Mountain Hotel, Urban Virginia

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Structural Option

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Mountian Hotel

Virginia

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Structural Option

Overview

-6 Story Hotel in urban Virginia
-82,000 SF Hotel with a 40,000 SF Parking Structure
-62ft roof height
-Design/Build

Project Team

-Owner: Not released
-General Contractor: not available at this time
-Acrhitect: Enviro Architects
-Civil: Walter L. Phillips inc
-Structural: Allince Engineers
-MEP: EPIC consultants

Architecture

-Colored EIFS tiles to reflect brick and concrete of surronding buildings
-Large arch vults supporting ramp leading to parking structure
-Porte-cochere covering entrance leading to main lobby and parking

MEP

-Separate through wall heat pumps for each guest room
-Constant Volume system for common and assembly areas

Structural

-Foundation comprised of reinforced concrete spread footings with 4 in thick slab on grade
-HSS for interior columns
-Light gauge steel stud bearing walls support most of the exterior walls and upper floors.
-All above grade floors are constructed using precast hollow core planks
-Flat strap bracing employed for lateral system in steel stud shear bearing walls (shown in Figure 1)

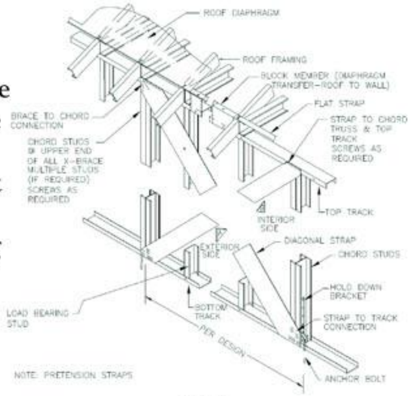

FIGURE 1

http://www.engr.psu.edu/ae/thesis/portfolios/2013/bob5027/

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Executive Summary

Located in an urban center in Virginia, the Mountain Hotel will soon be the latest addition to one of the largest hotel chains. Light gage steel stud bearing walls are the primary element supporting six stories of precast hollow core plank floors. Prior analysis of this system demonstrated that it was lightweight, economical, and highly efficient.

The primary goal of this thesis was to learn the reinforced concrete design process by a redesign of the Mountain Hotel's gravity and lateral structural systems using reinforced concrete, such that the building is occupiable immediately after a seismic event at a new location in earthquake prone San Francisco. Because all aspects of the design were originally performed for the Virginia location, two of the buildings other systems were analyzed, and modified to maintain the building's original performance level. The new concrete floor system is denser and therefore had the potential to reduce the sound absorbance compared to what would have been achieved by the hollow core planks. The sound transmission properties of the two floor systems were therefore analyzed to mitigate a reduction in the comfort of the hotel's guests. Thermal comfort was also considered. The heat transfer across the specified glazing was analyzed to determine a replacement glazing that would produce a similar thermal load for the new location in California.

Building Loads were determined in accordance with ASCE 7-10 referenced in the 2010 San Francisco Building Code. Design of both the gravity and lateral systems were performed using ACI 318-11. ASCE 41-06 was also considered in the design of the lateral system. A 12 inch floor slab was required in order to mitigate long-term deflections. An 18 x 24 column was chosen to support the floor reactions, which was enlarged to a 24 x 24 for several columns supporting the first and second floor to increase the shear area required to resist the 100psf live loads. On those stories 3 inch drop panels were also required and would not affect the architecture because they are covered by drop ceilings. 12- 18 inch thick shear walls spanning from the foundation to the roof were utilized in limiting the structure to the determined drift limit criteria. Because the soil at this location is not considered to be prone to soil liquefaction, spread footing could be used with thicknesses vary from 10 to 30 inches.

Building Introduction

The Mountain Hotel was to be located in a wealthy urban area of Virginia (Location shown in Figure 6-1). The site chosen for construction of the new hotel is a prominent location previously occupied by a chain of parking lots, which border the main street of the town.

Figure 6-1
An aerial view from bing.com maps with the building superimposed on. Hotel is in Red, Garage in Yellow.

In order to match the new building into its surrounding architecture the first two floor facades are brick with large glazing panels, while the upper facade uses a palette of varying shades from brick red to white which enables it to match the brick and concrete of the surrounding buildings, including the adjacent concrete parking structure. However, in place of the brick or concrete, the upper stories of the hotel use a lighter more cost effective cladding, exterior insulation finishing system (EIFS) panels. The Porte Cochere on the west side, shown in Figure 6-2, will help funnel visitors into the main lobby where they can check-in and be directed to their rooms, other amenities, or sites of the town.

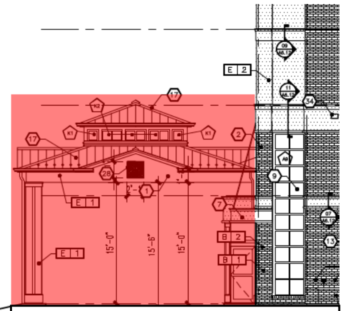


Figure 6-2
Porte Cochere attached to Hotel over main Entrance.

Guest rooms are located on the second through sixth floors totaling just over 40,000 square feet. Though the main function is to appease guests with a home away from home, it also contains meeting rooms for conferences, offices for hotel management, and a 40,000 square foot parking garage. Total building area is approximately 120,000 square feet.

Existing Structural Overview

Code Requirements

Standards and codes governing the existing structure are as follows:
2009 ICC/ANSI A117.1
2009 International Building Code
2009 Virginia Uniform Statewide Building Code
ACI 301, ACI 318 and ACI 302 latest editions.
ACI 530/ASCE 5, "Building code requirements for Masonry structures"
ACI 530/ASCE 6

Load Combinations

Listed here are all the load combinations that are being considered. All load combinations are based on LRFD and come from ASCE 7-10.

- 1.4D
- 1.2D + 1.6L + 0.5(Lr or S or R)
- 1.2D + 1.6(Lr or S or R) + (L or 0.5W)
- 1.2D + 1.0W + L + 0.5(Lr or S or R)
- 1.2D + 1.0E + L + 0.2S
- 0.9D + 1.0W
- 0.9D + 1.0E

Gravity System

Superstructure

This building uses several types of structural members to carry the various gravity induced loads to the earth. The hotel roof and all above grade floors utilize 9' – 25' long, four and eight inch thick, precast hollow core planks to support the dead loads of the structure as well as all the amenities people and other items. The planks typically rest on cold-formed steel stud shear walls, as shown in Figure 8-1 which pass the load onto the floor below, and so on until it either reaches either a reinforced concrete shear wall or a wide flange beam which it can do so as high as the fourth floor, or as low as the first floor. W-shapes made to the ASTM standard A992 range in size from W6x15 to W33x130. ASTM A500 Hollow Structural Section (HSS), ranging from HSS 4x4x¼ HSS 12x12x½, columns hold the beams in place. Most of the HSS columns terminate in the lower floors; however there are several members that transfer load directly from the roof into the foundations. The Elevator and stair towers are an exception the typical framing types. They use specially reinforced masonry sheer walls to resist both gravity and lateral loads stretching from above the normal roof height and down into the foundation.

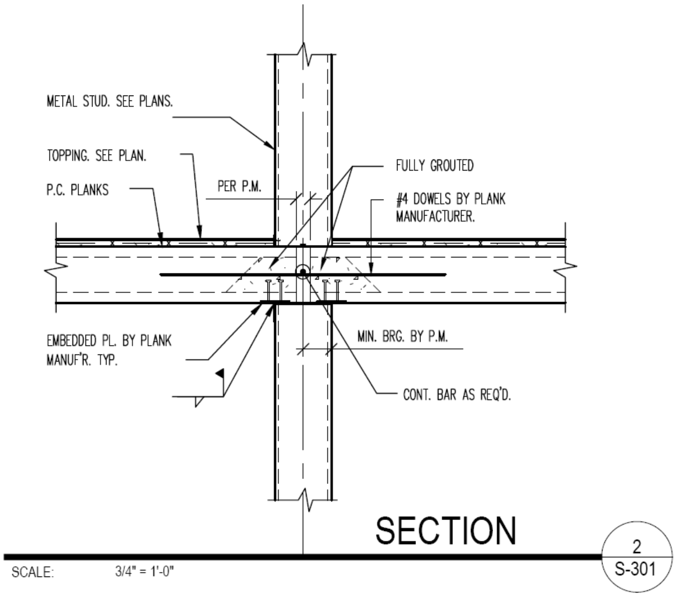


Figure 8-1
Hollow core plank ends spliced and resting on light gauge steel stud framed walls.

Substructure

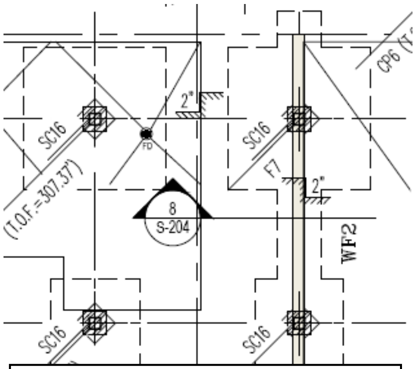


Figure 9-1
Shows a portion of the foundation plan using various structural elements.

The substructure uses a series of reinforced concrete shear walls to transfer the loads from the superstructure into the wall footings of the foundation (Figure 9-1). Under columns and column piers, there is a series of spread footings the largest of which is 16"x16"x42"deep. Footings maintain a minimum compressive strength of 3000psi. Other concrete members have an Fc of 5000psi. Footings rest upon soil which has a bearing pressure of 3000psf.

Lateral System

Façade

The exterior of the Mountain Hotel is clad both with Brick and Exterior Insulation and Finishing System. There are also numerous windows throughout the façade. Wind force is transferred from façades through the walls and into the diaphragm of the buildings as shown in Figure 9-2 to the elements of the main lateral force resisting system.

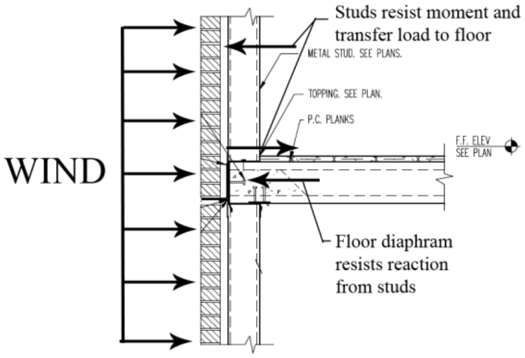
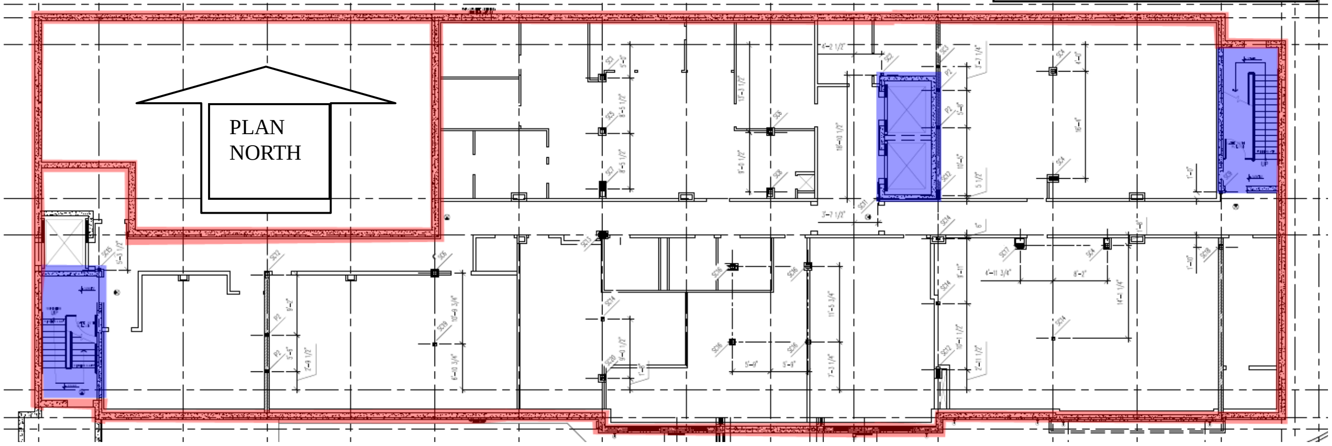


Figure 9-2
Load path for wind into the corresponding diaphragm

Main Lateral Force Resisting System

Figure 10-1
Locations of various Shear Walls



Wind and Seismic forces in the Mountain Hotel are resisted mainly by three different types of elements. Below grade, lateral forces are resisted through a system of reinforced concrete shear walls some of which are highlighted in red in Figure 10-1. The exterior walls are 14 inches in thickness while most of the interior walls are eight inches thick. A few of these walls extend up to the second story, but most of the superstructure instead employs cold-formed flat strap bracing to resist wind and earthquake loadings. Braced walls are shown in Figure 10-2 and are highlighted in yellow. In the design of the light gauge elements the structural engineer specified locations, possible member sizes and what forces these elements were required to resist. Much of the lateral strength of the Mountain

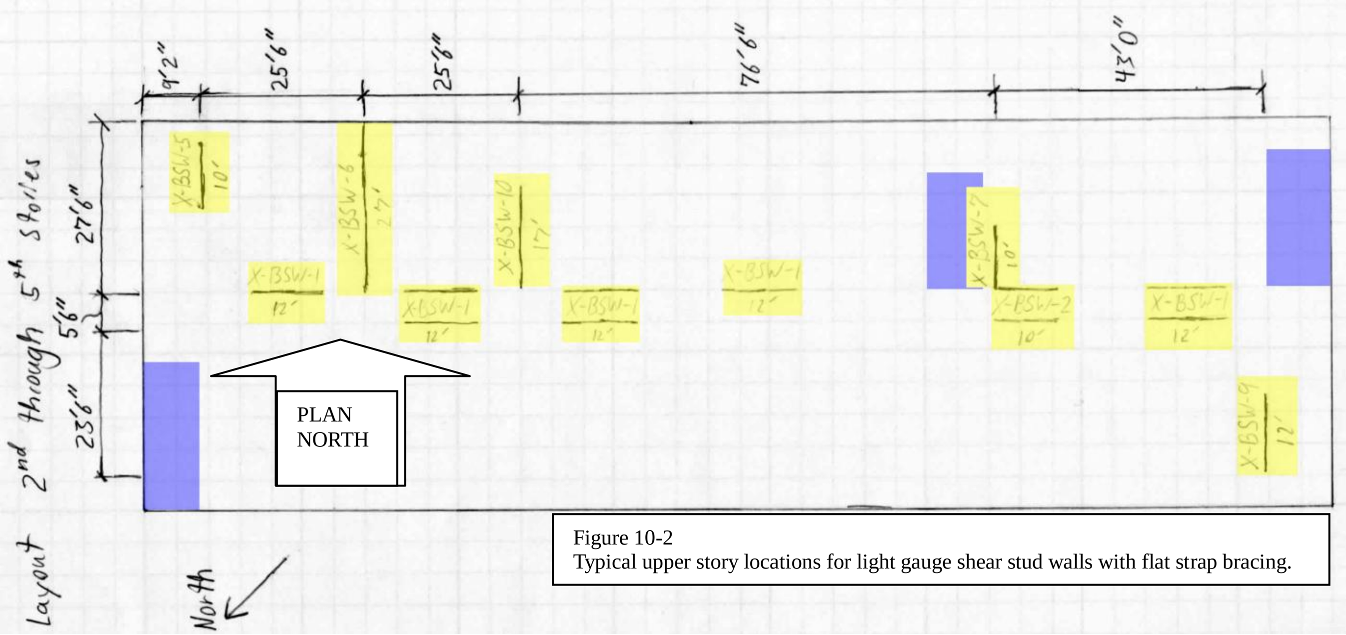


Figure 10-2
Typical upper story locations for light gauge shear stud walls with flat strap bracing.

Hotel is developed in the specially reinforced masonry shear walls surrounding the elevator and stair towers. Stair and Elevator tower locations are shaded in **blue**. A horizontal out of plane irregularity exists at the second floor under the E-W frames. A typical distribution of moment to the supporting beam is shown in Figure 11-1.

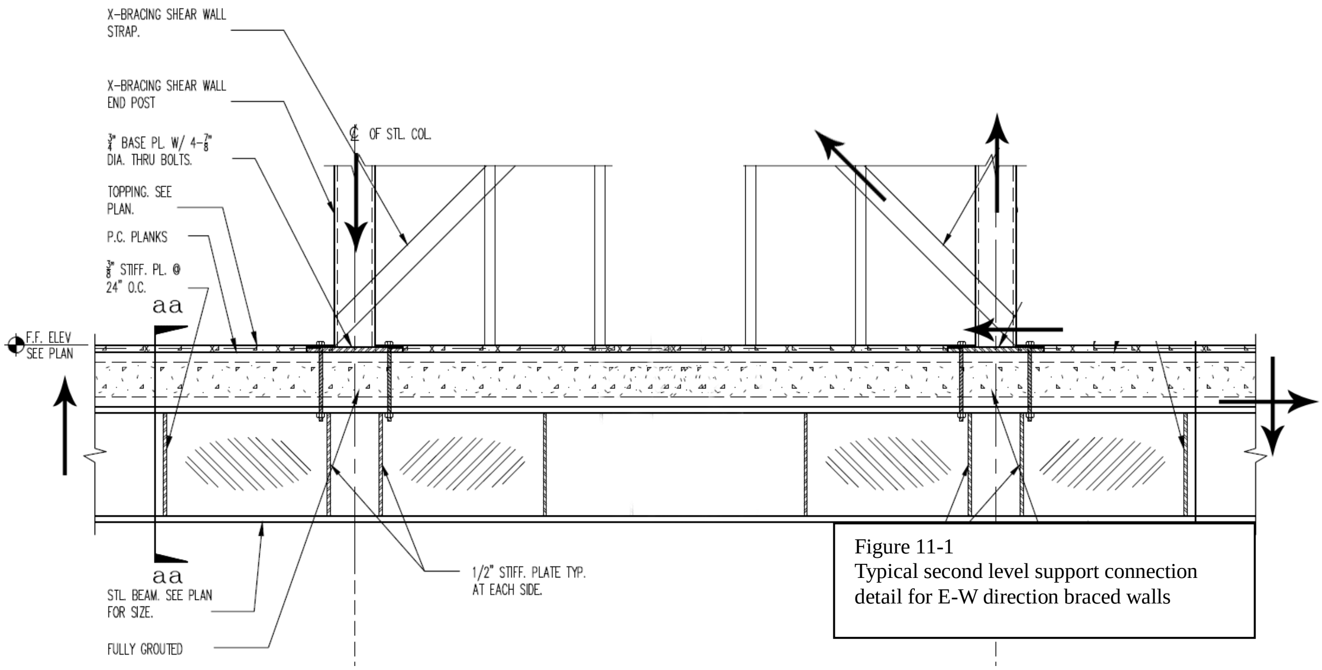


Figure 11-1
Typical second level support connection detail for E-W direction braced walls

Thesis Proposal

Problem Statement

The in-depth lateral systems analysis performed in Technical Report lll showed that the lateral system of the current structure is more than adequate in supporting the controlling seismic load case in the current geographical location. As an academic exercise, the Mountain Hotel will be converted to concrete and relocated to a site in a higher seismic region. After moving the Hotel to San Francisco, California, the lateral system must be redesigned to work with increased seismic loading and more stringent local and national seismic design codes.

Due to the increased likelihood of a seismic event and the owners desire to continue operations, after an earthquake the Hotel is to be designed for Immediate Occupancy as defined in ASCE 41-06 in which the post-earthquake damage state remains safe to occupy. A cost benefit analysis study is to be performed for designing the hotel for Immediate Occupancy over the standard design requirements for Life Safety.

Proposed Solution

The proposed thesis is to move the Mountain Hotel to San Francisco, California and redesign it using a two-way flat-plate reinforced concrete system. Changing the construction medium to concrete will require a complete overhaul of the hotel's gravity and lateral force resisting systems. Rectangular reinforced concrete columns will carry the load of the existing cold-formed load bearing walls, while reinforced concrete shear walls will replace lateral resistance given by the masonry walls and flat strap bracing. Locations of columns and shear walls must coordinate with the existing building layout. The conversion to concrete will significantly increase the mass and orientation of the structure leading to a redesign of the foundation system.

The new structure for the Mountain Hotel will be designed for Immediate Occupancy (S-1) as defined by ASCE 41 drift and damage criteria (requirements can be found in Figure 13-1 taken from FEMA 356 Prestandard and Commentary for the Seismic Rehabilitation of Buildings). Assuming that damage states to structural and nonstructural elements can be related to drift; a maximum displacement shall be established for components. An ETABS model of the lateral system shall be used to perform a linear static analysis which will be used to relate the drift criteria to design forces.

