Architectural Breadth Study

Introduction

The redesign of a concrete structural system to a steel structural system presents the opportunity of analyzing numerous impacts on other building systems. An analysis on the impact of the architecture of the building was chosen to be studied. Four major design impacts will be discussed including the redesign of the elevator/service core at the center of the tower, the architectural impact of concealing the beams and girders of the steel frame, the architectural impacts on both the interior and exterior of the tower due to the 10" floor to floor height increase, and fireproofing requirements for steel members and partitions.

Elevator/Service Core Redesign

In order to obtain efficient braced frame geometry where inverted "V" bracing configurations could be utilized, openings in the core had to be relocated. Relocating the openings in the core was not an easy task, as the layout of the entire core would also need to be redesigned. It was found that by rotating the elevators 45 degrees a more flexible core layout could be obtained to accommodate the braced frame core. Spaces were then redesigned to accommodate all services and lobbies. Below are two figures that compare the existing core to the redesigned core for a typical hotel level. Revised floor plans for levels 3, 6 thru 22, and 25 thru 39 can be found in Appendix G.

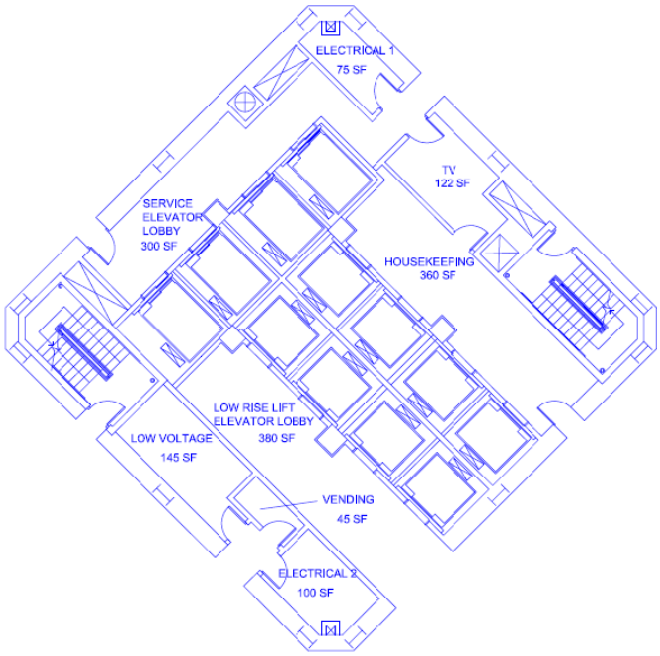

Figure 47: Redesigned Elevator/Elevator Core

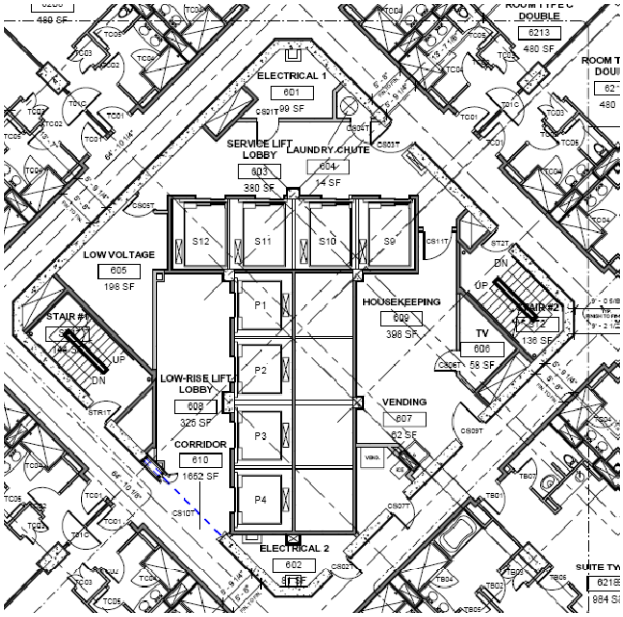

Figure 48: Existing Elevator/Service Core

Concealing the Steel Frame

Concealing the steel frame in such away to minimize the increase in floor to floor height required the steel girders and beams to be enclosed in gypsum panel soffits. These soffits will be visible throughout the guest rooms of the hotel tower and will hinder the visible area of the perimeter windows of all guest rooms. Figure 49 and Figure 50 are two renderings which directly compare the interior space of a typical guest room with the current filigree flat plate and steel frame with precast plank systems, respectively. Concealing the steel frame in the hallways also had an impact on the space. As shown with Figure 52, a gypsum board drop ceiling was utilized at the corners of the hallways to conceal the steel beams that frame into the core. This can be compared to the hallway rendering of the filigree flat plate floor system, shown in Figure 52.

