

B. Technical Analyses:**Introduction:**

The main theme of the construction management research analyses within this report is the reduction of productivity. The concrete analysis looks at using a concrete pump to improve productivity. The exterior façade analysis includes a productivity study of actual brick installation on WestEnd25. The third analysis looks at the implementation of a building information model as a tool to plan trade flow through a building. In theory this could lead to increased productivity by not having trades overlap and get in each other's way. Finally, the critical industry issue of owner involvement in LEED was analyzed through surveys of industry members including owners, architects and contractors.

Concrete Placement:**Building Structural System History:**

The original 1229-1231 buildings were constructed in the late 1960's with a concrete structural systems. Four additional stories were added to increase the amount leasable apartment rental space. The four additional stories added to WestEnd25 are also supported by a concrete structural system. The placement for the concrete was the crane and bucket method. The crane and bucket method used took 141 days to install at a package cost of \$4.5 million.

Project Problems:

Placing concrete with the crane and bucket method is a slow process. This process is not continuous, it cycles with only 5 cubic yards of concrete being moved and placed at any one time. The average cycle time was about one and a half minutes. Therefore, about 70cy of concrete was placed in an hour. At this rate approximately 110cy of concrete will be placed in a day. This translates as one day for placement of the connector slabs and six days for the placement of the full size stories.

Concrete Pump Solution:

An alternative method to placing the concrete is using a concrete pump. A concrete pump offers many favorable advantages, such as increased productivity. Increase productivity is important because it means faster completion allowing the owner to receive a return on their investment sooner. Productivity data for concrete placement was taken from R.S. Means data. The productivity rate for pump placement is 160cy per day. This translates into one day to place the connector slabs and four days to place the full stories. This is a savings of two days per floor.

Pump Description:

Using a pump to place the concrete allows for a steady flow from the delivery truck to the placement locations. A concrete pump consists of a hopper, a piston system and piping. The pump works by truck mixers pouring the concrete into a hopper that funnels the concrete to hydraulic pistons

that push the concrete through the piping. To maintain a continuous flow of concrete deliveries of concrete truck will have to be coordinated such that as one truck is empty a full truck can be discharged to the hopper.

However, the tower crane will be used for other purposes than moving concrete. The crane will also be used for heavy picks such as placing the mechanical equipment for the penthouse. In order to make these picks in the future a mobile crane will need to be brought to the site. The cost of a crane that could handle the need to make daily picks, such as rebar would offset the savings. Also, a larger mobile crane would also need to be brought in to make heavier picks such as the 10,000 pound energy recovery units in the penthouse.

Schedule:

Traditional concrete placement with a crane and bucket is time consuming. An advantage of placing concrete with a pump is the speed of installation. Below is a comparison of the time of job site installation for each system. The data used for activity durations were gathered from actual productivity data from the job site and from R.S. Means. Durations for the formwork, rebar, and bucket placement were taken from actual project data. While the pump placement durations were estimated from R.S. Means data. The schedules below conclude that the pump placement system takes 10 less days when compared to the crane and bucket placement method. The concrete placement is on the project’s critical path so a savings of ten days will shorten the project’s overall duration, savings 10 days worth of general conditions.

