THESIS PROPOSAL

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Embassy Suites Hotel, Springfield Virginia

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Executive Summery

The Embassy Suites Hotels is a 7 story all-suite hotel located in Springfield Virginia. Situated a few miles away from downtown Washington D.C., Embassy Suites contains 219 guestrooms and a host of amenities like a pool and bar areas. The building will also contain many retail stores located on the lower level. The building stands at 91feet 10 inches and is approximately 185,000 square feet. The building floor system contains an 8 inch cast in place reinforced slab connect to mostly 14"x 30" reinforced concrete columns. The columns run between the floors at a story height of approximately nine feet. The typical story height is 9 feet except for the ground storefront level and the roof level, having heights of 18 feet and 10 feet respectively. The foundation system contains a mud mat system due to soil differentials around the site. Aside from the mud mat system, some areas of the Embassy Suites foundation contain a typical strip footing and slab on grade system. The lateral and gravity load system are integrated and consist of reinforced concrete moment frames.

In conducing the 3 previous technical reports, which examined gravity and lateral loadings acting on the building, the buildings reissuance to these loading and an alternative floor design study it was determined that the Embassy suites hotel met all code and specification requirements and is adequate for its design.

The purpose of this report is to summarize an alternate proposed area of study for the Embassy Suites Hotel Project. For the structural depth proposal a conversion of the current concrete framing system to a steel framing system will be administered to the building project. As a result of this new design, framing members and floor systems will be selected and designed in looking to achieve an alternate design as efficient and functional as the existing system in place. Gravity and lateral load analysis will be performed in to order to determine the buildings response to these loads, its ability to resist them and compare the results to the existing design.

In addition to the structural depth, 2 alternative areas of study will be investigated. The studies selected for breathe topics are the impact of steel construction on the acoustical aspects of the Embassy Suites Hotel and the potential change of sustainable features and the building's LEED certification rating.

A timeline of the proposed tasks of this redesign can be found at the end of this report to ensure that progress of alternative study is on task.

Introduction: Embassy Suites Hotel

Figure: Site Map. (Photo taken from Google Earth)

The Embassy Suites Hotels is the newest, 7 story, luxury, hotel to become part of the Miller Global, LLC family. Along with Miller Global, the owner the collaborative construction team on this venture include, Cooper Carry, architect; SK & A Structural Engineers, PLLC , structural designers; Balfour Beatty Construction, construction manager; Jordan and Skala, MEP firm; Christopher Consultants, LTD, civil engineering firm. The site is located at the junction of I-95 and Fairfax County Parkway. The location lies in the Springfield region of Fairfax County, Virginia. The site is approximately 16 miles away from the heart of downtown Washington, D.C... Patrons will also be in close proximity to both the Fort Belvoir Main Army Post and the National Geospatial-Intelligence Agency (NGA) facility. The construction delivery method was design –bid - build. Construction began in November 2011 and will be completed July 13th 2013.

Figure: **Facade. (Photo taken from Miller Global, LLC website)**

Upon its completion, this 31.5 million, 185,000 square foot, hotel will feature many amenities. These include a large open air atrium and spacious two room suites. The hotel will serve as a model for comfort and convenience. The building's architecture boasts long flowing curved lines that give it immense visual appeal and a unique flow. The hotel's ground floor will contain a 1300 square foot pool area, a fitness center along with multiple meeting areas, a bar, a lounge and over 1400 square feet of retail space.

The ground level and upper floors store front materials will be made up of manufactured masonry (adhered concrete stone veneer). It is comprised of boral cultured stone country ledge stone along with architectural adhered precast concrete panels. It also contains 1" insulated glass windows with aluminum frames and automatic entrances. The upper levels the exterior façade will feature an exterior insulation finish system (EIFS).

This report will be describing the various structural elements and systems in place at the Embassy Suite Hotel project, proposed alternative problem statement, proposed solution to this problem and methods in which the problem will be solved.

