ANALYSIS 3

Structural Steel Erection Sequencing

Problem

The construction schedule of the AAHS was 24 months when the project was bid. Delays in funding delayed the project start date. Since the new school is being built adjacent to the existing school, no temporary classrooms were necessary, but the old school is slated for demolition following occupancy of the new school. Substantial completion is scheduled for August 23, 2007, with classes starting in the building, after the holiday break on January 8, 2008 in the new building.

Goal

The goal of this technical analysis is to examine the possibility of reducing or accelerating the schedule by several months focusing primarily on the steel erection sequence paired with the use of a precast façade system. With the existing brick façade system, brick work begins after topping out of structural steel. By allowing façade construction to begin as structural steel is still occurring will allow earlier turnover to occur possibly at the start of the school year to reduce impact on students. This would allow the Ambridge Area School District to move furnishings and equipment over the summer break period and allow students to begin the 2007-2008 school year in the new facility rather than transitioning to the new building half way through the year. The schedule reduction should decrease general conditions costs without forcing increased costs in structural steel work.

Methodology

1. Examine steel erection and façade sequencing used on project
2. Determine alternative sequence to reduce schedule
3. Model alternative sequence using 4-D modeling
4. Compute any additional costs attributed to overlapping façade and steel erection
5. Compute reduced general conditions costs after reduction in overall schedule

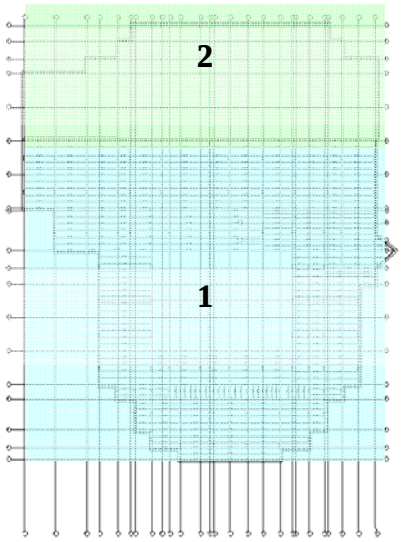
Figure 2 - Steel erection underway

Tools

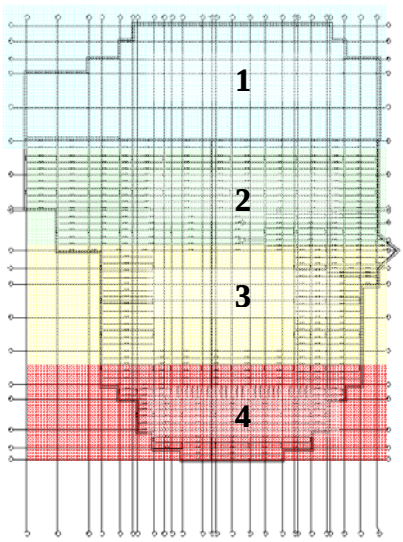
1. Penn State Architectural Engineering Faculty
2. Autodesk Revit Structure 4
3. Navisworks (4 Dimensional Model Capability)
4. High Concrete - precast manufacturer

Outcome

The steel erection sequence used on the Ambridge Area School District by the structural steel erector called for steel erection to begin at column line N and move west to column line A completing the East section of the building last from column line N to S. The proposed sequence would begin at the East side of the footprint at column line S and proceed in four phases to column lines N, K, E and A respectively, as shown below.

