Ursinus College Residence Hall 2

Collegeville, Pennslyvania

Senior Thesis Final Report

Spring 2007

Rusty Hoffman

Advisor: Dr. John Messner

Construction Management

Warfel Construction Company, Wallace, Roberts and Todd, LLC, Ursinus College

Rusty Hoffman
Construction Management

Ursinus College Residence Hall 2
Collegeville, Pennsylvania

Project Team

Owner: Ursinus College
GC/CM: Warfel Construction Company
Architect: Wallace, Roberts & Todd
Structural: David Chou & Assoc.
MEP/Fire: McHugh Engineers

Project Overview

Site: Ursinus College North Campus
Occupancy: Dormatory, R-2
Building Size: 52,114 S.F.
Building Cost: $10.6 Million
Schedule: June 2006 - July 2007
Project Delivery: Design - Bid

Electrical

- 500KVA Transformer in Richter Hall substation provides 4160V primary to 208/120V secondary.
- Main Feed is 2 sets 750KCMIL AL in 4" conduit.
- Emergency Generator: 125kW natural gas 208/120V supplies a 400A Emergency Distribution Panel.

Lighting

- Primarily flourescent and compact flourescent lighting
- Ballasts for lighting are Instant start flourescent and class H HID ballasts.

Structural

- CIP Concrete Footings
- Load Bearing 8" CMU Walls
- Pre-cast 8" Concrete Hollow Core Plank
- A-Frame Wood Truss Roof
- Minor Steel Members to support plank over long spans.

Mechanical

- 9 AHU's ranging from 1000-4900 CFM serve building.
- Electric heaters produce 2550-17065 BTU/HR.
- Roof top Energy Recovery Unit
- equipment is controlled by a DDC building automation system tied to the college's existing system.

Fire Protection

- A wet piping system serves the building.
- All sprinkler heads are quick release.
- There are two dry standpipes in the east and west stairways for fire company hook up.

Arch./Construction

- Main entry is a Central Tower which includes a glass curtainwall, steel trellis and brick facade.
- Features 112 student rooms for 181 students.
- Roof consists of a Wood Truss and asphalt shingles.

Table of Contents

Thesis Executive Summary

The first area of analysis is an alternate system to provide the proper soil bearing capacity need for the building. The technique chosen was Deep Dynamic Compaction (DDC). This method uses weight and compaction energy to give the soil the proper bearing capacity that is required. An alternative of a complete soil exchange is proposed adds one day to the schedule and saves $2,54.53. Although this presented a cost savings to the owner, it is recommended that the owner stick with the proposed plan of DDC.

The second area of technical analysis was proposing an entire precast superstructure wrapped with an architectural precast panel building envelop. Minimum reinforcement calculations were run for typical load bearing wall components and a study of the connection details of the old superstructure and the new superstructure was done. Construction management depth is also covered in this area of analysis with the sequencing of plank and new crane placements on the site for the erection phase of the proposed system. Over all this analysis added a cost of $151,720. However as a result of the increase in cost, the schedule is accelerated ten weeks and the building will be enclosed at an earlier date to allow interior trades to work with a controlled environment.

The third area of technical analysis is the design analysis of a basic temporary heating system. This system will serve the masonry subcontractor during the erection of the current building façade and also serve the main building during the three coldest winter months of the project, December, January, and February. This system will maintain the quality standards of the project over the winter months as well as keep the work rate of the employees at a level equal to that in more favorable weather conditions. This temporary heat system comes at a cost of $17,015.18.

The construction depth research was aimed at the precast concrete erection safety on projects. This work was tied back into the other technical analysis by developing a site specific safety plan that would be implemented in the beginning of this particular project. The research methods included contact with industry members, the Warfel Construction Company and Davis Construction Company Safety Directors, the OSHA handbook, and a survey that was sent to industry members. Key problems were identified and the site specific safety plan developed addressed the problems that were identified and presented feasible solutions for an accident and incident free work environment.

Acknowledgements

As the fifth year of my college career is coming to a close, this page is not long enough to acknowledge and thank all those who have impacted this time at one point or another. First and foremost I would like to thank my family and friends. If not for you, the time spent here at Penn State would not have been as memorable or possible.

Additionally, I would like following companies and people for there continued assistance and support throughout the year's coursework for senior thesis.

Warfel Construction Company

- Brett P. Calabretta — Project Manager
- Ashley Steffy — Director of Safety, HR
- Matthew B. Hartzler — VP and Manager of Operations
- Wayne Shroyer — Superintendent

Ursinus College

- Andy Feick — Owner's Representative

Wallace Roberts & Todd, LLC

- Henry Fey — Designer

MEP/FP Engineers

- Rogers Mechanical Company
- Gillespie Electric, Inc.
- SDR Mechanical
- Precision Fire Protection

The Pennsylvania State University

- Dr. John Messner — Asst. Professor, Faculty Advisor
- Dr. David Riley — Assoc. Professor, Faculty Consultant
- Moses Ling — Asst. Professor, Student Advisor

Project Introduction and Background

Residence Hall 2 is a 52,114 square foot facility that will primarily serve as a dormitory for Ursinus College. Warfel Construction Company was hired as the general contractor and construction manager for this project. The bid for the project that was approved by the college was originally for $10.6 million. This bid followed a schedule of fourteen months. The following information provided gives a brief introduction to the project and the parties involved in the project. This information is intended to familiarize you with the project and what exactly is involved in the scope of work for the project.

Client Information

Ursinus College

The owner of this project is Ursinus College. This is a small liberal arts college located 30 miles outside center city Philadelphia, in Montgomery County. The college sits on 167 acres and consists of 70 buildings and roughly 1,485 students. The college has an Office of the Physical Plant which handles utilities, site work, and similar work on construction projects which allows the college to avoid certain monetary charges. Andy Feick, the owner's representative, handles construction monitoring for the college and has contact with the board of trustees, WRT, and WCC.

Residence Hall 2 is being built for expansion purposes due to an increasing demand for student housing. The college works with an endowment of $105 million and an annual operating budget of $58.6 million, which includes financial aid. As well as in the past, cost continues to be an important factor. Some recent projects that have been completed on campus are The Kaleidoscope Center for the Performing Arts, Richter/North Residence Hall and The Lewis Baker Field House. Residence Hall 2 is included in a three-part construction project currently going on at the college. Renovations to both Bomberger Hall and a dining hall on campus are the other two parts. The college floated a bond of $16 million to cover costs for all of these projects. Currently the cost has risen to roughly $19 million. This is due to several factors which include the college increasing the bed count at Residence Hall 2, unforeseen structural conditions at Bomberger Hall and the inflation of material costs. To combat this rise in cost the college has taken credit on several items at Residence Hall 2 which include saving $80,000 on dynamic compaction and another $80,000 on HVAC system controls.

The schedule of this building is 14 months and needs to be turned over by early-mid August 2007 at the absolute latest. The college needs early August for FF&E in order to have the space ready for occupancy by students for the fall semester of 2007. The only other major milestones that the college is interested in are those such as floor by floor plank completion, building enclosure, MEP rough-ins, finishes, etc. These are important to the owner only to ensure them that the project is remaining on schedule as turnover is non-negotiable. The only early occupancy that has been discussed is to have a floor ready for commencement at the end of the spring semester 2007 because a conference is scheduled the day after commencement.

Ursinus purchases their own insurance to cover any losses and damages in the event of a disaster. Quality and safety are both significant issues to the college. As the budget for the project needs to stay at the current contract cost the college does not want to sacrifice quality for this. The college has contracted out a quality assurance company for structural and geotechnical on-site activities. David Blackmore and Associates performed the geotechnical reports as well as quality control for issues such as, strength of concrete and mortar, proper compaction of soils, and plank bearing. Safety is important to the college as they are constantly performing campus safety checks and hold student safety as a top priority. At Richter/North Hall there was a fatality during construction so Warfel Construction also holds safety as a top priority. WCC follows the OSHA guidelines and regulations but has also developed their own site specific safety program which all employees and those subcontractors working for WCC must comply with. They employ a full-time Safety Director which visits all sites once a week to ensure that safety at the workplace is being enforced.

This is a background on the owner for Residence Hall 2 and a look at areas that are of importance to the college. WCC holds high expectations for this project and their past performance has proven their ability to turn over a project that meets and in some areas exceeds the owner’s expectations. As part of this WCC needs to keep on schedule as a 14 month period is a small amount of time to complete a project of this size. Sequencing of trades and meeting certain project milestones, such as building enclosure, need to be executed as scheduled in order to deliver Residence Hall 2.

Project Delivery Method

Residence Hall 2 at Ursinus College is following a format of a design-bid project delivery system. As seen on the project organizational chart, the college holds a contract with both the architect and the GC/CM. Wallace, Roberts & Todd, LLC (WRT) was selected as the architect by the college in early October to design the project. The college holds a fee percentage contract with WRT. Ursinus was able to negotiate a good fee with WRT based on their past performance with Richter/North Hall, which WRT also designed. Warfel Construction Company (WCC) was selected as the general contractor/construction manager and holds a lump sum contract with the college. WCC was selected based on their past performance at Ursinus and the working relationship they have established. WCC has completed several other projects at the college including, The Kaleidoscope, Richter/North Hall, and a current renovation project at Bomberger Hall.

WCC holds a lump sum contract with each of the subcontractors shown on the organization chart. These subcontractors were selected based on two major criteria, price and scope of bid. As these are the two main factors WCC also considers the subs past performance, how much work the company can handle and any owner or architect preference. Along with the lump sum contract WCC also issues their own supplemental conditions with the contract which outline terms that are company specific to WCC. WRT does not hold a contract with WCC, however there is a line of communication between these two companies throughout the term of the project.

WRT does all architectural designing in house. They contracted McHugh Engineers to handle all MEP/Fire Protection engineering for the building. They also contracted David Chou & Associates, Inc. to design the structural system for Residence Hall 2. Consequently all major structural and MEP/Fire decisions must be approved by McHugh Engineers or David Chou & Associates, as well as WRT prior to a change being made in the field. All players on this particular project hold lines of communication with each other. This allows for the project to be delivered with minimal management by the Owner.

Insurance and bonds are very important on a job located on a college campus. In this particular case the college has their own insurance to cover any losses and damages that may occur throughout construction. WCC has their own insurance that covers them on the project. They carry general liability, workers compensation, automobile liability, and an umbrella liability policy. This insurance covers all those who are WCC employees on a particular project. WCC requires that all subcontractors carry workers compensation, employer's liability, commercial general liability, automobile liability, and commercial umbrella liability that equals or exceeds amounts outlined by WCC. This policy is part of WCC's general conditions. WCC also requires subcontractors to endorse their insurance policies so that it is not only primary to the subcontractor but to WCC and the college as well.

This project delivery system for Residence Hall 2 is best suited for the College. The college also handles certain job aspects in order to avoid additional fees from the general contractor and architect. In particular the college will perform utility work, site work, telecommunications/data and FF&E. All of these issues are outside of the contracts held with WRT and WCC. This allows the college to negotiate a good fee as well as a good lump sum contract and avoid additional fees. This project is part of a bond that was taken out by the college to cover renovations to Bomberger Hall, Dining Hall renovations and Residence Hall 2. Cost is a major issue with the college and this delivery system is best suited for that need.

Project Schedule Summary

The following schedule outlines key dates and milestones for this project. A full project schedule is attached in the PSAS appendix at the end of this report. This schedule however is intended to outline key milestones that will directly effect the project should one ore more of them become delayed and cause the project to not meet the current turnover date.

ID	Task Name	Duration	Start
1	WRT Schematic Design	20 days	Mon 10/3/05
2	Preliminary Land Developme	10 days	Mon 12/5/05
3	UC Approves Design Develo	5 days	Fri 6/9/06
4	WCC Priced 90% CD's	16 days	Tue 4/4/06
5	Final Building Permit Issued	1 day	Fri 6/9/06
6	UC Issues Notice to Proceed	1 day	Wed 4/19/06
7	Warfel Mobilizes Onto Site	15 days	Fri 5/19/06
8	Deep Dynamic Compaction	2 days	Mon 5/22/06
9	Footing Excavation	20 days	Tue 5/30/06
10	1st Floor East Plank	3 days	Thu 7/27/06
11	2nd Floor Plank	5 days	Tue 8/15/06
12	3rd Floor Plank	5 days	Thu 9/7/06
13	4th Floor Plank	3 days	Fri 9/29/06
14	Building Enclosure	82 days	Fri 10/20/06
15	Ground Floor MEP/Fire Rouç	26 days	Thu 11/23/06
16	First Floor MEP/Fire Rough-i	30 days	Mon 10/9/06
17	Second Floor MEP/Fire Rouç	30 days	Mon 10/16/06
18	Third Floor MEP/Fire Rough-	30 days	Mon 10/23/06
19	Fourth Floor MEP/Fire Rougł	42 days	Mon 11/20/06
20	Interior Drywall and Finishes	44 days	Thu 12/14/06
21	Interior Painting	53 days	Fri 12/29/06
22	Interior Flooring	61 days	Mon 2/26/07
23	Misc. Specialties	55 days	Mon 3/19/07
24	HVAC System Start-up & Te:	35 days	Wed 5/9/07
25	Final Inspections	13 days	Wed 6/27/07
26	Punchlist	10 days	Mon 7/16/07
27	Owner Occupancy	1 day	Mon 7/30/07

Residence Hall 2 Project Schedule Summary

It is important that the project not suffer any major set backs due to the fact that this is a dormitory and enrollment for the college has counted on the fact that they will have this building for students when they arrive for the fall semester of 2007. The above schedule states owner occupancy of the building is scheduled for July 30, 2007. As of the last schedule revision completed by Warfel Construction Company this date has been pushed back to August 7, 2007.

Building Systems Summary

Of all the systems and components that are a part of Residence Hall 2. The follow is a list of the key building systems what each of those systems includes.

Cast In Place Concrete

The CIP concrete on Residence Hall 2 is primary used in the footings. These continuous footings range in depth from 12” to 18”. These footings are for the load bearing CMU walls as well as the brick façade. According to the specifications this concrete is to have a 28 day compressive strength between 3,000-4,000 psi.

Precast Concrete

The precast concrete on this job is the flooring system. Each floor consists of 8” precast hollow core plank, fabricated by Say-Core, Inc. This company is located in Portage, Pennsylvania which is approximately four hours West of Collegeville. Plank is to have a minimum of 2” bearing and is set onto 1/8” thick high density plastic bearing pads. The plank is connected using reinforcing steel as well as steel connection plates to be field welded. All pre-cast plank is to be fully grouted with grout having a 28 day compressive of 3,000 psi and non-shrink grout to have a 28 day compressive strength of 10,000 psi. The mobile crane being used to erect this plank is an 80 ton hydraulic crane that is located in a controlled access zone directly to the North in the center of the project. It is from this location that the plank has been set on each floor. Part of the façade of this building is precast stone which is to be integrated with the face brick. This is being done to match the existing façade on Richter/North Hall.

Mechanical System

The mechanical system for Residence Hall 2 is being installed by Rogers Mechanical Company. It consists of nine air handling units that range from 1000-4900 CFM. There are two types of fan coil units throughout this project, 800 or 950 CFM, that help service the air conditioning system. The system runs from chilled water that is supplied from the existing chiller plant that is located to the North of the project and serves the rest of campus. The heating consists of electric heaters that produce anywhere from 2550-17,065 BTU/Hr and fin-tube radiation that is also run in different areas of the building. This is supplied by the colleges existing steam lines. Also part of the mechanical equipment is an energy recovery unit that sits on the roof. All equipment, as outlined in the operations will be controlled by a Direct Digital Control Building Autonomation System that will be tied in to the existing program that the college uses to service the rest of campus. There is a primary HVAC equipment room located on the ground floor. Also from the second to the fourth floor there are smaller mechanical closest and a small attic HVAC room.

Electrical System

The electrical system for Residence Hall is fed from a substation in Richter/North Hall. This substation is divided into four sections. There is a 200A load interrupter switch rated at 5KV, a 500KVA transformer, a 1600A main breaker section and a main distribution section. The new residence hall will be fed from an 800A 3 pole circuit breaker that will be installed in the main distribution panel in Richter/North. The main feed to the building is two sets of 750kcmil AL in 4" conduit. The voltage to the building will be 208/120V. This feeds all panel boards in the building for lighting, receptacles, and appliances. It also feeds the necessary MEP equipment as well. The emergency generator for Residence Hall 2 is a 125kW natural gas generator that is 208/120V 3 phase 4 wire generator that feeds a 400A emergency distribution panel. There is a main electrical service room located on the ground floor as well as electrical closets located on each of the remaining floors.

Masonry

The masonry on this project consists of two areas; the brick façade and CMU load bearing and non-load bearing walls. CMU's are connected to the CIP footings by vertical dowels that extend from the top of the footing into the CMU. This vertical reinforcing is continued vertically through the walls and to each floor. The load bearing walls are to be fully grouted with grout having a 28 day compressive strength of 3,000 psi. The brick veneer is attached to the CMU through the use of anchors which serve as horizontal reinforcement. The brick veneer is to match the existing brick veneer on Richter/North Hall. The CMU was erected using regular framing scaffold. The brick veneer will be erected using the same system or a mobile scaffold system. This is yet to be determined by Morgantown Masonry who is performing the work.

Curtain Wall

The curtain wall being installed on this project is a Glazed aluminum curtain wall, thermally broken with interior tubular section insulated from an exterior glass retaining member. Also included are drainage holes, deflector plates and internal flashings to accommodate the internal weep drainage system. Sloped members of the curtain wall are constructed of solid insulating wall and roof panels. It is being designed and fabricated by Entrance Systems, Inc. Final design must be approved by the architect. The manufacturer will have a representative present to provide field surveillance of the installation and will report installation procedures and unacceptable conditions upon completion of construction.

Fire Protection

The fire protection system for Residence Hall 2 consists of a wet piping system. The piping is schedule 10 for the main lines and schedule 40 for the branch lines. The sprinkler heads on the system are all quick response and being supplied by Viking. The rooms are classified as a light hazard and the laundry area classified as an ordinary hazard. Calculations were run accordingly and a pump is not required as the attic space has fire retardant wood trusses and plywood. There is a 4" standpipe that supplies all the floors at the Residence Hall. There is also a dry standpipe in the East and West stair towers that the fire company can use. The system is also connected to an alarm monitoring company should water be released from any sprinkler head.

Building System Cost Evaluation

Building System	System Cost	System Cost/Building SF
Mechanical	$1,299,748	$24.91
Electrical	$830,000	$15.93
Plumbing	$669,000	$12.84
Structural/Misc. Steel	$378,900	$7.27
Pre-cast Plank	$536,000	$10.29
CMU Masonry	$1,055,000	$20.24
Brick and Cast Stone	$668,000	$12.82
Fire Protection	$105,000	$2.01
Deep Dynamic Compaction	$75,400	$1.45

Building Systems Cost

The bid package that the college approved from Warfel Construction Company was for $10.6 million. The college performs several of the trades by themselves as they employ a full time Office of Physical Plant. This plant will do utility rough-ins and the final landscaping work among other activities. This allows the college to save money on projects they hire out. The cost of these activities performed by the colleges OPP brings the overall project cost to a total of $11.6 million. This accounts for over half of the construction budget for the campus and all of the projects it is currently undertaking.

Technical Analysis #1
Soil Remediation

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Soil Remediation Analysis

Executive Summary

Ursinus College Residence Hall 2 is located in Collegeville, Pennsylvania on the campus of a small liberal arts school. The location of the site is on the College's North campus. The proposed building consists of a four story West wing and five story East wing. The ground floor on East wing is a basement area that includes a laundry facility, mechanical spaces, a double room, double apartment and a kitchen. The main HVAC equipment room is on the ground floor here as well. Construction of the facility is to begin in May 2006.

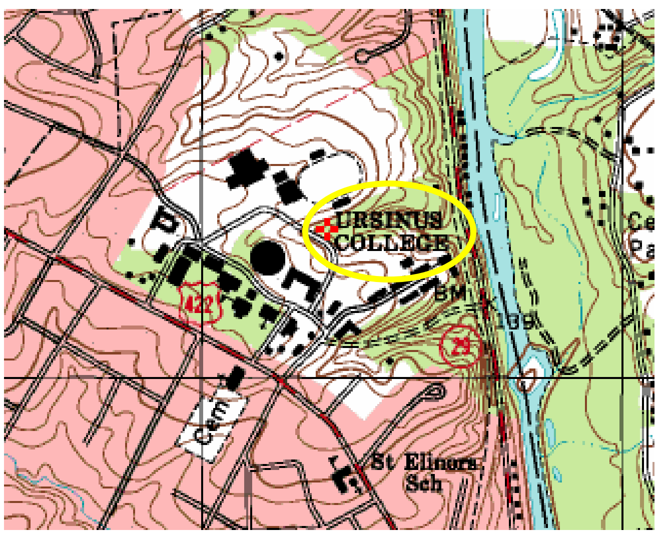
The existing design of the foundations consists of reinforced cast in place concrete footings to support load bearing CMU walls and precast concrete hollow core plank. The existing fill on site is excess soil placed by the college to fill an existing ravine in September 2005. This soil was never compacted properly and has been deemed unsuitable by the geotechnical engineer, David Blackmore and Associates, Inc.

This analysis will review the chosen soil remediation technique of Deep Dynamic Compaction (DDC), and compare it to a proposed complete soil exchange. Due to budget and time constraints, deep foundations such as mini piles and drilled caissons will not be considered for foundation structural support. The completed DDC was performed by Densification, Inc (DBA) out of Paeonian Springs, Virginia. The proposed complete soil exchange can be performed by any suitable site contractor with heavy machinery experience.

The proposed complete soil exchange will hopefully decrease the cost of the site remediation required. This problem was unforeseen and discovered after the initial bid for the project was approved by the college. This will be an added cost that was unexpected and the initial schedule for the project did not reflect. At this point foundations are scheduled to begin May 29, 2006.

Site Condition Overview

The site for Residence Hall 2 is located on the North campus of Ursinus College. This is in Collegeville, Pennsylvania which is in Montgomery County. Please refer to the Soil Remediation Appendix for a campus map of Ursinus. This site was determined to be unsuitable for the proposed building foundations by David Blackmore and Associates, Inc, the geotechnical engineering for this project. The site contains an existing fill layer that was placed there by the college in September of 2005 and never properly compacted. This layer was used to fill a wooded ravine with ranges in depth from three feet in the northeast corner to twenty one feet in the southeast corner. The following USGS topographical map outlines the location of the site and surrounding conditions.



USGS Map: Ursinus College

The geotechnical report revealed that the site geology is of the Trb – Brunswick Formation. This consists of reddish-brown shale, mudstone, and siltstone with beds of green and brown shale occurring. The soil on the site is on record as being of the Penn Series; specifically it is Penn Silt Loam with three to eight percent slopes. The site also contains groundwater, which was found in locations during the test boring. This groundwater was found to be at depths ranging from six feet to nineteen feet however it was noted that these elevations of groundwater are to vary dependent upon the season.

DBA performed test boring on a 75 foot grid pattern (Refer to the Soil Remediation Appendix). Fifteen boring locations were previously determined and the drilling was carried out by a subcontractor of DBA. After the laboratory results were released it was determined that this fill layer was unsuitable for the proposed foundation systems. It would not meet the bearing requirements due to the overall content and its dissimilarity in strength. The existing soil was found to have traces of deleterious material such as ash, cinders, asphalt, and organic salt among others.