Structural Systems

Existing Foundation

Prior to construction, subsurface exploration and geotechnical engineering analysis were conducted on the future Embassy Suites Hotel site and was completed in January11, 2011 by ECS Mid- Atlantic, LLC. The report indicates a number of test borings were performed on 3 separate occasions. The test borings were drilled at depths ranging from 2.5' to 79' to determine the soil composition in different areas of the site. ECS Mid- Atlantics results showed fill soil material was found in ten boring locations around the site. The fill material was composed of

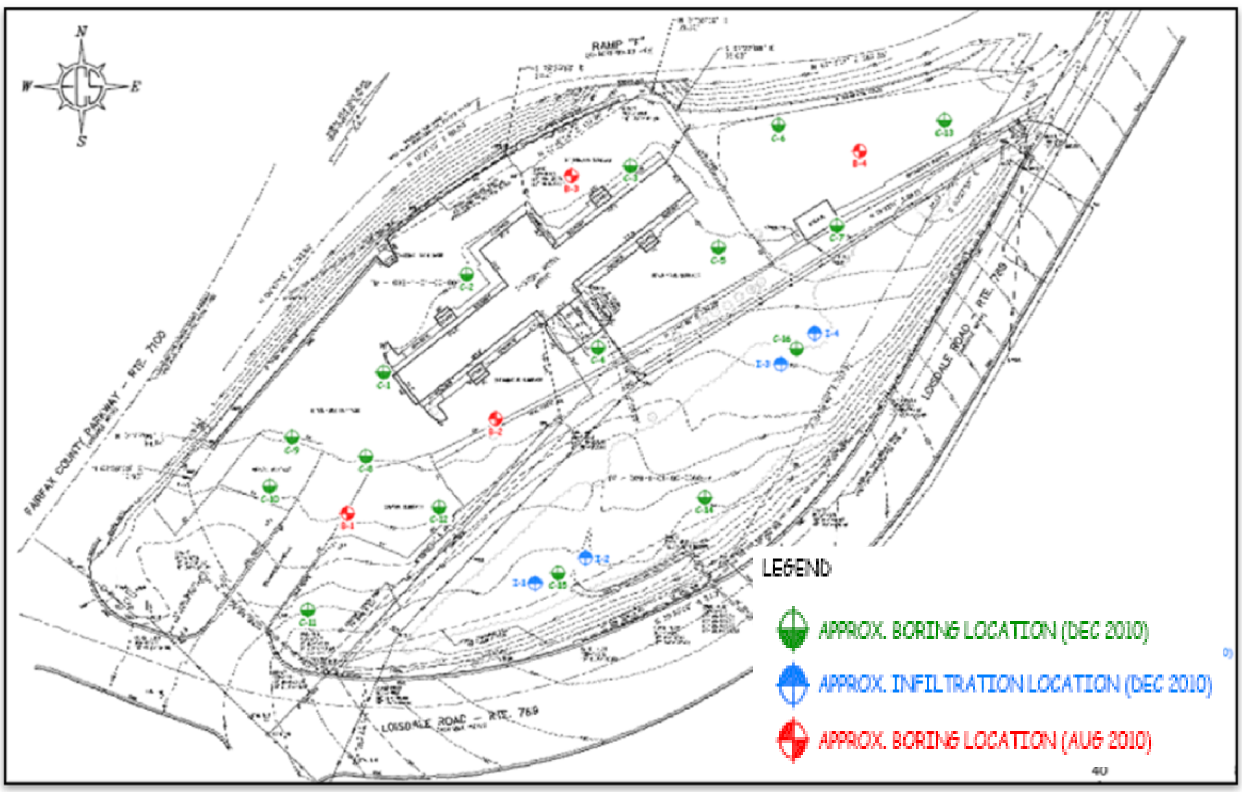


Figure: Core Boring Locations

silty sand and clay from depths of 6.5' to 8.5' below the ground surface. Further down the borings indicated the existence of natural soils that were mainly composed of clayey sand, silt and fat clay. A weather rock material was found at 77' to 78.6'and ground water was encountered at of 18.5' to 65'.

