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ORLANDO, FL

THESIS PROPOSAL
EXECUTIVE SUMMARY
DECEMBER 12, 2005

Introduction:

The University of Central Florida's Academic Villages located in Orlando, Florida is a complex of 10 separate dormitories built to accommodate approximately 500 new freshman students. Each building is 4 stories tall and range from approximately 14,000 to 22,000 square feet in area. Each floor typically has between eleven and fifteen 24 ft x 28 ft apartment units.

Current System:

The current structural system consists of a 2" Epicore metal deck and 4 ½" reinforced concrete slab supported by masonry bearing walls over a 12 foot span. The lateral system is composed of interior and exterior masonry shear walls in both directions.

Proposed System:

This proposed thesis will observe an investigation for an alternative structural system for the University of Central Florida's Academic Villages. A post-tensioned concrete system will be explored as a possible alternative. By switching to a post-tension system, I hope to achieve longer spans without sacrificing slab thickness to achieve greater flexibility in terms of floor layout.

Breadth Analysis 1:

Due to the building being occupied by students, it is important for it to be acoustically insulated. I am concerned that by switching to post-tensioned system, the acoustics properties of the structure will be less effective than the existing system. This proposal will explore various methods to supply this building with additional sound barriers.

Breadth Analysis 2:

The existing mechanical system may present problems with the proposed structural system since some of the ductwork protrudes through the metal deck and slab in the existing structural system. This is not good design for a post-tensioned system since it will weaken the slab significantly. This proposal will explore alternative mechanical systems to work with the new design.

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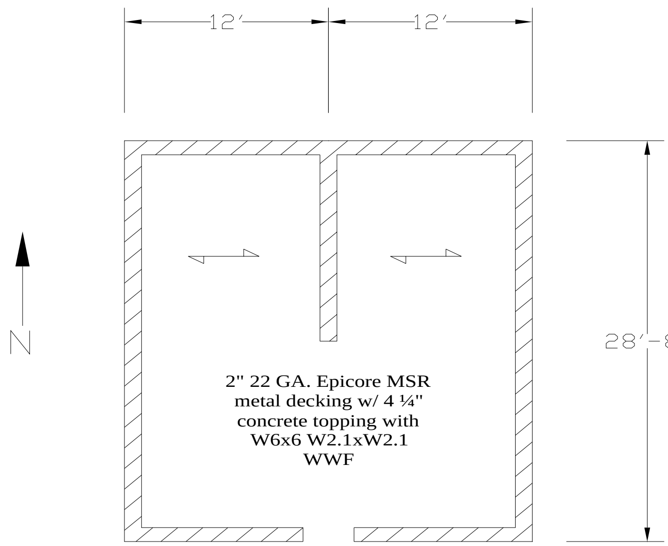
Building Description:

The University of Central Florida's Academic Villages is a complex of ten separate dormitories was completed in September of 2002 to accommodate 500 new freshman students. The buildings are various sizes ranging from approximately 14,000 square feet to 22,000 square feet. Each building is 4 stories tall and 44'-8" above the ground. Each floor has between eleven and fifteen 24 ft x 28 ft apartment units.

Existing Structural System:

