Cost Comparison

In addition to the cost analysis performed previously between the two steel floor systems that were designed, a complete cost estimate was made of the entire steel structure redesign and all additional costs that arose due to the change in the structural system. The previous estimates were built upon to obtain a total steel cost. Steel quantities were obtained from RAM for all beams, braces, and columns. A rough design of a few bracing connections and column base plates was done to determine approximate material, and fabrication quantities so that an average cost could be determined to be applied to all of these connections. Unit costs for items such as metal deck, concrete, slab reinforcing, and erection costs were obtained from vendors with the help of Jeremy Smith of Altoona Pipe & Steel Co. Since most of these costs were obtained from vendors in the Altoona area, they then needed to be adjusted for the Columbus, OH area. This was done by using the Cost Indexes in R.S. Means. All other unit costs were obtained directly from R.S. Means and adjusted for Columbus, OH. Additional items required due to the change in structural system were also estimated. These items include extra gypsum board for the brace infill walls, glass fiber insulation for acoustical purposes, and additional curtain wall due to the increase in building height. In the current building, there exists a 2 ½" metal stud wall with one layer of 5/8" gypsum board on each side of the main N-S shear walls, therefore, the only additional costs here were two layers of gypsum board and two layers of glass fiber insulation. Additional gypsum board was also required to hide the steel columns that replaced the exposed concrete columns. The unit costs for the gypsum board and glass fiber insulation were obtained from R.S. Means. The approximate unit costs for the two curtain wall systems were obtained from a project engineer with Turner Construction Co. who worked on the project. Tables 9.1 and 9.2 list the quantities and costs for the structure and additional items, respectively. It was also determined that the square foot cost for the structure was $8.88/ft^2, which is in the typical range for a structure of this nature.

Total Structure Cost

	Material	Fabricaction	Erection/Labor	Total
Beams				
Gravity	328309	131203	114878	574390
Lateral	19723	1291	5253	26267
Braces	23495	2336	6458	32288
Columns				
Gravity	122870	1538	31102	155510
Lateral	62540	985	15881	79406
Connections	33276	108003	35320	176599
Shear Walls	201814	0	459507	661321
Floor Slab	926751	0	252953	1179703
Fire Protection	42251	0	28743	70994
Totals	1761028	245357	950095	2956480

Square Ft. Cost = 8.88 $/SF

Table 9.1: Steel Structure Costs

Additional Costs						
Item	Unit	Quantity	Material	Cost	Labor	Cost
Gypsum Board (Cols.)	SF	1815	0.42	762	0.34	617
Gypsum Board (Wall)	SF	2480	0.42	1042	0.34	843
Glass Fiber Insulation (Ceiling)	SF	14661	0.14	2053	0.37	5425
Glass Fiber Insulation (Wall)	SF	2480	0.14	347	0.37	918
Precast Curtain Wall	SF	348	25.50	8874	5.25	1827
Glass Curtain Wall	SF	344	20.00	6880	6.00	2064
Totals/Story				19958		11693
Totals/Building				399153		233869

Table 9.2: Additional Costs due to the Change in the Structure

A cost estimate was also done for the existing concrete structure. A complete material takeoff was done using the structural plans to determine quantities for all structural items such as concrete, required formwork, steel reinforcing, and pre-stressing tendons. A rough estimate was made for the reinforcement splicing. All unit costs were obtained from R.S. Means. Table 9.3 lists the costs of the existing structure. Table 9.4 lists the cost savings by using a steel structure in place of the existing concrete structure. It was found that a savings of approximately $670,000. This cost savings can be mostly contributed to the labor associated with pre-stressing and placing concrete. The total savings was approximately $37,000. The reduction in savings from the structural system was attributed mainly to the increased amount of curtain wall required due to the building height increase.

Total Structure Cost				
	Material	Labor	Equipment	Total
Floor Slab	1406825	1195081	194338	2796244
Columns	164808	147230	8420	320458
Shear Walls	209181	290109	10497	509787
Totals	1780814	1632420	213255	3626489

Table 9.3: Existing Concrete Structure Costs

Cost Savings			
	Totals	Structure Savings	Total Savings
Existing Structure	$3,626,489	$670,010	$36,988
Steel Redesign	$2,956,480		
Additional Costs	$633,022		

Table 9.4: Cost Savings

Site Logistics

A proposed site plan for the steel erection phase of the project is presented below in figure 9.1. The large areas outlined in green are proposed to be the location for steel shakeout. The yellow lines are proposed site traffic. The two buildings located on the lower left portion of the site were phase two of the project and were not started until the residential tower was completed; therefore, there is a vast amount of space for steel shakeout and storage on site. It is proposed to use two cranes on the project. The main crane will be a tower crane with a maximum reach of approximately 175 ft located in the center of the building. This will allow it to reach all areas of the building. This crane will be used to erect the concrete shear wall cores as well as to erect the steel structure. A secondary crawler crane is also proposed to supplement the tower crane for erecting steel while it is being used to construct the shear walls. This crane will be located at various locations along the North side of the building. The reach of this crane will need to be approximately 65’ to 70’. Adjacent to its location will be another area for steel lay down. All of the heaviest steel pieces are located either very close to the building’s center or along the North face. By using a crawler crane along the North side, the required capacity of the main tower crane can be reduced because it will not have to lift the heavier members to the edge of the building.

