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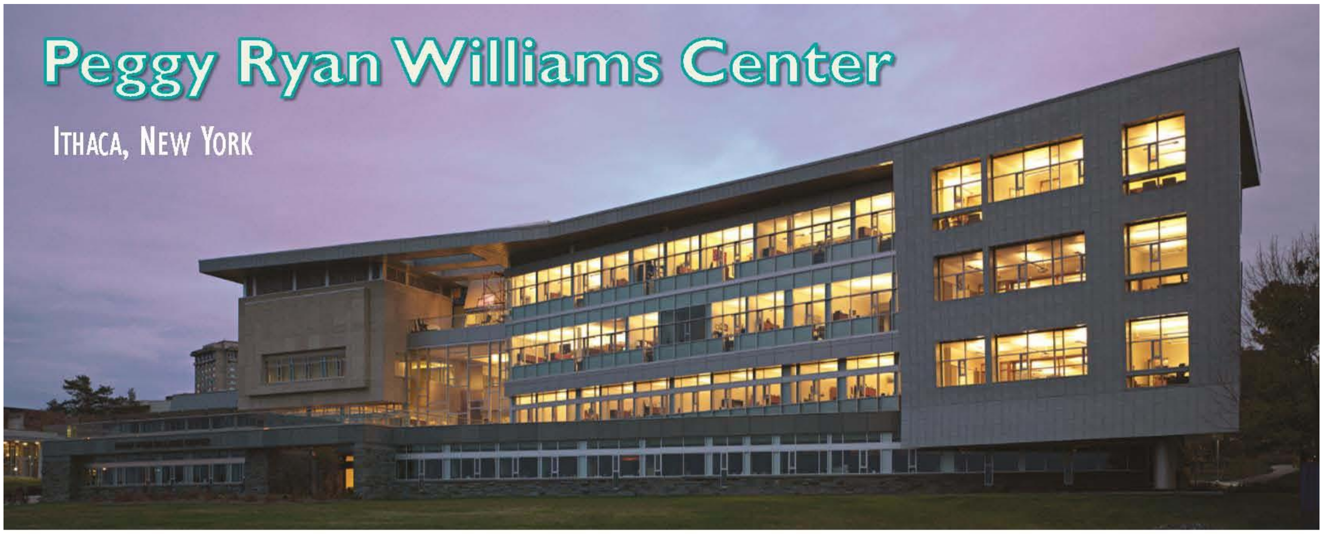
Structural Option
Advisor: Dr. Boothby
Peggy Ryan Williams Center
Ithaca, New York
9 April 2014

Peggy Ryan Williams Center

Final Report



Primary Project Team:

Owner | Ithaca College
Architect | Holt Architects
Structural Engineer | Ryan-Biggs Associates
Mechanical & Electrical Engineer | Delta Engineers
General Contractor | Christa Construction

General Building Data:

Building Occupant | Ithaca College
Occupancy | Office Use
Size | 58,200 gross square feet
Stories | 4 stories above grade
Substantial Completion | March 2010
Cost of Construction | approx. $19.3 million
Project Delivery Method | Design-Bid-Build

Architecture:

- Various aspects were driven by desire to be eco-friendly
- Large areas of glass provide views of Cayuga Lake
- Façade consists of zinc panels, blue stone veneer, composite aluminum panels, and limestone panels
- Pedestrian bridge connects PRWC to adjacent building

Structure:

- *Foundation*
  - Slab-on-grade, foundation walls, footings, various grade beams, piers and drilled piers
- *Framing System*
  - All floors are composed of composite steel decking
  - Steel framing consists of wide flange beams, girders, and columns
- *Lateral System*
  - Concentrically braced structural steel frames in both the North-South and East-West directions

Sustainability:

- Awarded LEED Platinum
- "V" shaped roof aids in rain water collection
- Day lighting made possible by large areas of glass
- Intensive Green Roof
- Atrium promotes natural ventilation

MEP:

- *Mechanical*
  - Main heating and cooling source is geothermal via a closed loop system adjacent to the building
  - Two dedicated outdoor air units (DOA) will utilize water to water heat pumps
- *Electrical*
  - Primary Service: 12.5 KV primary fused switches, 500 KVA transformer, 480/277 Volt Distribution Switchboard
  - Secondary Distribution: 150 KVA, 480V to 120/208 Volt transformer and (1) 120/208 Volt Main power panel
- *Plumbing*
  - Collect and store rainwater for gray water use
  - (3) rainwater collections tanks

Angela Mincemoyer | Structural | http://www.engr.psu.edu/ae/thesis/portfolios/2014/ahm5066/index.html

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Executive Summary

The Peggy Ryan Williams Center houses Ithaca College's admissions staff as well as numerous administrative offices at its location in Ithaca, New York. The building is an important feature of the college because it was intended to show its occupants and visitors that Ithaca College was moving forward and working to be more sustainable with their designs. Many of the architectural features of the building were influenced by the desire to be more "green" and to allow its occupants to view the nature around them. The existing building is a composite steel design with concentrically braced structural steel frames.

The following report consists of two main parts, the existing system and the redesigned system of the PRWC. The first section of the report explains some of the architectural and structural aspects of the building. The second portion of the report contains the details of the redesign of the existing steel building into a reinforced concrete building. In addition to presenting the existing and redesigned building, the pedestrian bridge, which is attached to the building, is also explained in detail. The bridge connects the PRWC to the adjacent Dillingham Center.