A Standard Penetration Resistance (SPR) test was performed at the boring locations. As outlined by the geotechnical report this is a test that determines the number of blows required of a 140 pound hammer dropping from 30 inches to drive a two inch split spoon sampler one foot. This test revealed that in several locations the SPR was below 5 blows per foot which is deemed unacceptable. The following table outlines in which locations DBA found the SPR test to be unacceptable:

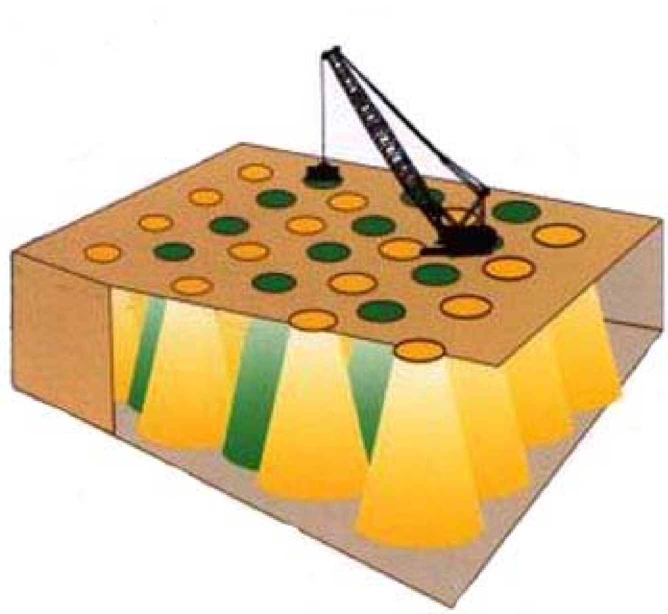
Boring Number	Depth	Blows/Foot
B7	2' to 4'	3
B8	2' to 4'	5
B9	2' to 4' & 10' to 12'	4
B11	2' to 4'	1
B14	10' to 12'	2

SPR Test Results

Due to the geotechnical investigation results and the issues outlined above, soil remediation must be performed on this site. Warfel Construction Company (WCC) put the work out to bid and received bids from Densification, Inc. to perform DDC and decided to pursue that route. This analysis will investigate a complete soil exchange as an alternative to DDC.

Deep Dynamic Compaction

Deep Dynamic Compaction was the chosen method of soil remediation by WCC for the site at Residence Hall 2. This work was performed by Densification, Inc. located in Paeonian Springs, Virginia. This company has performed geotechnical work in the United States for more than 20 years. Dynamic compaction consists of dropping anywhere from a six-20 ton weight from heights ranging from 40 to 70 feet. This technique will reduce settlement and increase the bearing capacity of the existing soil. This creates six foot diameter circle shaped craters in the ground that will range from two to six feet in depth. This will require backfill that Densification Inc outlines can be from the existing site, thus lowering the overall height of the site or can be structural fill that comes from off site if the site material is unsuitable. This method exposes softer material that the geotechnical engineer identified as being unsuitable for the proposed foundations. If need be a second pass can be made to ensure these areas have been properly compacted.



Deep Dynamic Compaction Impact

Densification Inc. has performed several projects in the recent years in surrounding areas to the college. They are a very experienced firm and have performed more than 300 dynamic compactions which account for more than half of the dynamic compaction work performed in the United States. Some of the projects located near Residence Hall 2 in Collegeville, PA are:

- Ikea Office Building – Plymouth Meeting
- Philadelphia Waterfront – Philadelphia
- Residential Project – Philadelphia
- Fox Hollow – Concordville

While performing this work, the team must take into account the surrounding facilities on campus and the effect of the vibration associated with compaction. Another residence hall is located directly across the street to the south and the campus's chiller plant is located several hundred feet to northeast of the site.

Site Specific Work

Densification Inc. submitted a bid to perform this work. This outlined the procedure and requirements that they will provide in order to perform the soil remediation. The work included in their scope of work is:

- Engineering Coordination, Reporting, and Grid Drawings
- Field Layout of Drop Points
- Mobilization/Demobilization of Equipment
- Full Time Supervision
- Vibration and Seismic Monitoring

The scope of work that is excluded from their bid is:

- No Earthwork
- All Permits and Fees
- Layout of Limits of Dynamic Compaction
- Identification of Existing Utilities
- Providing Backfill for Craters
- Surface Compaction After DDC is Complete
- Any Soil Bearings and Engineering Certification

Densification Inc has presented a plan to perform the work. This plan is to perform the DDC onsite using a crawler crane and dropping a weight of nine tons from a height of 50 feet. The grid pattern will be over the building footprint which is roughly an area of 13,000 square feet. Primary drops will be made at twelve feet on center with secondary also being made at twelve feet on center, thus creating a grid with drops at six feet on center (Refer to the Soil Remediation Appendix). It was noted that a second round of drops may be required at certain locations should the first round not meet compaction requirements.


DDC Program in Action

DDC Results

A test area was performed over the basement footprint. This is the area in which pore water pressures will be the greatest, thus having an effect on the density of the soil after the DDC was performed. The pore water pressures were allowed to reach their original levels before test drilling was performed by DBA. After the first round of primary and secondary drops were complete it was noted by DBA that compaction was acquired to depths of ten and eleven feet. These results indicated that the DDC program was effective in increasing the density of the soil and thus improving the bearing capacity of the soil for the foundations.

The rest of the building footprint received a single round of primary and secondary drops while the basement footprint received a second round of drops. As stated before the DDC program was completed over a 13,000 square foot area. After the craters were backfilled the area was then rolled and backfilled to meet the existing grade. Test results were favorable and WCC was given the OK to proceed with foundation excavation after the DDC program was complete and improved the bearing capacity of the soil.

Cost and Schedule Analysis

Deep Dynamic Compaction required the expertise of a specialty contractor to perform the work. This work was based on a schedule time of 27 days. It was also assumed that the excess fill on site was suitable to use for backfill and to bring the site back to existing grade. This is assumed to avoid cost on having soil brought in from off site. The original schedule for the project which this bid is based off of has the dynamic compaction taking 23 days to complete. This time does not include the backfill of holes left by compaction and the backfill of the site to bring it to the proper grade level needed. This is the schedule time that will be used for all cost calculations that are in excess of the bid received to perform the work. The excess work includes rolling and backfilling of the site after the dynamic compaction was complete. This earth work is needed to level off the site in order for proper grades to be met and to allow for excavation of footings to begin. All hourly costs and equipment costs are based on RS Means estimating guide.

Scope	Days	Included In Contract
Mobilization	2	Yes
Crawler Crane	20	Yes
Field Layout	1	Yes
Supervision	23	Yes
Seismic Monitoring	20	Yes
Total Contract Cost		**$80,000**

Densification Contract Scope

The following table outlines additional costs that were not part of the awarded contract. These costs will be calculated and added to the contract sum to determine the total cost of densification. The fill used to level the site is existing fill that is stockpiled on the site prior to DDC being completed. This will prevent having an added cost of fill being brought to the site.

Equipment	Daily Output	Cubic Yards	Days	Cost/CY	Total Cost
Dozer	1225	3306	2.7	$0.96	$3,173.76
Compaction Roller	5200	2301	0.5	$0.21	$483.21
Total Cost					**$3,656.97**

Additional DDC Costs

The total cost for the DDC work to be performed at Residence Hall 2 comes in at $83,656.97. The schedule time to complete this work is a total of 27 days. In order to meet the foundation scheduled start date of May 27, 2006 the crew will have to work Saturday's to complete the total work. The compaction completed on time however adding the additional earth work to the project pushed the schedule date over what was originally planned.

Complete Soil Exchange

An alternative method for soil remediation proposed by the geotechnical engineer is a complete soil exchange. All existing fill will be removed from underneath the structure and replaced with a designated structural fill that will meet requirements. This fill is required by DBA to have a compressive strength between 50 and 250psi. It is to be placed where Stratum IMF exists over the building footprint. This is a stratum that has been identified by the geotechnical engineer as unsuitable for the proposed foundations. This method of site remediation will be beneficial because no foundation redesign will be necessary once the operation is complete. This type of remediation also does not require a specialty contractor to complete the work. As stated the expense of the soil bearing problem presented the college with an added cost and the construction manager with added schedule time. This method will hopefully prove to decrease both issues and allow the project to carry on as scheduled in order to meet the occupancy deadline.

Criteria for Soil Exchange

All unsuitable materials are to be removed from the surface of the site and this is at the discretion of the geotechnical engineer. The unsuitable soil shall be removed from all structural areas of the building to ensure the new fill will meet the bearing requirements of the building. The following is the process that is to be taken in order to complete this project:

- Remove all existing fill in Stratum IMF (Identified on Geotech rpt.)
- Soil cuts should extend laterally to a distance that is equal to the depth below foundation bottom.
    - For this analysis it will be assumed that the maximum distance of 16’ will be used for lateral cuts and to calculate the amount of soil removed from site. This cut is in reference to building perimeter.
- Once soil is removed the exposed base will be leveled and rolled with a drum roller.
- At this time structural fill will be brought to the site and placed in lifts of eight inch maximums until desired grade is reached and compacted with a vibrating roller in two passes.

The following table outlines the depth of required cuts at certain boring locations. This was determined by the geotechnical engineer.

Boring	Existing Elev.	Proposed Elev.	Total Req'd Cut	Total Req'd Fill
B2	203.06	206	10.25	13.19
B4	201.98	206	9	13.02
B6	198.47	206	11.17	18.7
B8	198	194	18.5	14.5
B9	198.67	194	15	10.33
B12	195.49	194	16.25	14.76
B13	199.93	194	10.83	4.9
B14	192.37	194	12.5	14.13

Soil Replacement Requirements

There are several assumptions made for this analysis. The first being, as stated above, that the maximum lateral cut shall extend the around the entire perimeter of the building. In this case it is a distance of sixteen feet. This will ensure that the entire foundation will be bearing on suitable structural fill with several feet of cover. The second assumption is that all fill removed from the site will be left on site in a predetermined area for use in non structural areas such as landscaping, etc. This will allow the cost of moving soil to a minimum. The third assumption is that the new structural fill will come from a distance of no longer than thirty minutes driving time in order to ensure this method will not require excessive driving by dump trucks. Please note that this is very possible given the location of the site.

Cost and Schedule Analysis

A complete soil exchange will most require work to be performed by an excavation contractor and no other contractor shall have to be involved. All calculations for equipment and labor costs were completed using the RS Means Guide for pricing. The total amount of soil needed to be excavated is 13,455.1 CY. This will be stock piled on site for further use by the college for landscaping and other fill purposes. The total amount of structural fill needed based on guidelines from the geotechnical report is 13,194.3 CY. It is to be noted as well that Warfel Construction Company has competent personnel to perform all site layout and surveying necessary for this work to be completed.

Equipment	Daily Output	Days	Cost/CY	Cubic Yards	Total Cost
Dozer	610	11	$1.94	13455.1	$26,102.90
Extra Dozer	610	11	$0.81	13455.1	$10,898.63
Total Cost					**$37,001.53**

Excavation Cost Analysis 1

Equipment	Daily Output	Days	Cost/ CY	Cubic Yards	Total Cost
Dozer	1225	6	$0.96	13194.3	$12,666.53
Extra Dozer	1225	6	$0.40	13194.3	$5,277.72
4 Vibrating Rollers	260	11	$1.99	13194.3	$26,256.66
Total Cost					**$44,200.91**

Structural Fill Cost Analysis

Soil Exchange	Cubic Yards	Time(Days)	Total Cost
Excavation	13455.1	11	$37,001.53
Structural Fill	13194.3	17	$44,200.91
Totals	**26649.4**	**28**	**$81,202.44**

Soil Exchange Analysis

After this soil exchange operation is complete, the total cost of the operation is $81, 202.44. The total schedule time is 28 days. Based on the WCC mobilization date of April 25, 2006, assuming the soil exchange will start the same day, the operation will finish on June 1, 2006. If the crew works Saturdays, then the operation will be complete and ready for foundation work on May 27, 2006. At this point Saturdays will have to be incorporated into the schedule in order to meet the foundation start date of May 29, 2006.

Recommendation and Conclusion

After completing both analyses of the two options for soil remediation, it is determined that both or are basically of equal cost and schedule time. The following table outlines both procedures and the difference in cost and schedule of each.

Soil Remediation	Days	Total Cost
Deep Dynamic Compaction	27	$83,656.97
Complete Soil Exchange	28	$81,202.44
Difference	**1 Day**	**$2,454.53**

Cost/Schedule Comparison

A difference of $2,454.53 is not significant enough to opt out of the deep dynamic compaction program and buy into the complete soil exchange. The schedule time of one day that is saved performing the DDC is also a benefit to sticking to the DDC program and not consider the complete soil exchange. The money saved here will be made up in a separate are of the project and will not carry enough weight in the over scheme of the project to justify switching to a complete soil exchange. At this point the soil exchange was the best alternative to consider however this analysis has proved that the soil exchange will be less expensive but not to the extent that it will have a significant impact to the budget of the project. The DDC program is the best option for soil remediation.

Technical Analysis #2
Precast Superstructure and Architectural System (PSAS)

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Breadth #1: Precast Superstructure and Architectural System

Precast Concrete offers a great alternative to traditional construction that allows a construction manager to push and drive a schedule in order to achieve certain deadlines that if traditional construction methods were being used, the construction manager would be very pressed to meet. This does come at some cost however. Precast concrete is more expensive than a masonry building envelop or masonry load bearing walls. However this additional cost can be offset by the ability given to accelerate the schedule.

The original contract documents call for a CMU block and precast hollow core plank structural system. The building envelope will consist of architectural masonry and an aluminum and glass curtain wall system. Precast concrete is a very flexible construction method in that you can achieve the same looks aesthetically with precast that you can with other building materials.

The precast load bearing walls and precast hollow core plank structure, paired with the architectural precast panels will accelerate the schedule to a point where interior trades can begin work sooner with an enclosed building to work with. The superstructure is scheduled to begin on June 6, 2006 and be complete on October 18, 2006. The building envelope scheduled to start October 20, 2006 and be complete on April 2, 2007. This analysis will be an in depth review at how to accelerate the schedule while controlling the budget of Residence Hall 2.

Overview

The structural system at Residence Hall 2 is a masonry block and precast hollow core plank on cast in place concrete foundations. This system contains three separate bid packages that were awarded to three separate subcontractors. These bids were awarded to Rubright Construction (cast in place concrete footings), Morgantown Masonry (load bearing masonry and building envelope), and Say-core Inc. (precast hollow core plank).

East wing with typical area highlighted to be analyzed.

Early on in the project this presented a barrier between the foundation subcontractor and the masonry subcontractor. Time was lost when a mix up in reading the construction documents resulted in necessary reinforcement repair work to the foundations and the existing masonry load bearing walls. The proposed structural system that this analysis will cover reduces the amount of subcontractors working on the structural system by 33%. The cast in place concrete foundations will remain a subcontract and the load bearing walls, precast hollow core plank, and the building envelope will all be a part of the same bid package. The load bearing walls and building envelop will now be assessed as precast concrete. A cost analysis as well as a new schedule for the system will be calculated. This will be compared to the existing cost of the structural system and building envelope as well as compared to the existing schedule.

As is the case on any project, the structural system of the building is always on the critical path to the project. It is important to get the superstructure out of the ground in order to allow other trades to begin their work as soon as possible. Because of this critical path as well as an ongoing need to control the cost of the project, I will analyze the new system in terms of:

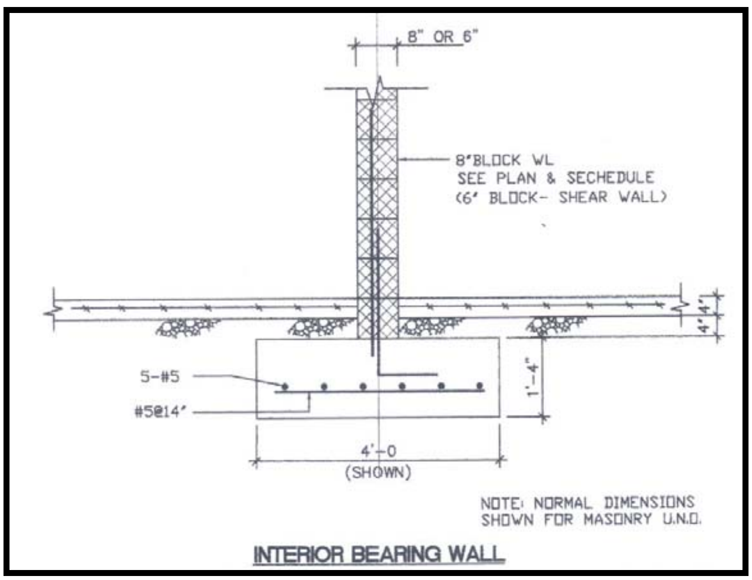
1. Constructability methods to determine if the new precast structure is a feasible alternative to the existing system.
2. Value engineering methods to determine if the precast structure does not blow the budget of Residence Hall 2 while achieving the same outcome as the existing building structure and envelope system.

Once this analysis is complete a recommendation will be made as to whether or not to pursue a precast structure and precast building envelop system. An entire precast system will ultimately allow for a significant acceleration in the schedule of the project and a negative impact on the project budget. However, efforts will be made to control this added cost and make the alternative system a feasible option.

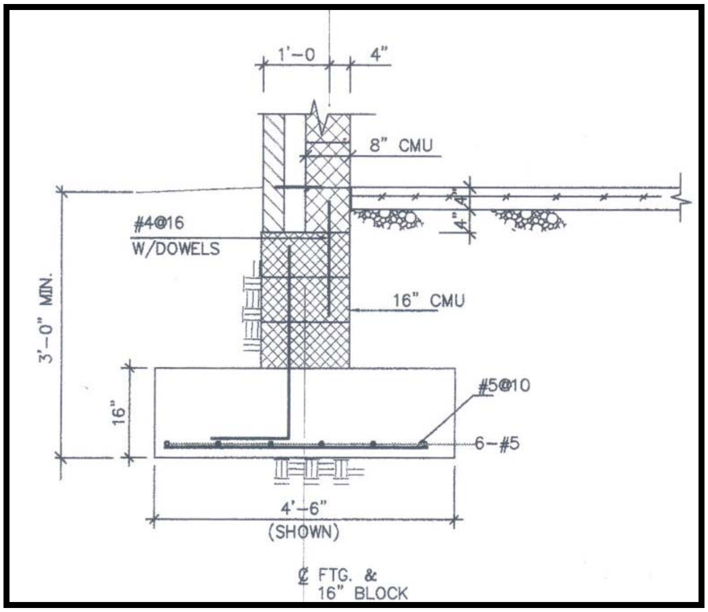
Understanding Design of Existing Structure

The existing structure at Residence Hall 2 will be briefly discussed and a key study of how the pieces of the superstructure are connected in order to create a stable frame will be analyzed. The dormitory directly across the street from this new facility was constructed in the same manor as this project is being constructed. WCC was the general contractor and construction manager on that project as well. This presented a familiar and simple structural design that could be built on schedule. However this was not the case once the project got under way. Through understanding the connections and design of the existing structural and building envelope system, a precast system can be designed, sequenced, and scheduled in order to maximize the acceleration potential that precast concrete offers.

From the ground up the superstructure begins with cast in place concrete footings. For the purpose of this particular analysis, this part of the structure will not be changed. These footings range in thickness from 12" to 18" and range in width from 2'-0" to 7'0" where maximum load is achieved in the building. From the footings the typical 8" load bearing CMU walls are tied into the foundation by the following typical connection detail.

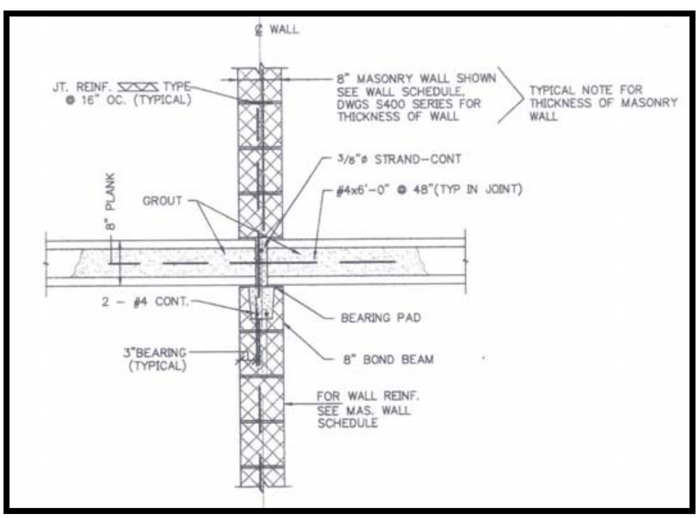


Typical Interior Connection Detail: LB Wall to Footing



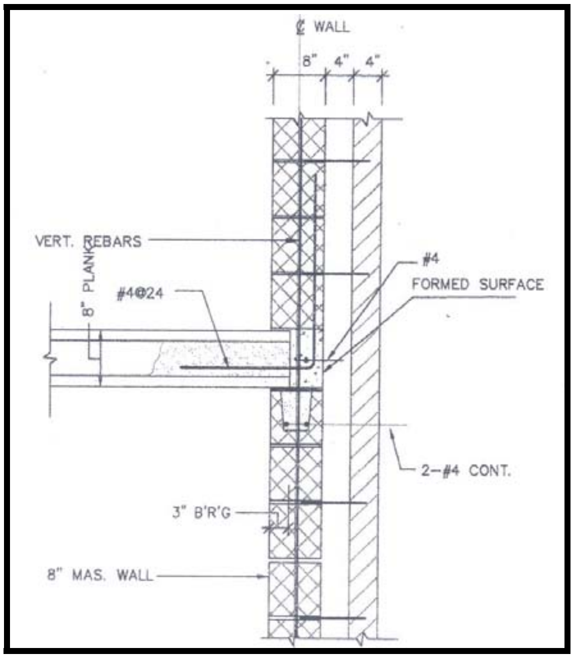
Typical Exterior Connection Detail: LB Wall to Footing

These walls are reinforced both horizontally and vertically to ensure maximum strength for the precast hollow core plank. Each end is reinforced with dowels that extend down to the top of the footing. These typical load bearing CMU walls extend up to the next level where precast hollow core plank is now introduced into the structural system. The top row of CMU block is a bond beam with an open top. This will allow for a solid connection to the plank once the connection is grouted. On this project there is a typical 2 - #4 rebar continuous vertically to connect the floor to floor CMU walls. There is also #4 rebar that is 6'-0" long typically in the joint of the plank and bearing pads that the plank will rest on. The plank requires a minimum of 2" of bearing on both ends. The connection described is shown below.



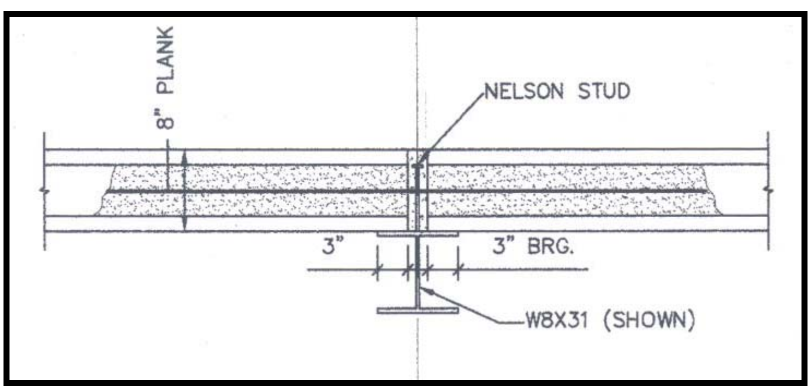
Typical Interior Connection Detail: LB Wall to Plank to LB Wall

The typical 8" CMU load bearing walls are then continued to the next floor level. On the exterior of the building where plank is not on both sides of a load bearing wall, there is rebar the is at a 90 degree angle that is extended into the core of the plank and into the next level of the load bearing CMU in order to connect the plank to the wall structure. This connection detail is shown here.