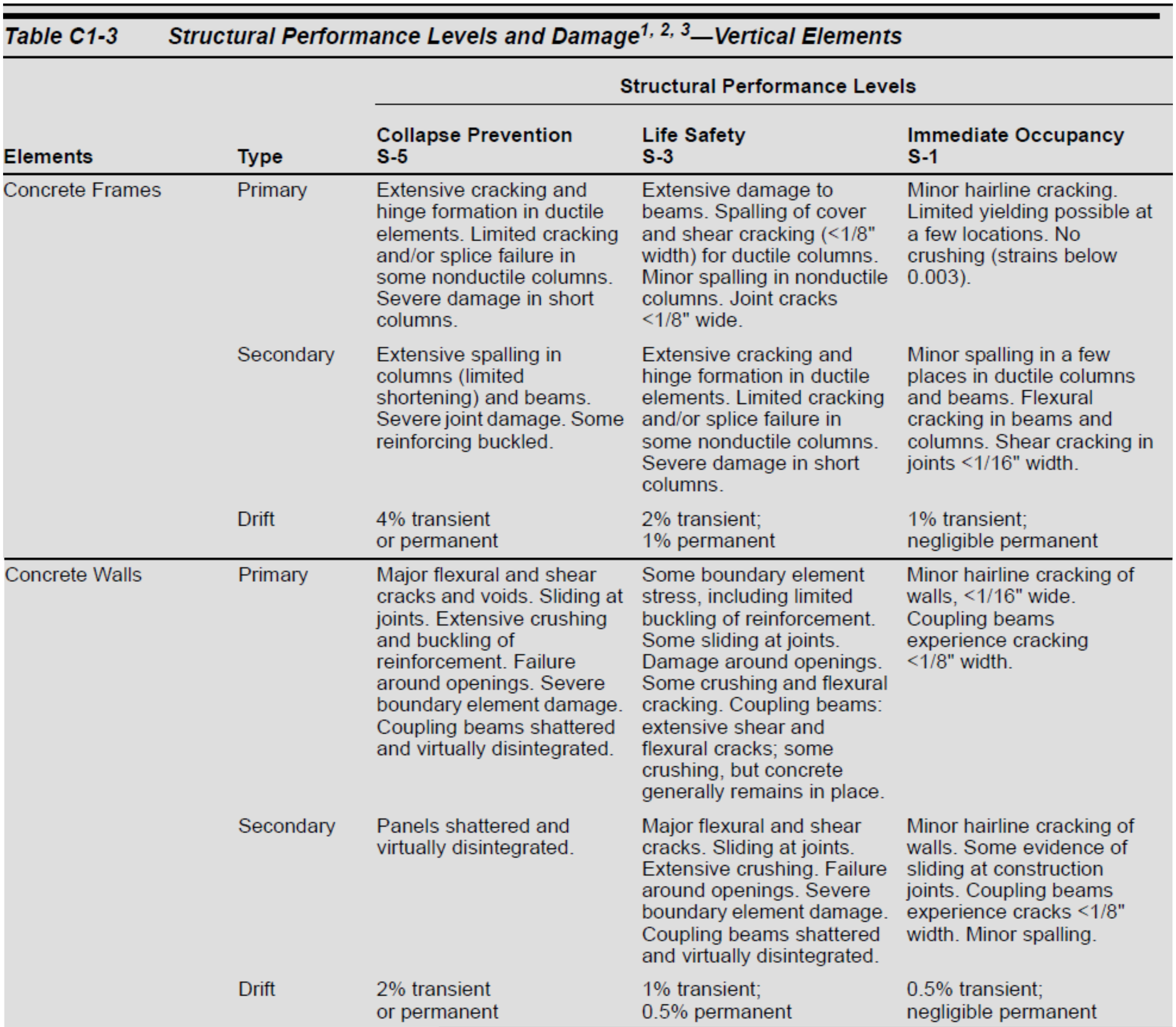


Table C1-3 Structural Performance Levels and Damage[1, 2, 3]—Vertical Elements

		Structural Performance Levels		
Elements	**Type**	**Collapse Prevention S-5**	**Life Safety S-3**	**Immediate Occupancy S-1**
Concrete Frames	Primary	Extensive cracking and hinge formation in ductile elements. Limited cracking and/or splice failure in some nonductile columns. Severe damage in short columns.	Extensive damage to beams. Spalling of cover and shear cracking (<1/8" width) for ductile columns. Minor spalling in nonductile columns. Joint cracks <1/8" wide.	Minor hairline cracking. Limited yielding possible at a few locations. No crushing (strains below 0.003).
	Secondary	Extensive spalling in columns (limited shortening) and beams. Severe joint damage. Some reinforcing buckled.	Extensive cracking and hinge formation in ductile elements. Limited cracking and/or splice failure in some nonductile columns. Severe damage in short columns.	Minor spalling in a few places in ductile columns and beams. Flexural cracking in beams and columns. Shear cracking in joints <1/16" width.
	Drift	4% transient or permanent	2% transient; 1% permanent	1% transient; negligible permanent
Concrete Walls	Primary	Major flexural and shear cracks and voids. Sliding at joints. Extensive crushing and buckling of reinforcement. Failure around openings. Severe boundary element damage. Coupling beams shattered and virtually disintegrated.	Some boundary element stress, including limited buckling of reinforcement. Some sliding at joints. Damage around openings. Some crushing and flexural cracking. Coupling beams: extensive shear and flexural cracks; some crushing, but concrete generally remains in place.	Minor hairline cracking of walls, <1/16" wide. Coupling beams experience cracking <1/8" width.
	Secondary	Panels shattered and virtually disintegrated.	Major flexural and shear cracks. Sliding at joints. Extensive crushing. Failure around openings. Severe boundary element damage. Coupling beams shattered and virtually disintegrated.	Minor hairline cracking of walls. Some evidence of sliding at construction joints. Coupling beams experience cracks <1/8" width. Minor spalling.
	Drift	2% transient or permanent	1% transient; 0.5% permanent	0.5% transient; negligible permanent

Figure 13-1 Comparison of performance requirements for different Structural Performance Levels for Concrete Walls and Columns found in ASCE 41 taken from FEMA 356.

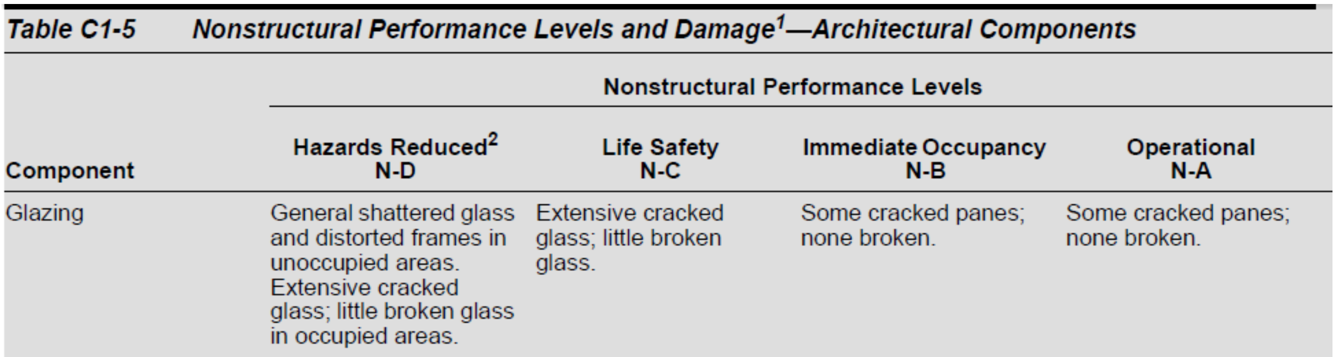


Table C1-5 Nonstructural Performance Levels and Damage[1]—Architectural Components

	Nonstructural Performance Levels			
Component	**Hazards Reduced[2] N-D**	**Life Safety N-C**	**Immediate Occupancy N-B**	**Operational N-A**
Glazing	General shattered glass and distorted frames in unoccupied areas. Extensive cracked glass; little broken glass in occupied areas.	Extensive cracked glass; little broken glass.	Some cracked panes; none broken.	Some cracked panes; none broken.

Figure 13-1 Comparison of performance requirements for Nonstructural Performance Levels for Glazing found in ASCE 41 taken from FEMA 356.

Breadth 1: Acoustics - Sound Isolation

The first breadth topic will be to look at a single hotel room and study the impact of the change in structural material to concrete, to see if the sound isolation has become an issue. If sound isolation is a problem then the walls and floors will be designed to reduce it to proper levels.

Breadth 2: Mechanical - Facade Study

The second breadth topic will evaluate the added thermal load by transmission through the glazing as a result of moving the Mountain Hotel to San Francisco. If the difference is significant, new glazing will be chosen to reduce the thermal load to that of the buildings original location. The new glazing will be designed to ASCE 41 standards for Immediate Occupancy (N-B) in order to supplement the depth design taken from FEMA 356.

Graduate Course Integration

When looking at the lateral system in ETABS advanced modeling techniques will be used to gain more accurate results. The models will use rigid and semi-rigid diaphragms. Shear walls will be modeled using area elements, and columns will be modeled using line elements. The lateral force analysis will consider inherent torsion, accidental torsion, and P-Delta effects.

AE 538 – Earthquake Resistant Design will be relied on heavily for this study, as the design of concrete structures for seismic applications was first taught in this class. Design for immediate occupancy was also introduced here.

Building Relocation and Concrete Redesign

New Site Characteristics

Figure 15-1
An aerial view from google.com maps of the new site with the building superimposed on. Hotel is in Red, Garage in Yellow.

Before work could begin redesigning the structure, a location had to be chosen for the building. In order reduce the impact of relocating the Mountain Hotel to San Francisco; the new site which was chosen for the hotel maintains a similar orientation to that if the existing designs similar orientation can be seen when comparing the plans in figures 15-1 and 6-1. A geotechnical report was obtained for a site in San Francisco which was used to determine the soil characteristics for ground motion and foundation design.

Design Codes and Standards

The first in the design was to determine what codes would govern the design. Calculations and analysis included in this report have been carried out with the use of the following codes and standards:

IBC 2009 – International Building Code, 2009 Edition
ASCE 7-10 – Minimum Design Loads for Buildings and Other Structures, 2010 Edition
ASCE 41-06 – seismic Rehabilitation of Existing Buildings, 2006 Edition
ACI 318-11 – Building Code Requirements from Structural Concrete and Commentary, 2011 Edition
ASHRAE Handbook of Fundamentals, 2009 Edition

Structural Redesign

As demonstrated in earlier technical reports the flat plate floor system was determined to be the most efficient alternative to the existing floor system, but before the design could be finalized for the building, the layout of related gravity resisting elements had to be determined. One of the goals of this redesign was to have a minimal impact on the existing architecture. Because the original design was essentially constructed using platform framing, the locations of structural elements within were able to vary their location in plan as the levels progressed vertically. One of the challenges of designing the new structure to utilize a flat plate floor system was to determine locations within the structure to place the vertical load elements in a manner which makes the floor system practical throughout the building which would not interfere with the existing building layout. Floors three through six are essentially identically in plan while the basement first and second floor layouts are radically different in order to include the main lobby, recreational and dining areas, and management facilities. It was therefore concluded that the column locations for the structure should be located in three rows along the long direction of the building. This created relatively square bays which are the most efficient for a two-way slab floor system.

The next step was to determine the loads. ASCE 7-10 Table 4-1 stipulates that the minimum design live load for the hotel rooms and corridors serving them, which considered to be residential, to be 40psf. All of the other above grade floors are public areas therefore requiring a design live load of 100psf per. The roof of the existing hotel was designed for a roof live load of 40psf as shown in the specifications compared to the 20psf required by ASCE 7-10. Because the reason for the additional live was unknown the new hotel was designed for the same live load, which also controlled over the snow load for the location in San Francisco. The loads of the rooftop equipment were also factored into the design.

Due to the high seismic forces predicted to control the lateral design, it was decided that 115lb/ft^3 lightweight concrete could help to reduce the overall seismic weight. An additional 20psf superimposed dead load was added to each floor to account for partitions, MEP, and suspended ceilings which were used above the corridors and lobby areas.

Flat Slab

Past experience in designing floor slabs has demonstrated that punching shear typically controls slab thickness. Therefore, an excel spreadsheet was created in which punching shears were used to determine the minimum required floor thickness based on the controlling load combinations and concrete properties, assuming 1½ inch clear cover, #5 bars and a column size of 18" x 24". This analysis determined that a 6000psi lightweight concrete thickness of just over nine inches would resist the ultimate shear design force for most of the columns.

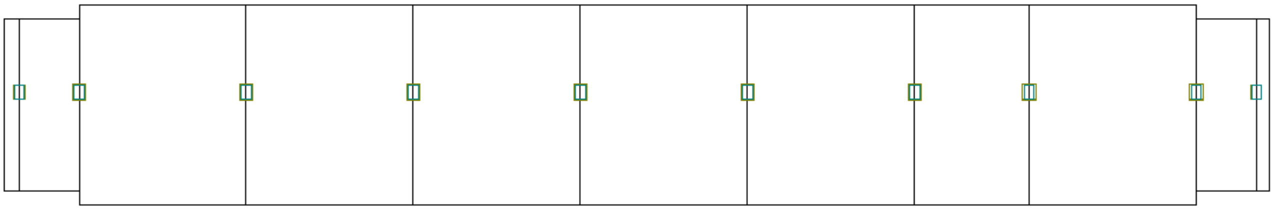


Figure 17-1
3rd Floor column and middle strip in the long plan direction as modeled in SPSlab.

The column layouts and concrete properties were than modeled in SPSlab (example of a third floor detail shown in figure 17-1) in order to determine the design moments, and rebar sizing of the slab. The model confirmed that a ten inch thickness was sufficient to resist the design shear and moments of the upper story columns. However, in most cases a thickness of 12 inches was required to limit long-term deflections, and unbalanced moments at the edge of the slabs pushed the shear high enough to require some of the columns to need additional shear resistance. For the purposes of weight reduction and constructability, all of the columns were subsequently fitted with three inch shear capitals. In the areas of building with a live load of 100psf such as the first floor detail shown in figure 17-2, drop panels were added to resist the additional shear, moment, and limit long-term deflections without continuing to increase the thickness and weight of the entire floor slab. All of the locations in which drop panels were added, were in areas covered by a drop ceiling therefore eliminating the necessity of changes to the existing architecture.

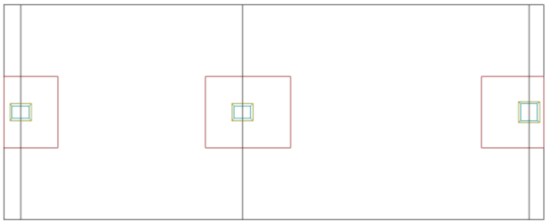


Figure 17-2
1st Floor column and middle strip in the short direction showing the drop panels and the enlarged edge column for combating excessive shear and moments resulting from high live loads.

Columns

A second spreadsheet was created to calculate the axial load imparted on all of the columns in the building, reducing the live load per ASCE 7-10 where it did not reach 100psf. Using the moments induced by eccentricity in the floor loading as calculated by SPSlab and the axial forces calculated in the spreadsheet, the 18"x24" section intended to be used for all of the columns was checked to verify its capacity to support the contributing loads. The interaction diagram for the column in each direction is shown in Figure 18-1. For constructability, simplification of design, and consistency a single column section was chosen to be used for all of the columns in the building and was checked against the maximum load and maximum eccentricity that any column can see.

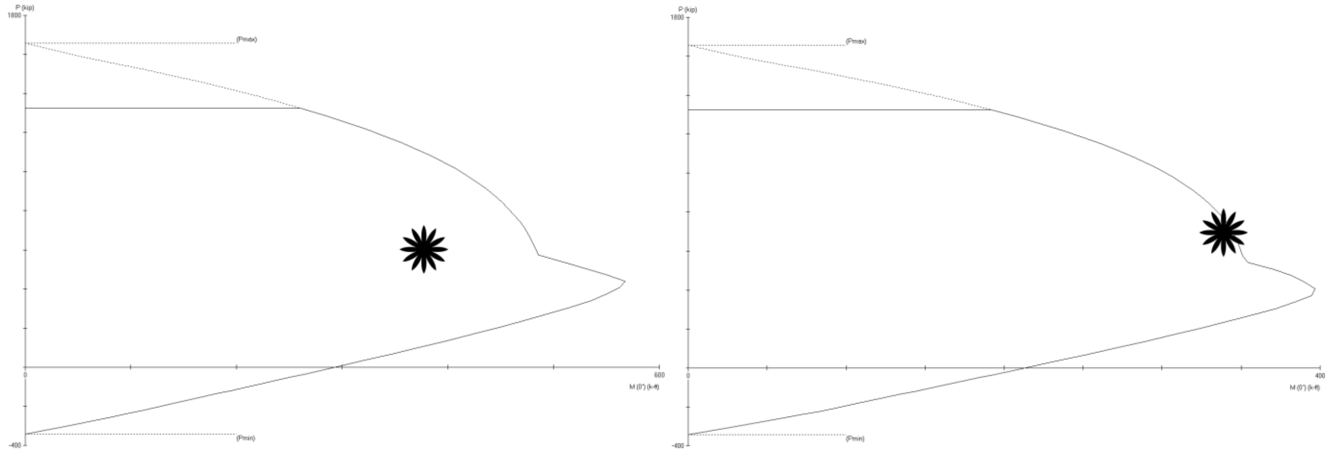


Figure 18-1
Interaction diagrams for an 18"x24" column with a star representing the maximum load.
Left: Diagram with respect to strong axis bending
Right: Diagram with respect to weak axis bending

Spread Footings

At this point it was possible to evaluate what footings would be required to support the building under gravity loading. The spreadsheet used for calculating the column loads was extended to size spread footings under each column at the base. The geotechnical report obtained for the new site specified that an allowable soil bearing pressure of 3500psf could be used for the design of the foundations. Loads transferred to the foundations were therefore recalculated for allowable stress design. The area of soil required to support the load was then determined for each column using a factor of safety of 3.0. Rectangular footprints were then chosen with at least the required area. 3000psi concrete was selected as the minimum concrete strength for the foundations as it is likely to be the most economical and there is little need for high strength. In order to eliminate the need for shear reinforcing in the foundations, the depth of each footing required to satisfy punching shear, which controls for a square column, was calculated and used to determine the thickness and reinforcing depth for each footing. The smaller d was then used to calculate the required reinforcement area and spacing. The top of each footing is 18 inches below frost depth as required by the San Francisco Building Code. The deepest footings are 30 inches thick, and largest footings are 25ft by 25ft which have only 1½ feet between it and the closest neighboring footing. Refer to Appendix for remaining footing sizes and locations.

Immediate Occupancy Design Philosophy

Because the IBC does not reference a method specifically for immediate occupancy, drift and damage criteria from ASCE-41 *Seismic Rehabilitation of Existing Buildings* (requirements can be found in Figure 12-1 taken from FEMA 356 Prestandard and Commentary for the Seismic Rehabilitation of Buildings) was used as a model for the design of the new structure. Since the new scope included this requirement, it was therefore necessary to construct a strategy which allows for the design of a building which can be occupied immediately after a significant seismic event. The philosophy used is as follows:

If the structure is designed such that the maximum drift as a result of a seismic event is less than that which causes damage to both structural and nonstructural elements, then it will remain in an occupy able state. Maximum drift should then be determined for each story as the minimum of: the codified drift limit, 0.5%, as prescribed in ASCE-41 Table C1-3, that which pushes any structural element into the plastic state (to limit permanent deflections to negligible levels), or that which causes significant damage to nonstructural components. The glazing however, is the only nonstructural component to be evaluated for damage within the scope of this report and will therefore be assumed to be the limiting drift criterion for nonstructural components.

Drift Criteria

Inter-story Drift

ASCE7-10 Seismic limit: 0.020hsx/(Cd/Ie)

ATS-192 General Glazing Guidelines: hsx /175

ASCE41-06: 0.005 hsx_

A spread sheet comparing the drift limits listed above for each story revealed that the code limitation of 0.020hsx(Cd/Ie) actually controlled over the other criteria considered. This is because the drift is now being design to be achieved within the elastic range.

Seismic Loads

Lateral forces in a building are typically caused either by wind on the building's façade or forces induced during an earthquake. Because this report focuses so heavily on Immediate Occupancy after an earthquake, it was not felt necessary to perform a wind analysis for this report. Furthermore, because of the high seismicity of the region and large mass of the structure it is very unlikely that wind force would control the design of the lateral system. Therefore the lateral system design outlined herein is designed only to resist the effects seismic activity.

Earthquake loads, are actually displacements induced as the mass of a structure attempts to regain equilibrium as the earth moves underneath it. These displacements are resisted by the main lateral force resisting system which sends the counter displacements, due to the momentum of the structure, back to the ground. In order to quantify the strength needed to resist these displacements the response force induced in the structure is determined using historical data.

Analysis Procedure Selection

Because of the additional drift criteria specified for immediate occupancy, specially reinforced concrete shear walls were chosen for the primary lateral force resisting elements. Then site class and seismic design category were determined in accordance with ASCE 7-10 and using information provided in the geotechnical report. Calculations and references can be viewed in Appendix C. The structure falls into seismic design category E. Because the height of the building is less than 160ft and will be designed to eliminate irregularities, Table 12.6.1 of ASCE 7-10 permits the use of the Equivalent Lateral Force Procedure to calculate the seismic design forces.

The equivalent lateral force procedure is outlined per chapters 11 and 12 of ASCE7-10. The weight of each story was calculated to include the weight of the diaphragm plus the weight of half the wall above and below each story plus any other dead loads. Spreadsheets were created in Microsoft Excel to reduce the required hand calculation.

Corresponding masses were then assigned to the center of each diaphragm. An overall building base shear was determined and used to find story forces and shear forces at each level. These forces travel to the foundations via the concrete shear walls. Calculations and spreadsheet can be found in Appendix C. Story and overall building drifts were tabulated and compared to the maximum allowable per ASCE 7-10 and the Immediate Occupancy criterion.

Shear Walls

According to ACI 318-11 Section 21.1.4.3 a maximum lightweight concrete compressive strength of 5000psi may be specified for special moment frames and structural walls. An initial design was therefore attempted using 5000psi lightweight concrete. Due to the low elasticity of lightweight concrete however, it was abandoned for a higher strength normal weight concrete alternative. 8000psi normal weight concrete was eventually selected for the walls in order to increase their resistance to lateral drift.

The existing architecture and layout of the building was then evaluated for the best locations for lateral force resisting elements. Stair and elevator towers were natural choices as they were the locations of the specially reinforce masonry shear walls in the existing design. A spreadsheet was subsequently created using 35% of the gross moments of inertia to predict the distribution of the lateral forces. Once forces were applied and drifts were determined it became clear that more elements were needed. The final shear wall layout can be seen in Figure 22-1. In initial design there was an additional a shear wall along column line sixteen. When forces were applied along the y axis the building drifted over 20% more at the first column line creating a torsional irregularity not permitted for the seismic design category of building type. The wall was found not to be required to limit the drift at that edge of the building and was later removed to reduce the buildings tendency to rotate.

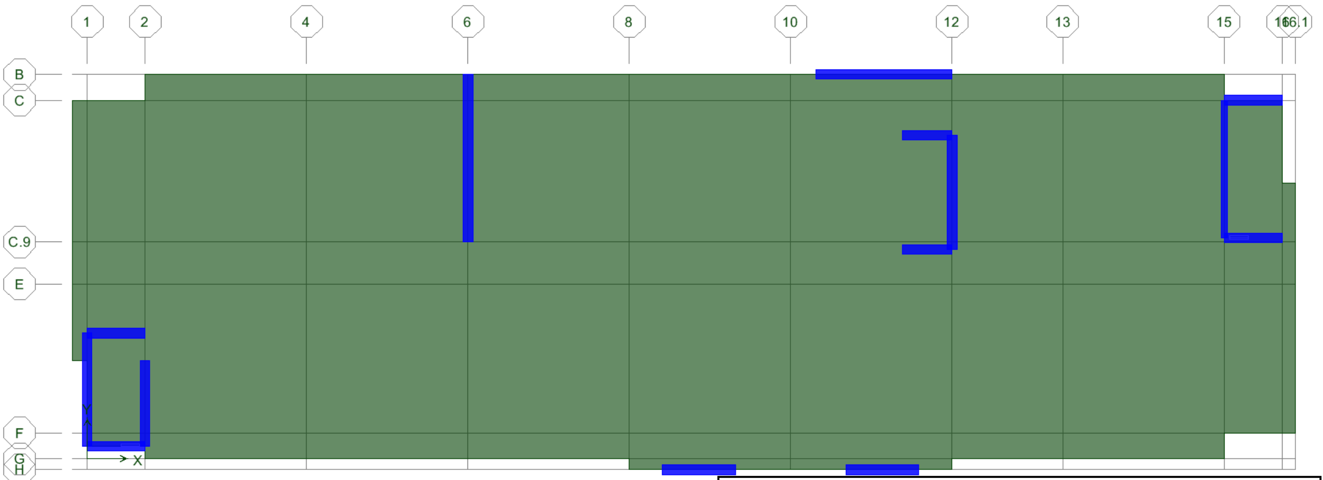


Figure 22-1
Layout of reinforce concrete shear walls shown at the roof level.