The first part of the redesign consisted of redesigning the gravity system of the building. One of the reasons that steel was originally chosen for the building material was due to a need to expedite the project schedule. However, a scenario was created in which the schedule was no longer critical. Therefore, the PRWC was redesigned using reinforced concrete. It was determined to complete the redesign using a one way concrete slab system with pan joists, girders, and columns. By using joists, the slab would only be required to span the small distance between the joists, thus allowing for a smaller slab depth. Therefore, it was hoped to decrease the original floor system depth. By orienting the joists along the existing steel beam span and then placing the concrete girders where the existing steel girders are located, the column locations would not need to be changed, thus the impact on the architecture would be low. By redesigning the building using concrete, the steel braced frames were no longer the best option. Since the building is only four stories, there was potential that the building's gravity system would double as its lateral system.

In addition to the redesign of the main building, a portion of the pedestrian bridge was also redesigned. Two inspirational concepts were considered for the redesign, a reflection on the building's original name, "The Gateway Building," and a reflection of New York's historical covered bridges. Upon choosing an inspiration to use for the redesign, one of the side trusses of the bridge was redesigned. This structural redesign led to both an architectural breadth on the façade of the pedestrian bridge and a lighting breadth of the exterior of the bridge.

Through the redesign, the floor system depth was decreased by changing the building material to concrete. This helped to open up the interior spaces and allow for a larger floor to ceiling height. The number of columns and girders in the building was decreased, which allowed for a more open floor plan. Finally, it was determined that the gravity system of the building was adequate to act as both the gravity system and the lateral system of the building.

Acknowledgements

I would first like to thank Ithaca College for allowing me to study the Peggy Ryan Williams Center this year. I would also like to thank Ryan-Biggs Associates and Holt Architects for providing to me the necessary information to complete this project.

None of this work would have been possible without the entire PSU AE Faculty. Thank you all for passing some of your knowledge onto me. I would specifically like to thank Dr. Boothby for always helping me and guiding me in my college career and beyond.

Finally, tremendous thanks to all of my family and friends for supporting me and always being there for me these last 5 years. I could not have done all of this without you guys. Thank you!

Building Introduction

With the global push towards sustainability, the Ithaca College decided that it was important to show that their college was moving forward with the times, being eco-friendly, and wanting to incorporate their beautiful surroundings into the campus design. This led to a new era of architecture at Ithaca campus.

The Peggy Ryan Williams Center (PRWC) is a key aspect of fulfilling the new architectural objectives of the college because it is seen as a gateway. The occupants of this 58,200 square foot, 74 foot tall building include the college's admissions staff as well as numerous administrative offices. A typical floor plan may be viewed below in Figure 1. The building is also one of the first sights that visitors see upon arriving to the campus. Therefore, Ithaca College saw the building as a way to show perspective students, employees, and visitors that their college was moving forward to be more "green" and incorporate the surrounding nature.

The architecture of the building was also driven by a desire to allow its occupants to not only view the nature around them; but, also, to feel as if they are a part of it. These sensations were achieved by providing large areas of glass and designing a floor plan at angles other than 90 degrees. The irregular angles help to direct the occupants' eyes to the most appealing surroundings, such as the breath-taking view of the nearby Cayuga Lake. The resultant irregular floor plan may be seen on Figure 1 and Figure 2 below.

Another important feature of the PRWC is the pedestrian bridge, which may be viewed in Figure 3 below. The bridge allows its users to go between the PRWC and the adjacent Dillingham Center without going outdoors. A glass façade allows large amounts of light penetration while tying this façade feature to the main building.

LEED Platinum is the prestigious title that the Peggy Ryan Williams Center was awarded by USGBC. However, this achievement required years of planning and sustainability considerations. Most of the architectural appearance of the building was governed by sustainability. Some examples of sustainability include the main roof taking on a slight "V" shape as to help collect rain water, the atrium being designed to assist with natural ventilation, green roofs, geothermal heat wells, solar shading, and many large areas of glass to allow for day lighting.

