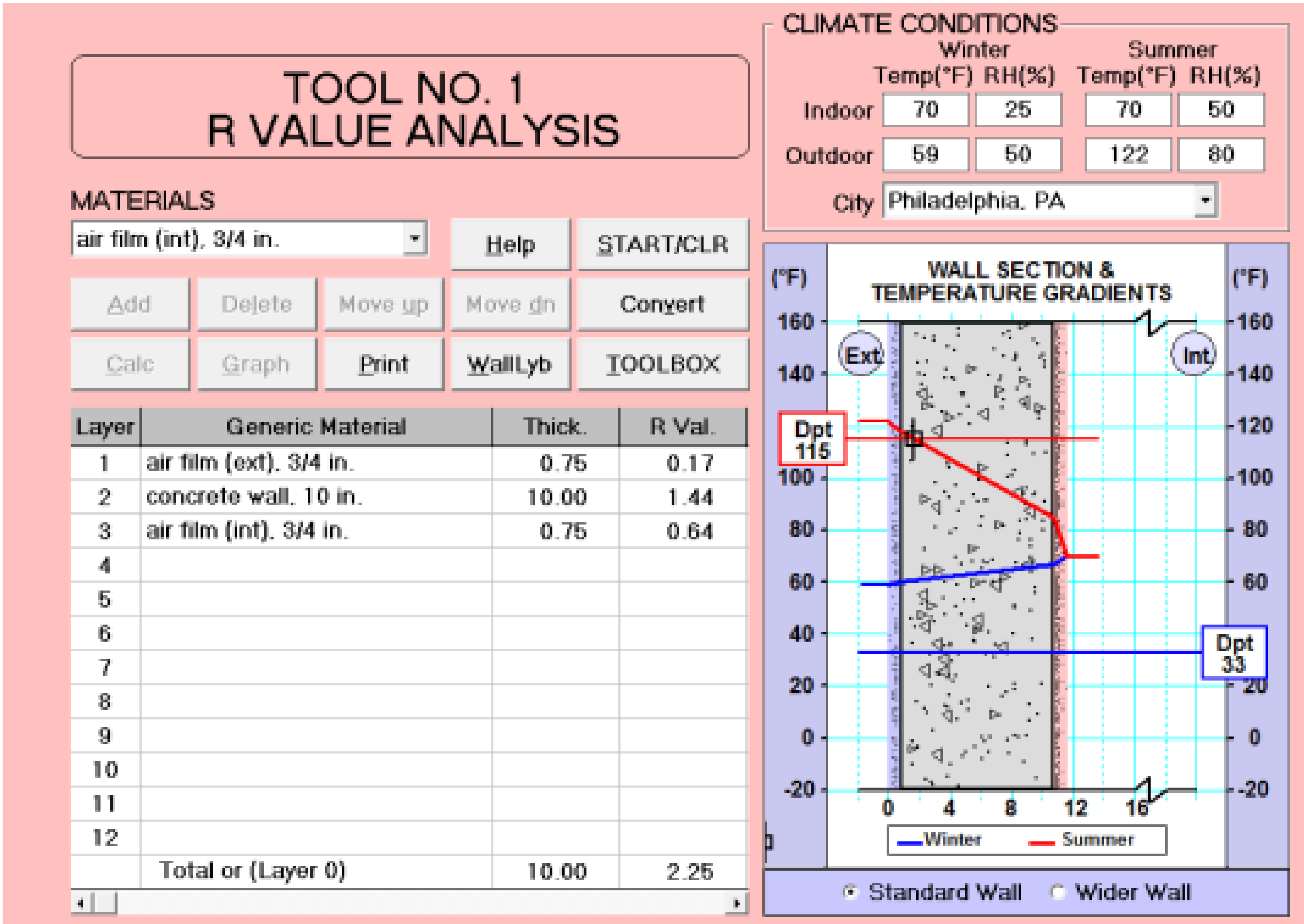
TABLE A - 4 AREAS OF REINFORCING BARS PER FOOT OF SLAB (IN.^{2})