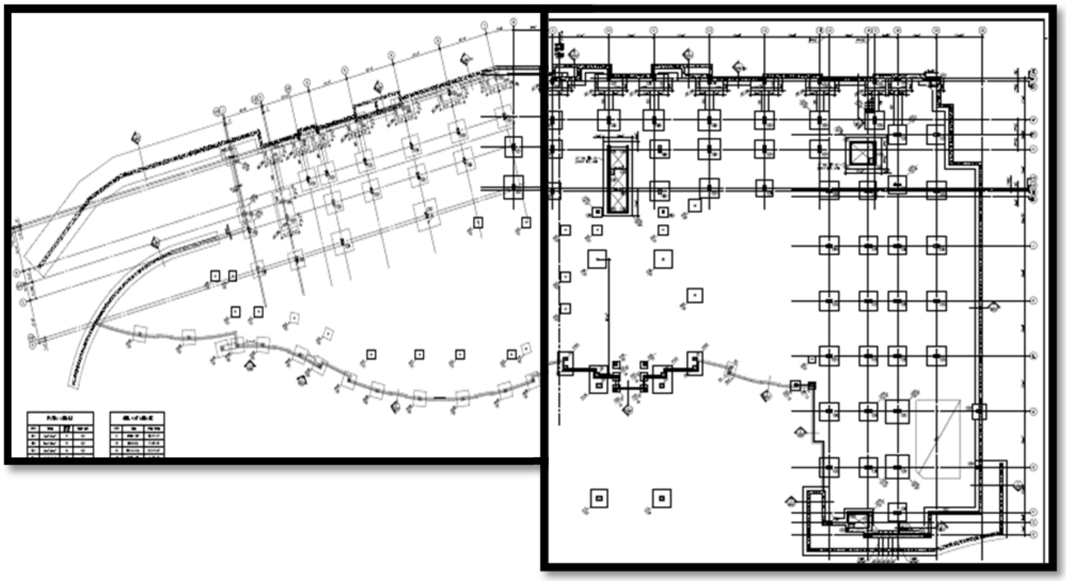


Figure: Foundation Plan

Due to the variability in soil composition, the project team had to employ a partial mud matt system to equalize the soil capacity around the site in some areas. A mud matt system is a thin layer of lean concrete mix (in this case 2000 psi) placed over the existing soil below and allows a stable base for construction.

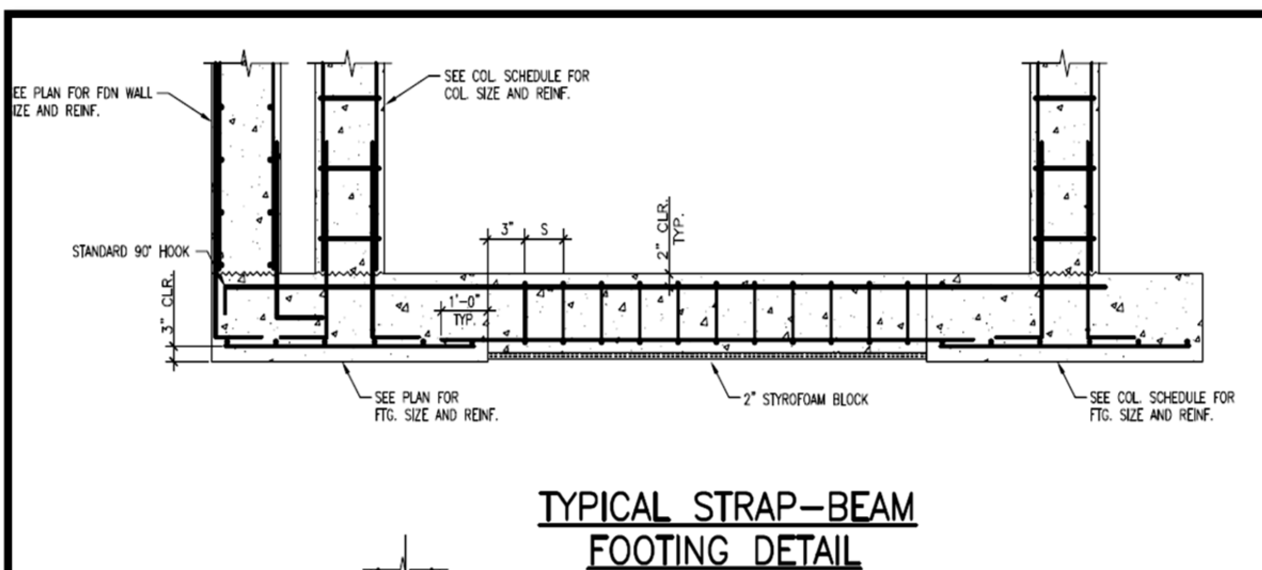
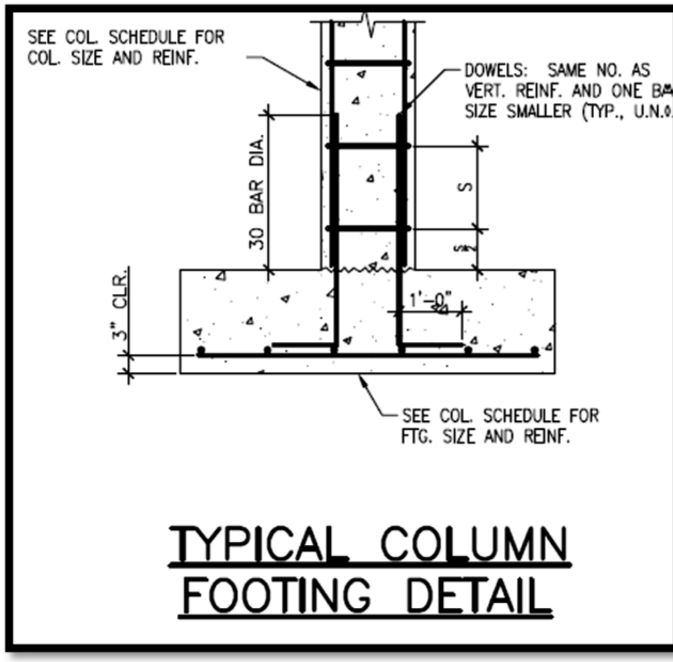