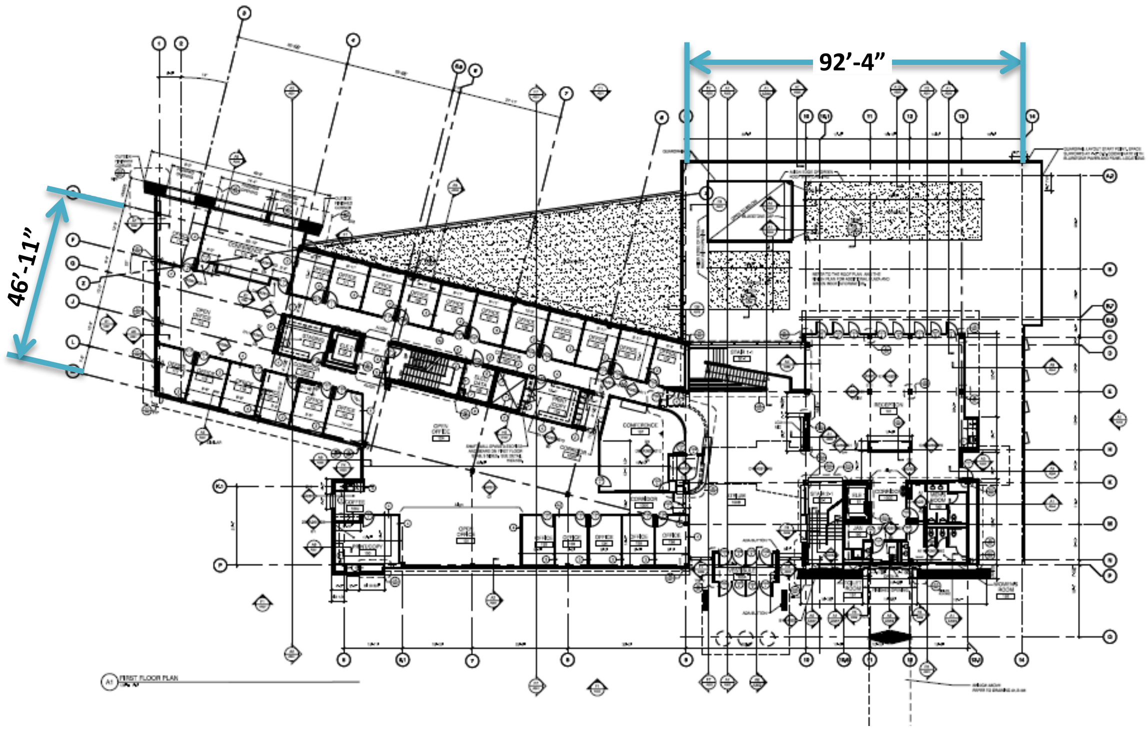


Figure 1: Typical Floor Plan (Level 1)
Drawing A101

Figure 2: View from the North Showing Irregular Facade of the PRWC
Photo provided courtesy of Holt Architects

Figure 3: View from the Southeast Showing the Pedestrian Bridge
Photo provided courtesy of Holt Architects

Structural Overview of the Building

The structural gravity system of the Peggy Ryan Williams Center consists of composite decking supported by wide flange beams, girders, and columns. The foundation consists of reinforced concrete grade beams and piers. The lateral system is comprised of concentrically braced structural steel frames. The following sections will discuss these components in detail, as well as material strengths.

Materials

The structural materials used throughout the PRWC are various strengths of steel and concrete. These material strengths may be viewed below in Table 1 and Table 2.

Steel Shape	Steel Grade
Rolled Steel W Shapes	ASTM A992 Grade 50
Rolled Steel C and MC Shapes	ASTM A36
Rolled Steel Plates, Bars, & Angles	ASTM A36
Hollow Structural Sections (HSS)	ASTM A500, Grade B or C
Pipe	ASTM A53, type E or S, Grade B
*For connections, provide higher grade as required for capacity.	

Table 1: Structural and Miscellaneous Steel Strengths (*Drawing S001*)

Concrete Component	Concrete Strength
Footings, Foundation Walls, Piers, Miscellaneous	f'c = 4,000 psi
Interior Slabs on Grade or Slabs on Deck	f'c = 3,500 psi
Retaining Walls, Basement Walls, Exterior Slabs, and Grade Beams	f'c = 4,000 psi
*Reinforcing Steel for Concrete → ASTM A615, Grade 60	

Table 2: Concrete Material Strengths (Drawing S001)

Geotechnical Report and Recommendations

Through their studies, the Geotechnical Engineer (CME Associates, Inc.) made numerous recommendations for the foundation of the Peggy Ryan Williams Center. On the north side, shale bedrock was found 15 feet below grade with unprepared fill on top. The bedrock stratum is underlain by silt. The 2002 Building Code of New York State (BCNYS) does not allow a foundation to bear on unprepared fill. Therefore, all foundations were required to bear on competent shale bedrock. The competent bedrock was presumed to have a soil bearing pressure of 20,000 psf. There is no need to drill into the exposed bedrock on the south side. In order to have competent bearing, CME Associates, Inc. recommends using drilled piers. This conclusion was drawn due to the variable depth to a competent bearing surface and the risks associated with large excavations close to groundwater. CME also recommended that all drilled piers should have a planned bottom elevation not less than 2'-6" below the top of the shale bedrock and a diameter not less than 2'-0". In regards to the drilled piers, the design and construction should follow ACI 336.3R.

Foundation System

The PRWC foundation includes a wide variety of structural components ranging from grade beams to drilled piers. The foundation walls themselves range from 1’-0” thick with 3’-0” wide footings to 1’-8.5” thick with 6’-0” wide footings. In areas where the footings cannot reach down to competent bedrock, drilled piers are used in combination with piers to reach bedrock. Most areas of the building on the Garden Level are provided with a 5” concrete slab-on-grade. This slab is depressed in areas where special flooring is used. In various portions of the building, grade beams are utilized to transfer the loads of bearing walls from above (stairwell and elevator shaft), braced frames, and to help tie back the column supporting the overhang in the north corner of the building. The grade beam sizes range from 12” wide and 36” deep to 51” wide and 48” deep.

Loads from the grade beams are then transferred to piers and in turn to the drilled piers in order to finally reach competent bedrock. The piers range in size and shape depending on the location. The loads from these piers are then transferred to the drilled piers. All of the drilled piers are 3’-0” in diameter. Pier depths range from simply resting on top of the bedrock to being drilled 4’-0” below the surface of the bedrock.

