Construction Management Breadth

One of the main objectives of this thesis was to design a more constructible structure for the John Jay College Expansion Project. Therefore, the objective of this study is to verify that the transfer system discussed in this report has a simpler construction method than that of the original design. There are many differences between the erection sequence and construction management of the existing transfer system design and the transfer system discussed in this thesis. Two main differences will be examined in this breadth study to display the differences in constructability: cost and sequencing.

A cost analysis was completed using material, labor, overhead, and profit costs obtained from Turner Construction Company. Overall costs of each transfer system were calculated based on weight.

The existing transfer system requires a very experienced construction team due to the difficult nature of hanging the structure. Temporary supports and braces are required until the connection of plate hangers to floor girders can be made. Deflections of each floor must be closely monitored throughout the construction process and the stresses in the built-up girders at the first level must be closely monitored. Placing concrete decking cannot begin until the penthouse trusses are complete and temporary supports are removed because the built-up girders at the 1st level do not have the capacity to support 14 levels of full dead load.

The new transfer system was designed to simplify the construction process, and therefore a steel erection sequence was prepared to justify this goal. This erection sequence remains identical to the existing design until the 5th level, which is where the truss construction begins. Once the trusses are complete, typical steel framing is used until erection is complete. Temporary supports and bracing is not needed once truss construction is completed and there is no need to check stress levels in the 1st level built-up box sections because construction loads from levels 5 through 14 are directly transferred to the braced frame core from the trusses. Therefore, concrete decking of each level can be placed once the steel erection of the level above is complete, rather than waiting until steel erection of the entire tower is complete.

Cost Study

A few simplifying assumptions were made when performing the cost analysis for this study. They are as follows:

- Cost differentials due to fireproofing the truss members were neglected. Cementitious spray on fireproofing is used for the existing design, where intumescent paint is used for the exposed trusses designed in this report. It is assumed that fireproofing costs are about the same since the number of members needing intumescent paint are about half of those needing cementitous spray on fireproofing.
- A 10% premium was added to built-up and custom steel members

- Material and labor costs used were provided by Turner Construction Company from 2005 to allow for a direct cost comparison between transfer systems
- Unit costs were increased by 15 % to include overhead and profit
- Foundation changes were minimal and therefore were neglected

It should also be noted that two additional premiums are included in the original estimate which can be omitted from the new cost analysis. The first premium charged was for hanger construction. Using the new transfer system, there are no hanging members, which results in additional savings for the owner. Another premium was charged for the difficult construction of the tower. This premium can also be neglected since typical steel framing is used for the tower in the new transfer system.

Existing Transfer System Cost

Using the unit cost information for material and labor provided by Turner Construction Company, detailed steel takeoffs were performed for the various systems used to transfer gravity loads over the Amtrak tracks. These include the penthouse transfer trusses, perimeter plate hangers, the braced frame core within the tower, and the built-up girders beneath the 1st level (see Appendix J for takeoff values).

The total estimated structural cost of the existing transfer system is $6.15 million. See Table 34 and Appendix J for more information.

Table 34 – Existing Transfer System Cost Analysis

Existing Transfer System Cost Comparison						
System	Quanitity (tons)	Material ($/ton)	Labor ($/ton)	Total ($/ton)	Total w/ 15% O&P ($/ton)	Total Cost ($)
Trusses	761	1320	1980	3300	3795	2886098
Perimeter Plate Hangers	54	1452	1980	3432	3947	211154
Braced Frame Core	652	1320	1980	3300	3795	2474340
Built-Up Box Sections	147	1452	1980	3432	3947	580180
					TOTAL (Million):	**6.15**

Thesis Transfer System Cost

The same unit cost information provided by Turner Construction Company was applied to estimate the costs associated with the new transfer system. Appendix J includes steel takeoff information. Table 35 displays the cost of each contribution to the transfer system for a total structural cost of $ 5.91 million. An additional $ 820,000 is associated with the curtain wall costs of increasing the total building height by 10 feet. This brings the total cost of the new transfer system to $ 6.74 million.

