Technical Analysis #1

Canton Crossing Tower as an Independent System with the Equipment Rooms Located in Basement Addition

Problem

The Canton Crossing Central Plant currently houses the mechanical and electrical equipment for the tower. The Central Plant is an $8.9 million one story concrete building that is located across South Clinton Street from the tower. The technical analysis will look into eliminating the Central Plant and making the tower an independent, stand alone system. The cost of the building itself, along with financing issues that arose with the tower due to the Central Plant made the thought of eliminating it arise. As the design was originally, the tower can not function without the Central Plant. Therefore the schedule issues that arose during the Central Plant's construction, the tower's opening was delayed. Also, the Central Plant was originally designed with the thought of two more high-rise buildings being built immediately following the tower. If this was the case, then the upfront costs of the plant would be justifiable. As it stands now the following two buildings are going to be delayed and the large upfront cost of the plant is going unused.

Not only will the cost impact of the new design proposal be looked at, but also the tower's capacity for the change. For example, where the equipment will be housed and whether or not the structural integrity of the tower will be in jeopardy by the addition of all the equipment are items that will need to be checked before the cost impact of implementation can be checked

Goal

The goal of the analysis is to illustrate to the audience that the tower could effectively operate as a stand alone system. The $8.9 million contract that was used on the Central Plant could be eliminated. Obviously a certain amount of that cost will still be needed for the tower, i.e. equipment costs, etc. but a cost savings will be made by making the tower an independent system. Also, the new location of the mechanical rooms will be a benefit to all of the tenant subcontractors in the tower in material and construction costs.

Due to the complexity of this technical analysis, it will act as a breadth topic in the mechanical, electrical, and structural areas.

Analysis Techniques

1. A list of all the equipment placed in the tower will need to be compiled, including the sizes, weights, assembly details, etc.
2. The new equipment floors will need to be selected, taking into account the existing structural steel design.
3. A construction plan will be created paying attention to all of the possible issues that will now arise from the new equipment, i.e. equipment placement techniques, etc.
4. The new structural loads resulting from all of the added equipment will then be calculated and analyzed for structural integrity.

5. An estimated schedule and budget will need to be created for the new construction plan, with help from the superintendent and project manager of the project team.
6. The results of the new plan's calculations will then be shown along with the existing system's numbers to show the advantages and disadvantages.

Tools

1. Architectural Engineering Faculty (Parfitt, Schneider, Hanagan)
2. Gilbane Building Company Canton Crossing Tower/Central Plant Construction Team
3. Microsoft Excel
4. EnerCalc
5. Ms. Nicole Hazy, Michael Baker Corporation
6. Soil Safe, Inc. , Maryland

Outcomes

Structural

The mechanical and electrical equipment that are going to be removed from the Central Plant have to be housed in the tower itself. Instead of jeopardizing the amount of income a floor makes the owner on a monthly lease agreement, I have decided to add a basement to the tower. The basement will house all of the mechanical and electrical equipment that was originally designed for the Central Plant. The square footage of the Central Plant and the footprint of the tower are similar, within 1000 square feet so the equipment will fit in the space with no trouble.

The structure of the basement will be the same as the above floors with the columns extending down through to the previously redesigned caissons. The concrete exterior walls designed will act as retaining walls. The floor will be an 8" concrete slab-on-grade with #6 @ 12", due to the heavier types of loads that could be encountered (i.e. equipment rollers, etc.). The loads that the equipment will introduce were taking into account by adding 190 psf dead load and 100 psf live load to the structural calculations for the caissons.

The walls of the basement are designed as 20" cast-in-place concrete walls with reinforcing. The footer is designed as 6' wide by 16" thick. The wall was design as a retaining wall because of the columns and the caissons carrying the loads of the buildings. A surcharge of 50 psf was added in the case of other buildings or roadways being added in the future. To verify my calculations I used the program EnerCalc to design a "Restrained Retaining Wall", with the wall being "at-rest" by being restrained at the top and bottom. The calculations, sections, and print outs from EnerCalc can all be found in the Appendix section on pages 32-36 .

Also, an areaway must be considered for access to the equipment once it is installed. The areaway will be installed on the Northeast portion of the tower, an area secluded from the majority of the vehicular and pedestrian traffic.

The excavation of the project will require the contaminated soils to be removed from site. The footprint of the building at 30,000 ft^2 and the basement at a depth of 20' will require approximately 36,000 tons of contaminated soil to be removed from site. At $30.00/ton, quoted from Soil Safe, Inc., to transport and disposal this will cost an extra $1,080,000.

Mechanical

The first task that I completed was the mechanical portion of the redesign. By moving the mechanical equipment into the tower, I will be eliminating the heat exchanger system which was major component of the original design. Also, the pump system will go from a primary secondary to strictly a primary for inside the tower. As I began to research the equipment in the Central Plant, I realized it was oversized. There are a couple of reasons for this but the main reason being that the equipment was purchased with the idea that future buildings would be joining into the system. Also, the fact that the equipment was originally sized as a part of the district system including a heat exchanger system made it much larger than necessary for a stand alone tower system.

