Temecula Medical Center
Temecula, CA

Senior Thesis Proposal

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Architectural Engineering – Structural Option
Senior Thesis Project

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Executive Summary

Building Description

The Temecula Medical Center is a 6-story hospital which features a 2-story Drug and Therapy center (D&T) as well as a 6-story bed tower. The engineers decided to resist the heavy west coast lateral forces with various concrete shear walls placed systematically throughout the plan. By using this approach, along with a concrete floor system, money was saved while still provided more than adequate force resisting systems. Hospital designs come with additional safety factors which had to be taken into consideration throughout the design of the structural system.

Proposal Summary

Due to the hospital's location in Southeastern California, many conservative design values had to be taken. The lateral force resistant system stayed fairly conservative by using a series of concrete shear walls as the main resisting system. This proposal includes a study of a design using steel to resist both the gravity and the lateral forces. The current gravity system is concrete flat plate, so the use of steel will require significant changes.

Also relevant to the medical center's location is the architectural motif used, which is that of many other buildings in the region. Plaster is used for the exterior façade with few windows besides on the bed tower. This proposal will explore the idea of placing predominant windows around the entire bed tower. This proposed change will come with many additions to accommodate the increased thermal and light changes. These additions will directly affect the architecture and most likely make a very unique change to the current surroundings.

The AISC Steel Construction Manual, 13th edition and ACI 318-05 will be used as a basis for the design of the new structural system. To supplement hand calculations, an ETABS model will be used to develop a computer model which can be used to compare results and design values.

Along with the structural breadth study of the new gravity and lateral systems, a study will be performed on the building envelope. This will include a look at the architectural changes and the affect on the surroundings. Along with changing the building envelope to glass, simple force resistant calculations will need to be performed on the exterior façade.

Existing Structural System

Floor System

The floor system of the first floor consists of a 5″ slab-on-grade while the remaining floors of the Drug and Therapy Center (D&T) are supported by various sized pre-cast, pre-stressed double-tees. The 6-story bed tower consist of two-way, 10″ reinforced concrete flat slabs. Slab reinforcement ranges from #4 bars to #6 bars, spaced from 6″ to 9″ on center.

Topping slabs of the double tees in the D&T consists of 6″ normal weight concrete, typically reinforced with #4 at 9″ o.c. Typical spans between tee's is 6′-0 but vary on location. Two-way flat slab reinforcement sizes for the 6-story bed tower vary but are placed equally across designed column and middle strips. A typical layout is included below.

Roof System

The lower roof over the 6-story bed tower is composite slab with 4 ½″ normal weight concrete over 2″, 16 gage composite metal deck (galvanized), reinforced with #3 at 9″ o.c. each way. Supporting the 1 ½″, 20 gage metal deck on the high roof are rolled steel W-shapes, typically W10x17, 33, or 45. The roof system over the 2-story D&T is very similar and consists of a 1 ½″, 20 gage metal deck held up by rolled steel W-shapes, varying in size from W8 to W18.

Lateral System

The lateral forces are resisted predominantly by concrete shear walls placed throughout the plan. The elevator shafts serve as the main resistance system. Shear walls are typically 27′-9″ long, and 2′ thick with varying reinforcement sizing and spacing. Each wall is built with a minimum 28-day compressive strength of 7000 psi. Specifically labeled walls have a compressive strength of 9000 psi. The shear walls are anchored to the supporting soil by footings, typically 6′ deep and reinforced with #9 at 9″ o.c.

