Thesis Proposal

Indiana Regional Medical Center

Indiana, PA

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The Pennsylvania State University

Architectural Engineering

Structural Option

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Executive Summary

The Indiana Regional Medical Center's existing conditions and structural system were analyzed in the previous technical assignments to aid in the creation of this proposal. Gravity loads and lateral loads were evaluated throughout the typical portions of the structure using design codes.

Indiana Regional Medical Center is a full service healthcare facility that resides in Indiana, Pennsylvania. It is made up of 6 separate buildings, but is mostly one seven story 98 ft high building that lies in the core of the other five. The entire structure has an orange brick façade and is used mostly as a hospital for the public. It is a constructed moment frame made mostly of steel with metal deck and lightweight concrete.

The current structural system in the Indiana Regional Medical Center is proved to be quite ideal, but other systems were found to be effective after much analysis. The Two-Way Post-Tensioned system was the initial choice, but failed to out-weigh the advantages of the Two-Way Flat Plate system. This leads to a proposed redesign of the building's structural system relying mostly on concrete material. The Two-Way Flat Plate system will allow simple bar placement, easy formwork, and low floor-to-floor height.

Two breadth topics were also decided upon based on the affects that the new structural system puts on the building. The architectural impact and the updated cost estimates and construction schedule were the two factors that were chosen as the breadths.

A layout of tasks and tools were created to outline and organize the process of redesign. The tasks were considered not only for the main depth that's being studied, but also for both of the breadths.

A proposed schedule of the semester was created to predict and ensure project completion.

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Introduction

Indiana Regional Medical Center (IRMC) is a 130,000 square foot hospital that resides in the heart of western Pennsylvania. It was first introduced to the public in November of 1914 and has seen many renovations and additions throughout its years. It is now the only full service health facility in its county. An elevation can be seen in Figure 1 and an aerial view in Figure 2. This building was designed and erected by Rea, Hayes, Large, & Suckling. This team is also responsible for all this building's renovations including the most recent one in 1975. Future renovations are now starting to emerge.

Figure 1 – Current Entrance to IRMC

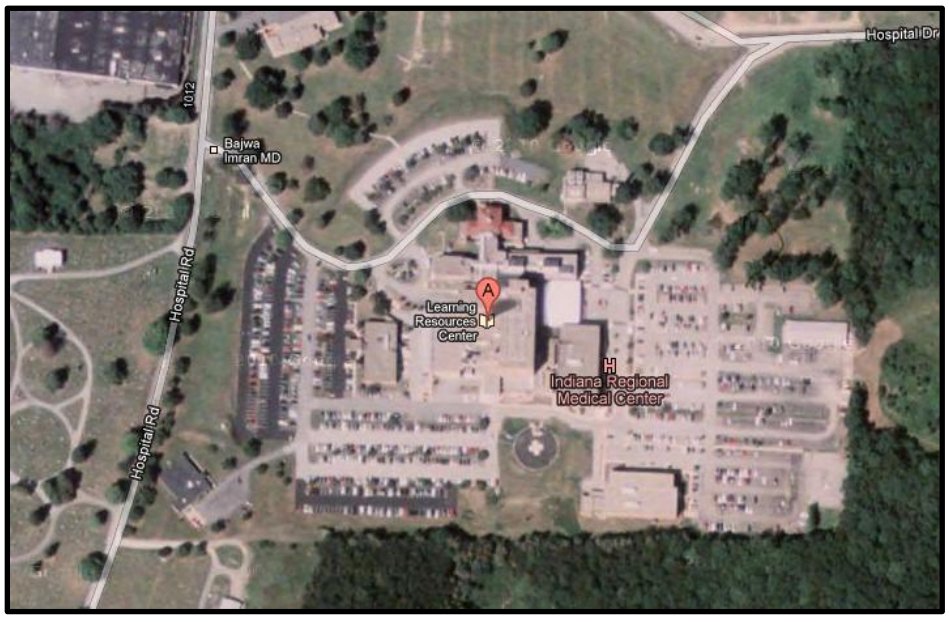


Figure 2 – Site of Indiana Regional Medical Center

The previous technical reports have analyzed the existing structural conditions of the Indiana Regional Medical Center in Indiana, PA. An analysis of gravity and lateral loads have been completed in the former technical assignments to aid with this proposal. An overview of the current structure has been included in this report. The main 98 ft tall building was the only structure that was evaluated.