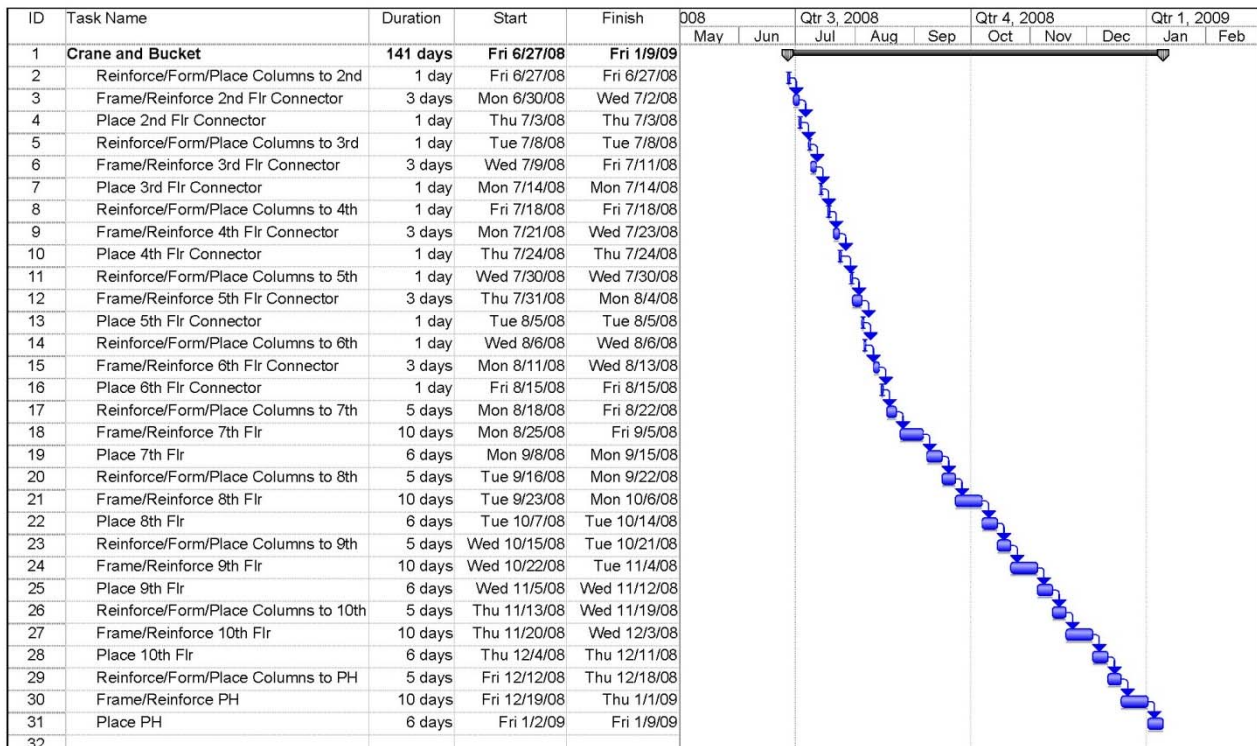


Figure CP1a: Placement Schedule Comparison



33	Concrete Pump	131 days	Fri 6/27/08	Fri 12/26/08
34	Reinforce/Form/Place Columns to 2nd	1 day	Fri 6/27/08	Fri 6/27/08
35	Frame/Reinforce 2nd Flr Connector	3 days	Mon 6/30/08	Wed 7/2/08
36	Place 2nd Flr Connector	1 day	Thu 7/3/08	Thu 7/3/08
37	Reinforce/Form/Place Columns to 3rd	1 day	Tue 7/8/08	Tue 7/8/08
38	Frame/Reinforce 3rd Flr Connector	3 days	Wed 7/9/08	Fri 7/11/08
39	Place 3rd Flr Connector	1 day	Mon 7/14/08	Mon 7/14/08
40	Reinforce/Form/Place Columns to 4th	1 day	Fri 7/18/08	Fri 7/18/08
41	Frame/Reinforce 4th Flr Connector	3 days	Mon 7/21/08	Wed 7/23/08
42	Place 4th Flr Connector	1 day	Thu 7/24/08	Thu 7/24/08
43	Reinforce/Form/Place Columns to 5th	1 day	Wed 7/30/08	Wed 7/30/08
44	Frame/Reinforce 5th Flr Connector	3 days	Thu 7/31/08	Mon 8/4/08
45	Place 5th Flr Connector	1 day	Tue 8/5/08	Tue 8/5/08
46	Reinforce/Form/Place Columns to 6th	1 day	Wed 8/6/08	Wed 8/6/08
47	Frame/Reinforce 6th Flr Connector	3 days	Mon 8/11/08	Wed 8/13/08
48	Place 6th Flr Connector	1 day	Fri 8/15/08	Fri 8/15/08
49	Reinforce/Form/Place Columns to 7th	5 days	Mon 8/18/08	Fri 8/22/08
50	Frame/Reinforce 7th Flr	10 days	Mon 8/25/08	Fri 9/5/08
51	Place 7th Flr	4 days	Mon 9/8/08	Thu 9/11/08
52	Reinforce/Form/Place Columns to 8th	5 days	Fri 9/12/08	Thu 9/18/08
53	Frame/Reinforce 8th Flr	10 days	Fri 9/19/08	Thu 10/2/08
54	Place 8th Flr	4 days	Fri 10/3/08	Wed 10/8/08
55	Reinforce/Form/Place Columns to 9th	5 days	Thu 10/9/08	Wed 10/15/08
56	Frame/Reinforce 9th Flr	10 days	Thu 10/16/08	Wed 10/29/08
57	Place 9th Flr	4 days	Thu 10/30/08	Tue 11/4/08
58	Reinforce/Form/Place Columns to 10th	5 days	Wed 11/5/08	Tue 11/11/08
59	Frame/Reinforce 10th Flr	10 days	Wed 11/12/08	Tue 11/25/08
60	Place 10th Flr	4 days	Wed 11/26/08	Mon 12/1/08
61	Reinforce/Form/Place Columns to PH	5 days	Tue 12/2/08	Mon 12/8/08
62	Frame/Reinforce PH	10 days	Tue 12/9/08	Mon 12/22/08
63	Place PH	4 days	Tue 12/23/08	Fri 12/26/08

