Analysis #2: Utilizing a Matrix Schedule

Problem Statement

In the past, the team has accelerated the schedule by re-sequencing or re-designing a specific system and/or piece of the schedule to gain back time lost during unforeseen conditions at some point in the excavation phase of the project. To counter act time lost during the excavation phase, the structural schedule along with others were accelerated. By utilizing a matrix schedule, the cast-in-place concrete structure could aid in reducing the current accelerated schedule along with improving the structural trade flow and organization within the building.

Goal

A matrix schedule will be utilized to explore the positive and negative implications to the overall project schedule. The focus of the matrix schedule will be on the cast in place concrete structure for levels P3 through the Ground, but mainly focus on the 2nd Level to the Roof. The goal of utilizing the matrix schedule is to allow for easier tracking of production based on standardized work zones and task durations along with obtaining shorter structural duration.

Research Steps

1. Perform independent research on matrix scheduling techniques and objectives.
2. For the Class A office building, divide each typical level into equal areas for duration calculations.
3. Determine the amount of time to complete each task by talking to industry professionals and using R.S. Means.
4. Create a matrix schedule based on the equal areas of construction and the equal time intervals to complete each task, starting at the P3 Level and working up to the Roof.
5. Figure out the total amount of time saved in the project schedule by using a SIP schedule.
6. Identify challenges of utilizing matrix schedule on the office building.
7. Identify solutions to challenges.

Expected Outcome

This research should expose some of the challenges related to utilizing a matrix schedule, particularly on a Class A core and shell office building, and solutions will be proposed after the challenges are clearly identified. The matrix schedule will also decrease the overall schedule time, enough to allow for early turnover to the owner. However, a matrix schedule is highly dependent on each trade completing their work in the given amount of time provided, which can be very challenging to coordinate and plan to get them all on the same page. Therefore it is important that all trades and subcontractors fully buy-in to the utilization of a matrix schedule, thus making it easier for the general contractor to track and communicate through the schedule.

Introduction to Matrix Schedule

Matrix schedules are used on construction projects where there is a large amount of repetitiveness in the building design, such as the construction of offices, apartment buildings, or hotels. The basic principle of matrix schedule is to keep the crews working on the same activity and consistently moving through the building in a pattern following immediately behind the preceding activity. This not only allows for fewer conflicts between the trades, but also, by keeping crews working on the same activity, productivity will increase.

Matrix schedules work by first breaking down the building into manageable sections. The section sizes are determined by the durations for the amount of work that needs to be completed. For example, if the matrix schedule is for pouring slabs, it would be most efficient to break the floor plan up into sections no larger than the maximum square footage of concrete that can be poured in one day. Next, the sequence of activities for each section needs to be developed. This can be done for the entire building form start to finish or for separate systems such as the structure or mechanical work. The following step is to balance the durations for each activity so that every crew is constantly moving through the building. This is done by either increasing or decreasing the crew size.

In the past, the team has accelerated the schedule by re-sequencing or re-designing a specific system and/or piece of the schedule to gain back time lost during unforeseen conditions at some point in the excavation phase of the project. To counteract time lost during the excavation phase, the structural schedule along with others were accelerated, thus The Office Building is a prime candidate to implement a short interval production schedule. The floor plans are repetitious from the P3 Level to Ground Level, and the 2nd Level to Roof are almost the same, except for the decrease in area size as the building rises in level, but not changing the building's form. Using a matrix schedule could help to reduce the overall duration of the project by taking advantage of the repetitiveness of the design. For this analysis, a detailed matrix schedule has been created for the cast in place concrete structure. The duration of the new matrix schedule was compared to the accelerated duration for the structure.

Original Schedule

The original duration for the cast in place concrete structure was approximately 54 weeks. This activity began in mid July of 2007 and finished later in August of 2008. The original schedule can be seen on pages 29 and 30 of this report.

Utilizing a Matrix Schedule

This matrix schedule was created for the cast in place concrete activity for levels P3 through the Ground level and for the 2nd Level to the Roof. These two areas are shown on the same schedule but are not related matrix schedules due to the difference in area size and design. The main concentration of this analysis was on the schedule for levels 2 to the Roof.