Foundation

Indiana Regional Medical Center rests on a shallow layer of bedrock so the foundation of the overall building is very shallow. The current level of grade is actually higher than initially since the foundation could not be placed deep into the ground. Concrete footings and columns make up the entire base of the building and our attached to the upper steel skeleton by a pinned connection as seen in Figure 3.

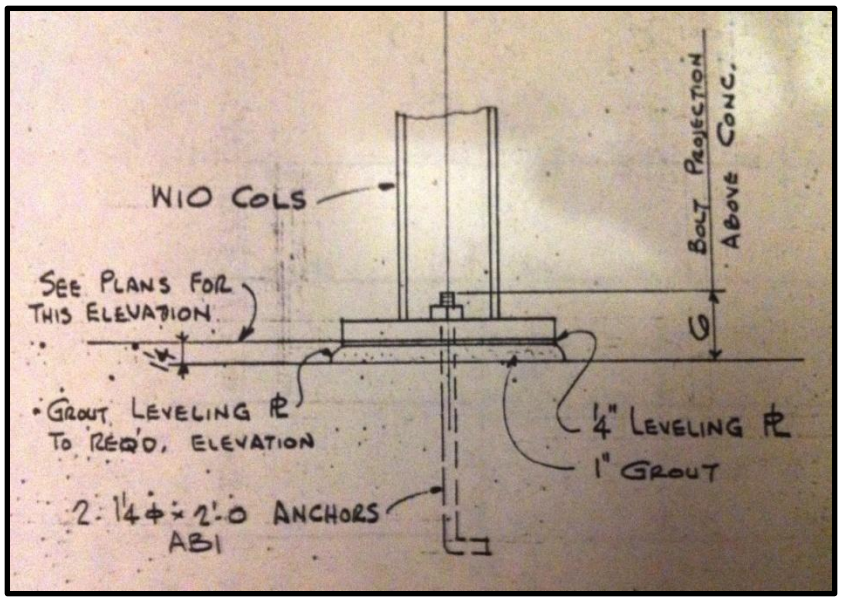


Figure 3 – Pinned Connection

Floor System

The existing floor system for the Indiana Regional Medical Center consists of Composite Steel Deck with 3 ½'' of lightweight 3000 psi concrete fill netting and a total thickness of 5 ½''. An example of this floor system can be seen in Figure 4. Composite deck systems are very appealing because they keep the weight of the building extremely low compared to other systems. It allows for shallower depth of members as well as giving the overall building a low profile. Some serviceability considerations include deflections and vibrations. The composite deck floor system was an excellent choice for the Indiana Regional Medical Center. It leaves a lot of flexibility with floor plans and allows the ability to span long distances that other systems cannot achieve.

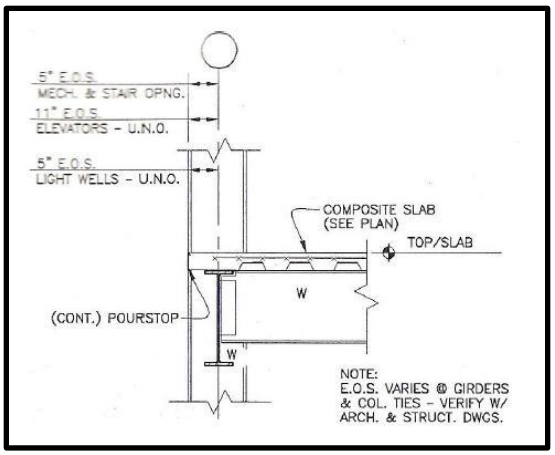


Figure 4 – Composite Slab

Columns

The Indiana Regional Medical Center uses a variety of steel columns to support the gravity load of the building. The sizes of these columns range from W14x38 all the way to a W14x111 throughout the entire structure. The building is supported by these steel columns from the 98 ft height all the way to the ground level. The steel columns within this structural system are typically spliced together at a 24'-0'' distance.

Lateral System

The hospital consists of one large seven story building with five smaller buildings branching off from all sides. Each building is rectangular in shape with a brick façade and has a flat roof. The largest building stands 98 feet in the air and has a rigid frame skeleton of steel. Along its North-South length, the hospital consists of 5 typical bays made up of W10, W14, and W16 steel. Moment frames allow more flexibility with the floor plan and awareness of moment connections throughout the structure. A simplified plan can be seen in Figure 5 below.

