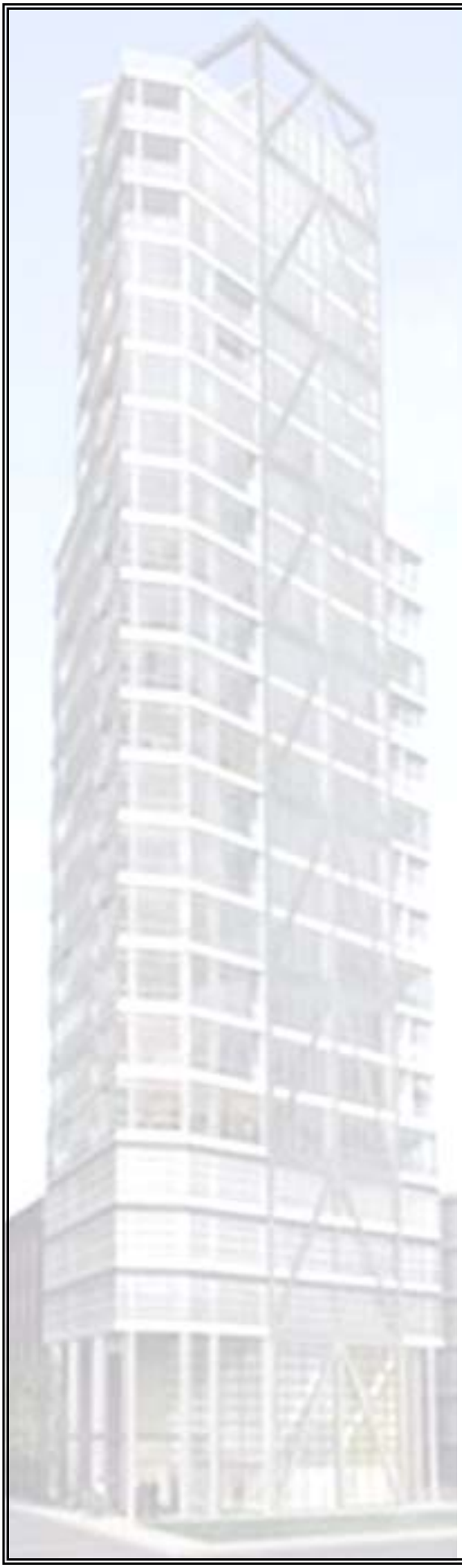

Breadth Studies

Construction Management

Changing the structural system of the building led to inherent changes in the constructability, construction schedule, and cost of 'Erie on the Park'. Probably due to the fact that steel is a long lead item and would inevitably push back the start date of construction of the superstructure, the first three stories have been designed and constructed in concrete. This allows construction to proceed earlier than it would have if the entire structure were constructed in steel, thus moving up the date of top-out and similarly the completion date. The drawback with this strategy is the interface between the steel and concrete systems. The tolerances for anchor rod placement in concrete are on the order of 1" where as the tolerances for steel are in the range of 1/8". This discrepancy can cause time delays due to initial rod placement or in fixing incorrect rod placement. Building the structure with one material, steel or concrete, would alleviate this system interface issue.

A constructability drawback to post-tensioned concrete systems is that all the other trades (i.e. mechanical, electrical, plumbing, telecommunication) have to know where their systems are going to require openings in the floor slab. This is so the tensioning tendons can be designed and laid out so they do not interfere with these openings and are still able to support the floor slab. This requires the other trades to be brought onto the project earlier so that they can design their system and where the through slab chases will be before the structural engineer finishes the design of the slab. This is necessary because drilling through a post-tensioned slab is not typically allowed due to the possibility of cutting a tensioning strand in the process.

After designing the alternative structural systems a cost estimate and construction schedule were determined for the initial steel system, a flat-plate with frame and shear wall interaction, and a post-tensioned flat-plate also with frame and shear wall interaction.

Design	Materials	Labor	Equipment	Cost	$ per SQFT	Incl O&P	$ per SQFT
Original	$3,224,006.22	$1,403,984.64	$254,026.53	$4,882,017.40	$22.91	$5,370,219.14	$25.21
RC Frame	$1,817,819.38	$2,013,858.70	$71,573.95	$3,903,252.03	$18.32	$4,683,902.44	$21.98
PT Frame	$1,612,342.94	$1,975,439.01	$69,008.05	$3,656,790.00	$17.16	$4,388,147.99	$20.60

Table 4: Cost breakdown for each structural system

	Steel		Decking		Floor Slabs		Concrete Columns	
Design	Crews	Duration	Crews	Duration	Crews	Duration	Crews	Duration
Original	1 - E2	105	2 - E4	24	2 - C8	42	1 - C14A	10
RC Frame	0	0	0	0	3 - C2	162	1 - C14A	45
PT Frame	0	0	0	0	2 - C2	194	1 - C14A	45