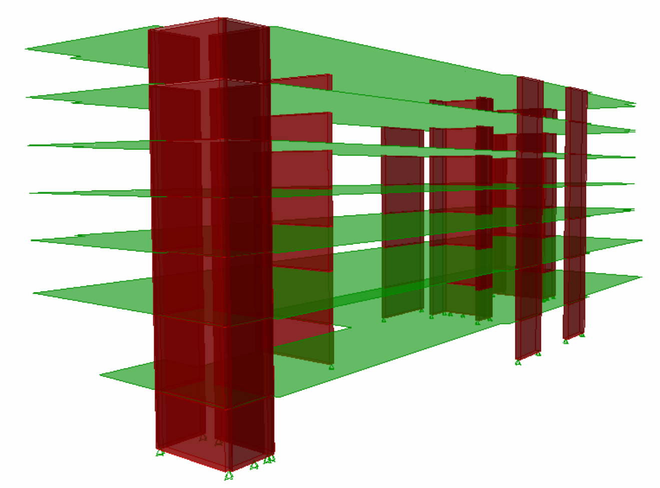


Figure 23-1
Main Lateral Force Resisting System as Modeled in ETABS, Composed of 18" thick Shear Walls and 12" thick floor diaphragms.

The projected lateral layout was then modeled in ETABS in order to analyze its effectiveness in resistance of seismic forces. A 3D representation of the lateral model can be seen in Figure 23-1. Non-iterative P-Delta effects were also considered in this model. Once the model was run it was realized that the connected elements of the stair towers were much more efficient at resisting lateral force than the other elements because the structures resist bending in a manner similar to a wide flange beam. This was a significant advantage for the purposes of limiting to small drifts. Story drifts were taken from the model and several iterations were performed before the building met the required drift criteria without torsional irregularity (shown in Tables 23-1 and 23-2). Once the layout was finalized the forces in the shear walls were checked to ensure they would not reach yield stress under the design loading in order to satisfy one of the Immediate Occupancy criterions.

Story	Height (in)	Load	Max Drift X (in)	Allowable Drift (in)
ROOF	112.00	EX	3.041	3.448
STORY6	112.00	EX	2.500	3.000
STORY5	112.00	EX	1.966	2.552
STORY4	112.00	EX	1.452	2.104
STORY3	134.00	EX	0.978	1.656
STORY2	159.00	EX	0.496	1.120
STORY1	120.00	EX	0.109	0.480
TOTAL	861.00		3.041	3.448

Table 23-1

Story	Height (in)	Load	Max Drift X (in)	Allowable Drift (in)
ROOF	112.00	EY	0.110	3.448
STORY6	112.00	EY	0.089	3.000
STORY5	112.00	EY	0.068	2.552
STORY4	112.00	EY	0.049	2.104
STORY3	134.00	EY	0.031	1.656
STORY2	159.00	EY	0.015	1.120
STORY1	120.00	EY	0.003	0.480
TOTAL	861.00		0.364	3.448

Table 23-2

Graduate Course Integration

When looking at the lateral system in ETABS advanced modeling techniques were used to gain more accurate results. The models used rigid diaphragms. Shear walls were modeled using area elements, and columns were modeled using line elements. The lateral force analysis considered inherent torsion, accidental torsion, and P-Delta effects.
AE 538 – Earthquake Resistant Design was relied on heavily for this study, as the design of concrete structures for seismic applications was first taught in this class. Design for immediate occupancy was also introduced here, and used in the design of this thesis.

Glazing Thermal Load Evaluation

Though effort was made to retain the performance characteristics originally observed by the Mountain Hotel, the relocation to a new site will still have a very large impact on the rest of the buildings systems. One item of particular interest is the glazing which has the potential to have a much higher thermal heat gain for the California location compared what would have been originally observed in Virginia.

Existing Glazing

The Glazing specified by the architect for the Mountain Hotel is one of Pilkington's most efficient glazing types. It is constructed at the factory using two panes of tempered glass. The exterior pane of the glazing has a low-e coating on the interior face to reduce the thermal gain transmission through the glass beyond what can normally otherwise be achieved. Figure 24-1 taken from ASHRAE 2009 Figure 13 of chapter 15 shows a typical configuration of coated double pane glazing. Pilkington publishes the thermal properties of this glazing type in their product brochure shown in Figure 25-1.

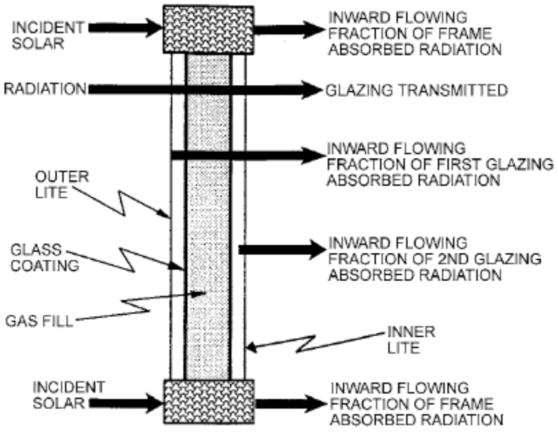
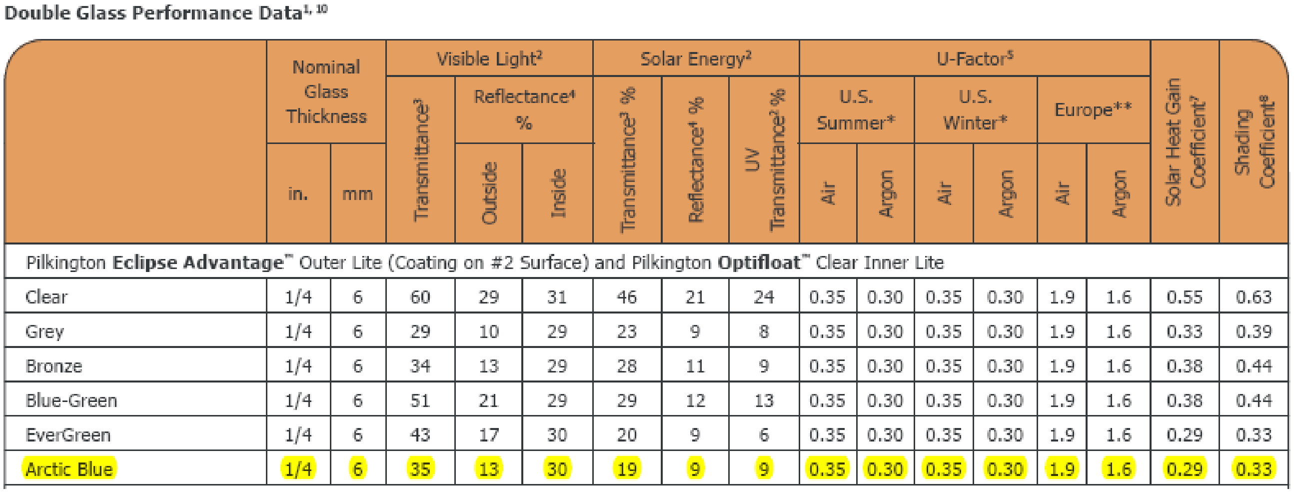


Figure 24-1
Components of Solar Radiant Heat Gain Double-Pane Windows, Including Both Frame and Glazing Contributions.



Double Glass Performance Data[1, 10]

	Nominal Glass Thickness		Visible Light[2]			Solar Energy[2]			U-Factor[5]						Solar Heat Gain Coefficient[7]	Shading Coefficient[8]
			Transmittance[3]	Reflectance[4] %		Transmittance[3] %	Reflectance[4] %	UV Transmittance[2] %	U.S. Summer*		U.S. Winter*		Europe**			
	in.	mm		Outside	Inside				Air	Argon	Air	Argon	Air	Argon		
Pilkington **Eclipse Advantage**™ Outer Lite (Coating on #2 Surface) and Pilkington **Optifloat**™ Clear Inner Lite																
Clear	1/4	6	60	29	31	46	21	24	0.35	0.30	0.35	0.30	1.9	1.6	0.55	0.63
Grey	1/4	6	29	10	29	23	9	8	0.35	0.30	0.35	0.30	1.9	1.6	0.33	0.39
Bronze	1/4	6	34	13	29	28	11	9	0.35	0.30	0.35	0.30	1.9	1.6	0.38	0.44
Blue-Green	1/4	6	51	21	29	29	12	13	0.35	0.30	0.35	0.30	1.9	1.6	0.38	0.44
EverGreen	1/4	6	43	17	30	20	9	6	0.35	0.30	0.35	0.30	1.9	1.6	0.29	0.33
Arctic Blue	1/4	6	35	13	30	19	9	9	0.35	0.30	0.35	0.30	1.9	1.6	0.29	0.33

Figure 25-1
Thermal Properties of Pilkington Eclipse Advantage with the Artic Blue used in the Mountain Hotel highlighted in yellow.

Tabulated weather data was then obtained from the airport closest to each site for use in the calculations.

Solar energy in the form of heat is passed into a building via three different processes. The first is the direct gain given as the radiation from the sun passes through the glazing into the space. The second is through radiation from the sun that is redirected through the earth's atmosphere into the interior of a space through the glazing. One of the methods glass manufacturers use to reduce thermal loads through the glazing is to put a coating which absorbs some of the solar radiation before it passes through the glass. Though much of this radiation is conducted into the outdoor atmosphere, some of the absorbed radiation is eventually passed into the space through conduction (refer to Figure 25-2). This is the third process.

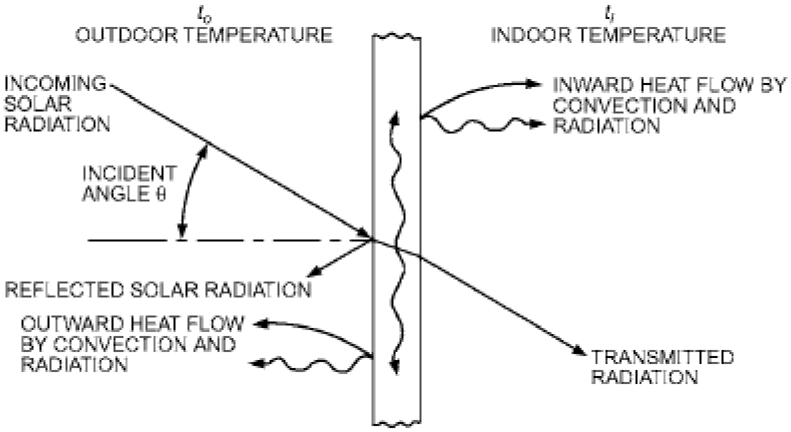


Figure 25-2
Instantaneous Heat Balance for sunlit Glazing Figure 14 of Chapter 15 of ASHRAE 2009

Using all of the data collected concerning the solar conditions and properties of the existing glazing, the total heart gain per square area was determined for a 24 hour period on the 21st day of the hottest month according to the given weather data. This analysis, which utilized part of an excel spreadsheet developed by Dr. Freihaut for calculating thermal heat load was performed for each of the four sides of the Hotel at the angles which the glazing faced. The total thermal energy transmitted through the glazing on the most was 436 BTU/sf/day.

The same process was then repeated for the building in California using the same glazing as specified by the architect so that a value for the increase in thermal heat load could be quantified. This result was only 436 BTU/sf/day or an increase of 0.51% and the maximum thermal load increase of the four sides. A curve for each of the thermal loads was plotted hourly for a 24 hour period in a graph shown in figure 26-1 for visual comparison. The difference in the design thermal loads between the two sites for the same glazing was therefore considered to be negligible, and it was decided that the existing glazing could be used in the new location and would have a minimal impact on the mechanical systems and comfort of the occupants.

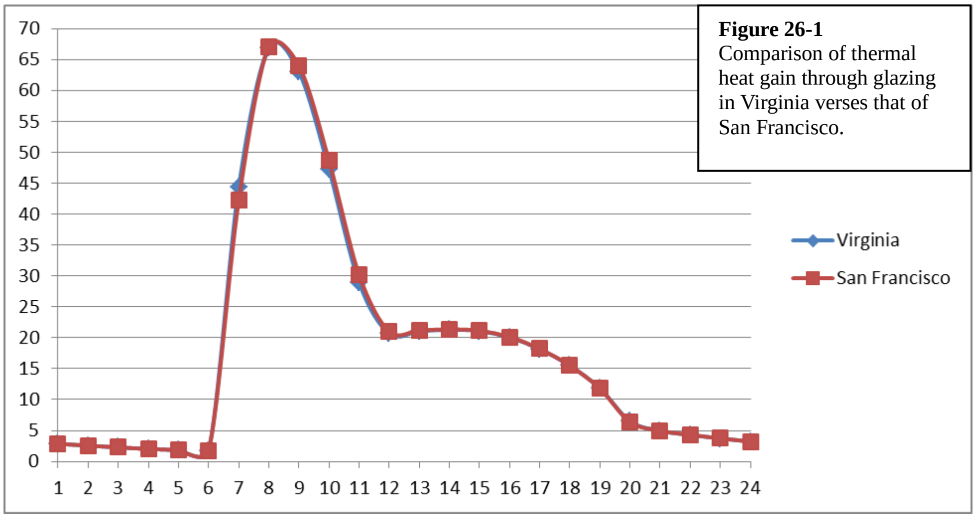
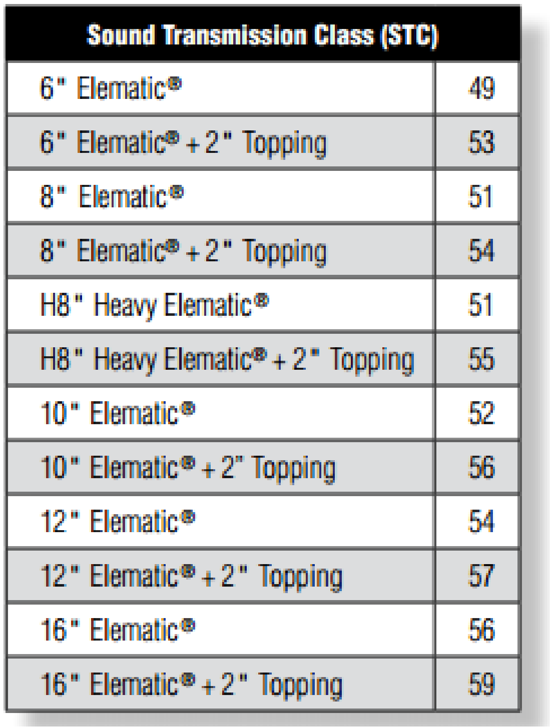


Figure 26-1
Comparison of thermal heat gain through glazing in Virginia verses that of San Francisco.

Acoustic Isolation Analysis

Section 1207 of the 2009 IBC stipulates that walls separating adjacent dwelling units are required to have a Sound Transmission Class of not less than 50 according to ASTM E 90. Hotel rooms considered residential so this should be an appropriate benchmark to verify the sound transmission properties of the new floors of the Mountain Hotel.

The precast hollow core plank system used in the original hotel design uses planks similar to the Elematic Hollow-core plank systems supplied by Oldcastle Precast Building Systems. The sound transmission class ratings of each of their planks are listed in table 27-1. In the analysis of the existing structure done for earlier technical assignments demonstrated that the thickness of the specified planks was way beyond that needed for strength or structural serviceability. The floors supporting the halls in the Hotel are only 4 inches thick and could have been sufficient for some of the spans over the guest rooms. However and shown in the table in the right even the 6 inch thick planks do not meet the STC criteria. Therefore an 8 inch plank was required as a means of providing proper sound Isolation.



Sound Transmission Class (STC)	
6" Elematic®	49
6" Elematic® + 2" Topping	53
8" Elematic®	51
8" Elematic® + 2" Topping	54
H8" Heavy Elematic®	51
H8" Heavy Elematic® + 2" Topping	55
10" Elematic®	52
10" Elematic® + 2" Topping	56
12" Elematic®	54
12" Elematic® + 2" Topping	57
16" Elematic®	56
16" Elematic® + 2" Topping	59

Table 27-1
STC values for various Elematic precast planks produced by Oldcastle Precast Building Systems.

The new hotel will be designed using lightweight cast in place concrete as its floor system. This system needs to be checked to make sure that the provided floor system is sufficient to control the design. High mass is almost always beneficial for increasing the Sound Transmission Class of a partition of floor. The addition of a thin layer of lightweight concrete is a typical suggestion for increasing the STC of a material.

Published values for the STC of light weight concrete could not be located. However, a 6 in panel is reported to have an STC of 55 in a document produced by the California Office of Noise control in 1981. It can therefore be inferred that a wall of twice the thickness and therefore twice the mass will have an STC much higher than 50 and therefore be more than adequate to mitigate any potential problems caused by sound transmission.

Conclusion

The Mountain Hotel has been successfully designed for Immediate Occupancy. If an earthquake of less than or equal to the design earthquake should occur the building should possess the ability to be occupied immediately after the shaking has terminated. All structural components meet or exceed the requirements of the local codes and the parameters specified for Immediate Occupancy. However, it is probably not the most efficient design and it is very unlikely to be the most economical. As predicted the choice to design a structure for Immediate Occupancy adds a lot of extra strength to a structure over a typically design for immediate occupancy. This translates to thicker shear walls or higher strength walls than would normally be required. The 18 inch walls used throughout the Mountain Hotel's lateral system were sufficient to resist the loads and maintain the deflections required in the design parameters.

The relocation has not significantly affected the performance of the glazing system which was designed initially only for the thermal loads in the conditions in Virginia. The thermal loads at the new location are within 0.5% of the thermal loads created at the new site.

It was also confirmed that the change of the existing floor system will not produce a potential for unwanted sound to infiltrate into neighboring rooms. It will most likely reduce the sound levels transferred from one room to the next to lower than that of the existing floors.

Several lessons learned through this design were:

Though lightweight concrete reduces the unit self-weight, the extra thickness required to mitigate detriment to the elasticity brings the loads of a similar magnitude.

If this analysis was to be considered again with the knowledge gained from this thesis, concrete shear walls would probably not be the optimal choice for this redesign because of the difficulty in adapting the large sections required to the existing floor plan. Steel braces could have been inserted into the walls between the windows and would have been able to have less of an impact on the existing architecture.

The attempt to fit a building which was design to use a system as radically different as light gage steel was not a practical choice, because so many of the systems would be impacted and the style of architecture (which was not covered as a major topic in this thesis) would most likely have been different from the start as the architect would have designed the building with a concrete system in mind.

Acknowledgements

To my family, friends, professors, and colleagues, who have helped me become who I am today, and to Jesus Christ who paid the ultimate price for my eternal salvation.

I would like to extend my personal gratitude to the following individuals and associations for their advice, and support throughout this year long project:

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    Dr. Linda Hanagan
    Dr. James Freihaut
    Dr. Andres Lepage
    Ryan Solnosky

Alliance Engineers
    Tim Kowalcyk

Applied Technology Council
    Dr. Ronald O. Hamburger

Appendix A – Gravity Load and Foundation Calculations

Concrete Weight	115	lb/ft^3
Slab Thickness	9	in

Superimposed Dead	20	psf
Dead	106.25	psf
Live	40	psf
Snow	25	psf
Roof Live	20	psf

	D	L	(Lr,S,R)	W	E
Load Combinations	1.4				
	1.2	1.6	0.5		
*L or 0.5W	1.2	1.0	1.6	0.5	
	1.2	1.0	0.5	1.0	
*0.2S	1.2	1.0	0.2		1.0
	0.9			1.0	
	0.9				1.0

Area

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00						51		51		51		51		51		35		51					
B						246		389		389		389		389		328		328		246				
	4.08				37		104		104		104		104		104		71		104		37			
C				76																		75		
	22.42		49		205		572		572		572		572		572		392		572		205		47	
C.9				187		536		775		775		775		775		653		653		536		185		
	30.17		65		277		769		769		769		769		769		528		769		277		63	
F				102																		101		
	4.08				37		104		104		104		104		104		71		104		37			
G						310		481		481		481		481		406		406		310				
	1.75						45		45		45		45		45		31		45					
H																								

$K_{LL}A_T$

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						932		1454		1454		1454		1454		1226		1226		932				
	4.08																							
C				254																		252		
	22.42																							
C.9				596		2031		3098		3098		3098		3098		2612		2612		2031		592		
	30.17																							
F				342																		339		
	4.08																							
G						1195		1836		1836		1836		1836		1548		1548		1195				
	1.75																							
H																								

Rooftop Mechanical Loads 1.2

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B																								
	4.08																							
C																								
	22.42																							
C.9						3821		2400		3138		888		2832		2490		534		4392				
	30.17																							
F																								
	4.08																							
G						420		228		390		96		420		300		42		187				
	1.75																							
H																								

Roof W_T = 167.5 psf

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						41173		65137		65137		65137		65137		54919		54919		41173				
	4.08																							
C				12672																		12516		
	22.42																							
C.9				31293		93577		132139		132877		130627		132571		111878		109922		94148		30926		
	30.17																							
F				17054																		16843		
	4.08																							
G						52310		80848		81010		80716		81040		68274		68016		52077				
	1.75																							
H																								

Level 6 1 W_T - L = 267.5 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				73042	114033	114033	114033	114033	96605	96605	73042		
	4.08												
C			23264									22977	
	22.42												
C.9			56436	159655	225690	226428	224178	226122	191381	189425	160226	55791	
	30.17												
F			31307									30921	
	4.08												
G				91764	140532	140694	140400	140724	119102	118844	91531		
	1.75												
H													

Level 5 2 W_T - L = 395 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				108842	170038	170038	170038	170038	144015	144015	108842		
	4.08												
C			35937									35493	
	22.42												
C.9			84027	236291	335651	336389	334139	336083	284353	282397	236862	83065	
	30.17												
F			48361									47764	
	4.08												
G				136588	209504	209666	209372	209696	177464	177206	136355		
	1.75												
H													

Level 4 3 W_T - L = 522.5 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				144176	225454	225454	225454	225454	190884	190884	144176		
	4.08												
C			48609									48009	
	22.42												
C.9			111175	312239	444807	445545	443295	445239	376586	374630	312810	109900	
	30.17												
F			65415									64607	
	4.08												
G				180893	277827	277989	277695	278019	235230	234972	180660		
	1.75												
H													

Level 3 4 W_T - L = 650 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				179269	280564	280564	280564	280564	237473	237473	179269		
	4.08												
C			61282									60525	
	22.42												
C.9			138094	387830	555438	556176	553926	555870	468777	466821	388402	136508	
	30.17												
F			82468									81450	
	4.08												
G				224930	345813	345975	345681	346005	292688	292430	224697		
	1.75												
H													

Level 2 5 W_T - L = 777.5 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				214208	335479	335479	335479	335479	283882	283882	214208		
	4.08												
C			73954									73041	
	22.42												
C.9			164866	463319	666587	667325	665075	667019	562491	560535	463890	162971	
	30.17												
F			99522									98293	
	4.08												
G				268795	413585	413747	413453	413777	349948	349690	268562		
	1.75												
H													

Level 1 6 W_T - L = 905 psf

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						249038		390255		390255		390255		390255		330164		330164		249038				
	4.08																							
C				86626																		85557		
	22.42																							
C.9				191535		540214		777737		778475		776225		778169		656206		654250		540785		189330		
	30.17																							
F				116575																		115136		
	4.08																							
G						312539		482022		482184		481890		482214		407068		406810		312306				
	1.75																							
H																								

d_{req} Footings square footing with uniform loading, punching shear will control

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						11.76		16.18		16.18		16.18		16.18		14.39		14.39		11.76				
	4.08																							
C				5.19																		5.14		
	22.42																							
C.9				9.68		20.18		25.62		25.64		25.59		25.63		22.95		22.91		20.20		9.60		
	30.17																							
F				6.59																		6.53		
	4.08																							
G						13.85		18.69		18.70		18.69		18.70		16.66		16.65		13.84				
	1.75																							
H																								

d of Footing top reinforcement

c_c = 3 in
d_b = 0.625 in

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						12.063		18.063		18.063		18.063		18.063		16.063		16.063		12.063				
	4.08																							
C				6.063																		6.063		
	22.42																							
C.9				10.063		26.063		26.063		26.063		26.063		26.063		26.063		26.063		26.063		10.063		
	30.17																							
F				8.063																		8.063		
	4.08																							
G						14.063		20.063		20.063		20.063		20.063		18.063		18.063		14.063				
	1.75																							
H																								

Mu k-ft

		0		1		2		4		6		8		10		12		13		15		16		16.1
			2.17		9.17		25.50		25.50		25.50		25.50		25.50		17.50		25.50		9.17		2.08	
A																								
	2.00																							
B						320.2		693.8		693.8		693.8		693.8		505.6		491.1		320.2				
	4.08																							
C				59.0																		58.2		
	22.42																							
C.9				199.5		1093.9		1960.5		2059.1		1956.7		2058.3		1572.8		1568.1		1162.0		197.2		
	30.17																							
F				93.3																		92.1		
	4.08																							
G						478.6		916.5		916.8		916.2		916.8		723.7		723.2		478.2				
	1.75																							
H																								

$A_{s,req}$ in^2

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				6.1	8.8	8.8	8.8	8.8	7.2	7.0	6.1		
	4.08												
C			2.3									2.2	
	22.42												
C.9			4.6	9.5	17.2	18.0	17.1	18.0	13.7	13.7	10.1	4.5	
	30.17												
F			2.7									2.6	
	4.08												
G				7.8	10.4	10.4	10.4	10.4	9.2	9.2	7.8		
	1.75												
H													

Spacing #5's @ in O.C.