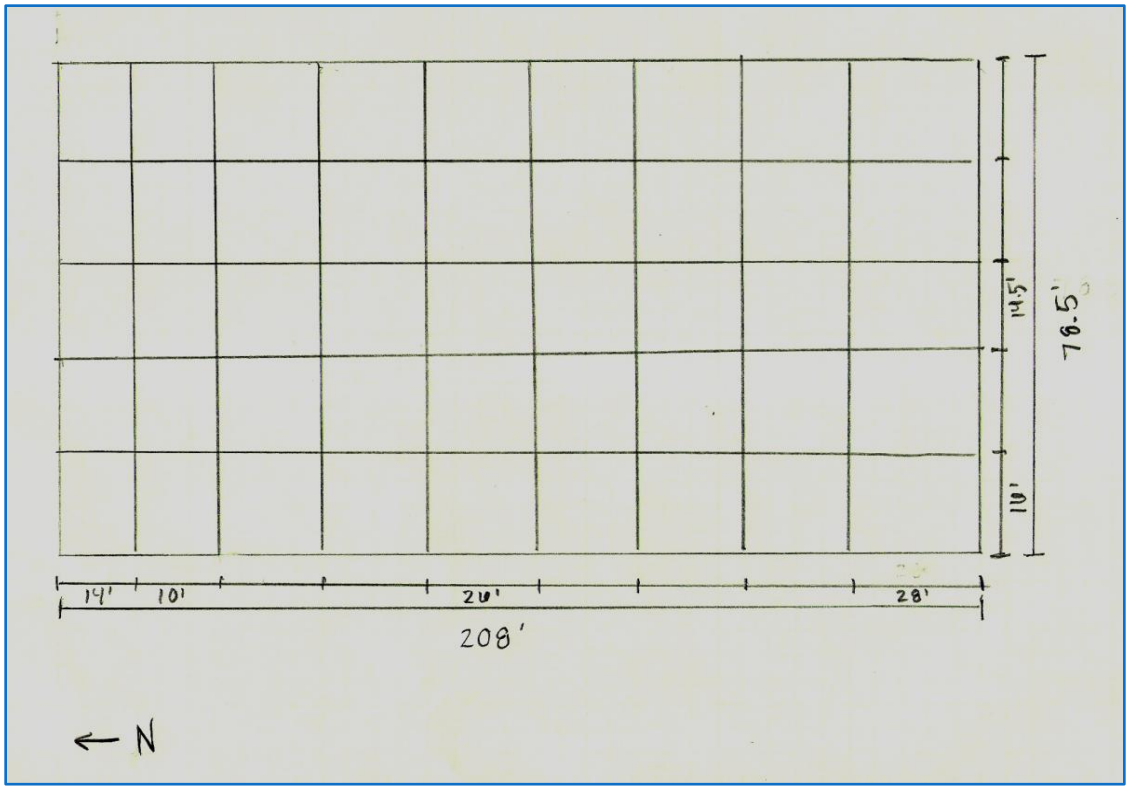


Figure 5 – Simplified Frame Layout

There are two lateral force resisting systems in the Indiana Regional Medical Center. One system is labeled “X-Frame” and has the lesser 78’-6’’ depth of the building. The other system is labeled “Y-Frame” and has the greater 208’-0’’ depth of the building. X-Frame contains mostly pinned connections while the Y-Frame continues mostly moment connections

Roof System

The roof structural system is similar to the floor structural system used throughout the Indiana Regional Medical Center. Even though the same composite deck and slab configuration is used, the fill beams are spaced closer together.

General Structural Information

The following codes were used throughout the semester for the identification of loads, wind load calculations, seismic load calculations, and spot checking.

Design Codes

1. AISC Manual of Steel Construction Ninth Edition (ASD)
2. AISC Manual of Steel Construction Load and Resistance Factor Design Second Edition
3. ASCE 7-98 Minimum Design Loads for Buildings and Other Structures
4. International Building Code 2003
5. AISC Manual of Steel Construction Thirteenth Edition
6. AISC 7-10
7. International Building Code 2010

Problem Statement

The Indiana Regional Medical Center has an existing moment frame structure with a lightweight concrete composite decking system. From recent research it was found that this structural system is the most ideal for this specific building. However, it was also found that there are alternate systems that add comparable benefits to the building that the existing system does not. With this in mind, it is being proposed to change the current structural system of the Indiana Regional Medical Center to a system that utilizes concrete material. The difference of the concrete material could reduce total costs and result in low floor-to-floor heights.

