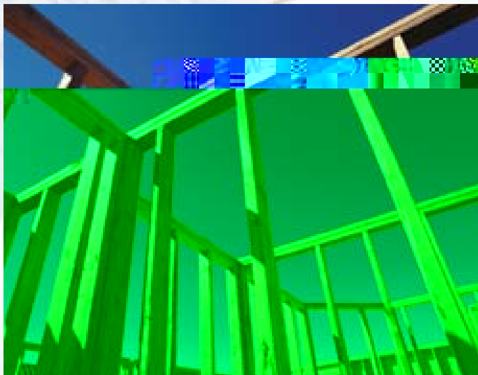

Fire Safe Construction
Cost Comparison Study

Executive Summary Report

Fire Safe Construction
Cost Comparison Study
Executive Summary Report

November 2, 2005
Commission Number 05119

Prepared By:

Haas Architects Engineers
1301 North Atherton Street
State College, Pennsylvania

Sponsored By:

New England/New York Fire Safety Construction Advisory Council
Pennsylvania Fire Safe Construction Advisory Council
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Cover Photo (center): Virginia Commonwealth University Fire
Photo by Bob Brown, © Richmond Times-Dispatch

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Introduction

With the phasing out of the three predominate model codes, BOCA National Building Code, Southern Building Code, and Uniform Building Code, and implementation of the new International Building Code and associated family of codes, there has been a shift in the approach to fire safety in the built environment. This shift has been characterized as a shift away from the use of passive construction techniques, such as compartmentalization and the use of fireproof construction materials, in favor of an increased reliance on active fire control techniques such as sprinkler systems, allowing for construction to occur using materials that are more susceptible to fire damage.

In conjunction with this shift there are also reservations with the current ASTM (American Society for Testing and Materials) methodology for testing fire assemblies ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials. This test allows for the removal and replacement of the fire tested specimen prior to the initiation of the hose stream test. This test combination is intended to model the effects of the application of a fire suppression stream immediately after the intense heat from a compartment fire. The effect of this provision is that the specimen is a virgin test specimen when the fire suppression stream is applied, theoretically allowing certain materials to artificially perform at a higher level than would be expected in the field.

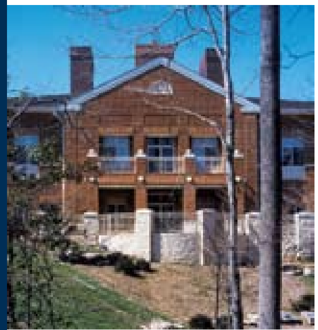
In addition, it has long been the opinion of legislators, code-officials, and design professionals that non-combustible concrete construction solutions are more costly than other alternatives such as gypsum fire walls with sprinklers.

Due to the perception of elevated cost, and the aforementioned code and testing issues, the acceptance of a balanced design approach incorporating both passive and active protection systems has met with resistance. Passive design incorporates the compartmentalization of the fire, limiting fire spread and protecting both the building occupants and the responding firefighters. This system is in place at all times and is not subject to failure due to the loss of utility service. An example of this is the incorporation of fireproof materials in the construction of floors and walls used for fire control. The active portion of the design uses a combination of detection systems to warn occupants, and sprinklers to control fire spread until the fire department arrives.

Currently, there is no reliable published documentation available to refute the perception regarding the increased building cost associated with this approach. Based on this lack of information, the design of a comparative study was undertaken to accurately document the increased cost associated with the use of balanced design in a common multi-family residential building. It is our pleasure to present the outcomes of this study.

Objectives

The objective of this study was to develop a construction cost model to accurately evaluate the relative construction cost of a multi-family building constructed using five different construction materials. The concept of multi-family would include traditional apartment type buildings, condominium style buildings, student housing, elderly housing, and others.



Methodology

Introduction

To accurately evaluate the relative construction cost between each of the five building systems, it was determined that a multi-family residential structure should be schematically designed meeting all of the requirements of the International Building Code 2003 edition. Once designed, the building would be reviewed for code compliance, and cost estimates would be prepared for the building using each of the different building systems.

The design team assembled included:

ARCHITECT & ENGINEER: *Haas Architects Engineers*

CODE OFFICIAL: *Tim E. Knisely*

COST ESTIMATION: *Poole Anderson Construction*

Haas Architects Engineers is a multi-disciplinary architectural and engineering firm located in State College, Pennsylvania with a thirty year history of client centered service including commercial, single and multi-family residential, retail, and sports based projects. Some projects include the Bryce Jordan Center and 2001 Beaver Stadium Expansion, both at The Pennsylvania State University.

Tim E. Knisely is a senior fire and commercial housing inspector for the Centre Region Code Administration, in State College, Pennsylvania. Mr. Knisely currently holds a certification as a registered Building Code Official in the Commonwealth of Pennsylvania and holds more than eight certifications from the International Code Council. In addition, Mr. Knisely has been involved in the fire service for more than 20 years.

Poole Anderson Construction is one of the largest building contractors in Central Pennsylvania with a 75 year history and an annual construction volume exceeding 60,000,000 dollars.

A firm profile for Haas Architects Engineers and Poole Anderson Construction is provided in Appendix A* along with resumes for each of the professionals involved with the project.

Building Model

The building model chosen for the project was a 4 story multi-family residential structure encompassing approximately 25,000 gross square feet of building area per floor. Based on the proposed target building types, it was decided that to better evaluate the relative construction costs, two different floor layouts would be used. The first model is a building comprised exclusively of single bedroom dwelling units. The second model is assembled using a mix of one and two bedroom dwelling units.

The combination of the two different layout considerations would more realistically address the variety of construction configurations commonly found in the multi-family dwelling marketplace. Schematic floor plans, elevations and detailed wall sections for each of the building models are provided. In Appendix B* full size copies of these are provided for additional clarity.

*Appendix is part of a total report of 800 pages.






Construction Types

The following construction types and alternates were evaluated:

- Conventional wood framing with wood floor system (Type 5B Construction)
  Alternate: Conventional wood framing with wood floor system (Type 5A Construction)
- Light Gauge Steel Framing with cast-in-place concrete floor system on metal form deck
- Load bearing concrete masonry construction with precast concrete plank floor system
  Alternate: Cast-in-place concrete floor system
- Precast concrete walls and precast concrete floor system
- Insulated Concrete Form (ICF) walls and precast concrete plank floor system
  Alternate: Cast-in-place concrete floor system
  Alternate: Interior bearing walls constructed of concrete masonry units (CMU)

With respect to the conventional wood framing system presented, the primary system is an un-protected construction Type 5B with an alternate of protected construction Type 5A. The additional construction type was presented since the Type 5B construction is not permitted to be used for a building of this type that is four stories tall. For the proposed use and construction height using conventional wood frame Type 5A would need to be used. Both systems are presented since the remaining systems are presented as un-protected framing systems.

For all systems other than the conventional wood frame systems, it was assumed that the partition walls within the dwelling unit would be constructed using metal stud finished with gypsum board.

Code Review

Once design was completed on each of the buildings, Mr. Knisely performed a detailed code review following the requirements of the International Building Code 2003 edition. This review was conducted following the plan review forms provided by the International Code Council. This review was in addition to the review performed internally by the professionals at Haas Architects Engineers.

The reader is alerted to the fact that there are a number of items that are common to all of the buildings that were not addressed in this study and that are missing from the code review forms. These items are typically dealing with site issues, soils information, etc. All of these items are common to each of the buildings and would add identical cost to each project. This was verified with the cost estimation personnel at Poole Anderson Construction.

