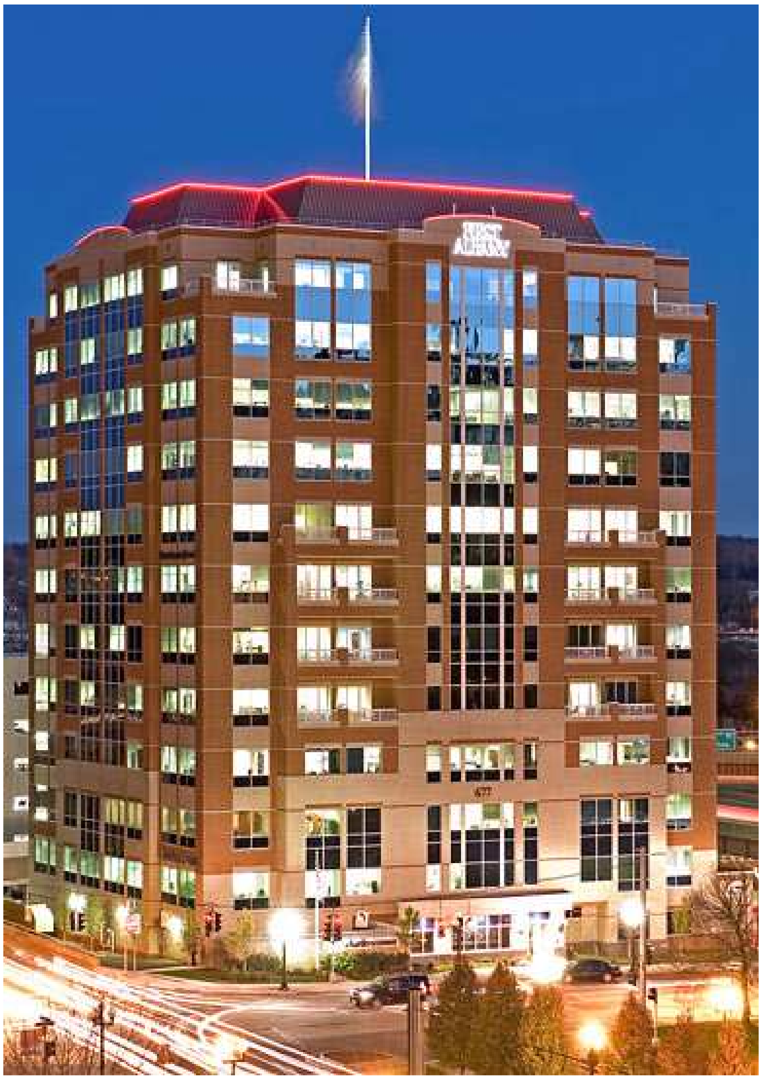
The First Albany Building

677 Broadway
Albany, NY



Gerald Craig

Architectural Engineering

Structural option

Consultant:
Dr. Boothby

January 15, 2010

Revised Thesis Proposal

TABLE OF CONTENTS

Section 1 - EXECUTIVE SUMMARY

The First Albany Building is located in downtown Albany, NY. It is a 12 story, 180,000 square feet structure designed for mixed-use office space and condominiums. The building's footprint is approximately 115' x 137'.

The foundation is a concrete slab on grade over a network of reinforced concrete grade-beams and pile caps. The first floor is at grade and the building has no basement. H-piles were driven to practical refusal to fully support the building. Gravity loads are resisted by a reinforced concrete slab supported by a grid of simply supported steel beams and girders. Partial composite beam and composite deck design was incorporated in to the building. The main lateral force resisting system is comprised of steel braced frames. There are five braced frames, two in the East – West direction and three in the North – South Direction, all located in the core of the building. The braced frames each act as a vertical, cantilevered truss.

A proposed alternative system will be studied in depth consisting of a full composite beam/composite deck design to resist gravity loads and special reinforced concrete shear walls to resist lateral loads (replacing braced frames). The core of the building will be altered slightly to reduce natural eccentricities created by lateral loads and eliminated the need for transfer girders at the perimeter. Upstate New York is a region of low seismic activity, for which The First Albany Building performs adequately. However, if the owner decided to build a nearly identical building in Charleston, South Carolina, significant modifications would be needed. A new building site will be chosen there. A light weight structural system with a higher response modification factor would be ideal to minimize base shears.