Table 35 – Thesis Transfer System Cost Analysis

Thesis Transfer System Cost Comparison						
System	Quanitity (tons)	Material ($/ton)	Labor ($/ton)	Total ($/ton)	Total w/ 15% O&P ($/ton)	Total Cost ($)
Trusses	690	1452	1980	3432	3947	2723292
Perimeter Columns	56	1320	1980	3300	3795	212520
Braced Frame Core	662	1320	1980	3300	3795	2512290
Built-Up Box Sections	118	1452	1980	3432	3947	464144
					TOTAL (Million):	**5.91**

Steel Sequencing Study

According to the construction schedule from Turner Construction Company, the structural steel erection began in May of 2008 and is scheduled to be completed in July of 2009. This amounts to a total of 62 weeks to erect the steel superstructure. The steel erection sequence for the John Jay Expansion Project includes beginning erection at 11th avenue (to the West) and erect towards the existing building (to the East). Tower erection will then continue while steel framing in the cascade area is topped out.

Rather than using the schedule provided by Turner Construction Company, the assumptions listed in Table 36 were used to create a steel erection sequence for the existing design and the thesis design to allow for a direct comparison. Durations were determined by assuming 40 pieces of steel would be erected per day.

Table 36 – Steel Sequencing Assumptions

Activity	Thesis (Duration in Days/Level)	Existing (Duration in Days/Level)
Erect Columns	1	1
Erect Braced Frames	1	1
Erect Typical Floor Framing	7	7
Decking and Detailing	10	10
Erect Temporary Columns	1	1
Erect Reinforced Plate Hangers	N/A	1
Erect Truss Bottom Chords	3	4
Erect Truss Top Chords	2	4
Erect Truss Web Members	3	6
Detail and Plum Trusses	5	10
Remove Temporary Columns/Reinforced Plates	1[1]	5[1]
Placing Concrete Decking	10[2]	2[3]

[1] - Unit is Total Days
[2] – Includes duration of embeds, box outs, rebar, and placing concrete
[3] – Includes placing concrete

Existing Construction Schedule

Using the assumptions listed in Table 36, a steel erection sequence was created based on the original structural design. Steel erection was determined to take a total of 63 weeks, which verifies that the assumptions used are fairly accurate (Turner's schedule estimated 62 weeks). Appendix J displays the entire existing schedule created for this study and Figure 54 displays a summary of the existing schedule. When placing of the concrete decking was taken into account, the total superstructure construction time increased to 70 weeks, because concrete work cannot begin until the penthouse trusses are complete (see Figure 55). This duration was determined assuming that all embeds, box outs, and rebar were put in place while steel erection was topped out. Therefore, when the penthouse trusses are complete, each floor only takes 2 days to complete concrete work.

	Task Name	Duration	Start	Finish
1	East Foundation	190 days	Tue 4/1/08	Mon 12/22/08
2	Steel Erection Podium West	82 days	Mon 5/19/08	Tue 9/9/08
3	Steel Erection Podium East	93 days	Tue 12/23/08	Thu 4/30/09
4	Steel Erection Tower	182 days	Wed 9/10/08	Thu 5/21/09
5	Truss Erection	46 days	Fri 5/22/09	Fri 7/24/09
6	Temporary Support Removal	8 days	Mon 7/27/09	Wed 8/5/09

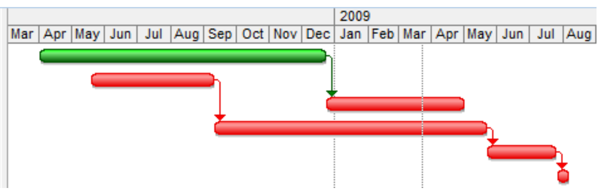

Figure 54 – Existing Design Steel Sequence Summary

	Task Name	Duration	Start	Finish
1	East Foundation	190 days	Tue 4/1/08	Mon 12/22/08
2	Steel Erection Podium West	82 days	Mon 5/19/08	Tue 9/9/08
3	Steel Erection Podium East	93 days	Tue 12/23/08	Thu 4/30/09
4	Steel Erection Tower	182 days	Wed 9/10/08	Thu 5/21/09
5	Truss Erection	46 days	Fri 5/22/09	Fri 7/24/09
6	Temporary Support Removal	8 days	Mon 7/27/09	Wed 8/5/09
7	Tower Concrete Deck	28 days	Thu 8/6/09	Mon 9/14/09

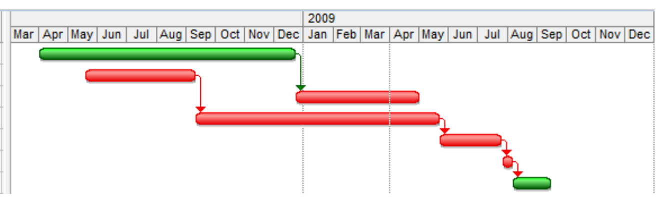

Figure 55 – Existing Design Steel Sequence Summary Including Concrete Decking

New Construction Schedule

A steel erection sequence for the new design was created using the assumptions presented in Table 36. Total steel erection time was found to be 60 weeks, which is 3 weeks less than the existing design. See Appendix J for a complete schedule of the new design and Figure 56 for a summary. Total superstructure construction time increased to 64 weeks when considering placing concrete decking, which is shown in Figure 57.