Figure 49: Interior Rendering of a Typical Guest Room – Filigree Flat Plate Floor System

Figure 50: Interior Rendering of a Typical Guest Room – Steel Frame with Precast Plank Floor System

Figure 51: Interior Rendering of Hotel Hallway – Filigree Flat Plate Floor System

Figure 52: Interior Rendering of Hotel Hallway – Steel Frame with Precast Plank Floor System

Architectural Impacts on the Tower Façade

The façade of the Trump Taj Mahal Hotel tower is impacted by the structural system redesigned in three ways. First, the floor to floor height increase makes the curtain wall glass panels appear to be more vertical in nature as compared to the original elevation of the tower. Second, the steel spandrel beams that line the perimeter of the tower are required to be enclosed by a gypsum board soffit which may or may not be visible from the outside of the tower. Because the glass panels specified by the architect are fairly reflective, this should not be an issue. Finally, the spandrel curtain wall panels that conceal the slab of the floor system will be increase 2", as the slab of the filigree floor system was 10" versus the 12" slab thickness of the precast planks with topping slab. Figure 53 and Figure 54 compare the curtain wall façade prior to and after the structural redesign, respectively. The 10" floor to floor height increase is hardly noticeable and the reflective property of the curtain wall glass conceals the spandrel beam soffits.

Resulting from the 10" floor to floor height increase, the overall height of the tower is increased by approximately 30 feet. This adds substantial costs to some of the architectural elements of the tower, especially to the elevator and curtain wall system. These additional costs will be further discussed in more detail in the construction management breadth study.

Figure 53: Exterior of the Current Façade

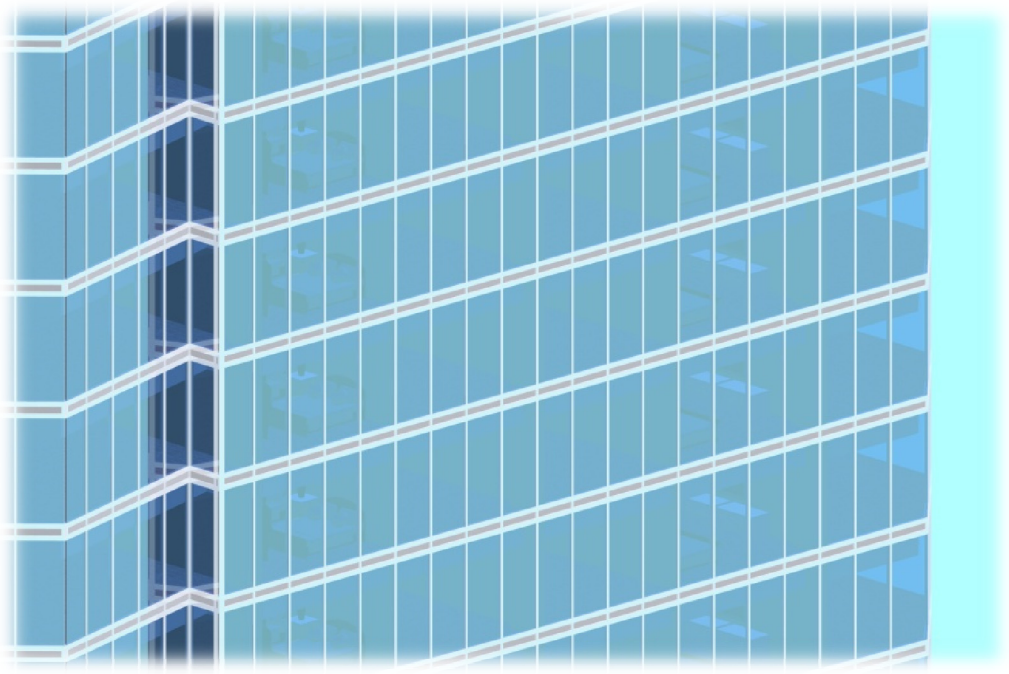

Figure 54: Exterior of the Façade Following to Structural Redesign

Steel Fireproofing and Fire Rated Partitions

Unlike its concrete counterpart, which has inherent fireproofing qualities, structural steel members of hotels and multi-family residential buildings are required to be provided with a 2 hour fire rated protection, as required by IBC 2003 for construction type 1A. As soffits were utilized to conceal the steel beams and columns, they will also be utilized as fireproofing where applicable.