Figure: Strap Beam Detail



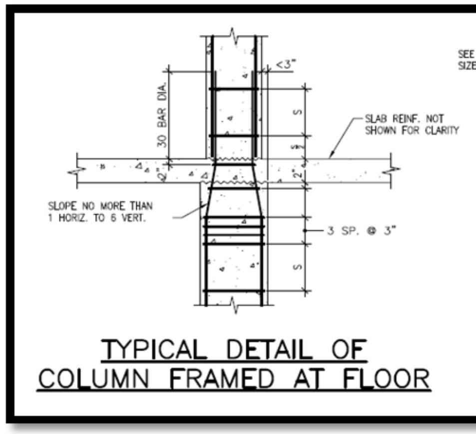
The spread footings were designed to have an allowable bearing capacity 6000 psi. The size of footings range from 3’ by 3’ to 12’ by 8’ and extend 2’ below the slab on grade. To tie the footings together, longitudinally placed strap beams ranging from 36 width x 24 depths to 42 width x 24 depth beams were used. A strap beam is a structural element used to connect to isolated footings together. These beams help distribute the building load to the footings and eventually the ground. The beams range in size and have varied vertical and horizontal reinforcing.

The typical slab on grade is a minimum of 5 inches in depth and sits on 4 inches of washed crushed stone. The capacity of the slab is 3500 psi for the interior portions and 5000 psi for exterior slab conditions. The slab contains 6x6 – W 2.0 x W2.0 welded wire fabric and has number 4 reinforcing steel bars spaced 12 inches on center each way.