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				4.8	5.0	5.0	5.0	5.0	5.0	5.0	4.8		
	4.08												
C			4.5									4.5	
	22.42												
C.9			4.8	5.4	3.9	3.9	3.9	3.9	4.5	4.5	5.5	4.8	
	30.17												
F			5.3									5.3	
	4.08												
G				4.6	4.6	4.6	4.6	4.6	4.8	4.8	4.6		
	1.75												
H													

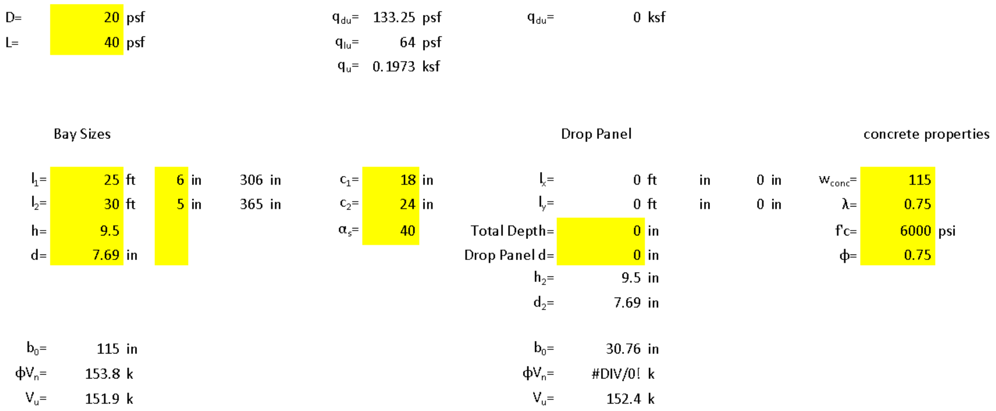
Level 1 6 W_T - L = 768.8 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				215546	337271	337271	337271	337271	285491	285491	215546		
	4.08												
C			76318									75376	
	22.42												
C.9			166080	466567	671803	672418	670543	672163	566811	565181	467043	164173	
	30.17												
F			102703									101435	
	4.08												
G				270260	416405	416540	416295	416565	351726	351511	270066		
	1.75												
H													

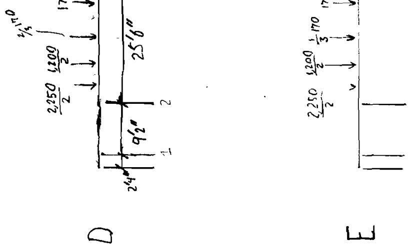
Foundations $P_{allowable}$ = 3500 psf

		0	1	2	4	6	8	10	12	13	15	16	16.1
		2.17	9.17	25.50	25.50	25.50	25.50	25.50	17.50	25.50	9.17	2.08	
A													
	2.00												
B				14	18	18	18	18	16	16	14		
	4.08												
C			9									9	
	22.42												
C.9			12	20	24	25	24	25	23	23	21	12	
	30.17												
F			10									10	
	4.08												
G				16	19	19	19	19	18	18	16		
	1.75												
H													

Punching Shear Calculations:



D=	20	psf					q_{du}=	133.25	psf	q_{du}=	0	ksf						
L=	40	psf					q_{lu}=	64	psf									
							q_u=	0.1973	ksf									
	Bay Sizes									Drop Panel						concrete properties		
l_1=	25	ft	6	in	306	in	c_1=	18	in	l_x=	0	ft	in	0	in	w_{conc}=	115	
l_2=	30	ft	5	in	365	in	c_2=	24	in	l_y=	0	ft	in	0	in	λ=	0.75	
h=	9.5						α_s=	40		Total Depth=	0	in				f'c=	6000	psi
d=	7.69	in								Drop Panel d=	0	in				ϕ=	0.75	
										h_2=	9.5	in						
										d_2=	7.69	in						
b_0=	115	in								b_0=	30.76	in						
ϕV_n=	153.8	k								ϕV_n=	#DIV/0!	k						
V_u=	151.9	k								V_u=	152.4	k						


D
2'4"
9'2"
25'6"
25'6"
25'6"
25'6"
25'6"
25'6"
17'6"
25'6"
9'2"
2'1"
1
2
4
6
8
10
12
13
15
16
2250/2
1200/2
2/3 170
170
375
300
1100/2
400
285
275
400
1/3 3500
170
375
170
300
175
375
2250/2
E
2250/2
1200/2
1/3 170
170
285
170
1100/2
375
375
400
300
400
1/3 3500
300
375
170
170
300
310

Appendix B – SPSlab Sample Output

```
spSlab v3.50 © StructurePoint                                                                   04-05-2013, 02:42:55 PM
Licensed to: Penn State University, License ID: 59919-1033954-4-22545-2CF68
T:\spSlab\floor_3_middle_long.slb                                                                                Page 1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                              ooooo    oooooo    oo         oo       ooooo    oo
                             oo    o   oo   oo    oo        oo      o    oo   oo
                             oo        oo   oo     ooo      oo       oooooo   oooooo
                              ooooo    oo   oo       ooo    oo      oo   oo   oo   oo
                                  oo   oooooo          oo   oo      oo   oo   oo   oo
                             o    oo   oo        oo    oo   oo  o   oo   oo   oo   oo
                              ooooo    oo         oooooo     ooo     ooooo o   ooooo   (TM)

         =================================================================================================
                                                 spSlab v3.50 (TM)
                          A Computer Program for Analysis, Design, and Investigation of
                           Reinforced Concrete Beams, One-way and Two-way Slab Systems
                                   Copyright © 2003-2011, STRUCTUREPOINT, LLC
                                              All rights reserved
         =================================================================================================

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         program.


==================================================================================================================
[2] DESIGN RESULTS*
==================================================================================================================

*Unless otherwise noted, all results are in the direction of analysis only. Another analysis
 in the perpendicular direction has to be carried out for two-way slab systems.

Strip Widths and Distribution Factors
=====================================
   Units: Width (ft).
               __________Width___________   ______ Moment Factor______
   Span Strip   Left**  Right**  Bottom*    Left**  Right**  Bottom*
   ---- ------ -------- -------- --------   -------- -------- --------
      1 Column     4.58     4.58     4.58      1.000    1.000    0.600
        Middle    21.71    21.71    21.71      0.000    0.000    0.400

      2 Column     4.58     4.58     4.58      1.000    0.750    0.600
        Middle    21.71    21.71    21.71      0.000    0.250    0.400

      3 Column     4.58    12.75    12.75      0.750    0.750    0.600
        Middle    25.79    17.63    17.63      0.250    0.250    0.400

      4 Column    12.75    12.75    12.75      0.750    0.750    0.600
        Middle    17.63    17.63    17.63      0.250    0.250    0.400

      5 Column    12.75    12.75    12.75      0.750    0.750    0.600
        Middle    17.63    17.63    17.63      0.250    0.250    0.400

      6 Column    12.75    12.75    12.75      0.750    0.750    0.600
        Middle    17.63    17.63    17.63      0.250    0.250    0.400

      7 Column    12.75     8.75    12.75      0.750    0.750    0.600
        Middle    17.63    21.63    17.63      0.250    0.250    0.400

      8 Column     8.75     8.75     8.75      0.750    0.750    0.600
        Middle    21.63    21.63    21.63      0.250    0.250    0.400

      9 Column     8.75     4.58    12.75      0.750    0.750    0.600
        Middle    21.63    25.79    17.63      0.250    0.250    0.400

     10 Column     4.58     4.58     4.58      0.750    1.000    0.600
        Middle    21.71    21.71    21.71      0.250    0.000    0.400

     11 Column     4.58     4.58     4.58      1.000    1.000    0.600
        Middle    21.71    21.71    21.71      0.000    0.000    0.400
   *Used for bottom reinforcement.   **Used for top reinforcement.

Top Reinforcement
=================
   Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)
   Span Strip  Zone       Width       Mmax     Xmax    AsMin    AsMax    AsReq   SpProv    Bars
   ---- ------ ------- -------- ---------- -------- -------- -------- -------- -------- -------
      1 Column Left        4.58       1.39    0.674    1.188   13.395    0.030   13.750    4-#5 *3
               Midspan     4.58       4.65    1.251    1.188   13.395    0.102   13.750    4-#5 *3
               Right       4.58      11.01    1.925    1.188   13.395    0.241    9.167    6-#5 *3
```

```
spSlab v3.50 © StructurePoint                                                     04-05-2013, 02:42:55 PM
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T:\spSlab\floor_3_middle_long.slb                                                                 Page 2

      Middle Left     21.71      0.00   0.000    5.627  63.441   0.000  13.710   19-#5 *3
             Midspan  21.71      0.00   0.962    5.627  63.441   0.000  13.710   19-#5 *3
             Right    21.71      0.00   1.925    5.627  63.441   0.000  13.710   19-#5 *3

    2 Column Left      4.58     39.70   3.373    1.188  13.395   0.874   9.167    6-#5 *3
             Midspan   4.58     81.47   5.585    1.188  13.395   1.812   9.167    6-#5
             Right     4.58    141.89   8.167    1.188  13.395   3.203   4.583   12-#5

      Middle Left     21.71      3.81   3.373    5.627  63.441   0.083  13.710   19-#5 *3
             Midspan  21.71     15.81   5.585    5.627  63.441   0.345  13.710   19-#5 *3
             Right    21.71     47.31   8.167    5.627  63.441   1.034  14.068   22-#5 *3

    3 Column Left      4.58    158.59   1.000    1.188  13.395   3.595   4.583   12-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right    12.75    236.97  24.500    3.305  37.262   5.274   8.500   18-#5

      Middle Left     25.79     52.86   1.000    6.685  75.377   1.156  14.068   22-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    17.63     78.99  24.500    4.568  51.510   1.731  14.100   15-#5 *3

    4 Column Left     12.75    231.44   1.000    3.305  37.262   5.149   8.500   18-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right    12.75    215.80  24.500    3.305  37.262   4.794   9.563   16-#5

      Middle Left     17.63     77.15   1.000    4.568  51.510   1.691  14.100   15-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    17.63     71.93  24.500    4.568  51.510   1.576  14.100   15-#5 *3

    5 Column Left     12.75    217.18   1.000    3.305  37.262   4.825   9.563   16-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right    12.75    217.16  24.500    3.305  37.262   4.825   9.563   16-#5

      Middle Left     17.63     72.39   1.000    4.568  51.510   1.586  14.100   15-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    17.63     72.39  24.500    4.568  51.510   1.586  14.100   15-#5 *3

    6 Column Left     12.75    215.77   1.000    3.305  37.262   4.793   9.563   16-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right    12.75    231.53  24.500    3.305  37.262   5.151   8.500   18-#5

      Middle Left     17.63     71.92   1.000    4.568  51.510   1.576  14.100   15-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    17.63     77.18  24.500    4.568  51.510   1.691  14.100   15-#5 *3

    7 Column Left     12.75    237.10   1.000    3.305  37.262   5.277   8.500   18-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right     8.75    159.47  24.500    2.268  25.572   3.548   8.750   12-#5

      Middle Left     17.63     79.03   1.000    4.568  51.510   1.732  14.100   15-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    21.63     53.16  24.500    5.605  63.200   1.163  13.658   19-#5 *3

    8 Column Left      8.75    139.74   1.000    2.268  25.572   3.101   8.750   12-#5
             Midspan   8.75     28.87  11.075    2.268  25.572   0.632  13.125    8-#5 *3
             Right     8.75    154.58  16.500    2.268  25.572   3.437   8.077   13-#5

      Middle Left     21.63     46.58   1.000    5.605  63.200   1.018  13.658   19-#5 *3
             Midspan  21.63      9.62  11.075    5.605  63.200   0.210  13.658   19-#5 *3
             Right    21.63     51.53  16.500    5.605  63.200   1.127  13.658   19-#5 *3

    9 Column Left      8.75    179.24   1.000    2.268  25.572   3.998   8.077   13-#5
             Midspan  12.75      0.00  12.750    0.000  37.262   0.000   0.000    ---
             Right     4.58    179.58  24.500    1.188  13.395   4.093   3.929   14-#5

      Middle Left     21.63     59.75   1.000    5.605  63.200   1.307  13.658   19-#5 *3
             Midspan  17.63      0.00  12.750    0.000  51.510   0.000   0.000    ---
             Right    25.79     59.86  24.500    6.685  75.377   1.309  14.068   22-#5 *3

   10 Column Left      4.58    158.62   1.000    1.188  13.395   3.596   3.929   14-#5
             Midspan   4.58     88.42   3.581    1.188  13.395   1.969   7.857    7-#5
             Right     4.58     42.09   5.794    1.188  13.395   0.927   7.857    7-#5 *3

      Middle Left     21.71     52.88   1.000    5.627  63.441   1.157  14.068   22-#5 *3
             Midspan  21.71     17.16   3.581    5.627  63.441   0.375  13.710   19-#5 *3
             Right    21.71      4.04   5.794    5.627  63.441   0.088  13.710   19-#5 *3

   11 Column Left      4.58      8.80   0.365    1.188  13.395   0.192   7.857    7-#5 *3
             Midspan   4.58      3.75   0.966    1.188  13.395   0.082  13.750    4-#5 *3
             Right     4.58      1.12   1.482    1.188  13.395   0.024  13.750    4-#5 *3

      Middle Left     21.71      0.00   0.365    5.627  63.441   0.000  13.710   19-#5 *3
             Midspan  21.71      0.00   1.224    5.627  63.441   0.000  13.710   19-#5 *3
             Right    21.71      0.00   2.083    5.627  63.441   0.000  13.710   19-#5 *3
   NOTES:
   *3 - Design governed by minimum reinforcement.
```

```
spSlab v3.50 © StructurePoint                                                           04-05-2013, 02:42:55 PM
Licensed to: Penn State University, License ID: 59919-1033954-4-22545-2CF68
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Top Bar Details
===============
   Units: Length (ft)
               _____________Left_____________  ___Continuous__  _____________Right____________
   Span Strip     Bars  Length    Bars  Length     Bars  Length     Bars  Length    Bars  Length
   ---- ------ ------- ------- ------- -------  ------- -------  ------- ------- ------- -------
      1 Column     ---             ---              4-#5    2.33     2-#5    1.41     ---
        Middle     ---             ---             19-#5    2.33      ---             ---

      2 Column     ---             ---              6-#5    9.17     3-#5    4.33    3-#5    2.51
        Middle     ---             ---             19-#5    9.17     3-#5    2.62     ---

      3 Column    6-#5    8.76    6-#5    5.70      ---             11-#5    8.76    7-#5    5.70
        Middle   22-#5    6.17     ---              ---             15-#5    7.72     ---

      4 Column   11-#5    8.76    7-#5    5.70      ---             11-#5    8.76    5-#5    5.70
        Middle   15-#5    7.97     ---              ---             15-#5    7.72     ---

      5 Column   11-#5    8.76    5-#5    5.70      ---             11-#5    8.76    5-#5    5.70
        Middle   15-#5    7.72     ---              ---             15-#5    7.72     ---

      6 Column   11-#5    8.76    5-#5    5.70      ---             11-#5    8.76    7-#5    5.70
        Middle   15-#5    7.72     ---              ---             15-#5    7.97     ---

      7 Column   11-#5    8.76    7-#5    5.70      ---              8-#5    8.76    4-#5    5.70
        Middle   15-#5    7.72     ---              ---             19-#5    6.17     ---

      8 Column    4-#5    6.12     ---              8-#5   17.50     5-#5    6.12     ---
        Middle     ---             ---             19-#5   17.50      ---             ---

      9 Column    8-#5    8.76    5-#5    5.70      ---              7-#5    8.76    7-#5    5.70
        Middle   19-#5    6.47     ---              ---             22-#5    6.22     ---

     10 Column    4-#5    4.05    3-#5    2.48      7-#5    9.17      ---             ---
        Middle    3-#5    2.62     ---             19-#5    9.17      ---             ---

     11 Column    3-#5    1.36     ---              4-#5    2.08      ---             ---
        Middle     ---             ---             19-#5    2.08      ---             ---

Bottom Reinforcement
====================
   Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)
   Span Strip     Width       Mmax      Xmax    AsMin    AsMax    AsReq   SpProv    Bars
   ---- ------ -------- ---------- -------- -------- -------- -------- -------- -------
      1 Column     4.58       0.00    0.962    0.000   13.395    0.000    0.000     ---
        Middle    21.71       0.00    0.962    0.000   63.441    0.000    0.000     ---

      2 Column     4.58       0.00    4.583    0.000   13.395    0.000    0.000     ---
        Middle    21.71       0.00    4.583    0.000   63.441    0.000    0.000     ---

      3 Column    12.75     126.95   12.000    3.305   37.262    2.799   13.909   11-#5 *3
        Middle    17.63      84.63   12.000    4.568   51.510    1.855   14.100   15-#5 *3

      4 Column    12.75     112.58   13.000    3.305   37.262    2.479   13.909   11-#5 *3
        Middle    17.63      75.06   13.000    4.568   51.510    1.645   14.100   15-#5 *3

      5 Column    12.75     117.63   12.750    3.305   37.262    2.591   13.909   11-#5 *3
        Middle    17.63      78.42   12.750    4.568   51.510    1.719   14.100   15-#5 *3

      6 Column    12.75     113.08   12.500    3.305   37.262    2.490   13.909   11-#5 *3
        Middle    17.63      75.39   12.500    4.568   51.510    1.652   14.100   15-#5 *3

      7 Column    12.75     128.27   13.250    3.305   37.262    2.828   13.909   11-#5 *3
        Middle    17.63      85.52   13.250    4.568   51.510    1.875   14.100   15-#5 *3

      8 Column     8.75      25.75    8.500    2.268   25.572    0.563   13.125    8-#5 *3
        Middle    21.63      17.17    8.500    5.605   63.200    0.375   13.658   19-#5 *3

      9 Column    12.75     140.80   12.750    3.305   37.262    3.108   13.909   11-#5 *3
        Middle    17.63      93.87   12.750    4.568   51.510    2.059   14.100   15-#5 *3

     10 Column     4.58       0.88    8.417    1.188   13.395    0.019   13.750    4-#5 *3
        Middle    21.71       0.58    8.417    5.627   63.441    0.013   13.710   19-#5 *3

     11 Column     4.58       0.00    1.224    0.000   13.395    0.000    0.000     ---
        Middle    21.71       0.00    1.224    0.000   63.441    0.000    0.000     ---
   NOTES:
   *3 - Design governed by minimum reinforcement.

Bottom Bar Details
==================
   Units: Start (ft), Length (ft)
                _______Long Bars_______ ______Short Bars_______
   Span Strip      Bars   Start  Length    Bars   Start  Length
   ---- ------- ------- ------- ------- ------- ------- -------
      1 Column      ---                     ---
        Middle      ---                     ---
```

```
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      2 Column      ---                     ---
        Middle      ---                     ---

      3 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

      4 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

      5 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

      6 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

      7 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

      8 Column     8-#5    0.00   17.50     ---
        Middle    19-#5    0.00   17.50     ---

      9 Column    11-#5    0.00   25.50     ---
        Middle    15-#5    0.00   25.50     ---

     10 Column     4-#5    0.00    9.17     ---
        Middle    19-#5    0.00    9.17     ---

     11 Column      ---                     ---
        Middle      ---                     ---

Flexural Capacity
=================
   Units: x (ft), As (in^2), PhiMn (k-ft)
   Span Strip         x AsTop AsBot       PhiMn-       PhiMn+
   ---- ------ --------- ----- ----- ------------ ------------
      1 Column     0.000  1.24  0.00       -56.11         0.00
                   0.674  1.24  0.00       -56.11         0.00
                   0.925  1.24  0.00       -56.11         0.00
                   1.167  1.39  0.00       -62.79         0.00
                   1.251  1.44  0.00       -65.12         0.00
                   1.925  1.86  0.00       -83.60         0.00
                   2.333  1.86  0.00       -83.60         0.00
        Middle     0.000  5.89  0.00      -266.49         0.00
                   0.674  5.89  0.00      -266.49         0.00
                   1.167  5.89  0.00      -266.49         0.00
                   1.251  5.89  0.00      -266.49         0.00
                   1.925  5.89  0.00      -266.49         0.00
                   2.333  5.89  0.00      -266.49         0.00

      2 Column     0.000  1.86  0.00       -83.60         0.00
                   0.792  1.86  0.00       -83.60         0.00
                   3.373  1.86  0.00       -83.60         0.00
                   4.583  1.86  0.00       -83.60         0.00
                   4.839  1.86  0.00       -83.60         0.00
                   5.585  2.48  0.00      -110.94         0.00
                   5.950  2.79  0.00      -124.16         0.00
                   6.654  2.79  0.00      -124.16         0.00
                   7.766  3.72  0.00      -163.88         0.00
                   8.167  3.72  0.00      -163.88         0.00
                   9.167  3.72  0.00      -163.88         0.00
        Middle     0.000  5.89  0.00      -266.49         0.00
                   0.792  5.89  0.00      -266.49         0.00
                   3.373  5.89  0.00      -266.49         0.00
                   4.583  5.89  0.00      -266.49         0.00
                   5.585  5.89  0.00      -266.49         0.00
                   6.544  5.89  0.00      -266.49         0.00
                   7.544  6.82  0.00      -307.93         0.00
                   8.167  6.82  0.00      -307.93         0.00
                   9.167  6.82  0.00      -307.93         0.00

      3 Column     0.000  3.72  3.41      -163.88       154.32
                   1.000  3.72  3.41      -163.88       154.32
                   4.453  3.72  3.41      -163.88       154.32
                   5.701  1.86  3.41       -83.60       154.32
                   7.508  1.86  3.41       -83.60       154.32
                   8.755  0.00  3.41         0.00       154.32
                   9.225  0.00  3.41         0.00       154.32
                  12.750  0.00  3.41         0.00       154.32
                  16.275  0.00  3.41         0.00       154.32
                  16.745  0.00  3.41         0.00       154.32
                  17.965  3.41  3.41      -154.32       154.32
                  19.799  3.41  3.41      -154.32       154.32
                  21.020  5.58  3.41      -250.42       154.32
                  24.500  5.58  3.41      -250.42       154.32
                  25.500  5.58  3.41      -250.42       154.32
        Middle     0.000  6.82  4.65      -308.68       210.47
```

```
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                 1.000  6.82  4.65      -308.68       210.47
                 5.171  6.82  4.65      -308.68       210.47
                 6.171  0.00  4.65         0.00       210.47
                 9.225  0.00  4.65         0.00       210.47
                12.750  0.00  4.65         0.00       210.47
                16.275  0.00  4.65         0.00       210.47
                17.781  0.00  4.65         0.00       210.47
                18.781  4.65  4.65      -210.47       210.47
                24.500  4.65  4.65      -210.47       210.47
                25.500  4.65  4.65      -210.47       210.47

     4 Column    0.000  5.58  3.41      -250.42       154.32
                 1.000  5.58  3.41      -250.42       154.32
                 4.509  5.58  3.41      -250.42       154.32
                 5.701  3.41  3.41      -154.32       154.32
                 7.564  3.41  3.41      -154.32       154.32
                 8.755  0.00  3.41         0.00       154.32
                 9.225  0.00  3.41         0.00       154.32
                12.750  0.00  3.41         0.00       154.32
                16.275  0.00  3.41         0.00       154.32
                16.745  0.00  3.41         0.00       154.32
                17.992  3.41  3.41      -154.32       154.32
                19.799  3.41  3.41      -154.32       154.32
                21.047  4.96  3.41      -223.13       154.32
                24.500  4.96  3.41      -223.13       154.32
                25.500  4.96  3.41      -223.13       154.32
       Middle    0.000  4.65  4.65      -210.47       210.47
                 1.000  4.65  4.65      -210.47       210.47
                 6.969  4.65  4.65      -210.47       210.47
                 7.969  0.00  4.65         0.00       210.47
                 9.225  0.00  4.65         0.00       210.47
                12.750  0.00  4.65         0.00       210.47
                16.275  0.00  4.65         0.00       210.47
                17.781  0.00  4.65         0.00       210.47
                18.781  4.65  4.65      -210.47       210.47
                24.500  4.65  4.65      -210.47       210.47
                25.500  4.65  4.65      -210.47       210.47

     5 Column    0.000  4.96  3.41      -223.13       154.32
                 1.000  4.96  3.41      -223.13       154.32
                 4.445  4.96  3.41      -223.13       154.32
                 5.701  3.41  3.41      -154.32       154.32
                 7.499  3.41  3.41      -154.32       154.32
                 8.755  0.00  3.41         0.00       154.32
                 9.225  0.00  3.41         0.00       154.32
                12.750  0.00  3.41         0.00       154.32
                16.275  0.00  3.41         0.00       154.32
                16.745  0.00  3.41         0.00       154.32
                18.000  3.41  3.41      -154.32       154.32
                19.799  3.41  3.41      -154.32       154.32
                21.055  4.96  3.41      -223.13       154.32
                24.500  4.96  3.41      -223.13       154.32
                25.500  4.96  3.41      -223.13       154.32
       Middle    0.000  4.65  4.65      -210.47       210.47
                 1.000  4.65  4.65      -210.47       210.47
                 6.719  4.65  4.65      -210.47       210.47
                 7.719  0.00  4.65         0.00       210.47
                 9.225  0.00  4.65         0.00       210.47
                12.750  0.00  4.65         0.00       210.47
                16.275  0.00  4.65         0.00       210.47
                17.781  0.00  4.65         0.00       210.47
                18.781  4.65  4.65      -210.47       210.47
                24.500  4.65  4.65      -210.47       210.47
                25.500  4.65  4.65      -210.47       210.47

     6 Column    0.000  4.96  3.41      -223.13       154.32
                 1.000  4.96  3.41      -223.13       154.32
                 4.453  4.96  3.41      -223.13       154.32
                 5.701  3.41  3.41      -154.32       154.32
                 7.508  3.41  3.41      -154.32       154.32
                 8.755  0.00  3.41         0.00       154.32
                 9.225  0.00  3.41         0.00       154.32
                12.750  0.00  3.41         0.00       154.32
                16.275  0.00  3.41         0.00       154.32
                16.745  0.00  3.41         0.00       154.32
                17.936  3.41  3.41      -154.32       154.32
                19.799  3.41  3.41      -154.32       154.32
                20.991  5.58  3.41      -250.42       154.32
                24.500  5.58  3.41      -250.42       154.32
                25.500  5.58  3.41      -250.42       154.32
       Middle    0.000  4.65  4.65      -210.47       210.47
                 1.000  4.65  4.65      -210.47       210.47
                 6.719  4.65  4.65      -210.47       210.47
                 7.719  0.00  4.65         0.00       210.47
                 9.225  0.00  4.65         0.00       210.47
                12.750  0.00  4.65         0.00       210.47
                16.275  0.00  4.65         0.00       210.47
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                17.531  0.00  4.65        0.00        210.47
                18.531  4.65  4.65     -210.47        210.47
                24.500  4.65  4.65     -210.47        210.47
                25.500  4.65  4.65     -210.47        210.47

      7 Column   0.000  5.58  3.41     -250.42        154.32
                 1.000  5.58  3.41     -250.42        154.32
                 4.480  5.58  3.41     -250.42        154.32
                 5.701  3.41  3.41     -154.32        154.32
                 7.534  3.41  3.41     -154.32        154.32
                 8.755  0.00  3.41        0.00        154.32
                 9.225  0.00  3.41        0.00        154.32
                12.750  0.00  3.41        0.00        154.32
                16.275  0.00  3.41        0.00        154.32
                16.745  0.00  3.41        0.00        154.32
                17.976  2.48  3.41     -112.14        154.32
                19.799  2.48  3.41     -112.14        154.32
                21.031  3.72  3.41     -167.05        154.32
                24.500  3.72  3.41     -167.05        154.32
                25.500  3.72  3.41     -167.05        154.32
        Middle   0.000  4.65  4.65     -210.47        210.47
                 1.000  4.65  4.65     -210.47        210.47
                 6.719  4.65  4.65     -210.47        210.47
                 7.719  0.00  4.65        0.00        210.47
                 9.225  0.00  4.65        0.00        210.47
                12.750  0.00  4.65        0.00        210.47
                16.275  0.00  4.65        0.00        210.47
                19.329  0.00  4.65        0.00        210.47
                20.329  5.89  4.65     -266.48        210.47
                24.500  5.89  4.65     -266.48        210.47
                25.500  5.89  4.65     -266.48        210.47

      8 Column   0.000  3.72  2.48     -167.05        112.14
                 1.000  3.72  2.48     -167.05        112.14
                 5.039  3.72  2.48     -167.05        112.14
                 6.115  2.48  2.48     -112.14        112.14
                 6.425  2.48  2.48     -112.14        112.14
                 8.750  2.48  2.48     -112.14        112.14
                11.075  2.48  2.48     -112.14        112.14
                11.385  2.48  2.48     -112.14        112.14
                12.486  4.03  2.48     -180.66        112.14
                16.500  4.03  2.48     -180.66        112.14
                17.500  4.03  2.48     -180.66        112.14
        Middle   0.000  5.89  5.89     -266.48        266.48
                 1.000  5.89  5.89     -266.48        266.48
                 6.425  5.89  5.89     -266.48        266.48
                 8.750  5.89  5.89     -266.48        266.48
                11.075  5.89  5.89     -266.48        266.48
                16.500  5.89  5.89     -266.48        266.48
                17.500  5.89  5.89     -266.48        266.48

      9 Column   0.000  4.03  3.41     -180.66        154.32
                 1.000  4.03  3.41     -180.66        154.32
                 4.420  4.03  3.41     -180.66        154.32
                 5.701  2.48  3.41     -112.14        154.32
                 7.475  2.48  3.41     -112.14        154.32
                 8.755  0.00  3.41        0.00        154.32
                 9.225  0.00  3.41        0.00        154.32
                12.750  0.00  3.41        0.00        154.32
                16.275  0.00  3.41        0.00        154.32
                16.745  0.00  3.41        0.00        154.32
                17.962  2.17  3.41      -97.21        154.32
                19.799  2.17  3.41      -97.21        154.32
                21.017  4.34  3.41     -189.90        154.32
                24.500  4.34  3.41     -189.90        154.32
                25.500  4.34  3.41     -189.90        154.32
        Middle   0.000  5.89  4.65     -266.48        210.47
                 1.000  5.89  4.65     -266.48        210.47
                 5.469  5.89  4.65     -266.48        210.47
                 6.469  0.00  4.65        0.00        210.47
                 9.225  0.00  4.65        0.00        210.47
                12.750  0.00  4.65        0.00        210.47
                16.275  0.00  4.65        0.00        210.47
                19.281  0.00  4.65        0.00        210.47
                20.281  6.82  4.65     -308.68        210.47
                24.500  6.82  4.65     -308.68        210.47
                25.500  6.82  4.65     -308.68        210.47

     10 Column   0.000  4.34  1.24     -189.90         56.11
                 1.000  4.34  1.24     -189.90         56.11
                 1.406  4.34  1.24     -189.90         56.11
                 2.476  3.41  1.24     -150.73         56.11
                 2.979  3.41  1.24     -150.73         56.11
                 3.581  2.71  1.24     -120.78         56.11
                 4.049  2.17  1.24      -97.21         56.11
                 4.583  2.17  1.24      -97.21         56.11
                 5.794  2.17  1.24      -97.21         56.11
```

