Breadth Study: Architecture

Problem Statement and Summary:

"To redesign public and typical floor plans to accommodate the new lateral system while maintaining similar spaces for employee, patron, and service uses. Special care should be used to maintain the atrium as a strong architectural focal point."

Changing the elevator core to resist larger seismic forces present in Monterey will have significant effects on the floor plan's inner core area. Electrical runs, mechanical runs, housekeeping spaces, vending machines, offices, and restrooms make use of the space that the new core will disrupt. Stairwells, fire exits, and fire protected areas present a particular problem that will need addressing.

The architect has chosen to make the full height open air atrium a larger focal point of the structure. Currently, passengers exit the elevators on guest floors and immediately view the atrium and the Grand River. The atrium could have easily been designed as additional guest quarters but at large financial cost the current design was chosen. Such an emphasis by the architect and owner needs to be maintained. An elevator system must be created that matches handling capacity, average interval time, and elevator speed of the original design.

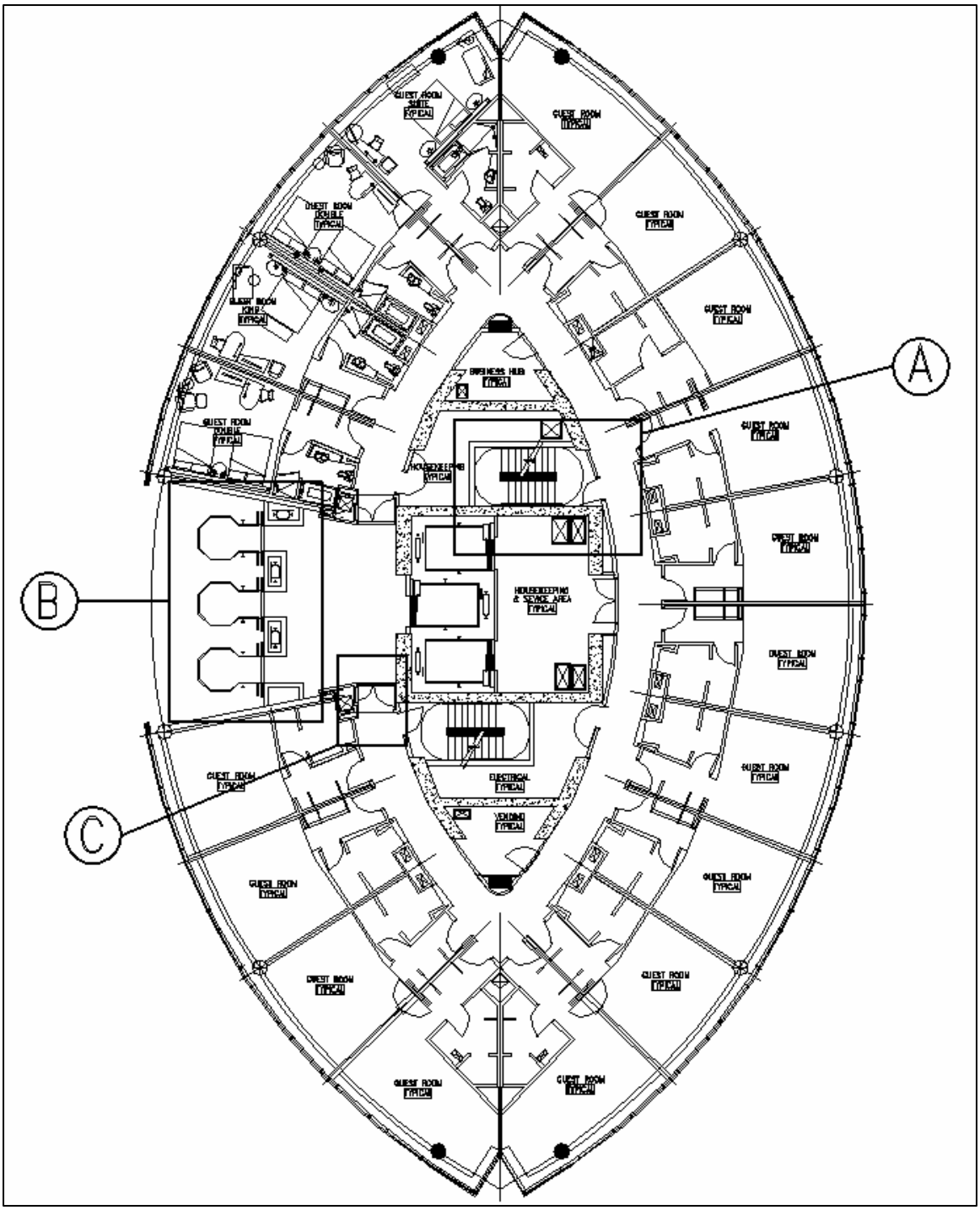

Figure 13. New typical floor plan

Solution:

Fire Protection:

In order to maintain proper fire protection a reconfiguration of stairwells and some corridors was necessary. The stairwells have been moved to their new location, highlighted in section A of Figure 13. The new location meets travel distance requirements without significantly affecting the architecture on public and typical floors. It should be noted that the northern stairwell exits on the second floor and transfers through a fire protected hallway (horizontal exit) to the larger multiuse fire exit. In order to keep the horizontal exit fire rated the bathroom entrances had to be changed to meet the following horizontal exit requirement per IBC:

> 1019.1: *"exit enclosure shall not be used for other than egress…"*
> 1019.1.2: *"no penetrations shall be allowed except those related to exit egress or systems directly related to the function of the exit way…"*

Now a vestibule will be used to enter those bathrooms to meet IBC requirements. The second floor plan can be seen in Appendix D.

Two pairs of magnetic release fire doors, located on opposite sides of guest elevators, have been moved in order to maintain a fire protected space for the elevator area (section C of Figure 13). The entire area is now considered a fire protected zone and allows the use of glass doors for elevator entrances instead of metal rated doors. This is an important architectural decision that allows patrons to look outward through the atrium while waiting for elevators much in the same way as was intended in the original design.

Elevator System:

The Marriott Corporation has various design standards for elevatoring its hotels with the JW series being the best the brand has to offer. Marriott has minimum design requirements of 1 elevator per 100 rooms. Its specified 12% handling capacity is based on 1.75 persons per room. The average interval should be near 42.5 seconds and typically run at a speed of 500 fpm.

In order to maintain the focus on the atrium it was necessary to remove the passenger elevators from the center of the lateral system. Three observation elevators will be relocated to line the atrium with three larger elevators (1 guest, 2 service elevators) remaining in the core's center. The views created by observation elevators will maintain the architect's vision for a strong atrium presence. The counterweights will be concealed within decorative columns between the glass elevator entrances to create ample space for three elevators side by side (section B of Figure 13).

The new elevator design will make the group more compact and centrally located. This benefit will remove any chance forcing passengers to sprint to end cars upon arrival. In addition this makes the group more efficient for ADA accessibility requirements. The End cars will not need to be held as long for the possibility of a mobility impaired person entering at any given floor. These advantages will improve performance somewhere on

the order of 1-2 seconds. This becomes a significant advantage when the system is compounded over the 23 floors above ground level.

An alternative to concealing the counterweights may be offered by using a proprietary system just released by Kone Elevator Co. The new "Maxi-Space" product does not require the use of a counterweight at all. The product is currently available at speeds up to 1000 fpm in Europe. Kone's new system is presently being sales released in North America and will face numerous code approvals but will ultimately become approved for use. This system would remove the need for the decorative columns to conceal counterweights and add space in the lobby/lounge area.

A Marriott standard approved handling capacity, interval time, and speed can be provided by either conventional counterweight or Kone systems.

Miscellaneous Interior Spaces:

On the ground floor, the new plans will most notably affect the lounge, front offices, and restrooms. The beginning of the atrium line has been moved back to allow for restaurant through traffic and patron build up on the first floor. The lounge area will be extended southward to compensate for area taken by the new elevator group. Equivalent overall lounge area and patron views are preserved. Two of the front office desks will now be located within the core adjacent to the front desk. The same number of desks has been kept. A significant advantage of the new design can be seen in the new restroom layout in the northern most core system quadrant. Before, a guest may have to walk from the restaurant to 90 ft past the front desk to reach accommodation if the single person restaurant bath is occupied. With an additional toilet in each bathroom the bar and restaurant can be better accommodated. The bathroom location and its entrance, just within the restaurant, will not disrupt dining patrons as the old location may have.

On typical floors there will be ample space for vertical electrical runs, mechanical ducts, and housekeeping quarters. Vending and ice machines will be repositioned in the two smaller spaces at the north and south poles of the lateral system.

Removal of Wall Columns:

One of the advantages of the new post tension floor system is the removal of the wall columns along the perimeter of the JWM. The use of circular columns instead and greater spans will give the architect several benefits. The floor plan may be designed with greater freedom without a column every 17 ft along the perimeter. Each room will gain floor area from the reduction of partitions thickness. Previously partitions between guest rooms were 16 inches thick in order to house wall columns, now partitions may be reduced to 8 inches thick. Each room will include a small obstruction cause by thicker columns. However the reduction of partition thickness will offset any loss due to the circular columns.