Bar Number

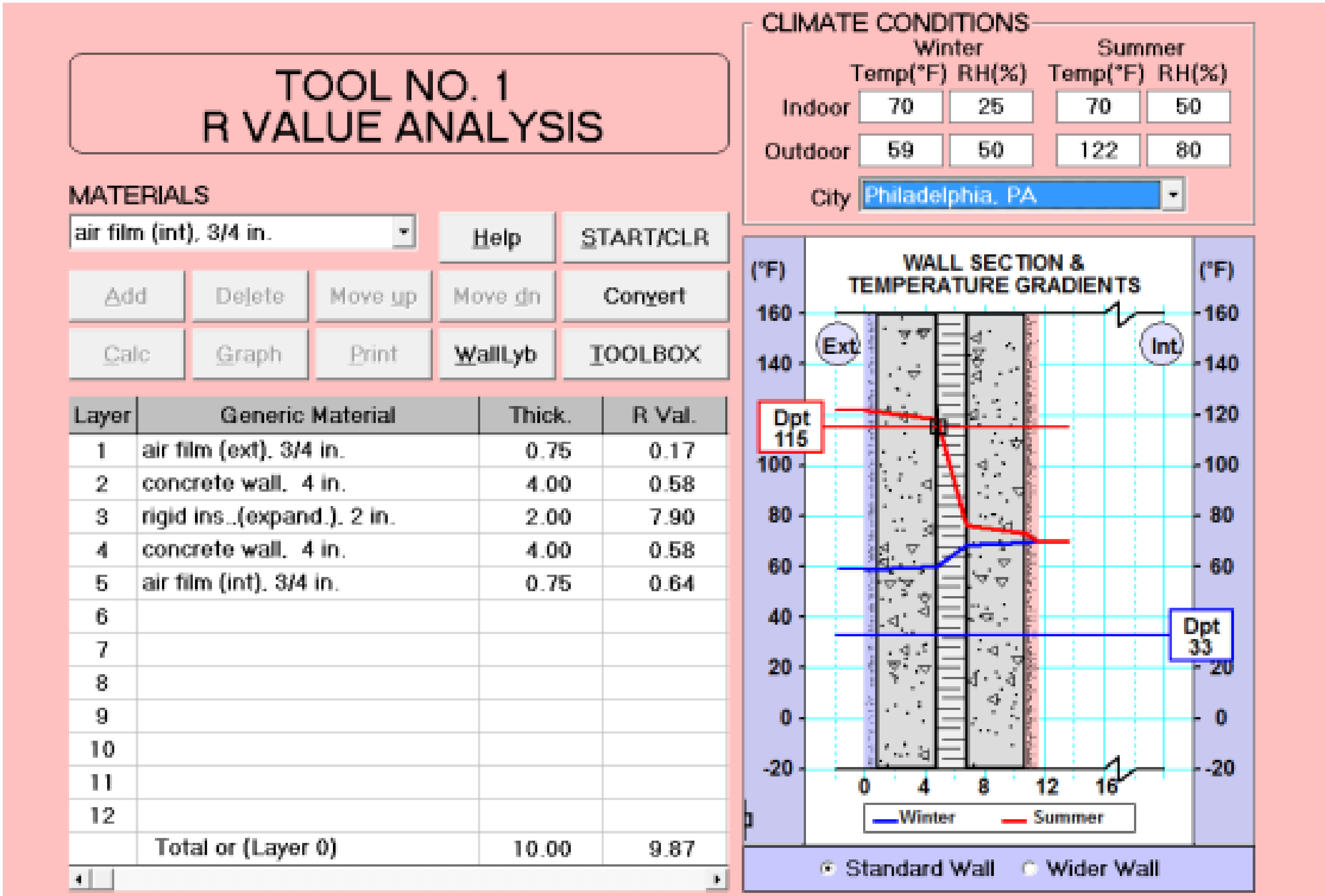
Bar Spacing	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
2"	0.30	0.66	1.20	1.86						
2½"	0.24	0.53	0.96	1.49	2.11					
3"	0.20	0.44	0.80	1.24	1.76	2.40	3.16	4.00		
3½"	0.17	0.38	0.69	1.06	1.51	2.06	2.71	3.43	4.35	
4"	0.15	0.33	0.60	0.93	1.32	1.80	2.37	3.00	3.81	4.68
4½"	0.13	0.29	0.53	0.83	1.17	1.60	2.11	2.67	3.39	4.16
5"	0.12	0.26	0.48	0.74	1.06	1.44	1.90	2.40	3.05	3.74
5½"	0.11	0.24	0.44	0.68	0.96	1.31	1.72	2.18	2.77	3.40
6"	0.10	0.22	0.40	0.62	0.88	1.20	1.58	2.00	2.54	3.12
6½"	0.09	0.20	0.37	0.57	0.81	1.11	1.46	1.85	2.34	2.88
7"	0.09	0.19	0.34	0.53	0.75	1.03	1.35	1.71	2.18	2.67
7½"	0.08	0.18	0.32	0.50	0.70	0.96	1.26	1.60	2.03	2.50
8"	0.08	0.16	0.30	0.46	0.66	0.90	1.18	1.50	1.90	2.34
9"	0.07	0.15	0.27	0.41	0.59	0.80	1.05	1.33	1.69	2.08
10"	0.06	0.13	0.24	0.37	0.53	0.72	0.95	1.20	1.52	1.87
11"	0.05	0.12	0.22	0.34	0.48	0.65	0.86	1.09	1.39	1.70
12"	0.05	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27	1.56
13"	0.04	0.10	0.18	0.29	0.41	0.55	0.73	0.92	1.17	1.44
14"	0.04	0.09	0.17	0.27	0.38	0.51	0.68	0.86	1.09	1.34
15"	0.04	0.09	0.16	0.25	0.35	0.48	0.64	0.80	1.02	1.25
16"	0.04	0.08	0.15	0.23	0.33	0.45	0.59	0.75	0.95	1.17
17"	0.03	0.08	0.14	0.22	0.31	0.42	0.56	0.71	0.90	1.10
18"	0.03	0.07	0.13	0.21	0.29	0.40	0.53	0.67	0.85	1.04