Typical Exterior Connection Detail: LB Wall to Plank to LB Wall

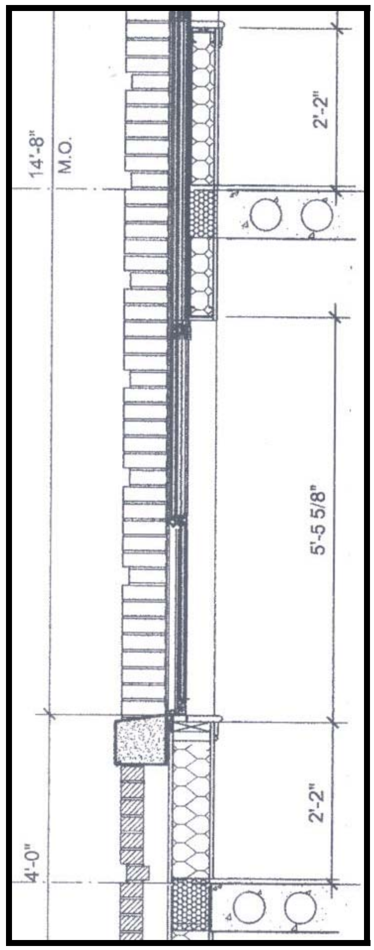
In some cases the plank has no bearing on the CMU load bearing walls. In locations such as these the structural engineering has showed a typical detail for connecting the plank and supporting the plank. The North side of the building has a curtain wall and store front system being install on it. In these areas there is no CMU load bearing wall. A W8x31 wide flange beam supports the plank in this case and plank is required to have 3" of bearing. The typical connection is shown below.



Typical Connection Detail: Wide Flange Beam Plank Support

The explanation provided above describes the connection of the individual typical members of the structural system to create a stable frame. This will be important to understand for the change of structural systems. The new proposed system will also have a description of how the individual members are connected and any new connection criteria that may exist will be shown as well.

The brick façade for Residence Hall 2 is anchored to the CMU walls where this method is applicable. In areas such as the south face of the building where the interior is exposed, the exterior wall will receive 6" metal stud framing with foam batt insulation prior to brick being anchored to concealed blocking in the metal frame wall. A wall section shown below illustrates this type of wall.



Typical Brick w/ Metal Stud Backing Section

This provides a brief understanding as to how the existing structure at Residence Hall 2 is constructed and stabilized. After analyzing this system the new system was analyzed in the same manor. As you will see in the next portion of this section, the precast superstructure and architectural panels are designed, sequenced and scheduled in a similar manor. An understanding of the existing structure is important to have.

Existing Superstructure Cost and Schedule

Residence Hall 2 has an overall project cost of $11.6 million dollars and an overall time frame of roughly 14 months. As previously stated there were a combined three bid packages for the superstructure and building envelope systems. The table below outlines two of the three packages and the contract amount that each package was awarded at by Warfel Construction Company (WCC). The CIP concrete footings package is not included in this table because the footing system is not being changed for the new precast structure. Therefore there will be no cost comparison of this piece of the superstructure. The contracts listed below are those that will be used to compare to the new estimate after this analysis is complete. These contract amounts have not changed throughout this project and each includes the costs of labor and any erection equipment that will be necessary to complete the scope of work.

Bid Package	Bid Winner	Contract Amount	% Total Project Cost
Brick and Cast Stone	Morgantown Masonry	$668,000	5.70%
CMU Masonry	Morgantown Masonry	$1,055,000	9.00%
Precast Hollow Core Plank	Say-Core	$536,000	4.60%
Total		**$2,259,000**	**19.30%**

Superstructure Cost Data

The original schedule for the superstructure showed the excavation for building footings beginning on May 30, 2006 and the final building enclosure to finish on February 12, 2007. This allows roughly seven and a half months for the building to be enclosed. A revision to the schedule was recently completed and the revision has the latest activity, East wing lounge curtain wall glass, being complete on May 18, 2007. For all intents and purposes the original schedule will be used for the comparison to the new schedule produced from the analysis of the new precast superstructure.

Alternative Precast Design Analysis

The alternative proposed to the block and plank superstructure is an entire precast superstructure including a precast building façade. This particular type of system is referred to as a “stack wall” system. In this case the precast wall panels are stacked floor to floor with the plank continuing to serve as the floor system for the building. Some of the architectural panels will also serve as load bearing wall components. This will reduce the total number of precast pieces for the project and thus reduce the total schedule time.

All interior finishes will remain the same on these panels. Where metal stud furring is called for or a hat track for GWB, these materials will still remain the same. The typical wall section where a load bearing wall exists where these panels will be placed have the following section properties from exterior to interior:

1. 4” Face Brick
2. 2” Air Space
3. 8” CMU Block
4. 3-5/8”” Metal Stud Wall
5. 3-5/8”” Batt Insulation
6. Vapor Barrier
7. 5/8”GWB
8. Interior Air Space

Where there is no load bearing wall and the brick façade is connected to concealed blocking in the metal stud wall, these are areas where the architectural precast will be place and these walls have the following section properties from exterior to interior:

1. 4” Face Brick
2. 1” Air Space
3. 5/8” Exterior Wall Sheathing
4. 6” Metal Stud Wall
5. 6” Batt Insulation
6. 5/8” Gypsum Wall Board

The wall constructions listed above will be similar to those once the precast concrete panels are installed on this project. The wall thickness will be kept as close to original as possible. An R-Value comparison is found later in this section. For purposes of this analysis it was assumed that the thickness of the structural precast will remain the same as the CMU load bearing walls. The thickness used for minimal steel reinforcement was 7”. It might have been possible to streamline the load bearing walls using the precast panel to get a thickness of 6”, but this was not considered for the purpose of this analysis which is to accelerate the schedule. The loading used for the minimum reinforcement requirements are as follows.

Unfactored Live Load Values:

- Snow Load = 30 psf
- Room Load = 40 psf
- Public Load = 100 psf
- **Total Live Load = 170 psf**

Unfactored Dead Load Values:

- Roof Load = 10 psf
- Partition Load = 20 psf
- Self Weight Load = 100 psf
- **Total Dead Load = 130 psf**

These loading values will be used to determine minimum reinforcement for the load bearing wall panels that are to be used for the construction. The thickness of architectural precast load bearing panel will be 9” and the thickness of architectural non load bearing panels is 7”. These are typical thickness based on information received from Nitterhouse Concrete and the calculation for minimum reinforcement uses 8” for the thickness based on the existing load bearing CMU walls.

There are several basic design criteria equations used to calculate the necessary information to ensure the precast panels will have the proper reinforcement and strength requirements. These equations were found in past notes from steel and concrete design classes in the AE curriculum. It should also be noted that the largest loads and test situations that these panels will face is when they are being hoisted on site and lifted into place. Often times this can create situations that will cause the member to fail because it was designed to be perfection vertical. It will be assumed that these panels will meet criteria necessary for the hoisting operation.

Design Equations:

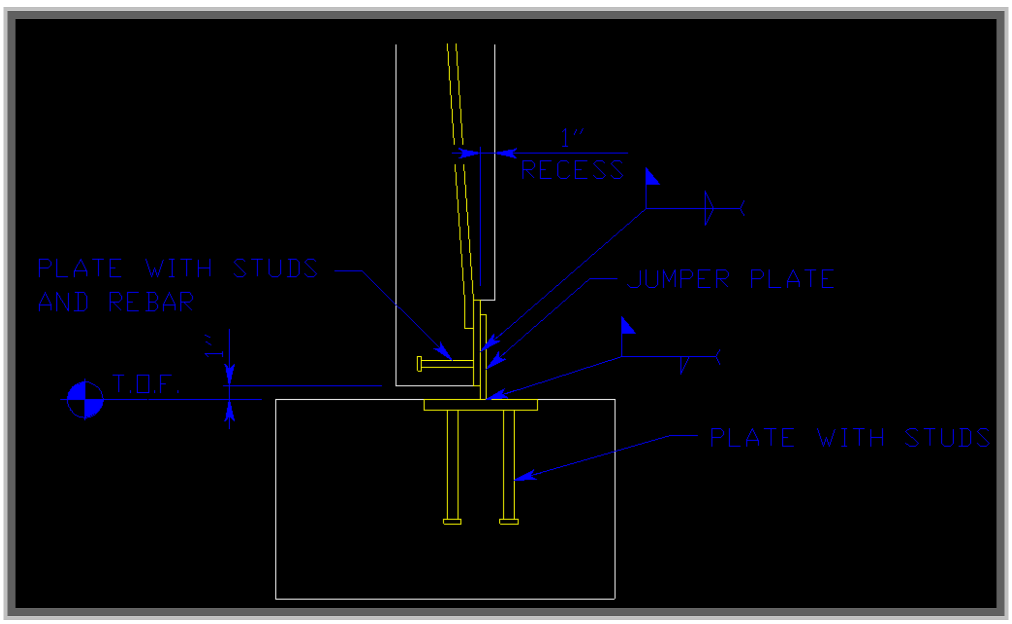
- Asmin = 0.0018bd
- Minimum Thickness = L/20
- a = As(fy)/0.85(f´c)(b)
- Maximum M = $wl^2/10$
- ØMn = ØAs(fy)(d-a/2)

The non architectural load bearing panels and architectural load bearing panels were calculated to have a minimum reinforcement of #4 @ 12” O.C. in both directions. This allows for a As = 0.2 in^2. Please note that the calculation for this value was performed using a b=12”. Please refer to the PSAS Appendix for the full minimum reinforcement calculation. For this application as well it can be assumed that the strictly architectural precast will have the same reinforcement in order to preserve the concrete over time. They will not be required to carry any load other than their self weight.

Connection Details of Precast

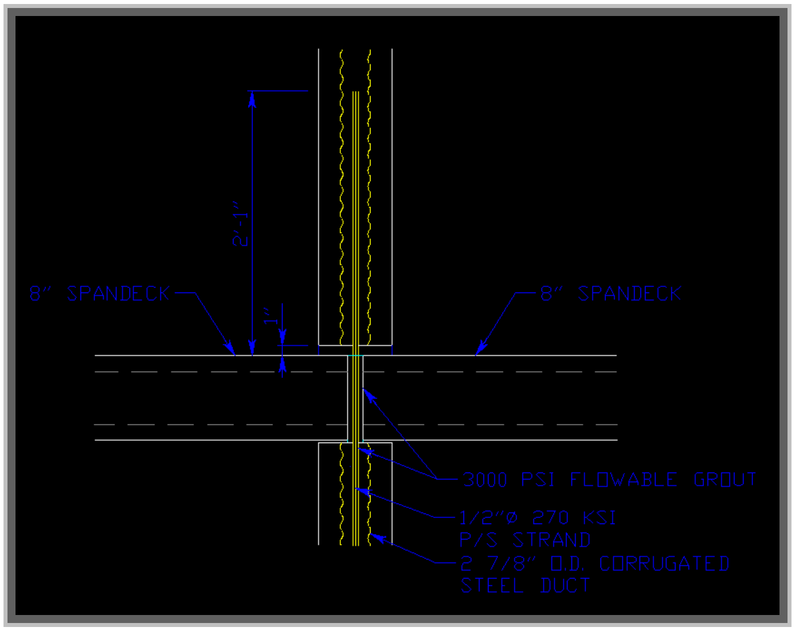
As the original systems connections were analyzed, so will these system connections in order to ensure that a stable frame will be created when using all the precast elements. Often times a stack wall system such as this can be unstable unless properly connected. All connections will not be the same as the original structure, however similarities do exist. Mark Taylor of Nitterhouse Concrete Products was consulted for assistance in determining the typical connections of the new system for Residence Hall 2. Mark Taylor is the Executive Vice President of Nitterhouse and a registered Professional Engineer. This company specializes in multi-housing complexes that utilize precast concrete for the superstructure and building envelope systems.

As previously stated the existing footing system of cast in place concrete will remain in tact. For a rigid connection from the footing to the load bearing panels, a connection plate with studs is cast into the concrete footing. Welded at a 90 degree angle to that plate is a second plate that will serve as the connection to the precast panel. The panel itself has a 1” recessed plate cast into it with studs and rebar to secure it and the panel. This plate is then welded to the jumper plate using a fillet weld to create a stable connection. This connection is shown in the following illustration.



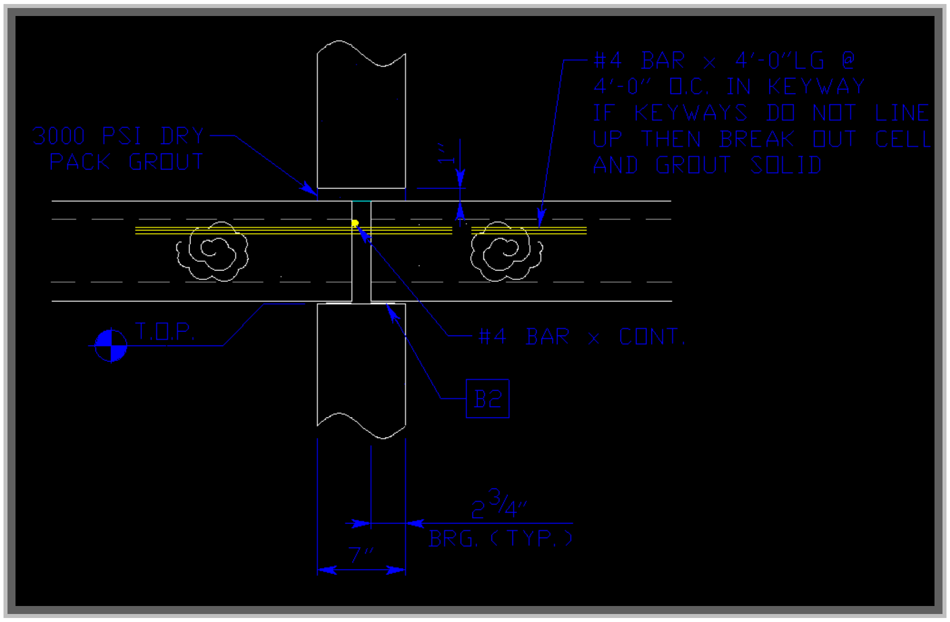
Typical Connection Detail: Precast Panel to Footing

The stack wall system is connected from floor to floor using a 1/2” steel strand that is inserted into a 2-7/8” corrugated steel duct that is cast into the precast wall panels. These ducts are then grouted to create a rigid connection from floor to floor. This is the typical connection description of an interior stack wall connection and is illustrated below.



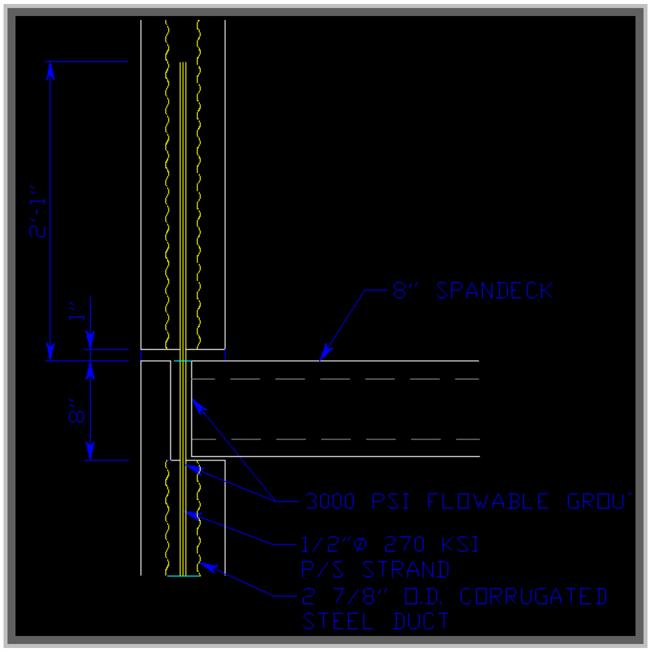
Typical Interior Connection Detail: Panel to Panel

In order to stabilize the connection not only the vertical direction but in the horizontal direction as well, the plank connection is grouted at the same time as the stack wall connection is grouted. The plank is connected using #4 rebar that is 4' long @ 4" O.C. This rebar extends in to the hollow cores of the plank which is then filled with grout. There is always a continuous piece of #4 rebar that runs perpendicular to the rebar that extends in to the plank cores. Each plank is set to have a minimum of 3" nominal bearing. This connection is as follows:



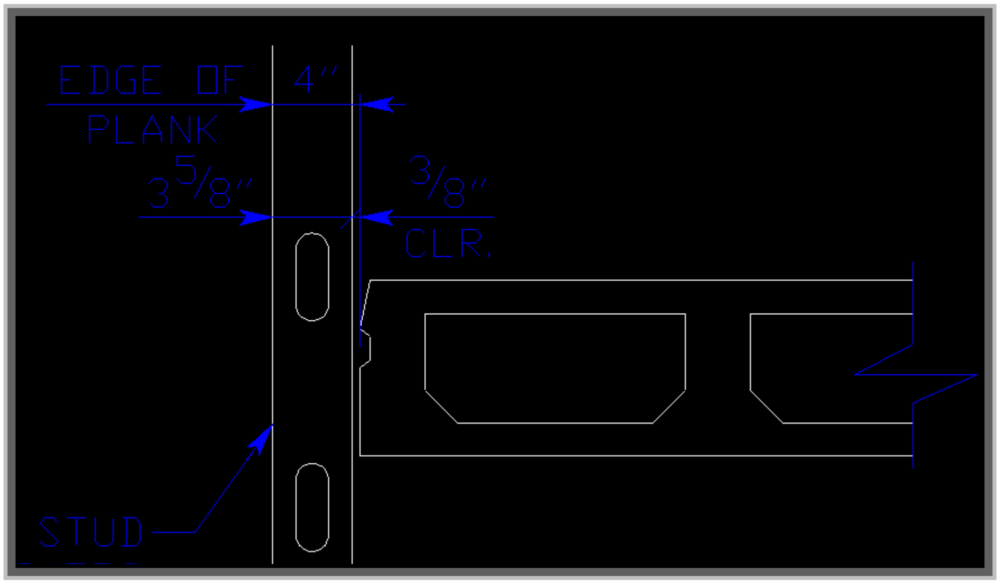
Typical Interior Connection Detail: Plank to Plank

The exterior stack wall connections are similar to the interior connections the same reinforcement applies. The only difference is that the lower wall panel is notched out to all bearing for the plank and the rebar to extend into the grout. The connection is illustrated below. For all connection made in this superstructure, the grout to be used in the system is all 3000 psi flowable grout to allow the grout to fill the entire corrugated steel sleeve in the precast panels.



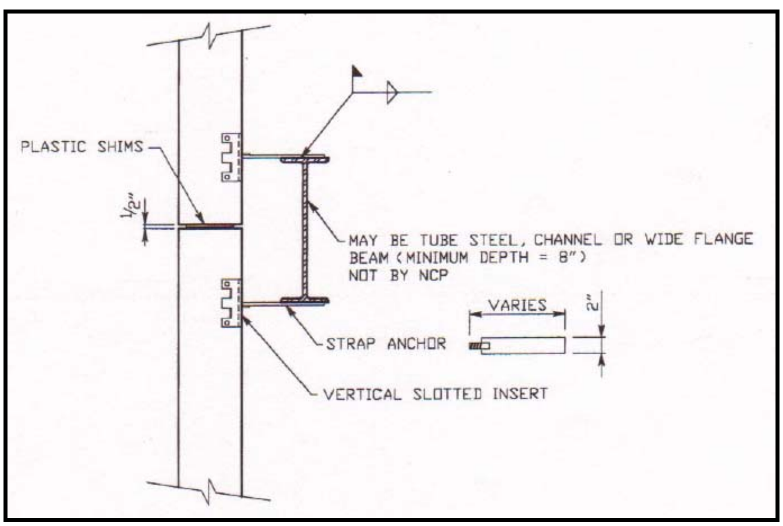
Typical Exterior Connection Detail: Stack Wall

These are the basic connection details for the superstructure of the facility. It is important to have a stable frame prior to adding the precast panels to the outside façade. These connections were also analyzed and discussed with Mark Taylor of Nitterhouse Concrete. The areas where the architectural precast system will be needed are those that the exterior wall is metal stud framing. The most common areas that have metal stud framing are on the North and South faces of all the single and double dormitory rooms. The detail shown below is of 4" metal stud and precast hollow core plank. This is a typical description of how the two facilities connect near each other and extend to the next floor level.



Typical Metal Stud Wall meets Precast Hollow Core Plank

It is in these areas as well that the precast architectural panels will to be connected to the structural frame. The most common tie back method that can be utilized at Residence Hall 2 is the use of a W-shaped beam that will span the opening. This beam was not designed in the analysis but it needs to be pointed out that this was noted for and a realization that this will be necessary should this system be put in to effect on a real project. The panels are stacked and tied back to this beam. The beam has a minimum depth requirement of 8". The stack wall panels are connected at the bottom by a plate and weld and the top is connected using a strap anchor. This connection detail is illustrated below.



Typical Connection Detail: Stacked Panel Tie Back

After the entire superstructure and architectural façade system is complete, each plank floor will receive and additional concrete topping which will further lock in the entire system. These typical connections will allow each precast piece to be connected and not count on gravity to keep the frame stable. These connections are also typical from floor to floor which create a means for workers to move faster as the project moves out of the ground. The connections will be more familiar and few errors will be encountered. This will allow for the schedule to be accelerated to a point where interior trades may begin work with an enclosed building over the winter months of this project.

R-Value Comparison

In order to show enough similarity between these two wall systems that the mechanical systems will also not be affected by the precast. A short analysis of the R-Value typical wall section will be completed. The following table outlines the two wall types and the R-Value associated with those wall sections.

CMU Masonry Wall		Precast Panel Wall	
Wall Component	**R-Value**	**Wall Component**	**R-Value**
Outside Air Film	0.17	Outside Air Film	0.17
4" Face Brick	0.385	9" Precast Panel	0.72
2" Air Space	0.61	3 1/2" Fiberglass Batt Ins.	11
8" CMU Block	1.71	5/8" GWB	0.56
3 1/2" Fiberglass Batt Ins.	11	Inside Air Film	0.68
5/8" GWB	0.56		
Inside Air Film	0.68		
Total	**15.115**		**13.13**

There is a minimal difference in the R-Values for these two wall construction types and this should not impact the mechanical systems for heating and cooling.

Alternative Schedule and Cost

Cost Analysis

The new superstructure and façade system is expected to increase the overall cost of the project however the objective of this analysis was to control the cost. In order to combat some of this added cost there is a possible solution to relieve the college of the financial burden.

When the Project started there was a built in contingency fund that WCC could pull from for items such as change orders. This was instituted to try and cut down on the number of change orders processed and to initially not put any added cost on WCC or the college in the beginning stages of this project. Since the beginning of the project this contingency fund has grown. The college has taken credit in certain areas of the project for some value engineering ideas. Two of the areas include an alternate control package that saved the college $80,000 and the deletion of the handicap ramp in the front of the project which saved the college $21,000. At this point in time the project contingency is currently at $268,000. With roughly five and a half months remaining on the project it is believed that money can be drawn from this fund in order to support the new proposed precast superstructure and building envelope.

When developing the cost analysis for the superstructure and façade system Mark Taylor of Nitterhouse Concrete again was consulted. He provided the following cost information for the different precast elements.