Along with a study of this alternative system, two breadth studies shall be done in the construction management and mechanical options. The breadth in construction management will be an investigation of the scheduling and cost impact of switching to a full composite action beam with reinforced shear wall design. Changes in the geographic location will also be considered (weather, seasonal changes, local labor and material costs). The Mechanical breadth work study will in Energy Conservation and Energy Cost Considerations. Time of day usage (energy storage methods), energy recovery (heat recovery), and alternate energy sources will be explored to see where savings can be made. Other areas to check are for in-efficiencies of mechanical equipment and building envelope parameters for a location in a warmer climate.

Section 2 - INTRODUCTION

This report outlines proposed alterations and investigations of The First Albany Building.

Section	Topic
3	Proposed Structural Alterations
4	Solutions to Proposed Alterations
5	Solution Methods for Proposed Alterations
6	Breadth Option Investigations
7	Tasks and Tools
8	Timetable

Building Information:

The First Albany Building is a 12 story, 180,000 square feet structure designed for mixed-use office space and condominiums. The building's footprint is approximately 115' x 137'. It is located along the Hudson River in downtown Albany, NY.

The foundation is comprised of a 6" thick concrete slab on grade over a network of reinforced concrete grade-beams and pile caps. The first floor is at grade and the building has no basement. H-piles were driven to practical refusal to fully support the building. Pile capacities are 120 tons, tested and verified on site during installation.

Gravity loads are resisted by a 4.5" reinforced composite concrete deck supported by a grid of simply supported beams and girders. Partial composite beam design was also incorporated in to the building's structural system. Bays are typically 25' by 25' with some variations. Sizes of floor members generally range between W12x14 and W18x60 shapes with a determined number of shear stud connectors on each member. Column lines transfer loads directly to the ground through pile caps and to the piles themselves. The piles were carefully laid out as to not cause eccentric forces in any one group of piles.

Wind and seismic loads are resisted by sets of concentrically braced frames around the core of the building. Two frames are oriented in the East – West direction and three narrower frames are oriented in the North – South direction. Bracing patterns include "K", inverted "K", and standard diagonal. The braced frames each act as a vertical, cantilevered truss.