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                   8.375  2.17  1.24       -97.21        56.11
                   9.167  2.17  1.24       -97.21        56.11
        Middle     0.000  6.82  5.89      -307.93       266.49
                   1.000  6.82  5.89      -307.93       266.49
                   1.623  6.82  5.89      -307.93       266.49
                   2.623  5.89  5.89      -266.49       266.49
                   3.581  5.89  5.89      -266.49       266.49
                   4.583  5.89  5.89      -266.49       266.49
                   5.794  5.89  5.89      -266.49       266.49
                   8.375  5.89  5.89      -266.49       266.49
                   9.167  5.89  5.89      -266.49       266.49

     11 Column     0.000  2.17  0.00       -97.21         0.00
                   0.365  2.17  0.00       -97.21         0.00
                   0.966  1.61  0.00       -72.59         0.00
                   1.042  1.54  0.00       -69.47         0.00
                   1.365  1.24  0.00       -56.11         0.00
                   1.482  1.24  0.00       -56.11         0.00
                   2.083  1.24  0.00       -56.11         0.00
        Middle     0.000  5.89  0.00      -266.49         0.00
                   0.365  5.89  0.00      -266.49         0.00
                   0.966  5.89  0.00      -266.49         0.00
                   1.042  5.89  0.00      -266.49         0.00
                   1.482  5.89  0.00      -266.49         0.00
                   2.083  5.89  0.00      -266.49         0.00

Slab Shear Capacity
===================
   Units: b, d (in), Xu (ft), PhiVc, Vu(kip)
   Span        b        d   Vratio        PhiVc           Vu           Xu
   ---- -------- -------- -------- ------------ ------------ ------------
      1   315.49    10.19    1.000       280.08         3.87         0.65
      2   315.49    10.19    1.000       280.08        41.82         7.32
      3   364.50    10.19    1.000       323.59        79.28        23.65
      4   364.50    10.19    1.000       323.59        75.72         1.85
      5   364.50    10.19    1.000       323.59        74.83         1.85
      6   364.50    10.19    1.000       323.59        75.73        23.65
      7   364.50    10.19    1.000       323.59        79.31         1.85
      8   364.50    10.19    1.000       323.59        48.87        15.65
      9   364.50    10.19    1.000       323.59        74.85        23.65
     10   315.49    10.19    1.000       280.08        45.38         1.85
     11   315.49    10.19    1.000       280.08         2.38         1.68

Flexural Transfer of Negative Unbalanced Moment at Supports
===========================================================
   Units: Width (in), Munb (k-ft), As (in^2)
   Supp    Width  Width-c        d       Munb Comb Pat  GammaF    AsReq   AsProv Add Bars
   ---- -------- -------- -------- ---------- ---- ---- ------ -------- -------- --------
      1    62.00    62.00    10.19      13.40 U2   Odd   0.622    0.182    1.860      ---
      2    66.00    66.00    10.19      53.93 U2   Odd   0.619    0.733    3.720      ---
      3    66.00    66.00    10.19      33.90 U2   Odd   0.619    0.460    2.407      ---
      4    66.00    66.00    10.19      29.96 U2   Odd   0.619    0.406    2.140      ---
      5    66.00    66.00    10.19      30.26 U2   Odd   0.619    0.410    2.140      ---
      6    66.00    66.00    10.19      35.68 U2   Odd   0.619    0.484    2.407      ---
      7    66.00    66.00    10.19      62.55 U2   Odd   0.619    0.851    2.338      ---
      8    66.00    66.00    10.19      65.58 U2   Odd   0.619    0.893    2.533      ---
      9    66.00    66.00    10.19      58.65 U2   All   0.619    0.798    4.340      ---
     10    62.00    62.00    10.19      12.89 U2   All   0.622    0.175    2.170      ---

Flexural Transfer of Positive Unbalanced Moment at Supports
===========================================================
   Units: Width (in), Munb (k-ft), As (in^2)
   Supp    Width  Width-t        d       Munb Comb Pat  GammaF    AsReq   AsProv Add Bars
   ---- -------- -------- -------- ---------- ---- ---- ------ -------- -------- --------
      1    62.00    62.00    10.19       0.21 U2   S3    0.622    0.003    0.000     1-#5
      2    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    0.000      ---
      3    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.471      ---
      4    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.471      ---
      5    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.471      ---
      6    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.471      ---
      7    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.559      ---
      8    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.559      ---
      9    66.00    66.00    10.19       0.00 U1   All   0.619    0.000    1.240      ---
     10    62.00    62.00    10.19       6.03 U2   S8    0.622    0.082    1.240      ---

Punching Shear Around Columns
=============================
   Critical Section Properties
   ---------------------------
   Units: b1, b2, b0, davg, CG, c(left), c(right) (in), Ac (in^2), Jc (in^4)
   Supp       b1       b2       b0     davg       CG  c(left) c(right)           Ac           Jc
   ---- -------- -------- -------- -------- -------- -------- -------- ------------ ------------
      1    30.19    36.19    96.56    10.19     5.66    20.75     9.44       983.73  1.0454e+005
      2    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      3    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      4    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      5    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
```

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      6    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      7    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      8    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
      9    34.19    40.19   148.75    10.19     0.00    17.09    17.09       1515.4  3.1313e+005
     10    30.19    36.19    96.56    10.19    -5.66     9.44    20.75       983.73  1.0454e+005

   Punching Shear Results
   ----------------------
   Units: Vu (kip), Munb (k-ft), vu (psi), Phi*vc (psi)
   Supp           Vu       vu         Munb Comb Pat  GammaV       vu   Phi*vc
   ---- ------------ -------- ------------ ---- ---- ------ -------- --------
      1        18.10     18.4       -15.65 U2   S1    0.378     32.5    174.3
      2       133.73     88.2        52.06 U2   All   0.381    101.2    174.3
      3       178.23    117.6       -10.94 U2   All   0.381    120.3    174.3
      4       172.01    113.5         2.73 U2   All   0.381    114.2    174.3
      5       172.00    113.5        -2.74 U2   All   0.381    114.2    174.3
      6       178.27    117.6        11.01 U2   All   0.381    120.4    174.3
      7       139.46     92.0       -52.42 U2   All   0.381    105.1    174.3
      8       146.91     96.9        58.83 U2   All   0.381    111.6    174.3
      9       141.76     93.5       -58.65 U2   All   0.381    108.2    174.3
     10        14.11     14.3        15.97 U2   S10   0.378     28.7    174.3

Deflections
===========
   Section properties
   ------------------
   Units: Ig, Icr, Ie (in^4), Mcr, Mmax (k-ft)                                   _________________Load Level______________
        ________Ie,avg_________                                                  _________Dead_______ _______Dead+Live____
   Span        Dead   Dead+Live Zone                 Ig         Icr     Mcr     Mmax          Ie     Mmax          Ie
   ---- ----------- ----------- ------- ----------- ----------- ------- -------- ----------- -------- -----------
      1       45431       45431 Right         45431        5617  274.93    -9.66       45431   -12.52       45431
      2       45431       45431 Left          45431        5617  274.93    -2.74       45431    -3.55       45431
                                Midspan       45431       45431  274.93     0.00       45431     0.00       45431
                                Right         45431        7306  274.93  -142.79       45431  -185.10       45431
      3       52488       52488 Left          52488        7467  317.63  -173.89       52488  -225.41       52488
                                Midspan       52488        5923  317.63   126.39       52488   163.83       52488
                                Right         52488        7279  317.63  -241.63       52488  -313.22       52488
      4       52488       52488 Left          52488        7279  317.63  -235.10       52488  -304.75       52488
                                Midspan       52488        5923  317.63   104.97       52488   136.07       52488
                                Right         52488        6898  317.63  -221.58       52488  -287.23       52488
      5       52488       52488 Left          52488        6898  317.63  -223.21       52488  -289.35       52488
                                Midspan       52488        5923  317.63   110.10       52488   142.73       52488
                                Right         52488        6898  317.63  -223.19       52488  -289.32       52488
      6       52488       52488 Left          52488        6898  317.63  -221.55       52488  -287.20       52488
                                Midspan       52488        5923  317.63   104.95       52488   136.04       52488
                                Right         52488        7279  317.63  -235.17       52488  -304.85       52488
      7       52488       52488 Left          52488        7279  317.63  -241.75       52488  -313.38       52488
                                Midspan       52488        5923  317.63   126.52       52488   164.00       52488
                                Right         52488        6898  317.63  -173.53       52488  -224.95       52488
      8       52488       52488 Left          52488        6898  317.63  -142.22       52488  -184.36       52488
                                Midspan       52488        6121  317.63     7.04       52488     9.13       52488
                                Right         52488        7089  317.63  -157.84       52488  -204.60       52488
      9       52488       52488 Left          52488        7089  317.63  -192.98       52488  -250.16       52488
                                Midspan       52488        5923  317.63   140.18       52488   181.71       52488
                                Right         52488        7839  317.63  -193.27       52488  -250.54       52488
     10       45431       45431 Left          45431        7666  274.93  -158.24       45431  -205.12       45431
                                Midspan       45431        5225  274.93     1.29       45431     1.67       45431
                                Right         45431         128  274.93     1.29       45431     1.67       45431
     11       45431       45431 Left          45431        5811  274.93    -7.70       45431    -9.98       45431

   Maximum Instantaneous Deflections - Direction of Analysis
   ---------------------------------------------------------
   Units:  D (in), Ig (in^4)
        ___________Frame__________ ____________________________Strips___________________________
   Span    Ddead    Dlive   Dtotal Strip             Ig    LDF  Ratio    Ddead    Dlive   Dtotal
   ---- -------- -------- -------- ------- ------------ ------ ------ -------- -------- --------
      1    0.003    0.001    0.004 Column       7920.03  0.800  4.589    0.015    0.004    0.019
                                   Middle       37510.8  0.200  0.242    0.001    0.000    0.001
      2   -0.006   -0.002   -0.007 Column       7920.03  0.738  4.230   -0.024   -0.007   -0.031
                                   Middle       37510.8  0.262  0.318   -0.002   -0.001   -0.002
      3    0.060    0.018    0.077 Column         22032  0.675  1.608    0.096    0.028    0.125
                                   Middle         30456  0.325  0.560    0.033    0.010    0.043
      4    0.042    0.012    0.055 Column         22032  0.675  1.608    0.068    0.020    0.088
                                   Middle         30456  0.325  0.560    0.024    0.007    0.031
      5    0.046    0.014    0.060 Column         22032  0.675  1.608    0.075    0.022    0.097
                                   Middle         30456  0.325  0.560    0.026    0.008    0.034
      6    0.042    0.012    0.055 Column         22032  0.675  1.608    0.068    0.020    0.088
                                   Middle         30456  0.325  0.560    0.024    0.007    0.031
      7    0.060    0.018    0.078 Column         22032  0.675  1.608    0.096    0.029    0.125
                                   Middle         30456  0.325  0.560    0.034    0.010    0.043
      8   -0.008   -0.002   -0.011 Column         15120  0.675  2.343   -0.019   -0.006   -0.025
                                   Middle         37368  0.325  0.457   -0.004   -0.001   -0.005
      9    0.072    0.021    0.093 Column         22032  0.675  1.608    0.116    0.034    0.150
                                   Middle         30456  0.325  0.560    0.040    0.012    0.052
     10   -0.006   -0.002   -0.008 Column       7920.03  0.738  4.230   -0.027   -0.008   -0.035
                                   Middle       37510.8  0.262  0.318   -0.002   -0.001   -0.003
     11    0.003    0.001    0.004 Column       7920.03  0.800  4.589    0.015    0.004    0.019
```

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                                   Middle       37510.8  0.200  0.242    0.001    0.000    0.001

   Maximum Long-term Deflections - Direction of Analysis
   ---------------------------------------------------
   Time dependant factor for sustained loads = 2.000
   Units:  D (in)
        ___________________Column Strip____________________ ____________________Middle Strip___________________
   Span    Dsust Lambda      Dcs    Dcs+lu     Dcs+l   Dtotal     Dsust Lambda      Dcs    Dcs+lu     Dcs+l   Dtotal
   ---- -------- ------ -------- -------- -------- -------- -------- ------ -------- -------- -------- --------
      1    0.015  2.000    0.030    0.034    0.034    0.049    0.001  2.000    0.002    0.002    0.002    0.003
      2   -0.024  2.000   -0.047   -0.055   -0.055   -0.078   -0.002  2.000   -0.004   -0.004   -0.004   -0.006
      3    0.096  2.000    0.192    0.221    0.221    0.317    0.033  2.000    0.067    0.077    0.077    0.110
      4    0.068  2.000    0.135    0.155    0.155    0.223    0.024  2.000    0.047    0.054    0.054    0.078
      5    0.075  2.000    0.149    0.171    0.171    0.246    0.026  2.000    0.052    0.060    0.060    0.086
      6    0.068  2.000    0.135    0.155    0.155    0.223    0.024  2.000    0.047    0.054    0.054    0.078
      7    0.096  2.000    0.192    0.221    0.221    0.317    0.034  2.000    0.067    0.077    0.077    0.110
      8   -0.019  2.000   -0.038   -0.044   -0.044   -0.063   -0.004  2.000   -0.007   -0.009   -0.009   -0.012
      9    0.116  2.000    0.231    0.266    0.266    0.381    0.040  2.000    0.081    0.093    0.093    0.133
     10   -0.027  2.000   -0.054   -0.062   -0.062   -0.089   -0.002  2.000   -0.004   -0.005   -0.005   -0.007
     11    0.015  2.000    0.029    0.033    0.033    0.048    0.001  2.000    0.002    0.002    0.002    0.003

