

# **How to Estimate the Cost of a Precast Concrete Parking Structure**

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## 1. INTRODUCTION

This Technical Paper is intended to help the reader understand a best practices approach for estimating the cost of a Precast Concrete Parking Structure including a checklist of items to consider when evaluating different design types. Related costs for site work; cast-in-place concrete foundations; miscellaneous metals; security access control; signage; sprinkler; mechanical and electrical systems will not be covered in this paper.

Main CSI Division – Division 3 Concrete

Subdivisions – Section 03210 Reinforcing Steel

Section 03405 Precast Concrete Design

Section 03410 Plant-Precast Structural Concrete

Section 03420 Plant-Precast Post-Tensioned Structural Concrete

Section 03450 Plant-Precast Architectural Concrete

Section 03480 Precast Concrete Specialties

### Brief Description

Precast concrete structures are viable alternatives to structural steel framed buildings and, as such, require concise procedures to estimate the cost of fabrication, delivery and erection. Understanding the components and definitions of a Precast Concrete Parking Structure will provide the reader with the framework needed to estimate these types of structures efficiently and accurately.

In addition to learning how to estimate the cost of a precast concrete parking garage, it is helpful to understand and communicate to the customer its benefits, such as long-term durability, low maintenance,

sustainable building elements and fast-track construction. It is important to be aware of the different precast parking garage design options available when dealing with the customer during the preconstruction phase. For this paper, we are estimating the building structure cost of a 184' x 268' four-level precast concrete parking garage with a total capacity for six hundred eighty four (684) cars.



*Station Plaza Parking Garage, Trenton, NJ*



*Fairfax Town Center Parking, Fairfax, VA*

## **2. TYPES AND METHODS OF MEASUREMENT**

First, begin by reviewing all of the plans and specifications for the project, including the General and Supplementary Conditions, carefully and thoroughly. Take notes and write down questions during this initial review phase for future research and reference when time allows.

During the initial review of the plans, look for precast components that are repetitive in size for quicker quantity take-off. Taking a bird's eye view toward the approach to the estimate in the very beginning will ultimately save time for the estimator(s) during the take-off and pricing stages.

Methods of measurement for the various elements of a precast concrete parking garage structure will be taken off by area, length, weight and piece count as outlined further in this technical report. In addition, specific information obtained during the take-off stage will be used to quantify and estimate costs for material, labor and equipment for plant fabrication; weights and piece counts for trucking and erection; surface areas for specialty finishes such as exposed aggregate or brick veneer on precast concrete

spandrel panels; and outsourced items such as miscellaneous metals, hot-dipped galvanizing and reinforcing steel.

Whether the take off is done manually or using an on-screen program, it is critical to organize the measured components in a logical manner before entering values into the cost sheets or cost estimating spread sheet program.

Next, check the scale of the plans against a known line of measurement to ensure accuracy. This is especially important for “On-Screen” or “Digitizing” programs where quantity take-off is done very quickly. When using “Building Information Modeling” programs to derive quantities from the design model, be sure to verify the accuracy of the major elements, such as the counts for DT’s, beams, etc.

### **3. SPECIFIC FACTORS THAT MAY AFFECT TAKE-OFF AND PRICING**

Economy of scale is an important consideration when estimating a precast parking garage. Larger scale projects will cost less per square foot than smaller scale projects due to set up time, mobilization, production rates and repetition of components during fabrication and erection.

Be sure to develop a checklist or template specifically designed to identify job-related cost factors. Some examples of checklist or template items include engineered calculations; detailed shop drawings; sales taxes; permit fees; transportation fees; union, non-union or prevailing wage labor; projected fabrication and delivery schedules relative to plant capacity; insurance and bonding requirements; potential impacts due to weather; delivery access and staging areas; and specialty items such as corrosion inhibitor additive, stainless steel connection hardware, precast concrete stairs, etc. Also develop a list of items that are specifically excluded from the cost estimate to clearly communicate what work is required by others such as safety cables; installation of embedded plates or anchor bolts in the cast-in-place concrete foundations; waterproofing; fire stopping; etc.