Foundation

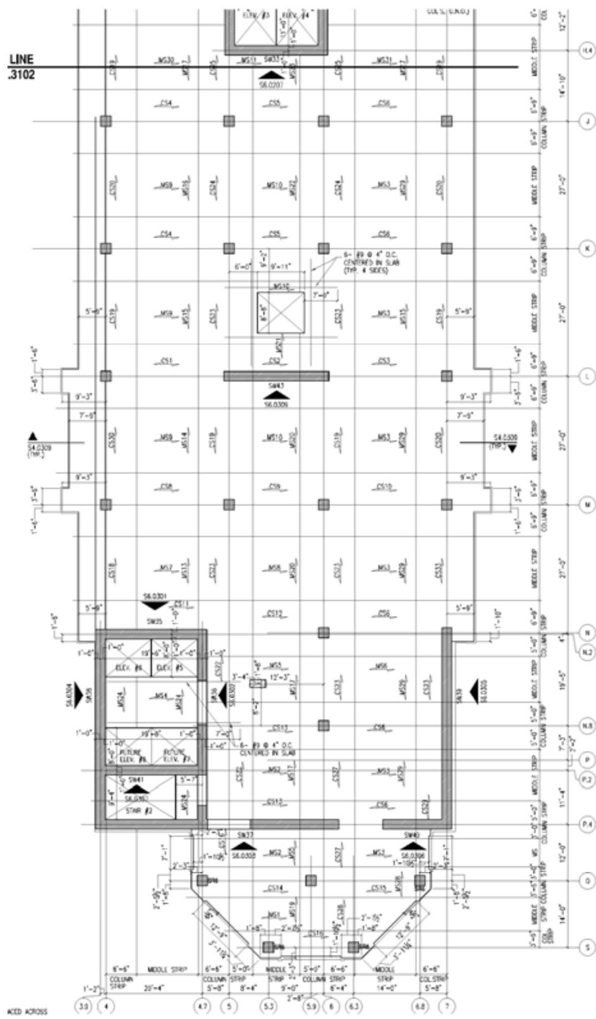
The foundation is a combination of spread footings and drilled piers with concrete pier caps. The spread footings vary in size from 5′x5′ to 18′x18′, depending on location, and are labeled F5-F18 accordingly. The reinforcement for these footings goes from 16 #5 each way in the F5 to 18 #9 each way in the F18.

Foundations for the shear walls feature footings anchored to the supporting soil by drilled piers, typically being 42" in diameter. Each pier is spirally reinforced, varying in size while the pier caps are typically reinforced with #9 - #11 at 9" o.c.

Columns

Vertical supports for the first level consist of 26" x 26" cast-in-place columns as well as 20" x 20" pre-cast columns, however the upper floors (2-6) have only the 26" x 26" cast-in-place columns. A typical bay size is 54' x 27', although they vary depending on location and demand.

The cast-in-place columns typically run from spread footing through each floor while being reinforced with 12 #9's vertically and #4 at 6" o.c. horizontally. Pre-cast columns are reinforced with 4 #9's vertically and #4 at 5" o.c. horizontally. The compressive strength for the C.I.P. columns is 5000 psi and 6000 psi for the P.C. columns.



01 PARTIAL LEVEL THREE FRAMING PLAN

Problem Statement

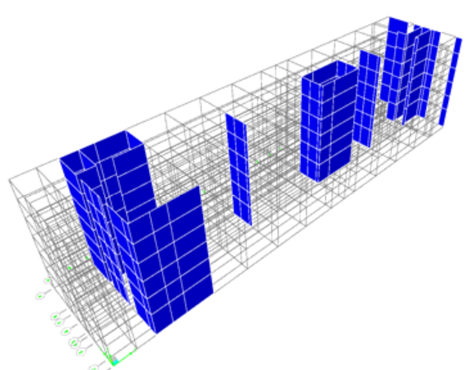
Technical assignments performed throughout the semester have shown that the current concrete flat plate system along with various concrete shear walls has effectively resisted all gravity and lateral loads. However, the design was effective; this report will propose a change to steel, which may be more efficient when it comes to thickness required in both the floor system and lateral resistant systems.

Solution

Although it was determined that the gravity and lateral load carrying structure could carry all of the required loads, a mainly steel structure may provide a more efficient design. Taking the place of the current concrete structure will be a composite steel floor system along with concentric diagonal bracing to resist the lateral loads.

The steel shapes used in the new design will be determined by use of AISC Steel Construction Manual, 13th edition. A previous seismic calculation performed in a past technical assignment will be used since the medical center will not be moving locations. While it is estimated that the floor system will need less thickness with the new steel system, floor-to-floor heights will be assumed to stay the same for comparison purposes.

Shown below is the designed concrete shear walls and where they are placed throughout the bed tower. The proposed steel lateral force resistant system will utilize diagonal bracing which will be placed in the same layout as the shear walls. With less wall thickness required for the steel bracing, more space will be available in the medical center.



