SECTION 2
CLADDING SYSTEM

Exterior Insulation Finish Systems
Precast Concrete Curtain Wall Panel
Life Cycle Cost Analysis
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Schedule Analysis of Cladding System

SECTION 2: CLADDING SYSTEM

An analysis was conducted to compare the current EIFS exterior cladding system to the use of a precast concrete panel system. The purpose of this analysis is to investigate the life cycle costs, determine the maintenance schedule and associated costs, and provide a best value analysis.

Economics plays a major role in the choice of building products and systems. Criteria that must be considered include the following:

- Type/use of building
- Desired appearance
- Economic performance
- Building location
- Local trends & conditions

Type/use of Building

Minitab Headquarters is a commercial office building.

Desired Appearance

A clean line is the goal for the exterior appearance of the building. Seamless mullion ribbon windows and a smooth finish cladding system provide a neat, clean façade.

Economic Performance

Minitab, Inc. desired an efficient building. Therefore, they chose to use an exterior insulation system to minimize thermal breaks and minimize heat loss through the exterior walls. Redesign of the exterior system must maintain the R-value of the wall to ensure that the building maintains its current thermal efficiency.

Building Location

The building is located in State College, Pennsylvania.

Local Trends & Conditions

Exterior insulation finish systems are the most used exterior cladding system in commercial construction and this holds true in State College as well. The climate is fairly moist, especially from November through April.

CLADDING SYSTEM

Exterior Insulation Finish Systems

Exterior insulation finish systems (EIFS) were first introduced to the commercial sector in the United States over thirty years ago. Today they are the most widely used exterior cladding in commercial construction, making up nearly thirty percent of the market. EIFS Industry Members Association (EIMA) defines EIFS as follows:

> *A non-load bearing exterior wall cladding system consisting of an insulation board, an adhesive and/or mechanical attachment of the insulation board to the substrate, and an integrally reinforced base coat on the face of the insulation board, a protective finish applied to the surface of the base coat and applicable accessories that interact to form an energy efficient exterior wall.*

Exterior insulation finish systems offer a number of benefits over other cladding systems. EIFS provide exceptional energy efficiency by providing a thermal blanket for the building. Air infiltration is reduced by as much as fifty-five percent over cladding systems such as masonry and stone. By placing insulation on the exterior of the building, thermal breaks are substantially minimized, the interior environment is stabilized, and energy consumption is reduced. Thus, lower-capacity heating and cooling equipment can often be specified. EIFS provide great design flexibility. Ornate detailing can be achieved that would be cost prohibitive with other systems. The finish can be applied to suit the intent of the design, ranging from a smooth finish to rough stucco like texture and is available in a wide color spectrum. The benefits of the use of EIFS result in increased market share each year.

EIFS has received a bad reputation in the past due to susceptibility to moisture infiltration and resulting damage to the system. The key to performance of an EIF system is proper attention paid to design, detail, and installation. For these reasons, EIFS has performed well in commercial applications since each stage from design through construction is monitored by industry professionals. As a quality assurance measure, a requirement for most projects is a mock-up of the system that includes all major elements of the wall assembly, interfaces with windows and penetrations, sealants and expansion joints, flashing, etcetera. The efforts of professionals in the commercial construction industry have led to the successful use of EIFS.

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Precast Concrete Curtain Wall Panel

Precast concrete offers one of the most durable and cost efficient exterior claddings on the market. Precast offers the same benefits as the EIFS exterior without the reputation for moisture problems. Precast has virtually unlimited design possibilities. The concrete can be color infused and textured to achieve the desired finish effect. Rigid insulation is attached to the precast, providing the building with an exterior thermal barrier in order to maintain the insulating properties of the current design. The benefits to the use of precast is that it is low maintenance and is not vulnerable to moisture. It is resistant to moisture, rot, insects, fire and general wear. The use of precast can achieve the design criteria set forth for this project.

Figure 2.1 Precast concrete panel finish appearance.
(Houston Co. Spec., Perry, GA – Tindall Corporation)

Life Cycle Cost Analysis

As discussed in the above sections, both precast and EIFS have the ability to provide the desired finished effect for the Owner. In order to provide an accurate best value analysis a life cycle cost analysis for building systems including all relevant expenses for the building or building system must be factored into the analysis, including:

- Installation
- Maintenance & Repair
- Energy savings*
- Inflation

* *Energy savings is not calculated in the life cycle cost analysis due to the fact that in comparison of the two cladding systems an equal R-value was provided.*

The life cycle cost analysis for EIFS and precast concrete panels is based on methods and factors provided by *ASTM Standard Practice for Measuring Life Cycle Costs of Buildings and Building Systems*. For life cycle cost calculations, please refer to Appendix A at the end of this document.