Provide cost options or value engineering suggestions not identified in the plans and specifications that will enhance the overall precast concrete parking structure and value without compromising the competitiveness of the bid proposal as outlined in the Bid Package and Contract Documents.

This report does not include the estimate for these suggestions, but some examples of cost options are:

1. Additional cost to design, fabricate and install precast concrete stair and elevator shaft walls in lieu of concrete masonry unit (CMU) shafts for potential cost and time savings.
2. Additional cost to design, furnish and install precast concrete stairs and landings in lieu of concrete-filled metal pan stairs to facilitate faster access to upper garage levels during construction and potential cost savings.
3. Additional cost to furnish and install optional threaded inserts in precast concrete columns to attach safety cable hardware provided by others.
4. Additional cost to provide structural component corrosion inhibitor additive (if not specified) in site locations where the building structure is more susceptible to corrosive environments such as northern climates or near bodies of salt water.

#### **4. OVERVIEW OF LABOR, MATERIAL, EQUIPMENT, INDIRECT COSTS AND MARK-UP APPROACH**

Budget your time carefully and check the progress of other staff working on the estimate (if applicable) to ensure the progression of quantity take-off, pricing and finalizing the estimate is done in an efficient manner. Double-check your work and the work of others to verify correct quantities. Material take-off accuracy is extremely important since this information is used to price related components such as labor, equipment, trucking and erection costs.

##### **Labor**

Labor costs are calculated on a per-hour basis, including direct burden for insurance and taxes.

### **Material**

Precast/Pre-topped Double Tees will be taken off by the top surface area in square feet and piece count. Precast Columns will be taken off by length in linear feet and piece count. Precast IT-Beams, L-Beams and R-Beams will be taken off by length in linear feet and piece count. Shear Walls will be taken off by single-side surface area in square feet and piece count. Reinforcing steel is taken off by length in linear feet, converted to weight by bar size in pounds and then total weight in tons. Connecting steel and hardware is taken off by piece count. Material take-off for this estimate was done using the On Screen Take-Off (OST) program.

### **Equipment**

In this estimate, equipment costs are calculated on a per hour basis including the equipment operator, fuel, oil and lubrication expenses. Crane size will be determined by the weight of the heaviest component and maximum reach.

### **Indirect Costs**

Indirect costs for engineering and shop drawings are typically calculated as a percentage of the total cost but should be checked for the total number of labor hours required for design depending on complexity of the project. Insurance is calculated on a unit rate per thousand dollars of the total cost. Bond premium is calculated on a scale depending on the total project cost at unit rate per thousand. Trucking costs are calculated per load based on an average cost per mile from the fabrication plant to the jobsite.

Cleaning, protection and repair work is often addressed in the specifications and must be taken into account in the estimate. Although hard to quantify, an allowance for this work based on historical information is important to include in the final analysis.

### **Mark-Up Approach**

The approach to every estimate is to provide an opinion of cost for a defined scope of work that is based on a quantified list of elements and associated costs for those elements derived from historical data, current market pricing and experience. The mark-up for profit and overhead is determined by the size of the project, anticipated work load, competing contractors and potential risks. Mark-up for this estimate is calculated on a percentage basis of the total cost and includes both profit and overhead.

## **5. SPECIAL RISK CONSIDERATIONS**

### **a. Supply and Demand**

Plant capacity associated with the anticipated schedule for award, shop drawings and fabrication may affect the cost estimate if additional manpower or overtime work is needed to meet the construction schedule. This estimate is based on adequate plant capacity without the extra cost of second shifts or overtime.

### **b. Site Conditions**

Whenever possible, a pre-bid or site meeting is important to understand any special or unusual site conditions that may affect the cost estimate such as traffic control, overhead obstructions, crane access and staging areas. This estimate includes the cost for traffic



control to enter the site from a main highway during delivery of precast concrete structural components.

**c. Labor Factors**

If the project is union, non-union or prevailing wage, how will it affect labor costs? In most cases, subcontractor bids for the erection will be solicited but for this estimate we are assuming the erection will be done internally based on non-union labor rates.