Material Takeoff
================
   Reinforcement in the Direction of Analysis
   ------------------------------------------
   Top Bars:      4206.7 lb   <=>  21.77 lb/ft   <=>  0.728 lb/ft^2
   Bottom Bars:   4861.8 lb   <=>  25.16 lb/ft   <=>  0.842 lb/ft^2
   Stirrups:         0.0 lb   <=>   0.00 lb/ft   <=>  0.000 lb/ft^2
   Total Steel:   9068.5 lb   <=>  46.93 lb/ft   <=>  1.570 lb/ft^2
   Concrete:      5777.1 ft^3 <=>  29.89 ft^3/ft <=>  1.000 ft^3/ft^2
```

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==================================================================================================================
[2] DESIGN RESULTS*
==================================================================================================================

*Unless otherwise noted, all results are in the direction of analysis only. Another analysis
 in the perpendicular direction has to be carried out for two-way slab systems.

Strip Widths and Distribution Factors
=====================================
   Units: Width (ft).
               __________Width___________    ______ Moment Factor______
   Span Strip    Left**  Right**  Bottom*     Left**  Right**  Bottom*
   ---- ------ -------- -------- --------   -------- -------- --------
      1 Column    12.75    12.75    12.75      1.000    1.000    0.600
        Middle    12.75    12.75    12.75      0.000    0.000    0.400

      2 Column    12.75    12.75    12.75      1.000    0.750    0.600
        Middle    12.75    12.75    12.75      0.000    0.250    0.400

      3 Column    12.75    12.75    12.75      0.750    1.000    0.600
        Middle    12.75    12.75    12.75      0.250    0.000    0.400

      4 Column    12.75    12.75    12.75      1.000    1.000    0.600
        Middle    12.75    12.75    12.75      0.000    0.000    0.400
   *Used for bottom reinforcement.   **Used for top reinforcement.

Top Reinforcement
=================
   Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)
   Span Strip  Zone       Width       Mmax     Xmax    AsMin    AsMax    AsReq   SpProv    Bars
   ---- ------ ------- --------- ---------- -------- -------- -------- -------- -------- -------
      1 Column Left        12.75       1.47    0.577    3.305   37.262    0.032   12.750   12-#5 *3
               Midspan     12.75       4.95    1.073    3.305   45.492    0.088   12.750   12-#5 *3
               Right       12.75      11.64    1.650    3.718   30.328    0.208   11.769   13-#5 *3

        Middle Left        12.75       0.00    0.000    3.305   37.262    0.000   13.909   11-#5 *3
               Midspan     12.75       0.00    0.825    3.305   37.262    0.000   13.909   11-#5 *3
               Right       12.75       0.00    1.650    3.305   37.262    0.000   13.909   11-#5 *3

      2 Column Left        12.75     144.71    1.125    3.856   32.157    2.465   11.769   13-#5 *3
               Midspan     12.75       9.44   16.806    3.305   37.262    0.206   13.909   11-#5 *3
               Right       12.75     461.50   25.250    3.856   32.157    8.061    4.636   33-#5

        Middle Left        12.75       0.75    2.224    3.305   37.262    0.016   13.909   11-#5 *3
               Midspan     12.75       1.83   16.806    3.305   37.262    0.040   13.909   11-#5 *3
               Right       12.75     153.84   25.250    3.305   37.262    3.399   10.929   14-#5

      3 Column Left        12.75     572.62    1.250    3.856   32.157   10.095    4.636   33-#5
               Midspan     12.75       0.00   17.188    0.000   37.262    0.000    0.000     ---
               Right       12.75     411.02   33.125    3.856   32.157    7.150    6.375   24-#5

        Middle Left        12.75     190.88    1.250    3.305   37.262    4.231   10.929   14-#5
               Midspan     12.75       0.00   17.188    0.000   37.262    0.000    0.000     ---
               Right       12.75       2.92   31.266    3.305   37.262    0.064   13.909   11-#5 *3
```

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      4 Column Left       12.75       8.91    0.306    3.580   28.499    0.170    6.375   24-#5 *3
               Midspan    12.75       3.79    0.812    3.305   42.749    0.072   12.750   12-#5 *3
               Right      12.75       1.09    1.245    3.305   37.262    0.024   12.750   12-#5 *3

        Middle Left       12.75       0.00    0.306    3.305   37.262    0.000   13.909   11-#5 *3
               Midspan    12.75       0.00    1.028    3.305   37.262    0.000   13.909   11-#5 *3
               Right      12.75       0.00    1.750    3.305   37.262    0.000   13.909   11-#5 *3
   NOTES:
   *3 - Design governed by minimum reinforcement.

Top Bar Details
===============
   Units: Length (ft)
               _____________Left______________  ___Continuous__  _____________Right_____________
   Span Strip     Bars  Length     Bars  Length     Bars  Length     Bars  Length     Bars  Length
   ---- ------ ------- ------- ------- -------  ------- -------  ------- ------- ------- -------
      1 Column     ---              ---            12-#5    2.00     1-#5    1.39      ---
        Middle     ---              ---            11-#5    2.00      ---              ---

      2 Column    2-#5    9.09      ---            11-#5   26.50    11-#5    9.21    11-#5    6.08
        Middle     ---              ---            11-#5   26.50     3-#5    6.56      ---

      3 Column   17-#5   11.77    16-#5    7.63      ---            13-#5   11.64    11-#5    7.50
        Middle   14-#5   10.93      ---              ---            11-#5    8.14      ---

      4 Column    6-#5    1.31     6-#5    1.31    12-#5    1.75      ---              ---
        Middle     ---              ---            11-#5    1.75      ---              ---

Bottom Reinforcement
====================
   Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)
   Span Strip     Width       Mmax     Xmax    AsMin    AsMax    AsReq   SpProv    Bars
   ---- ------ -------- ---------- -------- -------- -------- -------- -------- -------
      1 Column    12.75       0.00    0.825    0.000   37.262    0.000    0.000     ---
        Middle    12.75       0.00    0.825    0.000   37.262    0.000    0.000     ---

      2 Column    12.75     150.73   10.637    3.305   37.262    3.330   13.909   11-#5
        Middle    12.75     100.49   10.637    3.305   37.262    2.210   13.909   11-#5 *3

      3 Column    12.75     279.61   18.614    3.305   37.262    6.246    7.286   21-#5
        Middle    12.75     186.41   18.614    3.305   37.262    4.131   10.929   14-#5

      4 Column    12.75       0.00    1.028    0.000   37.262    0.000    0.000     ---
        Middle    12.75       0.00    1.028    0.000   37.262    0.000    0.000     ---
   NOTES:
   *3 - Design governed by minimum reinforcement.

Bottom Bar Details
==================
   Units: Start (ft), Length (ft)
                _______Long Bars_______ ______Short Bars_______
   Span Strip       Bars   Start  Length    Bars   Start  Length
   ---- ------- ------- ------- ------- ------- ------- -------
      1 Column      ---                     ---
        Middle      ---                     ---

      2 Column    11-#5    0.00   26.50     ---
        Middle    11-#5    0.00   26.50     ---

      3 Column    21-#5    0.00   34.25     ---
        Middle    11-#5    0.00   34.25    3-#5    5.14   29.11

      4 Column      ---                     ---
        Middle      ---                     ---

Flexural Capacity
=================
   Units: x (ft), As (in^2), PhiMn (k-ft)
   Span Strip         x AsTop AsBot       PhiMn-       PhiMn+
   ---- ------ --------- ----- ----- ------------ ------------
      1 Column    -0.000  3.72  0.00        -0.00         0.00
                   0.000  3.72  0.00      -168.14         0.00
                   0.000  3.72  0.00      -168.14         0.00
                   0.577  3.72  0.00      -205.81         0.00
                   0.614  3.72  0.00      -205.81         0.00
                   1.000  3.84  0.00      -212.36         0.00
                   1.073  3.86  0.00      -212.30         0.00
                   1.614  4.03  0.00      -221.34         0.00
                   1.650  4.03  0.00      -221.34         0.00
                   2.000  4.03  0.00      -221.34         0.00
        Middle     0.000  3.41  0.00      -154.32         0.00
                   0.577  3.41  0.00      -154.32         0.00
                   1.000  3.41  0.00      -154.32         0.00
                   1.073  3.41  0.00      -154.32         0.00
                   1.650  3.41  0.00      -154.32         0.00
                   2.000  3.41  0.00      -154.32         0.00
```

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      2 Column     0.000  4.03  3.41      -234.94      154.32
                   1.125  4.03  3.41      -234.94      154.32
                   4.417  4.03  3.41      -234.94      154.32
                   4.417  4.03  3.41      -181.94      154.32
                   8.087  4.03  3.41      -181.94      154.32
                   9.087  3.41  3.41      -154.32      154.32
                   9.569  3.41  3.41      -154.32      154.32
                  13.250  3.41  3.41      -154.32      154.32
                  16.806  3.41  3.41      -154.32      154.32
                  17.288  3.41  3.41      -154.32      154.32
                  18.306  6.82  3.41      -304.61      154.32
                  20.424  6.82  3.41      -304.61      154.32
                  21.442 10.23  3.41      -450.88      154.32
                  22.083 10.23  3.41      -450.88      154.32
                  22.083 10.23  3.41      -579.93      154.32
                  25.250 10.23  3.41      -579.93      154.32
                  26.500 10.23  3.41      -579.93      154.32
        Middle     0.000  3.41  3.41      -154.32      154.32
                   1.125  3.41  3.41      -154.32      154.32
                   9.569  3.41  3.41      -154.32      154.32
                  13.250  3.41  3.41      -154.32      154.32
                  16.806  3.41  3.41      -154.32      154.32
                  19.942  3.41  3.41      -154.32      154.32
                  20.953  4.34  3.41      -195.70      154.32
                  25.250  4.34  3.41      -195.70      154.32
                  26.500  4.34  3.41      -195.70      154.32

      3 Column     0.000 10.23  6.51      -579.93      291.11
                   1.250 10.23  6.51      -579.93      291.11
                   5.708 10.23  6.51      -579.93      291.11
                   5.708 10.23  6.51      -450.88      291.11
                   6.352 10.23  6.51      -450.88      291.11
                   7.626  5.27  6.51      -236.79      291.11
                  10.495  5.27  6.51      -236.79      291.11
                  11.769  0.00  6.51         0.00      291.11
                  12.406  0.00  6.51         0.00      291.11
                  17.125  0.00  6.51         0.00      291.11
                  21.969  0.00  6.51         0.00      291.11
                  22.606  0.00  6.51         0.00      291.11
                  23.847  4.03  6.51      -181.94      291.11
                  26.749  4.03  6.51      -181.94      291.11
                  27.990  7.44  6.51      -331.50      291.11
                  28.542  7.44  6.51      -331.50      291.11
                  28.542  7.44  6.51      -427.15      291.11
                  33.125  7.44  6.51      -427.15      291.11
                  34.250  7.44  6.51      -427.15      291.11
        Middle     0.000  4.34  3.41      -195.70      154.32
                   1.250  4.34  3.41      -195.70      154.32
                   5.137  4.34  3.41      -195.70      154.32
                   6.366  4.34  4.34      -195.70      195.70
                   9.668  4.34  4.34      -195.70      195.70
                  10.927  0.00  4.34         0.00      195.70
                  12.406  0.00  4.34         0.00      195.70
                  17.125  0.00  4.34         0.00      195.70
                  21.969  0.00  4.34         0.00      195.70
                  26.112  0.00  4.34         0.00      195.70
                  27.112  3.41  4.34      -154.32      195.70
                  33.125  3.41  4.34      -154.32      195.70
                  34.250  3.41  4.34      -154.32      195.70

      4 Column     0.000  7.44  0.00      -376.93        0.00
                   0.306  7.44  0.00      -376.93        0.00
                   0.307  7.44  0.00      -376.84        0.00
                   0.812  5.56  0.00      -287.18        0.00
                   0.875  5.33  0.00      -275.21        0.00
                   1.245  3.95  0.00      -178.42        0.00
                   1.306  3.72  0.00      -168.23        0.00
                   1.307  3.72  0.00      -168.14        0.00
                   1.750  3.72  0.00      -168.14        0.00
                   1.750  3.72  0.00      -168.14        0.00
                   1.750  3.72  0.00        -0.00        0.00
        Middle     0.000  3.41  0.00      -154.32        0.00
                   0.306  3.41  0.00      -154.32        0.00
                   0.812  3.41  0.00      -154.32        0.00
                   0.875  3.41  0.00      -154.32        0.00
                   1.245  3.41  0.00      -154.32        0.00
                   1.750  3.41  0.00      -154.32        0.00

Slab Shear Capacity
===================
   Units: b, d (in), Xu (ft), PhiVc, Vu(kip)
   Span        b        d   Vratio        PhiVc           Vu           Xu
   ---- -------- -------- -------- ------------ ------------ ------------
      1   306.00    10.19    1.000       271.65         0.00         0.00
      2   306.00    10.19    1.000       271.65       112.90        24.40
      3   306.00    10.19    1.000       271.65       136.02         2.10
      4   306.00    10.19    1.000       271.65         0.00         0.00
```

```
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Flexural Transfer of Negative Unbalanced Moment at Supports
===========================================================
   Units: Width (in), Munb (k-ft), As (in^2)
   Supp    Width  Width-c        d       Munb Comb Pat  GammaF    AsReq   AsProv Add Bars
   ---- -------- -------- -------- ---------- ---- ---- ------ -------- -------- --------
      1    69.00    69.00    13.19     223.14 U2   Even  0.582    2.220    1.817     2-#5
      2    69.00    69.00    13.19     265.88 U2   Odd   0.582    2.653    4.614      ---
      3    75.00    75.00    13.19     539.59 U2   All   0.602    5.661    3.647     7-#5

Punching Shear Around Columns
============================
   Critical Section Properties
   ---------------------------
   Units: b1, b2, b0, davg, CG, c(left), c(right) (in), Ac (in^2), Jc (in^4)
   Supp       b1       b2       b0     davg       CG  c(left) c(right)           Ac           Jc
   ---- -------- -------- -------- -------- -------- -------- -------- ------------ ------------
      1    43.19    37.19   123.56    13.19     6.50    28.09    15.09       1629.5  3.5341e+005
      2    43.19    37.19   160.75    13.19     0.00    21.59    21.59       2119.9   6.509e+005
      3    42.59    43.19   128.38    13.19    -7.46    14.13    28.46       1692.9  3.5754e+005

   Punching Shear Results
   ----------------------
   Units: Vu (kip), Munb (k-ft), vu (psi), Phi*vc (psi)
   Supp           Vu       vu         Munb Comb Pat  GammaV       vu   Phi*vc
   ---- ------------ -------- ------------ ---- ---- ------ -------- --------
      1       102.83     63.1       151.91 U2   All   0.418     95.7    174.3
      2       281.01    132.6       177.05 U2   All   0.418    162.0    174.3
      3       141.46     83.6      -451.63 U2   All   0.398    168.9    174.3

Punching Shear Around Drops
===========================
   Critical Section Properties
   ---------------------------
   Units: b1, b2, b0, davg, CG, c(left), c(right) (in), Ac (in^2), Jc (in^4)
   Supp       b1       b2       b0     davg       CG  c(left) c(right)           Ac           Jc
   ---- -------- -------- -------- -------- -------- -------- -------- ------------ ------------
      1    82.09   112.19   276.38    10.19    33.71    57.71    24.38       2815.6  2.0978e+006
      2   131.69   112.19   487.75    10.19     7.75    65.84    65.84         4969  1.3811e+007
      3    94.59   112.19   301.38    10.19   -43.90    29.69    64.90       3070.3  3.0588e+006

   Punching Shear Results
   ----------------------
   Units: Vu (kip), vu (psi), Phi*vc (psi)
   Supp           Vu Comb Pat        vu   Phi*vc
   ---- ------------ ---- ---- -------- --------
      1        85.83 U2   All      30.5    135.3
      2       251.56 U2   All      50.6    123.5
      3       121.85 U2   All      39.7    131.3

Deflections
===========
   Section properties
   ------------------
   Units: Ig, Icr, Ie (in^4), Mcr, Mmax (k-ft)                          ________________Load Level_______________
        ________Ie,avg_________                                         _________Dead_______ ______Dead+Live_____
   Span        Dead   Dead+Live Zone             Ig         Icr     Mcr     Mmax          Ie     Mmax          Ie
   ---- ----------- ----------- ------- ----------- ----------- ------- -------- ----------- -------- -----------
      1       60182       60182 Right         60182        7889  332.25    -7.37       60182   -12.47       60182
      2       48899       43321 Left          60182        7889  332.25   -94.75       60182  -164.07       60182
                                Midspan       44064        5007  266.65   105.53       44064   183.39       44064
                                Right         60182       13433  332.25  -325.30       60182  -563.91       22994
      3       45908       26086 Left          60182       13433  332.25  -399.92       40239  -693.22       18580
                                Midspan       44064        7450  266.65   195.79       44064   340.21       25081
                                Right         60182       10669  332.25  -232.92       60182  -403.62       38287
      4       60182       60182 Left          60182       10669  332.25    -5.65       60182    -9.55       60182

   Maximum Instantaneous Deflections - Direction of Analysis
   ---------------------------------------------------------
   Units:  D (in), Ig (in^4)
        ___________Frame__________ ____________________________Strips___________________________
   Span    Ddead    Dlive   Dtotal Strip             Ig    LDF  Ratio    Ddead    Dlive   Dtotal
   ---- -------- -------- -------- ------- ------------ ------ ------ -------- -------- --------
      1   -0.012   -0.010   -0.022 Column         22032  0.800  1.600   -0.019   -0.016   -0.035
                                   Middle         22032  0.200  0.400   -0.005   -0.004   -0.009
      2    0.055    0.050    0.105 Column         22032  0.738  1.475    0.081    0.073    0.155
                                   Middle         22032  0.262  0.525    0.029    0.026    0.055
      3    0.211    0.323    0.534 Column         22032  0.738  1.475    0.311    0.476    0.787
                                   Middle         22032  0.262  0.525    0.111    0.169    0.280
      4   -0.023   -0.024   -0.047 Column         22032  0.800  1.600   -0.037   -0.039   -0.076
                                   Middle         22032  0.200  0.400   -0.009   -0.010   -0.019

   Maximum Long-term Deflections - Direction of Analysis
   -----------------------------------------------------
   Time dependant factor for sustained loads = 2.000
   Units:  D (in)
        ___________________Column Strip____________________ ____________________Middle Strip___________________
```

```
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   Span    Dsust Lambda      Dcs   Dcs+lu    Dcs+l   Dtotal    Dsust Lambda      Dcs   Dcs+lu    Dcs+l   Dtotal
   ---- -------- ------ -------- -------- -------- -------- -------- ------ -------- -------- -------- --------
      1   -0.019  2.000   -0.038   -0.054   -0.054   -0.073   -0.005  2.000   -0.009   -0.013   -0.013   -0.018
      2    0.081  2.000    0.163    0.236    0.236    0.318    0.029  2.000    0.058    0.084    0.084    0.113
      3    0.311  2.000    0.622    1.098    1.098    1.408    0.111  2.000    0.221    0.391    0.391    0.501
      4   -0.037  2.000   -0.074   -0.113   -0.113   -0.150   -0.009  2.000   -0.019   -0.028   -0.028   -0.038

Material Takeoff
================
   Reinforcement in the Direction of Analysis
   ------------------------------------------
   Top Bars:      1763.5 lb   <=>  27.34 lb/ft   <=>  1.072 lb/ft^2
   Bottom Bars:   1842.3 lb   <=>  28.56 lb/ft   <=>  1.120 lb/ft^2
   Stirrups:         0.0 lb   <=>   0.00 lb/ft   <=>  0.000 lb/ft^2
   Total Steel:   3605.8 lb   <=>  55.90 lb/ft   <=>  2.192 lb/ft^2
   Concrete:      1695.8 ft^3 <=>  26.29 ft^3/ft <=>  1.031 ft^3/ft^2
```
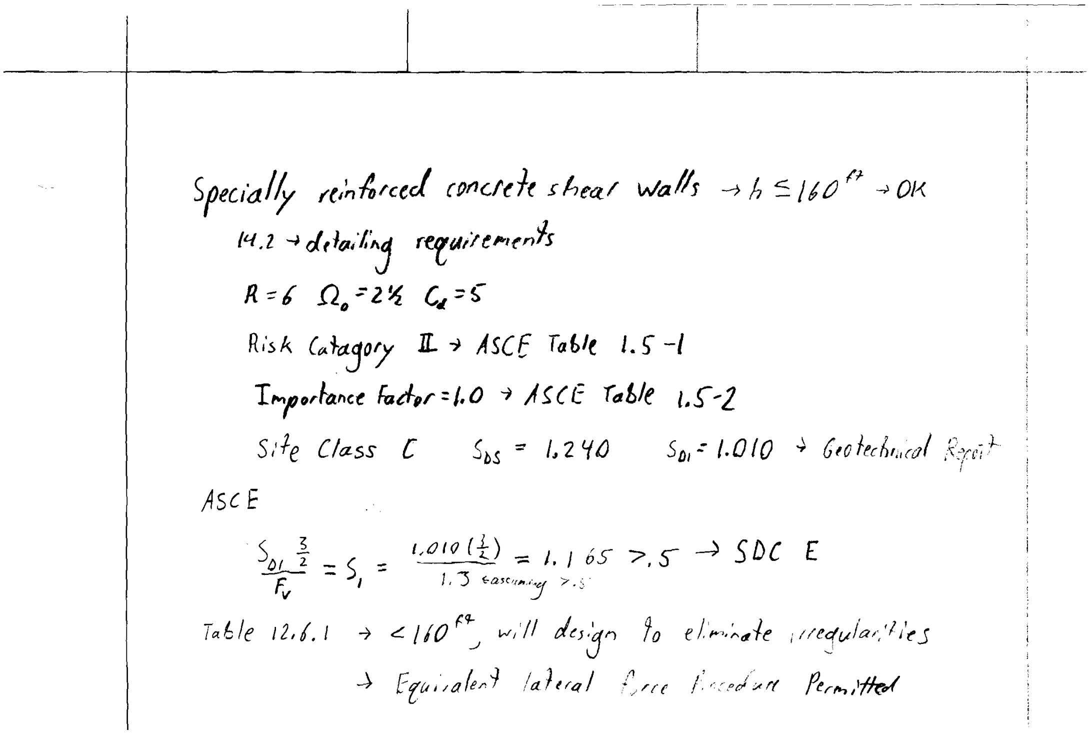

Appendix C – Seismic Calculations



Specially reinforced concrete shear walls → $h \le 160^{ft}$ → OK

14.2 → detailing requirements

$R = 6$ $\Omega_0 = 2\frac{1}{2}$ $C_d = 5$

Risk Catagory II → ASCE Table 1.5-1

Importance Factor = 1.0 → ASCE Table 1.5-2

Site Class C $S_{DS} = 1.240$ $S_{D1} = 1.010$ → Geotechnical Report

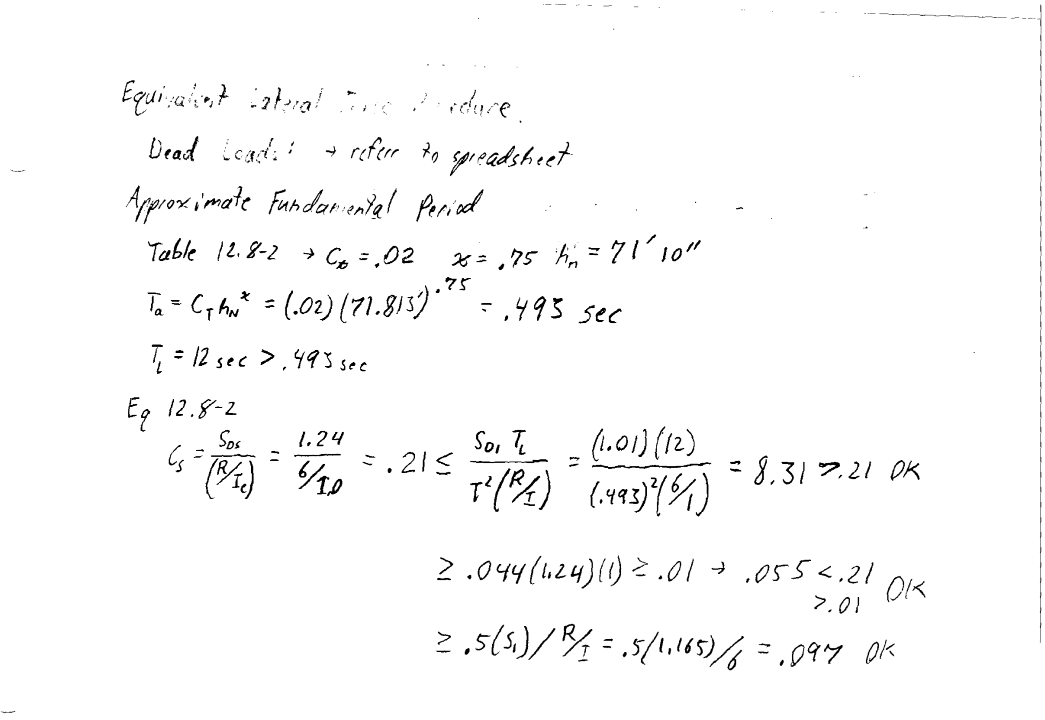
ASCE

$$\frac{S_{D1}\frac{3}{2}}{F_v} = S_1 = \frac{1.010\left(\frac{3}{2}\right)}{1.3} = 1.165 > .5 \rightarrow \text{SDC E}$$

1.3 ← assuming > .5

Table 12.6.1 → $< 160^{ft}$, will design to eliminate irregularities

→ Equivalent lateral force Procedure Permitted



Equivalent Lateral Force Procedure.