First the levels were broken up in to eight or four sections, depending of area size, and labeled A through H. Each section is roughly 7,000 square feet. This size allows for most of the activity durations to be one day. Next the sequence was developed for each section. The sequence for floors 2-14 is as follows:

Figure 12: Sequencing for 2nd Level to the Roof

Sequencing for 2nd Level - Roof

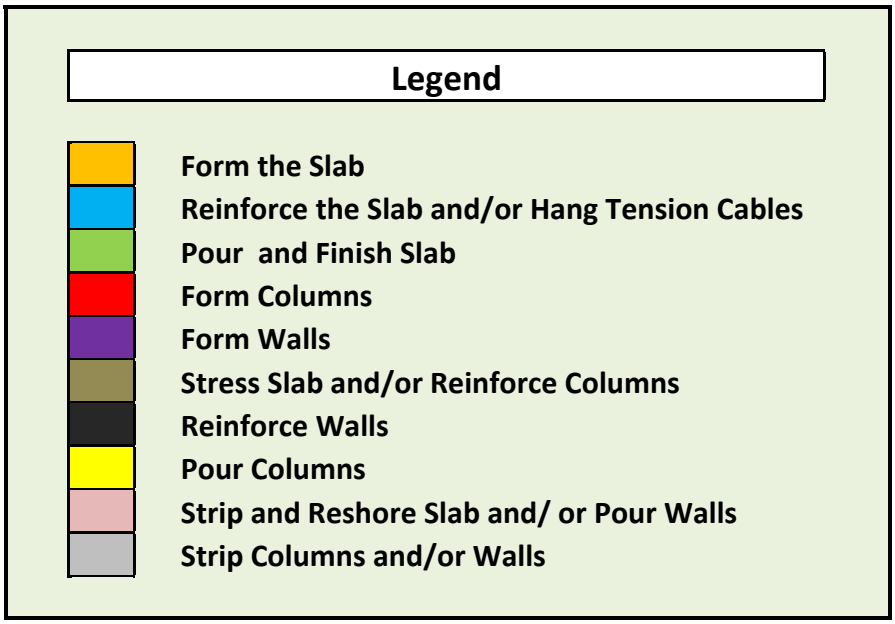
1	Form the slab
2	Reinforce the slab
3	Hang tension cables
4	Pour and finish slab
5	Form columns
6	Stress slab and reinforce columns
7	Strip and re-shore slab and pour columns
8	Strip columns

The durations for each activity were calculated by using daily output data from R.S. Means. The crew sizes were altered to have the durations of each activity be as close to the others as possible. However, some of the activities, such as forming the slab or finishing, could not be reduced to one-day durations without compromising the productivity due to too many people working in one area. Having varying durations in a matrix schedule can cause problems with movement of crews through the building. If one activity takes three days and the following activities take one day, the crews with the shorter duration activities will not be able to continually move on to the next section without being delayed by the preceding crew.

For the Office Building's matrix schedule, this problem could be corrected by setting the crew sizes so that the durations for the shorter activities would allow the crew to perform a similar but different activity on a different section. For example, the crew responsible for pouring the slab has a one-day duration. If they just poured the slab, then they would only have work every other day. However, this was corrected

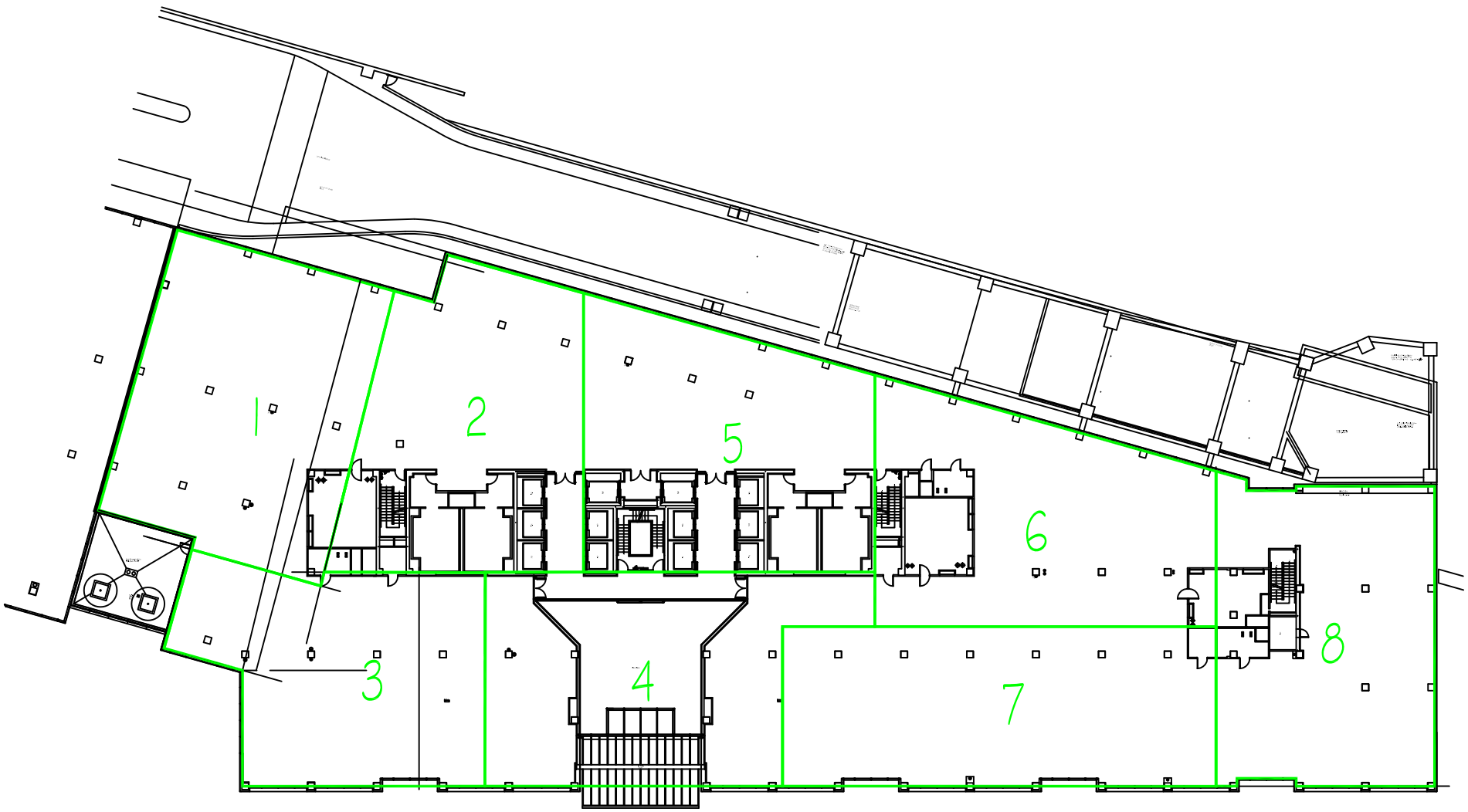
by having them pour the columns on a different section on alternate days. This problem could not be avoided with the post tensioning work. This work would be completed by a specialty contractor so there would not always be work on this project for them. Since it is a specialty contractor, this may still work well for them if they have another project that they could work on alternate days. It is difficult to show the sequence precisely on the graphic matrix schedule, because of the lack of ability to show durations that are fractions of a day. Some of the durations that were slightly less than a full day were rounded up to allow time for movement of the crew and their tools to the next work area. Others that were slightly higher than the whole day were rounded down to show a more accurate picture of the overall duration. These durations would most likely decrease as the project progresses due to the learning curve. Once the crews learned their portion of the work and became accustomed to the project, their productivity would increase.