**d. New Construction, Addition or Renovation**

Is the project a new stand-alone parking garage, addition to an existing building or parking garage, or renovation to an existing parking garage. All three scenarios will have unique factors that affect efficiency and overall costs. This estimate is based on a new stand-alone structure.

**e. Erection Factors**

If site access is restricted, how will this affect the overall duration of the precast concrete parking garage erection? Can trucks be staged at an off-site location to minimize downtime between picks? This estimate assumes site access is not restricted, staging of trucks is not required and traffic control is only required during delivery.

**f. Building Height**

Can the parking garage be erected in a sequence to stage the crane from inside the footprint of the building or will a larger crane be needed to provide the reach and lifting

capacity from outside of the building footprint? This estimate is based on staging the crane within the footprint of the building and erecting in two sections (See Figure 7-1).



*Figure 7-1  
Crane in middle bay setting three bays at a time – bringing the building out in one sequence.*

**g. Connection Details**

Do the engineer's connection details conform to industry standards per Precast/Prestressed Concrete Institute (PCI) standards? If not, can pre-bid clarification be obtained through an addendum to the Construction Documents? Often times the connection details are written in the performance specification to be designed by the precast concrete company. This estimate assumes the connections are designed by the fabricator's engineer within the performance requirements specified. Details of design and engineering are not included.

**h. Design Factors**

Are the design loads provided by the Engineer-of-Record in order to complete the comprehensive engineering analysis and details for the structural precast framing system and connections? Live-load deflection, seismic requirements, fire-resistance ratings, and movement due to expansion and contraction (within acceptable tolerances) must be considered. This estimate assumes normal design loads and ratings for a commercial precast concrete parking structure.

**i. Penetrations or Bond-Outs**

Check the civil, mechanical and electrical drawings for all penetration and bond-out locations required for piping, ductwork, or conduits. Typically precast double tees will require bond-outs for electrical conduit to light fixtures in the parking garage.

**6. RATIOS AND ANALYSIS – TOOLS TO TEST FINAL BID**

One way to check to test the final bid is to compare the cost per parking stall with a range of other estimates of similar size and design. Parking garage structures for six hundred (600) cars should be in the range of \$7,000 to \$8,000 per parking stall for this type of design, building location and market conditions (July 2009).

Another check is the overall cost per gross square foot of parking area based on historical data from similar projects adjusted for current market conditions. Typical parking garage structure for six hundred (600) cars should be in the range of \$30 to \$35 per gross square foot of parking area (July 2009).

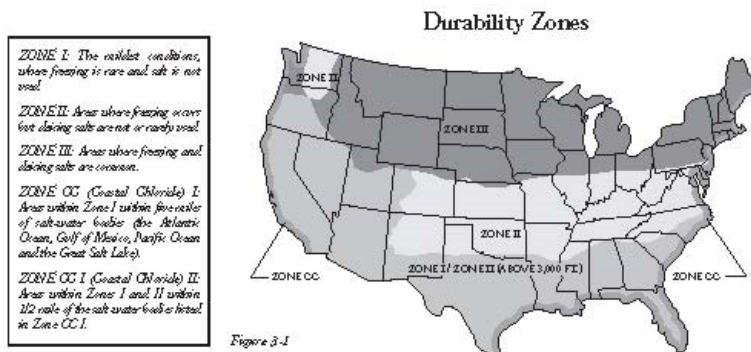
Reinforcing steel can be checked on the weight per square foot of surface area in the typical range of 1-2 pounds per square foot. Reinforcing steel for precast shear/lite walls will be higher in the amount of 3-6 pounds per square foot. Connection steel can be checked as a percentage of the total material cost and is usually less than 0.5%.

Erection can be checked by production rates if the crew expects to set an average of ten (10) picks per day divided by four hundred seventy (472) total pieces for duration of forty eight (48) working days. This is multiplied by the crew labor and crane equipment cost of \$11,787.50 per day (including mobilization/demobilization) for a total of \$565,800. Typically, erection cost should be in the range of \$1,200 to \$1,300 per pick which is confirmed ( $\$565,800 \div 472 \text{ picks} = \$1,198 \text{ per pick}$ ).