Cost Estimation

To increase the direct applicability of the cost study a decision was made to complete the study in three different locations. The locations were chosen by each of the contributing groups, feeling that they represented the construction climate in their respective area. The locations chosen are as follows:

- Framingham, Massachusetts
- Harrisburg, Pennsylvania
- Towson, Maryland
- Albany, New York (added after completion of the original study)

In addition to the original three cities listed above, alternate metropolitan areas were investigated. Only the results relevant to the South region (listed below) are reported herein:

- Athens, Georgia
- Savannagh, Georgia
- Charlotte, North Carolina
- Raleigh, North Carolina
- Columbia, South Carolina

To allow for a fair and uniform comparison of the construction costs between trades it was determined that the cost study would use accepted prevailing wage rates published for each of the locations. These labor rates would be typical for a publicly funded project and will allow for a fair labor comparison, eliminating potential undercutting by any of the trades.

The cost estimate for each building model included the complete fit out of each building with the exception of movable appliances and furniture.

Results and Discussion

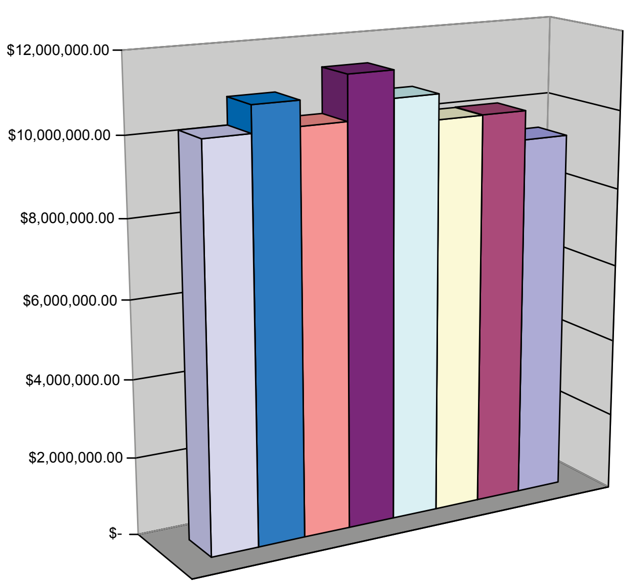
The results of the construction cost study for each geographic location are presented in the following tables. The relative cost presented is a percentage of the minimum cost system presented.

Columbia, SOUTH CAROLINA

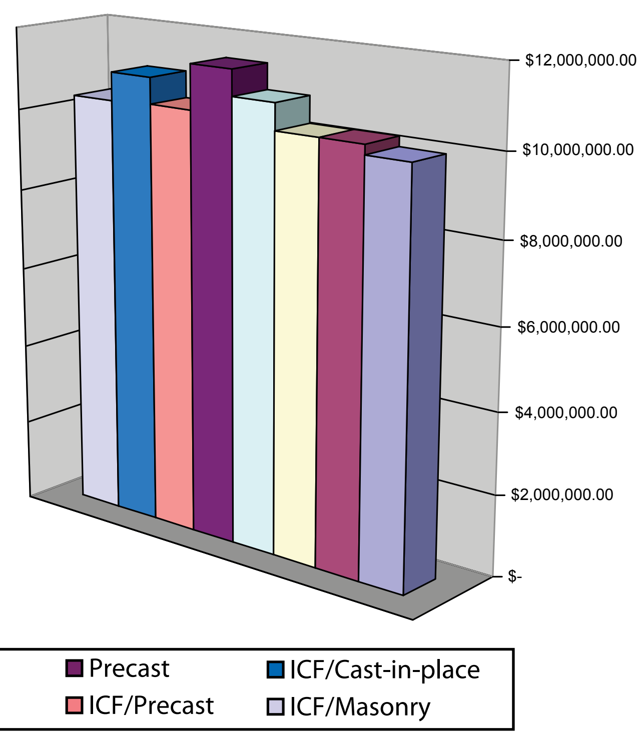
Building System	Cost	Relative Cost
Conventional Wood Framing Single Bedroom Scheme	$11,536,117.00	100
Stories Only	$ 9,323,705.00	
Conventional Wood Framing Mixed Bedroom Scheme	$11,993,226.00	100
3 Stories Only	$ 9,585,726.00	
Light Gauge Steel Framing Single Bedroom Scheme	$11,991,669.00	104
Light Gauge Steel Framing Mixed Bedroom Scheme	$12,297,143.00	103
Masonry & Precast Single Bedroom Scheme	$12,140,211.00	105
Masonry & Precast Mixed Bedroom Scheme	$12,276,406.00	102
Form In Place Concrete Floor Alternate (Single)	$13,463,378.00	117
Form In Place Concrete Floor Alternate (Mixed)	$13,667,826.00	114
Precast Construction Single Bedroom Scheme	$13,780,169.00	120
Precast Construction Mixed Bedroom Scheme	$13,851,510.00	116
ICF Walls & Precast Plank Single Bedroom Scheme	$12,279,484.00	106
ICF Walls & Precast Plank Mixed Bedroom Scheme	$12,445,030.00	104
Form In Place Concrete Floor Alternate (Single)	$13,901,442.00	121
Form In Place Concrete Floor Alternate (Mixed)	$14,154,962.00	118
Interior CMU Walls Alternate (Single)	$12,141,508.00	105
Interior CMU Walls Alternate (Mixed)	$12,262,224.00	102

The least expensive system for the single bedroom building is the conventional wood framing system; however the load bearing masonry wall system with precast concrete plank floor system was the least expensive system for the mixed bedroom building. The most expensive building system was found to be the insulated concrete form wall system with cast-in-place concrete floor with an increased cost of 20 percent for the single bedroom system. For the mixed bedroom building the precast concrete wall system with cast-in-place concrete floor system was deemed to be most expensive with an increased cost of 14 percent.