The Underwriter's Laboratory ANSI/UL 263 Design No. N501 gypsum board assembly was chosen to provide the minimum required 2 hour fire protection of the steel beams, minimum size being a W8x24. The Underwriter's Laboratory ANSI/UL 263 Design No. X521 (for columns larger than W14x258) and Design No. X518 (for columns smaller than W14x258) gypsum board assemblies were chosen to provide the minimum required 2 hour fire protection of the steel columns**.** The additional costs incurred of the gypsum board soffits have been estimated using R.S. Means 2008 Cost Data; this data is shown in Table 7. Details and specifications of Design No. N501, X518, and X521are found in Appendix G.

Due to the absence of the concrete wall after structural redesign, a 2 hour minimum fire rated partition is required to conceal the elevator/service core. The partition can also serve as a thermal envelope for the steel braced frame core, providing a minimum of a 2 hour fire rated protection. Chose because it only requires a minimum 5" thickness, the Underwriter's Laboratory ANSI/UL 263 Design No. U411 was utilized as an alternative to the concrete wall. This partition must be provided on both sides of the braced frame core in order to complete the thermal envelope of the steel braced frame core. The additional costs

incurred by takeoff of this partition have been estimated using R.S. Means 2008 Cost Data. Details and specifications of Design No. U411 are found in Appendix G.

Fire resistant drop ceilings shall be provided in the elevator/service core to provide a minimum 2 hour fire rated resistance. The Underwriter's Laboratory ANSI/UL 263 Design No. D502 gypsum board drop ceiling will be provided in the elevator/service core to conceal and fireproof the underlying steel structure. The additional costs incurred by takeoff of this drop ceiling have been estimated using R.S. Means 2008 Cost Data. Details and specifications of Design No. D502 are found in Appendix G.

Application	UL Assembly Designation	Cost/SF
Beam Soffit and Fireproofing – 2 hr Minimum	ANSI/UL 263 Design No. N501	$5.47
Column Fireproofing (up to W14x258) – 2hr Minimum	ANSI/UL 263 Design No. X518	$5.71
Column Fireproofing (larger than W14x258) – 2hr Minimum	ANSI/UL 263 Design No. X521	$5.71
Braced Frame Fireproof Envelope and Elevator/Service Core Fire Rated Partition - 2hr Minimum	ANSI/UL 263 Design No. U411	$5.16
Fire Resistant Drop Ceiling – 2hr Minimum	ANSI/UL 263 Design No. D502	$3.36

Table 7: Summary of Fire Rated Partition and Steel Fireproofing Assemblies

Architectural Breadth Study Conclusions

The structural redesign of the Trump Taj Mahal Hotel impacted the architectural aspects of the tower in several ways. The elevator/service core at the center of the tower required a redesign in order to provide enough flexibility to design an effective braced frame core. The architectural redesign of the core involved rotating the elevators 45 degrees, relocating openings through the core, and relocating rooms. The redesign of the core has only little impact on the functionality and can be considered a viable alteration to accommodate the structural redesign.

The filigree flat plate system is comprised only of a slab, where little or none of the structure was required to be concealed. The steel frame with precast plank floor system is much deeper than that of the filigree flat plate and requires that the steel beams and columns be concealed by gypsum panel soffits. Along the perimeter of the tower, the spandrel beams must be enclosed by a soffit. Also, the beams that run down the column lines in between 2 adjacent hotel rooms must be enclosed by soffits as well. These soffits are not too much of a concern; however they do have considerable drawbacks. The window area is blocked by the perimeter soffit and the soffit that encases the beams between the guest rooms protrudes into the space. Ultimately, the owner will have ball-in-court to decide the acceptability of these changes.

Additional costs that reflect on the overall building costs are incurred due to steel fireproofing requirements and the addition of fire rated partitions due to the loss of the concrete walls. These additional costs are substantial and must be evaluated in order to perform a cost comparison between the concrete and steel structural systems. Additional costs will be further discussed in more detail in the construction management breadth study.