## 7. MISCELLANEOUS PERTINENT INFORMATION

Related sections in the Project Manual describe information that could affect the cost estimate of the precast structural concrete work. Specifically, Division 4 – “Unit Masonry”, will list inserts or anchorages needed for connection of precast double-tees to CMU walls. Division 5 – “Metal Fabrications”, will list inserts or anchorages needed for attachment of miscellaneous metal guard rails or screens. Division 7 – “Joint Sealants”, will specify product materials and installation requirements for horizontal and vertical joint sealants. Division 5 or 7 – “Expansion Control”, will list acceptable products and installation requirements for expansion joint covers.

Make sure the Professional Engineer responsible for the delegated design and structural performance calculations is licensed in the state where the project is located. This precast parking structure is located in Durability Zone III (see Figure 3-1) and is designed to withstand freeze/thaw conditions, corrosive protection from deicing salts and positive deck drainage.



Quality control testing, reports and certifications are usually required for the Statement of Special Inspections prepared by the Structural Engineer and should be included as an indirect cost. Also, product data and mix design submittals associated with LEED Credits MR 4.1, MR 4.2 and ID 1.1 may be required if the project is looking to obtain LEED Certification.

## 8. SAMPLE SKETCHES

The following details were provided by the Precast/Prestressed Concrete Institute (PCI) to illustrate some of the basic components and details found in a precast concrete parking structure.

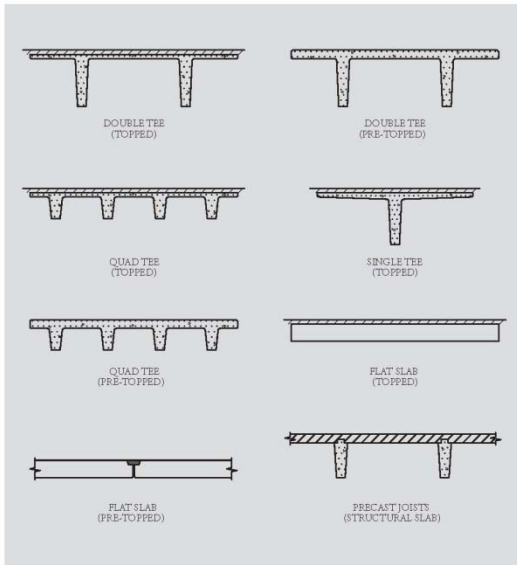
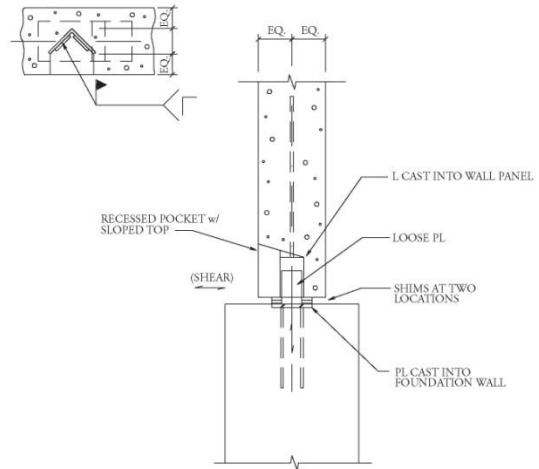