The cost analysis is based on a thirty year study period. This period was chosen to be representative of maintenance schedules that will cycle after the thirty year period. Since EIFS has only been in use in the U.S. for approximately thirty years, it is difficult to determine maintenance requirements past this time frame. Many references suggest that at this point the entire EIFS façade may require replacement. For the purpose of this study, the life cycle analysis is limited to thirty years so that reliable data could be utilized and maintenance projections could be quantified.

Based on an exterior façade area of 23,000 SF the initial installation cost for the Class PB exterior insulation and finish system is $344,761. The assembly includes metal stud framing, cavity fiberglass batt insulation, 4 in. EPS insulation, and EIFS finish coating materials. Thirty year maintenance costs include cleaning of 100% of the EIFS at fifteen years at a time adjusted cost of $7,318 and cleaning and recoating at thirty years at an adjusted cost of $11,119. The total thirty-year life cycle cost estimate is $363,198.

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Also based on 23,000 SF the initial installation cost for the precast concrete curtainwall panels is $275,377; a $69,384 initial cost savings to EIFS. The assembly includes non-loadbearing metal studs at 16 in. on center, cavity fiberglass batt insulation, flat precast concrete panel with 2 in. of rigid insulation, and an additional 2 in. of rigid insulation to equal the insulating value of the EIFS with an R-20. Recommended maintenance includes recaulking the panels at twenty years for an adjusted cost of $30,925 and cleaning at year 25 for an adjusted cost of $6,183. The total thirty-year life cycle cost estimate for precast panels is $303,639; a $59,559 savings to the EIF system.

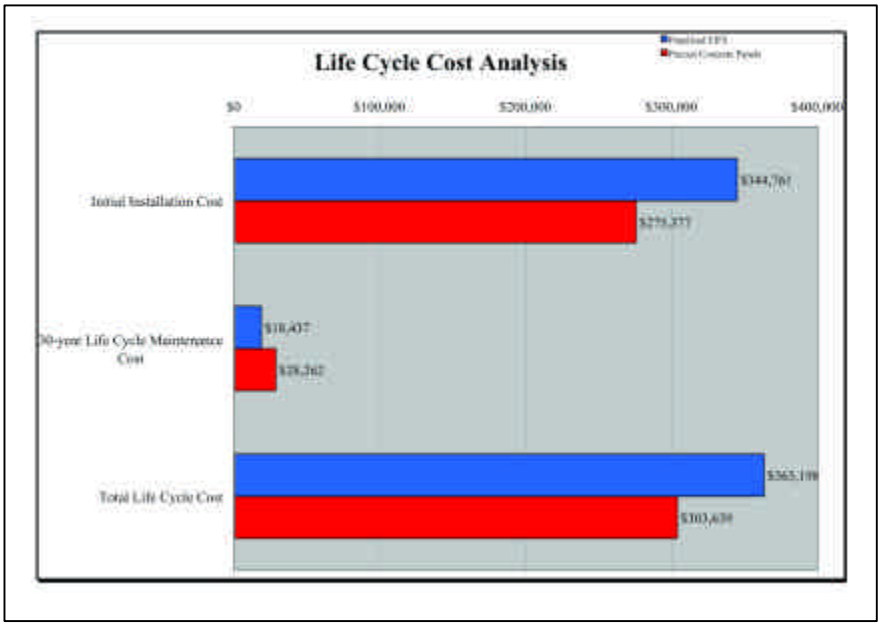

Figure 3.1 Thirty-year life cycle cost estimate of cladding systems – EIFS and precast concrete curtain wall system.