Breadth Options

Building Envelope

An analysis and redesign of the building envelope will involve replacing the existing plaster exterior façade with predominantly glass. This will include additions that limit incoming light and heat which in turn will affect the buildings architecture. With the western motif evident in the surrounding buildings, this change will make the Temecula Medical Center very unique. Horizontal extensions above the windows will appear to lengthen the building while blocking the incoming summer heat. An example of these extensions is shown to the right which appears on the Life Sciences building on the Penn State University campus. An all glass façade will present many obstacles but in the end will produce a more enjoyable day time interior as well as a more pronounced exterior at night. Calculations will be performed to prove (or disprove) the significant interior environment changes resulting in mechanical and electrical savings.

Construction Management

The second breadth will involve the constructability, time, and cost savings regarding the structure system being designed with steel instead of concrete. The scheduling impact due to the structural changes will be analyzed in order to compare with the current critical path of the schedule. While the building has not been constructed yet, this study will entail the comparison of steel erection time compared with typical concrete construction times. Also included will be an analysis of cost comparisons between steel and concrete floor and lateral resistant systems. Included in this analysis by default is the constructability of the steel system in the heavy seismic zone.

Tasks

1. Structural Changes – Gravity System Changes
    a.) Analyzing what needs to be done to change floor system from concrete flat plate to composite steel.
    b.) Using AISC Steel Construction Manual, 13th Edition as well as ASCE live and dead loads to size required composite floor system sizes by doing systematic spot checks.
    c.) Using manual and determined loads to size columns on typical bed tower floors.
    d.) Using ETABS to compare values and build computer model.

2. Structural Changes – Lateral Force Resisting System
    a.) Use AISC Steel Construction Manual, 13th Edition as well as ASCE live and dead loads in replacing shear walls with diagonal steel bracing.
    b.) Compare ETABS design sizes to those used in the initial design.
    c.) If the new design proves to be impossible or impractical using the same layout, experiment with alternative layouts.

3. Building Envelope Breadth Study
    a.) Analyze the current building envelope and surrounding architecture motifs.
    b.) Determine architectural changes needed to make the all glass system work.

4. Construction Management Breadth Study
    a.) Compare the extra cost and revenues associated with changing the structural system from concrete to steel.
    b.) Compare time saved in construction when erecting a steel building compared to casting a concrete system.
    c.) Compare long term vs. short term cost impact of the proposed building envelope changes.

5. Miscellaneous
    a.) Organize and format final report.
    b.) Prepare final presentation.

Schedule

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
	Jan. 12-16	Jan. 19-23	Jan. 26-30	Feb. 2-6	Feb. 9-13	Feb. 16-20	Feb. 23-27	Mar. 2-6
1-a.) Analysis of Floor System Changes								
1-b.) Size Composite Floor System Using Manual								
1-c.) Size Columns Using Manual and ASCE loads								
1-d.) Use ETABS to build model and compare values								
2-a.) Use manuals to size diagonal steel members								
2-b.) Compare ETABS model to initial design								
2-c.) Propose different layouts if needed								
3-a.) Analyze current envelope and surrounding area								
3-b.) Determine architectural changes								
4-a.) Compare costs differences in two systems								
4-b.) Compare time saved in different constructions								
4-c.) Compare long term vs. short term cost impacts								
5-a.) Organize final report								
5-b.) Prepare final presentation								

Schedule

Task	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
	Mar. 9-13	Mar. 16-20	Mar. 23-27	Mar. 30-3	Apr. 6-10	Apr. 13-17	Apr. 20-24	Apr. 27-1	Mar. 4-8
1-a.) Analysis of Floor System Changes	SPRING BREAK					PRESENTATION TO FACULTY			FINAL EXAMS
1-b.) Size Composite Floor System									
1-c.) Size Columns Using Manual and ASCE loads									
1-d.) Use ETABS to build model and compare									
2-a.) Use manuals to size diagonal steel members									
2-b.) Compare ETABS model to initial design									
2-c.) Propose different layouts if needed									
3-a.) Analyze current envelope and surrounding area									
3-b.) Determine architectural changes									
4-a.) Compare costs differences in systems									
4-b.) Compare time saved in different constructions									
4-c.) Compare long term vs. short term costs									
5-a.) Organize final report									

5-b.) Prepare final presentation									