Dead Loads: → refer to spreadsheet

Approximate Fundamental Period

Table 12.8-2 → $C_t = .02$ $x = .75$ $h_n = 71'10''$

$T_a = C_T h_N^{x} = (.02)(71.813')^{.75} = .493$ sec

$T_L = 12$ sec $> .493$ sec

Eq 12.8-2

$$C_s = \frac{S_{DS}}{\left(R/I_e\right)} = \frac{1.24}{6/1.0} = .21 \le \frac{S_{D1}T_L}{T^2\left(R/I\right)} = \frac{(1.01)(12)}{(.493)^2\left(6/1\right)} = 8.31 > .21 \text{ OK}$$

$$\ge .044(1.24)(1) \ge .01 \rightarrow .055 < .21,\ > .01 \text{ OK}$$

$$\ge .5(S_1)/R/I = .5(1.165)/6 = .097 \text{ OK}$$

Concrete	115	lb/ft^3
Partition	8	psf
Brick	48	psf
EIFS	10	psf
Mechanical	18000	lbs

Floor	Story Height (ft)	Slab Thickness (in)	Floor Area (ft^2)	Concrete unitweight (lb/ft^3)	Floor Weight (lbs)	Interior Wall Length (ft)	Interior Wall Unit Weight (psf)	Interior Wall Weight (lbs)	Interior Wall Story Contribution (lbs)	Brick Façade Wall Length (ft)	Brick Facade Unit Weight (psf)	Brick Facade Weight (lbs)	Brick Façade Story Contribution (lbs)	EIFS Façade Wall Length (ft)	EIFS Façade Unit Weight (psf)	EIFS Façade Weight (lbs)	EIFS Façade Story Contribution (lbs)	Mechanical Equipment (lbs)	Total Story Weight (k)	Ultimate Story Weight (k)	Sesimic Mass (k-in)
	7.5																				
Roof	9.33	12	12287	115	1413005		8	0	48533.3333		48	0	14560	510	10	38250	59017	18000	1553.1	1863.7	2.72608E-06
6th	9.33	12	12287	115	1413005	1300	8	97066.67	97066.6667	65	48	29120	31584	445	10	41533.33333	41020		1582.7	1899.2	2.77797E-06
5th	9.33	12	12287	115	1413005	1300	8	97066.67	97066.6667	76	48	34048	34048	434	10	40506.66667	40507		1584.6	1901.6	2.78139E-06
4th	9.33	12	12287	115	1413005	1300	8	97066.67	97066.6667	76	48	34048	34048	434	10	40506.66667	40507		1584.6	1901.6	2.78139E-06
3rd	11.17	12	12287	115	1413005	1300	8	97066.67	106600	76	48	34048	153704	434	10	40506.66667	20253		1693.6	2032.3	2.9726E-06
2nd	13.33	12	12287	115	1413005	1300	8	116133.3	116733.333	510	48	273360	299880	0	10	0	0		1829.6	2195.5	3.21141E-06
1st	10.00	12	11013	115	1266495	1100	8	117333.3	81866.6667	510	48	326400	285600	0	10	0	0		1634.0	1960.8	3.19976E-06
						580	8	46400		510	48	244800		0	10	0					

X-Direction Loading

S_{DS} = 1.24
S_{D1} = 1.01
C_d = 5
I_e= 1

C_t = 0.02
x = 0.75
C_u = 1.4
T from Model =

T= 0.493 s
k= 1.000
V_b= 2888 kips
C_s= 0.21

i	h_i ft	h ft	w kips	$w*h^K$	C_{VX}	f_i kips	V_i kips	By ft	5%By ft	Ax	M_z k-ft	M_{over} k-ft	M_r
Roof	9.33	71.83	1863.7	133879	0.232	669	669	65	3	1.0	2174	48061	
6	9.33	62.50	1899.2	118701	0.205	593	1262	65	3	1.0	1928	37076	
5	9.33	53.17	1901.6	101099	0.175	505	1768	65	3	1.0	1642	26862	
4	9.33	43.83	1901.6	83351	0.144	417	2184	65	3	1.0	1354	18259	
3	11.17	34.50	2032.3	70113	0.121	350	2534	65	3	1.0	1139	12089	
2	13.33	23.33	2195.5	51229	0.089	256	2790	65	3	1.0	832	5974	
1	10.00	10	1960.8	19608	0.034	98	2888	65	3	1.0	318	980	
0	0.00	0	0.0	0	0.000	0	2888	65	3	1.0	0	0	
		Σ	13754.6	577980		2888					9388	149300	1000649

Y-Direction Loading

C_t = 0.02
x = 0.75
C_u = 1.4
T from Model =

T= 0.493 s
k= 1.000
V_b= 2888 kips
C_s= 0.21

i	h_i ft	h ft	w kips	$w*h^K$	C_{VX}	f_i kips	V_i kips	Bx ft	5%Bx ft	Ax	M_z k-ft	M_{over} k-ft	M_r
Roof	9.33	71.83	1863.738	133879	0.232	669	669	194	10	1.0	6490	48061	
6	9.33	62.50	1899.211	118701	0.205	593	1262	194	10	1.0	5754	37076	
5	9.33	53.17	1901.552	101099	0.175	505	1768	194	10	1.0	4901	26862	
4	9.33	43.83	1901.552	83351	0.144	417	2184	194	10	1.0	4041	18259	
3	11.17	34.50	2032.275	70113	0.121	350	2534	194	10	1.0	3399	12089	
2	13.33	23.33	2195.542	51229	0.089	256	2790	194	10	1.0	2483	5974	
1	10	10	1960.754	19608	0.034	98	2888	194	10	1.0	950	980	
0	0	0	0	0	0.000	0	2888	194	10	1.0	0	0	
		Σ	13754.62	577980		2888					28018	149300	335268.9

Drift Limits

	Story Height	Height Above Seismic Base	Max Glazing Height	Glazing Limit	Glazing Ratio	0.5% transient	Code Allowable	Controlling Story Drift Limit	Max Building Drift at h
	h_i	h			$h_i/175$		$0.020h_{sx}/(C_d/I_e)$		
	(ft)	(ft)	(ft)	(in)	(in)	(in)	(in)	(in)	(in)
Roof	9.33	71.83	5.84	1.20	0.6400	0.5600	0.4480	0.4480	3.4480
6th	9.33	62.50	5.84	1.20	0.6400	0.5600	0.4480	0.4480	3.0000
5th	9.33	53.17	5.84	1.20	0.6400	0.5600	0.4480	0.4480	2.5520
4th	9.33	43.83	5.84	1.20	0.6400	0.5600	0.4480	0.4480	2.1040
3rd	11.17	34.50	5.50	1.52	0.7657	0.6700	0.5360	0.5360	1.6560
2nd	13.33	23.33	6.50	1.54	0.9143	0.8000	0.6400	0.6400	1.1200
1st	10.00	10.00	7.5	1.00	0.6857	0.6000	0.4800	0.4800	0.4800
Base	0.00	0.00	0.00	0.00	0.0000	0.0000	0.0000	0.0000	0.0000

Drift Limits

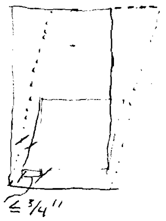
Allowable Story Drift according to ASCE 7-10 Table 12.12-1

$\Delta_a = .020 h_{sx}$

Design Story Drift according to ASCE 7-10 Eq 12.8-15

$\delta_x = \frac{C_d \delta_{xe}}{I_e} \le \Delta_a = .020 h_{sx}$

$\longrightarrow \delta_{xe} \le \frac{.020 h_{sx}}{C_d / I_e}$



Glazing Deflection Requirement ATS-192

$^{L}/_{175} \le 3/4''$ Limit story drift to $\delta_{xe} \le {}^{h_{sx}}/_{175} \le 3/4'' \frac{h_{sx}}{h_{glazing}}$ ← largest pane

ASCE 41-06 Table C1-3 Structural Performance Levels and Damage

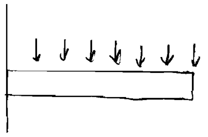
- Brittle Elements

- Concrete Walls

  - Immediate Occupancy → 0.5% transient → $\delta_{xe} \le .005 h_{sx}$

W&M reccommend wall thickness $\geq h_i/15 \rightarrow \frac{13\frac{4}{12}}{15} = 10\frac{2}{3}'' \rightarrow$ USE 12''

ASCE 41-06 reccomends $\Delta \leq .5\%$ transient → code drif equation controls @ $.02/5 = \frac{1}{250}$



ACI 318-11 Section 21.1.4.3 limits lightweight concrete strength to 5000psi for frames and walls of the lateral force resisting system

→ use normal weight higher elasticity and f'c

$$V_n = A_{cv}(\alpha_c \lambda \sqrt{f'c} + \rho_t f_y)$$

$$= A_{cv}(3.0\,(1.0)\sqrt{8000} + .00287(60{,}000))$$

$$= A_{cv}(440.5)$$

$V_b = 2888^k \leq .75\, A_{cv}\,(440.5)^{psi}$ for 18'' thick wall

$$\rightarrow l_w \geq \frac{2888^k}{.75(18'')(.4405^{ksi})} \times \frac{1^{ft}}{12''} = (40.5^{ft})$$

$$c \geq \frac{l_w}{600(\delta_u/h_w)} \qquad h_w = 71.83'$$

displacement @ top of wall

Appendix D – Wall Shears Forces and Moments

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WH1	71.83	Top	0	0	0	30.18	0.01	30.18	0.01	2167.93	0.718333	0	0	0		
ROOF	WH1		Bottom	0	0	0	30.18	0.01	30.18	0.01			3380.234	0.867	3381.101		
6TH	WH1	62.50	Top	0	0	0	61.56	0.1	31.38	0.09	1961.25	5.625	3380.234	0.867	3381.101		
6TH	WH1		Bottom	0	0	0	61.56	0.1	31.38	0.09			10274.62	12.516	10287.14		
5TH	WH1	53.17	Top	0	0	0	93.03	0.41	31.47	0.31	1673.155	16.48167	10274.62	12.516	10287.14		
5TH	WH1		Bottom	0	0	0	93.03	0.41	31.47	0.31			20694.48	58.738	20753.22		
4TH	WH1	43.83	Top	0	0	0	116.55	0.56	23.52	0.15	1030.96	6.575	20694.48	58.738	20753.22		
4TH	WH1		Bottom	0	0	0	116.55	0.56	23.52	0.15			33748.47	121.29	33869.76		
3RD	WH1	34.50	Top	0	0	0	135.6	0.63	19.05	0.07	657.225	2.415	33748.47	121.29	33869.76		
3RD	WH1		Bottom	0	0	0	135.6	0.63	19.05	0.07			51919.23	206.036	52125.26		
2ND	WH1	23.33	Top	0	0	0	163.45	1.02	27.85	0.39	649.8333	9.1	51919.23	206.036	52125.26		
2ND	WH1		Bottom	0	0	0	163.45	1.02	27.85	0.39			78071.9	368.638	78440.54		
1ST	WH1	10.00	Top	0	0	0	234.43	3.13	70.98	2.11	709.8	21.1	78071.9	368.638	78440.54	P =	0.15
1ST	WH1		Bottom	0	0	0	234.43	3.13	70.98	2.11			106203.8	744.547	106948.3	w_w =	1.5
																l_w =	15.25
											8850.153	62.015	8912.168	= M_{over}	≤	M_r =	1879.396

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WH2	71.83	Top	0	0	0	30.18	0.01	30.18	0.01	2167.93	0.718333	0	0	0		
ROOF	WH2		Bottom	0	0	0	30.18	0.01	30.18	0.01			3380.234	0.867	3381.101		
6TH	WH2	62.50	Top	0	0	0	61.56	0.1	31.38	0.09	1961.25	5.625	3380.234	0.867	3381.101		
6TH	WH2		Bottom	0	0	0	61.56	0.1	31.38	0.09			10274.62	12.516	10287.14		
5TH	WH2	53.17	Top	0	0	0	93.03	0.41	31.47	0.31	1673.155	16.48167	10274.62	12.516	10287.14		
5TH	WH2		Bottom	0	0	0	93.03	0.41	31.47	0.31			20694.48	58.738	20753.22		
4TH	WH2	43.83	Top	0	0	0	116.55	0.56	23.52	0.15	1030.96	6.575	20694.48	58.738	20753.22		
4TH	WH2		Bottom	0	0	0	116.55	0.56	23.52	0.15			33748.47	121.29	33869.76		
3RD	WH2	34.50	Top	0	0	0	135.6	0.63	19.05	0.07	657.225	2.415	33748.47	121.29	33869.76		
3RD	WH2		Bottom	0	0	0	135.6	0.63	19.05	0.07			51919.23	206.036	52125.26		
2ND	WH2	23.33	Top	0	0	0	163.45	1.02	27.85	0.39	649.8333	9.1	51919.23	206.036	52125.26		
2ND	WH2		Bottom	0	0	0	163.45	1.02	27.85	0.39			78071.9	368.638	78440.54		
1ST	WH2	10.00	Top	0	0	0	234.43	3.13	70.98	2.11	709.8	21.1	78071.9	368.638	78440.54	P =	0.15
1ST	WH2		Bottom	0	0	0	234.43	3.13	70.98	2.11			106203.8	744.547	106948.3	w_w =	1.5
																l_w =	15.25
											8850.153	62.015	8912.168	= M_{over}	≤	M_r =	1879.396

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WF.5	71.83	Top	3.89	-0.58	4.47	237.87	4.63	237.87	4.63	17087	332.5883	-4215.94	-92.215	4308.154		
ROOF	WF.5		Bottom	9.09	-2.73	11.82	237.87	4.63	237.87	4.63			4825.883	63.943	4889.826		
6TH	WF.5	62.50	Top	9.48	-3.65	13.13	381.66	7.25	143.79	2.62	8986.875	163.75	-1575.87	-68.785	1644.656		
6TH	WF.5		Bottom	11.69	-8.4	20.09	381.66	7.25	143.79	2.62			10074.14	99.874	10174.01		
5TH	WF.5	53.17	Top	11.93	-9.86	21.79	497.78	9.34	116.12	2.09	6173.713	111.1183	1066.774	-83.37	1150.144		
5TH	WF.5		Bottom	12.19	-16.67	28.86	497.78	9.34	116.12	2.09			16674.96	143.244	16818.2		
4TH	WF.5	43.83	Top	11.96	-18.62	30.58	595.63	11.14	97.85	1.8	4289.092	78.9	5544.27	-81.869	5626.139		
4TH	WF.5		Bottom	11.73	-27.17	38.9	595.63	11.14	97.85	1.8			24501.94	189.993	24691.94		
3RD	WF.5	34.50	Top	10.73	-29.5	40.23	654.49	12.44	58.86	1.3	2030.67	44.85	11879.87	-69.728	11949.6		
3RD	WF.5		Bottom	1.15	-41.84	42.99	654.49	12.44	58.86	1.3			34296.53	235.465	34531.99		
2ND	WF.5	23.33	Top	-2.61	-44.61	47.22	668.74	12.01	14.25	-0.43	332.5	-10.0333	20897.52	-35.846	20933.37		
2ND	WF.5		Bottom	-33.24	-62.66	95.9	668.74	12.01	14.25	-0.43			46690.56	280.082	46970.64		
1ST	WF.5	10.00	Top	-38.3	-66.13	104.43	542.16	8.89	-126.58	-3.12	-1265.8	-31.2	33995.26	46.786	34042.04	P =	0.15
1ST	WF.5		Bottom	-45.23	-80.52	125.75	542.16	8.89	-126.58	-3.12			56949.02	329.171	57278.19	w_w =	1.5
																l_w =	9.166667
											37634.05	689.9733	38324.02	= M_{over}	≤	M_r =	679.0495

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WE.2	71.83	Top	0.61	0.79	1.4	22.06	-2.56	22.06	-2.56	1584.643	-183.893	33.667	43.686	77.353		
ROOF	WE.2		Bottom	-11.93	4.49	16.42	22.06	-2.56	22.06	-2.56			1814.74	-39.345	1854.085		
6TH	WE.2	62.50	Top	-17.48	5.7	23.18	45.65	-3.88	23.59	-1.32	1474.375	-82.5	1509.335	27.115	1536.45		
6TH	WE.2		Bottom	-36.36	11.93	48.29	45.65	-3.88	23.59	-1.32			5584.413	-64.406	5648.819		
5TH	WE.2	53.17	Top	-44.75	13.76	58.51	73.26	-5.09	27.61	-1.21	1467.932	-64.3317	5122.896	36.349	5159.245		
5TH	WE.2		Bottom	-84.11	22.11	106.22	73.26	-5.09	27.61	-1.21			11163.56	-74.074	11237.63		
4TH	WE.2	43.83	Top	-97.16	24.44	121.6	93.47	-6.22	20.21	-1.13	885.8717	-49.5317	10445.82	53.943	10499.76		
4TH	WE.2		Bottom	-150.62	34.62	185.24	93.47	-6.22	20.21	-1.13			17974.81	-83.035	18057.85		
3RD	WE.2	34.50	Top	-168.88	37.35	206.23	123.07	-7.16	29.6	-0.94	1021.2	-32.43	16970.53	67.569	17038.1		
3RD	WE.2		Bottom	-265.09	52.12	317.21	123.07	-7.16	29.6	-0.94			28170.5	-80.138	28250.64		
2ND	WE.2	23.33	Top	-290.79	55.13	345.92	149.95	-7.19	26.88	-0.03	627.2	-0.7	26756.81	85.707	26842.51		
2ND	WE.2		Bottom	-462.45	73.6	536.05	149.95	-7.19	26.88	-0.03			41306.77	-48.567	41355.33		
1ST	WE.2	10.00	Top	-503.65	76.45	580.1	216.85	-4.53	66.9	2.66	669	26.6	39040.56	108.023	39148.58	P =	0.15
1ST	WE.2		Bottom	-651.06	87.12	738.18	216.85	-4.53	66.9	2.66			56954.48	151.025	57105.51	w_w =	1.5
																l_w =	9.166667
											7730.222	-386.787	8117.008	=M_{over}	≤	M_r =	679.0495

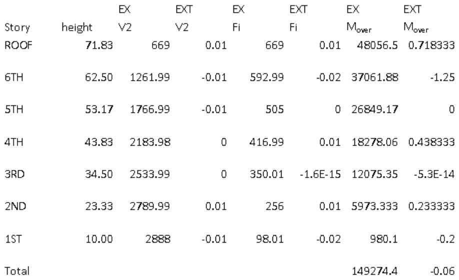
				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WD	71.83	Top	5.79	0.28	6.07	30.2	0.41	30.2	0.41	2169.367	29.45167	-274.902	-13.393	288.295		
ROOF	WD		Bottom	40.29	0.9	41.19	30.2	0.41	30.2	0.41			1468.274	3.633	1471.907		
6TH	WD	62.50	Top	53.01	1.17	54.18	53.9	0.74	23.7	0.33	1481.25	20.625	864.173	-9.416	873.589		
6TH	WD		Bottom	116.18	2.63	118.81	53.9	0.74	23.7	0.33			3900.541	3.755	3904.296		
5TH	WD	53.17	Top	136.15	3.11	139.26	80.78	1.19	26.88	0.45	1429.12	23.925	2951.884	-18.925	2970.809		
5TH	WD		Bottom	228.88	5.45	234.33	80.78	1.19	26.88	0.45			7594.04	3.376	7597.416		
4TH	WD	43.83	Top	255.79	6.13	261.92	101.41	1.6	20.63	0.41	904.2817	17.97167	6315.934	-29.051	6344.985		
4TH	WD		Bottom	371.87	9.25	381.12	101.41	1.6	20.63	0.41			12160.52	2.616	12163.14		
3RD	WD	34.50	Top	404.09	10.12	414.21	118.11	2.06	16.7	0.46	576.15	15.87	10630.17	-39.134	10669.3		
3RD	WD		Bottom	572.78	15.04	587.82	118.11	2.06	16.7	0.46			18444.45	3.007	18447.45		
2ND	WD	23.33	Top	610.54	16.18	626.72	134.81	2.72	16.7	0.66	389.6667	15.4	16650.59	-51.217	16701.81		
2ND	WD		Bottom	855.31	23.88	879.19	134.81	2.72	16.7	0.66			26594.09	18.997	26613.09		
1ST	WD	10.00	Top	904.89	25.23	930.12	185.24	2.49	50.43	-0.23	504.3	-2.3	24239.07	-45.429	24284.5	P =	0.15
1ST	WD		Bottom	1092.19	31.13	1123.32	185.24	2.49	50.43	-0.23			37571.67	-26.478	37598.15	w_w =	1.5
																l_w =	7.916667
											7454.135	120.9433	7575.078	=M_{over}	≤	M_r =	506.4811