Proposed Solution

Information gathered from Technical Assignment #2 resulted in two potential alternatives for the proposed concrete structural system. The Two-Way Post-Tensioned system was the initial front runner because of its ability to span long distances and its small affects on the architecture of the building. It was later discovered that the Two-Way Flat Plate system is more convenient after a redesign was configured. The Two-Way Flat Plate system has a lower total weight and cost per square foot than the Two-Way Post-Tensioned system. The small impact on the architecture of the building is the only advantage the post-tensioned system has over the flat plate system. Easy formwork, simple bar placement, and low floor-to-floor heights are a few of the advantages gained with the Two-Way Flat Plate system. A basic example of a Two-Way Flat Plate system can be seen in Figure 6. Lateral and gravity loads will have to be reexamined due to an increased weight of the building from the new structural system. Strengths and weaknesses of the current system and new system will be compared after the final design.

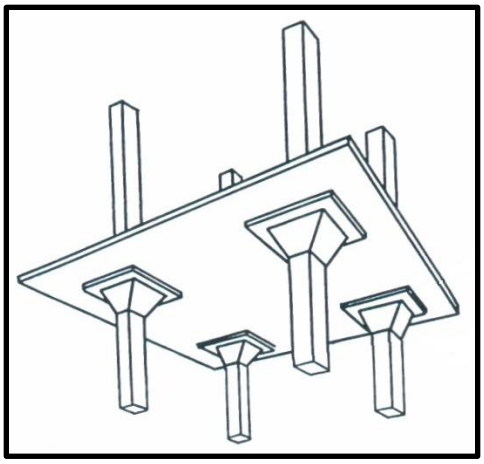


Figure 6 – Two-Way Flat Plate System

Solution Method

The first step of the solution process would be doing further research on the Two-Way Flat Plate system to confirm it is a valid solution for the Indiana Regional Medical Center. Once this is established, the exact system selected will have to be designed to fit the current layout of the building. A 3D ETABS model will then be created to determine the new loads made from the new system. After the respected gravity loads are discovered, new columns will be designed to coincide with the calculated weights. The new design for the lateral system will finally be developed by applying the lateral loads to the new gravity members.

Breadth Topics

Two breadth studies are required along with the depth study. Breadths were considered based on how each aspect of the building is affected by the proposed new structural system.

Breadth #1: Architecture

The first breadth topic that will be studied is the architectural impact the new structural system has on the overall building. New Columns may change the current layout of the building due to their size and location. The difference in floor-to-floor height may also create a needed alteration in window placement.

Breadth #2: Mechanical

The second breadth will study the alterations to the cost and schedule due to the new structural system. Updated cost estimates and construction schedules will be created for the new system. These updated costs and schedules will then be compared to the original costs and schedules.

Tasks & Tools

Depth

1. Further research on the Two-Way Flat Plate system to confirm it is a valid solution for the Indiana Regional Medical Center.
    a. This phase will be completed before the start of the spring semester.
2. Design the concrete slab system used for the new structural system.
    a. Slab design will be done by hand calculations and will be checked by computer applications.
3. Design new columns to coincide with updated weights.
    a. All respected gravity loads that are needed will be calculated after the slab system is designed.
4. Evaluate the lateral system by applying new lateral loads to the new gravity members.
5. Determine the affects of the new structural system on the foundation.