- Precast Hollow Core Plank $8.50/SF
- Precast Wall Panel $35.00/SF
- Precast Wall Panel W/Brick Façade $42.00/SF
- Architectural Panel $42.00/SF

These prices include manufacturing, delivery, and erection. Below is a table that breaks down the cost of the precast plank, the precast wall panels and the architectural precast elements for this project. Please also note that I have included an allowance for structural modifications for the precast panels that have to be tied back to W-shaped beams. It was noted above that these beams would need to be added but the calculation for the size of each beam was not a part of the original plan for this analysis, so an allowance will be made for the cost of these beams. The typical floor height used to determine the square foot of each piece is 10’-0”. For the full cost breakdown of the East wing, West wing, and Building Core/Central Tower please refer to the PSAS Appendix. The two inch concrete topping is not a part of the prices listed above therefore this will be accounted for in the cost estimate. Also refer to the PSAS Appendix for a floor by floor breakdown.

Residence Hall 2		
Precast Piece	**Total Pieces**	**Total Cost**
Precast Plank	562	$407,563.89
Structural Panel	123	$840,035
Architectural Panel	200	$878,829.09
Architectural Panel Steel Allow.		$250,000.00
Concrete Topping	300.8CY	$34,291.20
Total		**$2,410,719.18**

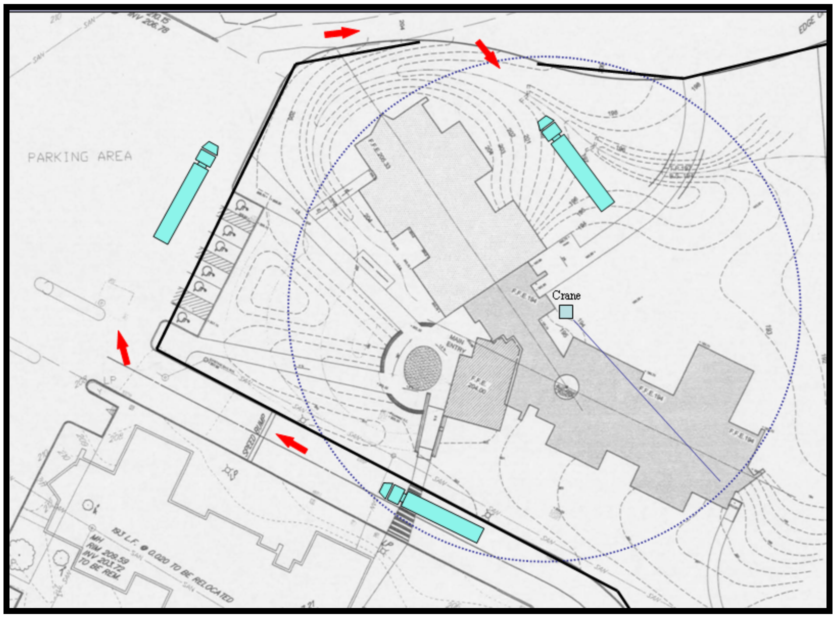
Precast System Takeoff

This total cost of the alternative system is roughly a 7% increase in cost from the original plan. This is a total increase of $151,720. It is key to point out as well that the cost of the plank was determined to be over $100,000 less expensive in this takeoff. The plank was bid out the first time in the beginning of 2006. The numbers could have decreased in rates since then or the number received from Nitterhouse concrete could have been more competitive for the square foot value.

Schedule/Sequence Analysis

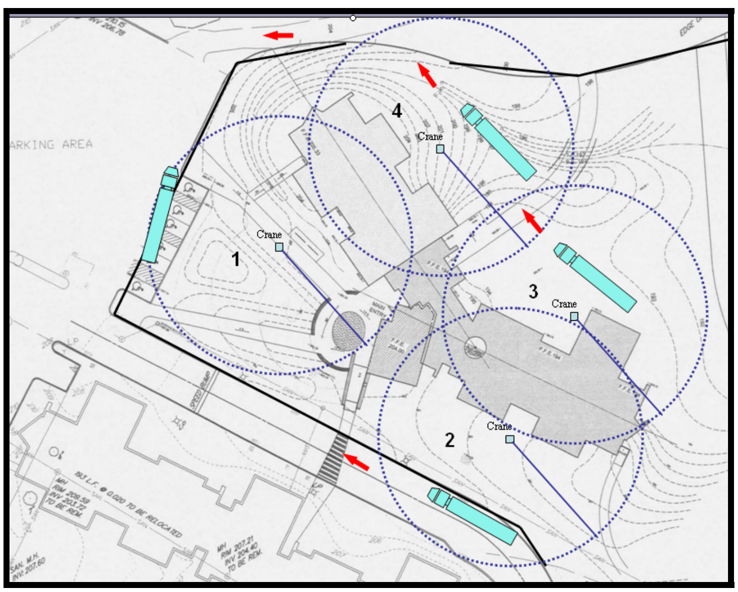
The precast superstructure and precast façade of the alternative option is a time effective method that will accelerate this schedule. This schedule will most likely be accelerated by months due to the implementation of this system. This is where the added 7% cost will be worth it when the schedule is at a point where the building is enclosed for the rough winter months where now the project is scheduled to have the building envelope being constructed during the harshest months of the year.

In order to ensure that this schedule will meet the maximum potential it is import to sequence these activities and pay attention to the crane locations for each erection phase. There will be a single crane location for the erection of the precast wall panels and precast hollow core plank. This will be the same location as the original project. Directly to the North of the Central Lounge/Tower there is a level work area that the crane can set up in. This will allow it to reach all necessary areas of the project without having to move during the erection of the superstructure. To the Northwest is the main material delivery entrance to the site. This will provide a staging area for plank and wall delivery trucks to back into and allow the crane to make the pick and place the precast without disturbing any other trades on site. The Building and crane location will be as follows:



Precast Wall and Plank Crane Location

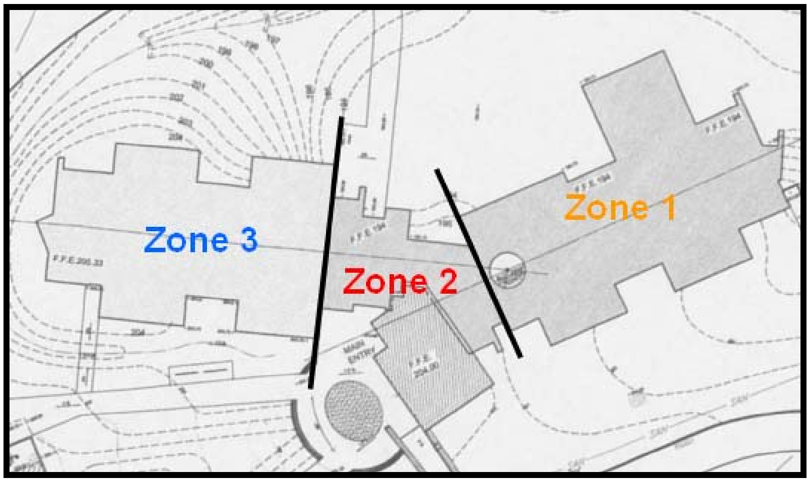
For the precast architectural panels the crane locations will be shown on the following site layout plan for the erection phase. The crane marked as 1 will be the first location and will follow numerical order until the 4th and final location.



Architectural Panel Crane Location and Sequence

These are the crane locations for this phase of the construction sequence. The added locations will not be a problem on site. They are located to make the flow of the site manageable by other trades as well.

For the superstructure erection phase the building will be sequence from East to West in 3 sections. Crews will begin erection the precast wall panels and then move to the precast plank on each floor. Once these activities are complete in each section and on each floor the crew will move directly to the next floor to erect the superstructure in the same sequence as the floor below. The crew will begin erection the precast walls in the east wing, move to the central core, and then move to the west wing. This will be the typical sequence from floor to floor. The 3 building zones are shown below.

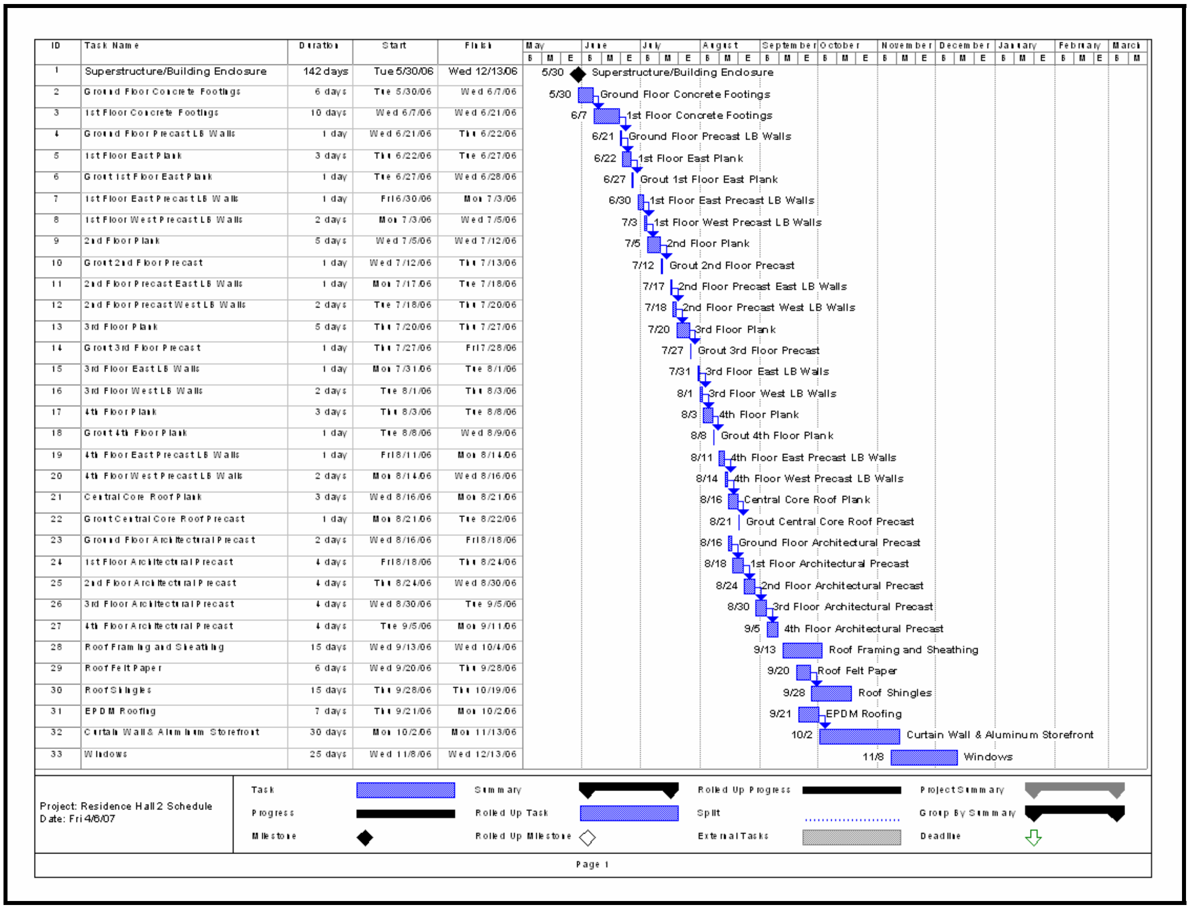


Building Zone Layout

The schedule for Residence Hall 2 based on the alternative for the superstructure and building façade has been significantly accelerated. In order to schedule the new construction of the building, Mark Taylor of Nitterhouse concrete was consulted and the following scheduling times have been used in order to create the new schedule for the superstructure.

- Precast Plank — Time used from Original Schedule
- Wall Panels — 30 Minutes/Panel
- Architectural Panel — 30 Minutes/Panel
- Grout/Concrete Topping — 12,000SF/Day

Please refer to the PSAS Appendix for a copy of the original schedule for Residence Hall 2. The analysis of the schedule found that the superstructure will take approximately 12 weeks to complete. This structure will be ready to receive the roof trusses at this point and ready for the last stages of the building enclosure. The entire structure will be dried in and set for interior trades after approximately 29 weeks to complete. The project schedule calls for the superstructure to be complete after 22 weeks. This is a total savings of 10 weeks in the superstructure phase of the project. The building on the original schedule is set to be enclosed after 39 weeks. This is a total building enclosure savings 10 weeks. The lack of a more acceleration time is accounted for when the brick veneer of the original façade will begin prior to the roof system being complete. Where as the decision was made, based on site congestions issues of having 2 cranes on site at the same time, would not be feasible for the proposed solution. This is where the time on the original schedule is made up to keep the total at 10 weeks. This is still a significant savings time and will allow interior trades to begin work prior to the winter months arriving on site. The following is a Gantt chart of the alternative superstructure and building enclosure.



ID	Task Name	Duration	Start	Finish
1	Superstructure/Building Enclosure	142 days	Tue 5/30/06	Wed 12/13/06
2	Ground Floor Concrete Footings	6 days	Tue 5/30/06	Wed 6/7/06
3	1st Floor Concrete Footings	10 days	Wed 6/7/06	Wed 6/21/06
4	Ground Floor Precast LB Walls	1 day	Wed 6/21/06	Thu 6/22/06
5	1st Floor East Plank	3 days	Thu 6/22/06	Tue 6/27/06
6	Grout 1st Floor East Plank	1 day	Tue 6/27/06	Wed 6/28/06
7	1st Floor East Precast LB Walls	1 day	Fri 6/30/06	Mon 7/3/06
8	1st Floor West Precast LB Walls	2 days	Mon 7/3/06	Wed 7/5/06
9	2nd Floor Plank	5 days	Wed 7/5/06	Wed 7/12/06
10	Grout 2nd Floor Precast	1 day	Wed 7/12/06	Thu 7/13/06
11	2nd Floor Precast East LB Walls	1 day	Mon 7/17/06	Tue 7/18/06
12	2nd Floor Precast West LB Walls	2 days	Tue 7/18/06	Thu 7/20/06
13	3rd Floor Plank	5 days	Thu 7/20/06	Thu 7/27/06
14	Grout 3rd Floor Precast	1 day	Thu 7/27/06	Fri 7/28/06
15	3rd Floor East LB Walls	1 day	Mon 7/31/06	Tue 8/1/06
16	3rd Floor West LB Walls	2 days	Tue 8/1/06	Thu 8/3/06
17	4th Floor Plank	3 days	Thu 8/3/06	Tue 8/8/06
18	Grout 4th Floor Plank	1 day	Tue 8/8/06	Wed 8/9/06
19	4th Floor East Precast LB Walls	1 day	Fri 8/11/06	Mon 8/14/06
20	4th Floor West Precast LB Walls	2 days	Mon 8/14/06	Wed 8/16/06
21	Central Core Roof Plank	3 days	Wed 8/16/06	Mon 8/21/06
22	Grout Central Core Roof Precast	1 day	Mon 8/21/06	Tue 8/22/06
23	Ground Floor Architectural Precast	2 days	Wed 8/16/06	Fri 8/18/06
24	1st Floor Architectural Precast	4 days	Fri 8/18/06	Thu 8/24/06
25	2nd Floor Architectural Precast	4 days	Thu 8/24/06	Wed 8/30/06
26	3rd Floor Architectural Precast	4 days	Wed 8/30/06	Tue 9/5/06
27	4th Floor Architectural Precast	4 days	Tue 9/5/06	Mon 9/11/06
28	Roof Framing and Sheathing	15 days	Wed 9/13/06	Wed 10/4/06
29	Roof Felt Paper	6 days	Wed 9/20/06	Thu 9/28/06
30	Roof Shingles	15 days	Thu 9/28/06	Thu 10/19/06
31	EPDM Roofing	7 days	Thu 9/21/06	Mon 10/2/06
32	Curtain Wall & Aluminum Storefront	30 days	Mon 10/2/06	Mon 11/13/06
33	Windows	25 days	Wed 11/8/06	Wed 12/13/06

Proposed Alternative Schedule: 10 Week Acceleration

Recommendation and Conclusion

In this case both systems have pro's and con's to using one against the other. In the case of the existing system you have a cost savings of roughly $150,000. However you push the schedule to the breaking point. As of the last revision to the schedule for this project the building is not scheduled to be completely enclosed until May 18, 2007. The final pieces of the glass curtain wall system are to be installed in the East lounge. This allows only a few months until turnover and students arriving on campus for the fall semester of 2007.

The alternative system will accelerate the schedule roughly 10 weeks. This acceleration comes at a 7% raise in the cost of the superstructure and building enclosure system. The open time created by this analysis is too valuable to waste. It was state above as well that the project contingency is currently at $268,000. With four months left on the project there is a good chance some of these funds will be remaining and thus allow the college to make the change to the system proposed.

After all is said and done it is recommended that the precast concrete superstructure and building façade system be implemented on this project. The investment is work the 10 weeks that will be saved on this project. The college can not afford to not have students in this dormitory once fall session arrives. As of now students are scheduled to occupy the facility on August 15, 2007. The acceleration to allow 10 weeks of float time for other trades and work to be completed is too valuable to waste. Overall the project is accelerated 10 weeks at a cost of $151,720.

Technical Analysis #3
Temporary Heat

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Breadth #2: Temporary Heat Analysis

Overview

Residence Hall 2 is currently being constructed over a 14 month time frame. The original schedule, attached in the PSAS Appendix, shows that the major brick veneer work and initial MEP rough-ins to begin in late November of 2006 and complete in late February of 2007. During this timeframe other interior trades are scheduled to begin work on the ground and first floors. Some of the trades are dependent upon have suitable weather conditions in order to insure the quality of their work. These trades include but are not limited to masonry, drywall finishing, and painting. As of the end of the work day on Friday April 6, 2007, the building exterior is represented at the right.

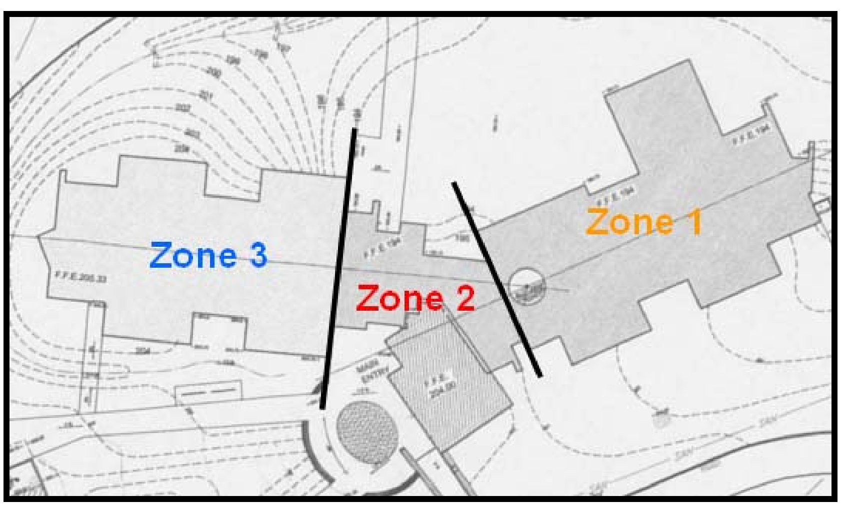
Providing temporary heating for these trades will not only help insure the quality of the work they will be completing but also increase the efficiency rate at which the work is being complete. Located in Collegeville, PA, the winter months are not known to be friendly to the construction industry.

This analysis will cover a temporary heat system that will serve the purpose of providing heat for these trades as well as improve the working conditions under which the activities are being completed. Calculations will be carried out which are all aimed at determining the amount of BTU/hr that are needed to heat the proposed spaces in the building as well as the space that the masonry subcontractor will perform the brick work in. This calculation will then be used determine that amount of BTU/day needed for the temporary heat system and determine the cost associated with the temporary heat. Temporary heat not only provides ways to control the quality of the project but also indirectly affects the moral of the workers performing the work.

Procedure

In order to obtain the BTU/day usage of a typical wing, you must understand the set up of the temporary heating system chosen for this project. The system that will be used is very simple and basic. It provides easy set-up and easy take-down once the system is no longer needed. Three areas of the building will be analyzed to determine the cost of adding temporary.

The first area that will be analyzed is a typical wing floor plan. Given that the building footprint is similar, the footprint of one wing will be used and assumed to be equal to the other wing to calculate the load on the temporary heat system. The system will be analyzed over three particular winter months. These months, which have been dictated by the construction schedule, are December, January, and February. The west wing floor plan will be analyzed and is located where Zone 3 is on the image located below. As you can see the floor plan has been divided into three zones. This is part of the original sequencing plan done by Warfel Construction Company (WCC). The central core (Zone 2) will not receive temporary heat because all trades will be focusing in the East wing (Zone 1) and West wing (Zone 3) during the winter months of this project.

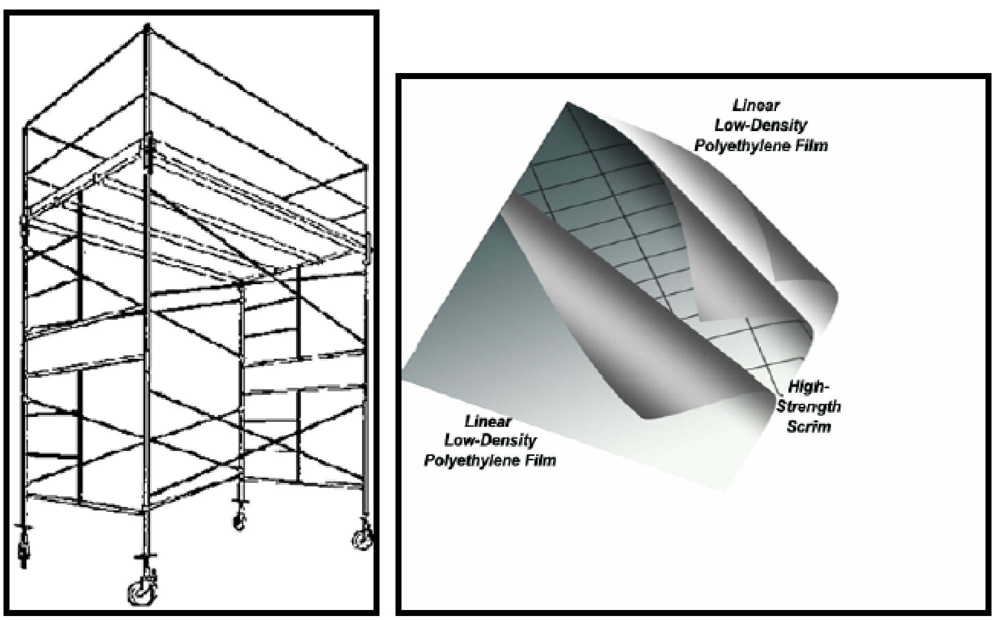


Building Zone Layout

The temporary heating system to be used will be a simple propane heat. The propane will be provided by three large tanks located on site and the heaters are similar to the ones found in the picture below.

Natural Gas Heater

For the masonry work that will be going on during the winter months there will be a change in the type of scaffold being used in order to provide temporary heat to the workers as well as the entire face of the building that they will be working at. The scaffold that will be used for this analysis is your typical four foot wide by six feet tall buck scaffold. This scaffold can be set up and on an entire face where the masons are and then wrapped with reinforced poly plastic. This plastic is very durable and can be reused in sections around the building several times before needing replaced. This temporary heating system is a cost effective way to provide heat for quality control of the masonry and heat for the workers.