Figure 2.1 – Existing Framing Layout

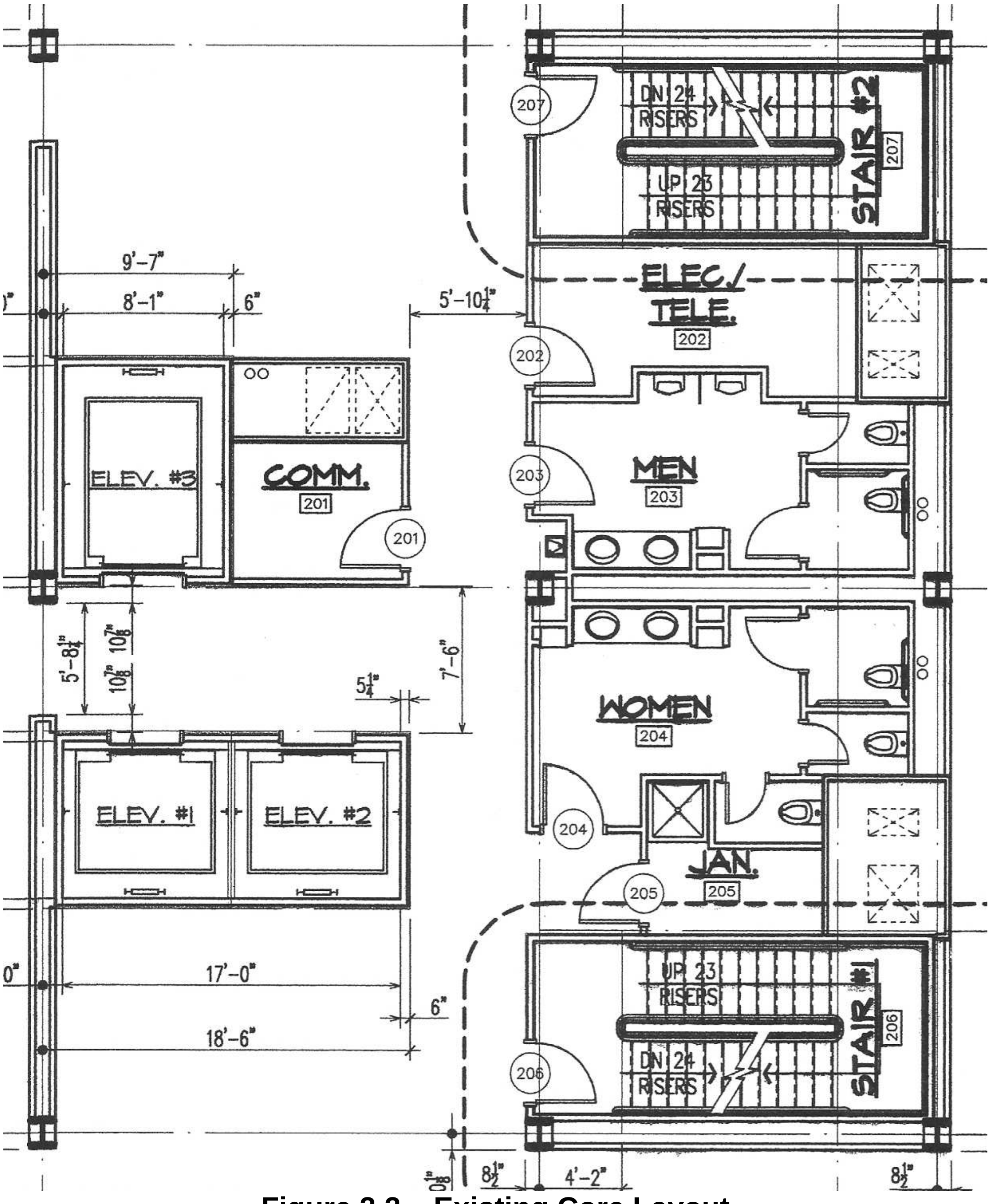


Figure 2.2 – Existing Core Layout

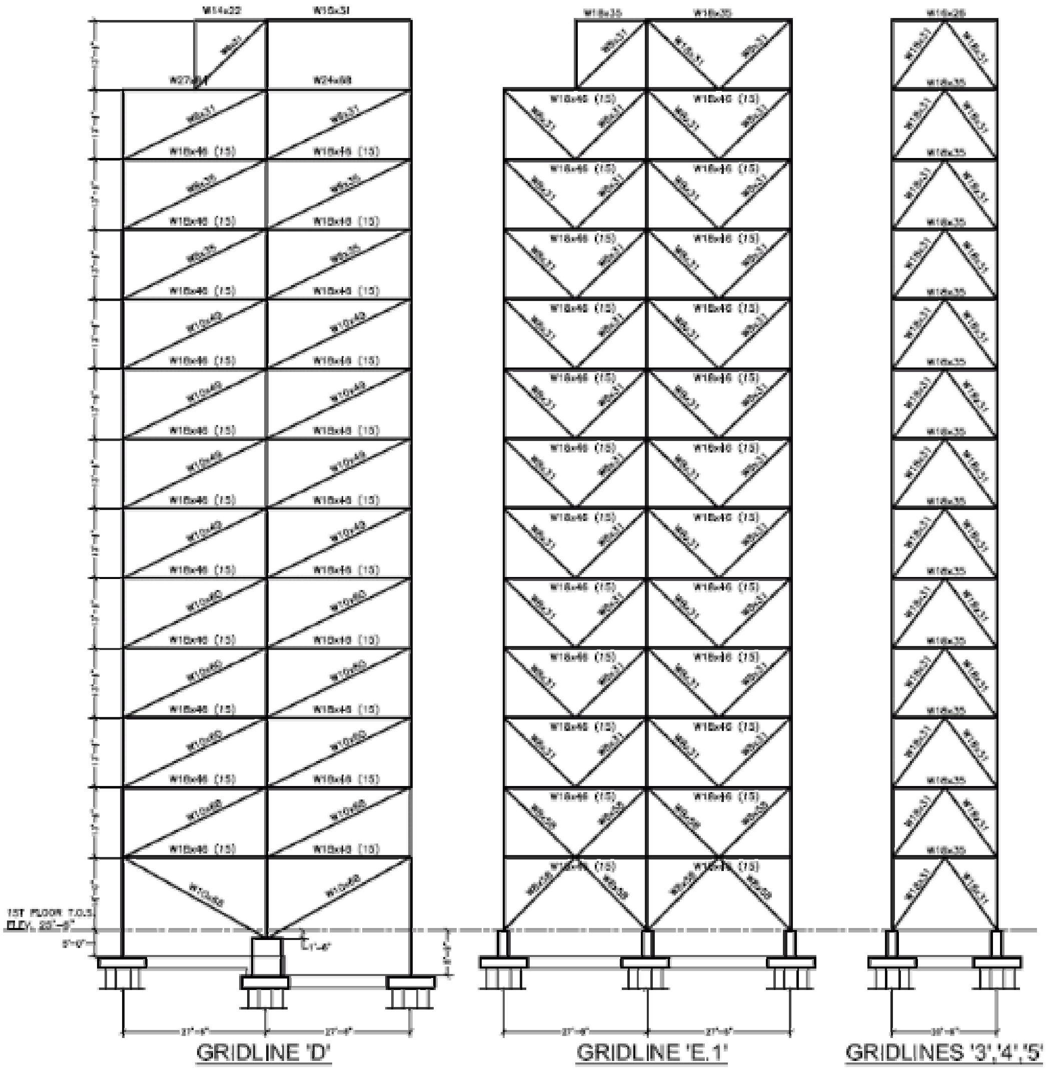


Figure 2.3 – Existing Braced Frame Elevations

Section 3 – PROPOSED STRUCTURAL ALTERATIONS

The proposed alternative system will consist of a full composite beam/composite deck design to resist gravity loads and special reinforced concrete shear walls to resist lateral loads. Choosing full composite beam action over partial composite beam action may result in lighter weight structural floor members. The core of the building will be altered slightly to reduce natural eccentricities created by lateral loads and eliminated the need for transfer girders at the perimeter. Elevators will be repositioned as shown in proposed core layout (figure 3.1).