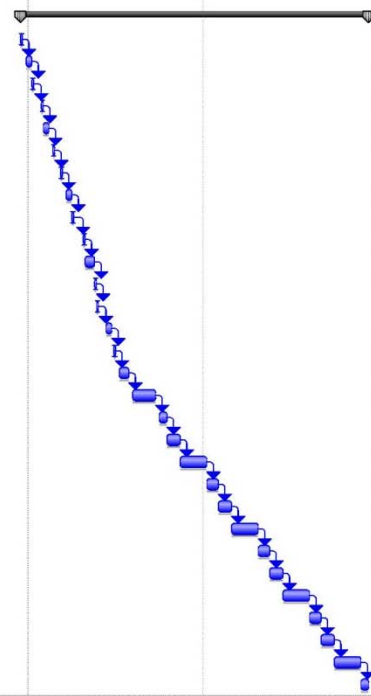
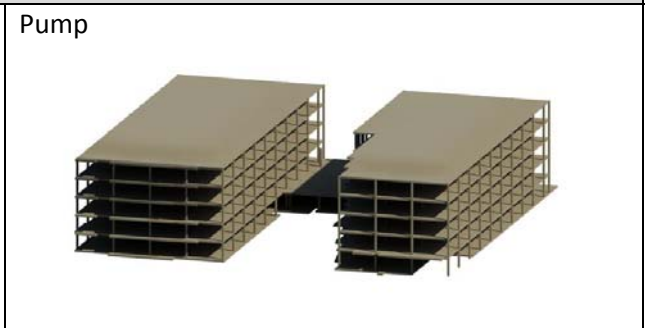
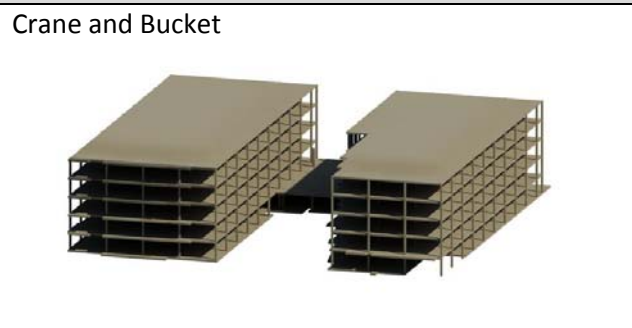


Figure CP1b: Placement Schedule Comparison

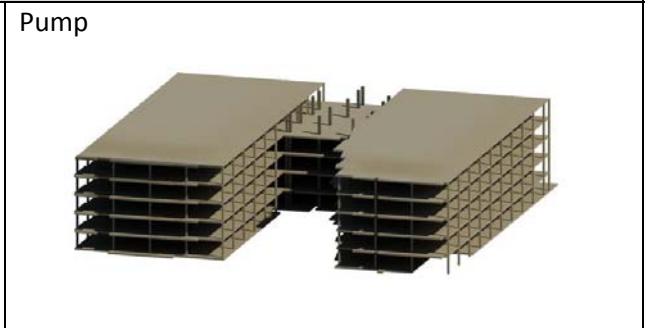
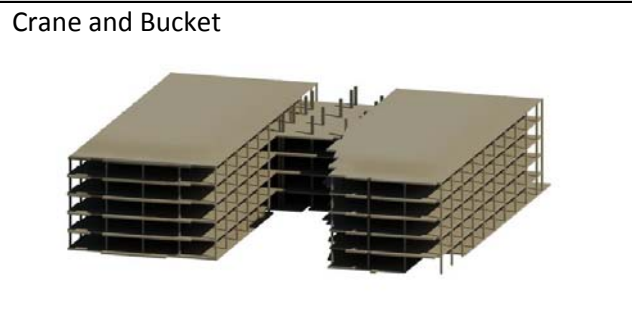
As can be seen from the schedules in Figure CP1 the formwork and rebar placement keep the two different placement methods at the relatively the same productivity. It is not until the full stories are placed that the effectiveness of the pump shortens the schedule. The full stories are 9.5 times larger than the connecting slabs. For the placement of the full slabs the pump shortens the placement time from 6 days per floor to four days per floor. The primary reason that the overall duration difference is not greater is the extensive time to place forms and rebar that need to be completed prior to the concrete placement. On WestEnd25 the connecting slabs were not large enough to offset the pours such that the formwork and rebar could be completed in one section while a concrete placement was happening in another section. However, the full stories did allow for this to occur and therefore the pump placement was more efficient. The images in Table PC1 show how the effects of the pump change from the smaller connector slabs to the larger story slabs.