Baker's Scaffold and Reinforced Poly: To Be Used For Temp Heat

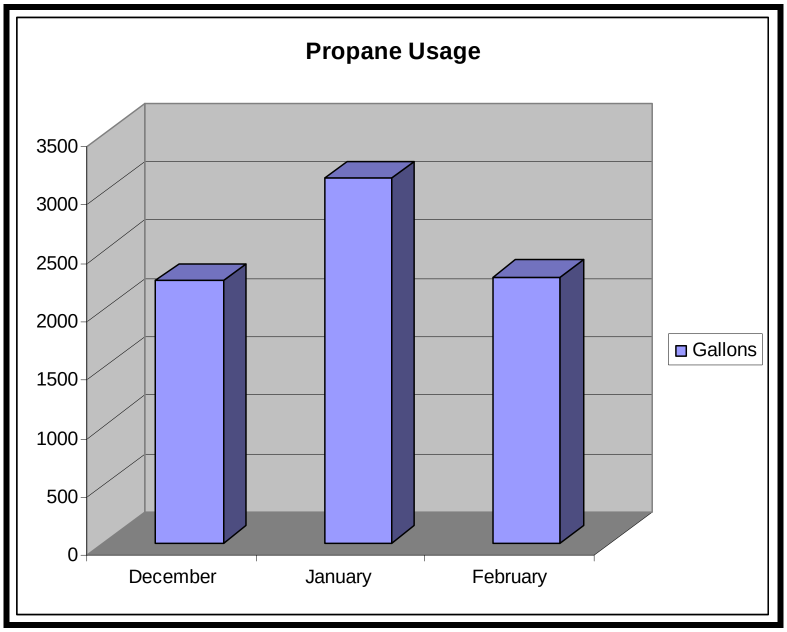
Design Analysis

The analysis of the temporary heating for this project will be done using basic mechanical equations and design criteria that has been chosen for this project. The calculations will be carried out using the following simple procedure:

1. Walls are assumed to be either 8”CMU or 4”Metal Stud with 3-5/8” Batt Insulation for the purposes of calculating the R-Value. Refer to calculations in the Temporary Heat Appendix.
2. Determine Area of Walls and R-Value of walls in order to determine the U-Value for the calculation.
3. Using the equation Q = UA(Tin-Tout) to determine the amount of BTU needed to heat the space.
4. Use information obtained on propane and the heaters to be used to calculate the amount of BTU/8hr day need to heat the space.
5. Calculate the total cost of the temporary heating system.

The calculations will be run for the months of December, January and February. The average daily temperature for those months in Collegeville, Pennsylvania, is 33º F, 28º F and 31º F, respectively. The temporary heat will be designed to keep the space at an average temperature of 50º F. In these cold winter months this will keep the workers who are in the building at a higher morale. These are areas for the project team that having the additional cost of a temporary heating system will pay them back.

For the complete calculations, please refer to the Temporary Heat Appendix. After performing the calculations the following results were found. It was determined that a total of 7,622.12 gallons of propane will be need for this temporary heating system. On the next page is a month by month breakdown of propane usage. In the coldest part of the season a single wing in a floor was determined to need approximately 46,467.52 BTU/hr. The natural gas heater showing in the picture on the previous page has the ability to produce 75,000-125,000 BTU/hr. The maximum BTU/hr it will need to support is for the scaffold enclosure which needs 109,597.84 BTU/hr.



Temporary Heat Propane Usage

The average cost of propane on the east coast during this months that this will be in use is approximately 106.6 cents per gallon. At this rate the cost of heating Residence Hall 2 will be $8,125.18. This is strictly the cost of the propane needed. The following table outlines additional equipment costs.

Equipment	Unit Cost	Units	Total Cost
Poly Sheathing	$26/Roll	15	$390
Baker Scaffold	$182/100SF	25	$4,550
Heater (125,000BTU/hr)	$259/Ea.	2	$1,554
Heater (375,000BTU/hr)	$599/Ea.	4	$2,396
Total Cost			**$8,890**

Equipment Cost of Temporary Heat

This will bring the total cost of the temporary heating system to $17,015.18. This is a cost that will be worth the investment to the project team. After the project is finished the same amount of money could be spent fixing quality issues within the building that may have been the effect of moisture or cold temperatures during the construction of this facility. In the cold winter months it is very important to provide heat so the quality of the work being complete meets contract requirements and the performance of the employee's remains at a high level.

The added cost would be only 1.5% of the total project. An investment of this nature would be very beneficial to make for quality purposes of the project and the workers both.

Results and Conclusion

The purpose of this mechanical analysis of a temporary heating system was to determine if it was economically feasible to heat this project over three winter months in order to keep employees working efficiently and to meet the quality requirements of the construction documents over brutal winter months.

A typical size scaffold setup was determined for an exterior working zone for the masons. This set up, through calculations of heat loss, was determined to lose at most 109,597.84 BTU/hr. For the typical wing on a floor it was determined that the maximum heat loss would be 363,400.62 BTU/hr. For these two operations two different heaters were chosen to be used that will produce 125,000 BTU/hr for the masonry work and 375,000 BTU/hr for heating the wings of the building. It was determined that the total cost to heat this project, based on the criteria listed above, is $17,015.18. This is roughly 1.5% of the total project cost.

This is a very good investment to make and is recommended even though it will add cost to the project. This is controllable though as stated in another analysis that there is a project contingency that can be drawn from and this cost can be controlled. If the project can be turned over on time and up the quality that the contract documents outline, this will reduce the maintenance and call back costs that Warfel will receive for the year after the project is turned over.

Precast Concrete Safety
Research and Analysis

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Precast Concrete Safety Research and Analysis

Executive Summary

Residence Hall 2 at Ursinus College is a structure that has seen a fair share of safety issues over the tenure of the project. This research and analysis focuses on precast concrete safety for the construction manager on projects as well as the subcontractor performing the work. Residence Hall 2 is a block and plank structure and pare of this thesis work reviewed a complete precast structure. This research will be applied to this project.

Precast concrete safety is an issue that has many grey areas and OSHA does a good job of playing both sides. OSHA standards will be reviewed, discussed, and grey areas will be pointed out in order to emphasis the need for OSHA to step in and address precast concrete safety one more time. One main area specifically is fall protection. This research deals with companies that go above and beyond that which is required by OSHA. As part of that there are reactions from those subcontractors who have had to work under more strict guidelines and how it has affected their work.

Also part of this analysis section is the design of site specific safety plan for this project. This plan will be a detailed safety plan that all parties involved with the project during the precast phase would have had to agreed to prior to starting work on site. That has been a reoccurring theme throughout this research. Communicating what safety standards the general contractor and construction manager is the key to a successful, but most importantly, a safe project.

Precast Safety Problems

Residence Hall 2 at Ursinus College has presented many safety issues to the project team and on site staff. The precast plank erector for the project also presented some minor difficulty in obeying certain safety standards that Warfel Construction Company (WCC) believed they needed to follow. In this day in age when there is a growing concern for the health and safety for employees of any company in any industry, it is important to study specific tasks on a construction project and develop specific safety guidelines to address those tasks. Too many times the safety issue at hand may be addressed indirectly and cause those parties involved to have different interpretations of the OSHA code. This presents the primary problem for the basis of this research.

Precast concrete erection safety is some what of a grey area in the OSHA safety codes. There are certain areas that need to be addressed by OSHA and clarified in order to create less confusion on site and ultimately prevent delays on precast projects. At Residence Hall 2 the project was delayed for roughly one day due to multiple interpretations of the OSHA safety code by both parties involved. It is key to point out however that ultimately the construction manager or general contractor on the project has the authority to shut down a project if the safety standards of a sub contractor do not meet that of the company employing that subcontractor. Often the case is that the subcontractor wants to get the job done as quickly and as inexpensive as they possibly can in order to increase their volume of work in a year and ultimately make more of a profit. They tend to throw caution to the wind and focus more on getting the job done.

The purpose of this research is to define which areas of precast concrete safety remain in a grey area and receive feedback from industry members regarding those grey areas. The OSHA guidelines will be outlined as well as a survey developed. Also briefly discussed are those companies that have exceeded the standards set by OSHA. This research will help to develop a site specific safety plan for Residence Hall 2 and possibly for further implementation by those working in the industry interested in precast concrete safety.

Problems Identified

Of many problems that face the precast erection trade, there are several that jump to the forefront of discussion. These issues directly apply to the erection phase of the project and there is one inparticular that stands above the rest. These issues need attention from OSHA and can no longer be left to interpretations of the parties involved. These areas have been identified as the most dangerous activities during precast erection. They include but are not limited to:

- Fall Protection Systems and Guidelines
- Warning Line System
- Pick and Placement of Precast Members
- Bracing of Panels Once Set
- Plank Swinging Near Other Activities
- Erectors Working At Leading Edge

These are problematic areas that have been identified and need attention. Construction sites are very vulnerable during any hoisting activity. For this research specific detail will be paid to fall protection and keeping those trades who are not directly involved with the precast erection aware of the activities going on around them. Certain procedures need to be implemented to protect these employees and in some cases OSHA does not directly address the issue.

The most debatable safety requirement OSHA has is that of Fall Protection. In the case of fall protection, it becomes a matter of what you can justify. If you take for example precast concrete safety where workers can be at an edge of 6'-0" or above, fall protection is required by OSHA section 1926.501 (b)(1) which states,

- "Each employee on a walking/working surface (horizontal and vertical surface) with an unprotected side or edge which is 6 feet or more above a lower level shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems."

However, the OSHA safety code goes on to provide subcontractors with a free pass to fall protection at leading edge work with OSHA section 1926.501(b)(2)(i) which states,

- "Each employee who is constructing a leading edge 6 feet or more above lower levels shall be protected from falling by guardrail systems, safety net systems, or personal fall arrest systems. Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer shall develop and implement a fall protection plan which meets the requirements of paragraph (k) of 1926.502."
- Paragraph k states that "This option is available only to employees engaged at leading edge work, precast concrete erection work, or residential construction work who can demonstrate that it is infeasible to or it creates a greater hazard to use conventional fall protection equipment."

This provides a free pass to those subcontractors in the field of precast concrete erection who do not want to use the fall protection equipment because it is just an added hassle to them and it might slow them down. But it is important to realize that should an accident occur the construction manager will be cited for not providing a safe site. Therefore can fall protection ever create the situation where it creates more of a hazard to use then to not use?

Other grey areas include warning systems and the work of other trades on site. This is not a safety issue that is grey in the OSHA handbook but it is a grey area when precast erectors arrive on site. Warning line systems, a controlled access zone, single entry to building away from where erection is taking place and guardrail systems are a few more safety issues that do not get the attention they deserve on site. Take the following picture for example.

Residence Hall 2 During Precast Erection

The following areas in this photo need attention if the precast erectors were installing the fourth floor plank.

- On the ground there needs to be a buffer zone that extends away from the building in order to protect workers from any debris that may fall during erection.
- The openings in the CMU walls need to be marked that erection will be taking place.
- Rebar needs to be capped for the fourth floor CMU walls.
- The crane location needs to have a controlled access zone that only the precast employees and delivery trucks are allowed to be in.

These are just a few of the items that would have to be addressed. For a full site specific safety plan of Residence Hall 2 during the precast erection phase, please refer to that section of this research.

Precast Concrete Safety Survey

The responsibility for jobsite safety often falls into the hands of the construction manager. As the overall manager of the site, they hold responsibility to provide safe working conditions for those under their employment. This is under OSHA's general duty clause which states:

"(a) Each Employer—

(1) Shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees

(2) Shall comply with occupational safety and health standards promulgated under this act." (www.osha.gov)

As a construction manager and/or general contractor this puts the responsibility on your company to ensure that no hazardous working conditions exist for your employees. As it is the responsibility of the subcontractors to perform their contract work in a safe manor, they do not always follow OSHA regulations.

As companies today develop their own jobsite safety program, that program is not always understood or followed by those contractor's participating in the project. It can be viewed as a communication barrier between the subcontractors on the project and the construction manager running the project.

The intent of this survey is to focus in on the industries thoughts regarding precast concrete safety as well as authority of a construction manager to enforce their own safety policy, including if the safety policy is more stringent than what OSHA requires on a construction project. This survey was sent to Warfel Construction Company and members of Partnership for Achieving Construction Excellence. A full copy of the survey is attached in Precast Safety Appendix.

The survey consisted of six basic questions and an open section for further input by those who responded. The results will provide a better understanding of important precast safety issues as well as general duty safety issues that face the industry. The six questions are as follows:

1. What aspect of precast concrete erection do you feel is the most dangerous and why?

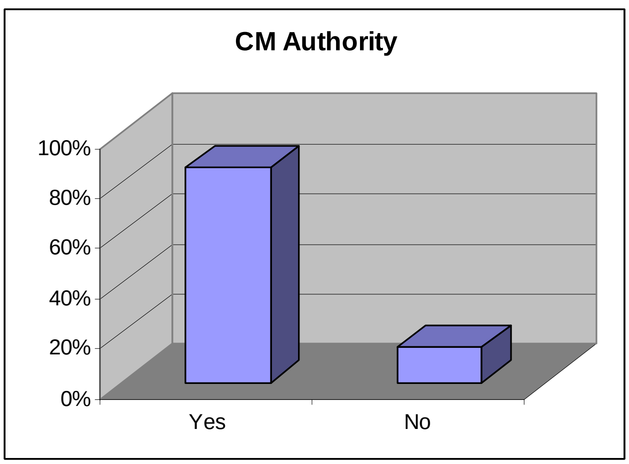
2. Do you feel it would be beneficial to have a general safety meeting with all subcontractors to discuss the GC/CM general safety plan prior to beginning work?
3. OSHA states fall protection is not necessary where it would be more hazardous to operate while being tied off. Do you agree with this? If not, why?
4. Is a safety monitoring system as good a safety precaution as tying off?
5. How would you go about addressing a precast concrete erection safety issue that is not directly addressed by OSHA (you and the subcontractor have differing opinions)?
6. Do you, as the construction manager, have the right to force a subcontractor to abide by your safety guidelines if they go above and beyond that which is required by OSHA?

Responses to this survey were received and below are the most common responses to each of the questions listed above. Also listed is one response that was unexpected and was to be learned from.

1. Once the precast arrives to it is important to have a controlled access zone for the precast to be removed from the truck and hoisted into place. Often times there are several trades on site that are only aware of the precast when it is in the air, but the precast is still unstable until it is properly braced and connected.
    a. Precast is used because it is a good schedule accelerator when a project has a repetitive floor plan. It was noted in one response that workers tend to get lazy when work becomes repetitive and are not as careful as a precast job progresses.
2. All parties who responded agreed that a safety meeting involving the GC/CM and at least the foreman of all those trades involved in the phase of work that is to take place should be present at a safety meeting to discuss issues such as unloading zone, crane swing radius, time of unloading, controlled access zone and the GC's fall protection requirements.
    a. Having an all hands safety meeting regarding a specific operation on site might cause those who are not involved in the to become bored and upset thus causing the opposite affect of that which is desired.
3. The responses to this question were mixed. Those who agreed that fall protection is not necessary where it would be more hazardous to operate while being tied off stated that having a lanyard or rope laying on the ground around your feet while working at leading edges creates even more of a hazard. Those that disagreed seemed to think that those being trained in the industry will become accustomed to working while being tied off thus creating the scenario of a 100% tie off.
    a. A unique response was to try and access the situation prior to employees taking part in it. Establish the grounds on which it might be more hazardous to where fall protection. In this case use

engineering and equipment to eliminate the hazard, i.e. railings, signs, or a scissor lift where applicable.

4. All responses indicated that it is not nearly as good an option as being tied off. Some only preferred that safety monitoring be used when perimeter work is taking place and going back to a PFAS system.
    a. In one response, both systems should be employed. Having a supplemental or secondary way of hazard prevention will only benefit those participating in the activity.
5. Most agreed that setting up a meeting between the subcontractor in question and the project team to identify risks of the issue at hand would be the best route to take. It is important to note that as the GC/CM on site you hold the responsibility to prevent serious harm or injury to those working on site.
    a. A few responses stated, if possible, that it made part of the contract that the subcontractor agrees to prior to performing the work on site. That way they must comply with the GC/CM's safety protocol while they are on site.
6. This question received feedback that stated it was most important to make sure that your requirements were part of some contract that the subcontractor previously agreed to. This would give the GC/CM the authority to force a subcontractor to abide by your safety guidelines. The responses were as follows:



CM Authority to Enforce Safety Rules

    a. What is important to check prior to enforcing your guidelines is the AHJ (Authority Having Jurisdiction) for local codes. Some projects as well may use OCIP (Owner Controlled Insurance Program) that may have requirements which exceed OSHA.

A Model Company

As safety becomes a major factor in on site work and a major factor in determining causes of accidents, it is important to note that there are companies in the industry that are going above and beyond that which is required by OSHA to protect the workers they are responsible for on the construction site. One company in particular was consulted for this research.

Davis Construction Company is a company that provides construction services in Maryland, Washington, D.C., and Virginia. They are a model company for safety requirements, as they have developed a more stringent set of guidelines for the precast projects that they build. A copy of this checklist is attached in Precast Safety Appendix.

A presentation was given by Bill Moyer of Davis Construction on a precast parking garage structure the company had been working on in Maryland. Unfortunately this structure collapsed and as a result from this collapse Davis decided to enact there own precast safety plan for future projects to prevent such catastrophes from occurring. Several of the additions they add were as follows:

1. Are there any unique Precast erection situations on this project that we should take special notice of?
2. Does the Precast Erector have adequate fall protection equipment on site? Is the Precast Erector aware that all workers must be tied off, or have alternate fall protection above 6'-0"? (Unless Davis and erector agree that circumstances prohibit safe and feasible tie off) The use of a Safety Monitoring system is not permitted without written permission from the Davis Safety Department. Describe the system to be used.
3. Describe fall protection controls used by subcontractor while guard rails or perimeter barricades are taken down in order to set the panels.
4. Has Precast Erector performed a survey of the installation area?
5. Has the Erector selected the size and type of crane required to set all panels without exceeding 75% of the cranes capacity?
6. Verify that all Safety Plan elements are presented to and agreed upon by all parties involved including all lower tier subcontractors.

These are several of the requirements that provide a framework for Davis Constructions precast installation checklist. The topics that are hit hard for this plan are fall protection, awareness of the site during erection, and communication of safety policies to all those involved in the project at the time of precast erection. Communication is key in the site safety plans for all projects. Several accidents and disagreements can be avoided if all parties involve communicate their concerns prior to construction beginning.

The important sections of this checklist include that Davis must agree that safe and feasible tie off is not possible. They don't give a free pass to fall protection unless they agree with the circumstances. Unique situations are identified prior to any work taking place on site. This is important because Davis can than discuss these matters with the precast erector prior to them arriving on site for construction. This will allow the project not to be delayed by differing opinions. The most important of the things listed above is that all safety plan elements are presented to and agreed upon by all parties involved including all lower tier subcontractors. This will ensure that everyone is on board and understands what is expected of them prior to arriving on site.

This policy will aid in developing a site specific safety plan for Residence Hall 2. I would also like to thank Mike McCaffrey of Davis construction for providing information about the Davis safety plan for precast projects.

Lessons to Take From Research

It is one thing to review all the requirements on specific sites and to appease a construction manager, but it is another to actual comply with a construction manager and work together with them to create a safe and hazard free work site.

The biggest lesson learned from performing this analysis is that the importance of communication gets lost on projects. It would be incredible to find what safety issues can be avoided if subcontractors and construction managers were to communicate prior to the job taking place, what safety expectations each hold. If there are differing opinions, then take the time to develop a plan that is feasible and reasonable for the subcontractor to carry out when they arrive on site to perform work.

Subcontractors need to understand that the construction managers on site are not always out to get them. It is the job of the sub to provide safe working conditions on site but need to realize that it is the construction manager's site and they will have the final say. In the end they are looking out for what is in the best interest of not only their project, but also in the best interest of the safety of the employees on their project.

It is important to have a plan ready perhaps prior to even awarding any contracts to the site and make that safety plan clear as day to those parties involved. Be sure to have them agree to this plan prior to them being allowed on to the site. If they have problems with the plan then hold a safety meeting to work these problems out. In the end, communication is the most important part of any successful project. If subcontractors know what is expected of them prior to them arriving on site, then they have no excuse to not comply with those expectations.

Residence Hall 2 Site Specific Safety Plan

Warfel Construction Company is dedicated to the safety of there employees as well as the safety of those under their supervision on all projects. WCC has a Safety committee as well as a Safety Department which has developed a mission statement and safety plan for all projects that WCC completes. WCC Safety Committee Mission Statement is:

"To provide an accident – incident free work environment through training, educational information, management and positive attitude."

Keeping this mission statement in mind as well as applying what was learned through the safety survey and evaluation of what a company such as Davis has done, a site specific safety plan has been developed for Residence Hall 2 during the precast erection phase of the project.

Preconstruction Phase

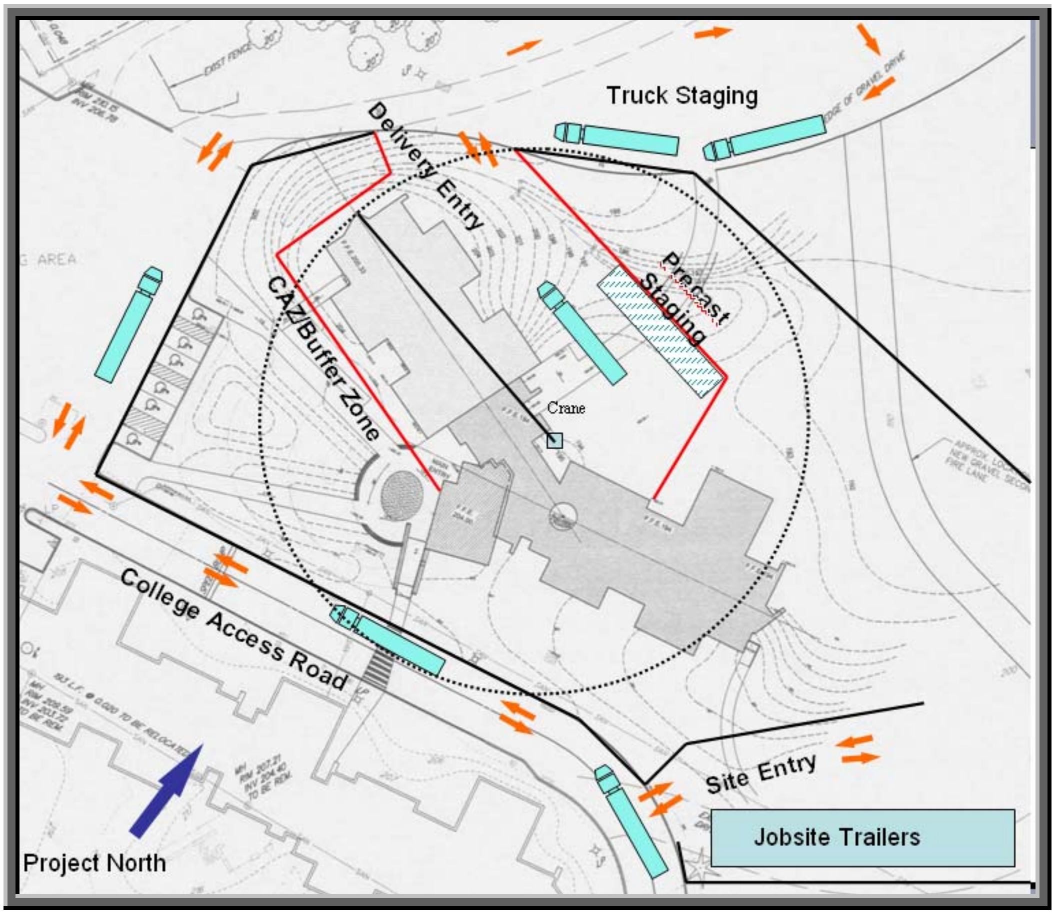
Please note that the following activities will take place prior to the precast erector arriving on site to begin erection of precast.