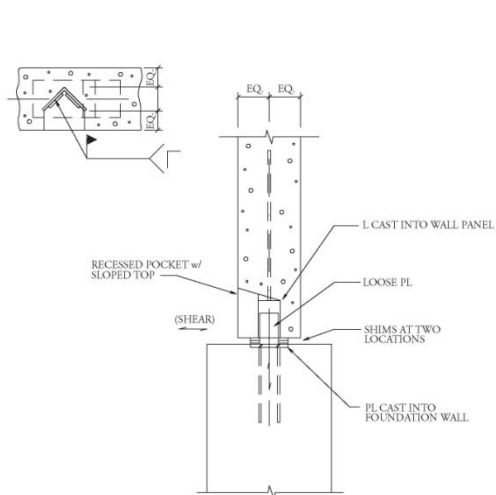
Figure 4-28



**ERECTOR NOTE :**  
FILL ENTIRE JOINT AND CONNECTION  
POCKET w/ NON-SHRINK GROUT.

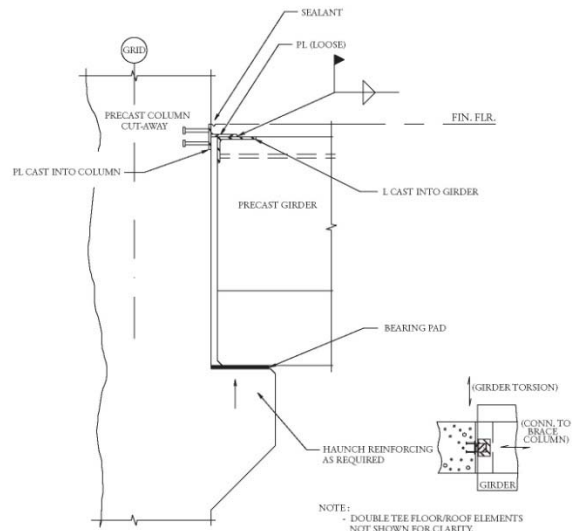
WALL PANEL TO FOUNDATION CONNECTION

## TYPICAL STEMMED FLOOR MEMBERS

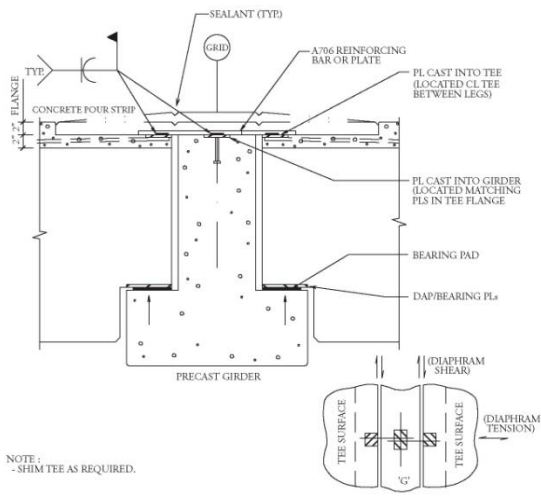


**ERECTOR NOTE :**  
FILL ENTIRE JOINT AND CONNECTION  
POCKET w/ NON-SHRINK GROUT.

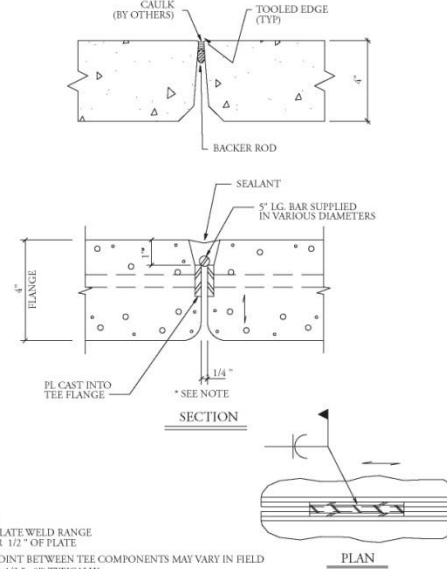
WALL PANEL TO FOUNDATION CONNECTION



BEAM TO COLUMN CONNECTION



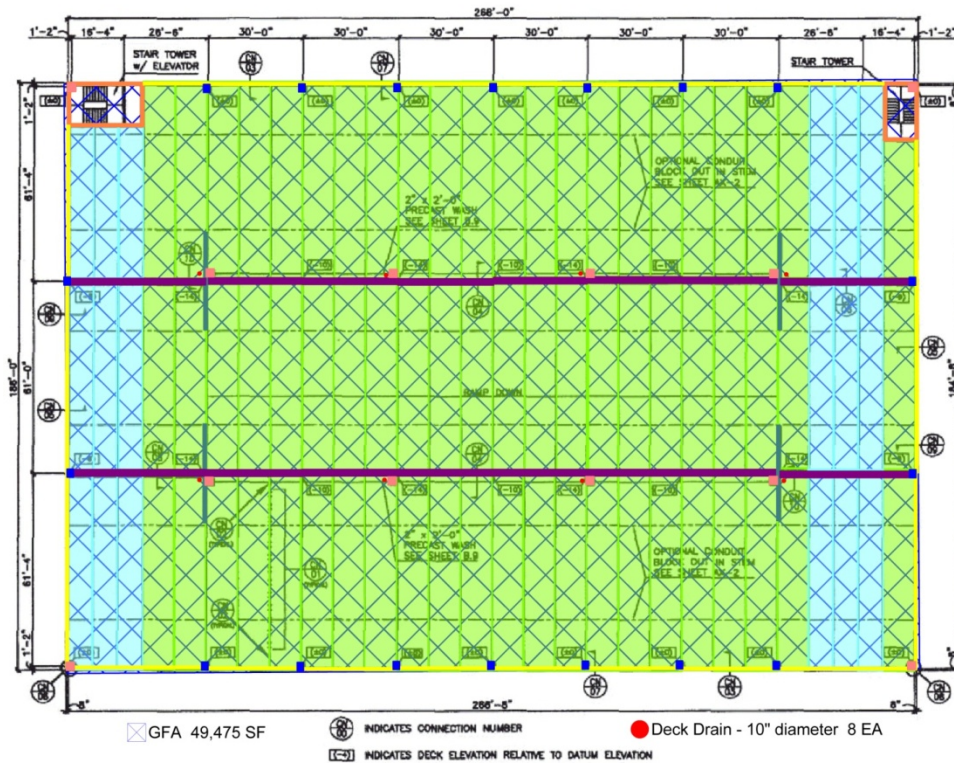
DOUBLE TEE TO GIRDER CONNECTION



DOUBLE TEE FLANGE CONNECTION

### 9. TAKE-OFF PRICING SHEETS

- Precast/Pre-Topped Double Tees - 10' wide 40,483 SF
- Precast/Pre-Topped Double Tees - 8' wide 8,536 SF
- Precast Shear/Stair Wall - 12" thick 1,296 SF
- Precast Column - 24" x 30" 180 LF
- Precast Column - 30" x 30" 120 LF
- Precast Shear/Lite Wall - 12" thick 1,217 SF
- Precast Spandrel Panels - 10" thick 5,440 SF
- Precast Inverted Tee Beams - 36" deep 529 LF



PARKING DECK LAYOUT (TYPICAL FLOOR)

**Takeoff Tab**  
**Precast Garage**  
Bid No. 52