Columbia, South Carolina Single Bedroom



Columbia, South Carolina Mixed Bedroom

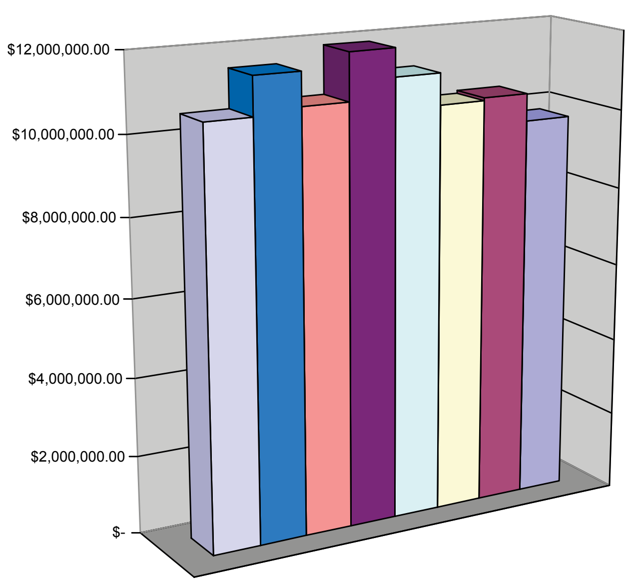


Charlotte, NORTH CAROLINA

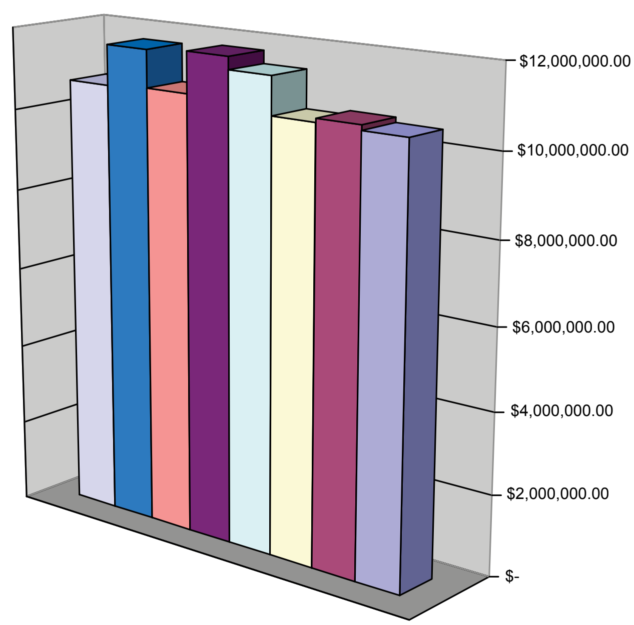
Building System	Cost	Relative Cost
Conventional Wood Framing Single Bedroom Scheme	$ 9,779,168.00	100
3 Stories Only	$ 7,500,568.00	
Conventional Wood Framing Mixed Bedroom Scheme	$10,505,962.00	100
3 Stories Only	$ 8,047,545.00	
Light Gauge Steel Framing Single Bedroom Scheme	$10,468,503.00	107
Light Gauge Steel Framing Mixed Bedroom Scheme	$10,630,854.00	101
Masonry & Precast Single Bedroom Scheme	$10,395,114.00	106
Masonry & Precast Mixed Bedroom Scheme	$10,535,671.00	100
Form In Place Concrete Floor Alternate (Single)	$11,183,589.00	114
Form In Place Concrete Floor Alternate (Mixed)	$11,451,411.00	109
Precast Construction Single Bedroom Scheme	$11,884,830.00	122
Precast Construction Mixed Bedroom Scheme	$11,760,470.00	112
ICF Walls & Precast Plank Single Bedroom Scheme	$10,691,266.00	109
ICF Walls & Precast Plank Mixed Bedroom Scheme	$10,770,580.00	103
Form In Place Concrete Floor Alternate (Single)	$11,527,079.00	118
Form In Place Concrete Floor Alternate (Mixed)	$11,686,321.00	111
Interior CMU Walls Alternate (Single)	$10,560,446.00	108
Interior CMU Walls Alternate (Mixed)	$10,699,491.00	102

The least expensive system for the single bedroom building is the conventional wood framing system; however the load bearing masonry wall system with precast concrete plank floor system was the least expensive system for the mixed bedroom building. The most expensive building system was found to be the insulated concrete form wall system with cast-in-place concrete floor with an increased cost of 20 percent for the single bedroom system. For the mixed bedroom building the precast concrete wall system with cast-in-place concrete floor system was deemed to be most expensive with an increased cost of 14 percent.

Charlotte, North Carolina Single Bedroom



Charlotte, North Carolina Mixed Bedroom

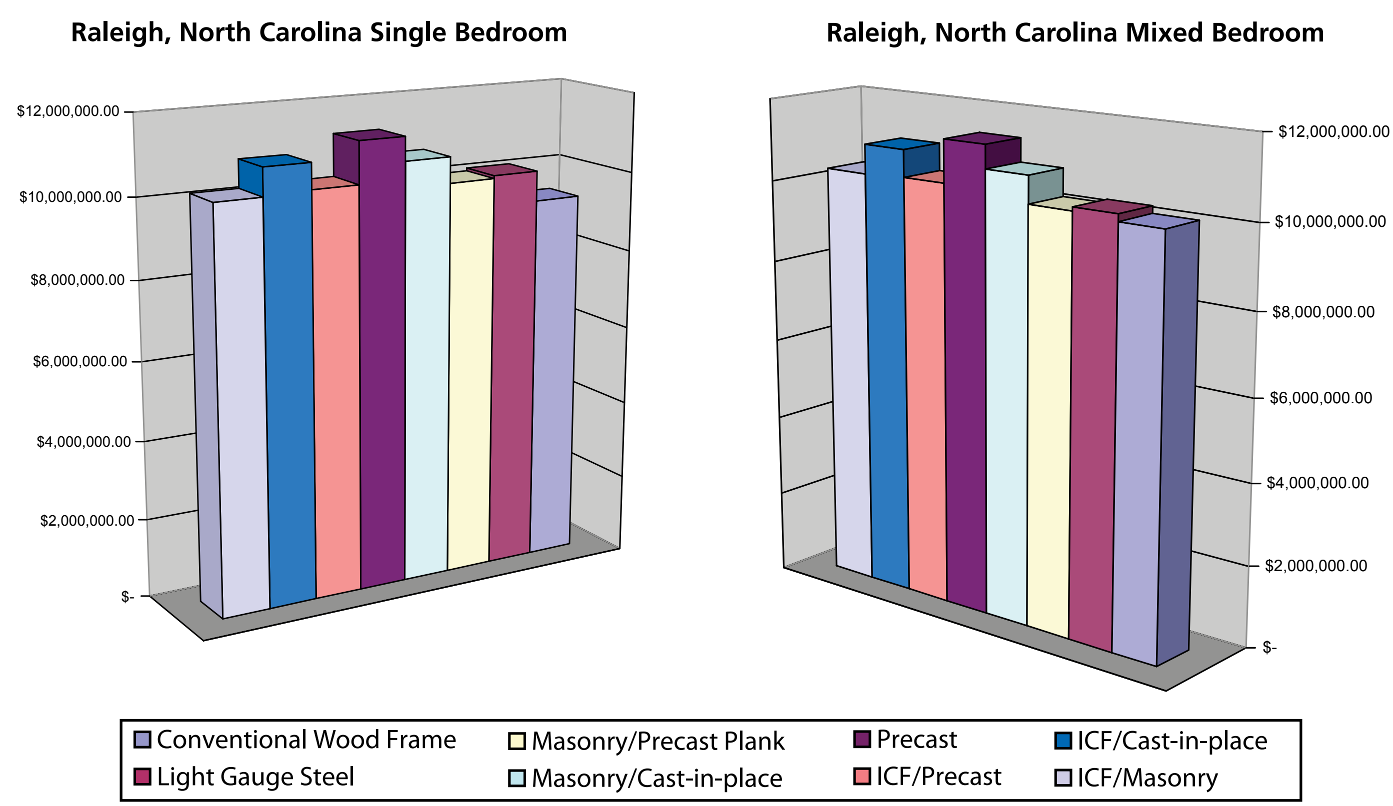


Conventional Wood Frame	Masonry/Precast Plank	Precast	ICF/Cast-in-place
Light Gauge Steel	Masonry/Cast-in-place	ICF/Precast	ICF/Masonry

Raleigh, NORTH CAROLINA

Building System	Cost	Relative Cost
Conventional Wood Framing Single Bedroom Scheme	$ 9,339,410.00	100
3 Story Only	$ 7,157,624.00	
Conventional Wood Framing Mixed Bedroom Scheme	$10,069,094.00	100
3 Story Only	$ 7,660,356.00	
Light Gauge Steel Framing Single Bedroom Scheme	$10,085,412.00	108
Light Gauge Steel Framing Mixed Bedroom Scheme	$10,240,311.00	102
Masonry & Precast Single Bedroom Scheme	$10,013,283.00	107
Masonry & Precast Mixed Bedroom Scheme	$10,154,542.00	101
Form In Place Concrete Floor Alternate (Single)	$10,662,778.00	114
Form In Place Concrete Floor Alternate (Mixed)	$10,817,308.00	107
Precast Construction Single Bedroom Scheme	$11,257,204.00	121
Precast Construction Mixed Bedroom Scheme	$11,386,754.00	113
ICF Walls & Precast Plank Single Bedroom Scheme	$10,210,912.00	109
ICF Walls & Precast Plank Mixed Bedroom Scheme	$10,346,245.00	103
Form In Place Concrete Floor Alternate (Single)	$10,854,250.00	116
Form In Place Concrete Floor Alternate (Mixed)	$11,009,013.00	109
Interior CMU Walls Alternate (Single)	$10,153,111.00	109
Interior CMU Walls Alternate (Mixed)	$10,287,667.00	102

The least expensive system for the single bedroom building is the conventional wood framing system. However, the load bearing masonry wall system with precast concrete plank floor system proved equal in cost to the conventional wood frame system in the mixed bedroom scheme. The most expensive building system was found to be the insulated concrete form wall system with cast-in-place concrete floor with an increased cost of 24% in the single bedroom scheme, and 19% in the mixed bedroom scheme. The insulated concrete form wall system combined with precast plank flooring and interior concrete masonry walls compared very favorably with both the wood framing and light gauge steel alternatives.