1. A safety meeting will be conducted with the Safety director from WCC as well as from the Erector. This meeting will also include the foreman of those trades on site at the time of precast erection.
2. The Erector's safety director will be expected to walk the site and develop a site specific safety plan of the work that is to take place prior to the general safety meeting.
3. WCC's and the Erector's safety director will identify any unique circumstances that may exist at this particular job. The issue's will be addressed and resolved at the meeting.
4. All parties on site must sign and date an agreement of the safety plan that has been constructed based on these meetings and must comply with that plan during the erection phase of the precast.

Precast Erection

5. The Erection contractor must agree to:
    a. The crane location must be clearly identified for all erection sequences.
    b. Fall Protection required above 6'-0". All employees must be tied off during erection. This will be a pilot project for a precast anchor to be installed in the every 3rd plank that workers can tie off too. This will cut down on lanyard chord length and prevent the workers from tripping while performing work at the leading edge.
    c. A staging area that will not interfere with other trades accessing the site and allow the crane to have access to precast without swinging the precast over other trades during erection.
    d. A Controlled Access Zone must be identified prior to the precast arriving on site. Only the Erector's employees and delivery trucks will be allowed access to this area.
    e. Proper signage where precast elements are not secure and safety rail has not been assembled.
    f. A 10' buffer zone around the building perimeter where precast erection is taking place.
    g. All holes in precast plank for shall be covered and clearly marked.
6. No trades may work under the area where precast is being erected.
7. Each trade on site during erection shall designate one competent person in case of emergency.

As all of these requirements can not be graphically illustrated, the ones that can are shown below on the next page on the site layout plan. This plan shows the crane location, controlled access zone, buffer zone, staging areas, and truck delivery roots during the erection of all west wing superstructure precast elements. This plan is feasible and will be implemented during this phase of construction.



Site Layout Safety Plan

Post Erection Precast Safety Precautions

8. All leading edge precast shall have a safety rail erected. The safety rail to be used on this project is seen in the picture below.
9. Safety Rail shall remain in place until final metal studs are in place and exterior wall prevents employees from falling.
10. All holes in precast plank shall be properly covered and marked.

This site specific safety plan was developed in order to apply lessons that were learned from performing research on precast concrete safety. This plan will provide a safe worksite not only for the precast erector but also for those trades on site during erection. It is Warfel's goal to provide a safe worksite and this plan will definitely do that during the precast erection phase of this project.

Conclusion

This area of research and analysis proved something that was reinstated during my summer internship with Warfel Construction Company. Communication is the vital key to the success of a safe project. All the subcontractors and construction managers on site are the bricks that lead to the keystone. The keystone in the arch to a safe project is communication. Make the subcontractors working for you well aware of what safety requirements you will have them abide by and talk about any problems they may have with them prior to them arriving on site. This will allow for a better relationship between the CM and subcontractor for the remainder of the project. CM employees are not out to get the subcontractor if they are doing a job that is unsafe. They are out for the best interest of their own employees and the employees on site that they are responsible for.

OSHA needs to take a stance on certain issues pertaining to precast concrete safety. In particular, they need to develop a standard for fall protection that does not leave an open option for a subcontractor to not wear the fall protection based on the fact that it will be more hazardous to the work at hand if the employee were tied off. I can not fathom a situation where it would be determined that risking someone falling will be less hazardous then the person being tied off.

This argument will go on for years. There have already been letters issued to OSHA asking for clarification of the code and which sections can be applied to certain situations. If practicing professionals need OSHA to elaborate on their standards and need a further explanation from OSHA regarding certain standards, the panel needs to step in a develop a standard that all will understand and is straight forward.

The site specific safety plan for Residence Hall 2 developed in this analysis section was aimed at creating a safety plan that was straight forward and to the point. This plan hopefully will create a line of communication that will allow trades to work on site and perform there tasks in accordance to the WCC safety standard.

Senior Thesis Summary and Conclusion

After the analysis areas and research was performed it was determined that an overall additional cost of $166,280.65 was spent in order to accelerate the schedule a total of 10 weeks and provide better working conditions for the workers and to insure the quality of the work being installed during the three coldest months of the year in Collegeville, Pennsylvania.

It is recommended that the college stick with the current soil remediation plan of deep dynamic compaction due to the minimal savings and no schedule acceleration if the complete soil exchange were chosen. It is also recommended that the college spend the additional $151,720 to change the superstructure and façade system. This has a schedule acceleration of 10 weeks that is very valuable to a project that must be finished for the start of the fall semester of 2007. The temporary heat provides workers with a more comfortable work environment and will insure that they work they are completing meets the quality requirements of the contract.

Precast concrete safety is a major issue for all projects. The site specific safety plan based on the research results that I found will help to make this site a safe place to work and also allow future projects to plan ahead and communicate safety problems between everyone involved in the project. This proved to be very helpful for my own understanding of safety aspects of projects as well.

Over all the work performed in the last semester's worth of course work will improve the project delivery and the overall project itself to the owner, Ursinus college. With a project contingency fund sitting at $268,000 and three and a half months remaining on the project, it is feasible that the added cost of the proposed systems can be covered. Barring a major setback the college would still be refunded $101,719.35. All the work performed was a valuable experience.

Soil Remediation Appendix

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

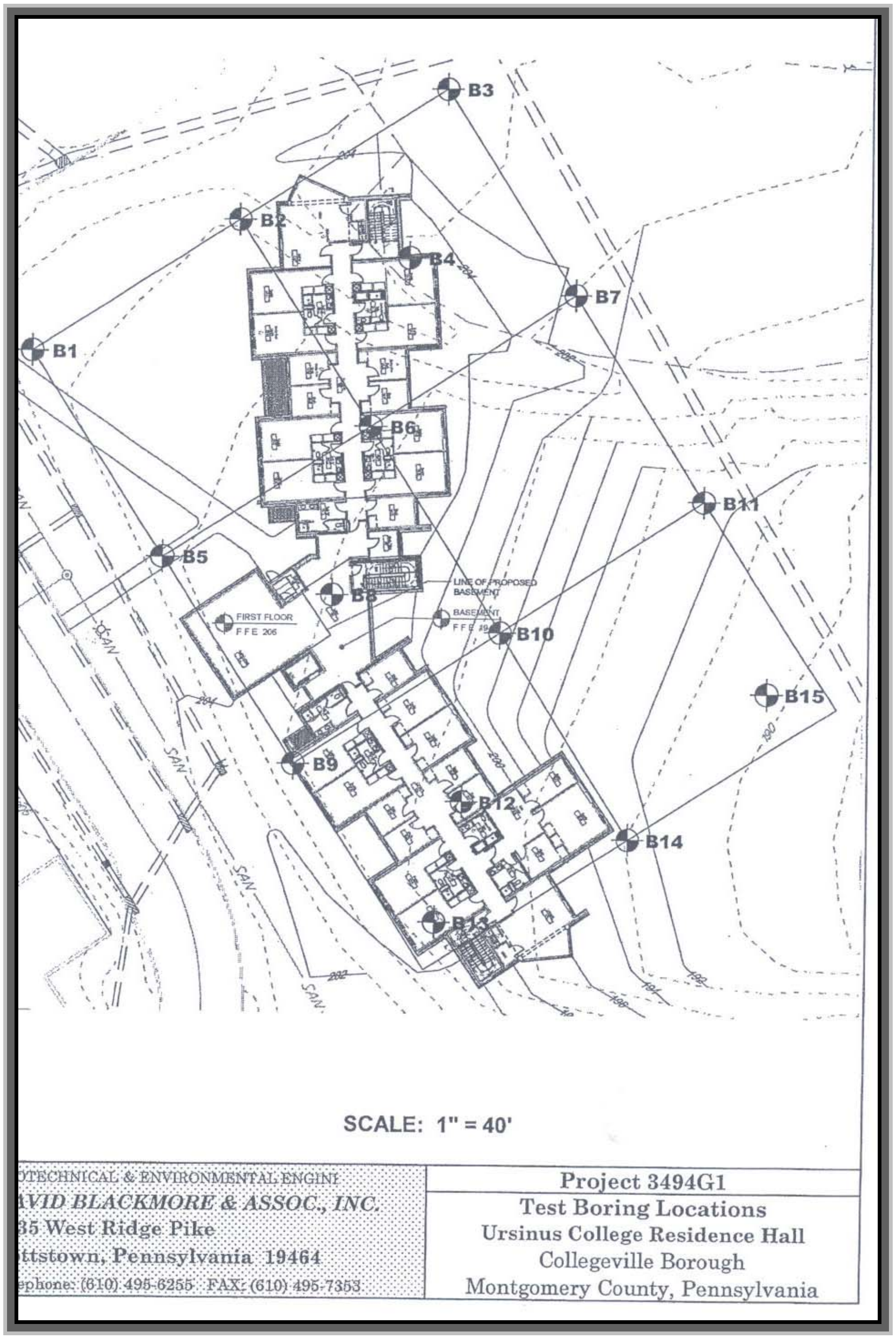
Ursinus Campus Map

Map Key

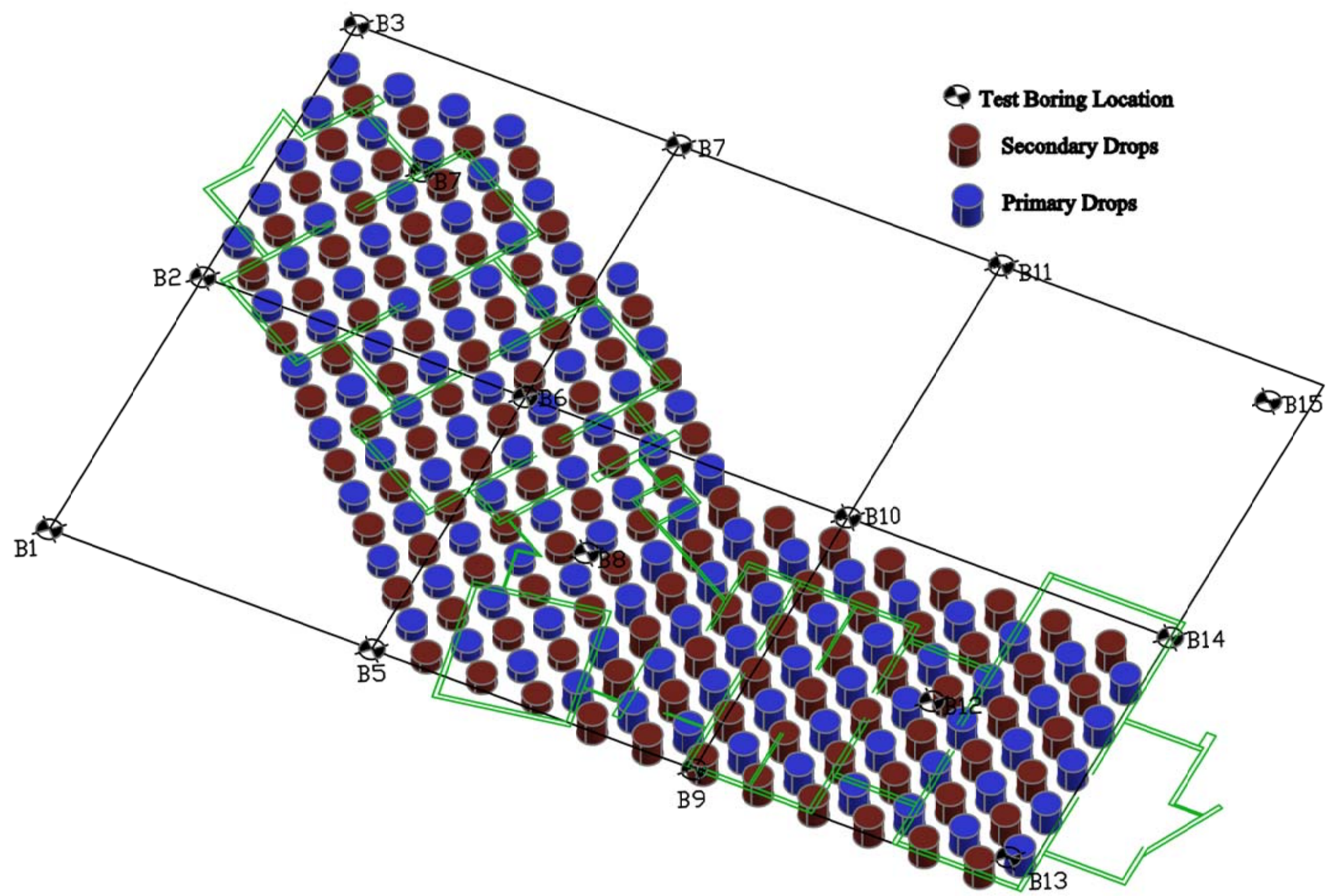
	Academic & Administrative Locations		Residence Halls
1	Corson Hall	A	944 Main St.
2	Unity House	**B**	942 Main St.
3	Berman Museum of Art	**C**	143 9th Ave.
4	Olin Hall	**D**	Cloake House (811 Main)

5	Bomberger Hall	**E**	Isenberg Hall (801 Main)
5a	Fetterolf House (Center for Continuous Learning	**F**	732 Main
6	Myrin Library	**G**	Elliott House (785 Main)
7	Hillel House	**H**	Todd Hall (724 Main)
8	Pfahler Hall	**I**	777 Main
9	Thomas Hall	**J**	Wicks House (716 Main)
10	The Kaleidoscope	**K**	Omwake Hall (701 Main)
11	Book Store	**L**	Reimert Hall
12	Wismer Center	**M**	Curtis Hall
13	Campus Safety	**N**	Wilkinson Hall
14	Facilities Services	**O**	Brodbeck Hall
15	Floy Lewis Bakes Center (incl. Helfferich Gym)	**P**	702 Main
16	Ritter Hall	**Q**	Schaff Hall
17	Practice Field South	**R**	Olevian Hall
18	Patterson Field (football)	**S**	624 Main
19	Snell Field (hockey)	**T**	Swingli Hall (620 Main)
20	Baseball Field	**U**	Duryea Hall (612 Main)
21	Tennis Courts	**V**	Schreiner Hall (600 Main)
22	Softball Field	**W**	Musser Hall (23 Sixth)
23	Practice Field North	**X**	Hobson Hall (568 Main)
24	Soccer/Lacrosse Field	**XX**	Sprankle Hall
25	Hunsberger Woods	**Y**	Sturgis Hall (26 Sixth)
		Z	30-32 Sixth
		AA	Beardwood Hall
		BB	Paisley Hall
		CC	Stauffer Hall
		DD	Richter Hall
		EE	North Hall
		FF	Fetterolf House (554 Main)
		GG	Maples Hall (512 Main)
		HH	Keigwin Hall (513 Main)
		II	Commonwealth (500 Main
		JJ	New Residence Hall
		KK	Barbershop (476 Main)
		LL	Clamer Hall (409 Main)
		MM	444 Main
		NN	424-426 Main

Test Boring Grid



DDC Layout Plan



Precast Superstructure and Architectural System (PSAS) Appendix

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Precast Concrete and Architectural System Takeoffs

East Wing						
Typ. Precast Member	**Typ. Flr Ht.**	**Length**	**Area (SF)**	**Quantity**	**Cost/SF**	**Total Cost**
Structural Wall Panel	9'-0"	20'-7"	185.25	4	$35	$25,935
Structural Wall Panel	9'-0"	15'-9"	141.75	4	$35	$19,845
Structural Wall Panel	9'-0"	19'-0"	171	15	$35	$89,775
Structural Wall Panel	9'-0"	26'-0"	234	20	$35	$163,800
Structural Wall Panel	9'-0"	21'-0"	189	20	$35	$132,300
Structural Wall Panel	9'-0"	19'-4"	174	4	$35	$24,360
Structural Wall Panel	9'-0"	10'-0"	90	4	$35	$12,600
Hollow Core Plank		18'-2"	72.66	76	$8.50	$46,938.36
Hollow Core Plank		27'-0"	108	124	$8.50	$113,832
Hollow Core Plank		9'-4"	37.33	40	$8.50	$12,692.20
Arch. Precast Panel	9'-0"	9'-0"	73	4	$42	$12,264
Arch. Precast Panel	9'-0"	14'-0"	92.66	32	$42	$124,544
Arch. Precast Panel	9'-0"	8'-8"	61.33	16	$42	$41,216
Arch. Precast Panel	9'-0"	15'-8"	124.33	8	$42	$41,776
Arch. Precast Panel	9'-0"	10'-2"	91.5	16	$42	$61,488
Arch. Precast Panel	9'-0"	26'-8"	223.33	8	$42	$75,040
Arch. Precast Panel	9'-0"	19'-4"	174	4	$42	$29,232
Total Precast Conc.				**399**		**$1,027,638**

Building Core/Central Tower						
Typ. Precast Member	**Typ. Flr Ht.**	**Length**	**Area(SF)**	**Quantity**	**Cost/SF**	**Total Cost**
Structural Wall Panel	9'-0"	28'-0"	196	4	$35	$27,440
Arch. Wall Panel	9'-0"	30'-0"	249	4	$42	$41,832
Arch. Wall Panel	9'-0"	30'-0"	153.33	4	$42	$25,760
Arch. Wall Panel	9'-0"	28'-0"	196	4	$42	$32,928
Hollow Core Plank		20'-0	80	60	$8.50	$40,800
Hollow Core Plank		28'-0"	112	30	$8.50	$28,560
Total Precast Conc.				**106**		**$197,320**

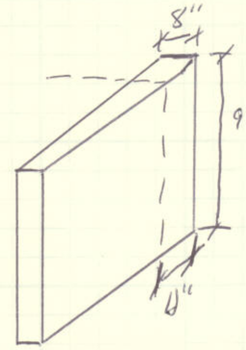
West Wing						
Typ. Precast Member	**Typ. Flr Ht.**	**Length**	**Area (SF)**	**Quantity**	**Cost/SF**	**Total Cost**
Structural Wall Panel	9'-0"	11'-2"	100.5	4	$35	$14,070
Structural Wall Panel	9'-0"	18'-3"	164.25	4	$35	$22,995
Structural Wall Panel	9'-0"	26'-0	234	32	$35	$262,080
Structural Wall Panel	9'-0"	19'-10"	178.5	4	$35	$24,990
Structural Wall Panel	9'-0"	15'-9"	141.75	4	$35	$19,845
Hollow Core Plank		20'-4"	81.33	76	$8.50	$52,541.33
Hollow Core Plank		25'-0"	100	116	$8.50	$98,600
Hollow Core Plank		10'-0"	40	40	$8.50	$13,600
Arch. Precast Panel	9'-0"	13'-0"	83.61	32	$42	$112,373.33
Arch. Precast Panel	9'-0"	10'-0"	90	40	$42	$151,200
Arch. Precast Panel	9'-0"	10'-0"	73.33	16	$42	$49,280
Arch. Precast Panel	9'-0"	21'-0"	155.66	8	$42	$52,301.76
Arch. Precast Panel	9'-0"	18'-3"	164.25	4	$42	$27,594
Total Precast Conc.				**380 Pieces**		**$901,470**

Floor Topping	Total Concrete (CY)	Cost/CY	Total Cost
First Floor	71.94	$114	$8,201.16
Second Floor	71.48	$114	$8,148.72
Third Floor	67.4	$114	$7,683.60
Fourth Floor	71.48	$114	$8,148.72
Roof Plank	18.5	$114	$2,109
Total	**300.8**		**$34,291.20**

Minimum Steel Calculations for Precast Wall Panels

Min. Steel Req'd

1) Loading For typ Panel



Live: Snow = 30 psf

Rooms = 40 psf

Public = 100 psf

$\boxed{\text{Total} = 170 \text{ psf}}$

Dead: Roofing = 10 psf

Partitions = 20 psf

Self Weight = 100 psf

$\boxed{\text{Total} = 130 \text{ psf}}$

$$W_{concrete\,self} = \frac{150(8)(12)}{144}$$

$$W_{concrete\,self} = \boxed{100 \text{ psf}}$$

$$\text{Load} = 1.2D + 1.6L = 1.2(130\text{psf}) + 1.6(170\text{psf})$$

$$\boxed{\text{Load} = 428 \text{ psf}}$$

2) Max Moment

$$M = \frac{wl^2}{10} = \frac{(428\text{ psf})(9')^2}{10} = 3.47'^{k}$$

$$\boxed{\text{Max } M = 3.47'^{k}}$$

3) Min. Steel

$A_{s\,min} = 0.0018bd$

$b = 12''$

$d = 8'' - \#5\,bar - \frac{1}{2}(\#5\,bar)$

$d = 8'' - (.625) - \frac{1}{2}(.625)$

$d \cong 7''$

$A_{s\,min} = 0.0018(12'')(7'')$

$\boxed{A_{s\,min} = 0.1512\ in^2}$

* Try #4's @ 12" O.C. *

$A_s = 0.2\ in^2$

4) $a = \dfrac{A_s f_y}{0.85 f'_c b}$

$f_y = 60\ ksi$

$f'_c = 4000\ psi$

$A_s = 0.2\ in^2$

$$a = \frac{(0.2)(60{,}000\,psi)}{0.85(4000\,psi)(12'')}$$

$\boxed{a = 0.294}$

5) $\phi M_n = \phi A_s f_y (d - a/2)$

* $Max\ M \leq \phi M_n$ *

$\phi M_n = (0.2\,in^2)(60\,ksi)(7'' - \frac{.294}{2})$

$\boxed{\phi M_n = 6.85'k}$

$Max\ M \leq \phi M_n \therefore$ Ok

Use #4 Bars @ 12" O.C.

Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float	2006 SEP OCT NOV DEC / 2007 JAN FEB MAR APR MAY JUN JUL AUG SEP
Schematic Design							
1000	WRT Schematic Design	20d	0	03OCT05 A	07NOV05 A		
1010	UC approve schematic design	8d	0	10OCT05 A	18NOV05 A		
1050	WCC schematic design pricing	15d	0	05OCT05 A	08NOV05 A		
1060	UC approve schematic estimate	5d	0	17OCT05 A	11NOV05 A		
Permitting							
2000	Preliminary land development plan submittal	10d	0	05DEC05 A	16DEC05 A		
2010	WRT meet w/ Hank Clemmer prelim review	5d	0	13FEB06 A	20APR06 A		m review
2030	Planning Commission final submission	5d	0	30MAR06 A	30MAR06 A		
2060	Borough Council final approvals	5d	0	06APR06 A	06APR06 A		
2080	Apply to Borough Building permit	5d	0	10APR06 A	09JUN06 A		ding permit
2085	Sitework/foundation permit issued	1d	0	30MAY06 A	05JUN06 A		rmit issued
2095	Final building permit issued	5d	0	09JUN06 A	09JUN06 A		issued
Design Development							
3000	WRT Design development	20d	0	11NOV05 A	30DEC05 A		
3010	UC approve design development drawings	5d	0	30DEC05 A	06JAN06 A		
Construction Documents							
3300	WRT CD's to 30%	20d	0	03JAN06 A	03FEB06 A		
3320	Structural 40% CD's	20d	0	19DEC05 A	03FEB06 A		
3330	MEP 10% CD's	20d	0	11JAN06 A	06FEB06 A		
3400	WCC price 30% CD's	18d	0	25JAN06 A	28FEB06 A		
3440	UC approve 30% CD pricing	5d	0	02MAR06 A	02MAR06 A		
3500	WRT CD's to 90%	40d	0	06FEB06 A	03APR06 A		
3510	Structural CD's to 100%	41d	0	06FEB06 A	03APR06 A		
3520	MEP CD's to 90%	40d	0	06FEB06 A	03APR06 A		
3600	WCC finalize excavation / soil remediation	5d	0	13MAR06 A	21APR06 A		ediation price
3610	WCC finalize concrete pricing	5d	0	26APR06 A	27APR06 A		
3620	WCC finalize precast plank pricing	5d	0	26APR06 A	27APR06 A		ng
3630	WCC finalize masonry pricing	5d	0	13APR06 A	14APR06 A		
3640	WCC finalize roof truss pricing	5d	0	02MAY06 A	09JUN06 A		ss pricing
3650	WCC finalize structural steel pricing	5d	0	03MAY06 A	02JUN06 A		l steel pricing
3670	UC authorize release of plank, mason	5d	0	28APR06 A	28APR06 A		nason
3675	WCC award plank, masonry, concrete	5d	0	28APR06 A	02MAY06 A		ncrete
3680	UC authorize release of steel, roof trusses	1d	0	08JUN06 A	09JUN06 A		of steel, roof trusses

Early bar
Progress bar
Critical bar
Summary bar
Start milestone point
Finish milestone point

Warfel Construction Company
Ursinus College Residence Hall

Date	Revision	Checked	Approved
19APR06	Revision 1		
05MAY06	Revision 2		
08JUN06	Superstructure		
19SEP06	Revision 3		

Start date	03APR06
Finish date	20SEP07
Data date	19SEP06
Run date	28SEP06
Page number	1A

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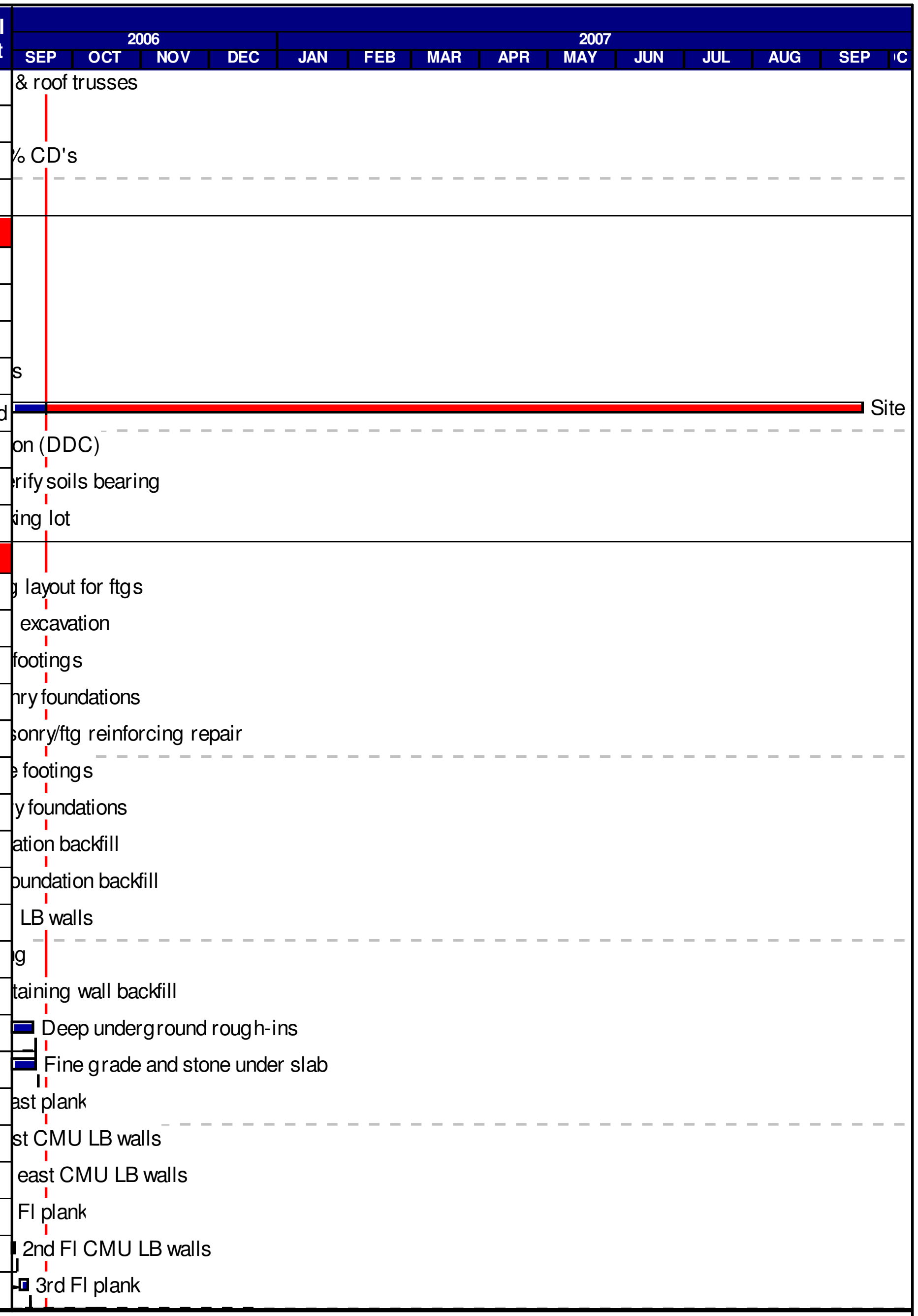
Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float
3685	WCC award steel & roof trusses	2d	0	02JUN06 A	23JUN06 A	
3700	WCC price 90% CD's	16d	0	04APR06 A	26APR06 A	
3740	WCC present initial GMP on 90% CD's	2d	0	27APR06 A	27APR06 A	
3800	UC issue Notice to Proceed	1d	0	19APR06 A	19APR06 A	
Site Work						
4000	WCC mobilize onto site	15d	0	25APR06 A	28APR06 A	
4100	ES&C	4d	0	25APR06 A	28APR06 A	
4140	Strip topsoils	3d	0	26APR06 A	28APR06 A	
4180	Site cut & fills	8d	0	27APR06 A	14JUL06 A	
4200	Site improvements	260d	260d	01MAY06 A	20SEP07	-37d
4300	Deep Dynamic Compaction (DDC)	2d	0	28APR06 A	26MAY06 A	
4310	DBA complete SPT to verify soils bearing	2d	0	12MAY06 A	29MAY06 A	
4400	Gravel parking lot	5d	0	01MAY06 A	20JUL06 A	
Superstructure						
5400	Building layout for ftgs	15d	0	29MAY06 A	03AUG06 A	
5430	Footing excavation	20d	0	30MAY06 A	03AUG06 A	
5480	Ground Fl concrete footings	6d	0	30MAY06 A	14JUN06 A	
5485	Ground Fl masonry foundations	6d	0	05JUN06 A	28JUN06 A	
5486	Ground Fl masonry/ftg reinforcing repair	8d	0	21JUN06 A	06JUL06 A	
5490	1st Fl concrete footings	10d	0	14JUN06 A	07JUL06 A	
5495	1st Fl masonry foundations	6d	0	03JUL06 A	10JUL06 A	
5497	1st Fl foundation backfill	3d	0	11JUL06 A	17JUL06 A	
5500	Ground Fl foundation backfill	3d	0	14JUN06 A	17JUL06 A	
5550	Ground Floor CMU LB walls	7d	0	06JUN06 A	16JUN06 A	
5590	Waterproofing	8d	0	28JUN06 A	14JUL06 A	
5600	Ground Fl retaining wall backfill	5d	0	10JUL06 A	12JUL06 A	
5650	Deep underground rough-ins	5d	0	11JUL06 A	14SEP06 A	
5700	Fine grade and stone under slab	6d	0	23AUG06 A	15SEP06 A	
6000	1st Fl East plank	3d	0	27JUL06 A	31JUL06 A	
6200	1st Fl west CMU LB walls	6d	0	17JUL06 A	28JUL06 A	
6250	1st Fl east CMU LB walls	6d	0	01AUG06 A	10AUG06 A	
6400	2nd Fl plank	5d	0	15AUG06 A	18AUG06 A	
6500	2nd Fl CMU LB walls	13d	0	18AUG06 A	05SEP06 A	
6580	3rd Fl plank	5d	0	07SEP06 A	12SEP06 A	



Early bar
Progress bar
Critical bar
Summary bar
Start milestone point
Finish milestone point

Warfel Construction Company
Ursinus College Residence Hall

Date	Revision	Checked	Approved
19APR06	Revision 1		
05MAY06	Revision 2		
08JUN06	Superstructure		
19SEP06	Revision 3		

Start date	03APR06
Finish date	20SEP07
Data date	19SEP06
Run date	28SEP06
Page number	2A

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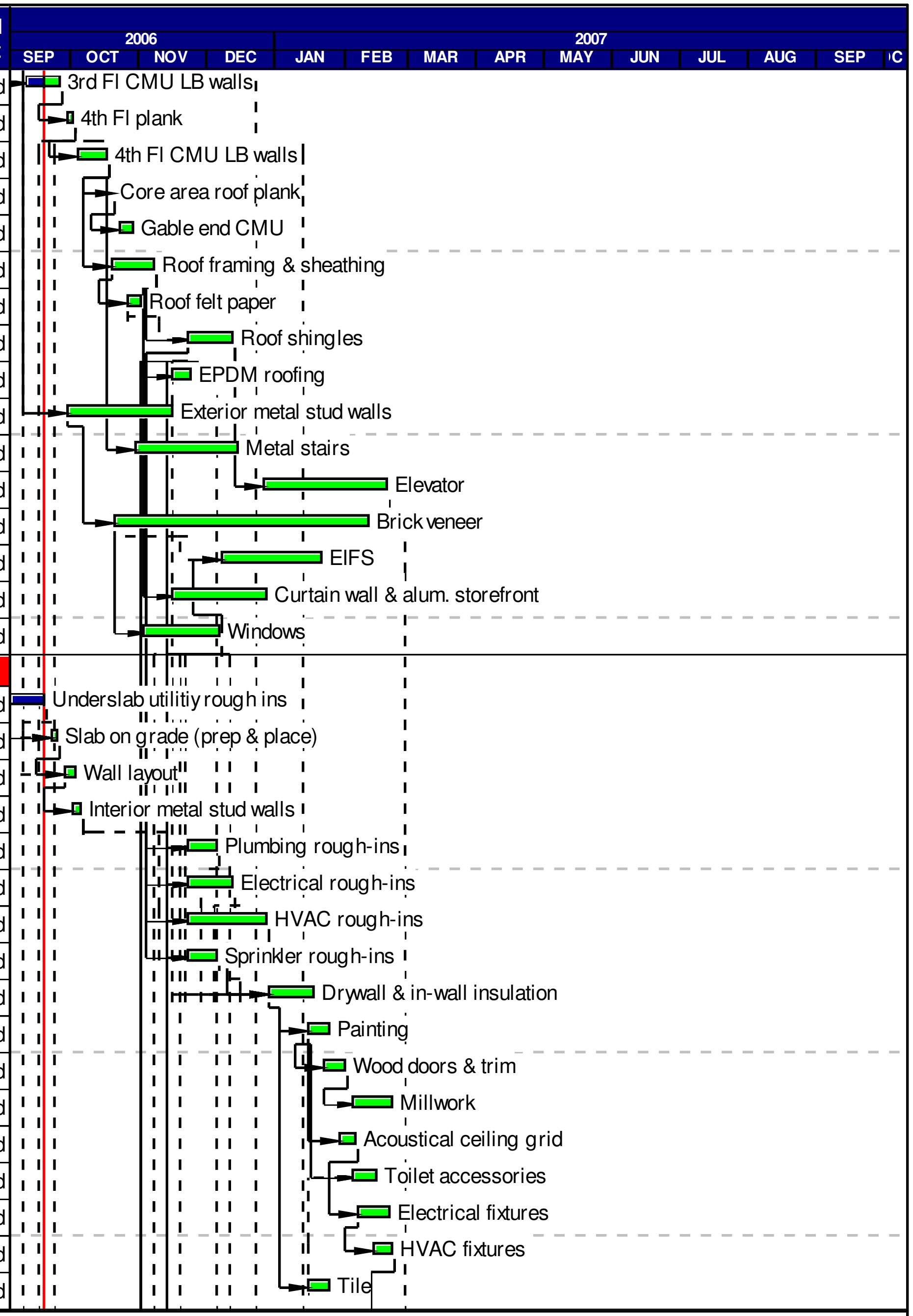
Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float
6600	3rd Fl CMU LB walls	11d	7d	11SEP06 A	27SEP06	2d
6680	4th Fl plank	3d	3d	29SEP06	03OCT06	2d
6700	4th Fl CMU LB walls	11d	11d	04OCT06	18OCT06	26d
6780	Core area roof plank	1d	1d	20OCT06	20OCT06	193d
6800	Gable end CMU	6d	6d	23OCT06	30OCT06	193d
6900	Roof framing & sheathing	15d	15d	19OCT06	08NOV06	26d
6920	Roof felt paper	6d	6d	26OCT06	02NOV06	46d
7000	Roof shingles	15d	15d	23NOV06	13DEC06	26d
7050	EPDM roofing	7d	7d	16NOV06	24NOV06	174d
7500	Exterior metal stud walls	35d	35d	29SEP06	16NOV06	44d
7520	Metal stairs	35d	35d	30OCT06	15DEC06	159d
7530	Elevator	40d	40d	26DEC06	20FEB07	26d
7540	Brick veneer	80d	80d	20OCT06	12FEB07	44d
7545	EIFS	30d	30d	08DEC06	22JAN07	135d
7550	Curtain wall & alum. storefront	30d	30d	16NOV06	28DEC06	151d
7570	Windows	25d	25d	03NOV06	07DEC06	44d
Ground Floor						
8000	Underslab utilitiy rough ins	7d	2d	07AUG06 A	20SEP06	139d
8020	Slab on grade (prep & place)	2d	2d	22SEP06	25SEP06	138d
8040	Wall layout	5d	5d	28SEP06	04OCT06	138d
8060	Interior metal stud walls	5d	5d	02OCT06	06OCT06	138d
8080	Plumbing rough-ins	10d	10d	23NOV06	06DEC06	120d
8100	Electrical rough-ins	15d	15d	23NOV06	13DEC06	115d
8120	HVAC rough-ins	25d	25d	23NOV06	28DEC06	105d
8140	Sprinkler rough-ins	10d	10d	23NOV06	06DEC06	120d
8160	Drywall & in-wall insulation	15d	15d	29DEC06	19JAN07	105d
8180	Painting	10d	10d	15JAN07	26JAN07	105d
8200	Wood doors & trim	10d	10d	22JAN07	02FEB07	111d
8220	Millwork	15d	15d	05FEB07	23FEB07	111d
8230	Acoustical ceiling grid	7d	7d	29JAN07	06FEB07	105d
8240	Toilet accessories	10d	10d	05FEB07	16FEB07	116d
8260	Electrical fixtures	12d	12d	07FEB07	22FEB07	105d
8280	HVAC fixtures	8d	8d	14FEB07	23FEB07	105d
8290	Tile	10d	10d	15JAN07	26JAN07	126d



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19SEP06	Revision 3		

Start date	03APR06
Finish date	20SEP07
Data date	19SEP06
Run date	28SEP06
Page number	3A

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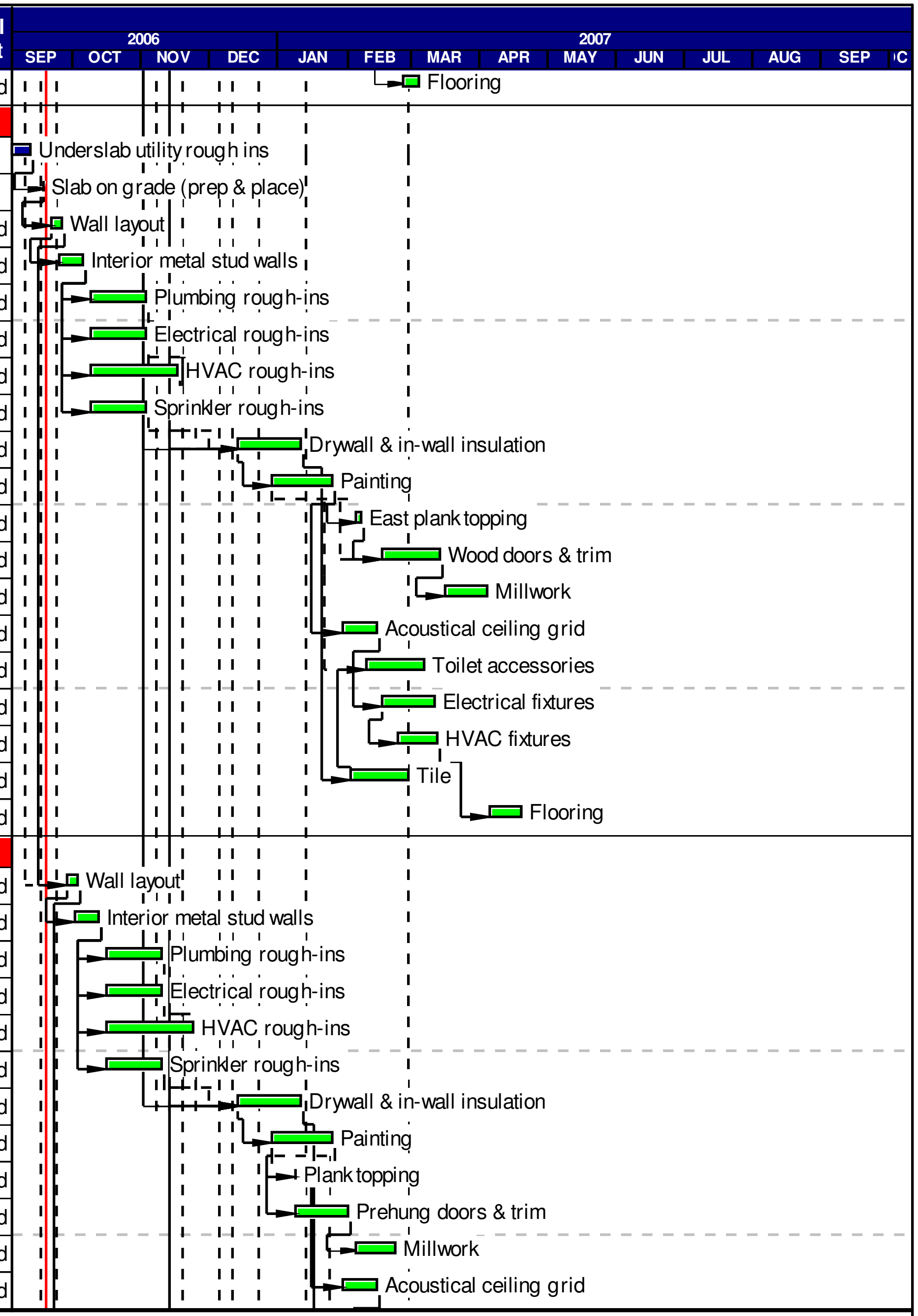
Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float
8300	Flooring	6d	6d	26FEB07	05MAR07	105d
First Floor						
9000	Underslab utility rough ins	7d	0	04SEP06 A	13SEP06 A	
9020	Slab on grade (prep & place)	2d	0	18SEP06 A	18SEP06 A	
9040	Wall layout	5d	5d	21SEP06	27SEP06	1d
9060	Interior metal stud walls	10d	10d	25SEP06	06OCT06	89d
9080	Plumbing rough-ins	20d	20d	09OCT06	03NOV06	99d
9100	Electrical rough-ins	20d	20d	09OCT06	03NOV06	99d
9120	HVAC rough-ins	30d	30d	09OCT06	17NOV06	89d
9140	Sprinkler rough-ins	20d	20d	09OCT06	03NOV06	99d
9160	Drywall & in-wall insulation	20d	20d	14DEC06	12JAN07	71d
9180	Painting	20d	20d	29DEC06	26JAN07	71d
9185	East plank topping	4d	4d	05FEB07	08FEB07	82d
9200	Wood doors & trim	20d	20d	16FEB07	15MAR07	82d
9220	Millwork	15d	15d	16MAR07	05APR07	82d
9240	Acoustical ceiling grid	14d	14d	29JAN07	15FEB07	71d
9260	Toilet accessories	20d	20d	09FEB07	08MAR07	102d
9280	Electrical fixtures	18d	18d	16FEB07	13MAR07	71d
9300	HVAC fixtures	14d	14d	23FEB07	14MAR07	71d
9320	Tile	20d	20d	02FEB07	01MAR07	102d
9340	Flooring	12d	12d	05APR07	20APR07	71d
Second Floor						
10040	Wall layout	5d	5d	28SEP06	04OCT06	1d
10060	Interior metal stud walls	10d	10d	02OCT06	13OCT06	63d
10080	Plumbing rough-ins	20d	20d	16OCT06	10NOV06	73d
10100	Electrical rough-ins	20d	20d	16OCT06	10NOV06	73d
10120	HVAC rough-ins	30d	30d	16OCT06	24NOV06	63d
10140	Sprinkler rough-ins	20d	20d	16OCT06	10NOV06	73d
10160	Drywall & in-wall insulation	20d	20d	14DEC06	12JAN07	50d
10180	Painting	20d	20d	29DEC06	26JAN07	50d
10185	Plank topping	2d	2d	08JAN07	09JAN07	144d
10200	Prehung doors & trim	20d	20d	08JAN07	02FEB07	111d
10220	Millwork	15d	15d	05FEB07	23FEB07	111d
10240	Acoustical ceiling grid	14d	14d	29JAN07	15FEB07	50d



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Start date	03APR06
Finish date	20SEP07
Data date	19SEP06
Run date	28SEP06
Page number	4A