	Task Name	Duration	Start	Finish
1	East Foundation	190 days	Tue 4/1/08	Mon 12/22/08
2	Steel Erection Podium West	84 days	Mon 5/19/08	Thu 9/11/08
3	Truss Erection	39 days	Tue 8/19/08	Fri 10/10/08
4	Temporary Support Removal	1 day	Mon 10/13/08	Mon 10/13/08
5	Steel Erection Podium East	93 days	Tue 12/23/08	Thu 4/30/09
6	Steel Erection Tower	182 days	Wed 10/29/08	Thu 7/9/09

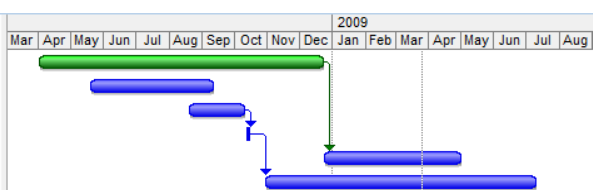

Figure 56 – Thesis Design Steel Sequence Summary

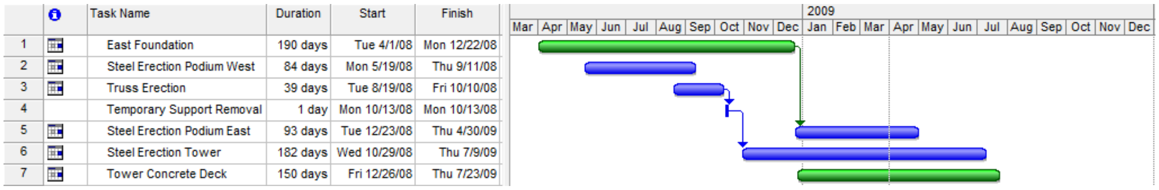

Figure 57 – Thesis Design Steel Sequence Summary Including Concrete Decking

Construction Management Conclusion

As displayed by Table 37, the cost study of the two transfer systems resulted in similar results. Total costs of the new transfer system, including the costs associated with increasing the curtain wall height 10 feet, are $ 6.74 million. The existing design was determined to cost $ 6.15 million. This cost does not include the expensive premiums charged for the difficult construction of the hanging structure of the existing design, and therefore the two transfer systems cost about the same.

Major differences can be seen between the construction schedules of the two transfer systems. When examining the steel erection sequence of each system, the transfer system designed in this thesis takes 60 weeks, where the existing design takes 63 weeks. This 3 week decrease in steel erection time of the new transfer system is created by using less pieces of steel for the transfer trusses than the existing design, as well as the need for only 1 level of temporary supports, where the existing design needs 9 levels of temporary supports.

These differences are increased when the placing of concrete decking is inspected. For the existing transfer system, concrete work cannot begin until the penthouse trusses are complete and the temporary columns are removed. This is because the built-up girders at the 1st level must support all 14 levels of steel framing during construction and any additional dead loads would overstress the girders. When the penthouse trusses are complete, the temporary supports are removed. This allows the building to hang, and gravity loads of levels 6 through the roof are transferred using the penthouse trusses. Now, only levels 1 through 5 are supported by the built-up girders at the 1st level, and the placement of concrete decking can begin. This increases the superstructure construction time to 70 weeks.

The new transfer system design simplifies the construction process of the superstructure. Traditional steel erection methods can be used to erect the structure, with the exception of building the transfer trusses at the 5th level. Concrete decking can be placed slightly after steel erection begins, given that the 5th through roof levels will be directly transferred over the Amtrak tracks using the trusses at level 5, rather than using the built-up girders at level 1. When including the placing of concrete decking, the total superstructure construction time amounts to 64 weeks, which is 6 weeks less than the existing design.

Table 37 – Construction Management Study Summary

	Thesis Transfer System	Existing Transfer System
Structural System Cost	$ 5.91 Million	$ 6.15 Million
Total Cost	$ 6.74 Million*	$ 6.15 Million
Steel Erection Schedule (Weeks)	60	63
Entire Superstructure Schedule (Weeks)	64	70

* - Includes increased cost of curtain wall