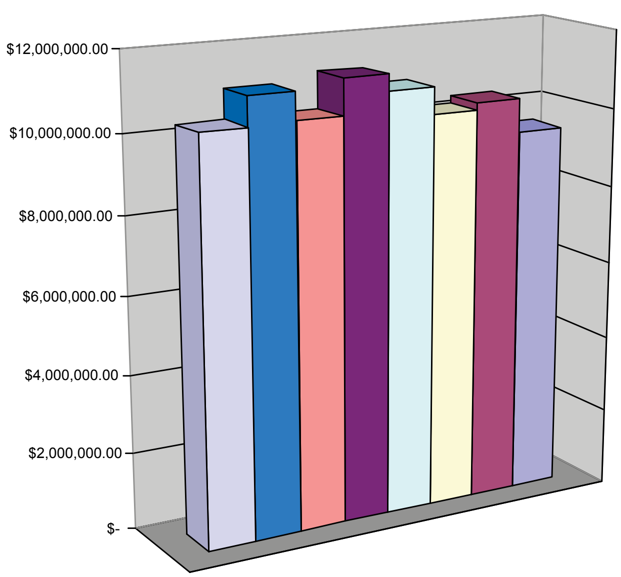


Athens, GEORGIA

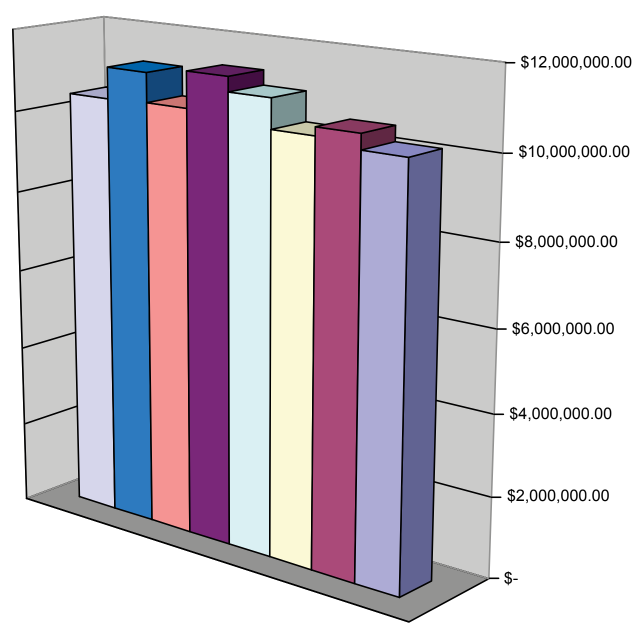
Building System	Cost	Relative Cost
Conventional Wood Framing Single Bedroom Scheme	$ 9,459,837.00	100
3 Stories Only	$ 7,247,175.00	
Conventional Wood Framing Mixed Bedroom Scheme	$10,117,846.00	100
3 Stories Only	$ 7,749,000.00	
Light Gauge Steel Framing Single Bedroom Scheme	$10,307,073.00	109
Light Gauge Steel Framing Mixed Bedroom Scheme	$10,486,005.00	104
Masonry & Precast Single Bedroom Scheme	$10,129,190.00	107
Masonry & Precast Mixed Bedroom Scheme	$10,275,336.00	102
Form In Place Concrete Floor Alternate (Single)	$10,825,044.00	114
Form In Place Concrete Floor Alternate (Mixed)	$10,992,418.00	109
Precast Construction Single Bedroom Scheme	$11,228,505.00	119
Precast Construction Mixed Bedroom Scheme	$11,346,884.00	112
ICF Walls & Precast Plank Single Bedroom Scheme	$10,320,039.00	109
ICF Walls & Precast Plank Mixed Bedroom Scheme	$10,471,051.00	103
Form In Place Concrete Floor Alternate (Single)	$11,019,449.00	116
Form In Place Concrete Floor Alternate (Mixed)	$11,188,092.00	111
Interior CMU Walls Alternate (Single)	$10,277,053.00	109
Interior CMU Walls Alternate (Mixed)	$10,425,698.00	103

The least expensive system for both building models is the conventional wood framing system. The relative cost of the most expensive framing system, the insulated concrete form system with cast-in-place concrete floor is 21 percent and 18 percent higher for the single bedroom model and mixed bedroom model respectively. The load bearing masonry wall system with precast concrete plank floor system and insulated concrete form wall system with precast concrete plank floor system both compare very favorably with both the conventional wood frame system and the light gauge steel framing system, with an increased cost of less than 6 percent over the conventional wood frame system.

Athens, Georgia Single Bedroom



Athens, Georgia Mixed Bedroom



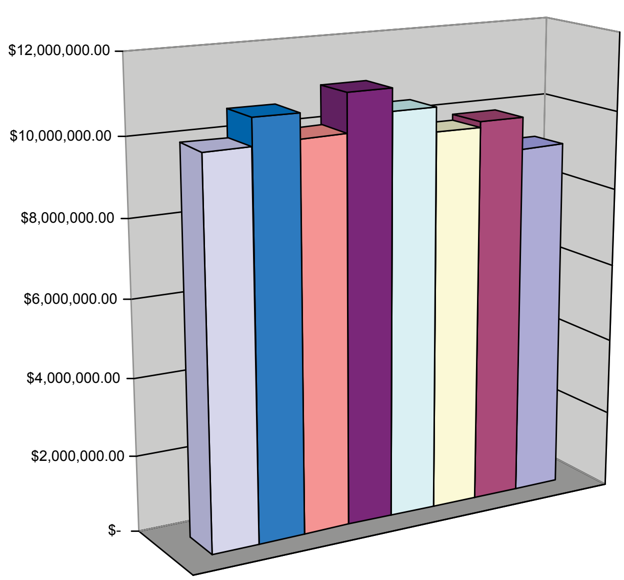
Conventional Wood Frame · Masonry/Precast Plank · Precast · ICF/Cast-in-place
Light Gauge Steel · Masonry/Cast-in-place · ICF/Precast · ICF/Masonry