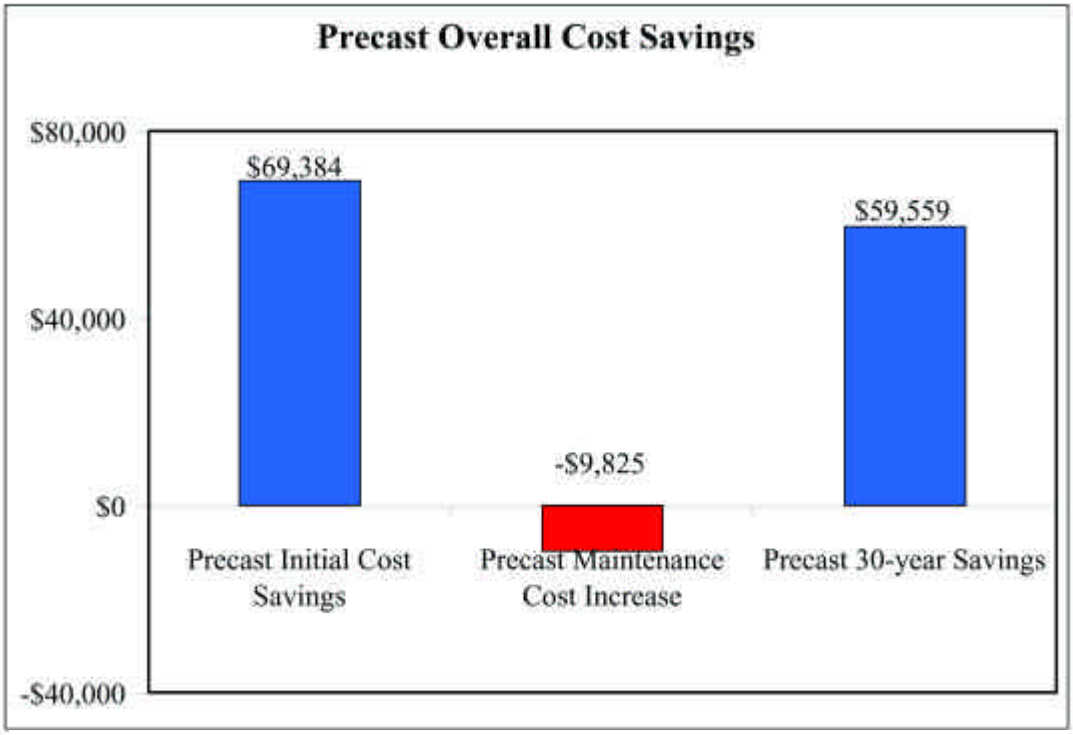

Figure 3.2 Life cycle cost savings of precast curtain wall system to EIF system.

Structural Impact of Cladding System

The structural frame of the building is bays which are typical 24'-0"x19'-9"/19'-5" (see 'Typical Structural Frame' Appendix B). The EIFS panels are connected to the perimeter beams by angles; shown in Figure 3.3. The precast panels are attached in a similar manner, but are only connected to the perimeter columns of the frame. Each panel spans the perimeter columns and therefore does not impose load on the beams. For purpose of a simplified structural analysis, a typical panel size of 24'-0" x 7'-3" was used. The weight of the EIFS panel includes 4 in. expanded polystyrene rigid insulation, heavyweight reinforcing mesh, and 20 ga., 6 in. metal studs at 16 in. on center for a total weight of 581 pounds per panel. The weight of the precast panel includes 4 in. expanded polystyrene rigid insulation and 6 in. lightweight concrete (50 pcf) for a total weight of 4,408 pounds per panel. The precast panel is 3,827 pounds heavier than the EIFS; the overall weight increase per bay with three panels per span is 11,481 pounds.

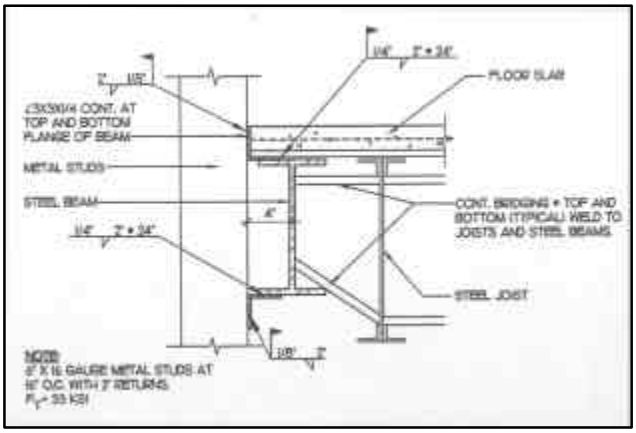

Figure 3.3 EIFS Panel Connection Detail

TABLE 3.1 *Panel Weight*

Cladding Assembly	Panel Size	Weight (per Panel)
EIFS Panel - 4 in. EPS insulation - Heavyweight reinforcing mesh - 20 ga., 6 in. metal studs @ 16" o.c.	24'-0" x 7'-3"	581 lbs.
Precast Panel - 6 in. lightweight concrete (50 pcf) - 4 in. EPS insulation	24'-0" x 7'-3"	4,408 lbs.