Floor System

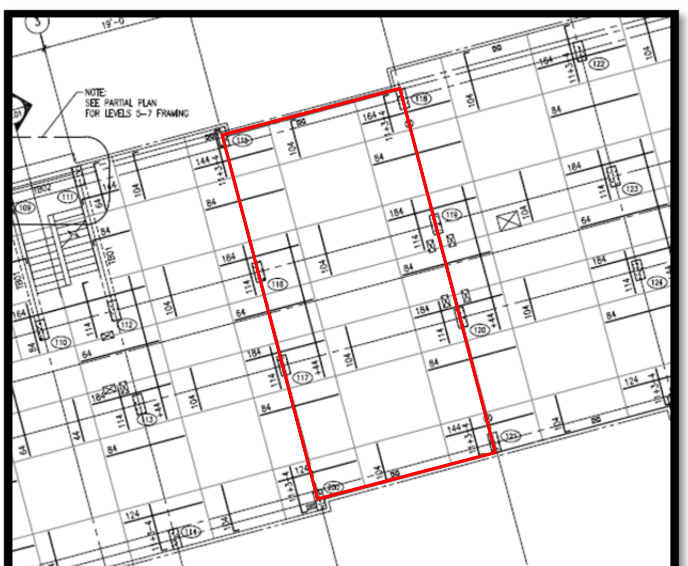
The Embassy Suites Hotel is made up of a typical flat slab construction. The two way slab thickness is 8 inch and the compressive strength of the normal weight concrete is 5000 psi. The slab reinforcing includes number 4 reinforcing bars spaced at 10 inches on center, either way and run the full length from column to column. The floor system also uses drop panel system around one of the interior columns to provide increased negative moment capacity and to protect against punching shear. Punching shear is a failure mechanism were the slab separates from the column due to concentrated shear force. Drop panels are 3.5 inches thick (total slab thickness around column on typical floor is 11.5 inches) and extend 5 feet from either side of the columns.

Framing System



TYPICAL DETAIL OF COLUMN FRAMED AT FLOOR

In the image below, a typical framing plan section is shown for floors of the Embassy Suites Hotel (Floors 3 to 7). A typical bay size is 23' by 18' for floors containing the guest suites. The columns chosen in for the framing plan were almost all 14" x 30" rectangular reinforced concrete columns. The majority of the columns have a minimum compressive strength of 6,000psi. There are no beams running in between the interior and exterior columns. The only reinforced beams found are located in stairwell openings and elevator shafts.



Due to the increased load on the second floor, large concrete transfer girders had to be used to accommodate for the fitness and pool area. Level 2 also contains HSS columns along with a variety of wide flange shape beams. These are located in the section of the hotel where future retail stores will be housed.

Lateral System

To resist lateral forces due to wind and seismic loads the structural engineers employed reinforced concrete moment frames moment frames. The concrete moment frames are the main lateral force resisting system in the building. The lower storefront levels have welded steel moment connections as shown in welded moment detail. The moment connections were designed to develop the full capacity of the member. The connections use high strength ¾ or 7/8 inch ASTM A325 or A490 threaded bolts. The bolts connect the ¼ x 1 inch plates to the beams were the plates are butt and penetrate welded.