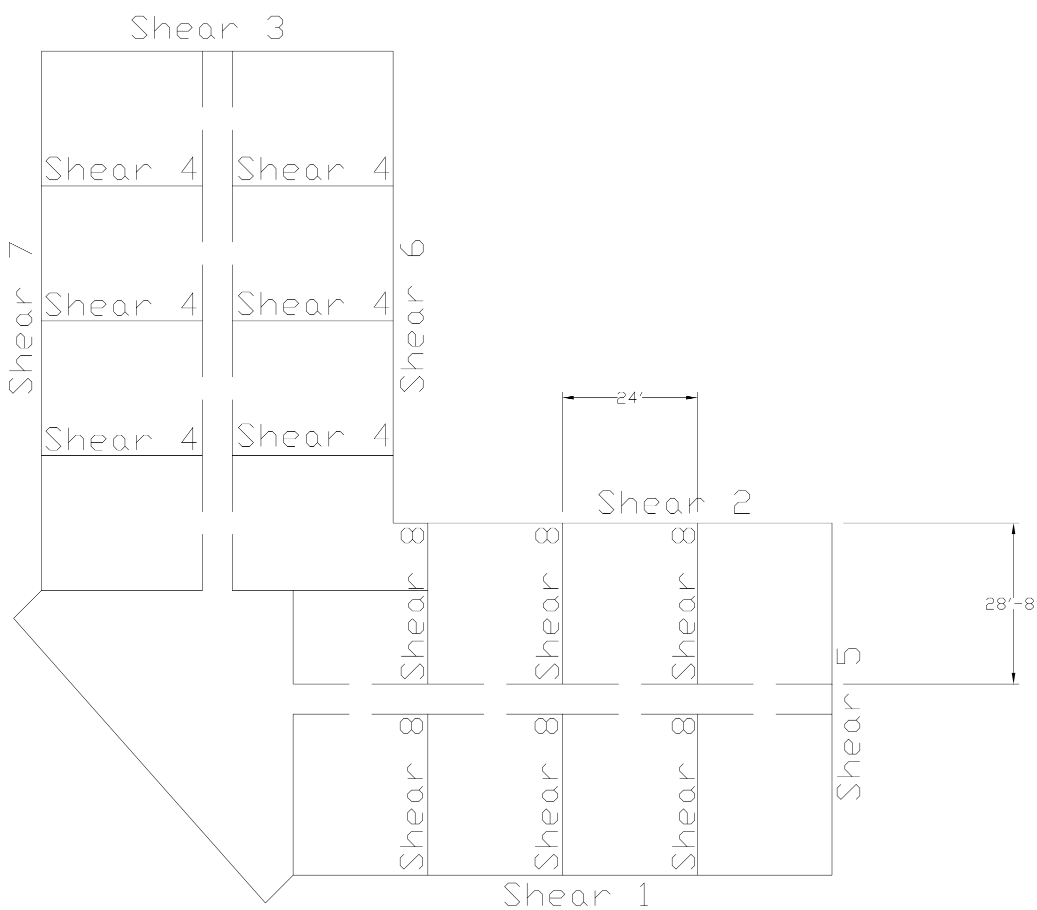
The existing floor system for the University of Central Florida's Academic Villages is called the "Infinity System." This is a composite floor system with 2" 22 GA. Epicore MSR metal decking with a 4 ¼" concrete topping with W6x6 W2.1xW2.1 WWF reinforcement. The slab has a 28 day strength of 3000 psi. It spans between interior and exterior load bearing CMU walls in the east-west direction and load bearing metal stud wall panels. Epicore MSR has triangular dovetail shaped ribs spaced 8" on center that allow for longer spans and higher concrete strength. The bottom flutes are completely closed which allows for the deck to have a flat bottom profile. This makes it ideal to combine with load bearing stud walls because it distributes the load evenly over the metal studs eliminating the need for load distribution devices. The typical span in this building for this floor type is 12 feet. The typical bay for this floor system is shown below.



Lateral System:

The lateral system for the Academic Villages uses both exterior and interior masonry shear walls in both N-S and E-W directions to resist seismic and wind forces. All shear walls are typically 8” masonry units with Type S mortar and #5@24” reinforcement. See the diagram below for the location of the shear walls at every level.

Typical Shearwall layout



Foundation:

The foundation used in the Academic Villages is a shallow foundation system consisting of continuous strip footings to support 8” masonry shear walls and stepped footings of various sizes centered under the interior concrete columns. The footings were designed to take the maximum soil bearing pressure of 2000 psi. The footings work together with a 4” concrete slab on grade. Both the footings and the slab have a 28 day strength of 3000 psi.

Columns:

Concrete Columns with a 28 day compressive strength of 4000 psi span only between the foundation and the first floor. The columns are reinforced with Grade 60 #6 bars and #3 ties at various spacings. In addition to the concrete columns, there are also light gage metal built-up columns incorporated within the metal stud walls. These columns are found on every floor.

Roof:

The roof of the Academic Villages is a hip roof consisting of hip trusses, girder trusses and light gage metal trusses spaced 4' o.c. All trusses are shop fabricated and have a minimum yield strength of 33 ksi. Metal roof decking is 11" - 2Ø Gauge Galvanized G-9Ø spanning a minimum of 3 spans. Several of the buildings have flat roofs. The roofs of these buildings consist of the same Epicore metal decking and concrete slab found in the floor systems.

Problem Statement:

There are many different design solutions that can work for one particular building. Some designs work better than others based on which design considerations are most important to the owner. For my proposed thesis, I decided that building flexibility was the most important design consideration to be taken into account. The existing system of a 2" metal deck and 4 ½" concrete slab allows for a 12 foot span in the east-west direction forcing an interior bearing wall to be included in the middle of each bay. This design essentially divides each 24 ft x 28 ft apartment unit in half and does not allow for a greater level of flexibility which is desired in dwelling units such as apartments and dormitories.