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WC.8	71.83	Top	-9.58	1.13	10.71	46.13	-2.09	46.13	-2.09	3313.672	-150.132	-526.98	61.952	588.932		
ROOF	WC.8		Bottom	-52.78	3.34	56.12	46.13	-2.09	46.13	-2.09			2264.044	-51.059	2315.103		
6TH	WC.8	62.50	Top	-68.55	4.32	72.87	79.32	-3.3	33.19	-1.21	2074.375	-75.625	1396.894	2.97	1399.864		
6TH	WC.8		Bottom	-144.7	9.67	154.37	79.32	-3.3	33.19	-1.21			6093.07	-72.649	6165.719		
5TH	WC.8	53.17	Top	-168	11.27	179.27	113.46	-4.62	34.14	-1.32	1815.11	-70.18	4811.444	15.038	4826.482		
5TH	WC.8		Bottom	-272.93	18.65	291.58	113.46	-4.62	34.14	-1.32			11747.52	-96.185	11843.7		
4TH	WC.8	43.83	Top	-302.99	20.71	323.7	140.04	-5.62	26.58	-1	1165.09	-43.8333	10094.04	16.979	10111.02		
4TH	WC.8		Bottom	-430.92	29.7	460.62	140.04	-5.62	26.58	-1			18743.3	-118.225	18861.53		
3RD	WC.8	34.50	Top	-465.98	32.1	498.08	161.26	-6.37	21.22	-0.75	732.09	-25.875	16814.89	13.757	16828.65		
3RD	WC.8		Bottom	-645.64	44.87	690.51	161.26	-6.37	21.22	-0.75			28542.61	-138.05	28680.66		
2ND	WC.8	23.33	Top	-685.2	47.54	732.74	174.45	-6.65	13.19	-0.28	307.7667	-6.53333	26366.99	8.524	26375.52		
2ND	WC.8		Bottom	-931.2	64.17	995.37	174.45	-6.65	13.19	-0.28			40749.47	-140.763	40890.23		
1ST	WC.8	10.00	Top	-980.22	66.87	1047.09	245.35	-5.23	70.9	1.42	709	14.2	38053.51	7.392	38060.91	P =	0.15
1ST	WC.8		Bottom	-1160.97	77.46	1238.43	245.35	-5.23	70.9	1.42			57553.68	-37.718	57591.4	w_w =	1.5
																l_w =	9.166667
											10117.1	-357.978	10475.08	=M_{over}	≤	M_r =	679.0495

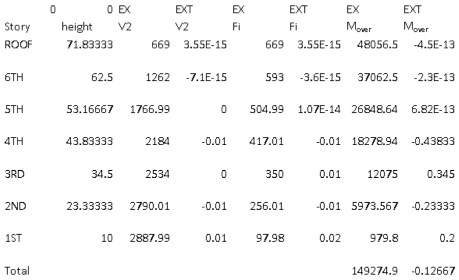
				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WC.2	71.83	Top	6.2	-0.34	6.54	31.2	-0.72	31.2	-0.72	2241.2	-51.72	-294.592	16.24	310.832		
ROOF	WC.2		Bottom	42.1	-1.29	43.39	31.2	-0.72	31.2	-0.72			1494.945	-19.53	1514.475		
6TH	WC.2	62.50	Top	54.61	-1.67	56.28	52.53	-1.07	21.33	-0.35	1333.125	-21.875	900.614	-1.861	902.475		
6TH	WC.2		Bottom	114.68	-3.53	118.21	52.53	-1.07	21.33	-0.35			3931.015	-33.535	3964.55		
5TH	WC.2	53.17	Top	133.85	-4.12	137.97	79.07	-1.68	26.54	-0.61	1411.043	-32.4317	3020.102	-5.082	3025.184		
5TH	WC.2		Bottom	223.05	-7.02	230.07	79.07	-1.68	26.54	-0.61			7638.955	-55.942	7694.897		
4TH	WC.2	43.83	Top	249.05	-7.86	256.91	99.7	-2.18	20.63	-0.5	904.2817	-21.9167	6403.996	-16.124	6420.12		
4TH	WC.2		Bottom	361.54	-11.62	373.16	99.7	-2.18	20.63	-0.5			12227.66	-81.384	12309.04		
3RD	WC.2	34.50	Top	392.55	-12.66	405.21	114.88	-2.61	15.18	-0.43	523.71	-14.835	10754.8	-31.856	10786.65		
3RD	WC.2		Bottom	553.78	-18.34	572.12	114.88	-2.61	15.18	-0.43			18490.25	-111.961	18602.21		
2ND	WC.2	23.33	Top	589.66	-19.61	609.27	129.95	-3.05	15.07	-0.44	351.6333	-10.2667	16785.72	-51.538	16837.26		
2ND	WC.2		Bottom	820.68	-28	848.68	129.95	-3.05	15.07	-0.44			26604.7	-141.734	26746.44		
1ST	WC.2	10.00	Top	868.77	-29.58	898.35	183.56	-3.66	53.61	-0.61	536.1	-6.1	24320.45	-66.374	24386.83	P =	0.15
1ST	WC.2		Bottom	1053.19	-36.61	1089.8	183.56	-3.66	53.61	-0.61			37588.3	-171.057	37759.36	w_w =	1.5
																l_w =	7.916667
											7301.093	-159.145	7460.238	= M_{over}	≤	M_r =	506.4811

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WC	71.83	Top	-5.39	-1.05	6.44	40.38	1.64	40.38	1.64	2900.63	117.8067	-296.666	-57.785	354.451		
ROOF	WC		Bottom	-41.11	-2.88	43.99	40.38	1.64	40.38	1.64			2261.225	25.638	2286.863		
6TH	WC	62.50	Top	-54.66	-3.74	58.4	72.97	2.73	32.59	1.09	2036.875	68.125	1515.571	-21.507	1537.078		
6TH	WC		Bottom	-120.47	-8.55	129.02	72.97	2.73	32.59	1.09			6068.772	20.226	6088.998		
5TH	WC	53.17	Top	-141.54	-9.98	151.52	109.02	3.79	36.05	1.06	1916.658	56.35667	4909.771	-58.325	4968.096		
5TH	WC		Bottom	-239.09	-16.62	255.71	109.02	3.79	36.05	1.06			11754.5	1.245	11755.75		
4TH	WC	43.83	Top	-268.04	-18.46	286.5	139.55	4.66	30.53	0.87	1338.232	38.135	10162.24	-100.373	10262.61		
4TH	WC		Bottom	-394.07	-26.59	420.66	139.55	4.66	30.53	0.87			18859.58	-25.579	18885.15		
3RD	WC	34.50	Top	-430.01	-28.77	458.78	168.24	5.37	28.69	0.71	989.805	24.495	16882.8	-145.075	17027.88		
3RD	WC		Bottom	-620.42	-40.46	660.88	168.24	5.37	28.69	0.71			28954.72	-67.783	29022.5		
2ND	WC	23.33	Top	-662.44	-42.92	705.36	178.06	6.03	9.82	0.66	229.1333	15.4	26643.75	-203.536	26847.29		
2ND	WC		Bottom	-926.48	-58.43	984.91	178.06	6.03	9.82	0.66			40610.99	-92.103	40703.09		
1ST	WC	10.00	Top	-978.2	-60.77	1038.97	252.69	2.88	74.63	-3.15	746.3	-31.5	37766.3	-221.238	37987.54	P =	0.15
1ST	WC		Bottom	-1168.27	-69.71	1237.98	252.69	2.88	74.63	-3.15			57634.99	-367.019	58002.01	w_w =	1.5
																l_w =	9.166667
											10157.63	288.8183	10446.45	= M_{over}	≤	M_r =	679.0495

				EX	EXT	Total	EX	EXT	EX	EXT	EX	EXT	EX	EXT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	WB	71.83	Top	0	0	0	200.8	-1.32	200.8	-1.32	14424.13	-94.82	0	0	0		
ROOF	WB		Bottom	0	0	0	200.8	-1.32	200.8	-1.32			22489.3	-148.103	22637.4		
6TH	WB	62.50	Top	0	0	0	452.84	-2.68	252.04	-1.36	15752.5	-85	22489.3	-148.103	22637.4		
6TH	WB		Bottom	0	0	0	452.84	-2.68	252.04	-1.36			73207.75	-448.37	73656.12		
5TH	WB	53.17	Top	0	0	0	627.56	-3.76	174.72	-1.08	9289.28	-57.42	73207.75	-448.37	73656.12		
5TH	WB		Bottom	0	0	0	627.56	-3.76	174.72	-1.08			143494.9	-869.182	144364.1		
4TH	WB	43.83	Top	0	0	0	781.08	-4.5	153.52	-0.74	6729.293	-32.4367	143494.9	-869.182	144364.1		
4TH	WB		Bottom	0	0	0	781.08	-4.5	153.52	-0.74			230976.4	-1373.45	232349.8		
3RD	WB	34.50	Top	0	0	0	922.74	-4.99	141.66	-0.49	4887.27	-16.905	230976.4	-1373.45	232349.8		
3RD	WB		Bottom	0	0	0	922.74	-4.99	141.66	-0.49			354623	-2042.31	356665.3		
2ND	WB	23.33	Top	0	0	0	1027.13	-5.9	104.39	-0.91	2435.767	-21.2333	354623	-2042.31	356665.3		
2ND	WB		Bottom	0	0	0	1027.13	-5.9	104.39	-0.91			518963.6	-2986.86	521950.5		
1ST	WB	10.00	Top	0	0	0	793.29	-7.11	-233.84	-1.21	-2338.4	-12.1	518963.6	-2986.86	521950.5	P =	0.15
1ST	WB		Bottom	0	0	0	793.29	-7.11	-233.84	-1.21			614157.9	-3840.58	617998.5	w_w =	1.5
																l_w =	21.5
											51179.84	-319.915	51499.76	= M_{over}	≤	M_r =	3735.558



		EX	EXT	EX	EXT	EX	EXT
Story	height	V2	V2	Fi	Fi	M_{over}	M_{over}
ROOF	71.83	669	0.01	669	0.01	48056.5	0.718333
6TH	62.50	1261.99	-0.01	592.99	-0.02	37061.88	-1.25
5TH	53.17	1766.99	-0.01	505	0	26849.17	0
4TH	43.83	2183.98	0	416.99	0.01	18278.06	0.438333
3RD	34.50	2533.99	0	350.01	-1.6E-15	12075.35	-5.3E-14
2ND	23.33	2789.99	0.01	256	0.01	5973.333	0.233333
1ST	10.00	2888	-0.01	98.01	-0.02	980.1	-0.2
Total						149274.4	-0.06



0	0	EX	EXT	EX	EXT	EX	EXT
Story	height	V2	V2	Fi	Fi	M_{over}	M_{over}
ROOF	71.83333	669	3.55E-15	669	3.55E-15	48056.5	-4.5E-13
6TH	62.5	1262	-7.1E-15	593	-3.6E-15	37062.5	-2.3E-13
5TH	53.16667	1766.99	0	504.99	1.07E-14	26848.64	6.82E-13
4TH	43.83333	2184	-0.01	417.01	-0.01	18278.94	-0.43833
3RD	34.5	2534	0	350	0.01	12075	0.345
2ND	23.33333	2790.01	-0.01	256.01	-0.01	5973.567	-0.23333
1ST	10	2887.99	0.01	97.98	0.02	979.8	0.2
Total						149274.9	-0.12667

				EY	EYT	Total	EY	EYT	EX	EXT	EX	EXT	EY	EYT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	W1	71.83	Top	-3.69	1	4.69	221.92	-37.61	221.92	-37.61	15941.25	-2701.65	-3495.94	614.729	4110.666		
ROOF	W1		Bottom	-4.21	2.98	7.19	221.92	-37.61	221.92	-37.61			6666.898	-1022.18	7689.074		
6TH	W1	62.50	Top	-8.56	4.35	12.91	371.38	-63.83	149.46	-26.22	9341.25	-1638.75	1466.116	-103.827	1569.943		
6TH	W1		Bottom	-26.16	10.31	36.47	371.38	-63.83	149.46	-26.22			16964.12	-2636.1	19600.22		
5TH	W1	53.17	Top	-30.18	11.99	42.17	486.16	-85.52	114.78	-21.69	6102.47	-1153.19	9453.743	-1285.68	10739.43		
5TH	W1		Bottom	-44.82	19.46	64.28	486.16	-85.52	114.78	-21.69			30242.27	-4732.16	34974.43		
4TH	W1	43.83	Top	-48.31	21.52	69.83	580.39	-104.24	94.23	-18.72	4130.415	-820.56	20985.45	-3024.35	24009.8		
4TH	W1		Bottom	-61.91	30.4	92.31	580.39	-104.24	94.23	-18.72			46073.58	-7249.99	53323.57		
3RD	W1	34.50	Top	-64.94	32.76	97.7	656.41	-120.73	76.02	-16.49	2622.69	-568.905	35487.05	-5248.85	40735.89		
3RD	W1		Bottom	-73.13	44.06	117.19	656.41	-120.73	76.02	-16.49			67841.8	-10786.9	78628.74		
2ND	W1	23.33	Top	-74.26	46.56	120.82	657.85	-125.8	1.44	-5.07	33.6	-118.3	56622.17	-8593.6	65215.77		
2ND	W1		Bottom	-72.36	61.96	134.32	657.85	-125.8	1.44	-5.07			94671.54	-15276.4	109947.9		
1ST	W1	10.00	Top	-70.25	64.97	135.22	595.19	-115.25	-62.66	10.55	-626.6	105.5	84173.21	-13136	97309.2	P =	0.15
1ST	W1		Bottom	-51.65	75.89	127.54	595.19	-115.25	-62.66	10.55			117485.7	-18984.2	136469.9	w_w =	1.5
																l_w =	17.83333
											37545.08	-6895.85	44440.93	=M_{over}	≤	M_r =	2570.062

				EY	EYT	Total	EY	EYT	EX	EXT	EX	EXT	EY	EYT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	W2	71.83	Top	6.12	-1.63	7.75	-11.65	5	-11.65	5	-836.858	359.1667	495.827	-132.091	627.918		
ROOF	W2		Bottom	31.41	-8.25	39.66	-11.65	5	-11.65	5			1240.226	-107.841	1348.067		
6TH	W2	62.50	Top	39.67	-10.48	50.15	-5.05	5.8	6.6	0.8	412.5	50	1908.975	-288.276	2197.251		
6TH	W2		Bottom	77.36	-20.86	98.22	-5.05	5.8	6.6	0.8			4396.311	-479.434	4875.745		
5TH	W2	53.17	Top	86.19	-23.65	109.84	16.62	4.21	21.67	-1.59	1152.122	-84.535	5111.507	-705.583	5817.09		
5TH	W2		Bottom	120.52	-35.71	156.23	16.62	4.21	21.67	-1.59			9754.399	-1210.29	10964.68		
4TH	W2	43.83	Top	128.58	-38.91	167.49	32.11	3.64	15.49	-0.57	678.9783	-24.985	10406.99	-1469.74	11876.73		
4TH	W2		Bottom	160.94	-52.64	213.58	32.11	3.64	15.49	-0.57			16624.23	-2174.2	18798.43		
3RD	W2	34.50	Top	168.42	-56.2	224.62	43.95	3.42	11.84	-0.22	408.48	-7.59	17229.78	-2462.98	19692.76		
3RD	W2		Bottom	204.55	-74.75	279.3	43.95	3.42	11.84	-0.22			26046.48	-3507.05	29553.52		
2ND	W2	23.33	Top	207.58	-77.98	285.56	92.6	-4.5	48.65	-7.92	1135.167	-184.8	26292.17	-3768.25	30060.42		
2ND	W2		Bottom	203.07	-94.62	297.69	92.6	-4.5	48.65	-7.92			40742.1	-5836.96	46579.06		
1ST	W2	10.00	Top	190.14	-95.78	285.92	212.41	-25.13	119.81	-20.63	1198.1	-206.3	39695.23	-5930.46	45625.68	P =	0.15
1ST	W2		Bottom	106.85	-95.59	202.44	212.41	-25.13	119.81	-20.63			58438.16	-8931.43	67369.59	w_w =	1.5
																l_w =	13.5
											4148.488	-99.0433	4247.532	=M_{over}	≤	M_r =	1472.808

				EY	EYT	Total	EY	EYT	EX	EXT	EX	EXT	EY	EYT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	W6	71.83	Top	0	0	0	93.4	-5.02	93.4	-5.02	6709.233	-360.603	0	0	0		
ROOF	W6		Bottom	0	0	0	93.4	-5.02	93.4	-5.02			10460.27	-561.807	11022.08		
6TH	W6	62.50	Top	0	0	0	229.28	-15.21	135.88	-10.19	8492.5	-636.875	10460.27	-561.807	11022.08		
6TH	W6		Bottom	0	0	0	229.28	-15.21	135.88	-10.19			36139.16	-2265.67	38404.83		
5TH	W6	53.17	Top	0	0	0	343.57	-22.41	114.29	-7.2	6076.418	-382.8	36139.16	-2265.67	38404.83		
5TH	W6		Bottom	0	0	0	343.57	-22.41	114.29	-7.2			74619.38	-4775.96	79395.34		
4TH	W6	43.83	Top	0	0	0	439.88	-28.59	96.31	-6.18	4221.588	-270.89	74619.38	-4775.96	79395.34		
4TH	W6		Bottom	0	0	0	439.88	-28.59	96.31	-6.18			123886.5	-7977.85	131864.3		
3RD	W6	34.50	Top	0	0	0	528.34	-33.82	88.46	-5.23	3051.87	-180.435	123886.5	-7977.85	131864.3		
3RD	W6		Bottom	0	0	0	528.34	-33.82	88.46	-5.23			194683.9	-12510.3	207194.1		
2ND	W6	23.33	Top	0	0	0	619.62	-38.41	91.28	-4.59	2129.867	-107.1	194683.9	-12510.3	207194.1		
2ND	W6		Bottom	0	0	0	619.62	-38.41	91.28	-4.59			293823	-18655.1	312478.1		
1ST	W6	10.00	Top	0	0	0	613.81	-31.1	-5.81	7.31	-58.1	73.1	293823	-18655.1	312478.1	P =	0.15
1ST	W6		Bottom	0	0	0	613.81	-31.1	-5.81	7.31			367480	-22387	389867.1	w_w =	1.5
																l_w =	26.5
											30623.38	-1865.6	32488.98	=M_{over}	≤	M_r =	5675.058

				EY	EYT	Total	EY	EYT	EX	EXT	EX	EXT	EY	EYT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	W12	71.83	Top	-0.43	0.18	0.61	142.12	9.01	142.12	9.01	10208.95	647.2183	-3145.54	-201.157	3346.695		
ROOF	W12		Bottom	-3.04	1.19	4.23	142.12	9.01	142.12	9.01			4991.485	302.464	5293.949		
6TH	W12	62.50	Top	-4.09	1.48	5.57	249.95	16.26	107.83	7.25	6739.375	453.125	1849.551	93.977	1943.528		
6TH	W12		Bottom	-9.35	2.67	12.02	249.95	16.26	107.83	7.25			13808.06	845.205	14653.27		
5TH	W12	53.17	Top	-10.55	3.03	13.58	361.57	25.35	111.62	9.09	5934.463	483.285	8861.194	498.18	9359.374		
5TH	W12		Bottom	-14.45	4.69	19.14	361.57	25.35	111.62	9.09			25981.12	1649.867	27630.99		
4TH	W12	43.83	Top	-15.42	5.15	20.57	458.2	33.33	96.63	7.98	4235.615	349.79	19334.2	1159.572	20493.77		
4TH	W12		Bottom	-19.08	7.08	26.16	458.2	33.33	96.63	7.98			41062.25	2677.595	43739.84		
3RD	W12	34.50	Top	-19.94	7.57	27.51	544.01	41.31	85.81	7.98	2960.445	275.31	32981.4	2058.15	35039.55		
3RD	W12		Bottom	-23.54	9.84	33.38	544.01	41.31	85.81	7.98			62040.23	4178.871	66219.1		
2ND	W12	23.33	Top	-23.99	10.23	34.22	622.83	51.06	78.82	9.75	1839.133	227.5	52461.41	3400.853	55862.26		
2ND	W12		Bottom	-24.02	12.29	36.31	622.83	51.06	78.82	9.75			90450.87	6387.347	96838.21		
1ST	W12	10.00	Top	-22.61	12.98	35.59	695.94	60.4	73.11	9.34	731.1	93.4	79750.42	5438.714	85189.13	P =	0.15
1ST	W12		Bottom	-12.54	16.37	28.91	695.94	60.4	73.11	9.34			117932.5	8519.475	126451.9	w_w =	1.5
																l_w =	18
											32649.09	2529.628	35178.71	= M_{over}	≤	M_r =	2618.325

				EY	EYT	Total	EY	EYT	EX	EXT	EX	EXT	EY	EYT	Total		
Story	Pier	height	Loc	P	P	P	V2	V2	Fi	Fi	M_{over}	M_{over}	M3	M3	M3		
ROOF	W15	71.83	Top	0.56	-0.23	0.79	223.21	28.62	223.21	28.62	16033.92	2055.87	-6604.58	-848.101	7452.676		
ROOF	W15		Bottom	3.74	-1.36	5.1	223.21	28.62	223.21	28.62			5985.775	782.334	6768.109		
6TH	W15	62.50	Top	4.93	-1.73	6.66	416.44	56.98	193.23	28.36	12076.88	1772.5	623.855	65.766	689.621		
6TH	W15		Bottom	10.8	-3.35	14.15	416.44	56.98	193.23	28.36			18081.94	2489.114	20571.06		
5TH	W15	53.17	Top	12.14	-3.85	15.99	559.07	78.37	142.63	21.39	7583.162	1137.235	9493.794	1311.767	10805.56		
5TH	W15		Bottom	16.65	-6.07	22.72	559.07	78.37	142.63	21.39			32615.44	4626.785	37242.22		
4TH	W15	43.83	Top	17.77	-6.7	24.47	673.42	95.85	114.35	17.48	5012.342	766.2067	21704.6	3105.679	24810.27		
4TH	W15		Bottom	22.08	-9.28	31.36	673.42	95.85	114.35	17.48			49592.59	7171.558	56764.15		
3RD	W15	34.50	Top	23.06	-9.96	33.02	761.29	109.82	87.87	13.97	3031.515	481.965	36999.42	5390.595	42390.02		
3RD	W15		Bottom	27.13	-13.19	40.32	761.29	109.82	87.87	13.97			72025.06	10578.84	82603.91		
2ND	W15	23.33	Top	27.75	-13.77	41.52	797.11	117.64	35.82	7.82	835.8	182.4667	58124.01	8579.436	66703.45		
2ND	W15		Bottom	28.1	-17.15	45.25	797.11	117.64	35.82	7.82			99580.92	14884.84	114465.8		
1ST	W15	10.00	Top	26.42	-18.18	44.6	770.64	111.09	-26.47	-6.55	-264.7	-65.5	85670.9	12921.1	98591.99	P =	0.15
1ST	W15		Bottom	14.42	-23.11	37.53	770.64	111.09	-26.47	-6.55			123116.9	18645	141761.9	w_w =	1.5
																l_w =	21.75
											44308.91	6330.743	50639.66	= M_{over}	≤	M_r =	3822.936