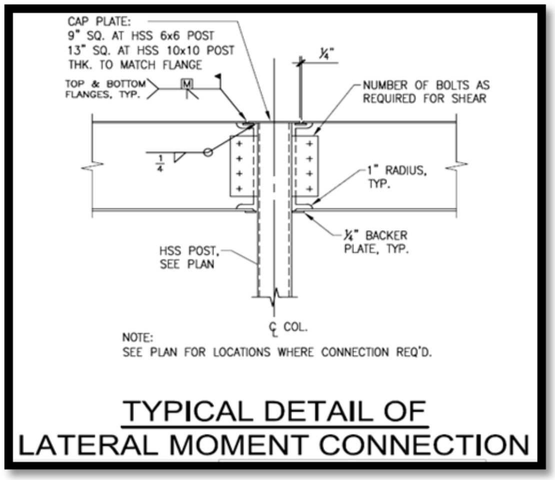


Figure: Welded Moment Connection

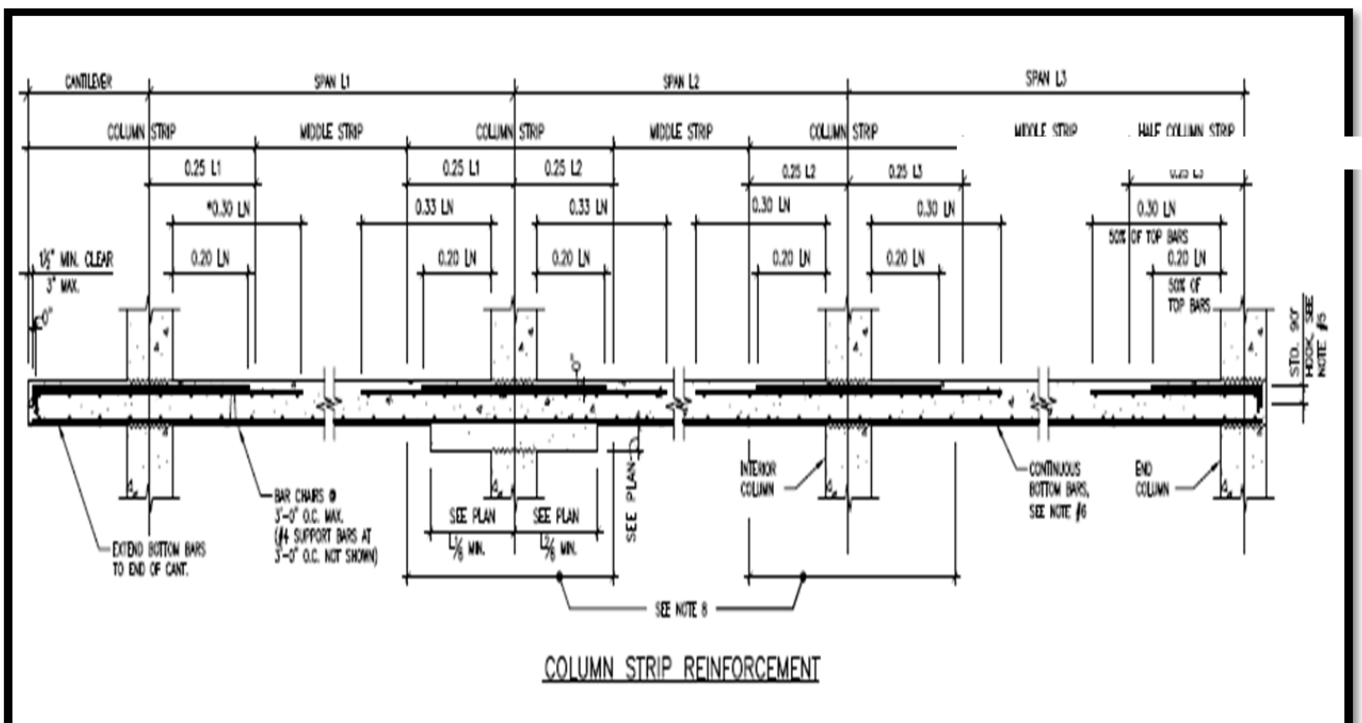


Figure: Main Lateral Force Resisting System

Roofing System

The high level roofing system consists of 3.25 inch light weight concrete slab. This slab has a compressive strength of 3,500 psi. The lower level roof (top of retail space) is made of 1.5 inch deep 20 gauge Type B cold formed metal deck. The roof deck systems are supported by wide flange beams, concrete reinforced beams varying in size and open web steel joists. The lower level roof system is comprised of a thermoplastic membrane fully adhered with heat welded seams and vapor retarder over a metal deck. Part of the lower level roof (top of part of the second floor) contains a green roof system that includes a pre-vegetated 50 percent extensive and a 50 percent intensive system that is placed upon a protective mat.

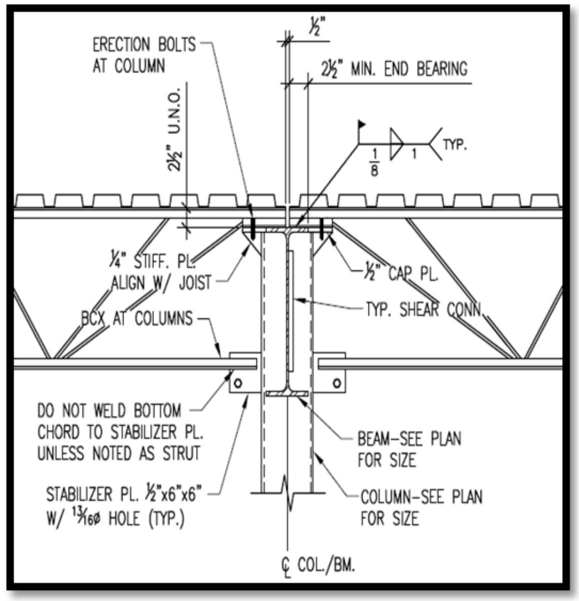


Figure 1: Lower Roof System Connection

Problem Statement

In examining the Embassy Suites Hotel, a predominantly concrete structure, it was determined that the system in place is the most practical and efficient design possible, having building system components that adequately carry the loads applied to the gravity and lateral force resisting systems. In addition, the systems met all code requirements including serviceability and drift.