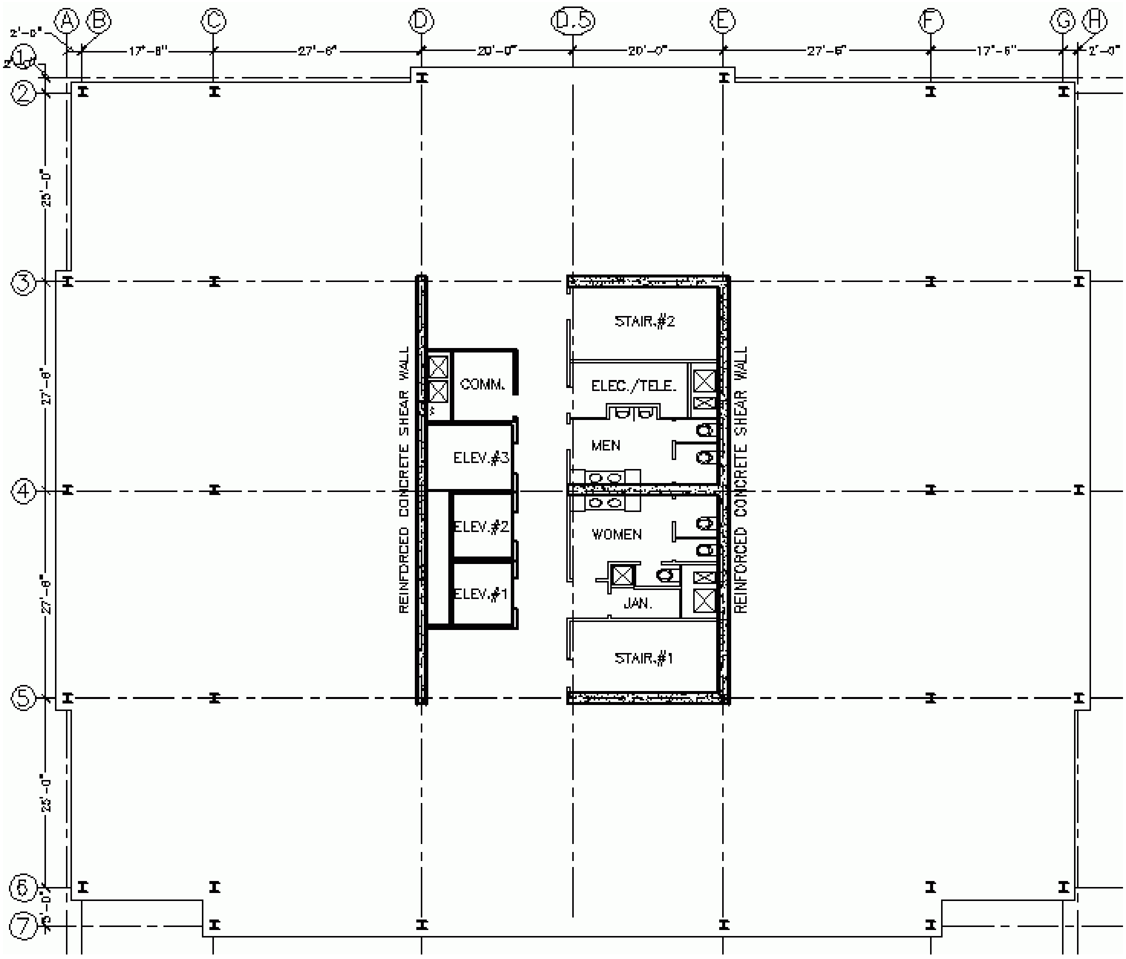


Figure 3.1 – Proposed Core Layout

Upstate New York is a region of low seismic activity, for which The First Albany Building performs adequately. However, if the owner decided to build a nearly identical building in Charleston, South Carolina, significant modifications would be needed. Charleston is located in an area of high seismic risk. A light weight structural system with a higher response modification factor would be ideal to minimize base shears and design requirements.

Section 4 – SOLUTIONS TO PROPOSED ALTERATIONS

To provide sufficient lateral stability, special reinforced concrete shear walls need to be sized and reinforced appropriately. Lateral and gravity loads have already been calculated based on ASCE 7-05 in Technical Report 1 (revised in Technical Report 3). The walls will be designed in accordance with Chapter 21 of ACI 318-08 (Section 21.9 - Special Structural Walls and Coupling Beams). The need for boundary elements will be determined from section 21.9.6. Transverse reinforcement (hoops and ties) will designed in accordance with Section 21.6. In special reinforced concrete walls, transverse reinforcing spacing is reduced to better confine the concrete and keep other reinforcing from buckling.

To obtain a light weight structural floor system, full composite action beam design and composite deck design will be taken advantage of. Findings presented in Technical Report 2 - Pro-Con Structural Study of Alternate Floor Systems show that weight savings can be attained through the use of full composite action verses partial composite action.

Using special reinforced concrete shear wall will increase the response modification factor from 5 to 6 (ASCE 7-05 Table 12.2-1). This combined with a lighter floor system will lessen the design base shear of a building in an area of high seismic risk. Dual systems have not been chosen as options because they require that moment frames capable of resisting 25% of the seismic forces be incorporated into the design. Moment frames generally need larger sections to resist loads, making the structure heavier. A lighter floor system is desired.

Section 5 – SOLUTION METHODS

To obtain the lowest possible base shears, every effort will be made to eliminate weight from the structure. Different beam selections and spacing will be investigated to obtain the lightest floor system possible.

The modified building will then be modeled as a vertical, cantilevered beam and analyzed through the use of structural analysis software; ETABS. ETABS uses the Stiffness method to analyze structures. It compiles a global structure stiffness matrix and uses an element force recovery method to determine member forces and stresses. Base shears and building periods will be determined by using the provisions set forth in Chapter 12 of ASCE 7-05. The Equivalent Lateral Force Method will be used to determine how the base shear is distributed to the lateral system. The 3-D model created for Technical Report 3 (Lateral System Analysis and confirmation Design) will be altered to represent the proposed structural alterations and a dynamic spectral analysis of the seismic loads will be computed.

Local building codes and zoning ordinances applicable to Charleston, S.C. will also be investigated for special limitations or requirements.