	Shear Walls		Post-Tensioning		Total Duration		Total
Design	Crews	Duration	Crews	Duration	Days	Months	Crews
Original	2 - C2	20	0	0	140	7	8
RC Frame	2 - C2	107	0	0	167	8.4	6
PT Frame	2 - C2	80	2 - C4	50	199	10	7

Table 5: Duration and crews per task for each structural system

LEED/Mechanical

Designing a building so that it is environmentally friendly has become a concern of owners, contractors, designers, and tenants over the past decade. Each has their own reasons for this movement to make 'green' buildings. Building owners are interested in this because they are able to save money on utilities by making their buildings more water and energy efficient. Contractors and designers are interested in green buildings because few of them are certified and experienced in building and designing these buildings so there is less competition for these contracts and they are able to charge a premium for their services. Tenants want green buildings because of the better materials which lead to fewer costs of replacing defective materials. Companies are profoundly interested in leasing space in green buildings because the higher quality of the indoor environment produces workers who are more content and more efficient.

When designing a green building there are five areas where designers focus their efforts to reduce the use of materials and provide a better indoor atmosphere. These focuses are planning for a sustainable site, water efficiency, energy and atmosphere, materials and resources, and the quality of the indoor environment. The largest green building certifying agency in the United States is the U. S. Green Building Council (USGBC) and if a building is designed to meet their criteria it would receive a LEED (Leadership in Energy and Environmental Design) rating. There are four levels of ratings that a building could obtain depending on how many of the criteria are met: Certified, Silver, Gold, and Platinum. The USGBC claims that a Silver rating is within the margin of error of the original cost estimate.

The intent of this case study was to collect the rain water that falls on the roof and investigate the design and cost implications if it were to be used for the toilets in each of the condominiums and common areas. The average rainfall per year in Chicago is 36.5". The monthly average is about 3", with August receiving the most rainfall of 4.62" and February receiving the least amount with only 1.63". The rainfall would be collected in two large cisterns located below grade next to the elevator pits and since that area needs to be excavated already additional excavation costs are minimal. The cisterns have been designed for the 5 year, 60 minute design storm and have a capacity of 10,000 gallons each. Should the storm produce rain in excess of this amount, there will be an overflow drain which allows the extra water to flow into the sewer using the same system that is already in place for the grey water that the building produces. The water that is collected will be pumped to a 400 gallon tank in the mechanical space on the 25th floor by two 5 HP pumps that work in series to overcome the head pressure. From there it will drain down into the toilets. Since there is not enough rain during the year to fully supply the toilets with water, and since rainfall is unpredictable, this system will have to run in parallel with a utility water supplied system.

Assumptions

80	gal/person/day
330	residents
256	toilets
4	flushes/toilet/day
1.6	gal/flush
7.48	gal/ft3
36.5	in rain/year
18300	ft^2 roof area

	Total Usage	Toilet Usage	Rain
Day	26400	1638.4	---
Month	792000	49152	34221
Year	9636000	598016	416355.5
% of Total	100	6.206	4.321

Table 6: Water usage (in gallons)

Equipment	Size	Quantity	Cost/Item	Total
Cistern	10000 gal	2	$10,000.00	$20,000.00
Compression Tank	400 gal	1	$5,250.00	$5,250.00
Pump/Controls	5HP 3500RPM	2	$5,500.00	$11,000.00
Piping	3/4"	2500	$7.70	$19,250.00

Table 7: Cost for the rainwater collection system components.

	Base Cost	Incl. O&P
Cost of System	$55,500.00	$63,825.00
% of Building Cost	0.1088	0.1251

Table 8: Overall cost for the rainwater collection system.

Savings per Year	Quantity	Cost/gal	Total	%
Water	9636000	$0.002434	$23,453.06	---
Rain	-416355.5	$0.002434	-$1,013.37	4.321

Table 9: Yearly water and cost savings

Implementing this system costs $64,000 but it reduces the water usage by 4.3%, saving about $1,000 each year on utility costs. This system also satisfies LEED points which would get the building that much closer to being certified. The first LEED point this satisfies is Sustainable Site 6.1 which is storm water quantity control. This requires a 25% reduction of storm water runoff during a two year, 24 hour design storm. The system, as designed, would reduce the runoff of this design storm by 47.4%. The other LEED point that this system begins to satisfy is Water Efficiency 3.1. This point requires a 20% reduction in water usage and since no-one can adjust how much it rains this collection system only reduces the water usage by 4.3% or $1/5^{th}$ the required amount. This is a giant step in the direction of achieving this LEED point, though. The rest of the water use reduction would have to be achieved by using high-efficiency fixtures possibly with motion sensors to reduce the potable water demand.