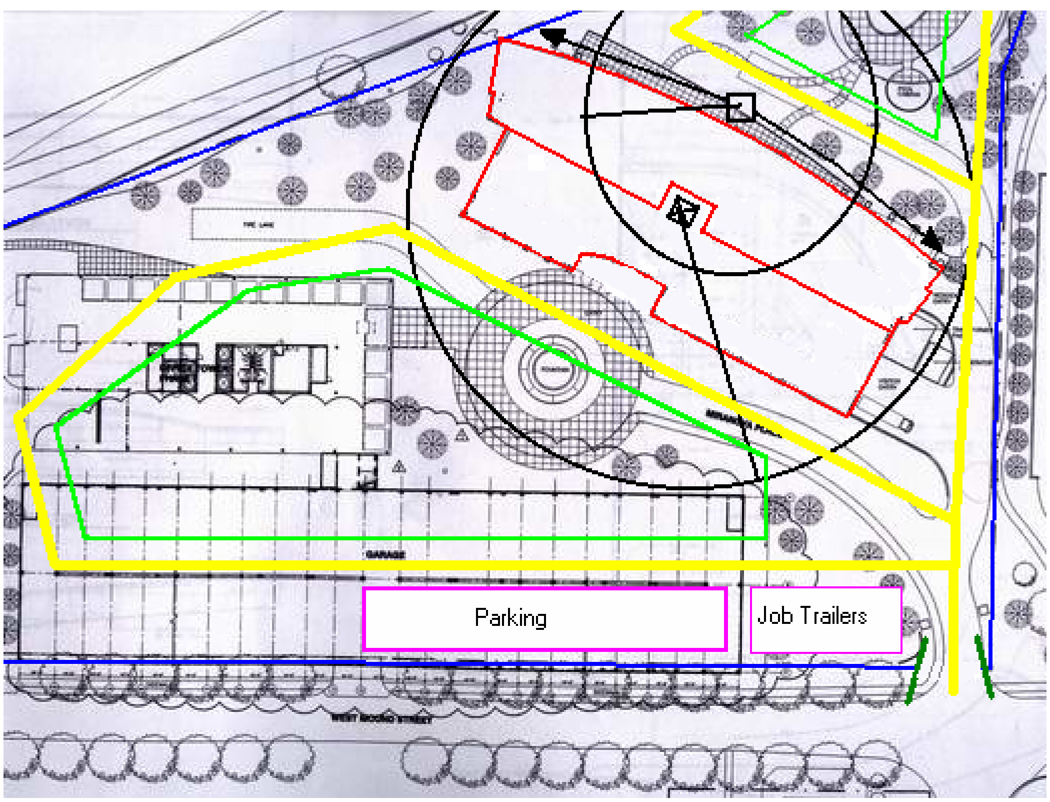

Figure 9.1: Site Plan for Steel Erection Phase.

Other Construction Management Issues

Steel Lead Time

One disadvantage to using steel for a building structure is the required lead-time. The lead time required to have steel on the site for this project will have no effect on the schedule of the construction for a few reasons. The foundation and first five stories of the building will not be changed. Only the structure of the tower will consist of steel framing, therefore, the steel will not need to be on site at the beginning of the super structure construction. As described previously the foundation is a 5'-3" to 5'-9" mat foundation under the tower and 2'-9" to 3'-3" mat under the five story portion of the building. A very big disadvantage to using a mat foundation is the time that it takes to construct. Also, the entire foundation must be complete prior to the beginning of construction on the super structure. The construction of this foundation will give extra time to the steel fabricator to produce shop drawings, have them approved, fabricate the material, and ship it to the site. The first five stories must also be complete before steel can be erected also. The floor slabs in these lower stories include a large amount of reinforcing and post-tensioning tendons, which need to be stressed before construction can resume upward. These tendons must be stressed as soon as possible because most of them are in locations where there is no other reinforcement and the concrete alone will not have the capacity to carry the construction loads. After talking with a few steel fabricators, it was determined that as long as the order for steel was promptly placed, the time required for excavation, foundation construction, and the construction of the first five concrete stories would provide ample time for the fabricators to have steel on site when needed. They all felt that steel could be on site and waiting for up to two weeks prior to it being needed.

Schedule Impact

The first phase of the project in which the foundation and lower five stories are constructed will not be affected by the change in the tower structure. It was found from some initial research and rough calculations that steel is generally faster to erect than concrete, especially a post-tensioned concrete system. A small amount of time is expected to be saved in the super structure construction phase by switching to a steel structure. The added amount of time required for the erection and placing of the additional curtain wall, gypsum board, and glass fiber insulation will offset and savings in structure scheduling. Overall, the length of time required to complete the building should not be affected.