A structural analysis of the weight increase effect on the perimeter columns is included in Appendix B. Loading calculations include a tributary area of 242 sq.ft. with a total design load

increase of 8%; 13,777 pounds per bay. The total design load for the columns with the use of precast is 184 kips. The current steel frame design is W12x45 perimeter columns with a design load of 350 kips. To accommodate the increased load, the perimeter columns should be increased to a W12x50 with a design load of 393 kips; an increase in design load of 12.3%. There are thirty perimeter columns, each 38 feet in length, which will be up-sized by 5 lb/lf. The additional steel is 5,700 lbs. Based on the original GMP estimate, steel is $1,420/ton; for a total increase in structural steel of $4,047.

The adjusted installation cost savings of the precast system is $65,337 and the life cycle cost savings is $55,552.

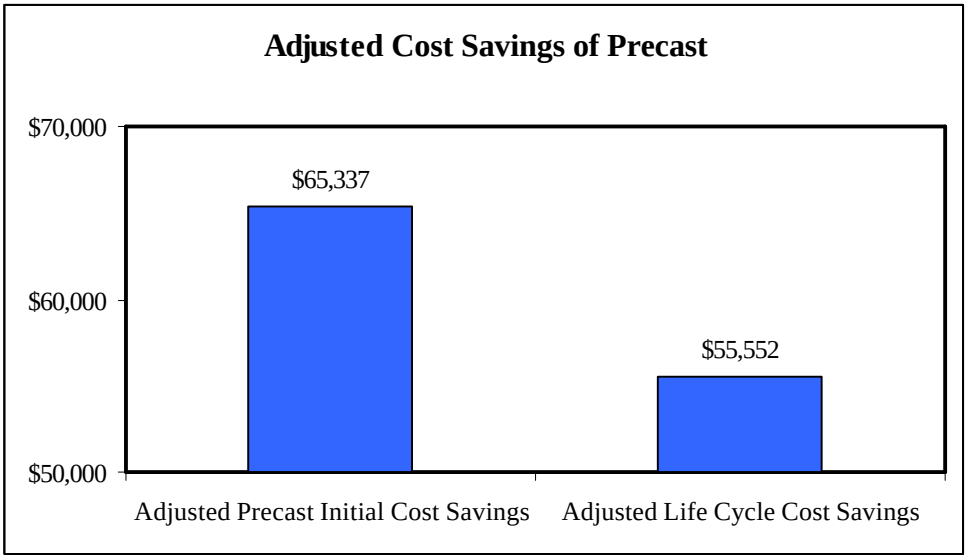

Figure 3.4 Adjusted precast cost savings.

Schedule Analysis of Cladding Systems

The activity prior to exterior cladding is erection of the structural steel. Immediately following the completion of the steel structure, installation of the prefabricated EIFS panels begins. These activities are both on the critical path as they directly effect the project schedule duration. Both the EIF system and the precast panel system require a total of fifty panels. Any time that can be saved in erection of the cladding system will result in potential early project completion. Figure 3.5 shows the original project schedule summary.