Savannah, GEORGIA

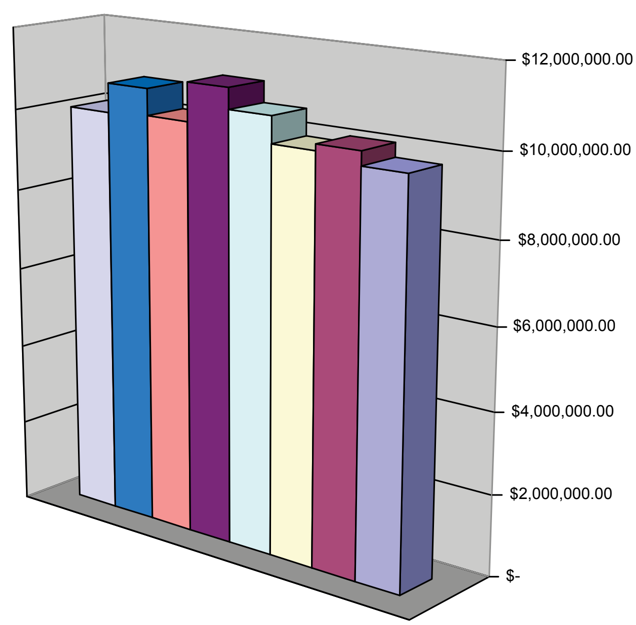
Building System	Cost	Relative Cost
Conventional Wood Framing Single Bedroom SCHEME	$ 9,092,906.00	100
3 Stories Only	$ 6,976,958.00	
Conventional Wood Framing Mixed Bedroom Scheme	$ 9,722,817.00	100
3 Stories Only	$ 7,452,788.00	
Light Gauge Steel Framing Single Bedroom Scheme	$ 9,908,443.00	109
Light Gauge Steel Framing Mixed Bedroom Scheme	$10,059,557.00	103
Masonry & Precast Single Bedroom Scheme	$ 9,755,867.00	107
Masonry & Precast Mixed Bedroom Scheme	$ 9,900,002.00	102
Form In Place Concrete Floor Alternate (Single)	$10,392,118.00	114
Form In Place Concrete Floor Alternate (Mixed)	$10,541,285.00	108
Precast Construction Single Bedroom Scheme	$10,941,806.00	120
Precast Construction Mixed Bedroom Scheme	$11,049,650.00	114
ICF Walls & Precast Plank Single Bedroom Scheme	$ 9,962,721.00	110
ICF Walls & Precast Plank Mixed Bedroom Scheme	$10,115,847.00	104
Form In Place Concrete Floor Alternate (Single)	$10,587,431.00	116
Form In Place Concrete Floor Alternate (Mixed)	$10,761,116.00	111
Interior CMU Walls Alternate (Single)	$ 9,900,066.00	109
Interior CMU Walls Alternate (Mixed)	$10,045,235.00	103

The least expensive system for both building models is the conventional wood framing system. The relative cost of the most expensive framing system, the insulated concrete form system with cast-in-place concrete floor is 24 percent and 20 percent higher for the single bedroom model and mixed bedroom model respectively. The load bearing masonry wall system with precast concrete plank floor system and insulated concrete form wall system with precast concrete plank floor system both compare very favorably with both the conventional wood frame system and the light gauge steel framing system, with an increased cost of less than 6 percent over the conventional wood frame system.

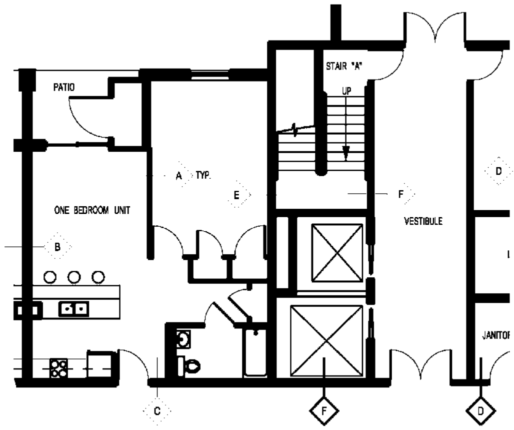
Savannah, Georgia Single Bedroom



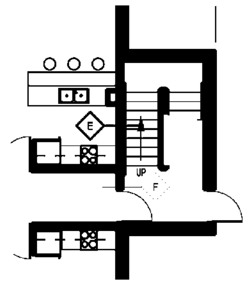
Savannah, Georgia Mixed Bedroom



Conventional Wood Frame | Masonry/Precast Plank | Precast | ICF/Cast-in-place
Light Gauge Steel | Masonry/Cast-in-place | ICF/Precast | ICF/Masonry



1 ENLARGED WOOD CONSTRUCTION PLAN
A10.1 SCALE: 1/8" = 1'-0"



4 ENLARGED WOOD CONSTRUCTION PLAN
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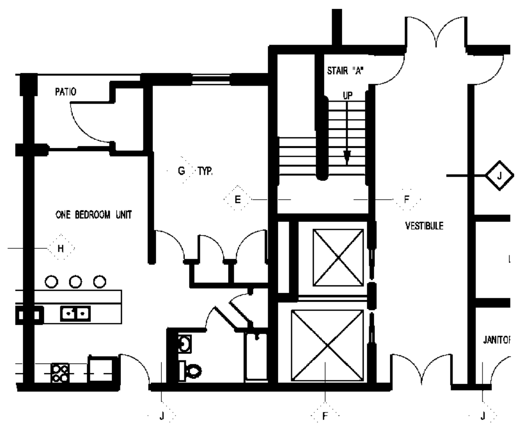

2 ENLARGED METAL STUD CONSTRUCTION PLAN
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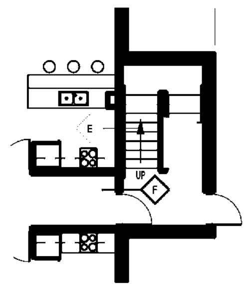

5 ENLARGED METAL STUD CONSTRUCTION PLAN
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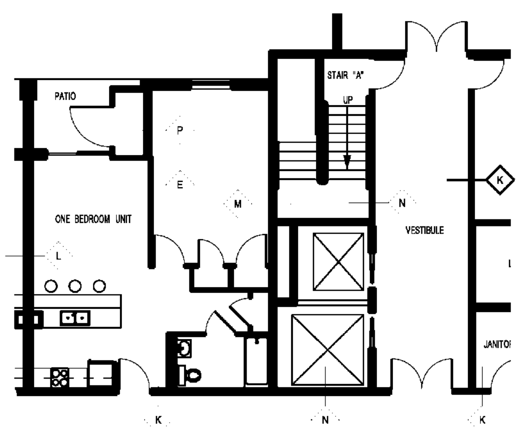

3 ENLARGED MASONRY / PRECAST CONSTRUCTION PLAN
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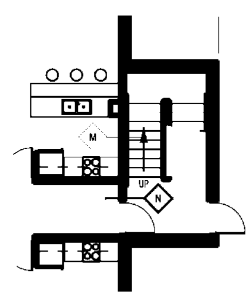