In the study of this building in technical report 1, gravity and lateral loads were determined and compared to code and specification requirements put forth in ACSE 7-05 and IBC 2009 having values adequate to rest loadings. A study of alternative floor systems conducted in technical report 2 concluded that the existing floor system was the best option for the concrete design but the composite floor on steel framing did show promise. In technical report 3, a further analysis into lateral load resting systems showed that the concrete moment frames resisted loads due to gravity and wind adequately and proved to be the best option for the building. In examining the structural system, composed of mainly structural reinforced concrete, it was determined to be a sound design and using concrete as a material for construction was the best option due to height limitations put forth in zoning requirements.

Having delved in many aspects of the design and analysis of this reinforced concrete system and gaining in depth knowledge of this topic, it draws the question if there is an alternative material that could be as efficient as structural concrete for the existing design. To answer this question a redesign of the Embassy Suites Hotel framing system using steel construction will be studied. The effectiveness and impacts of this new material on other components of the building design will be compared to existing system. This proposal will investigate this alternative building solution and its impact other aspects of the Embassy Suites Hotel.

Problem Solution

Structural Depth: Alternative Framing System

For the depth topic of the study, the selection of an alternative material for the redesign of the Embassy Suites framing system will be examined. It is known that by selecting a steel system that this would affect building height and the possibility of losing a floor. For this report it will be chosen to keep the same amount of stories even if the zoning limitations are determined to be exceeded. Converting the Embassy Suites Hotel into a steel framed structure in tern affects how the building responds to gravity and lateral loads. Design of steel moment frames to produce the lateral forces exerted on the building will have to be examined.

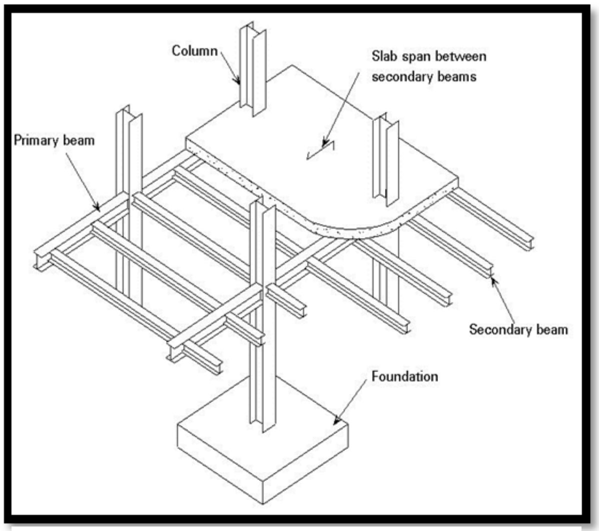


Figure: Steel Framing System with Composite Floor.
(Photo taken from www.tatasteelconstruction.com)

In changing the framing system itself the components of this system will also be altered. Columns and beams at respective locations in the buildings will have to be designed and checked for adequacy and will be again compared to the existing structure for efficiency. With altering the columns of the Embassy Suites Hotel a look into the overall column placement will have to studied. In addition, if the building is converted to steel, alternative floor systems that work more efficiently with steel framed structures will be considered. A composite floor system along with a slim floor system will be studied in determined the best option for a floor system in a steel framed structure with height limitations.

The investigation into this material and its affect on the overall design will be compared to the existing design of the Embassy Suites Hotel and will determine whether this material can be as efficient as the existing structure material.

Solution Method

In developing an alternate design using steel construction in the Embassy Suites Hotel hand calculations methods will be used in determining preliminary sizes of steel framing members which will be able to resisting lateral and gravity loads that are applied to the building. Various specifications, codes and industry specifications which include AISC Steel Construction Manual, ASCE 7-05, Vulcraft Deck Catalogue and Slim Floor Design guides, will be used in calculation of these member sizes of beams and columns. Recalculations of gravity loads due to material change will have to be used to determine the forces acting on the framing system. Load assumptions will be in accordance to ASCE 7-05. Once the framing elements are determined the floor system could be investigated calculating the capacity and determined which steel framing floor system will function best for the steel frame construction

In accordance with hand calculations, computer models will be developed to check the adequacy of members developed by the use of hand calculation. Also, for the lateral system, the computer models will also be used to determine the building resistance to lateral forces acting on the building in examining shear, torsional effects, overturning moments and ASCE serviceably limitations.