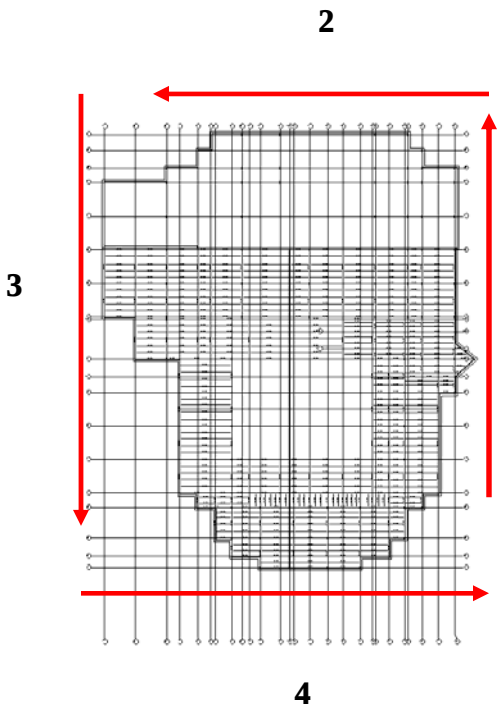


Erection Sequence Used

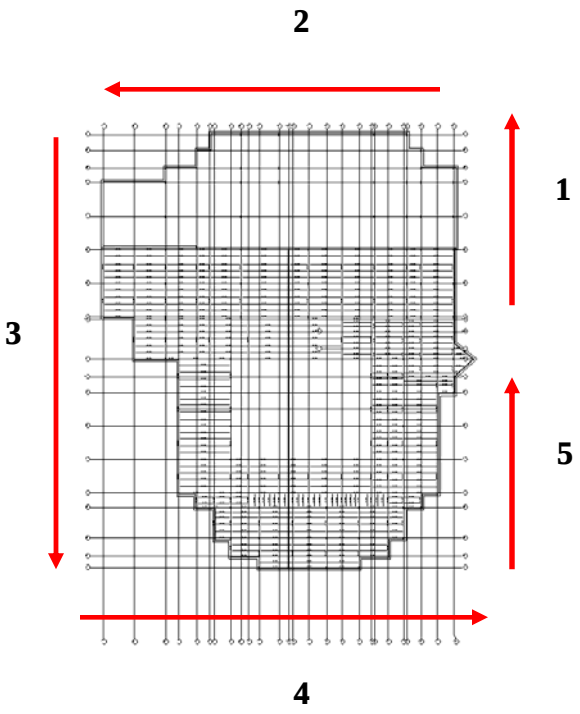


Proposed Sequence

Currently, the exterior façade of CMU and brick begins after structural steel is completely erected and detailing of structural steel and deck has begun. Using this alternative sequence of steel erection would allow precast panels to begin erection on the South elevation of the building after phase 3 of the structural steel erection has completed. The current sequence begins on the South façade and progresses around the building footprint in a counterclockwise rotation ending back on the South façade. The proposed sequence begins on the south façade adjacent to the main building entrance on column line K. This sequence also progresses around the footprint in the same fashion as the existing sequence but is concurrent to steel erection underway in phase 4. This method allows for an earlier exterior façade completion date and less congestion around the site because of the elimination of mason's scaffolding around the entire footprint of the building. Please refer to Appendix A for project specific site plans.



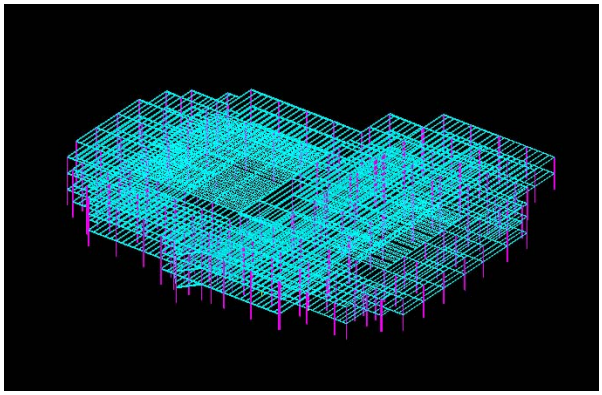
Facade Sequence Used



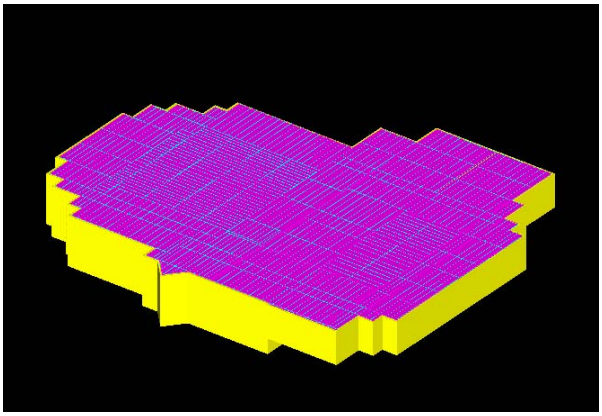
Facade Sequence Proposed

Schedule Impacts

After modeling and analyzing the structural steel and façade erection sequence used on the Ambridge Area High School, it is evident that while the alternative sequence chosen has the potential to expedite the time when the exterior façade is complete. Currently the exterior façade completion date is 7/12/2006 with building enclosure occurring on 10/7/2006. The revised sequence allows for exterior façade completion to occur approximately one month earlier on 6/13/2006 but as the EPDM roof schedule ties to the topping out of structural steel and this duration remains unchanged regardless of the sequence chosen, building enclosure still occurs on 10/17/2006. While other trades are able to complete work on the exterior façade after the completion of precast erection, and interior trades on lower floors may begin to put work in place which is not moisture sensitive, moisture sensitive activities are driven by the completion of the roofing system. As a result, no reduction in the overall project schedule occurs because the timeline for building enclosure remains unchanged.



Navisworks model of steel erection complete



Navisworks model of steel and façade work complete

Cost Impacts

As initially intended this analysis would provide a reduction in the overall project schedule and thus provide savings in the way of a refund to the owner of general conditions costs per month saved on the total duration. The impact on the structural steel erector and precast erector are minimal, and additional costs to erect in this sequence adds no additional costs to the project as the durations for each portion of the project remain the same, require no additional materials, and crane usage remains unchanged.

Conclusion

As a result of looking into the re-sequencing of the façade and steel erection on the Ambridge Area High School, it can be seen that the proposed sequence provides an exterior façade completion date approximately one month prior to that of the existing sequence. This duration can be attributed to the speed differential of erection of precast panels over that of traditional masonry construction. The costs attributed to changing to the proposed sequence and the cost savings by doing so are minimal if any because overall scope of work and overall project schedule are unaffected.

With these factors in mind, it is recommended that the Ambridge Area High School use this method of sequencing on the structural steel and façade areas of the project to provide an exterior façade completion date earlier thus allowing other trades to begin work in a less congested environment.