6 ENLARGED MASONRY / PRECAST CONSTRUCTION PLAN
A10.1 SCALE: 1/8" = 1'-0"

NOT FOR CONSTRUCTION

A10.1

ENLARGED PLANS AND PARTITION TYPES

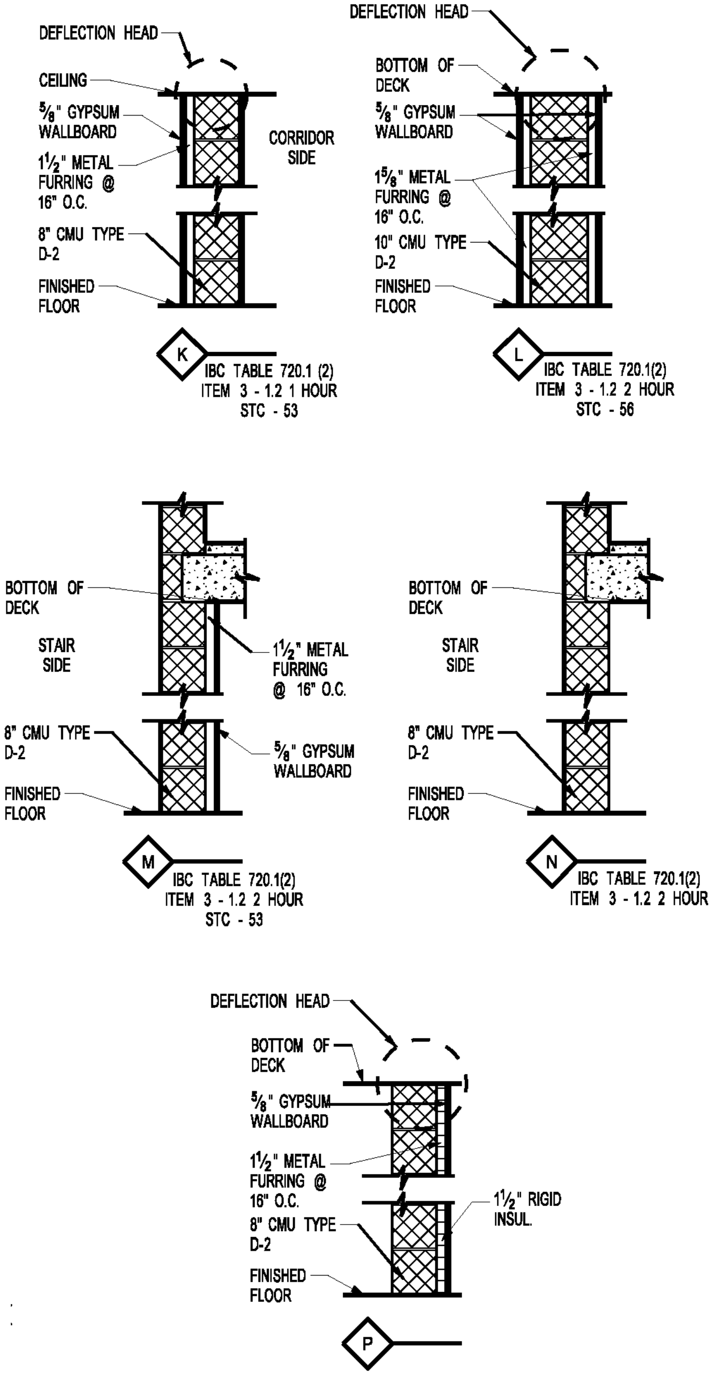
05119

CMC

OCTOBER 19, 2005

BUILDING COST COMPARISON STUDY

HAAS ARCHITECTS ENGINEERS



7 A10.1 PARTITION TYPES
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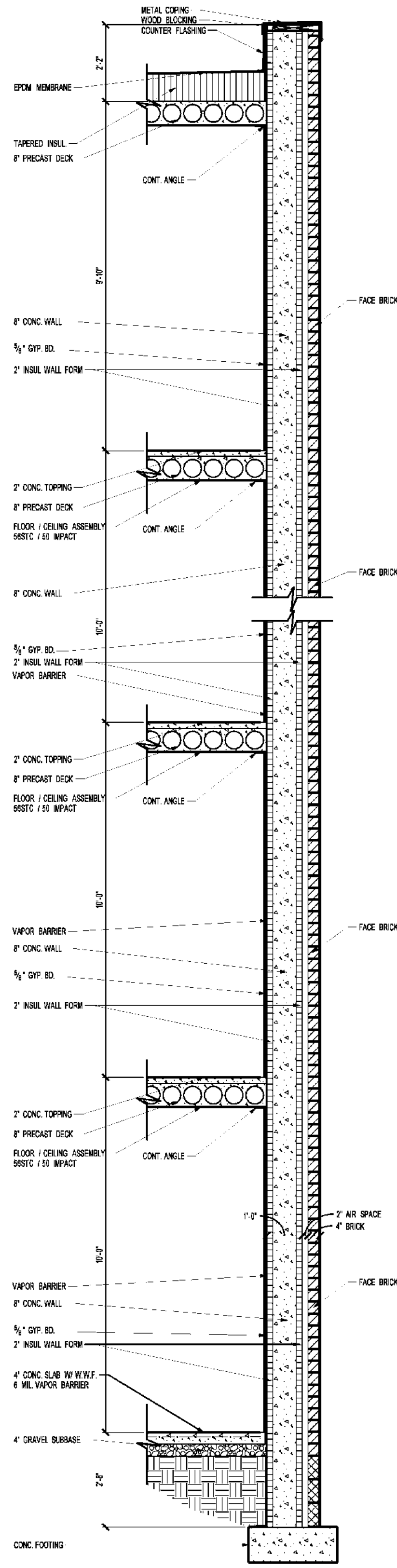
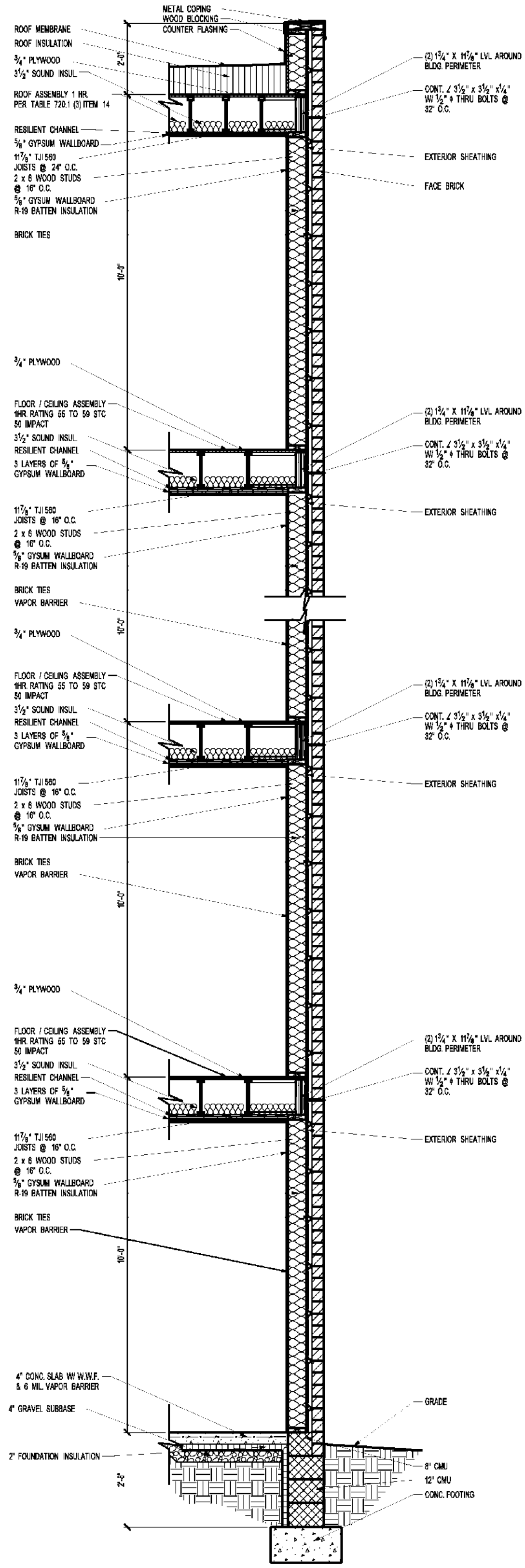


NOT FOR CONSTRUCTION

A10.2 ENLAGED PLANS AND WALL SECTION	COMM NO.: 05119	DRAWN: CMC CHECKED:	REV DATE:	DATE: OCTOBER 19, 2005	SCALE:

BUILDING COST COMPARISON STUDY

HAAS ARCHITECTS ENGINEERS
1301 NORTH ATHERTON STREET • STATE COLLEGE PA 16803 • 814-238-1551
FAX : 814-238-8046 www.HaasAEP.com mail@HaasAEP.com



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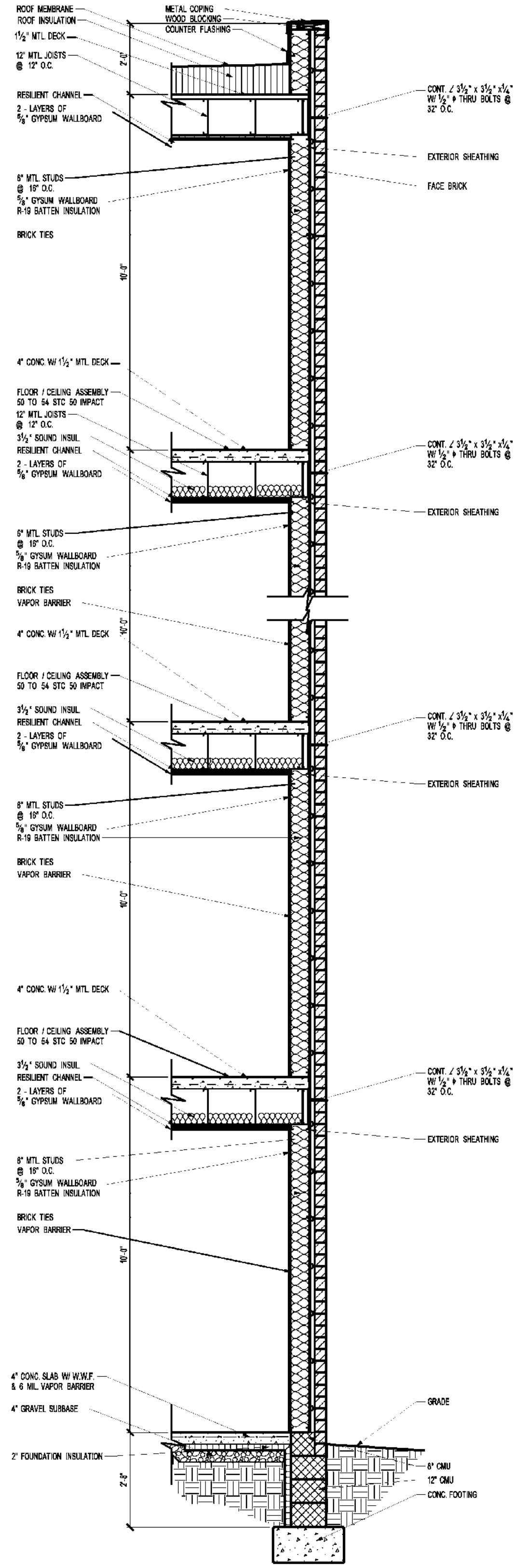

2 METAL STUD CONSTRUCTION SECTION
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NOT FOR CONSTRUCTION

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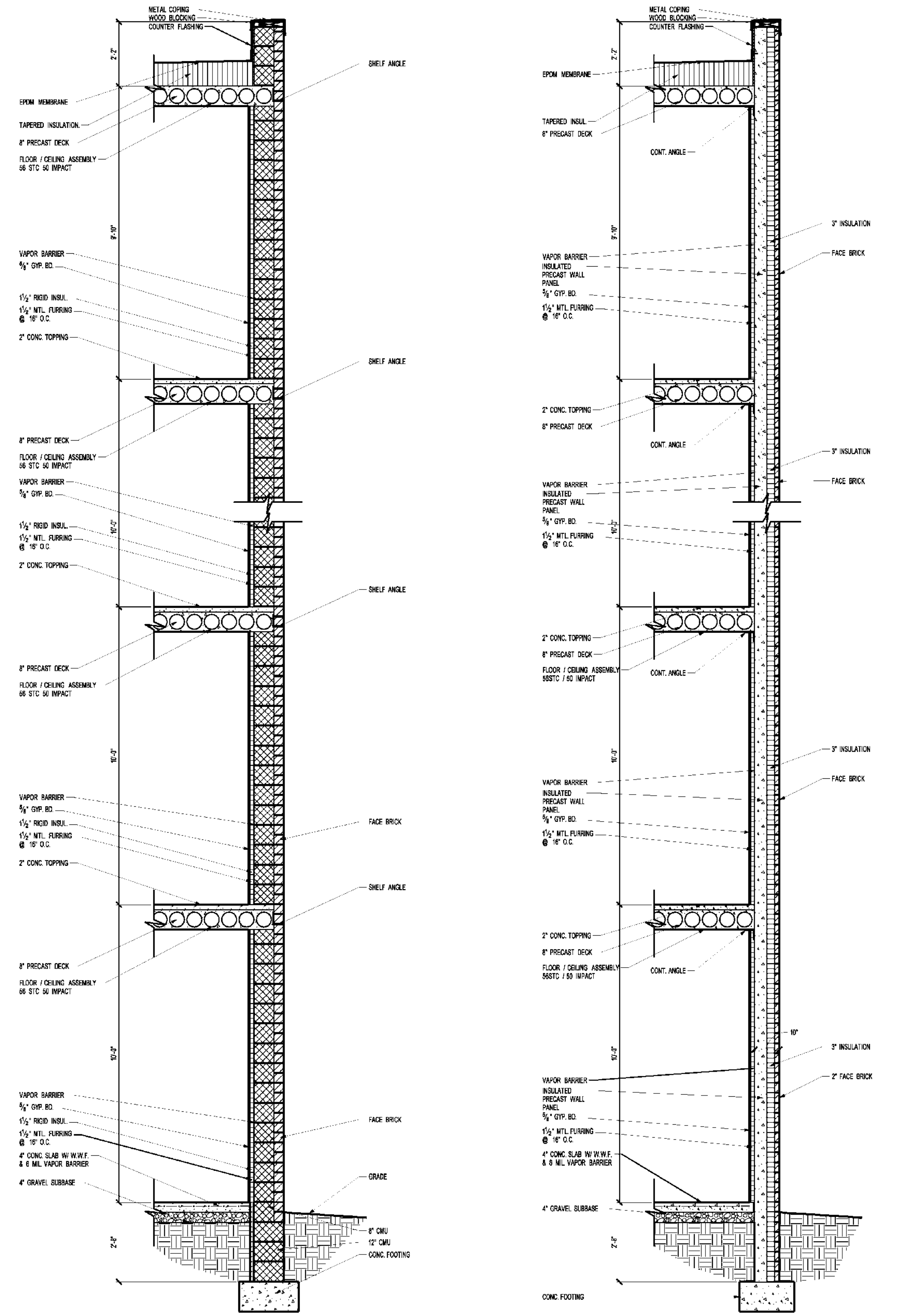
BUILDING COST COMPARISON STUDY

HAAS ARCHITECTS ENGINEERS



3 A7.1 MASONRY / PRECAST CONSTRUCTION SECTION
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4 A7.1 PRECAST CONSTRUCTION SECTION
SCALE: 1/2" = 1'-0"

NOT FOR CONSTRUCTION

A7.1 WALL SECTIONS 0519 CMC OCTOBER 19, 2006

BUILDING COST COMPARISON STUDY

HAAS ARCHITECTS ENGINEERS

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MICHAEL J. SIGGINS........................ AIA
DALLAS L. MILLER .... AIA
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November 13, 2006

At the request of the sponsoring agencies, two additional wall construction types have been added to the fire safe construction cost comparison study. The addition of these two wall construction types is based on current industry construction trends and the perceived initial construction cost and lifecycle cost associated with each of the new wall systems. The first wall type is a single wythe concrete masonry unit (CMU) wall system. The single wythe CMU wall system is detailed in the amended Fire Safe Construction Cost Comparison Study report, and the reader is referred to this wall section for specific construction details. The second wall system is an architectural precast concrete façade panel similar to the precast concrete building system considered in the original study. The reader is referred to the wall section included in the amended Fire Safe Construction Cost Comparison Study report for specific construction details.