Proposed Investigations:

The main controlling factor in this proposed solution is to incorporate a floor system with a longer span. Other factors such as cost, constructability, availability, and overall performance will be taken into consideration after flexibility when evaluating this proposed structure. After looking at alternative structural systems in Tech 2, I discovered that there were several feasible alternative solutions. However, after consulting with my advisor, I am proposing a post-tensioned system as a replacement for the existing slab on metal deck system. I will explore whether a post-tensioned system will give me the flexibility that I'm looking for by allowing for a longer span while maintaining the slab thickness at a reasonable and profitable level. In doing so, the interior masonry bearing wall in the middle of each bay will no longer be needed and the floorplan becomes much more flexible.

Breadth Investigation 1:

It is important for it to be acoustically insulated since it will be occupied by students. Since metal deck typically is a better sound insulator than concrete, I am concerned that by switching to post-tensioned system, the acoustical properties of the structure will be less effective than that of the existing system. I will be exploring various methods used with post-tensioned to supply buildings with additional sound barriers.

Breadth Investigation 2:

The existing mechanical system consists of a series of ductwork providing natural ventilation throughout each apartment unit in addition to a central system providing conditioned air to public spaces on the first floor. Some of the ductwork protrudes through the floors of the existing structure. This is a concern with prestressed concrete since a hole in the slab would hinder the effectiveness of the strands. I will explore alternative mechanical systems that will work better with the proposed post-tensioned design.

Means and Methods:

A post-tensioned system will be designed using ACI 2002 and IBC 2002 codes. I also hope to use the knowledge learned in CE 543, a class I'm taking next semester on prestressed concrete behavior and design. Throughout the semester I will be investigating prestressed concrete behavior and the different materials available and their effect on the structure. I will determine the flexure, shear, and deflection components of post-tensioned concrete systems and will verify whether partial prestressing or prestressing over continuous spans will provide better results.

ADOSS will be used to model and analyze the post-tensioned slab and ETABS 8 Nonlinear will be used to model and analyze the shear wall designs. Since I'm not very familiar with either of these software programs right now and the learning curve to becoming comfortable with these programs is rather long; time will have to be allocated next semester specifically to becoming familiar with this programs.

The building acoustics will be referenced from the Universal Building Code/International Building Code (UBC/IBC). Both airborne sounds from the buildings occupants and impact sounds from the proposed floor system will be used to determine the best solution for the structures acoustical system. In addition, two rating systems, the STC (Sound Transmission Class) and ICC (Impact Insulation Class) will be used to determine building's acoustical quality.

The buildings mechanical system will evaluated based on the International Building Code 2002.

Tasks and Tools:

1. Become familiar with ADOSS and ETABS 8 Nonlinear
2. Investigate various components of prestressed concrete
3. Gravity Analysis
    a. Determine gravity loads
    b. Design post-tensioned slab
        i. Determine slab thickness
        ii. Determine strand reinforcement
    c. Create model using ADOSS
    d. Check deflections
    e. Redesign if necessary
4. Lateral Analysis
    a. Preliminary shear wall design
    b. Determine stiffness in each shear wall
    c. Calculate deflections based on stiffness

d. Create model using ETABS 8 Nonlinear and check drift
5. Perform a cost analysis for the proposed system
6. Perform a schedule analysis for the proposed system.
7. Investigate alternative acoustical systems
8. Investigate alternative mechanical systems
9. Compare proposed system with existing structure
10. Finalize all work and prepare presentation

Schedule:

Week	Tasks
9-Jan	Become familiar with ADOSS and ETABS 8 Nonlinear
16-Jan	Investigate various components of prestressed concrete
23-Jan	Determine gravity loads
	Design post-tensioned slab
30-Jan	Create model using ADOSS
	Check deflections
	Redesign if necessary
6-Feb	Preliminary shear wall design
	Determine stiffness in each shear wall
	Calculate deflections based on stiffness
13-Feb	Create model using ETABS 8 Nonlinear and check drift
20-Feb	Perform a cost analysis for the proposed system
27-Feb	Perform a schedule analysis for the proposed system.
6-Mar	Spring Break
13-Mar	Investigate alternative acoustical systems
20-Mar	Investigate alternative mechanical systems
27-Mar	Compare proposed system with existing structure
3-Apr	Finalize all work and prepare presentation
10-Apr	Presentations