Gravity System

Floor System

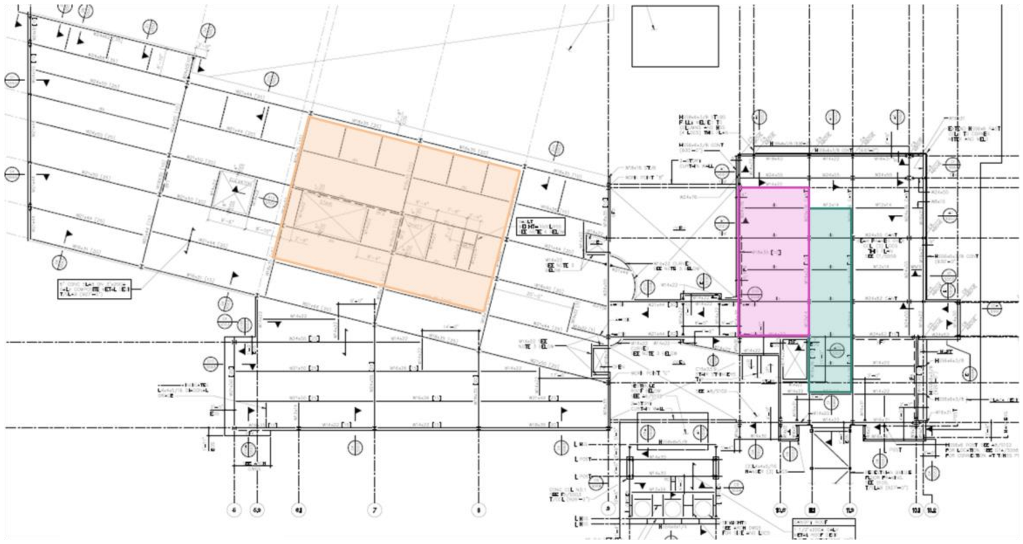
Each level of the PRWC has a 6” concrete slab on a 3”x20 gauge galvanized composite metal deck. However, a few areas have some deviation from this typical floor system. One example of this deviation occurs on the plaza deck and green roof areas. These areas have reinforcement in the deck system to lessen the effects of shrinkage and thermal contraction/expansion. Due to this slab being exposed to the weather, it is prone to the above thermal effects. The corrugations of each of the various types of decking run perpendicular to the wide-flange beams.

(Note: The Garden Level floor system (slab-on-grade) was discussed above in the foundation system section.)

Framing System

The structural framing system of the PRWC is very irregular due to changes in geometry, cantilevers, and locations of increased loads (such as adjacent to elevator shafts and stairwells). Levels 1 through 3 include numerous beam and girder sizes and spans. On those levels there are three different regions which utilize consistent beam shapes and sizes up through the levels. These regions may be viewed in Figure 4 below.

The vast majority of the columns from the foundation (Garden Level) continue up through the building. The columns range from W8x28 to W10x60, while some HSS5x5x5/16 are also present. Column type 2 (W10x49) is the most commonly used size throughout the superstructure of the building. On Level 1, various W10x39 columns were added along the southern perimeter of the building. These columns bear on the load bearing foundation. A few columns are also added to the cantilevered regions in upper levels of the building. These columns are typically W8x48 or W8x31. The column schedule may be viewed in Figure 5 below. These columns have a pinned connection at their base which allows no moment transfer to the pier below.



W12x14

W14x22

W18x35

Figure 4: Typical Bays for Levels 1 Through 3
Drawing S102

COLUMN SCHEDULE		
MARK	SIZE	BASE PLATE TYPE
C1	W10x60	BP1
C2	W10x49	BP1
C3	W10x39	BP2
C4	W8x48	C1/S559
C5	W8x31	C1/S559
C6	HSS5x5x5/16	BP6
C7	W8x28	BP3

NOTE:
BASE PLATE TYPES ARE TYPICAL FOR COLUMNS INDICATED IN SCHEDULE UNLESS NOTED OTHERWISE ON PLAN. SEE F1/S555 FOR BASE PLATE DETAILS.

Figure 5: Column Schedule
Drawing S555

Roof Gravity System

The roof system of the PRWC follows the same basic structural system of the floors below; decking, wide-flange beams, girders, and columns. However, the roof is not supported by a composite deck. Instead, since the roof does not support as large of a load, a much lighter 1.5"x20 gauge galvanized metal roof deck is used. The deck is then supported by wide flange steel beams and girders. A tapered HSS8x6x3/8 sits on top of the wide-flange girders along the perimeter of the building. The HSS is tapered to match the slope of the roof deck which it supports. A roof cantilever (5'-10") is formed from wide-flange beams spaced at 5'-3".

Typical Gravity Loads

The following loads, as seen in Table 3 and Table 4, were based on ASCE7-98 and industry standards.

Location	Typical Dead Load (psf)	Typical Live Load (psf)
Floor	87.5	80
Green Roof	171	100
Roof	43.2	35 (snow)

Table 3: Typical Dead and Live Loads

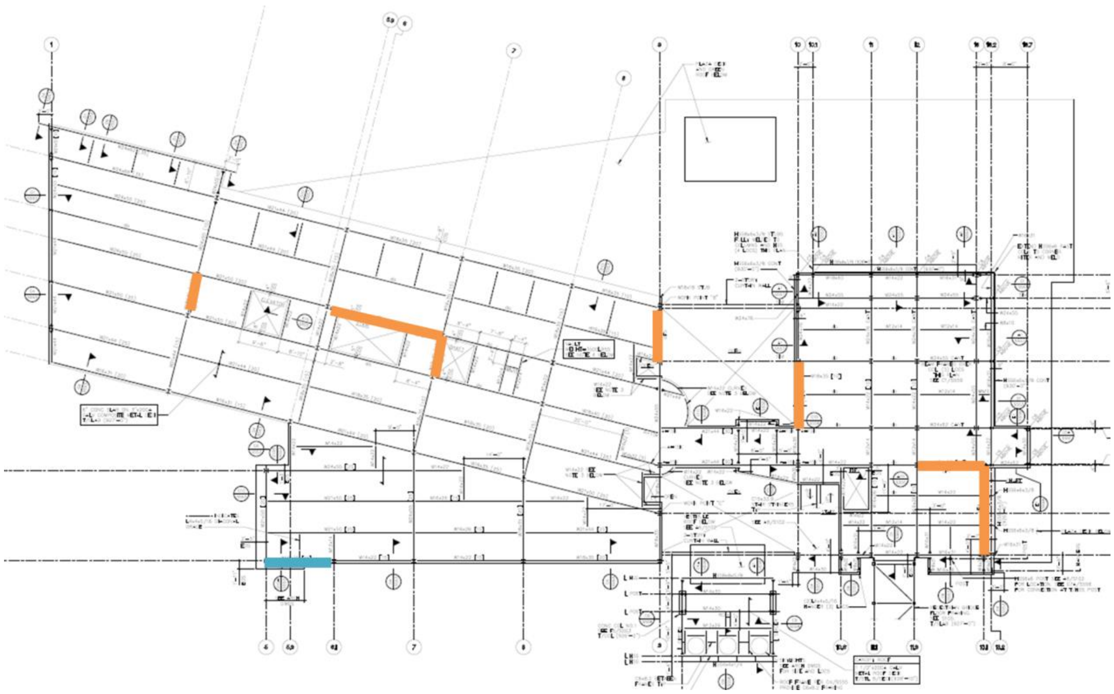
Exterior Wall Type	Typical Dead Load (psf)
Zinc Panel	13.9
Aluminum Storefront	12.0
Composit Aluminum Panel	12.9
Limestone Panel	28.0
Blue Stone Veneer	176.5