Appendix K – R-Value Analysis of Both Systems

R-Value for Cast in Place Concrete System H.A.M. Toolbox vs. Manually Calculated



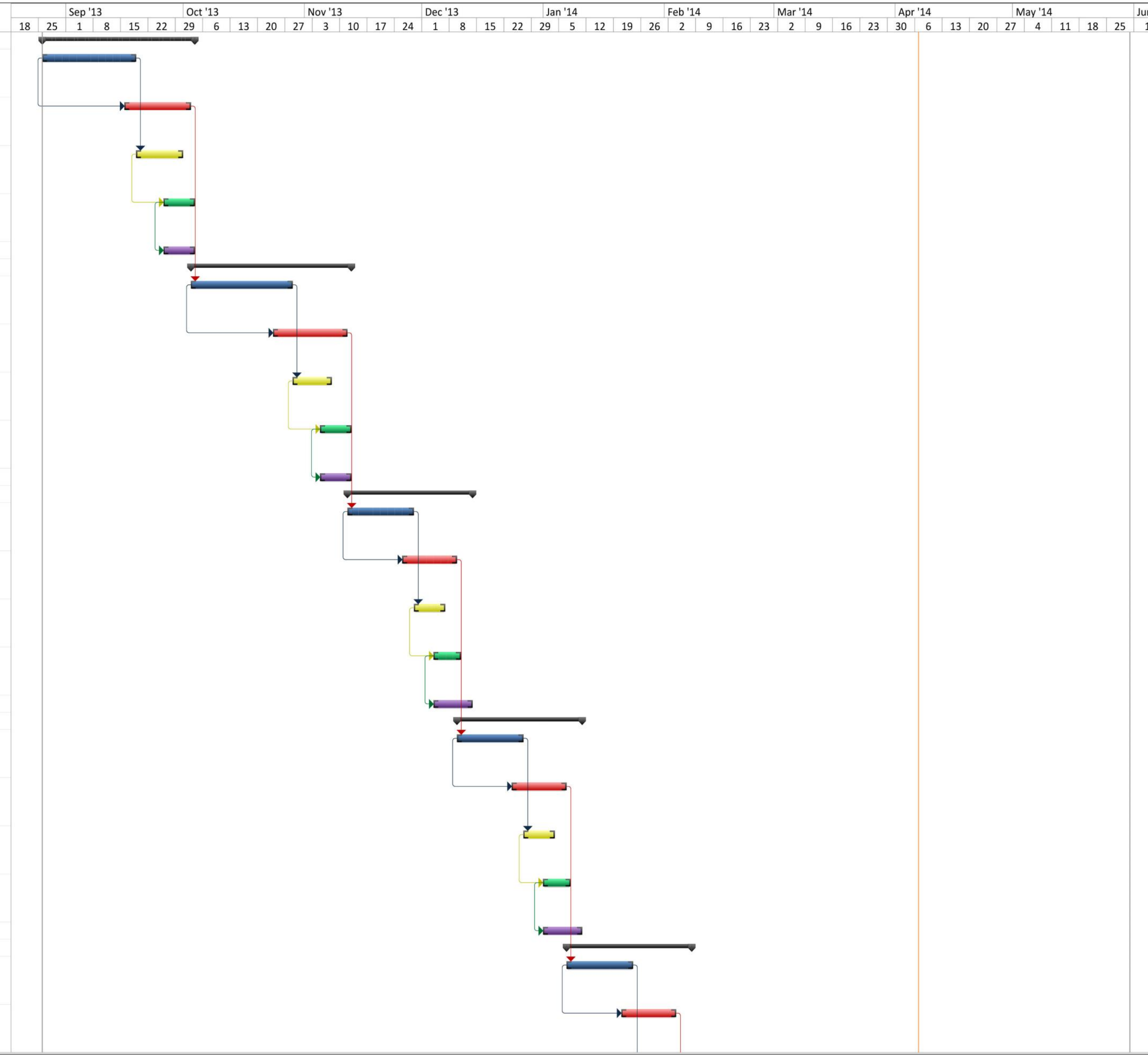
R-Value for Precast Concrete System



Appendix L – SIPS Schedule

SIPS Schedule - Building Superstructure

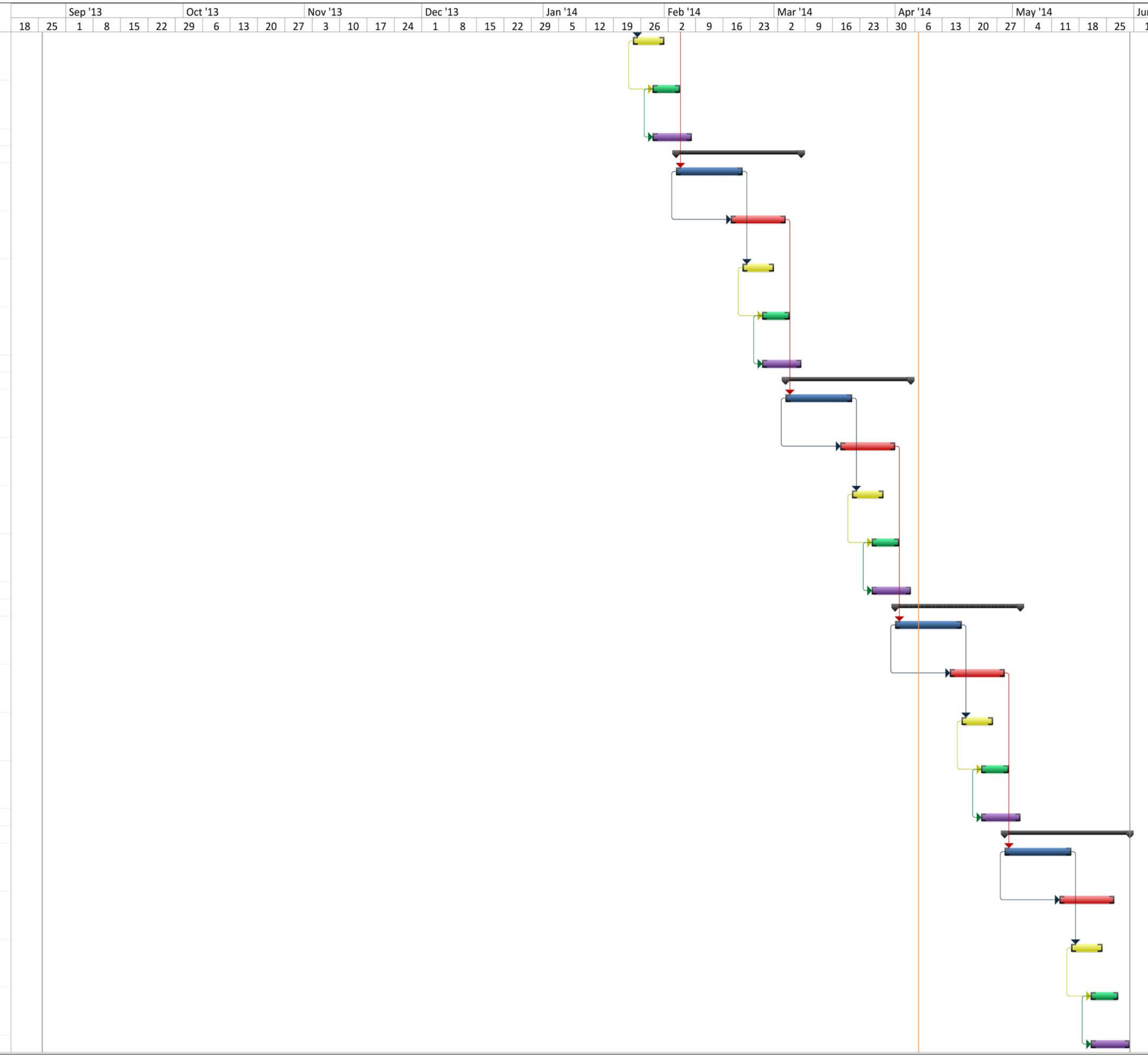
ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1			**Ground**	**29 days**	**Mon 8/26/13**	**Thu 10/3/13**		
2			Beams & Slabs/Ramp - Formwork/Reinforcem	18 days	Mon 8/26/13	Wed 9/18/13		
3			Columns & Walls - Fomwork/Reinforcem Casting	13 days	Mon 9/16/13	Wed 10/2/13	2SS+15 days	
4			Waterproofing works above Slab & Ramp	8 days	Thu 9/19/13	Mon 9/30/13	2	
5			Cement sand screed above water proofing	6 days	Thu 9/26/13	Thu 10/3/13	4SS+5 days	
6			Hollow Block	6 days	Thu 9/26/13	Thu 10/3/13	5SS	