No.	Name	Height	Area	Quantity1 UOM1	Quantity2 UOM2	Quantity3 UOM3
<b>GFA</b>						
1	GFA	0"	Parking Structure - 4 Level (684 Cars)	197,902 SF	0	0
<b>Div. 03 - Concrete</b>						
2	Precast/Pre-Topped Double Tees - 10' wide	2' 6"	Parking Structure - 4 Level (684 Cars)	161,931 SF	16,193 LF	264 EA
3	Precast/Pre-Topped Double Tees - 8' wide	2' 6"	Parking Structure - 4 Level (684 Cars)	34,142 SF	4,268 LF	72 EA
4	Precast Shear/Stair Wall - 12" thick	10' 0"	Parking Structure - 4 Level (684 Cars)	5,182 SF	518 LF	32 EA
5	Precast Column - 24" x 30"	10' 0"	Parking Structure - 4 Level (684 Cars)	720 LF	72 EA	0
6	Precast Column - 30" x 30"	10' 0"	Parking Structure - 4 Level (684 Cars)	480 LF	48 EA	0
7	Precast Shear/Lite Wall - 12" thick	10' 0"	Parking Structure - 4 Level (684 Cars)	4,867 SF	487 LF	16 EA
8	Precast Spandrel Panels - 10" thick	6' 6"	Parking Structure - 4 Level (684 Cars)	21,760 SF	3,348 LF	88 EA
9	Precast Inverted Tee Beams - 36" deep	3' 0"	Parking Structure - 4 Level (684 Cars)	2,115 LF	64 EA	0
10	Deck Drain - 10" diameter	0"	Parking Structure - 4 Level (684 Cars)	32 EA	0	0