Table 4: Exterior Wall Loads

Lateral System

In both the North-South and the East-West directions, concentrically braced structural steel frames resist the lateral load. The braced frames are located throughout the building and may be seen on the plan below (Figure 6). Braced frame columns are typically W10s, while HSS6x6x3/8 are commonly used for the diagonal braces. A typical braced frame may be viewed below in Figure 7.

Various braced frames are provided in the north-south direction to resist the lateral loads. However, in the east-west direction, there is a lack of effective braced frames. In order to resist unbalanced loads there should be at least two (staggered) frames in each direction.



Braced Frame Extends from Garden Level to Roof

Braced Frame Extends from Level 1 to Level 3

Figure 6: Level 2 Braced Frame Layout
Drawing S102

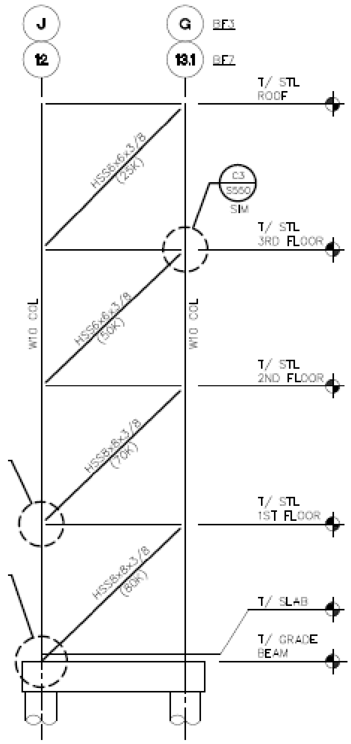


Figure 7: Typical Braced Frame
Drawing S550

Lateral Loads Summary

Note: The following lateral loads were calculated based on a simplified version of the PRWC, which only included the east end of the building.

Wind Loads

Wind loading was determined in accordance with ASCE7-98. Table 5 and Table 6 below show a summary of the wind forces in the North-South and the East-West directions. For the analysis, all four wind cases illustrated in ASCE7-98 Figure 6-9 were considered.

Diaphragm	Windward Pressure (psf)	Leeward Pressure (psf)
Level 1	7.73	-7.26
Level 2	9.18	-7.26
Level 3	10.17	-7.26
Roof	14.86	-10.51

Table 5: North-South Direction Wind Loads

Diaphragm	Windward Pressure (psf)	Leeward Pressure (psf)
Level 1	7.72	-4.29
Level 2	9.31	-4.29
Level 3	10.39	-4.29
Roof	15.05	-7.50

Table 6: East-West Direction Wind Loads

Seismic Loads

Four seismic load cases were used to calculate the applied seismic forces. Two of these load cases were in the North-South direction, accounting for positive and negative accidental torsion, and two were in the East-West direction, accounting for accidental torsion in that direction. The seismic loads may be seen below in Table 7 and Table 8.

Diaphragm	Story Force (kips)	Adjustment	Adj Story Force (kips)	Story Shear (V_i) (kips)	Bx (ft)	5% Bx (ft)	Ax	Mz (ft-kip)
Level 1	25.77	0.53	13.62	13.62	98.00	4.9	1.0	66.8
Level 2	15.42	0.35	5.45	19.07	88.00	4.4	1.0	24.0
Level 3	18.49	0.41	7.50	26.57	79.50	3.975	1.0	29.9
Roof	8.79	0.40	3.49	30.07	83.50	4.175	1.0	14.6

Table 7: North-South Direction Seismic Loads

Diaphragm	Story Force (kips)	Adjustment	Adj Story Force (kips)	Story Shear (V_i) (kips)	By (ft)	5% By (ft)	Ax	Mz (ft-kip)
Level 1	25.77	0.53	13.62	13.62	113.00	5.65	1.0	77.0
Level 2	15.42	0.35	5.45	19.07	74.50	3.725	1.0	20.4
Level 3	18.49	0.41	7.50	26.57	75.50	3.775	1.0	28.4
Roof	8.79	0.40	3.49	30.07	80.00	4	1.0	14.0

Table 8: East-West Direction Seismic Loads

Structural Overview of the Pedestrian Bridge

A 100-foot long box truss pedestrian bridge connects the Peggy Ryan Williams Center to the adjacent Dillingham Center.

Foundation and Columns

The pedestrian bridge has a separate foundation system from that of the PRWC, in which its columns rest on a 5'-0"x13'-0"x1'-6" footing.

The columns take on a hexagonal shape, roughly 11'-0"x3'-6". They are constructed of concrete with #8 vertical reinforcement and various #4 rebar ties. Figure 8 below shows the bridge column detail.