PROJECT SCHEDULE SUMMARY

Description	Duration	Start Date
PRE-CONSTRUCTION PHASE		
Schematic Design/Design Development	40	02JAN02
Design Approval	60	13MAR01
Approvals & Permits	110	21JUN01
CONSTRUCTION PHASE		
SITE		
Preliminary Site Work	120	29JUN01
Finish Site Work	165	21AUG02
STRUCTURE AND EXTERIOR SKIN		
Excavation	60	26JUN01
Footings & Foundations	50	20AUG01
CMU @ stairs	95	21SEP01
Underslab Roughin	35	21SEP01
Prep & pour slab on grade	40	10OCT01
Erect structural steel	40	12NOV01
Erect Decking @ 1st Floor	4	15NOV01
Erect Decking @ 2nd Floor	4	03DEC01
Slab on Deck - 1st Floor	4	05DEC01
Erect Decking @ 3rd Floor	4	21DEC01
Slab on Deck - 2nd Floor	4	21DEC01
Slab on Deck - 3rd Floor	4	04JAN02
Erect Roof Deck	5	09JAN02
Roofing	95	04JAN02
Prefabricated EIFS Panels South Wall	18	22JAN02
Prefabricated EIFS Panels West Wall	12	22JAN02
Prefabricated EIFS Panels North Wall	18	28JAN02
Prefabricated EIFS Panels East Wall	12	04MAR02
CMU @ elevator shaft walls	60	11MAR02
Windows Exterior West Wall	8	18MAR02
Windows Exterior North Wall	15	21MAR02
Windows Exterior South Wall	23	25MAR02
Windows Exterior East Wall	8	26MAR02
Install elevators	70	17APR02
INTERIOR FITOUT		
MEP Roughins	150	19DEC01
GWB soffits/acoustical ceiling grid	115	18MAR02
Drywall	105	19MAR02
Paint walls & soffits	70	13MAY02
Door frames, doors/hardware/casework	55	14JUN02
MEP Trimout	80	17JUN02
Floor coverings	30	12AUG02
Preliminary punchlist	25	11SEP02
COMMISIONING AND FF&E		
FF&E Selection and install	205	21DEC01
Testing and balancing	45	22AUG02
Final punchlist / substantial completion	5	22OCT02
Owner Occupancy	5	29OCT02

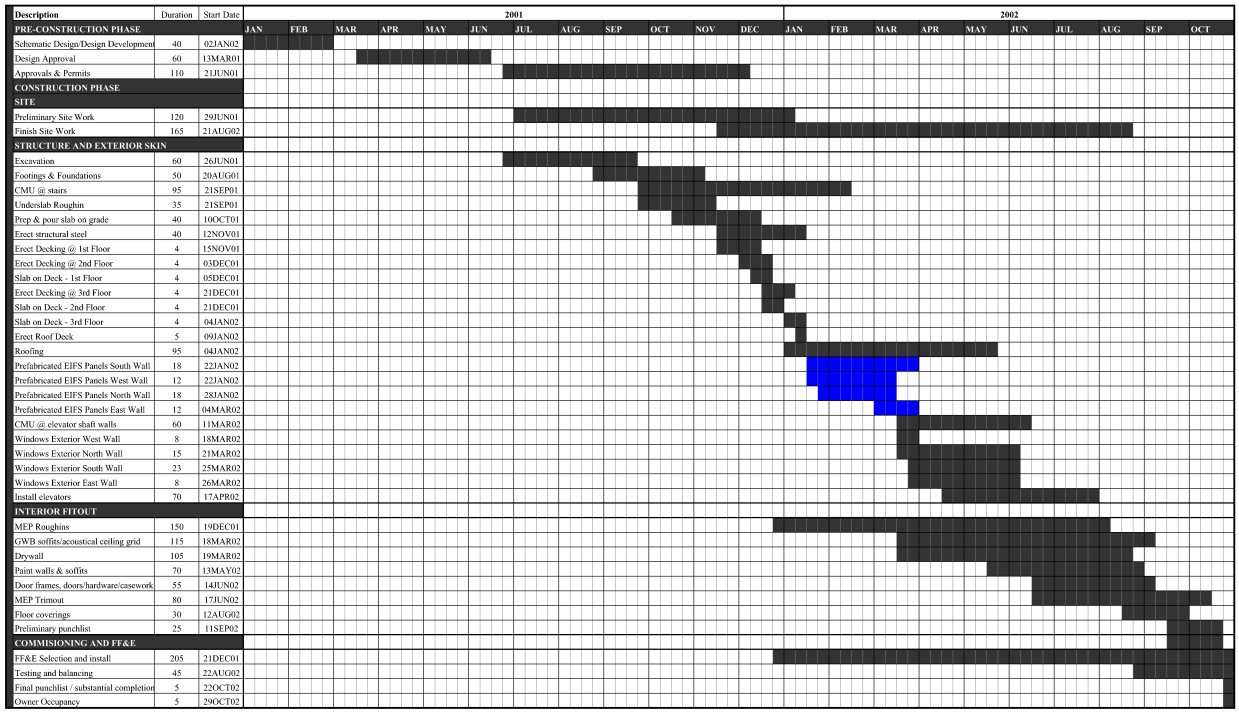

Figure 3.5 Original Project Schedule Summary *(11x17 format in Appendix C)*

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Schedule Analysis: Exterior Insulation Finish System

The schedule duration for the erection of the prefabricated EIFS panels is forty-eight days, an average of one panel per day. Originally it was planned to use the cranes that were used for the steel erection for EIFS panel installation. The installers found it more feasible to use a telescoping fork lift to hoist the panels into place and devised an attachment rigging. With each panel weighing only 581 pounds, the fork lift was able to perform this task with ease. The procedure for hoisting the panels is depicted below with the installation of the first panel.