**Precast Parking Structure - Sample Estimate**

Division	Description	Takeoff Quantity	Labor Cost/Unit	Labor Amount	Material Cost/Unit	Material Amount	Sub Cost/Unit	Sub Amount	Equip Cost/Unit	Equip Amount	Total Cost/Unit	Total Amount	Notes
<b>Div 3</b>	<b>Concrete</b>												
	Precast/Pre-Topped Double Tees - 10' wide	161,931.00 sf	3.25 /sf	526,276	5.75 /sf	931,103	-	-	2.25 /sf	364,345	11.25 /sf	1,821,724	
	Precast/Pre-Topped Double Tees - 8' wide	34,142.00 sf	3.25 /sf	110,962	5.75 /sf	196,317	-	-	2.25 /sf	76,800	11.25 /sf	384,079	
	Precast Shear/Stair Walls - 12" thick	5,182.00 sf	15.25 /sf	79,026	12.50 /sf	64,775	-	-	4.25 /sf	22,024	32.00 /sf	165,824	
	Precast Shear/Lite Walls - 12" thick	4,867.00 sf	15.25 /sf	74,222	12.50 /sf	60,808	-	-	4.25 /sf	20,695	32.00 /sf	155,744	
	Precast Spandrel Panels - 10" thick	21,760.00 sf	15.25 /sf	331,940	13.75 /sf	299,200	-	-	4.25 /sf	92,480	33.25 /sf	723,620	Exposed aggregate finish
	Precast Columns - 24" x 30"	720.00 lf	105.00 /lf	75,600	95.00 /lf	68,400	-	-	10.00 /lf	7,200	210.00 /lf	151,200	
	Precast Columns - 30" x 30"	480.00 lf	105.00 /lf	50,400	100.00 /lf	48,000	-	-	10.00 /lf	4,800	215.00 /lf	103,200	
	Precast Inverted Tee Beams - 24" wide x 36" deep	2,115.00 lf	105.00 /lf	222,075	110.00 /lf	232,650	-	-	10.00 /lf	21,150	235.00 /lf	475,875	
	Deck Drains - 10" dia	32.00 ea	5.00 /ea	1,600	15.00 /ea	3,750	-	-	2.00 /ea	600	22.00 /ea	5,550	
	Corrosion Inhibitor - 2 gal/ty	5,218.00 gal	-	5.00 /gal	26,090	-	-	-	10.00 /ea	52,180	5.00 /gal	26,090	
	Anchor Bolts - 1-1/2" dia x 18" long	480.00 ea	-	-	20.00 /ea	9,600	-	-	-	20.00 /ea	9,600	9,600	Supply only
	Spiglot Hardware - S&S DT Flange Connections	1,278.00 ea	-	-	25.00 /ea	31,950	-	-	-	25.00 /ea	31,950	31,950	
	Beam Pads - 10" x 24"	120.00 ea	-	-	45.00 /ea	5,400	-	-	-	45.00 /ea	5,400	5,400	
	Embedded Plates - Galvanized	472.00 ea	35.00 /ea	16,520	15.00 /ea	7,080	-	-	-	50.00 /ea	23,600	23,600	
	Loose Erection Hardware	240.00 ea	-	-	15.00 /ea	3,600	-	-	-	15.00 /ea	3,600	3,600	
	Material Testing	1.00 ea	-	-	-	-	5,000.00 /ea	5,000	-	-	5,000.00 /ea	5,000	In House
	Mock-Up Panel / Samples	1.00 ea	-	-	1,500.00 /ea	1,500	1,000.00 /ea	1,000	-	-	2,500.00 /ea	2,500	
	LEED Submittals	16.00 hr	35.00 /hr	560	-	-	-	-	-	-	35.00 /hr	560	
	Loading	80.00 hr	35.00 /hr	2,800	-	-	-	-	75.00 /hr	6,000	110.00 /hr	8,800	
	Trucking / Transportation	94.00 ea	-	-	-	-	1,350.00 /ea	126,900	-	-	1,350.00 /ea	126,900	
	Road Permits	1.00 ea	-	-	-	-	5,000.00 /ea	5,000	-	-	5,000.00 /ea	5,000	
	Traffic Control	160.00 hr	35.00 /hr	5,600	-	-	-	-	-	-	35.00 /hr	5,600	
	Crane - 300 Ton Crawler incl. mobil/demob	3.00 mo	-	-	-	-	-	-	35,000.00 /mo	105,000	35,000.00 /mo	105,000	
	All Terrain Marshes (2) - 80' reach	48.00 day	-	-	-	-	-	-	150.00 /day	7,200	150.00 /day	7,200	
	Pre-Erection Survey - Embedded Items	130.00 hr	-	-	-	-	190.00 /hr	19,000	-	-	190.00 /hr	19,000	
	Precast Erection	48.00 day	9,000.00 /day	432,000	-	-	-	-	-	-	9,000.00 /day	432,000	
	Field Welding	180.00 hr	45.00 /hr	8,100	-	-	-	-	35.00 /hr	6,300	80.00 /hr	12,600	
	Cooking	20,461.00 hr	-	-	-	-	1.75 /hr	35,807	-	-	1.75 /hr	35,807	
	Pre-Erection Survey - Embedded Items	16.00 hr	35.00 /hr	560	-	-	-	-	-	-	35.00 /hr	560	
	Cleaning	180.00 ea	35.00 /ea	6,300	-	-	-	-	-	-	35.00 /ea	6,300	
	Miscellaneous Piggy Back Work	1.00 ea	-	-	-	-	7,500.00 /ea	7,500	-	-	7,500.00 /ea	7,500	
	Rescheduling work	196,073.00 sf	-	-	-	-	0.15 /sf	29,411	-	-	0.15 /sf	29,411	
<b>Div 3 Concrete</b>		<b>197,906.00 sf</b>	<b>9.97 /sf</b>	<b>1,972,090</b>	<b>10.07 /sf</b>	<b>1,992,652</b>	<b>1.16 /sf</b>	<b>230,118</b>	<b>3.71 /sf</b>	<b>734,123</b>	<b>24.91 /sf</b>	<b>4,928,982</b>	