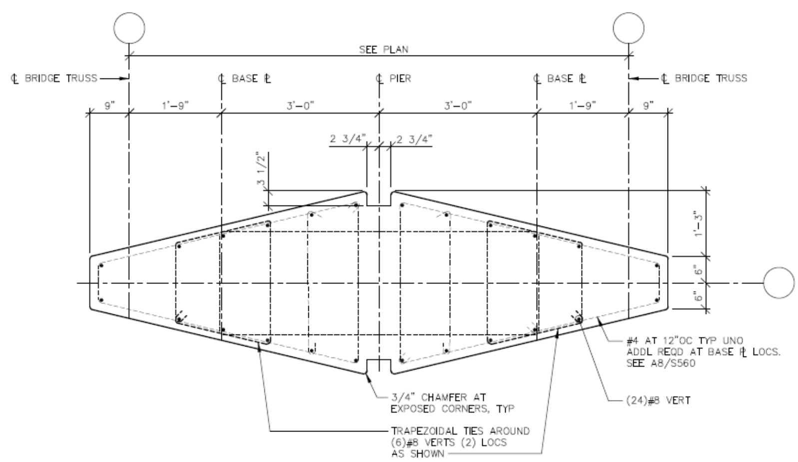


Figure 8: Bridge Column Detail
Drawing S560

Structural Framing

The pedestrian bridge is a box truss which is constructed using various hollow structural steel shapes and pipes. The top and bottom chords are both framed with HSS12x6x3/8 and the horizontal and diagonal braces are typically HSS4x4x1/4. The two side Pratt trusses have HSS5x5x5/16 vertical members and 3.5" pipe diagonal braces. There is a 2" expansion joint on either end of the bridge. This allows for expansion and contraction of the bridge due to variations in temperature. Figure 9 below shows the bridge truss schematic.

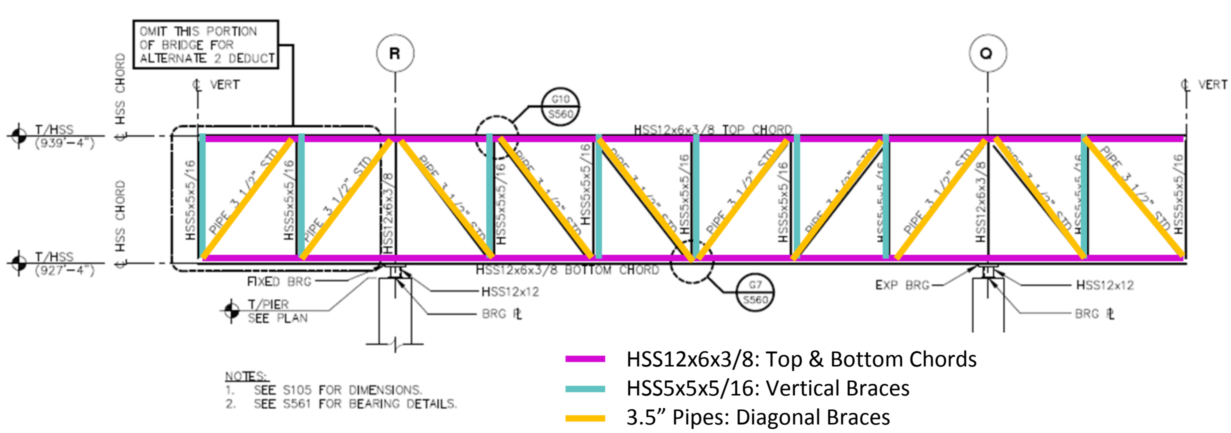


Figure 9: Bridge Truss Schematic
Drawing S560

Problem Statement

As previously stated, the steel structure of the Peggy Ryan Williams Center meets strength and serviceability requirements. The steel system was a good solution for dealing with the irregular geometry of the building and its floor openings. However, since a scenario has been created in which the schedule for the project is no longer critical, a reinforced concrete system may also prove to be a good design for the building. The concrete system would prove to be beneficial when it comes to the cantilevers since steel moment connections add significant cost to a project. A post-tensioned concrete slab design was explored in Technical Report 3. The system was found to be beneficial in terms of the floor system depth. However, the region of the building designed using that system had the building's longest spans. Therefore, when it is taken into account that the east end of the building contains much smaller spans, a post-tension slab is not the best solution. Instead, a one way concrete slab system with pan joists and girders will be designed. The pan joist system will better accommodate the varying spans. By changing the structural system to reinforced concrete, the lateral system will also need to be redesigned. Because the building is only four stories, the concrete gravity system may act as the lateral system.

The existing structure of the pedestrian bridge is a box truss comprised on Pratt trusses on either side. In order to create a learning opportunity, the bridge structure will be redesigned. As previously discussed, there are two options which will be considered for the bridge redesign. The first option is a reflection of New York's historical covered bridges, in particular that of the Newfield Bridge. The second option for the bridge redesign reflects on the original name of the building, "The Gateway Building" by mimicking the aesthetics of the Golden Gate Bridge.

Proposed Solution

Because the schedule is no longer critical, the structure of the building will be redesigned using reinforced concrete. For reasons previously stated, a one way concrete slab system with pan joists, girders, and columns will be designed. This system appears to be a good choice for the irregular geometry of the building because it lends itself to the varying bay sizes and the cantilevers. The various floor openings would also not cause problems with this system. A thinner slab can be used because it only needs to span the short distance between the pan joists. The pan joists will run in the direction of the existing beams of the structure. In turn, the girders will be located where the existing girders are located. This will minimize the architectural effects within the building due to columns' locations not changing. The floor system will first be designed through the use of computer programs such as spSlab and spBeam. Time permitting, the design will then be checked by hand. Because the building is only four stories, this gravity system may also work as the lateral system for the building. All structural framing members will be designed using ACI318-11.