7			**Mezzanine**	**29 days**	**Thu 10/3/13**	**Tue 11/12/13**		
8			Beams & Slabs/Ramp - Formwork/Reinforcem	18 days	Thu 10/3/13	Mon 10/28/13	3	
9			Columns & Walls - Fomwork/Reinforcem Casting	13 days	Thu 10/24/13	Mon 11/11/13	8SS+15 days	
10			Waterproofing works above Slab & Ramp	8 days	Tue 10/29/13	Thu 11/7/13	8	
11			Cement sand screed above water proofing	6 days	Tue 11/5/13	Tue 11/12/13	10SS+5 days	
12			Hollow Block	6 days	Tue 11/5/13	Tue 11/12/13	11SS	
13			**First Floor**	**24 days**	**Tue 11/12/13**	**Fri 12/13/13**		
14			Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 11/12/13	Thu 11/28/13	9	
15			Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 11/26/13	Mon 12/9/13	14SS+10 days	
16			Waterproofing works above Slab & Ramp	6 days	Fri 11/29/13	Fri 12/6/13	14	
17			Cement sand screed above water proofing	5 days	Wed 12/4/13	Tue 12/10/13	16SS+3 days	
18			Hollow Block	8 days	Wed 12/4/13	Fri 12/13/13	17SS	
19			**Second Floor**	**24 days**	**Tue 12/10/13**	**Fri 1/10/14**		
20			Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 12/10/13	Thu 12/26/13	15	
21			Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 12/24/13	Mon 1/6/14	20SS+10 days	
22			Waterproofing works above Slab & Ramp	6 days	Fri 12/27/13	Fri 1/3/14	20	
23			Cement sand screed above water proofing	5 days	Wed 1/1/14	Tue 1/7/14	22SS+3 days	
24			Hollow Block	8 days	Wed 1/1/14	Fri 1/10/14	23SS	
25			**Third Floor**	**24 days**	**Tue 1/7/14**	**Fri 2/7/14**		
26			Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 1/7/14	Thu 1/23/14	21	
27			Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 1/21/14	Mon 2/3/14	26SS+10 days	