In all, it was required that I resize the chillers, boilers, heating and chilled water pumps, condenser water pumps. The resizing calculations were made based on the data given on the drawings for the tower. For the chillers, the components to the load were Air Handlers, Fan Coils, and Heat Recovery Air Handlers. The tons needed for the tower came to a total of 700. For redundancy options, I have chosen to use (3) 350 ton capable chillers for the tower. The boiler calculations were comprised of Air Handlers, VAV Fan Powered Terminal Units, Fan Coils, Unit Heaters, Heat Recovery Air Handlers, and Cabinet Unit Heaters. In all, the boiler is required to support a 497 ton load, or 5,964 MBH. Once again for redundancy purposes I have chosen (3) 3,000 MBH, 100 HP boilers. The next redesign was the pump system. The chilled water pumps need to support a load of 920 GPM, therefore I have chosen (3) 460 GPM pumps. The heated water pumps are required to produce 600 GPM so the new design is (3) 300 GPM pumps. The condenser pumps are required to produce 1,100 GPM, the new design will be (3) 550 GPM.

The other major component of the mechanical system is the cooling tower. Currently the cooling towers are located on the site that is between the tower and the Central Plant. The original design has the condenser supply and return coming from the Central Plant. With the new design, these condenser lines will be run from the tower to the cooling towers. Additional equipment that will need to be place in the tower is expansion tanks, air separators, a chemical feed for the heated water, and a make-up water system.

Electrical

The electrical components for the tower than were originally housed in the Central Plant were not oversized like the mechanical equipment. Currently there are two generators, main service switchgear, main distribution switchgear, two service transformers, and emergency switchgear. All of this equipment will be transferred over to the tower for the new design.

Comparisons

Schedule

The schedule comparisons between the old design and the proposed design are not going to be significant. The newly proposed basement structure is cast-in-place concrete just as the Central Plant walls are. The square footage of the basement and the

Central Plant are within roughly 1,500 sq. ft. of one another. With the location being similar for delivery purposes, the size being nearly identical, and the construction methods being used are identical I cannot see the schedule being affected.

The only schedule concern I had at the beginning of this analysis was the idea of the Central Plant's completion to be delaying the opening of the tower. With the proposed solution, the tower will be ready to open when its construction is complete with no outside factors affecting it.

<u>Cost</u>

Shown below in *Table TA1.1* are the pieces of equipment that were removed and the newly designed equipment with their respective costs. Also shown below is *Table TA1.2* which shows the overall cost comparison of the new system, including excavation, structure, mechanical, and electrical.

Table TA1.1

Equipment Cost Comparisons of Stand Alone System			
Equipment Added	**Quantity**	**Unit Cost**	**Cost**
Boiler - 3000 MBH, 100 HP	3	36,000	108,000
Chiller - 350 Ton, Centrifigal	3	140,000	420,000
Chilled Water Pumps - 460 GPM	3	3,200	9,600
Heated Water Pumps - 300 GPM	3	2,500	7,500
Condesner Water Pumps - 550 GPM	3	4,350	13,050
TOTAL ADDED COST			***$558,150***
Equipment Eliminated	**Quantity**	**Unit Cost**	**Cost**
Boiler - 15,000 MBH, 475 HP	1	100,000	100,000
Chiller - 2500 Ton, Centrifial	1	700,000	700,000
Chilled Water Pumps - 3500 GPM	3	4,200	12,600
Heated Water Pumps - 1030 GPM	3	10,000	30,000
Condesner Water Pumps - 4160 GPM	3	11,500	34,500
TOTAL ELIMINATED COST			***$877,100***
	TOTAL SAVINGS		***$318,950***

Table TA1.2

Overall Cost Comparison for Tower as a Stand Alone System		
Added Costs		
Category	**Description**	**Cost**
Excavation/Remediation of Soils	36,000 tons @ $30/ton	$1,080,000
Structure of Basement	30000 s.f. @ $92/s.f.	$2,750,000
Mechanical - New Chiller	(3) 350 Ton Centrifigal Chillers	$420,000
Mechanical - New Boiler	(3) 3000 MBH, 100 HP Boilers	$108,000
Mechanical - New Pumps	Heated, Chilled, & Condeser Water Pumps	$30,150
Additional Mechanical Contract from CP	Add'l Equipment & Contract from CP	$400,000
Electrical from CP Contract	Value from Equipment @ CP	$350,000
	TOTALS	***$5,138,150***
Subtracted Costs		
Category	**Description**	**Cost**
CP Contract minus the Equipment Removed	CP contract minus $877,100 for equipment	$8,022,900
	TOTALS	***$8,022,900***
	Total Savings for Stand Alone System	***$2,884,750***

Conclusion

Upon completion of my analysis I feel that the owner would have been better off designing the Canton Crossing Tower as a stand-alone system. The schedule and cost comparisons illustrated and discussed above speak for themselves. I do understand the thought process of the design team and the owner with the 14+ buildings going up in the future at Canton Crossing, but the outside factors such as financing became larger than anyone expected. With the new proposal, nearly 3 million dollars could have been saved with a few simple changes. As it is now, the Central Plant is largely oversized and will no be needed in its full capacity for at least 2-3 more years.

In my opinion, it would have been advisable to eliminate the Central Plant and all of its issues, financing, schedule issues, etc. This advice is based on the speed that the entire campus is being built. Each building built on the campus in the future could have been designed as stand-alone systems as well. This would relieve some of the pressure and up-front costs that the owner is dealing with and will inevitably have to deal with during the entire development project at Canton Crossing.