In order to provide a learning opportunity, two different redesigns of the pedestrian bridge structure will be considered. Early on in the spring semester, sketches will be done to determine which redesign will best fit the existing site and its adjacent buildings. The first option is a reflection of New York's historical covered bridges, in particular that of the Newfield Bridge. For this redesign, the bridge supports will be moved closer to either building creating a longer span to give the illusion of the bridge only being supported by either building. A steel Warren truss will then be designed. The façade of the bridge will lend itself to an architectural breadth in which the façade will reflect on the covered bridge concept while incorporating some of the materials of the façade of the Peggy Ryan Williams Center. The second option for the bridge redesign reflects on the original name of the building, "The Gateway Building." This redesign will reflect upon the Golden Gate Bridge. Two towers (similar to those of the

Golden Gate Bridge) will be designed near the location of the existing two supports. A box truss will then be designed to be suspended from the towers. This option also lends itself to an architectural breadth. Both of these options allow for the consideration of a study of the exterior lighting systems.

Breadth Topics

Architectural Breadth – Bridge Façade Redesign

By changing the structure of the pedestrian bridge, an architectural breadth will need to be performed. If the covered bridge option is chosen, the roof of the bridge will mirror that of a traditional covered bridge. However, various façade materials will be considered which incorporate the materials of the nearby buildings, especially those of the Peggy Ryan Williams Center. The Warren truss will lend itself to large diamond shaped windows on the façade of the bridge. These windows will not only mirror the lattice truss of the Newfield Bridge; but, also, play off of the angles of the roof of the Peggy Ryan Williams Center. If the Golden Gate Bridge option is chosen, the façade of the bridge will most likely remain entirely glass. The appearance, placement, and materials of the towers will need to be taken into consideration. In order to explore these options, hand sketches will be completed. A Revit model of the chosen design will then be created and rendered.

Lighting Breadth – Exterior Lighting of the Bridge

In order to complement the structural redesign of the bridge and the architectural breadth, an exterior lighting breadth will be performed. Use of such techniques as wall washers will be investigated in order to create a modern façade that will complement its surroundings. Luminaires will then be selected. Revit and lighting software will be used to perform a rendering of the new lighting design.

Structural Depth

Gravity System of the Building

Through the use of concrete, numerous columns were able to be removed from the original design. The number of girders was also greatly reduced. The same depth was used throughout (24-½") the floor system for a more economical and constructible design. The original system depth was 30-⅛"; therefore, the floor system depth was decreased by 6-⅝" throughout the building. This allowed for a slightly larger floor-to-ceiling height, thus opening up the interior spaces of the Peggy Ryan Williams Center. Due to time constraints only the level one framing was designed; however, the framing layout was drafted for level 2, level 3, and the roof level. These layouts may be viewed in Appendix A.2: Framing Layouts.

Pan Joist System

Because the pan joist system determined the depth of the floor system used throughout the building, it was designed first. The design was completed though the use of the *Concrete Reinforcing Steel Institute Design Handbook 2008 (CRSI)*. In order to be economical, the same joist size and spacing was used throughout the entire floor system. That allowed for the reuse of formwork. As seen in Table 9 below, two locations were considered in determining the joist size and reinforcement. Those two locations were found to have the worst loading and span conditions. It should be noted that all of the joist load capacities provided in the *CRSI* table have previously been investigated for deflection. Also, due to the footnote at the bottom of the table, additional deflection calculations did not need to be completed. It was determined to use 30" forms with 6" ribs at 36" on center. The required rib depth was found to be 20" with a 4.5" top slab, thus producing a 24.5" total system depth. The 24.5" depth was then continued throughout the entire floor system of the building. Using concrete with a compressive strength equal to 4000 psi and steel with a yielding strength of 60000 psi, the required top reinforcement was #5 bars at 8" and the required bottom reinforcement was (1) #6 bar and (1) #7 bar per rib. Because the slab only spans the 30" between ribs, only minimum reinforcement was required. Therefore, in the direction perpendicular to the joist span, the slab utilizes #3 bars at 12". The pan joist system design may be viewed in Figure 10 below.

Location	Span (ft)	Live Load (psf)	Dead Load (psf)	Factored Loading (psf)	Top Reinf	Bottom Reinf
D3-D4	35	100	21	185.2	#5 @ 9"	#6 & #7 per rib
D4-D5	31.5	100	99	278.8	#5 @ 8"	#6 & #6 per rib