Breadth #1: Architecture

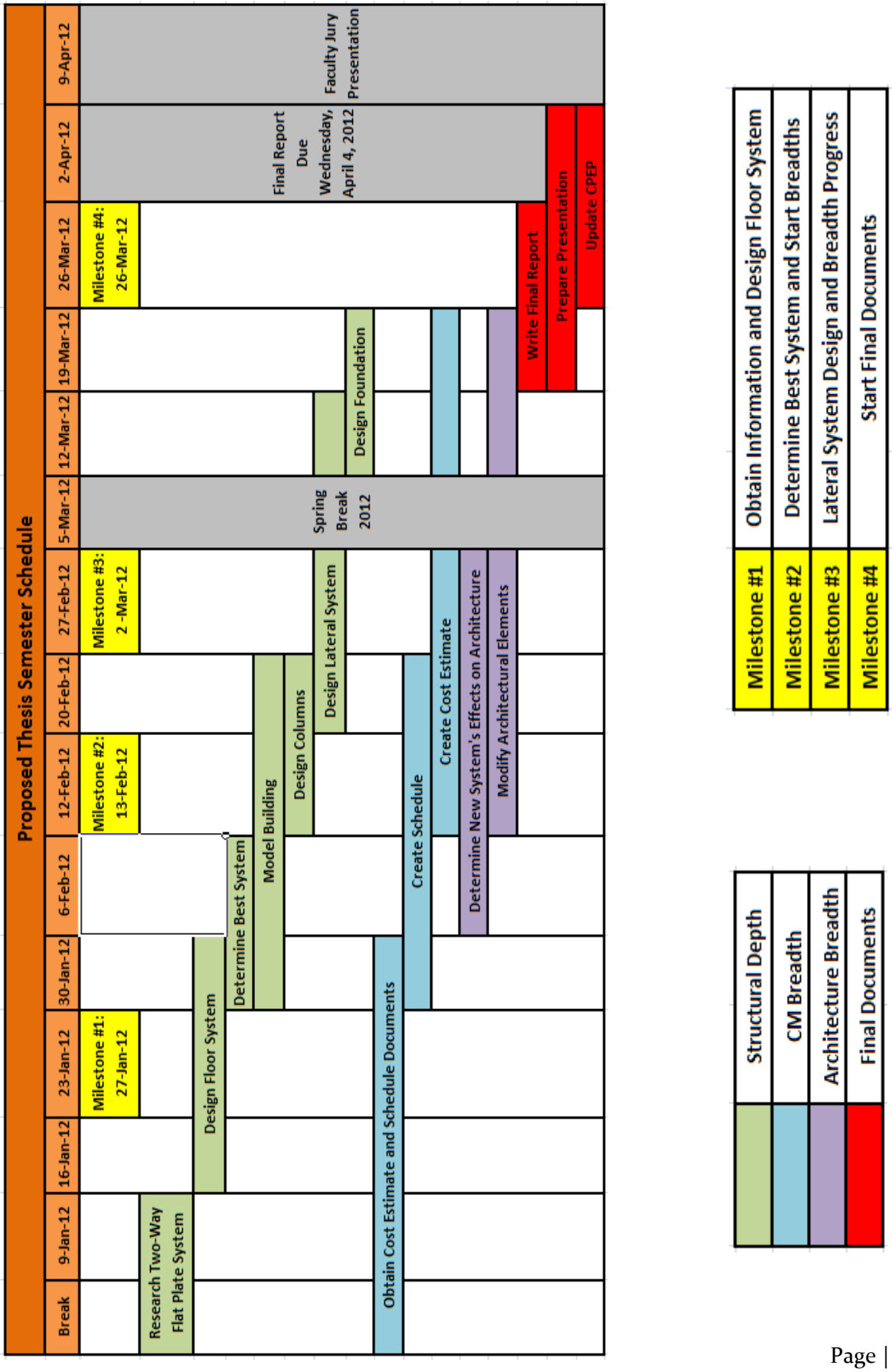
1. Analyze the new structural system's affects on the building's current layout.
2. Develop a modified or completely new layout if needed.
3. Develop a modified or new façade if needed.

Breadth #2: Mechanical

1. Obtain all necessary information needed from original cost estimates and schedule.
2. Estimate the cost of the new structural system.
3. Update the original construction schedule to correspond with the new system.
4. Compare the new cost and schedule to the originals.

Conclusion

During the spring semester, the entire gravity system of the Indiana Regional Medical Center will be redesigned using concrete. The current moment frame structure will be replaced by a Two-Way Flat Plate system. Hand calculations will be utilized during this new design as well as computer modeling programs. New loadings will not only change the gravity system, but the lateral system as well. The architectural impact and the updated cost estimate and construction schedule due to the new system are the two breadths being studied for this redesign.


Proposed Thesis Semester Schedule
Break
9-Jan-12
16-Jan-12
23-Jan-12
30-Jan-12
6-Feb-12
12-Feb-12
20-Feb-12
27-Feb-12
5-Mar-12
12-Mar-12
19-Mar-12
26-Mar-12
2-Apr-12
9-Apr-12
Milestone #1: 27-Jan-12
Milestone #2: 13-Feb-12
Milestone #3: 2 -Mar-12
Spring Break 2012
Milestone #4: 26-Mar-12
Final Report Due Wednesday, April 4, 2012
Faculty Jury Presentation
Research Two-Way Flat Plate System
Design Floor System
Determine Best System
Model Building
Design Columns
Design Lateral System
Design Foundation
Obtain Cost Estimate and Schedule Documents
Create Schedule
Create Cost Estimate
Determine New System's Effects on Architecture
Modify Architectural Elements
Write Final Report
Prepare Presentation
Update CPEP
Structural Depth
CM Breadth
Architecture Breadth
Final Documents
Milestone #1
Obtain Information and Design Floor System
Milestone #2
Determine Best System and Start Breadths
Milestone #3
Lateral System Design and Breadth Progress
Milestone #4
Start Final Documents