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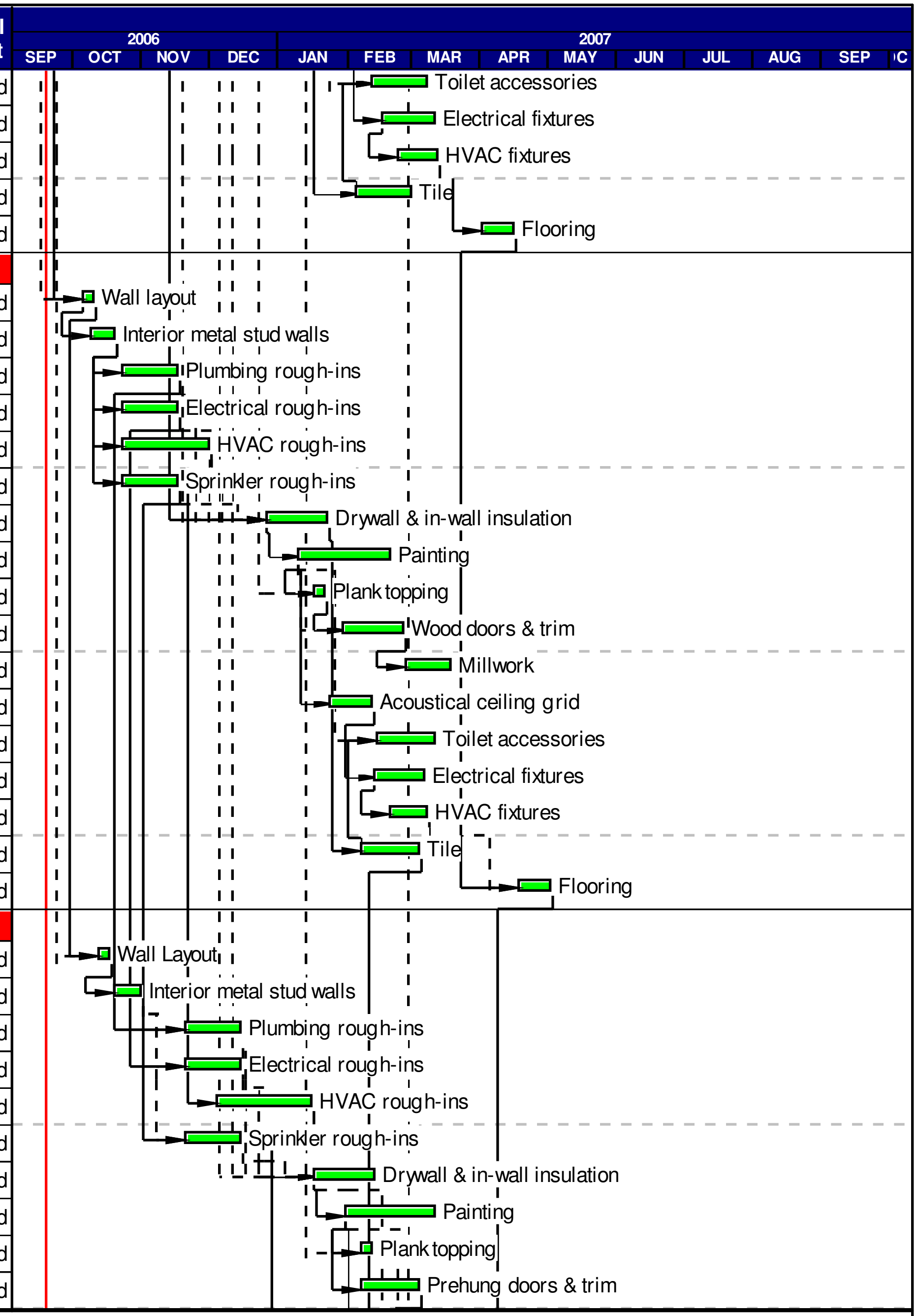
Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float
10260	Toilet accessories	20d	20d	12FEB07	09MAR07	101d
10280	Electrical fixtures	18d	18d	16FEB07	13MAR07	50d
10300	HVAC fixtures	14d	14d	23FEB07	14MAR07	50d
10320	Tile	20d	20d	05FEB07	02MAR07	101d
10340	Flooring	12d	12d	02APR07	17APR07	50d
Third Floor						
11020	Wall layout	5d	5d	05OCT06	11OCT06	1d
11040	Interior metal stud walls	10d	10d	09OCT06	20OCT06	1d
11060	Plumbing rough-ins	20d	20d	23OCT06	17NOV06	38d
11080	Electrical rough-ins	20d	20d	23OCT06	17NOV06	38d
11100	HVAC rough-ins	30d	30d	23OCT06	01DEC06	1d
11120	Sprinkler rough-ins	20d	20d	23OCT06	17NOV06	38d
11140	Drywall & in-wall insulation	20d	20d	26DEC06	23JAN07	77d
11160	Painting	30d	30d	10JAN07	20FEB07	77d
11165	Plank topping	4d	4d	17JAN07	22JAN07	95d
11180	Wood doors & trim	20d	20d	30JAN07	26FEB07	95d
11200	Millwork	15d	15d	27FEB07	19MAR07	95d
11220	Acoustical ceiling grid	14d	14d	24JAN07	12FEB07	77d
11240	Toilet accessories	20d	20d	14FEB07	13MAR07	99d
11260	Electrical fixtures	18d	18d	13FEB07	08MAR07	77d
11280	HVAC fixtures	14d	14d	20FEB07	09MAR07	77d
11300	Tile	20d	20d	07FEB07	06MAR07	79d
11320	Flooring	12d	12d	18APR07	03MAY07	50d
Fourth Floor						
12020	Wall Layout	5d	5d	12OCT06	18OCT06	50d
12040	Interior metal stud walls	10d	10d	19OCT06	01NOV06	50d
12060	Plumbing rough-ins	20d	20d	20NOV06	15DEC06	38d
12080	Electrical rough-ins	20d	20d	20NOV06	15DEC06	38d
12100	HVAC rough-ins	30d	30d	04DEC06	16JAN07	1d
12120	Sprinkler rough-ins	20d	20d	20NOV06	15DEC06	38d
12140	Drywall & in-wall insulation	20d	20d	17JAN07	13FEB07	18d
12160	Painting	30d	30d	31JAN07	13MAR07	18d
12165	Plank topping	4d	4d	07FEB07	12FEB07	120d
12180	Prehung doors & trim	20d	20d	07FEB07	06MAR07	18d



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Start date	03APR06
Finish date	20SEP07
Data date	19SEP06
Run date	28SEP06
Page number	5A

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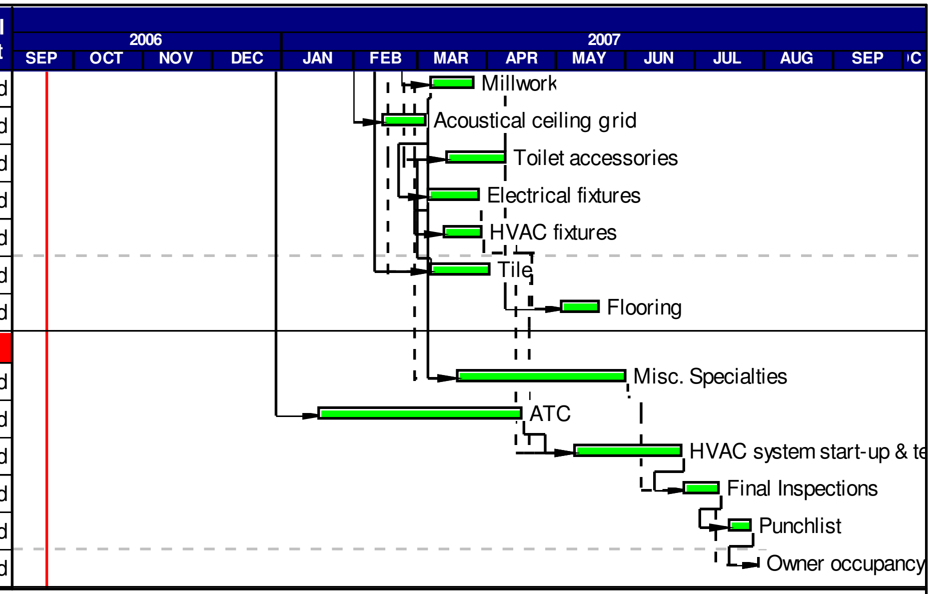
Act ID	Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float
12200	Millwork	15d	15d	07MAR07	27MAR07	18d
12220	Acoustical ceiling grid	14d	14d	14FEB07	05MAR07	18d
12240	Toilet accessories	20d	20d	14MAR07	10APR07	79d
12260	Electrical fixtures	18d	18d	06MAR07	29MAR07	18d
12280	HVAC fixtures	14d	14d	13MAR07	30MAR07	18d
12300	Tile	20d	20d	07MAR07	03APR07	79d
12320	Flooring	12d	12d	04MAY07	21MAY07	50d
Final						
14000	Misc. Specialties	55d	55d	19MAR07	01JUN07	18d
14050	ATC	65d	65d	17JAN07	17APR07	1d
14100	HVAC system start-up & testing	35d	35d	09MAY07	26JUN07	1d
14200	Final Inspections	12d	12d	27JUN07	13JUL07	1d
14250	Punchlist	10d	10d	16JUL07	27JUL07	1d
14300	Owner occupancy	1d	1d	30JUL07	30JUL07	1d



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Data date	19SEP06
Run date	28SEP06
Page number	6A

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Temporary Heat Appendix

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Heat Loss Calculations

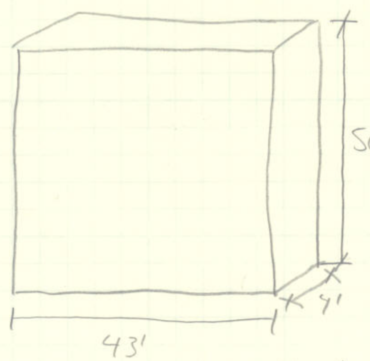
1) Temp Heat Calc For Masonry Work

R-Value of Scaffold Section: Masonry Back*

1-layer Renforced Poly = 0.85
8" CMU Block = 1.71

* 50 days total on Brick veneer with this set up

Biggest set of scaffold: Based on SF



East End

Ren. Poly Walls - 3walls Plus top
Area = 3028 SF
CMU Block - 1wall
Area = 2408 SF

$U = \frac{1}{R}$

Block
$U = \frac{1}{1.71} = .585$

Reinforced Poly
$U = \frac{1}{0.85} = 1.18$

Heat Loss

$Q = UA(T_{in} - T_{out})$

December: $T_{in} = 50°F$ $T_{out} = 33°F$

Poly-Walls

$Q = 1.18(3028SF)(50-33) = 60{,}741.68$ BTU/hr

Block Wall

$Q = .585(2408SF)(50-33) = 23{,}947.56$ BTU/hr

$\boxed{\text{Total} = 84689.24 \text{ BTU/hr}}$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

January: $T_{in} = 50°F$ $T_{out} = 28°F$

$Q = 1.18\,(3028SF)(50-28) = 78,606.88$ BTU/hr

$Q = .585\,(2408)(50-28) = 30,990.96$ BTU/hr

$\boxed{\text{Total} = 109,597.84 \text{ BTU/hr}}$

February: $T_{in} = 50°F$ $T_{out} = 31°F$

$Q = 1.18\,(3028)(50-31) = 67,887.76$ BTU/hr

$Q = .585\,(2408)(50-31) = 26,764.92$ BTU/hr

$\boxed{\text{Total} = 94,652.68 \text{ BTU/hr}}$

Average Day BTU Usage: Masonry

December: 84,689.24 BTU/hr (8hr) = 677,513.92 BTU

January: 109,597.84 BTU/hr (8hr) = 876,782.72 BTU

February: 94,652.68 BTU/hr (8hr) = 757,221.44 BTU

Total = 2,311,518.08

$\boxed{\text{Averge BTU/Day} = 770,506.03 \text{ BTU/Day}}$

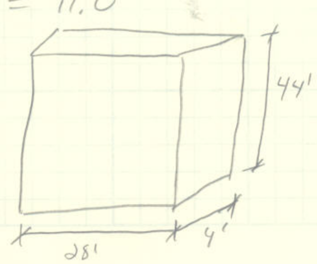
R-Value of scaffold section: 3½" Batt Ins. Back*

1-layer Reinforced Poly = 0.85

3½" Batt Insul. = 11.0

Biggest scaffold set:

*30 Days of 80 day BrickWork



AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

Area of Poly Walls = 1696 SF
Area of 3½" Batt Wall = 1232 SF

U-Value: $U = \frac{1}{R}$

Poly: $\frac{1}{0.85} = 1.18$

3½" Batt: $\frac{1}{11} = 0.09$

Heat Loss

$Q = UA(T_{in} - T_{out})$

December: $T_{in} = 50°F$ $T_{out} = 33°F$

$Q = 1.18\,(1696\,SF)(50-33) = 34{,}021.76$ BTU/hr

$Q = 0.09\,(1232\,SF)(50-33) = 1{,}884.96$ BTU/hr

$\boxed{\text{Total} = 35{,}906.72 \text{ BTU/hr}}$

January: $T_{in} = 50°F$ $T_{out} = 28°F$

$Q = 1.18\,(1696\,SF)(50-28) = 44{,}028.16$ BTU/hr

$Q = 0.09\,(1232\,SF)(50-28) = 2{,}439.36$ BTU/hr

$\boxed{\text{Total} = 46{,}467.52 \text{ BTU/hr}}$

February: $T_{in} = 50°F$ $T_{out} = 31°F$

$Q = 1.18\,(1696\,SF)(50-31) = 38{,}024.32$ BTU/hr

$Q = 0.09\,(1232\,SF)(50-31) = 2{,}106.72$ BTU/hr

$\boxed{\text{Total} = 40{,}131.04 \text{ BTU/hr}}$

Average BTU/Day Usage

December = 35,906.72 BTU/hr (8 hr) = 287,253.76 BTU
January = 46,467.52 BTU/hr (8 hr) = 371,740.16 BTU
February = 40,131.04 BTU/hr (8 hr) = 321,048.32 BTU

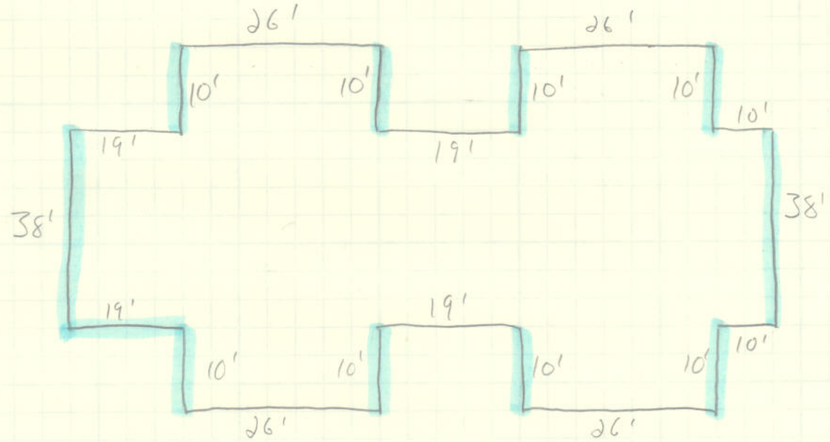
$\boxed{\text{Total} = 980{,}042.24 \text{ BTU}}$

$\boxed{\text{Average} = 326{,}680.75 \text{ BTU/day}}$

2.) Temp Heat For Average Floor in a Wing

R-Values		U-Value
3½" Batt Insulation	= 11.0	.09
8" Hollow Core Plank	= .64	1.56
8" CMU Block	= 1.71	.58
1 layer Poly	= 0.85	1.17

Typical Floor in a Wing: 9' Wallheight



= CMU Block

Area

Plank Floor and Cieling:

Floor = 4840 SF

Ceiling = 4840 SF

Walls

3½" Insul. = 1504 SF

8" CMU = 1575 SF

Windows (Poly) = 315 SF

December: T_{out} = 33°F

$Q = .09(1504SF)(50-33) = 2301.12$ BTU/hr

$Q = 1.56(9680SF)(50-33) = 256,713.6$ BTU/hr

$Q = .58(1575SF)(50-33) = 15,529.5$ BTU/hr

$Q = 1.17(315SF)(50-33) = 6,265.35$ BTU/hr

Total = 280,809.57 BTU/hr

$\boxed{\text{Per Day BTU loss} = 2,246,476.56 \text{ BTU}}$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

January: $T_{out} = 28°F$

$Q = .09(1504SF)(50-28) = 2977.92$ BTU/hr
$Q = 1.56(9680SF)(50-28) = 332,217.6$ BTU/hr
$Q = .58(1575SF)(50-28) = 20,097$ BTU/hr
$Q = 1.17(315SF)(50-28) = 8,108.1$ BTU/hr
Total = 363,400.62 BTU/hr

$\boxed{\text{Per Day BTU loss} = 2,907,204.96 \text{ BTU}}$

February: $T_{out} = 31°F$

$Q = .09(1504SF)(50-31) = 2571.84$ BTU/hr
$Q = 1.56(9680SF)(50-31) = 286,915.2$ BTU/hr
$Q = .58(1575SF)(50-31) = 17,356.5$ BTU/hr
$Q = 1.17(315SF)(50-31) = 7002.45$ BTU/hr
Total = 313,845.99 BTU/hr

$\boxed{\text{Per Day BTU loss} = 2,510,767.92 \text{ BTU}}$

Assume that Only 2 Floors Will have Temp heat on them
4 wing sections
1 Gallon Propane = 91,502 BTU

BTU Usage For Per Day

December
2,246,476.56 BTU/Day (2 wings/Floors)(2 Floors) = 8,985,906.24 BTU

$\boxed{\text{Gallons Propane / Day} = 98.2 \text{ Gallons}}$

January
2,907,204.96 BTU/Day (2 wings/Floors)(2 Floors) = 11,628,819.84 BTU

$\boxed{\text{Gallons Propane / Day} = 127.08 \text{ Gallons}}$

February
2,510,767.92 BTU/Day (2 wings/Floor)(2 floors) = 10,043,071.68 BTU

$\boxed{\text{Gallons Propane / Day} = 109.76 \text{ Gallons}}$

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

Masonry Gallons Propane / Day: 2 Wall Types

Avg BTU/Day = 770,506.03 BTU/Day = 8.42 Gallons

Avg BTU/Day = 326,680.75 BTU/Day = 3.57 Gallons

December Gallons Per Day:

$8.42_g + 98.2_g = 106.62$ Gallons Propane

21 Work Days × 106.62 Gallons = 2,239.02 Gallons

January Gallons Per day:

$8.42_g + 127.08_g = 135.5$ Gallons Propane

23 Work days × 135.5 Gallons = 3116.5 Gallons

February Gallons Per day:

3.57 Gallons × 109.76 Gallons = 113.33 gallons

20 Work days × 113.33 gallons = 2,266.6 Gallons

$\boxed{\text{Total Propane Used For TempHeat = 7,622.12 Gallons}}$

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

Precast Safety Appendix

Faculty Consultant: Dr. John Messner
Department of Architectural Engineering
The Pennsylvania State University
April 12, 2007

Precast Concrete Safety
Senior Thesis, Architectural Engineering, Penn State
Ursinus College Residence Hall 2
Collegeville, PA
52,000 SF, 5 Story Block and Precast Plank

As a fifth year Architectural Engineering student at Penn State University, I am working on my senior thesis research project. As part of this process, I will be developing a site specific safety plan based on the responses from the safety survey questions below. I would appreciate it if you could take the time out of your schedule to respond to these questions.

The focus for this survey is the industry's thoughts regarding precast concrete safety, specifically during the erection phase. There seem to be aspects of precast concrete safety that OSHA does not directly address; rather they leave it to the interpretation of those parties involved in the project. I am interested in finding areas that those in the industry feel are a grey area, or OSHA guidelines that the industry feels need to be stricter.

All responses to this survey can be emailed to: rch172@psu.edu

Please answer the following questions to the best of your ability. All responses will be greatly appreciated and will be kept anonymous when presented in my final thesis project.

Precast Concrete Safety Survey 1

1. What aspect of precast concrete erection do you feel is the most dangerous and why?
2. Do you feel it would be beneficial to have a general safety meeting with all subcontractors to discuss the GC/CM general safety plan prior to beginning work?
3. OSHA states fall protection is not necessary where it would be more hazardous to operate while being tied off. Do you agree with this? If not, why?
4. Is a safety monitoring system as good a safety precaution as tying off?
5. How would you go about addressing a precast concrete erection safety issue that is not directly addressed by OSHA (you and the subcontractor have differing opinions)?
6. Do you, as the construction manager, have the right to force a subcontractor to abide by your safety guidelines if they go above and beyond that which is required by OSHA?

**Please note that if you have any other thoughts regarding precast concrete safety that you feel would be beneficial to my research, please do not hesitate to add them at the end of the questions.

Thank you very much for your time and input.

Regards, Rusty Hoffman, Construction Management Option

JAMES G. DAVIS CONSTRUCTION CORPORATION

Precast Installation Preconstruction Checklist

Project:______________________________________ **Date:** __________________

1. Has the Erector been provided with a written copy of the DAVIS Job Safety Standards, which are a part of the Precast Fabricator's subcontract with DAVIS, and does the Erector agree to work in accordance with those Safety Standards?
2. Are there any unique Precast erection situations on this project that we should take special notice of?
3. Does the Precast Erector have adequate fall protection equipment on site? Is the Precast Erector aware that all workers must be tied off, or have alternate fall protection above 6'0"? (Unless Davis and erector agree that circumstances prohibit safe and feasible tie off) The use of a Safety Monitoring system is not permitted without written permission from the Davis Safety Department. Describe the system to be used.
4. Has the subcontractor provided formal employee Fall Protection Training? Is documentation of the training available upon request?
5. Describe fall protection controls used by subcontractor while guard rails or perimeter barricades are taken down in order to set the panels.
6. Have any imbeds been modified? If yes, was the Structural Engineer notified and was the documentation produced?
7. Has Precast Erector preformed a survey of the installation area?
8. Are there adequate access roads into and through the site for safe delivery and movement of equipment?
9. Has the Erector selected the size and type of crane required to set all panels without exceeding 75% of the cranes capacity?
10. Is there a properly graded, compacted, drained area(s) for the crane to set up and operate?
11. How will the pre-shift crane inspection be recorded?
12. Is there adequate staging area for precast delivery trucks?
13. Does the Precast Erector have his sequencing plan in place, including how he intends to avoid lifting loads over other workers?
14. Who is the competent person / qualified rigger for Precast erector?
15. Have welders' certificates been submitted (if required)?
16. Have MSDS/Safety plan been submitted to DAVIS?
17. Have insurance certificates from both the Precast Fabricator & Erector been submitted to DAVIS?
18. Have erection drawings been reviewed?
19. Has deck /safety cable form been reviewed?
20. For all welding, cutting, burning or any other open flame work must have a hot work permit completed prior to work being performed daily?

Precast Deck and Safety Cable Release

PROJECT NAME: ____

TRANSFER OF CUSTODY OF FALL PROTECTION:

In accordance with OSHA all fall protection provided shall remain in the area to be used by other trades. Where cables already in place have to be disturbed by the erection process, the erector shall maintain a barricade or guardrail system that protects workers adjacent to the erection area and that excludes them from the hazards of the erection process. Prior to beginning work the erector will survey the area in which work must take place and acknowledge the adequacy of the guardrail system in place. Until the erection process is complete, the erector shall maintain control and responsibility of the fall protection until returned to the control of Davis in the original completed condition and by means of the document provided below. The following checklist is the document that transfers that responsibility in both directions as needed.

Upon acceptable completion of the following checklist DAVIS/Erector will assume responsibility for the maintenance of the fall protection for the specific area or entire floor as noted in item #6 below. Until that time employees of DAVIS or employees of other subcontractors are not permitted access to any area or floor not released to DAVIS.

1. Are all cable guardrails and other barriers in place?
2. Are floor opening covers in place, secured and marked “HOLE” or “COVER”?
3. Are perimeter cables in place and properly tensioned?
4. Are top rails flagged with bright color tape at 8’ intervals or orange/visible fence installed?
5. Is area below precast installation barricaded to keep workers free of overhead exposures during the operation?
6. Area or floor being released ____

THIS DOCUMENT TRANSFERS RESPONSIBILITY FOR FALL PROTECTION IN THE SPECIFIED AREA/AREAS ABOVE

FROM/TO (CIRCLE ONE)

General Contractor: JAMES G. DAVIS CONSTRUCTION CORPORATION

Name: ____

Title: ____

Date: ____

FROM/TO (CIRCLE ONE)

Precast Erector: ____

Name: ____

Title: ____

Date: ____

SUPPLEMENTAL SAFETY CONSIDERATIONS FOR PRECAST CONCRETE BUILDINGS & GARAGES

1. Confirm soil bearing capacity for the crane in all travel-ways.

2. Provide documentation for crane inspection prior to first lift.

3. Provide copy of load chart for the crane configuration to be used.

4. Compute the maximum radius and load to be encountered on this erection project.

5. Show location of adjacent buildings potentially impacted by erection of new structure and to show intended path of all lifts. At no time shall any load be lifted over other buildings.

6. Document limits for operation of crane in windy conditions.

7. Provide description of method for determining and verifying actual weight of all precast pieces.

8. Precast erector shall describe vehicular traffic plan including training and certification of all flaggers.

9. Crane operator is to provide documentation to Davis field office of pre-shift crane inspections.

10. Verify that all Safety Plan elements are presented to and agreed upon by all parties involved including <u>all</u> lower tier subcontractors.

Precast Preconstruction Meeting Attendance Sign In Sheet

Print Name and Company

Signature