Figure Prefabricated EIFS panels were hoisted into place with a special rigging attached to a fork lift. An average of 1 panel per day was raised by this method.

Though the actual schedule duration indicates a production rate of one panel per day, according to an activity duration analysis the crew will be installing eight panels per day. This is based on best case scenario. For purpose of accurate comparison, it is estimated that six panels per day will be installed using the fork lift method. Resulting in a total activity duration of nine days.

Panelized EIFS Installation Detail

ACTIVITY	DURATION
1. Attached panel to fork lift rigging.	10 min.
2. Maneuver forklift to panel installation location.	5 min.
3. Align panel with pre-installed steel angle attachments.	15 min.
4. Level and attach panel to structural steel frame.	30 min.
TOTAL EIFS PANEL INSTALLATION DURATION (per panel):	1 hour
TOTAL ACTIVITY DURATION:	**9 DAYS**

EIFS
ACTIVITY SCHEDULE

Description	Duration	NOV	DEC	JAN	FEB
Erect structural steel frame	40				
Prefabricated EIFS Panels	9				
Windows - Exterior	8				

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Schedule Analysis: Precast Concrete Curtain Wall Panels

Weighing in at just over 4,400 pounds, it is not conceivable to use a fork lift to hoist the precast panels into place. Therefore, the cranes used to erect the steel must remain to erect the precast panels. The process for erecting the precast panels is much the same as the procedure used for the EIFS panels. Each panel will be lifted from the staging area and maneuvered to the installation location. The panels are attached to the perimeter columns with steel angles welded to the columns and steel clips embedded in the precast. Based on a production rate of 2.25 hours per panel (see table), the duration to install 50 panels is nineteen days.

Precast Panel Installation Detail

ACTIVITY	DURATION
1. Attached panel to crane rigging.	15 min.
2. Maneuver panel to installation location.	30 min.
3. Align panel with pre-installed steel angle attachments.	30 min.
4. Level and attach panel to structural steel frame.	60 min.
TOTAL EIFS PANEL INSTALLATION DURATION:	2.25 hours
TOTAL ACTIVITY DURATION:	**19 DAYS**

PRECAST PANEL ACTIVITY SCHEDULE

Description	Duration	NOV	DEC	JAN	FEB
Erect structural steel frame	40				
Precast Panels	19				
Windows - Exterior	8				

Summary of Activity Duration for Alternate Cladding Systems

Cladding System	Production Rate	Number of Panels	Total Activity Duration
EIFS Panels	**1.0 hour/panel**	**50**	**9 days**
Precast Panels	**2.25 hour/panel**	**50**	**19 days**

Alternate Cladding Systems Analysis Conclusions

Analyses conducted to compare the current EIFS exterior cladding system to the alternate use of a precast concrete panel system result in a first cost savings of $69,384. Precast panels' thirty year life cycle cost analysis yield maintenance costs of $28,262 while the maintenance costs over a thirty year period for EIFS are calculated at $18,437. Thus, based on life cycle cost analysis, the cost saving for using the alternate precast panel system is $59,559. The use of precast panels results in an increased curtainwall load of 13,777 pounds per structural bay; an overall increase in structural steel required of 2.85 tons or $4,047. The result is a decrease in first cost savings to $65,337. An overall life cycle cost savings of $55,512, a 16% savings on the exterior cladding budget and a 0.5% savings on the project estimated cost. Schedule impact of using the precast panel system results in an activity duration extension for the exterior cladding of ten days. The overall project schedule will be extended due to the fact that the cladding activity is on the critical path of the project. A ten day extension in time may be compensated by the substantial cost savings and it is possible that this time will be made up in other areas of construction. Precast concrete offers superior durability and moisture protection. Coupled with the associated cost savings, precast is a preferable system to utilize for the exterior cladding of Minitab Headquarters.