The single wythe CMU wall system is constructed of 10 inch split face CMU with metal furring, R13 fiberglass batt insulation, and 5/8 in Type-X gypsum wall board. The floor system is a hollow core precast concrete plank with cast-in-place concrete topping. The interior compartmentalization walls are constructed of standard CMU with metal furring and 5/8 in Type-X gypsum wall board.

The precast concrete system is a complete precast concrete building system similar to the original study option. However, this system differs from the original in that the façade treatment is an architectural precast concrete exposed panel system, as compared with the thin brick embedded in the original panel façade. The architectural precast panel is a sandwich panel system with 3 in of rigid foam insulation. The interior finish is obtained with metal furring, and additional 1 in of rigid foam insulation and 5/8 in Type-X gypsum wall board. The internal compartmentalization walls are constructed of precast concrete panels with metal furring and 5/8 in Type-X gypsum wall board. With the combination of the 3 in rigid foam in the sandwich panel and the additional 1 in of rigid foam in the furring space the net thermal resistance exceeds an R20.

As with the original study all internal non-compartmentalization walls are constructed with lightgage metal framing and 5/8 in Type-X gypsum wall board or with wood stud framing and 5/8 in Type-X gypsum wall board for the wood framing systems.

Both of the new wall systems provide the building with an up-scale architectural façade utilizing cementious materials. However, the original cost study was conducted with all of the buildings being designed and estimated with a brick façade to remove one major variable in the study, the aesthetic appearance of the building. With the architectural appearance of the building now a variable in the study we feel that a fair cost comparison cannot be made with the other wall systems. The addition of these two wall types to the study was done to illustrate to the potential savings either if the brick façade treatment was not desired or if the façade treatment was optimized for the construction material. It should be noted that for each of the wall types considered in the original base study, that the brick façade treatment was not necessarily the most economical. However, it was felt that this provided a consistent façade treatment for all systems to be compared against.

Based on this, we do not feel that a fair comparison can be made between the two new wall types (Single Wythe CMU and Architectural Precast) and the original study. The reader is encouraged to use the additional data presented on the two new wall types in the manner in which it was intended, as a snapshot into the cost savings available if the façade treatment is optimized for the specific wall system. We feel that the only fair comparison is one where the single wythe CMU system is compared with the CMU with precast plank floor system from the original study, or the architectural precast system is compared with the precast system from the original study, to see the potential savings associated with removal of the brick in favor of an alternate façade treatment.

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SINGLE WYTHE WALL COMPARISON

Athens, GEORGIA

Building System	Cost	Relative Cost
Masonry & Precast Single Bedroom Scheme (Base)	$10,129,190.00	100
Single Wythe	$ 9,305,652.00	92
Masonry & Precast Mixed Bedroom Scheme (Base)	$10,275,336.00	100
Single Wythe	$ 9,485,095.00	92
Precast Construction Single Bedroom Scheme (Base)	$11,228,505.00	100
Architectural Precast Concrete	$10,994,890.00	98
Precast Construction Mixed Bedroom Scheme (Base)	$11,346,884.00	100
Architectural Precast Concrete	$11,088,729.00	98

Savannah, GEORGIA

Building System	Cost	Relative Cost
Masonry & Precast Single Bedroom Scheme (Base)	$ 9,755,867.00	100
Single Wythe	$ 8,989,749.00	92
Masonry & Precast Mixed Bedroom Scheme (Base)	$ 9,900,002.00	100
Single Wythe	$ 9,164,421.00	93
Precast Construction Single Bedroom Scheme (Base)	$10,941,806.00	100
Architectural Precast Concrete	$10,680,146.00	98
Precast Construction Mixed Bedroom Scheme (Base)	$11,049,650.00	100
Architectural Precast Concrete	$10,765,276.00	97

Charlotte, NORTH CAROLINA

Building System	Cost	Relative Cost
Masonry & Precast Single Bedroom Scheme (Base)	$10,395,114.00	100
Single Wythe	$ 9,652,103.00	93
Masonry & Precast Mixed Bedroom Scheme (Base)	$10,535,671.00	100
Single Wythe	$ 9,689,540.00	92
Precast Construction Single Bedroom Scheme (Base)	$11,884,830.00	100
Architectural Precast Concrete	$11,311,464.00	95
Precast Construction Mixed Bedroom Scheme (Base)	$11,760,470.00	100
Architectural Precast Concrete	$11,397,826.00	97

Raleigh, NORTH CAROLINA

Building System	Cost	Relative Cost
Masonry & Precast Single Bedroom Scheme (Base)	$10,013,283.00	100
Single Wythe	$ 9,185,795.00	92
Masonry & Precast Mixed Bedroom Scheme (Base)	$10,154,542.00	100
Single Wythe	$ 9,335,765.00	92
Precast Construction Single Bedroom Scheme (Base)	$11,257,204.00	100
Architectural Precast Concrete	$10,939,443.00	97
Precast Construction Mixed Bedroom Scheme (Base)	$11,386,754.00	100
Architectural Precast Concrete	$11,020,370.00	97

Conclusion

Based on the construction cost estimates prepared by Poole Anderson Construction, the cost associated with a compartmentalized construction method utilizing a concrete based material was generally less than 5 percent of the overall construction cost. Comparatively speaking this amount is less than the contingency budget typically recommended for the owner to carry for unanticipated expenditures during the project.

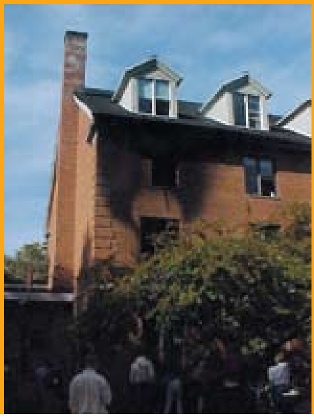
The minimal increase in construction cost can be paid for over the life of the structure. Materials like concrete masonry, precast concrete, and cast-in-place concrete have many other advantages beyond their inherent fire performance including resistance to mold growth, resistance to damage from vandalism, and minimal damage caused by water and fire in the event of a fire in the building. In many cases, with this type of construction the damage outside of the fire compartment is minimal. This provides for reduced cleanup costs and quicker reoccupation of the structure.

Containment Example: Dormitory Fire Contained

On October 11, 2001, fire engulfed the **Rees Hall Dormitory at Hobart and William Smith Colleges** in Geneva, New York. Temperatures soared as high 1800°F resulting in melted plastic picture frames, light fixtures, smoke detectors, metal hinges and the steel door of the room where the fire began. Within 20 minutes, the raging fire had caused approximately $100,000 in damages. This small repair bill was attributed to the fact that concrete construction contained the fire and saved the building from being completely destroyed.

Originally constructed in 1969 with concrete masonry and hollow-core floor planks, the building is **"durable and fire resistant,"** says Christopher J. Button, Senior Project Manager, HWS, **"and has much lower maintenance and insurance costs."** Replacing the entire structure would have cost as much as $5 million.

Button says he'd always believed any building with a smoke detector and non-combustible materials would withstand similar catastrophes, but after seeing how concrete stood up to the intense fire, he's ***"a believer in concrete construction."***



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