Crane and Bucket vs. Concrete Pump Placement

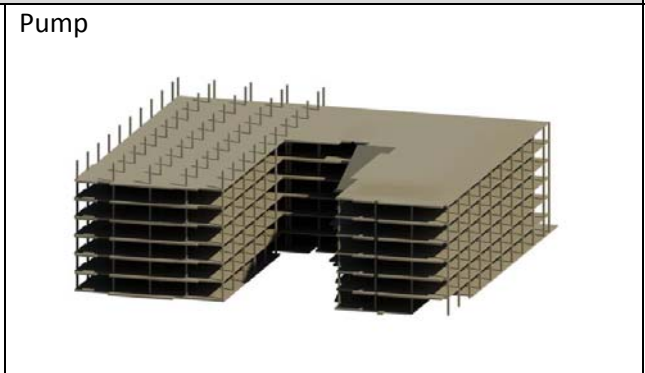
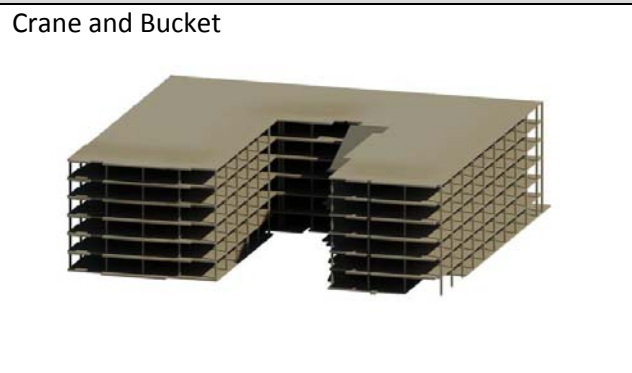
Date: 7/3/08



Date: 8/5/08



Date: 9/15/08



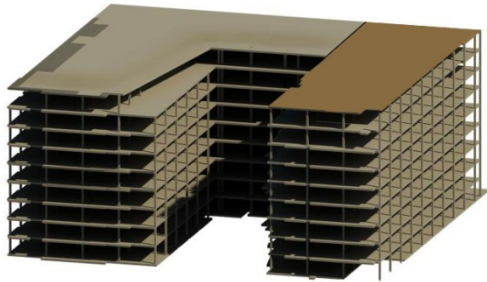
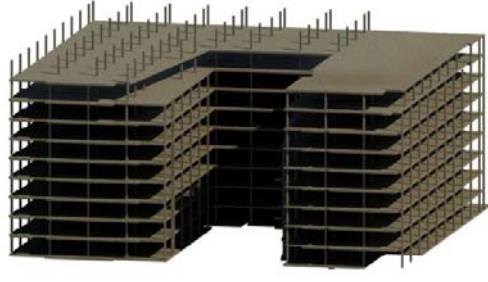


Date: 11/8/09	
<p>Crane and Bucket</p> 	<p>Pump</p> 
Finish	
<p>Crane and Bucket 1/9/09</p> 	<p>Pump 12/26/09</p> 

Table PC1: Visualization of Comparison

Cost:

The cost difference is a vital number in determining the feasibility of pump placement. Costs of the crane and bucket placement have been gathered from actual project data. Pump placement costs have been estimated using supplier information and R.S. Means. A location factor .93 was applied to the data from R.S. Means to account for the Washington D.C. location. In Table PC2 below a breakdown of associated costs is shown.



Item	Quantity	Cost Basis	Total Cost
Crane and Bucket Placement	4,106 CY	Equipment = \$7,000/week Labor = \$13/ CY	\$193,375
Pump Placement	4,106 CY	\$18.20/ CY	\$74,750
		Cost Difference	\$118,625
Supplemental Crane: *Assumed 18 Ton; quote from Capitol Building Supply, Inc.		\$650/day For 131 days	(\$85,150)
		Net Savings:	\$33,475
General Conditions Savings		\$5,925/day For 10 days	\$59,250
		Total Savings:	\$92,725

Table PC2: Placement Cost Breakdown

The result of the cost analysis is quite profound. With the utilization of the pump placement system there would only be a savings of \$33,475. However, the effect of a decreasing the duration of installing the structure is a shorter project duration which results in a further savings of \$59,250, resulting in a total savings of \$92,725.

Placement Conclusions:

From the 33% increase in productivity between the connecting slabs and full stories it can be concluded that the effectiveness of the pump concrete placement method increases as the pour size increases. In other words, the smaller the pour the less effective the pump will be at saving overall project time. WestEnd25 has too many small pours to reap the benefits from the pump. Nevertheless, the pump placement seems to be a considerable savings in cost. However, \$92,725 is only 2% of the package cost and 0.12% of the total project cost. Therefore, the benefits of the more productive pump placement are not realized on this project and a more familiar but slower method is acceptable.