**Estimate Totals**

Description	Amount	Totals	Rate	Cost per Unit	Percent of Total
Labor	1,972,090	<b>4,928,983</b>	5,404,029	<b>24.906 /SF</b>	39.4%
Material	1,952,652				39.6%
Subcontract	230,118				4.2%
Equipment	734,123				13.6%
<b>Sub-Total Structure</b>					
Engineering / Shop Drawings	49,290		1.000 %	0.249 /SF	0.91%
General Liability Insurance	27,020		0.500 %	0.137 /SF	0.50%
Bond	41,768		5.000 %	0.211 /SF	0.77%
Material Sales Tax	99,533			0.503 /SF	1.84%
Indirect Costs	217,711			26.007 /SF	4.03 95.24%
<b>Overhead &amp; Profit</b>					
	257,335		5.000 %	1.300 /SF	4.76%
	<b>257,335</b>	<b>5,404,029</b>		<b>27.307 /SF</b>	<b>4.76 #####</b>
<b>Total</b>		<b>5,404,029</b>		<b>27.307 /SF</b>	

## **10. TERMS/GLOSSARY**

PCI – Precast/Prestressed Concrete Institute.

Precast – Fabrication process performed in a controlled environment.

Prestressed – Reinforcing strands installed in tension during concrete placement in the mold or form to increase load capacity of structural beam or deck slab.

Pre-topped – Factory topped double tee section with entire deck thickness integrally cast.

LEED – Leadership in Energy and Environmental Design.

CMU – Concrete masonry units.

## **11. REFERENCES**

Precast/Prestressed Concrete Institute (PCI) Parking Structures: Recommended Practice for Design and Construction Manual MNL-129-98

Concrete Specification Institute (CSI) [www.csinet.org](http://www.csinet.org)

RS Means Building Construction Cost Data, 67<sup>th</sup> Annual Edition 2009

LEED for New Construction & Major Renovation, Version 2.2 Reference Guide, 3<sup>rd</sup> Edition, October 2007