Figure 13: Color Legend for Matrix Schedule



Please reference Appendix I for Matrix Schedule Duration Calculations

Year	2007																										2008																									
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Date	7/9/2007	7/16/2007	7/23/2007	7/30/2007	8/6/2007	8/13/2007	8/20/2007	8/27/2007	9/3/2007	9/10/2007	9/17/2007	9/24/2007	10/1/2007	10/8/2007	10/15/2007	10/22/2007	10/29/2007	11/5/2007	11/12/2007	11/19/2007	11/26/2007	12/3/2007	12/10/2007	12/17/2007	12/24/2007	12/31/2007	1/7/2008	1/14/2008	1/21/2008	1/28/2008	2/4/2008	2/11/2008	2/18/2008	2/25/2008	3/3/2008	3/10/2008	3/17/2008	3/24/2008	3/31/2008	4/7/2008	4/14/2008	4/21/2008	4/28/2008	5/5/2008	5/12/2008	5/19/2008	5/26/2008	6/2/2008	6/9/2008	6/16/2008	6/23/2008	6/30/2008
Level																																																				
Mat Foundation/ P3 Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
P2 Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
P1 Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
Lower Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
Ground Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
2nd Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
3rd Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
Section H																																																				
4th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
5th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
6th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
7th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
Section G																																																				
8th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Section E																																																				
Section F																																																				
9th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
10th Level																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				
Roof																																																				
Section A																																																				
Section B																																																				
Section C																																																				
Section D																																																				


1
2
5
6
3
4
7
8

Results

After completing the matrix schedule for the cast in place concrete structure and comparing it to the present schedule, it was found that the task could be completed in 52.5 weeks. If this were inserted into the original schedule, it would begin in mid July of 2007 and be completed in mid August of 2008, thus only 1.5 weeks shorter than the original schedule duration for this activity.

Conclusion & Recommendations

After completing this analysis it is noted that the Office Building project would gain 1.5 weeks in the cast-in-place concrete structure by implementing a matrix schedule, thus the structure would take 52.5 weeks to complete instead of 54 weeks. Though this amount of time saved may not seem to be a huge gain in reducing the schedule, however it allows for time to be allotted if any unforeseen work stoppages or delays occur while construction the building structure. The currently accelerated schedule is quit efficient, nevertheless the matrix schedule would allow for a little cushion in the schedule.

However, in utilizing a matrix schedule, this allows the project team members to more effectively track the work done on the structure, along with creating a consistent work pattern in constructing the cast-in-place structure. If this type of scheduling was implemented for the rest of the project, there could have potentially been a time savings of one to two months on the entire duration. This would depend heavily on the actual durations compared to the estimated ones used in the matrix schedule; a further analysis would need to be completed to establish actual time savings.