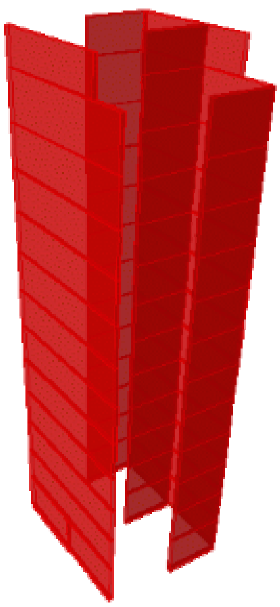


Figure 5.1
Model with Proposed Structural Alterations

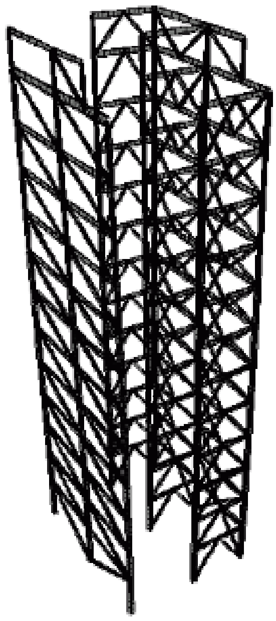


Figure 5.2
Original Structural Model

Section 6 – BREADTH OPTION INVESTIGATIONS

Two individual breadth studies will be conducted.

The first breadth study will involve the constructability, scheduling, and cost analysis of the proposed structural alterations. This study will entail research of the construction schedule and determination of the critical path in the construction process. If the critical path is affected by the core-only design, a determination of whether or not the impact is beneficial to the construction schedule will be done. In addition to scheduling, the cost of the proposed design will be studied and compared to the original design. Changes in the geographic location will also be considered (weather, seasonal changes, local labor and material costs).

The second breadth study will in Energy Conservation and Energy Cost Considerations. Time of day usage (energy storage methods), energy recovery (heat recovery), and alternate energy sources will be explored to see where savings can be made. Other areas to check are for in-efficiencies of mechanical equipment and building envelope parameters for a location in a warmer climate. The building's current chiller may need to be increased in size and the heating system maybe able to be down sized. Different glazing (lower 'e' value, higher reflectivity) will likely help reduce heat gains during South Carolina's hot summer season.

Section 7 – Tools & Tasks

Task 1 – Building in Charleston, S.C
- a) Investigate key differences in local building codes
- b) Gather area/site specific parameters

Task 2 – Redesign Floor System as Full Composite Beam Action
- a) Gravity Loads
  - Determine dead loads from architectural and structural drawings
  - Determine live loads in accordance with ASCE7-05
- b) Design Beam Sizes
  - Use MS Excel to tabulate beam strengths
  - Check beam designs against acceptable floor deflections

Task 3 – Redesign Lateral Load Resisting System
- a) Calculate Lateral Loads for Charleston, S.C.
  - Wind
  - Seismic
- b) Special Reinforced Concrete Shear Walls
  - Select trial wall thicknesses
  - Create new 3D Model with ETABS
  - Finalize wall thicknesses
- c) Wall Reinforcement
  - Select trial reinforcement scheme
  - Check strength & Deflections/Drift
  - Detail Reinforcement

Task 4 – Construction Scheduling and Cost Impact
- a) Investigate Original Schedule
- b) Determine Effects of the Proposed Alterations on Scheduling
- c) Investigate Original Structure Cost
- d) Calculate Cost Impact

Task 5 – Energy Conservation and Energy Cost Reduction
- a) Investigate Current Energy Usage
  - Time of Day
  - Seasonal Changes
- b) Explore Inefficiencies
  - Existing Mechanical Equipment
  - Building Envelope Parameters
- c) Propose General Modifications
  - Pro/Con

Section 8 – Time Table

Task	Week														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Building in Charleston, S.C															
Investigate key differences in local building codes															
Gather area/site specific parameters															
Redesign Floor System as Full Composite Beam Action															
Determine Gravity Loads															
Design Beam Sizes															
Redesign Lateral Load Resisting System															
Calculate Lateral Loads for Charleston, S.C.															
Special Reinforced Concrete Shear Wall Design															
Wall Reinforcement & Detailing															
Construction Scheduling and Cost Impact															
Investigate Original Schedule															
Determine Effects of the Proposed Alterations on Scheduling															
Investigate Original Structure Cost															
Calculate Cost Impact															
Energy Conservation and Energy Cost Reduction															
Investigate Current Energy Usage															
Explore Inefficiencies															
Propose General Modifications															
Report / Presentation															
Report Finalizing / Editing															
Presentation Preparation															

Spring Break   Presentation Week

APPENDIX A – PICTURES


677