Project: Mansoura Development
Start Date: 8/26/13

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
28		Waterproofing works above Slab & Ramp	6 days	Fri 1/24/14	Fri 1/31/14	26	
29		Cement sand screed above water proofing	5 days	Wed 1/29/14	Tue 2/4/14	28SS+3 days	
30		Hollow Block	8 days	Wed 1/29/14	Fri 2/7/14	29SS	
31		**Fourth Floor**	**24 days**	**Tue 2/4/14**	**Fri 3/7/14**		
32		Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 2/4/14	Thu 2/20/14	27	
33		Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 2/18/14	Mon 3/3/14	32SS+10 days	
34		Waterproofing works above Slab & Ramp	6 days	Fri 2/21/14	Fri 2/28/14	32	
35		Cement sand screed above water proofing	5 days	Wed 2/26/14	Tue 3/4/14	34SS+3 days	
36		Hollow Block	8 days	Wed 2/26/14	Fri 3/7/14	35SS	
37		**Fifth Floor**	**24 days**	**Tue 3/4/14**	**Fri 4/4/14**		
38		Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 3/4/14	Thu 3/20/14	33	
39		Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 3/18/14	Mon 3/31/14	38SS+10 days	
40		Waterproofing works above Slab & Ramp	6 days	Fri 3/21/14	Fri 3/28/14	38	
41		Cement sand screed above water proofing	5 days	Wed 3/26/14	Tue 4/1/14	40SS+3 days	
42		Hollow Block	8 days	Wed 3/26/14	Fri 4/4/14	41SS	
43		**Sixth Floor**	**24 days**	**Tue 4/1/14**	**Fri 5/2/14**		
44		Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 4/1/14	Thu 4/17/14	39	
45		Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 4/15/14	Mon 4/28/14	44SS+10 days	
46		Waterproofing works above Slab & Ramp	6 days	Fri 4/18/14	Fri 4/25/14	44	
47		Cement sand screed above water proofing	5 days	Wed 4/23/14	Tue 4/29/14	46SS+3 days	
48		Hollow Block	8 days	Wed 4/23/14	Fri 5/2/14	47SS	
49		**Seventh Floor**	**24 days**	**Tue 4/29/14**	**Fri 5/30/14**		
50		Beams & Slabs/Ramp - Formwork/Reinforcem	13 days	Tue 4/29/14	Thu 5/15/14	45	
51		Columns & Walls - Fomwork/Reinforcem Casting	10 days	Tue 5/13/14	Mon 5/26/14	50SS+10 days	
52		Waterproofing works above Slab & Ramp	6 days	Fri 5/16/14	Fri 5/23/14	50	
53		Cement sand screed above water proofing	5 days	Wed 5/21/14	Tue 5/27/14	52SS+3 days	
54		Hollow Block	8 days	Wed 5/21/14	Fri 5/30/14	53SS	



Project: Mansoura Development
Start Date: 8/26/13

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress