TRUMP TAJ MAHAL HOTEL

Atlantic City, New Jersey

Technical Report Number Two

Pro-Con Structural Study of Alternate Floor Systems

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Executive Summary

This report is an investigation of alternate floor framing systems for the Trump Taj Mahal Hotel in Atlantic City, New Jersey. Schematic designs were conducted on four possible alternatives and compared for their feasibility. Comparisons considered a number of factors, including: structural effectiveness, architectural and mechanical system impacts, construction impacts, fire rating, serviceability, and cost.

The existing floor system of the Trump Taj Mahal Hotel is a filigree flat plate system. It meets the current demands of providing a low floor to floor height while effectively carrying the loads of the floor. Other systems that were analyzed are:

1. Steel Frame with Precast Hollow Core Planks
2. Composite Steel Frame with Slab on Metal Deck
3. Two-Way Post-Tensioned Flat Plate
4. One-Way Concrete Slab and Beams

A post-tensioned flat plate system appears to be the best alternate floor framing system. This system provides a total depth of 8", the lowest of all systems. A flat plate is flat on both sides and requires substantially less floor and ceiling finishes. Often, the bottom of the flat plate system is exposed and serves as the ceiling. Although this system was the heaviest of those analyzed, column and foundation cost will be offset by the savings in building height reduction; providing cost savings on vertical MEP runs, partitions, curtain walls, and shear walls.

If it is decided that the lateral system of the tower will be changed to a system of steel frames, the composite steel with slab on metal deck will be further investigated. Of the two steel systems investigated, a composite steel system was the least expensive and required the lowest floor to floor height. One of its major disadvantages is the requirement of a suspended ceiling, necessary if the structured is to be concealed.

Table of Contents

Introduction

Atlantic City is known as the “Las Vegas” of the east coast. It is home to some of the largest and finest hotels, resorts, and casinos, as well as one of the largest boardwalks in the world. Donald Trump came to Atlantic City with a vision to create one of the world’s finest casinos along with Atlantic City’s most luxurious hotels. At the 900 block of the Atlantic City boardwalk in 1990, Trump unveiled the first Taj Mahal Hotel, unprecedented in craftsmanship and opulence. Its stern use of iconic architecture, rich with lights and signage, matches that of the rest of Atlantic City.

The Trump Taj Mahal Hotel Tower at 1000 Boardwalk resembles a powerful type of iconic architecture, signifying the power and wealth of Donald Trump along with the luxury you can expect from such a hotel. Such iconic characteristics that are clearly expressed on the building include large, bold signage (Both the Taj Mahal running down the east and west sides of the building and Trump across the top of the building.), a unique and pure geometric plan that rivals its neighboring predecessor, and it’s overwhelming height as compared to the neighboring buildings along the ocean front skyline. The facade of the building is constructed with mostly modern materials, comprised of a reflective glass curtain wall, metal panels, and architectural pre-cast concrete panels.

The new Taj Mahal Hotel will serve as an expansion to its older and neighboring hotel tower that was built in the early 1990s. It will provide an additional 786 guest suites, ranging from spacious single rooms to deluxe 3 bay super suites. The tower will have 732,000 square feet of usable space and will soar 435 feet, 40 stories, into the air, making it an icon in the view of the Atlantic City skyline.

Schematic design is the most important phase in the structural design of any project. Many different types of systems must be considered and ultimately the best match for the project will be chosen. This report was written to introduce the possibilities of utilizing an alternate floor system to the existing filigree flat plate system of The Trump Taj Mahal Hotel in Atlantic City, New Jersey.

Four types of floor systems were chosen for consideration. These floor systems were each designed for a typical area of the floor plan of the hotel tower, following the design criteria set forth in this report. This design is not in depth and is only meant to be a schematic preliminary design. Once designed, pro/con analyses were performed on each floor system considering structural effectiveness, architectural and mechanical system impacts, construction impacts, cost, and overall system weight. The floor systems were then pitted against each other and ultimately the best matches for the project were chosen for possible farther consideration.

Floor System Design Criteria

A general list of relevant structural criteria will be discussed to clarify all design assumptions. The criteria include the typical area of analysis, codes and standards, deflection limitations, and design loads.

Area under Consideration

The area under consideration is a typical 64'-0" by 38'-6" area that exists on all four sides of the tower. This area is comprised of four bays, two of which are 32'-0" by 18-9". The other two are 32'-0" by 19'-9". For simplicity, only the typical tower floor that was designed for levels 5 thru 39 will be considered because of varying floor loading. The area under consideration for redesign is highlighted in Figures X and X.

Figure 1: Area under consideration

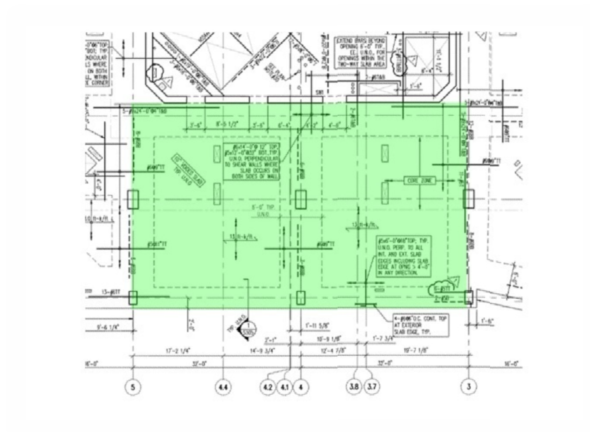


Figure 2: Enlarged area under consideration

Codes and Standards

Building Code:

New Jersey State Uniform Construction Code (IBC 2000)

Loads:

Minimum Design Loads for Buildings and Other Structures, ASCE 7-02
American Society of Civil Engineers
Comment: Standards of ASCE 7-02/7-05 are referenced by IBC

Structural Concrete:

ACI 318-02
American Concrete Institute

Manual of Standard Practice, 27th Edition, March 2002
Concrete Reinforcing Steel Institute

Structural Steel:

Steel Construction Manual, 13th Edition
American Institute of Steel Construction

Detailing for Steel Construction
American Institute of Steel Construction

Welding:

Structural Welding Code – Steel, AWS D1.1-2002
Structural Welding Code – Reinforcing Steel, AWS D1.4-1998

Metal Decking:

Design Manual for Floor Decks and Roof Decks
Steel Deck Institute

Deflection Limitations

Live Load = L/360
Total Load = L/240
Edge Beams and Slabs = ¾" (Maximum Allowable for Curtain Wall)

Design Loads

Only gravity loads were considered in the redesign of the floor system. The dead load of the system was taken as the self weight of the framing members and a superimposed load of 15psf to account for MEP equipment, lighting fixtures, etc. The live load was taken out of ASCE 7-02 Section 4 as 40psf for hotels and multi-family houses.

Existing Floor System

Voided Filigree Flat Plate

A filigree flat plate acts as a composite system, utilizing both pre-cast and cast-in-place concrete elements. 8'-0" wide 2 ¼" thick pre-stressed planks form the base of the system. Foam voids are cast on top of the planks, lowering the dead weight of the system. However, some floors of the tower with higher loads may have solid slabs instead of voided slabs. A layer of concrete is poured on top of the planks and 2 ¼" on top of the voids, if present. 10x10 W4xW4 Welded Wire Fabric is used as temperature reinforcing for the cast –in-place concrete.

The loads of the filigree flat slab are transferred to the columns via 8'-0" wide conventionally reinforced in-slab beams that run 32'-0" x 16'-0" bays, typically. The filigree flat slabs are connected to the in-slab beams by reinforcing dowels, typically #7 bars on the top layer. The base of the beams are formed using the filigree planks, however the planks are not utilized in the design strength of the beam.

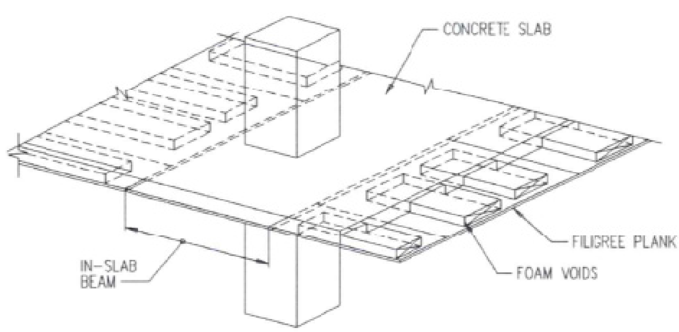
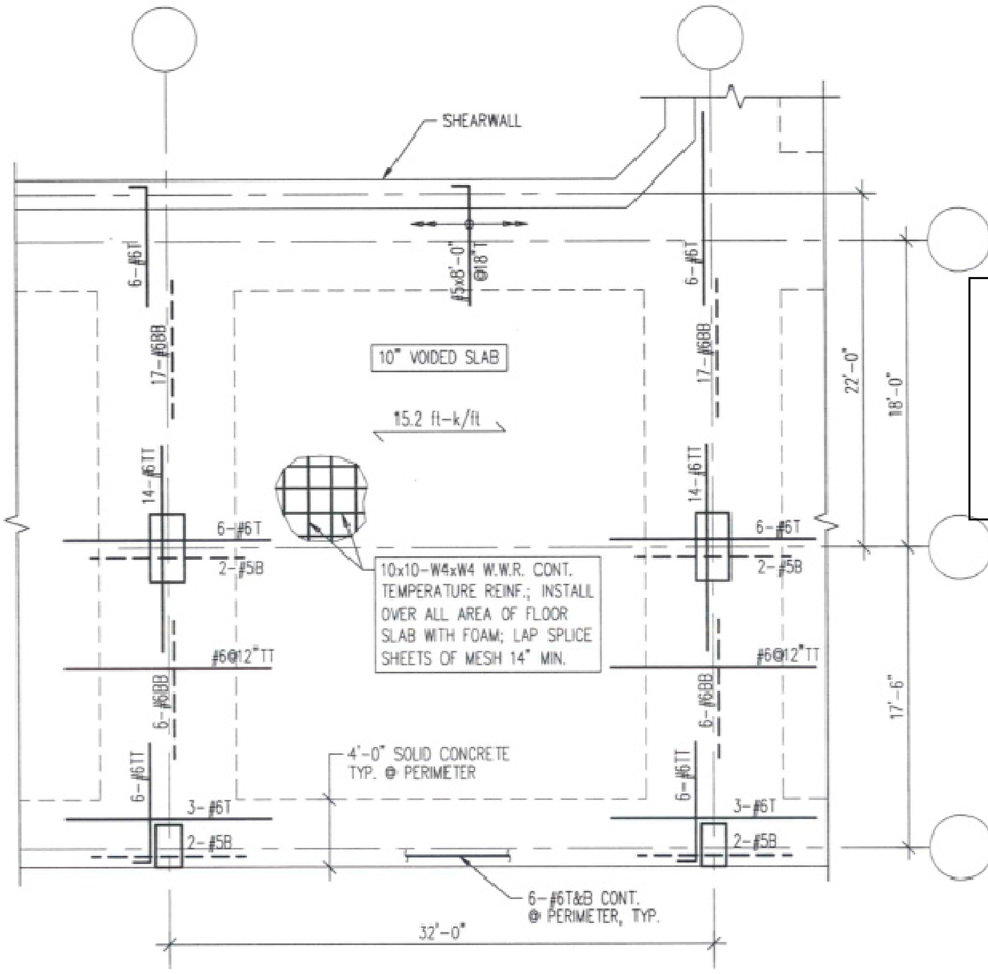


Figure 3: Filigree Flat Plate System

Figure 4: Filigree Construction Photo

Level Number	Solid or Voided	Total Depth (inches)
2, 3	Voided	12
4	Solid	10
5 thru 39	Voided	10
40	Solid	12
41	Solid	10

Figure 5: Different Types of Filigree Slabs Utilized Throughout the Tower



Material Properties:

f_y = 60 ksi

f_{py} = 270 ksi

f'_c = 5000 psi

Tendons: 7 strand, low relaxation

Figure 6: Typical Filigree Framing Plan

System Effectiveness

Structural Impacts

A filigree flat plate is capable of spanning long distances by utilizing pre-stressed planks. Foam voids reduce the weight of the structure by 30%, translating to foundation and column costs. Edge beams must be provided in order to achieve deflections to meet the curtain wall criteria. These edge beams are reinforced using mild reinforcing and are built integrally into the slab. In slab beams are extremely shallow and inefficient, as the filigree plank on the bottom cannot be utilized in the flexural strength of the beam.

Architectural and Mechanical Impacts

The top of the filigree system is comprised of a cast-in-place slab which can serve as the final underlayment to any floor finishes. The pre-cast planks will be exposed on the bottom of the slab surface. Since these planks are very rough, a finish will be required in order to achieve proper ceiling aesthetics.

Construction Impacts

Because the precast planks are also used as the formwork for the system, substantial erection time is saved by using the filigree system. However, shoring is still required to support the planks. Since planks form the underlayment of the entire floor system, it may be difficult to form the planks to the shape of the floor plan. Rough-in is often required to get the planks to fit correctly. A long lead time will be required to accommodate the filigree plank manufacturer. Concrete curing may be an issue since structural erection is currently set to take place during the winter. A concrete blanket, space heater, or curing compound may be needed in order to prevent delays.

Summary

Advantages	Disadvantages
Precast filigree planks are also used as the formwork	In-slab beams are extremely inefficient
Foam voids lower the dead weight of the system	Rough in required to form the floor
Pre-stressed filigree planks allow for long one-way spans	Long lead time required for planks
Shallow depth provides lower floor to floor heights	Shoring is required
2 hour fire rating achieved with no additional fire protection	A finished surface must be applied to the underside of the filigree plank
	Curing difficulties in colder weather

Alternate Floor Systems

Four floor systems were considered as alternatives to the filigree floor system. Those systems marked with an * denote systems in which the number and arrangement of columns has changed.

- Steel Frame with Precast Hollow Core Planks* - Additional 4 Columns
- Composite Steel Frame with Slab on Metal Deck
- Two-Way Post-Tensioned Flat Plate System
- One-Way Concrete Slab and Beam System

Several references and software programs were utilized throughout the design of the alternate floor systems.

References:

- *Notes on ACI 318-05 Building Code Requirements for Structural Concrete*
  Portland Cement Association
- *Design of Concrete Structures, 13th Edition*
  Nilson, Darwin, and Dolan
- *AISC Manual of Steel Construction, 13th Edition*
  American Institute of Steel Construction
- *RS Means Construction Cost Data – Unit Pricing*
  RS Means Company
- *RS Means Assemblies Cost Data*
  RS Means Company
- *USD Manual*
  United Steel Deck, Inc.

Software:

- RAM Structural Systems
- RAM Concept
- PCA Slab

Option 1: Steel Frame with Precast Hollow Core Planks

This system utilizes precast, pre-stressed hollow core concrete planks as the floor slab and steel girders. The planks span the length of the bay and are supported by steel girders that transfer the loads to steel columns. A 2" topping slab is provided and is used for both fire protection and as a surface to apply floor finishes.

Structural steel members were designed using RAM Structural System. Precast concrete planks were chosen using load tables provided by Nitterhouse, a well-known precast plank manufacturer on the east coast. Calculations, results, and references used to determine beam sizes, precast plank sizes, and cost can be found in Appendix B.

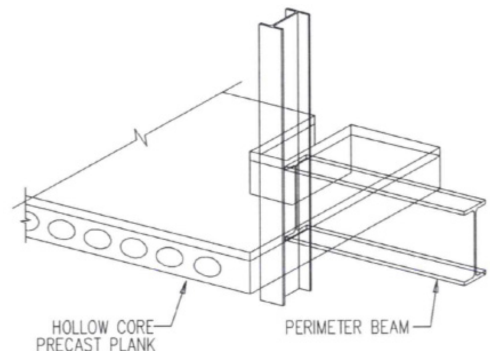
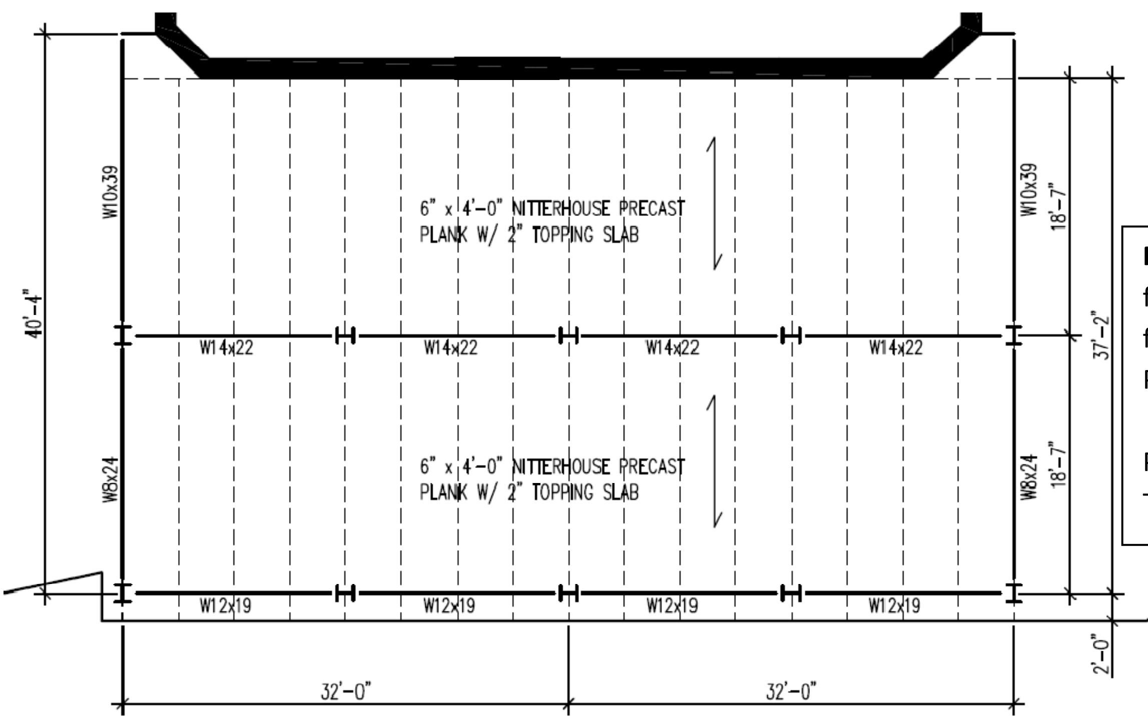


Figure 7: Diagram of Steel Frame with Hollow Core Planks



Material Properties

f_y = 50 ksi

f'_c = 6000 psi

Prestressing: (4) 1/2" ϕ

f_{up} = 270 ksi

Plank: 6" x 4'-0"

Topping: 2", 3000 psi

Figure 8: Option 1 Framing Plan

System Effectiveness

Structural Impacts

This system fits nicely into the 16'-0" wide bays because the planks are manufactured in 4'-0" wide modules. A 2 hour fire rating was obtainable using a 6" thick plank with a 2" topping slab. Planks were oriented to span the north/south direction of the bay in order to accommodate the 2'-0" cantilever that lines the perimeter of the building. If a shear wall is to be kept as the lateral force resisting system, a continuous angle will have to be embedded into the shear walls to support the planks. This connection will be costly and complicated. It may be best to consider this system only if the lateral system is changed to a steel frame.

In order to obtain shallower steel girders, the bays of the system had to be reduced from 32' to 16', adding four columns to the floor layout. This also limits the hollow cores to a mere 18'-7" span. This is extremely inefficient for hollow core planks under these types of loading conditions. The plank chosen is capable of carrying a 141 psf maximum superimposed load, but maximum load on the floor is 82 psf.

Architectural and MEP Impacts

Precast planks can be used as the exposed surface of the ceiling and can easily be coated with paint or plaster. As mentioned previously, a 2 hour fire rating was obtainable with a 2" topping slab. This topping slab will also serve as a great surface to apply floor finishes to.

4 additional columns were added to decrease the span of the steel girders, thus allowing for shallower members. Beams will have to run down the centerlines of the partitions in between in the guest rooms. In order for the beams to be concealed, a soffit must be provided. Beams and columns will disrupt mechanical chases that service the guest rooms. Chases will have to be either relocated or increased in size for MEP equipment to be rerouted around the structure.

The total maximum depth of this system will be approximately 28", 18" deeper than the current filigree system. This will add substantial height to the tower, increasing the vertical runs of MEP equipment, elevators, stairs, partitions, shear walls, and the curtain wall. Floor to floor height can be decreased utilizing a special detail in which the top of planks align evenly with the top of steel. This is made possible by adding vertical angles to the web of the beam and then attaching a continuous horizontal support angle (See Figure 9). However, this detail will add fabrication cost to the project.

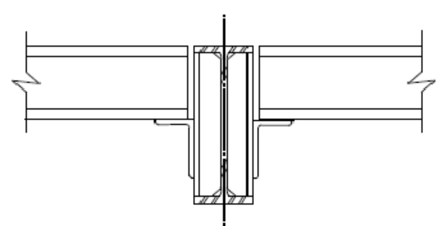


Figure 9: Special Connection Detail to Decrease System Depth

Construction Impacts

Structural steel projects are generally erected in a timely manner compared to that of concrete structures. However, pre-cast planks are difficult to erect. Steel columns are usually fabricated in larger lengths and erected prior to the planks. This means that the crane operator will have to be careful to avoid hitting an erected steel column with a plank.

Precast planks are pre-manufactured in a controlled environment. This allows for better quality control assurance and almost guarantees that each plank will perform to the specified standards. Manufacturing in a controlled environment also means that the concrete will not be exposed to the weather during curing. Thus, the erection of this type of system can easily be scheduled during any of the four seasons. For this particular project, the erection of the structure is currently underway and will go well into the winter months.

Both the steel beams and precast planks must have long lead times in order to accommodate the fabricators. This means that coordination of MEP openings must be completed in a timely manner to avoid delays. Change orders are often difficult to issue because of this long lead time.

Summary

Advantages	Disadvantages
Extremely fast erection time	Very deep system will increase floor to floor height
Quality control not an issue for precast planks	Long lead times until steel and plank procurement
Planks allow for erection in all kinds of weather	Change orders often difficult to issue once mill order is placed
Finished surfaces can easily be applied to the underside of the plank	Spray on fireproofing required for steel
2 hour fire rating obtainable for plank with 2” topping slab	Difficulty of erection
4’-0” modular planks fit nicely into the 16’-0” wide bays	Inefficient use of concrete planks
Project can be fast tracked	Additional columns required
	Difficulty connecting precast planks to shear wall, must consider steel frame

Option 2: Composite Steel Frame with Slab on Metal Deck

This system utilizes the composite action between a steel frame and a concrete slab on metal deck. This type of system usually results in shallower steel sections because of the composite action, making it more economical. The slab on metal deck spans the spacing of the steel joists, usually in 3 span lengths. The joists connect to larger steel girders and the load is transferred to the steel columns.

Structural steel members were designed using RAM Structural System. The slab on metal deck was chosen using loading tables provided in the USD Manual. Calculations, results, and references used to determine beam sizes, deck sizes, and cost can be found in Appendix C.

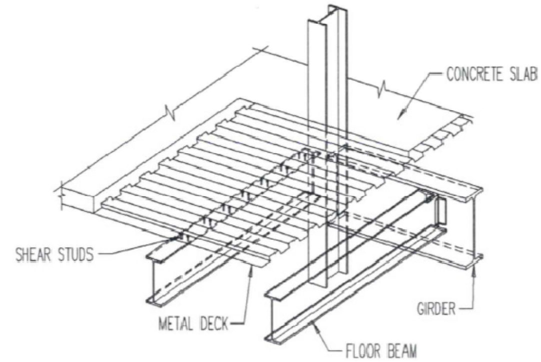
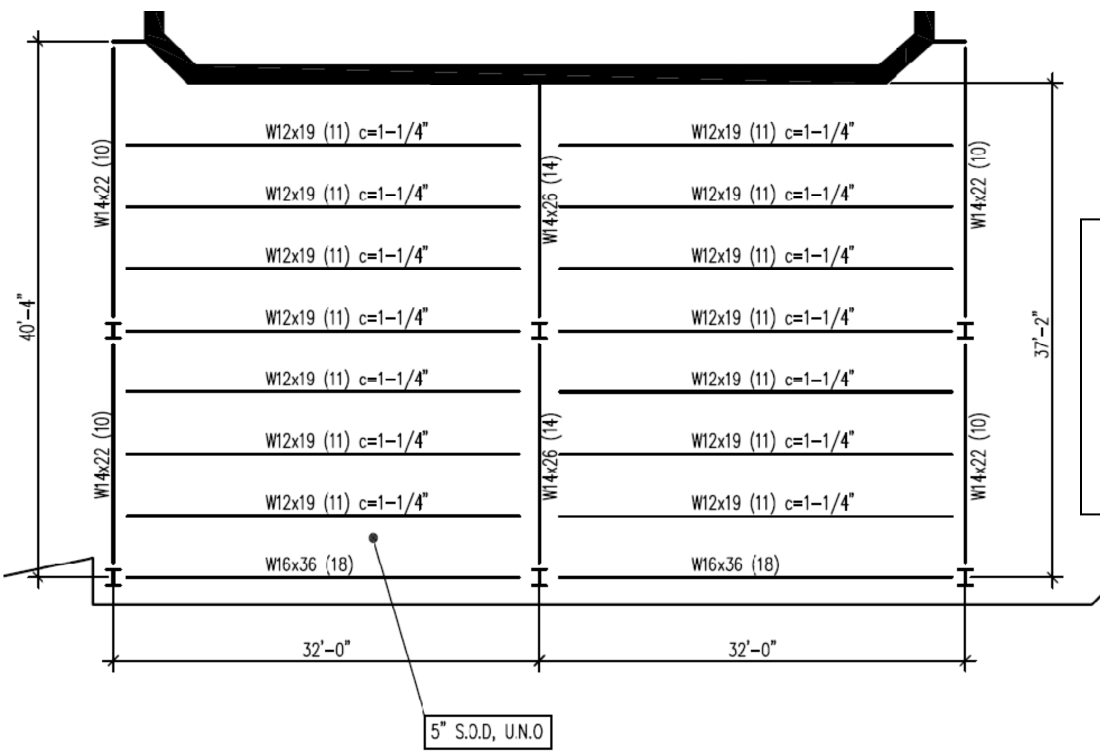


Figure 10: Diagram of Steel Frame with Slab on Metal Deck



Material Properties

F_y = 60 ksi

f'_c = 3000 psi

5" Slab on Metal Deck

1 ½" USD Lok Floor Deck

115 pcf Lightweight Concrete

Figure 11: Option 2 Framing Plan

System Effectiveness

Structural Impacts

The composite steel frame with slab on metal deck is an effective structural system for the Trump Taj Mahal Hotel. It fits the current column layout perfectly, allowing for ideal span lengths. A 1 ½" steel deck with a 5" concrete slab was able to span the spacing of the steel joist while obtaining the specified 2 hour fire rating. Spray on fireproofing will be required for the steel beams.

Architectural and MEP Impacts

The total maximum depth of this system will be approximately 19", which is 9" deeper than the current filigree system. This will add height to the tower and increase the vertical runs of MEP equipment, elevators, stairs, partitions, shear walls, and curtain walls. If the system is to be completely concealed, a suspended ceiling must be provided.

Since column lines run down the center line of guest room partitions, beams will disrupt mechanical chases that service the rooms. These mechanical chases will have to be either relocated or increased in size to avoid conflict.

Construction Impacts

Structural steel projects are generally erected in a timely manner compared to that of concrete structures. The metal decking allows the concrete slab to be poured with no form work or shoring, saving time and money. Both the steel beams and slab on metal deck can be erected in sequences, reducing erection time.

Steel must have long lead times in order to accommodate the demands of the fabricator and assure that steel will be delivered to the site on time. This means that coordination of all openings and the design of the structure must be completed in a timely manner to avoid delays. Change orders are often difficult to issue after a mill order is placed because of this long lead time.

Summary

Advantages	Disadvantages
Extremely fast erection time	Moderately deep system will increase floor to floor height
Construction sequencing	Long lead times until steel procurement
Composite construction allows for shallower beam sections	Change orders often to fulfill once mill order is placed
Metal decking eliminates the need for formwork and shoring	Spray on fireproofing required for steel beams
Project can be fast tracked	Suspended ceiling required if structure is no be concealed

Option 3: Two-Way Post-Tensioned Flat Plate

A flat plate concrete system requires no beams or drop panels, as the floor slab sits directly on top of the columns. Loads are transferred directly from the floor slab onto the columns utilizing two-way action. This type of floor system is often utilized in hotel and residential high-rise construction because it is capable of being designed with shallow slab depths, allowing for smaller floor to floor height.

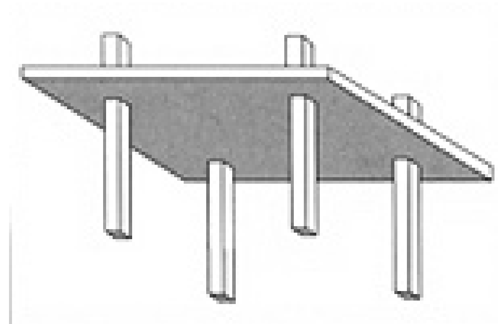
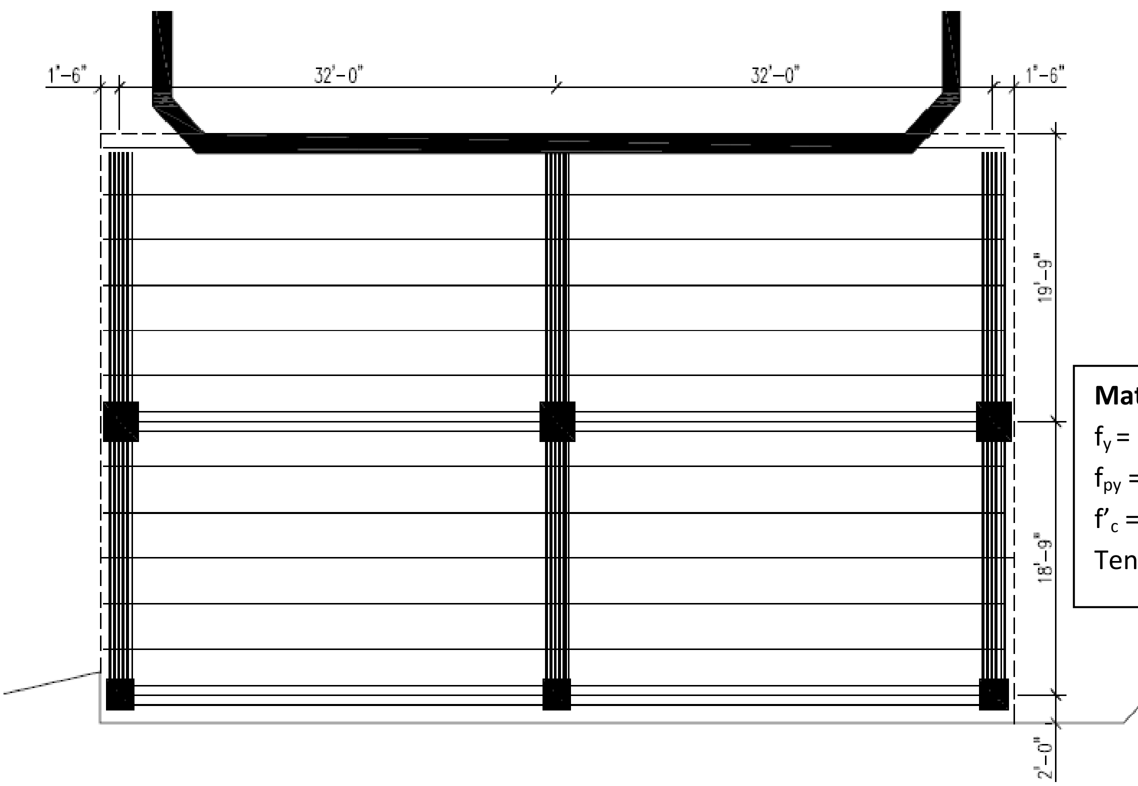


Figure 12: Diagram of a Two-way Flat Plate

This particular flat plate design incorporates the use of post-tensioning as compared to conventional reinforcing. Post-tensioning introduces compression forces into the slab while the slab is unloaded. These compression forces are used to effectively counteract the tension forces induced into the slab when it is loaded.

The slab was designed for flexure and shear utilizing RAM Concept. Punching shear was checked by hand per ACI 318-05. Calculations, results, and references used to determine required reinforcement, shear reinforcement, and deflections can be found in Appendix D.



Material Properties:
f_y = 60 ksi
f_{py} = 270 ksi
f'_c = 5000 psi
Tendons: 7 strand, low relaxation

Figure 13: Option 3 Tendon Layout
Note: For mild reinf. see Appendix D.

System Effectiveness

Structural Impacts

This system effectively handled the loads of the floor using the current spans and bay sizes. However, two-way systems tend to benefit more from square columns because of biaxial moments. For the purpose of this exercise 24”x24” (exterior) and 30”x30” (interior) square columns were used. A 2 hour fire rating was obtaining by providing at least 1 ¾” clear cover to the steel tendons.

Because of the high compression forces induced by the post-tensioning, these types of floor systems are often susceptible to shrinkage problems. In order to alleviate this issue shear walls are often located in the center of a building’s floor plan. This is ideal situation for the current shear wall layout.

Architectural and MEP Impacts

The total depth of this system is 8”, 2” shallower than the current filigree system. This will decrease the height of the tower, lowering the vertical runs of MEP equipment, elevators, stairs, shear walls, and curtain walls. The slab can be utilized as the exposed surface of the ceiling and floor.

Construction Impacts

A flat plate system offers the benefits of repetitive formwork, which allows for faster cycle times. Post-tensioned systems also allow for the formwork to be stripped in 4 – 7 days after the concrete is placed.

Safety is a big issue with post-tensioning because of the large jacking stresses that are induced into the tendons. Tendons may snap, causing serious injury. It may be necessary to have an inspector on site during the placement of post-tensioning to assure that the proper amount of strain is induced in each tendon. It is also important to coordinate any openings that exist in the floor slab prior to the pouring of concrete. Openings that must be put in after the concrete has cured face the risk of snapping tendons.

Concrete curing may be affected by the cold weather of winter. Since the erection of the structure is currently scheduled through the winter months, it may be necessary to use concrete blankets, space heating, or curing compounds to avoid weather delays.

Summary

Advantages	Disadvantages
Shallowest depth of all systems analyzed	Post-tensioning tendons may cause serious injury to workers
Repetitive formwork allows for faster cycling times	Curing difficulties in cold weather
2 hour fire rating is obtainable with no added fire protection	Openings are difficult to add after concrete is poured
Clean concrete surface with no protrusions	Tendons can easily be cut during fit-out
Inherent concrete moment frame	
Finished surfaces can easily be applied to the concrete	
Formwork is able to be stripped in 4 to 7 days	

Option 4: One-Way Concrete Slab and Beams

This system utilizes a one way slab that frames into concrete beams. The column layout of the current filigree system was unchanged; however the columns were reoriented with the strong axis in the direction of the beam span. Beams were kept as shallow as possible while still meeting the strength and deflection criteria. All members of this system were designed utilizing PCA Slab design software. Calculations and results can be found in Appendix D.

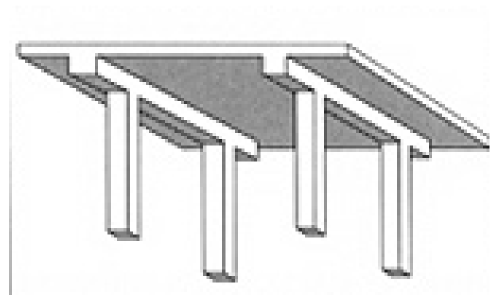
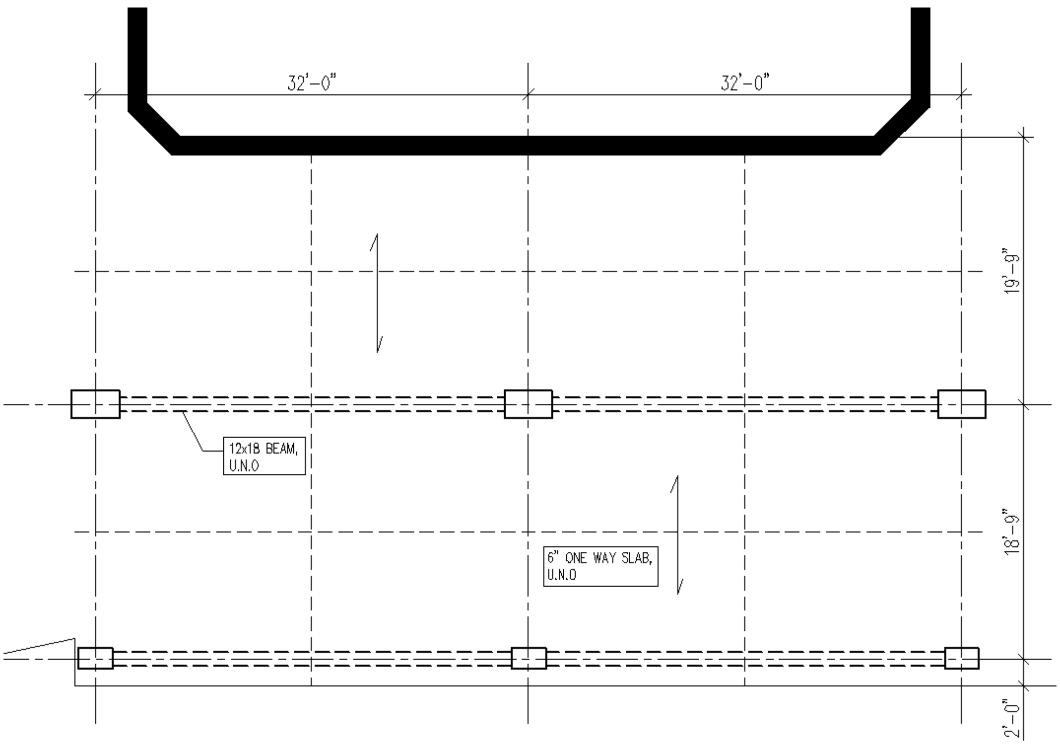


Figure 14: Diagram of One-Way Slab with Beams



Material Properties:
f_y = 60 ksi
f'_c = 5000 psi

Figure 15: Option 4 Framing Plan
Note: For reinforcing layouts of beams and slabs, see Appendix E.

System Effectiveness

Structural Impacts

The one-way slab and beam system was able to meet the needs of the design criteria established. This system achieved the lowest slab depth, at 6". However, a 12"x18" beam was necessary to transfer the loads from the slabs to the columns. Columns had to be rotated 90 degrees in order to re-orient the strong axis in the direction of the beam spans. A 2 hour fire rating is obtainable by providing a 1 ½" reinforcement clear cover for beams and ¾" clear cover for slabs.

The concrete frame has inherent moment connections and can be utilized as a lateral force resisting system. The beams add substantial stiffness to the frame and may alleviate the shear walls of some duty, thus allowing for a size reduction.

Architectural and MEP Impacts

The depth of the beams will add another 10" onto the floor to floor height of the tower, increasing the vertical runs of MEP equipment, elevators, stairs, shear walls, and curtain walls. Beams will span through the middle and will line the guest rooms at the curtain wall. These beams can be concealed or they can be left exposed to open up more space. Columns will protrude farther into the floor space of the guest rooms because of the re-orientation.

Construction Issues

The major construction issue with a one-way slab and beam system is formwork. Formwork is often complicated, taking more time to install and strip. More time is required for the concrete to cure until the formwork is able to be stripped. Reinforcing steel is often cumbersome and difficult to place. This causes quality control issues that may need to be addressed by an on-site inspector.

Concrete curing may be affected by the cold weather of winter. Since the erection of the structure is currently scheduled through the winter months, it may be necessary to use concrete blankets, space heating, or curing compounds to avoid weather delays.

Summary

Advantages	Disadvantages
Idea system for rectangular bays with aspect ratio > 1.5	Complicated formwork and reinforcing a constructability issue
Shallow slab depth requires less concrete	18" deep beam required
2 hour fire rating is obtainable with no added fire protection	Additional floor to floor height if structure is to be concealed
Inherent stiff concrete moment frame	Column orientation will interfere with floor space
Finished surfaces can easily be applied	Difficulty curing concrete in winter

Conclusion

Comparison Matrix

Floor Systems	Filigree Flat Plate	Composite Steel w/ S.O.M.D.	Steel Frame w/ Precast Hollow Core	Two-Way Post-Tensioned Flat Plate	One-Way Slab and Beams
Slab Depth	10”	5”	8” w/ Topping	8”	6”
Total Depth	10”	19”	28”/20”	8”	18”
Structural Weight (psf)	88	57	76	100	83
Cost per SF	$12.31	$14.65*	$16.93*	$14.56	$14.16*
Fireproofing	No Additional	Spray On Steel Beams	Spray On Steel Beams	No Additional	No Additional
Structural Advantages	Long spans for one-way slab	Shallower beams required	Modular design	High span to depth ratio	Shallow slab depth
Structural Disadvantages	Inefficient in-slab beams		Additional columns required	Loss of pres-tresses	Deep beam required
Maximum Total Deflection	n/a	0.539”	0.807”	0.38”	0.933”
Vibration Control	Great	Fair	Good	Great	Great
Architectural Impacts	Bottom of planks need finish	- Increased floor to floor height - Suspended ceiling	Increased floor to floor height	Smooth finished surfaced	- Protruding deep beam - Column orientation
MEP Impacts	n/a	Easy to fit in openings	Interrupts MEP chase scheme	Easy to fit in openings	Interrupts MEP chase scheme
Constructability Advantages	Planks double as formwork	Construction sequencing	Quality control	Repetitive formwork	Little laborer skills necessary
Constructability Disadvantages	Difficulties forming planks to floor plan	Long lead time	Erection issues	- Safety issues - Fit out issues	- Difficult formwork - Difficult rebar placement
Column Grid Changes	n/a	None	Additional 4	Square columns should be utilized	Strong axis rotated 90 degrees
Lateral System Effects	n/a	Steel frame should be considered	Steel frame recommended	May share lateral loads	May share lateral loads
Viable Solution?	Current	Yes, but only if a steel frame is considered for the lateral system	No, costs are too high and system is too deep	Yes	Yes, provides a strong lateral force resisting system

*Not accounting for additional costs because of increased floor to floor height

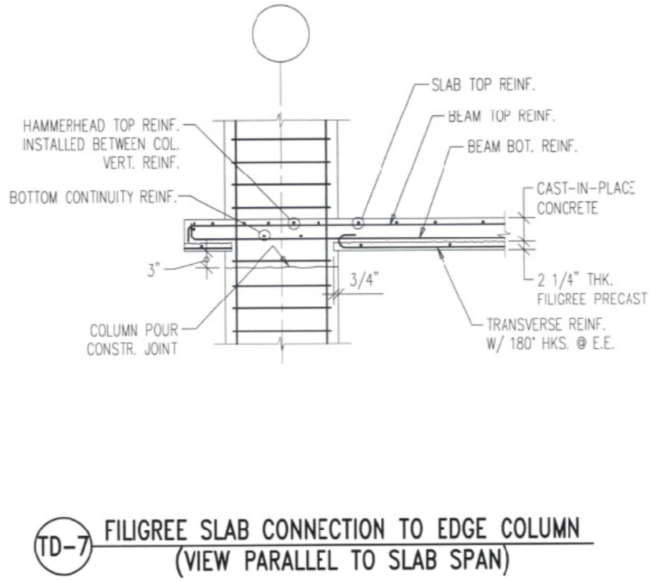
Final Remarks

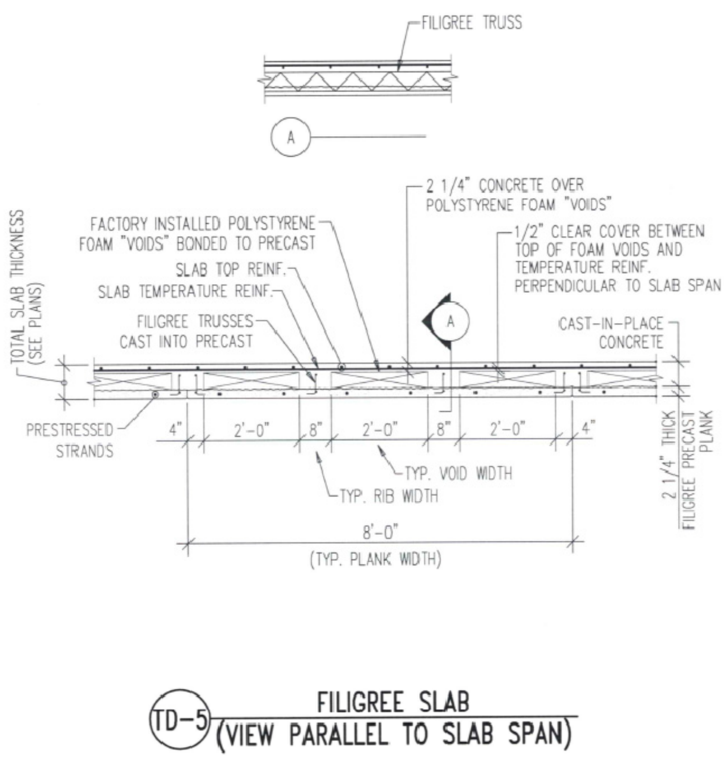
- The composite steel with slab on metal deck seems to be the most viable steel alternative because of low cost and constructability. However, the increase in floor to floor height will add substantial cost to the building. This system should only be farther considered if a redesign of the later force resisting system is to be made utilizing steel frames.
- The steel frame with precast hollow core planks does not merit farther consideration because of cost and the impact it has on floor to floor height. The height of the building will be increased 60’, adding substantial cost to the project.
- The post-tensioned concrete flat plate system is a great system because it provides a depth 2” less than the current floor system. This could add up to substantial cost savings. The post-tensioned flat plate also offers the most adaptability to the current column line scheme, however square columns should be considered.
- The one-way slab and beam system was found to be the cheapest of all four alternatives. This system also provides a great later force resisting frame because of its stiffness. However, 18” deep beams will merit an increase in floor to floor height. Beam depth may have to be increased even further if the system is to be used as a wind frame. This will add substantial costs to the building. The one-way slab and beam system will only be considered if a concrete moment frame proves to be a sound alternative to the shear walls.

Appendix

Section **Page**

Appendix A – Filigree Flat Plate System





Typical Filigree Flat Slab Details

(Provided by The Harman Group)

Project: Trump Taj Mahal - Tech 2
Engr: Steve Reichwein
Date: 10/21/2007

RS Means 2008 Cost and Labor Estimation

Floor System: 10" Filigree Flat Plate

Atlantic City Adjustment Factor: 1.058 %

Filigree Planks

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	5.15	1.31	0.56	7.02	$17,550.00	**$18,567.90**

Reinforcing Steel

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
1.20	Ton	990.00	475.00	0.00	1465.00	$1,758.00	**$1,859.96**

Concrete

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
77.16	CY	109.00	0.00	0.00	109.00	$8,410.49	**$8,898.30**

Placing Concrete - Pumped

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
77.16	CY	0.00	13.00	4.86	17.86	$1,378.09	**$1,458.02**

GRAND TOTAL	**$30,784.18**
Cost Per SF	**$12.31**

Appendix B: Steel Frame with Precast Hollow Core Planks

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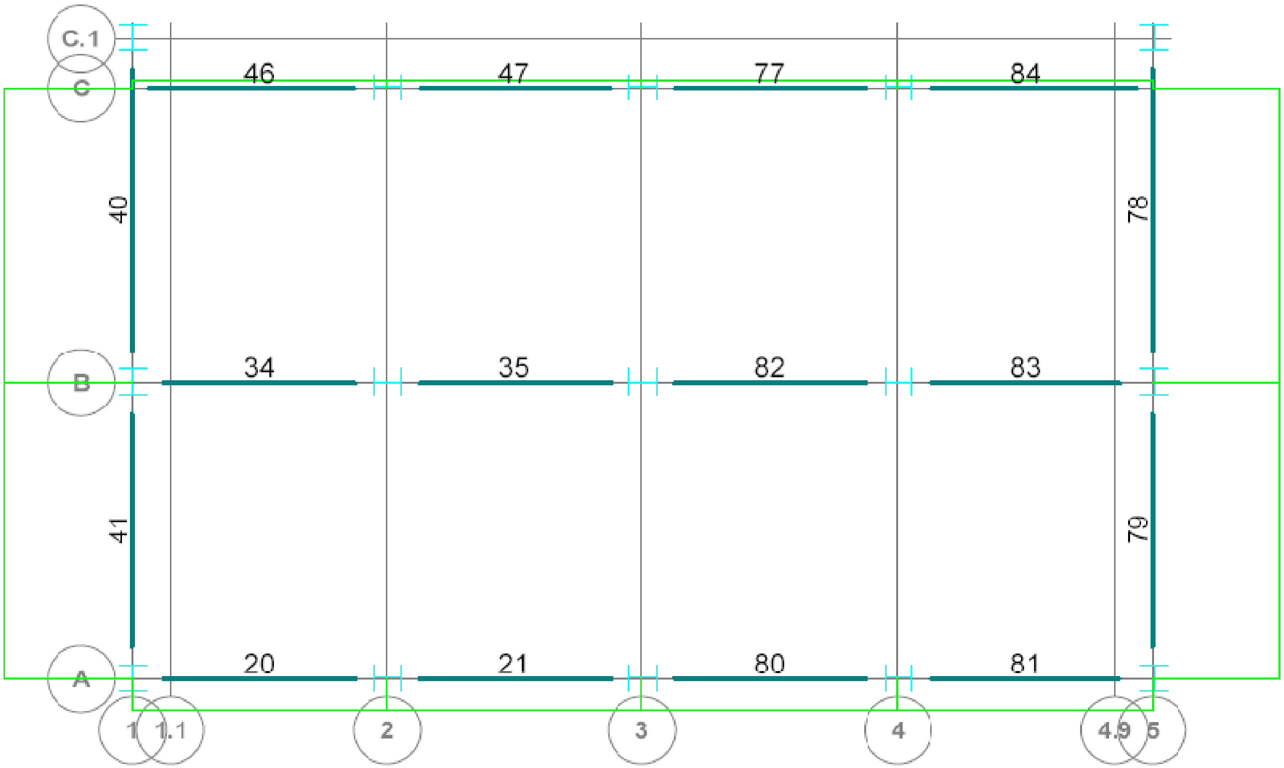
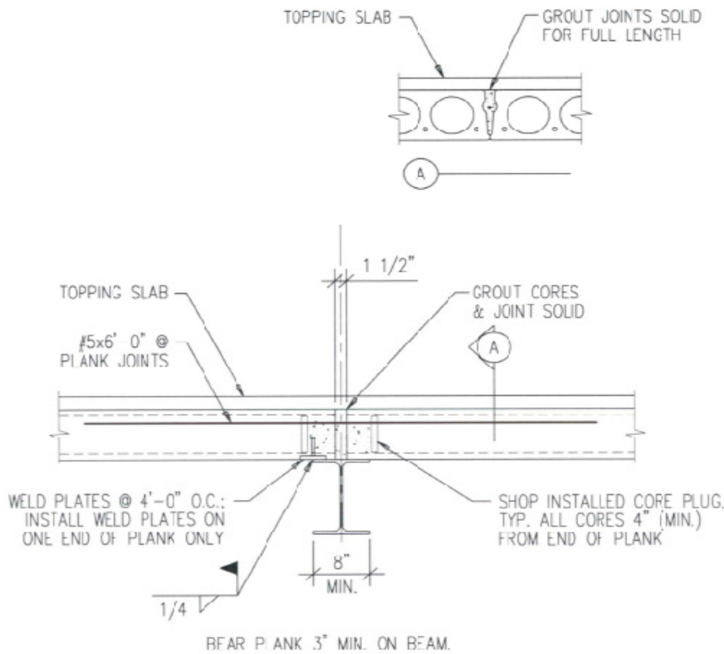
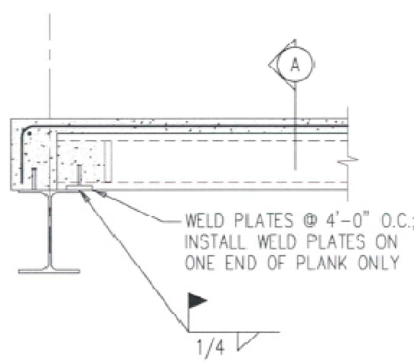


RAM Model with Beam Numbering



TD-9 PLANK BEARING ON STEEL BEAM WITH PLANK ON BOTH SIDES



TD-10 PLANK BEARING ON STEEL BEAM ON ONE SIDE

Typical Steel Frame with Precast Hollow Core Plank Details

(Provided by The Harman Group)

Beam Summary

RAM Steel v11.0
DataBase: TECH2_~2 10/24/07 01:47:43
Building Code: IBC Steel Code: ASD 9th Ed.

STEEL BEAM DESIGN SUMMARY:

Floor Type: Typical

Bm #	Length ft	+M kip-ft	-M kip-ft	Seff in3	Fy ksi	Beam Size	Studs
41	18.58	28.8	0.0	20.9	50.0	W8X24	
20	16.00	47.1	0.0	21.3	50.0	W12X19	
40	21.75	56.2	0.0	42.1	50.0	W10X39 u	
34	16.00	74.1	0.0	29.0	50.0	W14X22	
46	16.00	40.8	0.0	14.9	50.0	W12X14	
21	16.00	47.1	0.0	21.3	50.0	W12X19	
35	16.00	74.1	0.0	29.0	50.0	W14X22	
47	16.00	40.8	0.0	14.9	50.0	W12X14	
80	16.00	47.1	0.0	21.3	50.0	W12X19	
82	16.00	74.1	0.0	29.0	50.0	W14X22	
77	16.00	40.8	0.0	14.9	50.0	W12X14	
81	16.00	47.1	0.0	21.3	50.0	W12X19	
83	16.00	74.1	0.0	29.0	50.0	W14X22	
84	16.00	40.8	0.0	14.9	50.0	W12X14	
79	18.58	28.8	0.0	20.9	50.0	W8X24	
78	21.75	56.2	0.0	42.1	50.0	W10X39 u	

* after Size denotes beam failed stress/capacity criteria.
# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.

Beam Designs from RAM

Beam Deflection Summary

RAM Steel v11.0
DataBase: TECH2_~2 10/24/07 01:47:43
Building Code: IBC Steel Code: ASD 9th Ed.

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: Typical

Noncomposite

Bm #	Beam Size	Dead in	Live in	NetTotal in	Camber in
41	W8X24	0.523	0.224	0.747	
20	W12X19	0.399	0.177	0.576	
40	W10X39	0.567	0.240	0.807	
34	W14X22	0.427	0.164	0.591	
46	W12X14	0.507	0.225	0.732	
21	W12X19	0.399	0.177	0.576	
35	W14X22	0.427	0.164	0.591	
47	W12X14	0.507	0.225	0.732	
80	W12X19	0.399	0.177	0.576	
82	W14X22	0.427	0.164	0.591	
77	W12X14	0.507	0.225	0.732	
81	W12X19	0.399	0.177	0.576	
83	W14X22	0.427	0.164	0.591	
84	W12X14	0.507	0.225	0.732	
79	W8X24	0.523	0.224	0.747	
78	W10X39	0.567	0.240	0.807	

Beam Deflections from RAM

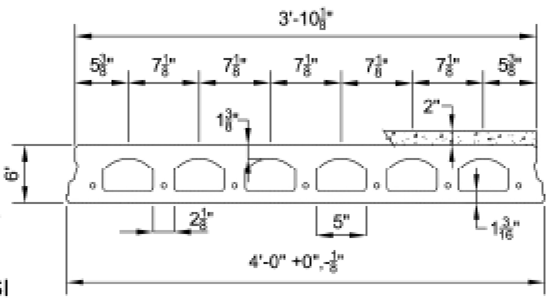
Prestressed Concrete
6"x4'-0" Hollow Core Plank

2 Hour Fire Resistance Rating With 2" Topping

PHYSICAL PROPERTIES
Composite Section

A_c = 253 in.^{2}	Precast S_{bc} = 370 in.^{3}
I_c = 1519 in.^{4}	Topping S_{tc} = 551 in.^{3}
Y_{bc} = 4.10 in.	Precast S_{tc} = 799 in.^{3}
Y_{tc} = 1.90 in.	Wt.= 195 PLF
	Wt.= 48.75 PSF

DESIGN DATA



1. Precast Strength @ 28 days = 6000 PSI
2. Precast Strength @ release = 3500 PSI.
3. Precast Density = 150 PCF
4. Strand = 1/2"Ø 270K Lo-Relaxation.
5. Strand Height = 1.75 in.
6. Ultimate moment capacity (when fully developed)...
   4-1/2"Ø, 270K = 67.5 k-ft
   7-1/2"Ø, 270K = 104.2 k-ft
7. Maximum bottom tensile stress is $7.5\sqrt{f'c}$ = 580 PSI
8. All superimposed load is treated as live load in the strength analysis of flexure and shear.
9. Flexural strength capacity is based on stress/strain strand relationships.
10. Deflection limits were not considered when determining allowable loads in this table.
11. Topping Strength @ 28 days = 3000 PSI. Topping Weight = 25 PSF.
12. These tables are based upon the topping having a uniform 2" thickness over the entire span. A lesser thickness might occur if camber is not taken into account during design, thus reducing the load capacity.
13. Load values to the left of the solid line are controlled by ultimate shear strength.
14. Load values to the right are controlled by ultimate flexural strength or fire endurance limits.
15. Load values may be different for IBC 2000 & ACI 318-99. Load tables are available upon request.
16. Camber is inherent in all prestressed hollow core slabs and is a function of the amount of eccentric prestressing force needed to carry the superimposed design loads along with a number of other variables. Because prediction of camber is based on empirical formulas it is at best an estimate, with the actual camber usually higher than calculated values.

SAFE SUPERIMPOSED SERVICE LOADS		IBC 2003 & ACI 318-02 (1.2 D + 1.6 L)																		
Strand Pattern		SPAN (FEET)																		
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4 - 1/2"ø	LOAD (PSF)	227	187	360	306	268	229	194	165	141	120	102	86	73	61	50				
7 - 1/2"ø	LOAD (PSF)	367	305	495	455	418	387	340	312	275	243	215	189	167	147	130	114	97	83	70

NITTERHOUSE
CONCRETE PRODUCTS
2655 Molly Pitcher Hwy. South, Box N
Chambersburg, PA 17201-0813
717-267-4505 Fax 717-267-4518

This table is for simple spans and uniform loads. Design data for any of these span-load conditions is available on request. Individual designs may be furnished to satisfy unusual conditions of heavy loads, concentrated loads, cantilevers, flange or stem openings and narrow widths. The allowable loads shown in this table reflect a 2 Hour & 0 Minute fire resistance rating.

05/14/07

6F2.0T

Precast Hollow Core Plank Specification

Project: Trump Taj Mahal - Tech 2
Engr: Steve Reichwein
Date: 10/21/2007

RS Means 2008 Cost and Labor Estimation

Floor System: Steel Framing with Hollow Core Planks

Atlantic City Adjustment Factor: 1.058

10" Thick Hollow Core Plank

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	6.60	1.01	0.67	8.35	$20,875.00	$22,085.75

Steel Framing

W8x24

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
74.33	LF	29.00	4.26	2.85	36.11	$2,684.18	$2,839.86

W12x19

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
64.00	LF	23.00	3.61	2.42	29.03	$1,857.87	$1,965.63

W10x39

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
74.33	LF	47.27	5.03	3.37	55.68	$4,138.36	$4,378.38

W14x22

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
64.00	LF	26.50	2.66	1.78	30.94	$1,980.16	$2,095.01

Continuous Angle - Embedded to Concrete Wall

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
53.00	LF	28.00	18.40	2.32	48.72	$2,582.16	$2,731.93

2" Topping Slab

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
15.43	CY	97.00	114.00	5.55	216.55	$3,341.82	$3,535.65

Fireproofing - Beams

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	0.45	0.49	0.08	1.02	$2,550.00	$2,697.90

TOTAL	$42,330.10
Cost Per SF	$16.93

Additives

Additional Curtain Wall

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
96.00	SF				45.00	$4,320.00	$4,570.56

ADD TOTAL	$4,570.56
Cost Per SF	$1.83

Cost Analysis of Steel Frame with Hollow Core Planks

Appendix C: Steel Composite Frame with Slab on Metal Deck

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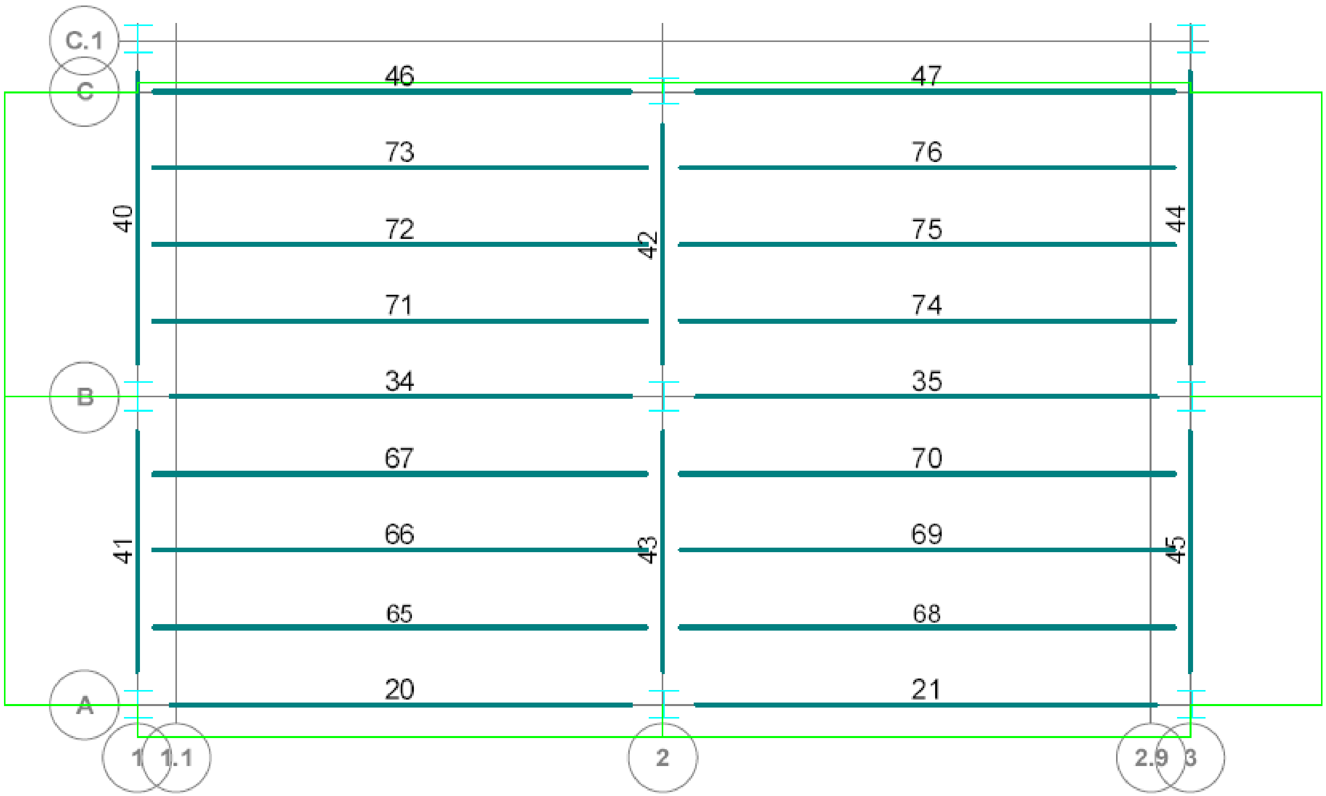
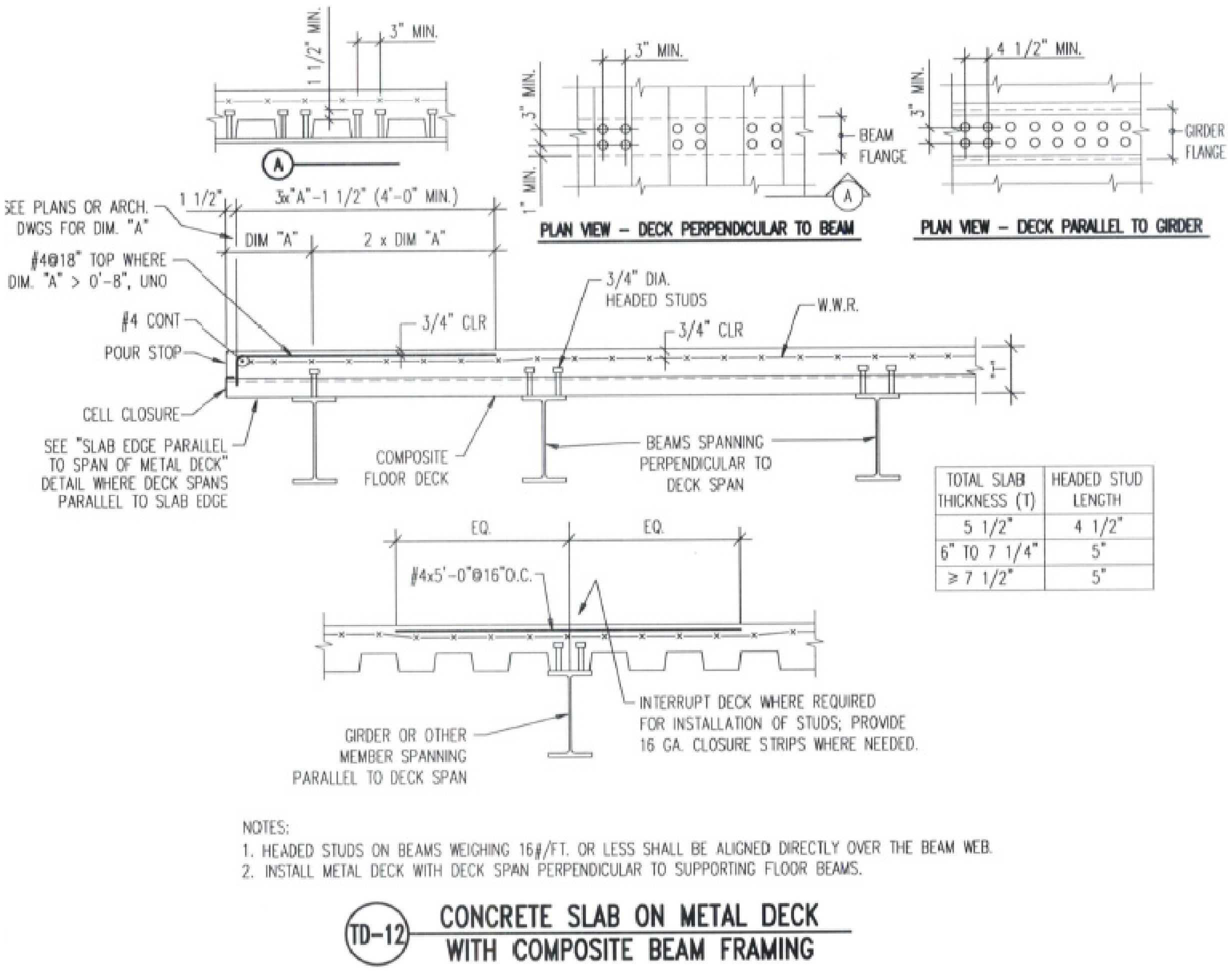


RAM Model with Beam Numbering



Composite Steel Frame with Slab on Metal Deck Typical Details

(Provided by The Harman Group)

Beam Summary

RAM Steel v11.0
DataBase: Tech2_Composite Short Span 10/23/07 14:43:42
Building Code: IBC Steel Code: ASD 9th Ed.

STEEL BEAM DESIGN SUMMARY:

Floor Type: Typical

Bm #	Length ft	+M kip-ft	-M kip-ft	Seff in3	Fy ksi	Beam Size	Studs
41	18.58	113.8	0.0	44.7	50.0	W14X22	10
20	32.00	67.2	0.0	76.6	50.0	W16X36 u	18
65	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
66	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
67	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
40	21.75	149.7	0.0	62.6	50.0	W14X43 u	
34	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
71	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
72	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
73	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
46	32.00	43.3	0.0	32.8	50.0	W12X19 u	11
43	18.58	149.3	0.0	54.5	50.0	W14X26 u	14
21	32.00	67.2	0.0	76.6	50.0	W16X36 u	18
68	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
69	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
70	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
42	18.58	149.3	0.0	54.5	50.0	W14X26 u	14
35	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
74	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
75	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
76	32.00	69.7	0.0	34.0	50.0	W12X19 u	11
47	32.00	43.3	0.0	32.8	50.0	W12X19 u	11
45	18.58	113.8	0.0	44.7	50.0	W14X22	10
44	21.75	149.7	0.0	62.6	50.0	W14X43 u	

* after Size denotes beam failed stress/capacity criteria.
# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.

Beam Designs from RAM

Beam Deflection Summary

RAM Steel v11.0
DataBase: Tech2_Composite Short Span 10/23/07 14:43:42
Building Code: IBC Steel Code: ASD 9th Ed.

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: Typical

Composite / Unshored

Bm #	Beam Size	Initial in	PostLive in	PostTotal in	NetTotal in	Camber in
41	W14X22	0.666	0.136	0.188	0.853	
20	W16X36	0.522	0.146	0.201	0.722	
65	W12X19	1.808	0.392	0.539	1.097	1-1/4
66	W12X19	1.808	0.392	0.539	1.097	1-1/4
67	W12X19	1.808	0.392	0.539	1.097	1-1/4
34	W12X19	1.808	0.392	0.539	1.097	1-1/4
71	W12X19	1.808	0.392	0.539	1.097	1-1/4
72	W12X19	1.808	0.392	0.539	1.097	1-1/4
73	W12X19	1.808	0.392	0.539	1.097	1-1/4
46	W12X19	1.145	0.263	0.362	0.757	3/4
43	W14X26	0.724	0.125	0.187	0.911	
21	W16X36	0.522	0.146	0.201	0.722	
68	W12X19	1.808	0.392	0.539	1.097	1-1/4
69	W12X19	1.808	0.392	0.539	1.097	1-1/4
70	W12X19	1.808	0.392	0.539	1.097	1-1/4
42	W14X26	0.724	0.125	0.187	0.911	
35	W12X19	1.808	0.392	0.539	1.097	1-1/4
74	W12X19	1.808	0.392	0.539	1.097	1-1/4
75	W12X19	1.808	0.392	0.539	1.097	1-1/4
76	W12X19	1.808	0.392	0.539	1.097	1-1/4
47	W12X19	1.145	0.263	0.362	0.757	3/4
45	W14X22	0.666	0.136	0.188	0.853	

Noncomposite

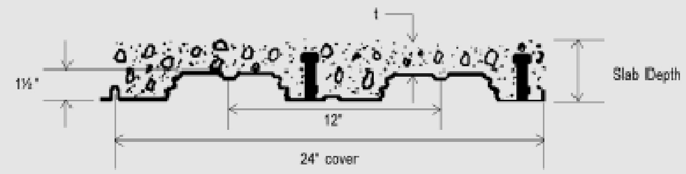
Bm #	Beam Size	Dead in	Live in	NetTotal in	Camber in
40	W14X43	0.693	0.319	1.012	
44	W14X43	0.693	0.319	1.012	

Beam Deflections from RAM

1.5 x 12" DECK F_y = 33ksi f'_c = 3 ksi 145 pcf concrete

United Steel Deck, Inc. LRFD

1.5" LOK-FLOOR



The **Deck Section Properties** are per foot of width. The **I** value is for positive bending (in.[4]); **t** is the gage thickness in inches; **w** is the weight in pounds per square foot; S_p and S_n are the section moduli for positive and negative bending (in.[3]); R_b and ϕV_n are the interior reaction and the shear in pounds (per foot of width); studs is the number of studs required per foot in order to obtain the full resisting moment, ϕM_{rf}.

DECK PROPERTIES									
Gage	t	w	As	I	S_p	S_n	R_b	ϕV_n	studs
22	0.0295	1.5	0.430	0.189	0.206	0.207	692	1560	0.36
20	0.0358	1.8	0.520	0.237	0.267	0.270	972	1890	0.43
19	0.0418	2.1	0.610	0.276	0.327	0.330	1280	2200	0.51
18	0.0474	2.3	0.650	0.313	0.378	0.376	1610	2490	0.57
16	0.0598	3.0	0.870	0.395	0.474	0.474	2370	3130	0.72

The **Composite Properties** are a list of values for the composite slab. The **slab depth** is the distance from the bottom of the steel deck to the top of the slab in inches as shown on the sketch. U.L. ratings generally refer to the cover over the top of the deck so it is important to be aware of the difference in names. ϕM_{rf} is the factored resisting moment provided by the composite slab when the "full" number of studs as shown in the upper table are in place; inch kips (per foot of width). A_c is the area of concrete available to resist shear, in.[2] per foot of width. **Vol.** is the volume of concrete in ft.[3] per ft.[2] needed to make up the slab; no allowance for frame or deck deflection is included. **W** is the concrete weight in pounds per ft.[2]. S_c is the section modulus of the "cracked" concrete composite slab; in.[3] per foot of width. I_{av} is the average of the "cracked" and "uncracked" moments of inertia of the transformed composite slab; in.[4] per foot of width. The I_{av} transformed section analysis is based on steel; therefore, to calculate deflections the appropriate modulus of elasticity to use is 29.5 x 10[6] psi. ϕM_{no} is the factored resisting moment of the composite slab if there are no studs on the beams (the deck is attached to the beams or walls on which it is resting) inch kips (per foot of width). ϕV_{nt} is the factored vertical shear resistance of the composite system; it is the sum of the shear resistances of the steel deck and the concrete but is not allowed to exceed $\phi 4(f'_c)^{1/2}A_c$; pounds (per foot of width). The next three columns list the **maximum unshored spans** in feet; these values are obtained by using the construction loading requirements of the SDI; combined bending and shear, deflection, and interior reactions are considered in calculating these values. A_{wwf} is the minimum area of welded wire fabric recommended for temperature reinforcing in the composite slab; square inches per foot.

COMPOSITE PROPERTIES													
	Slab Depth	ϕM_{rf} in.k	A_c in²	Vol. ft³/ft²	W psf	S_c in³	I_{av} in³	ϕM_{no} in.k	ϕV_{nt} lbs.	Max. unshored spans, ft. 1span	2span	3span	A_{wwf}
22 gage	4.00	36.40	30.7	0.271	39	0.97	4.4	27.26	4420	4.86	6.49	6.57	0.023
	4.50	42.43	36.0	0.313	45	1.16	6.2	32.47	4910	4.62	6.20	6.27	0.027
	4.75	45.45	38.8	0.333	48	1.25	7.3	35.12	5170	4.52	6.07	6.14	0.029
	5.00	48.46	41.7	0.354	51	1.35	8.4	37.79	5440	4.42	5.95	6.02	0.032
	5.50	54.50	47.0	0.396	57	1.54	11.1	43.20	5940	4.25	5.72	5.79	0.036
	5.75	57.51	49.4	0.417	60	1.64	12.7	45.94	6160	4.17	5.62	5.69	0.038
	6.00	60.53	51.8	0.438	63	1.74	14.3	48.68	6380	4.12	5.53	5.59	0.041
	6.50	66.56	56.5	0.479	69	1.93	18.1	54.22	6820	4.03	5.35	5.41	0.045
	6.75	69.57	58.9	0.500	73	2.03	20.2	57.00	7040	3.98	5.27	5.33	0.047
	7.00	72.59	61.3	0.521	76	2.13	22.4	59.79	7260	3.94	5.19	5.25	0.050
20 gage	4.00	43.31	30.7	0.271	39	1.16	4.8	32.48	4750	5.74	7.68	7.79	0.023
	4.50	50.61	36.0	0.313	45	1.38	6.7	38.69	5240	5.45	7.30	7.42	0.027
	4.75	54.25	38.8	0.333	48	1.49	7.8	41.86	5500	5.32	7.13	7.25	0.029
	5.00	57.90	41.7	0.354	51	1.61	9.0	45.06	5770	5.20	6.97	7.10	0.032
	5.50	65.19	47.0	0.396	57	1.84	11.8	51.55	6270	4.99	6.68	6.82	0.036
	5.75	68.84	49.4	0.417	60	1.95	13.5	54.83	6490	4.90	6.54	6.70	0.038
	6.00	72.49	51.8	0.438	63	2.07	15.2	58.13	6710	4.84	6.42	6.58	0.041
	6.50	79.78	56.5	0.479	69	2.31	19.2	64.78	7150	4.72	6.18	6.36	0.045
	6.75	83.43	58.9	0.500	73	2.43	21.4	68.12	7370	4.67	6.08	6.26	0.047
	7.00	87.07	61.3	0.521	76	2.55	23.7	71.48	7590	4.62	5.97	6.16	0.050
19gage	4.00	49.98	30.7	0.271	39	1.34	5.1	37.46	5060	6.51	8.49	8.77	0.023
	4.50	58.54	36.0	0.313	45	1.59	7.1	44.68	5550	6.17	8.07	8.33	0.027
	4.75	62.81	38.8	0.333	48	1.72	8.2	48.37	5810	6.03	7.88	8.14	0.029
	5.00	67.09	41.7	0.354	51	1.86	9.5	52.10	6080	5.89	7.70	7.96	0.032
	5.50	75.65	47.0	0.396	57	2.13	12.5	59.67	6580	5.64	7.38	7.63	0.036
	5.75	79.92	49.4	0.417	60	2.26	14.2	63.49	6800	5.54	7.24	7.47	0.038
	6.00	84.20	51.8	0.438	63	2.40	16.1	67.34	7020	5.46	7.10	7.33	0.041
	6.50	92.76	56.5	0.479	69	2.68	20.2	75.10	7460	5.33	6.84	7.07	0.045
	6.75	97.03	58.9	0.500	73	2.82	22.5	79.00	7680	5.27	6.72	6.94	0.047
	7.00	101.31	61.3	0.521	76	2.96	25.0	82.92	7900	5.21	6.61	6.83	0.050
18 gage	4.00	56.70	30.7	0.271	39	1.49	5.3	41.82	5350	7.11	9.05	9.36	0.023
	4.50	65.38	36.0	0.313	45	1.78	7.4	49.93	5840	6.74	8.61	8.90	0.027
	4.75	70.22	38.8	0.333	48	1.93	8.6	54.07	6100	6.58	8.41	8.69	0.029
	5.00	75.06	41.7	0.354	51	2.08	10.0	58.27	6370	6.42	8.22	8.50	0.032
	5.50	84.73	47.0	0.396	57	2.38	13.1	66.77	6870	6.15	7.88	8.15	0.036
	5.75	89.57	49.4	0.417	60	2.53	14.9	71.08	7090	6.03	7.73	7.98	0.038
	6.00	94.41	51.8	0.438	63	2.69	16.8	75.41	7310	5.95	7.58	7.83	0.041
	6.50	104.09	56.5	0.479	69	3.00	21.1	84.14	7750	5.81	7.31	7.55	0.045
	6.75	108.93	58.9	0.500	73	3.16	23.5	88.54	7970	5.74	7.18	7.42	0.047
	7.00	113.76	61.3	0.521	76	3.31	26.1	92.95	8190	5.67	7.06	7.30	0.050
16 gage	4.00	56.70	30.7	0.271	39	1.83	5.8	41.82	5710	8.14	10.15	10.49	0.023
	4.50	65.38	36.0	0.313	45	2.19	8.1	49.93	6480	7.71	9.66	9.98	0.027
	4.75	70.22	38.8	0.333	48	2.37	9.5	54.07	6740	7.51	9.44	9.75	0.029
	5.00	75.06	41.7	0.354	51	2.56	10.9	58.27	7010	7.34	9.23	9.54	0.032
	5.50	84.73	47.0	0.396	57	2.94	14.3	66.77	7510	7.02	8.85	9.15	0.036
	5.75	89.57	49.4	0.417	60	3.13	16.3	71.08	7730	6.88	8.68	8.97	0.038
	6.00	94.41	51.8	0.438	63	3.32	18.3	75.41	7950	6.79	8.52	8.80	0.041
	6.50	104.09	56.5	0.479	69	3.71	23.0	84.14	8390	6.62	8.21	8.49	0.045
	6.75	108.93	58.9	0.500	73	3.91	25.6	88.54	8610	6.54	8.08	8.34	0.047
	7.00	113.76	61.3	0.521	76	4.10	28.3	92.95	8830	6.46	7.94	8.21	0.050

1.5" LOK-FLOOR

26

Deck Loading Tables, Provided by USD, Inc.

USD United Steel Deck, Inc.

U.L. Fire Ratings - Composite Deck, cont'd.

RESTRAINED ASSEMBLY RATINGS (HOURLY)	U.L. DES. NO.	F.P.	CONCRETE COVER	USD PRODUCTS
2	D216	S	2 ½ NW,LW	BL,BLC,LF2,LFC2,LF3,LFC3,NL,NLC
	D502	S	2 ½ NW	BL,BLC,LF2,LFC2,LF3,LFC3,NL,NLC
	D703	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D704	C	2 ½ NW	BL,BLC,LF15,LFC1
	D706	C	2 ½ NW	LF3,LFC3
	D712	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D716	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3*
	D722	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D726	C	2 ½ NW,LW	LF15,LF2,LF3,NL *
	D727	C	2 ½ NW	INV.BL,INV. NL *
	D730	C	2 ½ NW	LF2,LFC2,LF3,LFC3,NL,NLC*
	D733	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D739	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC,AWC2,AWC3*
	D742	C	2 ½ NW	LF15,LF2,LF3,NL*
	D743	C	2 NW,LW	LF2,LFC2,LF3,LFC3*
	D745	C	2 ½ NW,LW	LF2,LF3 *
	D746	C	2 ½ LW	BL *
	D747	C	2 ½ LW	LF2 *
	D750	C	2 ½ NW,LW	BL,INV.BL,LF2,LF3,NL *
	D752	C	2 ½ LW	BL,BLC, ,LF2,LFC2,LF3,LFC3*
	D755	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D759	C	2 ½ NW,LW	BL,LF15,LF2,LF3,NL*
	D760	C	2 ½ NW,LW	LF2,LF3
	D767	C	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,AWC2,AWC3
	D777	C	2 ½ NW	LF15,LF2,LF3,NL*
	D772	C	2 ½ NW,LW	LF2,LF3*
	D773	C	2 ½ LW	BL*
	D774	C	2 ½ LW	LF2*
	D775	C	2 ½ NW,LW	BL,INV. BL,LF2,LF3*
	D779	C	2 ½ NW,LW	BL,LF15,LF2,LF3
	D822	F	2 ½ NW,LW	LF2,LFC2,LF3,LFC3,NL,NLC*
	D824	F	2 ½ NW,LW	BL,BLC,LF15,LFC1
	D825	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D826	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D831	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D832	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D833	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3*
	D837	F	2 ½ NW	BL,BLC,LF15,LFC1*
	D840	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D847	F	2 ½ NW,LW	LF2,LFC2,LF3,LFC3,NLC*
	D852	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3*
	D858	F	2 ½ NW,LW	LF2,LFC2,LF3,LFC3,AWC2, AWC3*
	D859	F	2 NW,LW	LF2,LFC2,LF3,LFC3*
	D860	F	3 ¼ LW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC*
	D861	F	2 ½ NW,LW	LF2,LF3*
	D862	F	2 ½ LW	LF2,LF3*
	D870	F	2 ½ NW,LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3*
	D902	N	4 ½ NW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D902	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D902	N	3 ½ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D906	N	3 ¼ LW	NLC
	D907	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3
	D908	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D913	N	3 ¼ LW	BL,LF15,LF2,LFC2,LF3,LFC3
	D916	N	4 ½ NW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D916	N	3 ¼ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D916	N	3 ½ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D918	N	4 ½ NW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D918	N	3 ¼ LW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D918	N	3 ½ LW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D919	N	3 ¼ LW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D919	N	3 ½ LW	LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D920	N	3 ¼ LW	LF2,LFC2,LF3,LFC3
	D922	N	4 ½ NW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D922	N	3 ½ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D923	N	4 ½ NW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D923	N	3 ½ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D925	N	4 ½ NW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D925	N	3 ½ LW	BL,BLC,LF15,LFC1,LF2,LFC2,LF3,LFC3,NL,NLC
	D927	N	4 ½ NW	B,BLC,LF2,LF2C,LF3,LF3C, NL,NLC
	D927	N	3 ¼ LW	B,BLC,LF2,LF2C,LF3,LF3C, NL,NLC
	D929	N	4 ½ NW	B,BLC,LF2,LF2C,LF3,LF3C, NL,NLC
	D929	N	3 ¼ LW	B,BLC,LF2,LF2C,LF3,LF3C, NL,NLC

FIRE RATINGS, CONT'D

48

Fire Rating of Slab on Metal Deck, Provided by USD, Inc.

Project: Trump Taj Mahal - Tech 2
Engr: Steve Reichwein
Date: 10/21/2007

RS Means 2008 Cost and Labor Estimation

Floor System: Steel Composite Framing

Atlantic City Adjustment Factor: 1.058 %

1.5" 20 Gage USD Lok-Floor Deck

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	1.85	0.37	0.03	2.25	$5,625.00	**$5,951.25**

Steel Framing

W14x22

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
80.66	LF	26.50	2.66	1.78	30.94	$2,495.62	**$2,640.37**

W14x26

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
74.33	LF	31.50	2.37	1.58	35.45	$2,635.14	**$2,787.98**

W12x19

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
448.00	LF	23.00	3.61	2.42	29.03	$13,005.12	**$13,759.42**

W16x36

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
64.00	LF	43.55	2.84	1.90	45.64	$2,921.19	**$3,090.62**

Shear Studs

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
238.00	Each	0.48	0.74	0.37	1.59	$378.42	**$400.37**

5" LWT Slab

Concrete

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
34.72	CY	100.00	14.90	5.55	120.45	$4,182.29	**$4,424.86**

Welded Wire Fabric

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
25.00	CSF	13.25	19.65		32.90	$822.50	**$870.21**

Fireproofing - Beams

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	0.45	0.49	0.08	1.02	$2,550.00	**$2,697.90**

TOTAL W/O ADDITIVES	**$36,622.97**
Cost Per SF	**$14.65**

Additives

Additional Curtain Wall

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
48.00	SF				45.00	$2,160.00	**$2,285.28**

Suspended Ceiling

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	1.14	0.59	0.00	1.73	$4,325.00	**$4,575.85**

TOTAL ADD.	**$6,861.13**
Cost Per SF	**$2.74**

Cost Analysis of Composite Steel Frame with Slab on Metal Deck

Appendix D: Two-Way Post-Tensioned Flat Plate

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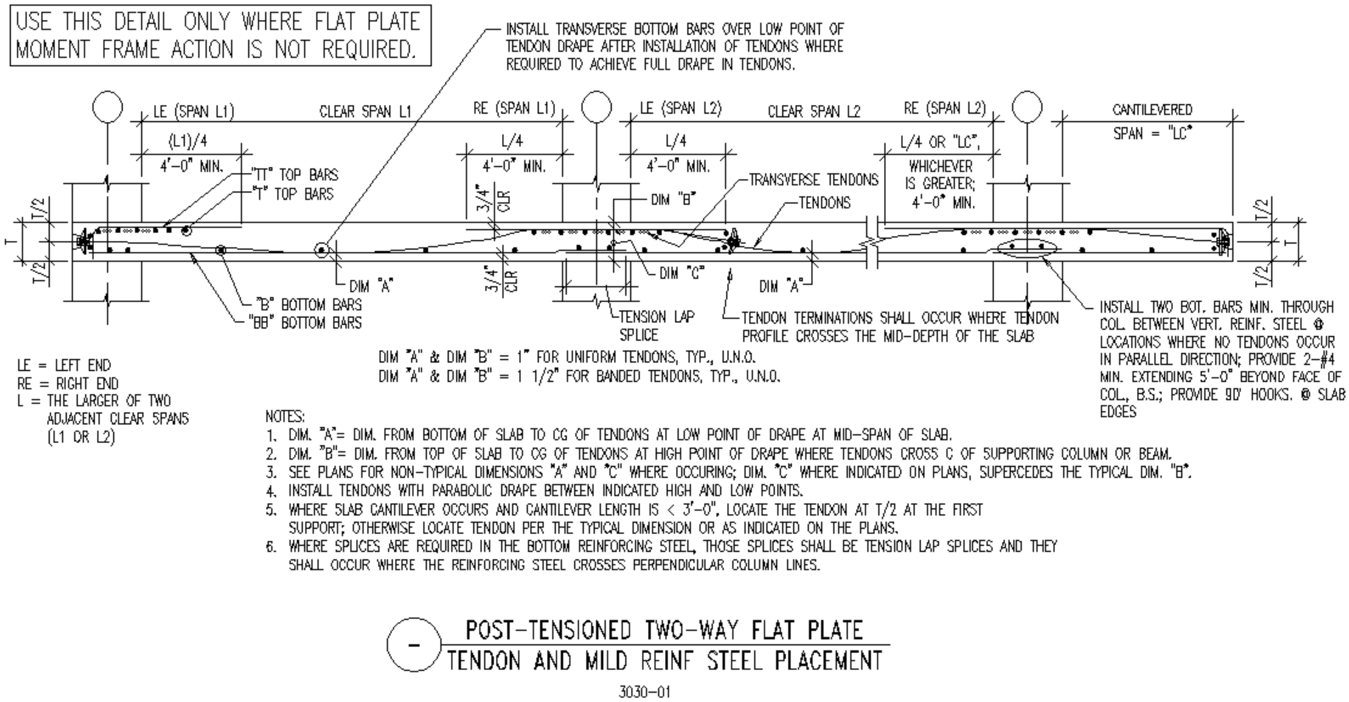
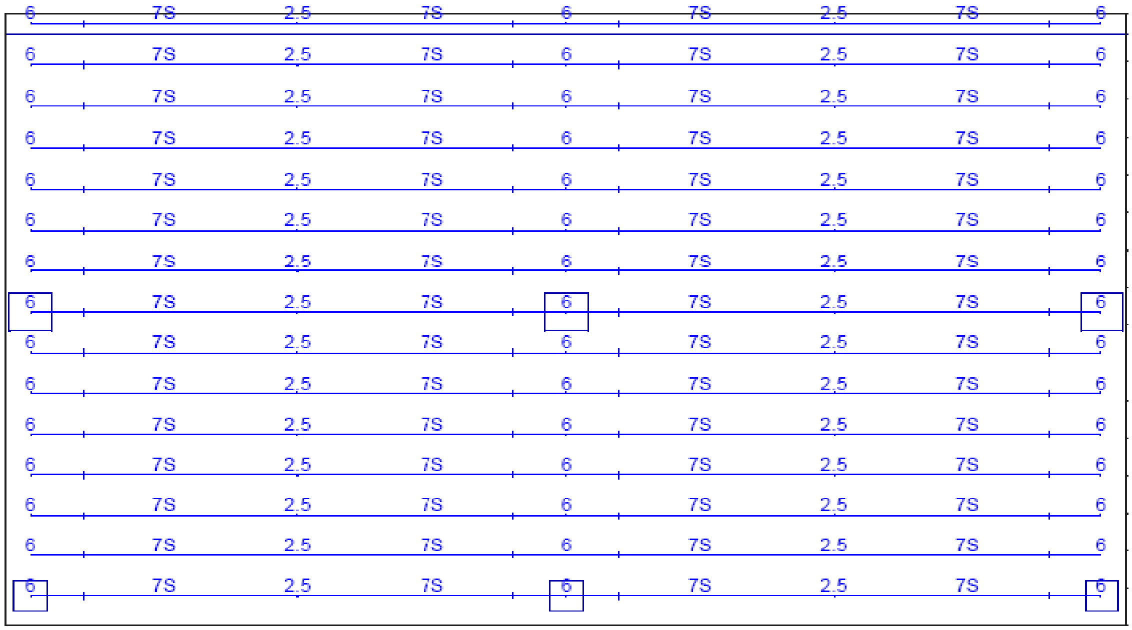
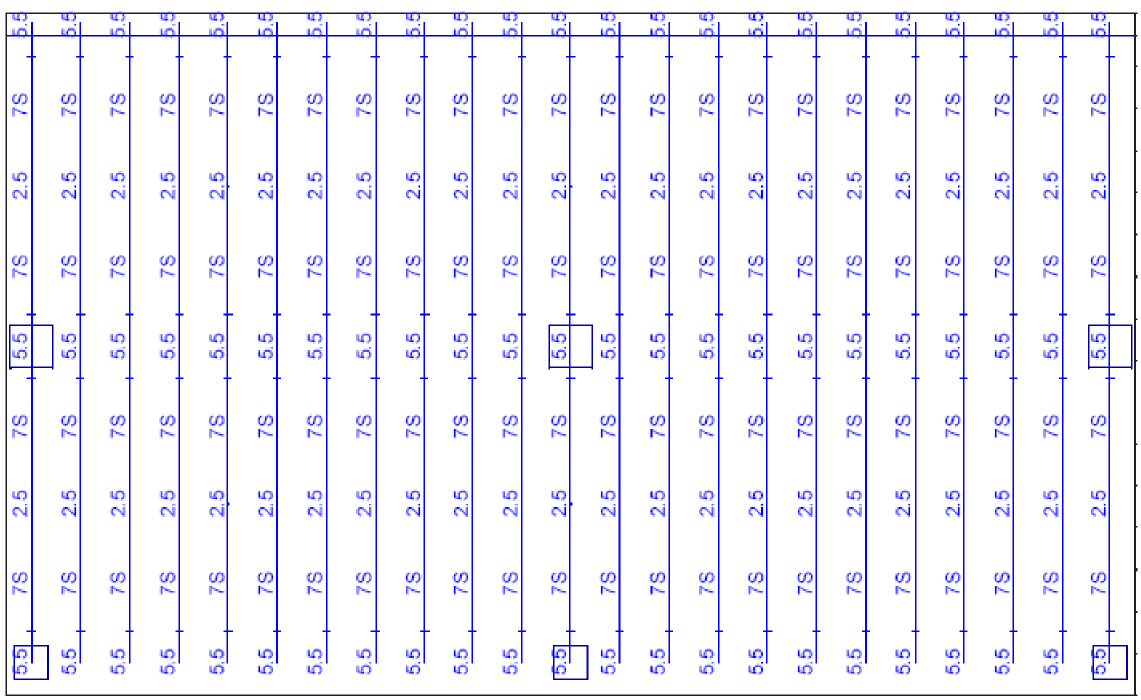


Typical Post-Tensioned Two-Way Flat Plate Tendon and Reinforcement Detail

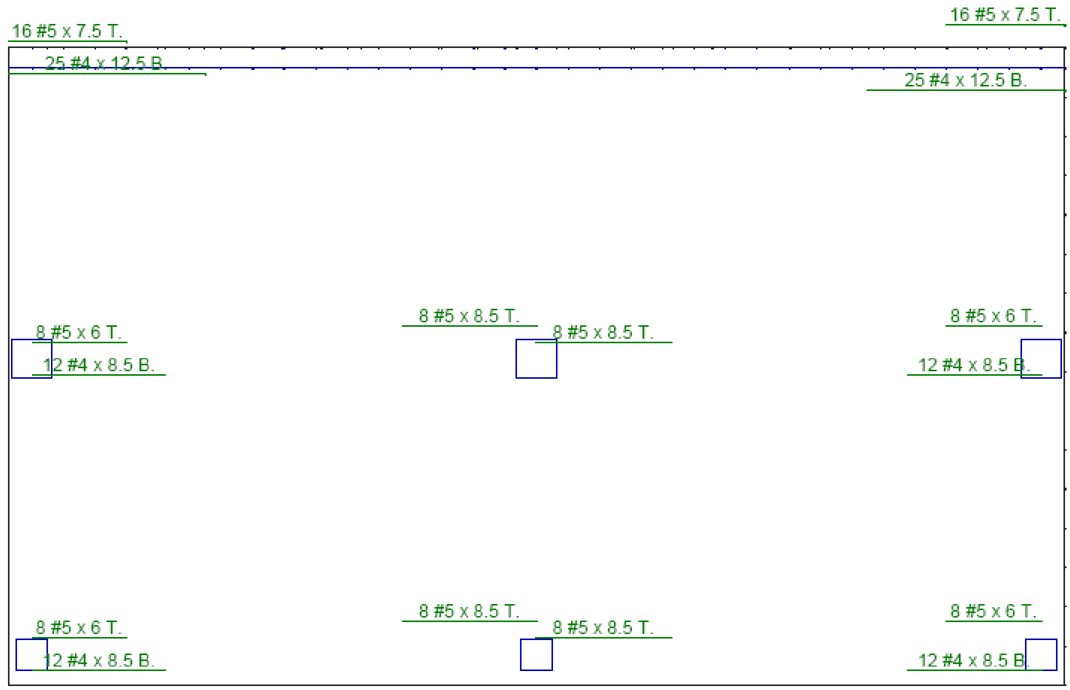
(Provided by The Harman Group)



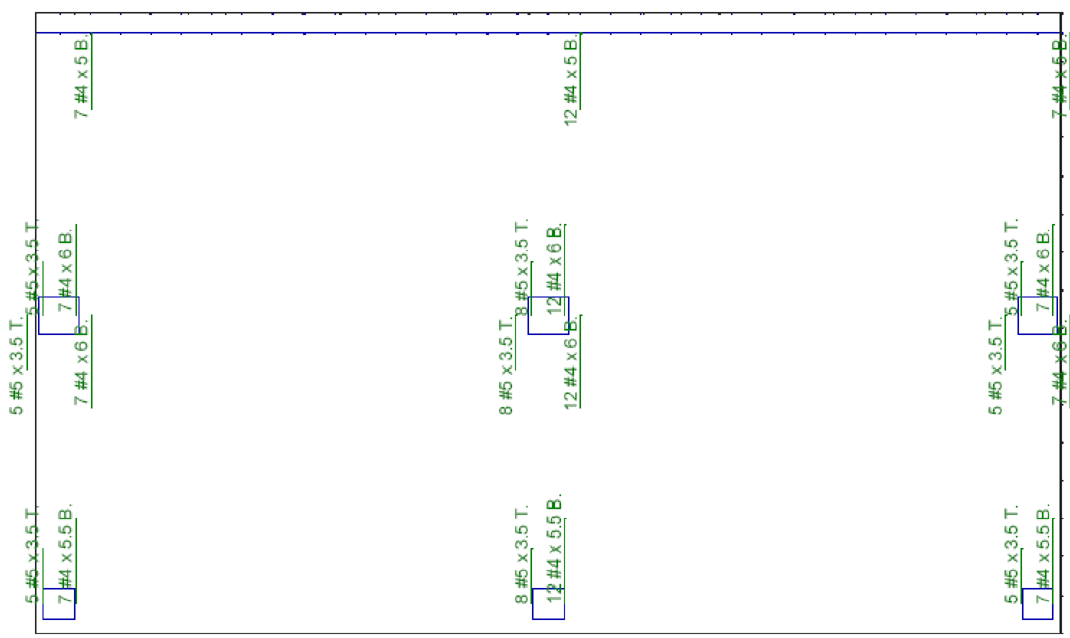
Latitude Tendon Design Strip Plan



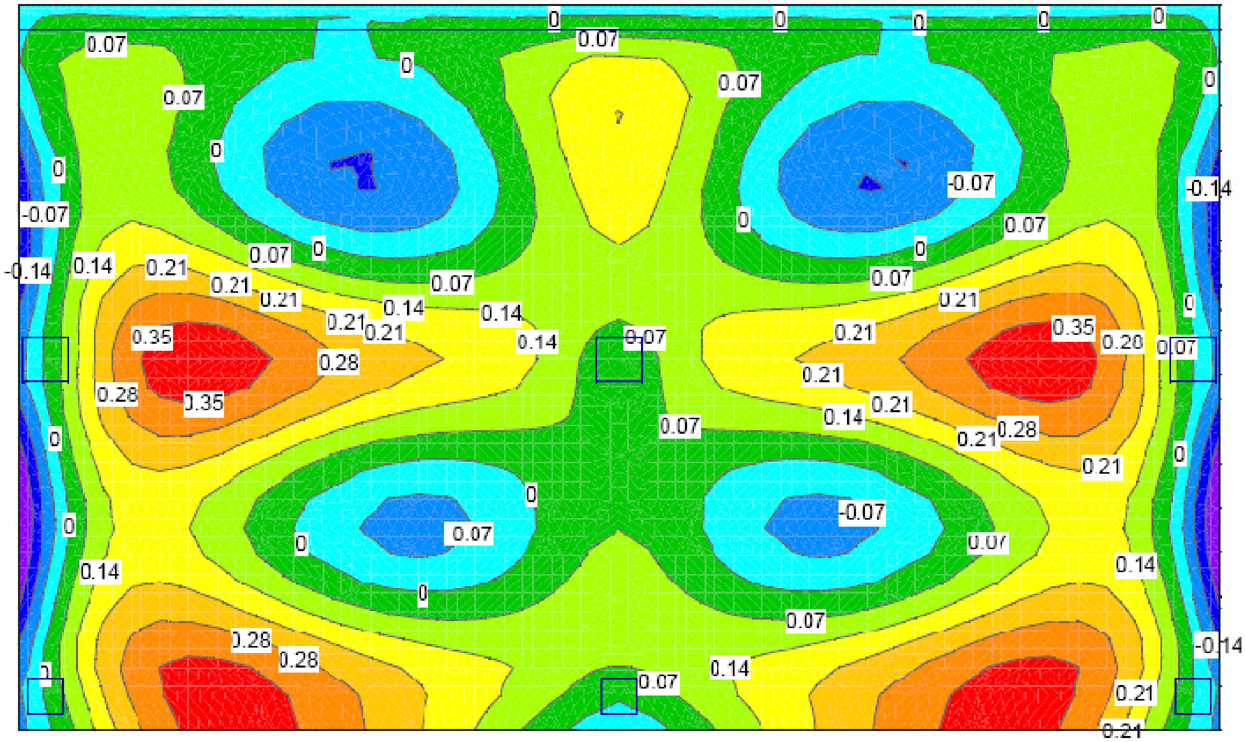
Longitude Tendon Design Strip Plan



Latitudinal Top and Bottom Reinforcing Requirements per Design Strip



Longitudinal Top and Bottom Reinforcing Requirements per Design Strip



Slab Deflection, in Inches

Project: Trump Taj Mahal - Tech 2
Engr: Steve Reichwein
Date: 10/21/2007

RS Means 2008 Cost and Labor Estimation

Floor System: Post-Tensioned Flat Plate

Atlantic City Adjustment Factor: 1.058 %

Formwork

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	2.89	3.56	0.00	6.45	$16,125.00	**$17,060.25**

Reinforcing Steel

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
1.02	Ton	990.00	475.00	0.00	1465.00	$1,497.23	**$1,584.07**

Prestressing Steel

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
5531.00	lb	0.51	1.09	0.02	1.62	$8,960.22	**$9,479.91**

Concrete

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
61.73	CY	109.00	0.00	0.00	109.00	$6,728.40	**$7,118.64**

Placing Concrete - Pumped

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
61.73	CY	0.00	13.00	4.86	17.86	$1,102.47	**$1,166.41**

GRAND TOTAL	**$36,409.29**
Cost Per SF	**$14.56**

Cost Analysis of Post-Tension Flat Plate System

Appendix E: One-Way Concrete Slab and Beams

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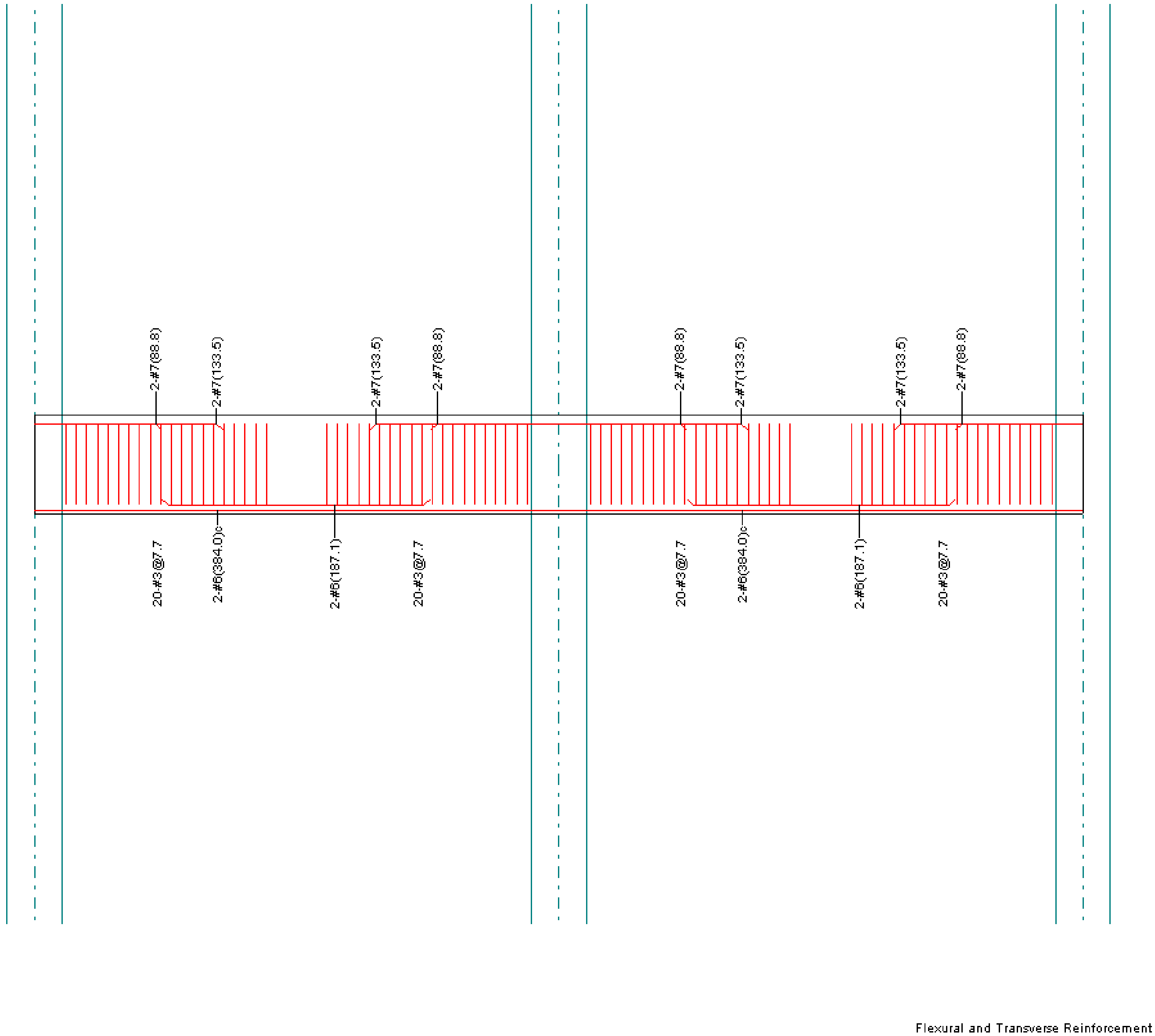
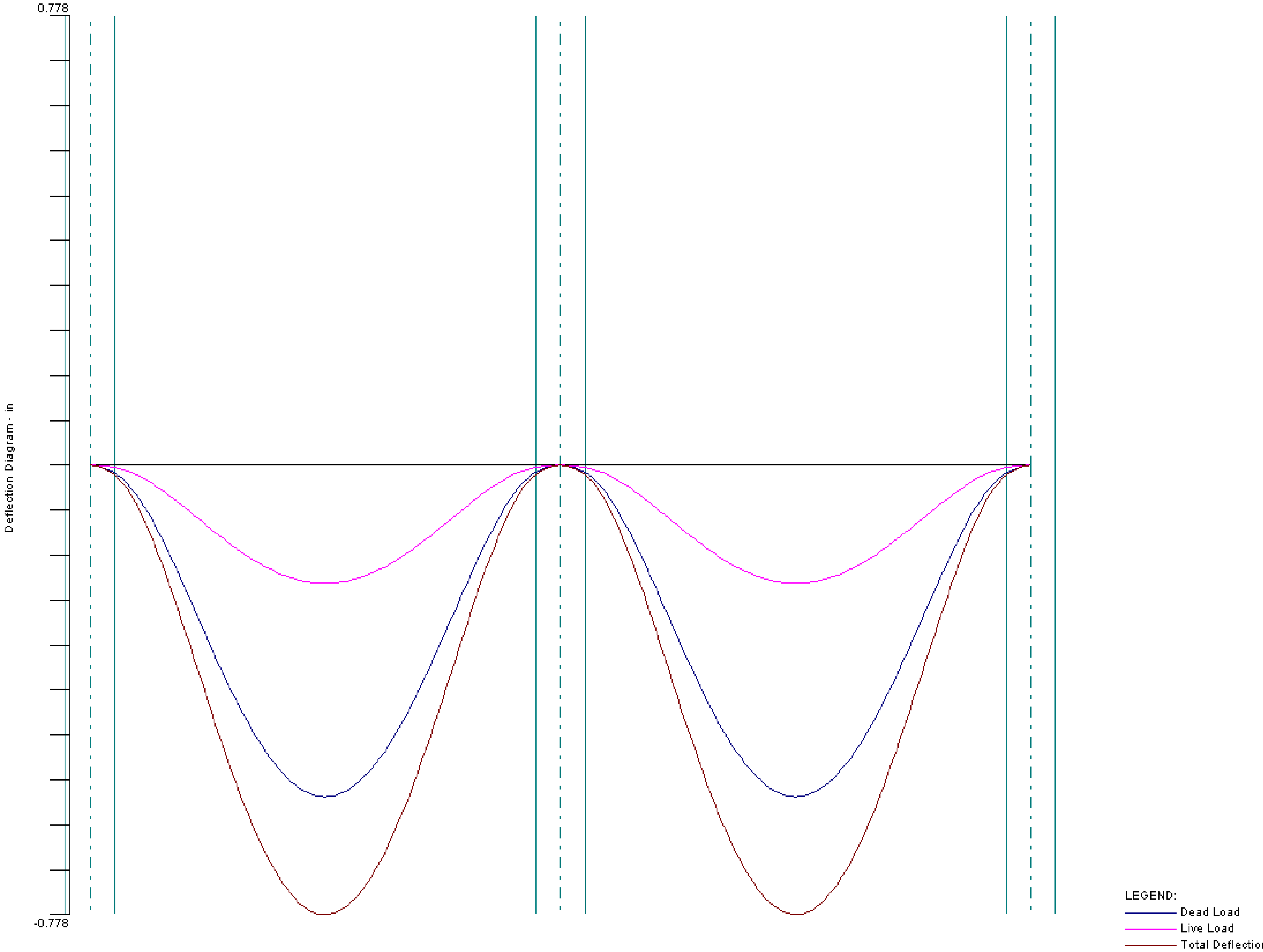
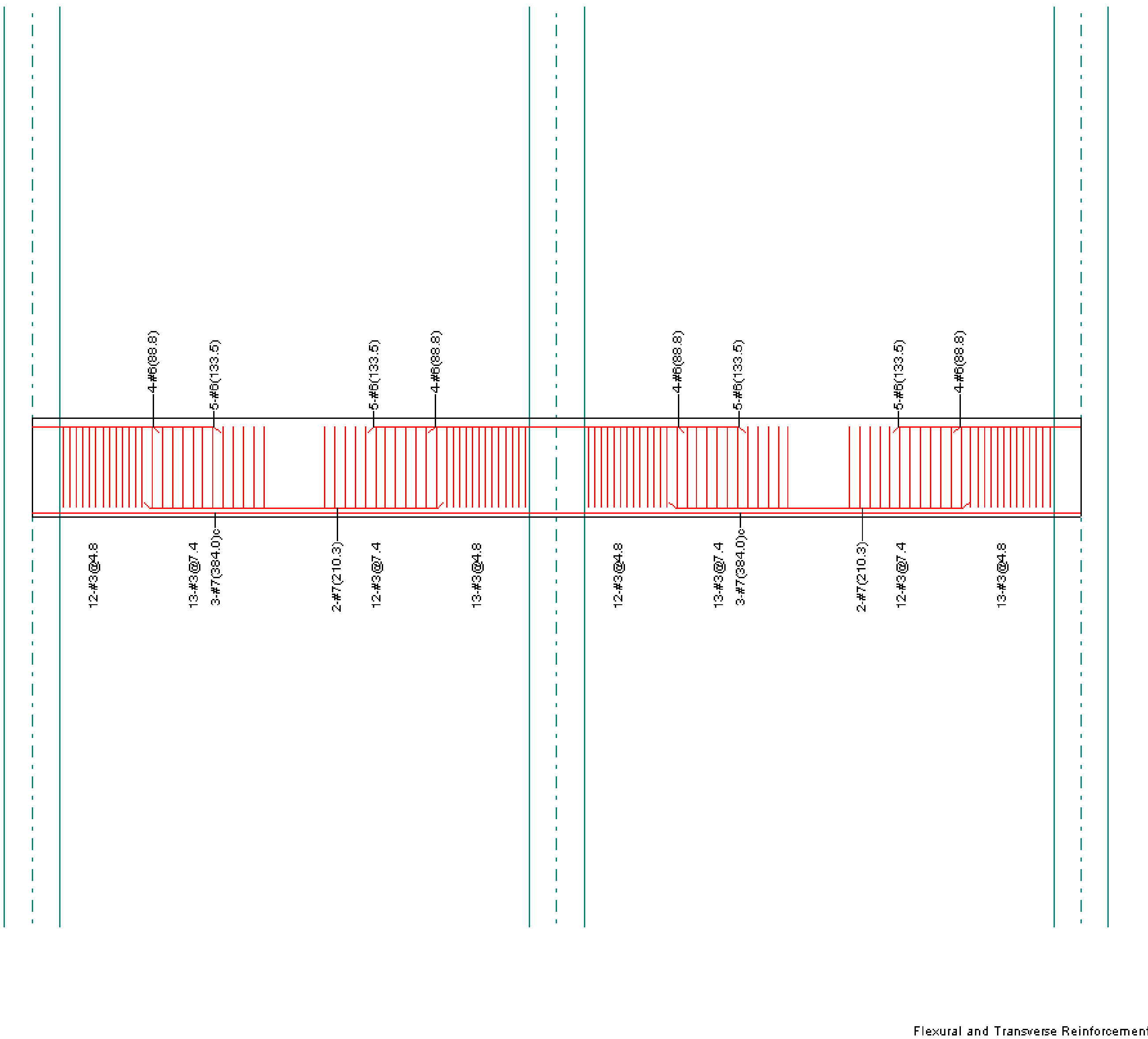


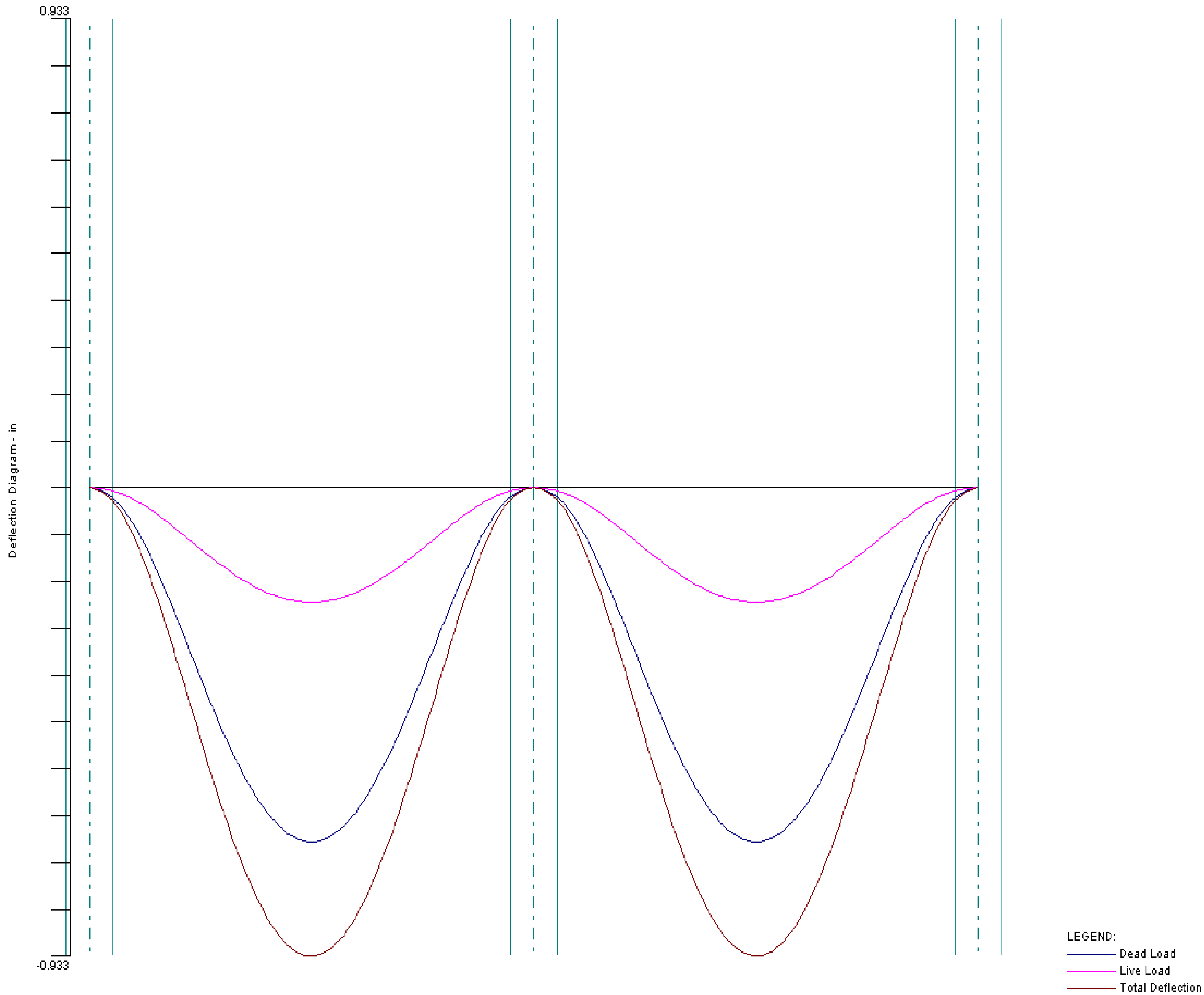
Exterior Beam Flexural and Shear Reinforcement Design



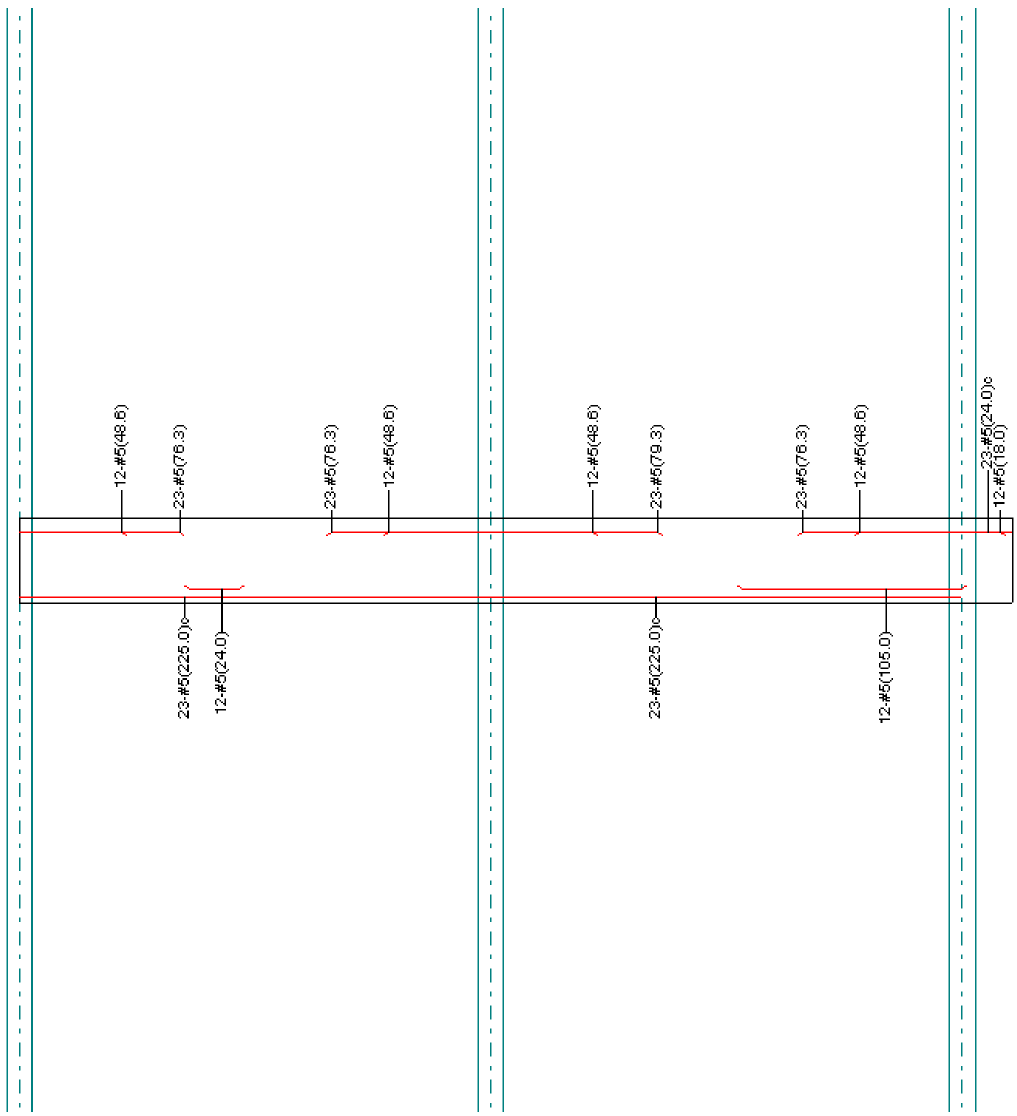
Exterior Beam Deflection in Inches



Interior Beam Flexural and Shear Reinforcement Design

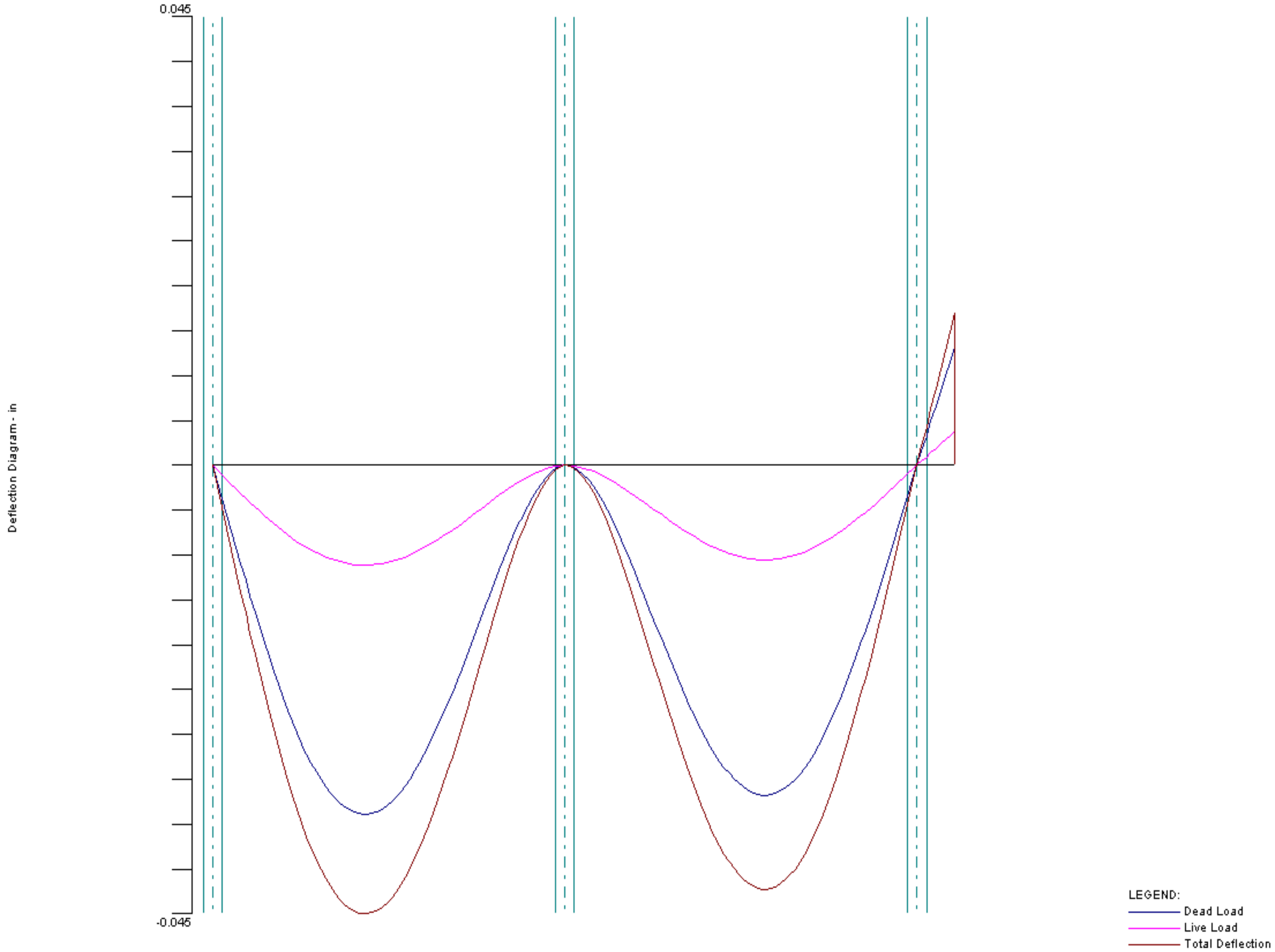


Interior Beam Deflection in Inches



Flexural and Transverse Reinforcement

Slab Flexural Reinforcement Design



Slab Deflection in Inches

Project: Trump Taj Mahal - Tech 2
Engr: Steve Reichwein
Date: 10/21/2007

RS Means 2008 Cost and Labor Estimation

Floor System: One-Way Concrete Slab and Beam

Atlantic City Adjustment Factor: 1.058 %

Formwork - Slab

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2500.00	SF	4.10	4.00	0.00	8.10	$20,250.00	**$21,424.50**

Formwork - Beam

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
150.00	SFCA	1.30	6.00	0.00	7.30	$1,095.00	**$1,158.51**

Reinforcing Steel

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
2.67	Ton	990.00	475.00	0.00	1465.00	$3,918.29	**$4,145.55**

Concrete

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
64.63	CY	109.00	0.00	0.00	109.00	$7,044.50	**$7,453.08**

Placing Concrete - Pumped

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
64.63	CY	0.00	13.00	4.86	17.86	$1,154.26	**$1,221.21**

GRAND TOTAL	**$35,402.85**
Cost Per SF	**$14.16**

Additives

Additional Curtain Wall

Quantity	Unit	Material	Labor	Equipment	Total	Cost	Adjusted Cost
42.67	SF				45.00	$1,920.00	**$2,031.36**

ADD Total	**$2,031.36**
Cost Per SF	**$0.81**

Cost Analysis of One-Way Slab and Beams