Conclusion:

The new lateral force resisting system will disrupt much of the architecture. However, a viable solution has been presented that creates several advantages. The new elevator group will meet the rigorous Marriott standards. Observation elevators with glass doors will preserve the architect's vision for a dramatic full height atrium. The buildings fire stairwells and corridors have been adjusted to meet IBC requirements at minimal costs. All service spaces have been relocated with similar area allocations. The architect will have greater freedom to design spaces with the removal of wall columns and addition of greater spans between columns. The new floor plans will serve guests and employees in a manner befitting a JW Marriott.

Breadth Study: Construction Cost

Problem Statement and Summary:

"To investigate the effects of the new post tension system on the price and duration of construction and compare the results to the existing flat plate system."

Inherent schedule, constructability, and cost effects will accompany any change in floor systems to the JWM. Post tension floor systems are more skill intensive than are flat plate systems and therefore will lead to larger overall costs by slowing the schedule and pricier labor. In addition to the change in floor systems the JWM will suffer negative location effects resulting from the relocation to Monterey, CA from Grand Rapids, MI.

Secondary cost effects of the post tension system change will be felt by the project coordination process. Other trades, for instance MEP, will need to be brought on the project earlier to determine slab openings for ducts/pipes. Because of the possibility of severing a stressed tendon cutting the slab after tendons have been stressed is dangerous and typically avoided. Only after slab openings are known can a final tendon layout be established by the structural engineer. These longer coordination times will result in increased consultant fees.

Comparison:

RS Means 2007 was used to gather the construction data presented below in Table 12. A complete list of assumptions is available within the hand calculations presented in Appendix B.

Conclusion:

The actual construction schedule totals 47 weeks from the beginning of the ground floor to the completion of the roof level. The data found by RS Means cannot account for the unique circumstances of the JWM. With an average annual snow fall of 64 inches in Grand Rapids, winter weather effects demanded an allowance in the schedule. The odd shape and winter weather can be held accountable for the projected 9 week discrepancy.

Due to the lower daily production, cost of labor, and deeper slab thickness the new post tension system will significantly increase the price of the structural system. The existing flat plate uses a 7.5 in. slab while the post tension system uses a 9.5 in. slab. This change in thickness results in an addition of over 1500 cubic yards of concrete to the structure.

Finally, any delay in floor system completion will affect the critical path. This delay will produce staggering secondary effects in the form of capital interest losses. If the owner wished to avoid secondary affects by matching the existing schedule labor costs would increase 3 fold. Based on cost and schedule affects, it is unlikely that the owner would choose to use a post tension system designed in accordance with this thesis.

Table 12. Floor System Construction Comparison

Flat Plate	
Location	Grand Rapids
Crew	C-17B
Daily Output (cy)	30.24
Labor Hours (cy)	6.878
Material ($)	242
Labor ($)	253
Equipment ($)	24
Total ($)	519

Concrete (cy)	5707
Material ($)	1,381,094
Labor ($)	1,443,871
Equipment ($)	136,968
Total ($)	**2,961,933**
Incl. O&P ($)	**3,909,752**
Duration (weeks)	**38**

Post Tension	
Location	Monterey
Crew	C-17B
Daily Output (cy)	10
Labor Hours (cy)	8.2
Material ($)	475
Labor ($)	315
Equipment ($)	31
Total ($)	821

Concrete (cy)	7228
Material ($)	3,433,300
Labor ($)	2,276,820
Equipment ($)	224,068
Total ($)	**5,934,188**
Incl. O&P ($)	**7,536,419**
Duration (weeks)	**145**

Post Tension (x2.0)	
Location	Monterey
Crew	(2) C-17B
Daily Output (cy)	20
Labor Hours (cy)	8.2
Material ($)	475
Labor ($)	630
Equipment ($)	31
Total ($)	1136

Concrete (cy)	7228
Material ($)	3,433,300
Labor ($)	4,553,640
Equipment ($)	224,068
Total ($)	**8,211,008**
Incl. O&P ($)	**10,427,980**
Duration (weeks)	**72**

Post Tension (x3.0)	
Location	Monterey
Crew	(3) C-17B
Daily Output (cy)	30
Labor Hours (cy)	8.2
Material ($)	475
Labor ($)	945
Equipment ($)	31
Total ($)	1451

Concrete (cy)	7228
Material ($)	3,433,300
Labor ($)	6,830,460
Equipment ($)	224,068
Total ($)	**10,487,828**
Incl. O&P ($)	**13,319,542**
Duration (weeks)	**48**

Location Effects		
Location	Adjust. Factor	
Grand Rapids	83.3	
Monterey	121.8	

System	Adj. Cost, Incl. O&P ($)	Duration (weeks)
Flat Plate	3,256,823	38
Post Tension	9,179,358	145
Post Tension (x2.0)	12,701,280	72
Post Tension (x3.0)	16,223,202	48