In proposing this alternate design, it will ultimately be compared to the existing building to examine if there could be an alternative material that will perform as well as the existing structure and will be able to resist the forces applied to it.

Breath Studies

In accordance with the depth study, 2 alternative areas of investigation are required in areas other than ones concentration. The studies selected are the impact of steel construction of the acoustical aspects of the Embassy Suites Hotel and the affect on sustainable features of the building.

Breath Study I: Acoustics

For hotels, acoustics play a significant part in the planning of a structure to ensure the guest privacy and comfort. In the early phases of construction, an acoustical study was done to determine the sound vibrations due to the location of the hotel near major highways and air force base. This study will delve into the effects of having a steel framed structure on the acoustics of the buildings and what practices and solutions could be put forth to ensure that sound and noise levels will be controlled.

Breathe Study II: Sustainability

Currently, the Embassy Suites Hotel project has many construction practices in place that will help it strive towards getting a LEED certified rating upon its completion in July of next year. By changing the framing system to steel construction it will be examined how altering the predominant material in the building will affect sustainable practices. Additionally look into how more sustainable practices could be implemented in the existing structure along with looking into by changing to steel construction could possibly allow for the achievement of a higher LEED rating.

Tasks and Tools

I. Structural Depth
   A. Steel Framing System
      1. Task 1: Investigation of Composite Floor and Slim Floor Systems and loads applied to floor members.
         a. Establish if column layout and at typical bay size will be affected due to steel construction
         b. Determine dead and live loads in accordance with ASCE 7-05 and IBC 2009
         c. Design of Composite Floor System Framing members selecting preliminary sizes based on hand calculations for a typical bay size
         d. Design of Slim Floor System Framing members selecting preliminary sizes based on hand calculations for a typical bay size
         e. Comparison of two systems to select most efficient design.

      2. Task 2: Determination of Story gravity loads and design of columns members.
         a. Apply loads at each floor to determine load distribution to columns
         b. Design a standard column size to resisting load for proposed redesign of framing members by use of hand calculations for a typical bay.
         c. Examine if overall height will be affected will be affected

      3. Task 3: Creation of a computer frame models to verify adequacy of selected steel framing members.
         a. Add designed floor and column members for a typical bay into model for gravity analysis
         b. Input calculated loads in model
         c. Verify if selected framing members are adequate for redesign comparing model results to hand calculations

   B. Lateral System
      1. Task 4: Determine Lateral loads applied to the frame
         a. Recalculate building weight for determination of lateral load

   b. Check wind load calculations using ASCE specifications
   c. Recalculate seismic loading with new story weights

2. Task 5: Perform Lateral Load Analysis
   a. Analysis moment frames by use of hand calculation when checking shear torsion and overturning
   b. Create Frames using a computer model to check ASCE load specifications
   c. Modify framing members if results show inadequate resistance to lateral load

II. Breadth Study I: Acoustical Study

A. Task 6: Investigation of existing acoustics and noise levels
   1. Research acceptable noise levels for hotels and noise levels of the surroundings building location
   2. Investigate noise level material properties of steel and concrete and their acoustical impact on a typical guest room.
   3. Determine the efficiency of the steel material in terms of noise level and acoustical properties as compared to the concrete material by use of hand calculations.

III. Breadth Study II: Sustainability Study

A. Task 7: Examination of Sustainable practices and LEED rating
   1. Research the existing sustainable practices in place on the building project
   2. Establish criteria used to determine existing LEED rating for current building.
   3. Determine new possible sustainable practices in existing structure and in new proposed redesign and how this new construction will affect the current LEED rating.
   4. Compare and contrast results for existing and proposed redesign.

IV. Presentation

A. Task 8: Prepare final presentation
   1. Create Final Presentation.
   2. Complete Final Report.
   3. Update CPEP site.

Time Table

Below is a description of the semester layout and project schedule for the proposed redesign.