Table 9: Locations Considered for Pan Joist Design

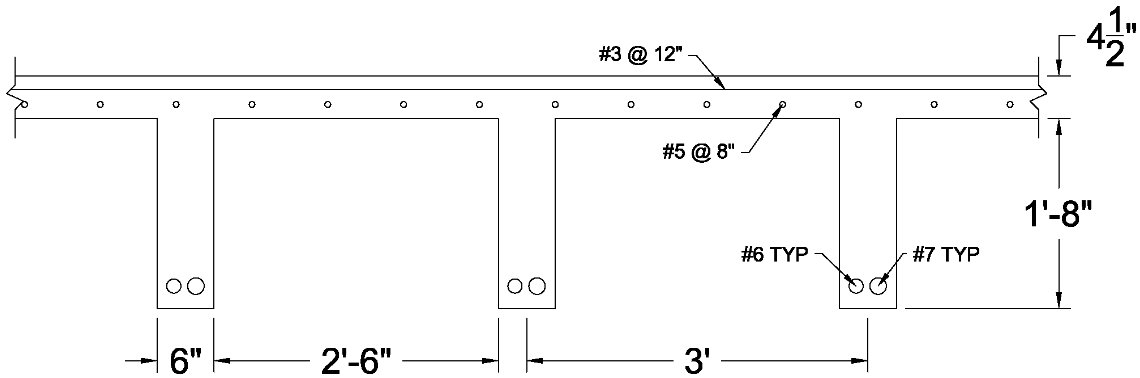


Figure 10: Pan Joist System Design

Girder Design

Three frames were chosen to be designed from the level one framing. Those frames were considered to be the most critical cases due to their long spans, large tributary widths, and high loadings. The girders were designed using spBeam. The predetermined dead and live loads were applied. An area load was also applied to account for the weight of the pan joists. Once the girders were designed for strength requirements, deflections were checked per ACI 318-11 Table 9.5b. The girder along column line 13 failed in deflection. In order to account for this, the width of the girder was increased slightly. The detailed designs for the girders along column lines 2, 8, and 13 may be viewed in Appendix A.3: Girder Designs. All of the stirrups are composed of two legs of their respective sizes, unless otherwise noted. The spBeam output is available in Appendix A.4: spBeam Output for Girders.

Beam Design

Beams were laid out along column lines D, F, and L in order to transfer the column loads from above back away from the cantilever and into the main structure of the building. The beam along column line D was designed due its large span. To be conservative in the design and not count on the dead load of the floor system to resist the uplift from the cantilever, the beam was designed with only considering the point load on the end of the cantilever and the member's own self weight. The assumed column loads from above first had to be carried down through the building and to the first level. This calculation was done using an excel sheet and may be viewed in Appendix A.5: Assumed Column Loads From Above. Once the beam was designed for strength requirements using spBeam, deflections were checked per ACI318-11 Table 9.5b. The cantilever failed in deflection. To provide better serviceability, compression reinforcement was added. Without the compression reinforcement, the beam would have needed to be over seven feet wide. The beam design may be viewed in Figure 11 below. Top reinforcement and stirrups were used in order to support the loaded cantilever. All of the stirrups are composed of two legs of their respective sizes. The spBeam output is available in Appendix A.6: spBeam Output.

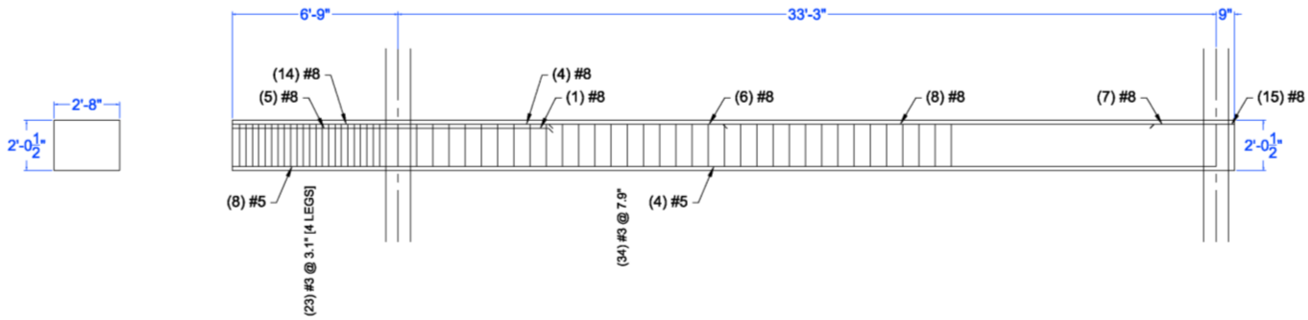


Figure 11: Beam Design for Column Line D

Column Design

The columns on column lines 2, 8, and 13 were designed using spColumn. The assumed loadings from above, as well as the loads from the floor system of level one, were applied to the level one columns. A Microsoft Excel sheet was utilized to determine the loads applied to each column, including both axial loads and moments. The Excel sheet may be viewed in Appendix A.7: Load to Apply to Level 1 Columns. A square section was chosen for the columns for ease of construction and to aid with the future lateral system design. Constructability was considered when designing the columns. The reinforcement was kept as #6, #8, and #10 bars. Equal spacing was also kept between bars. The column designs for frame 2 may be viewed below in Figure 12, while the remaining designed columns may be seen in Appendix A.8: Column Designs. The spColumn output is available in Appendix A.9: spColumn Output. For constructability, all column sizes were increased to be an 18" x 18" section. This increase in size is shown in the lateral system of the building.

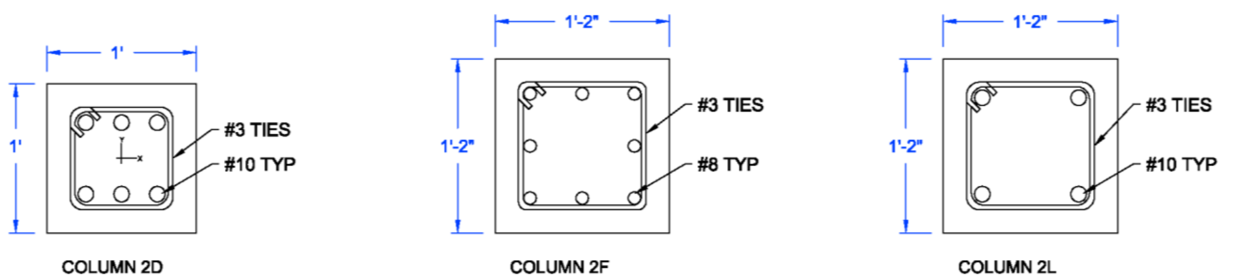


Figure 12: Column Designs for Column Line 2

Final Gravity Framing

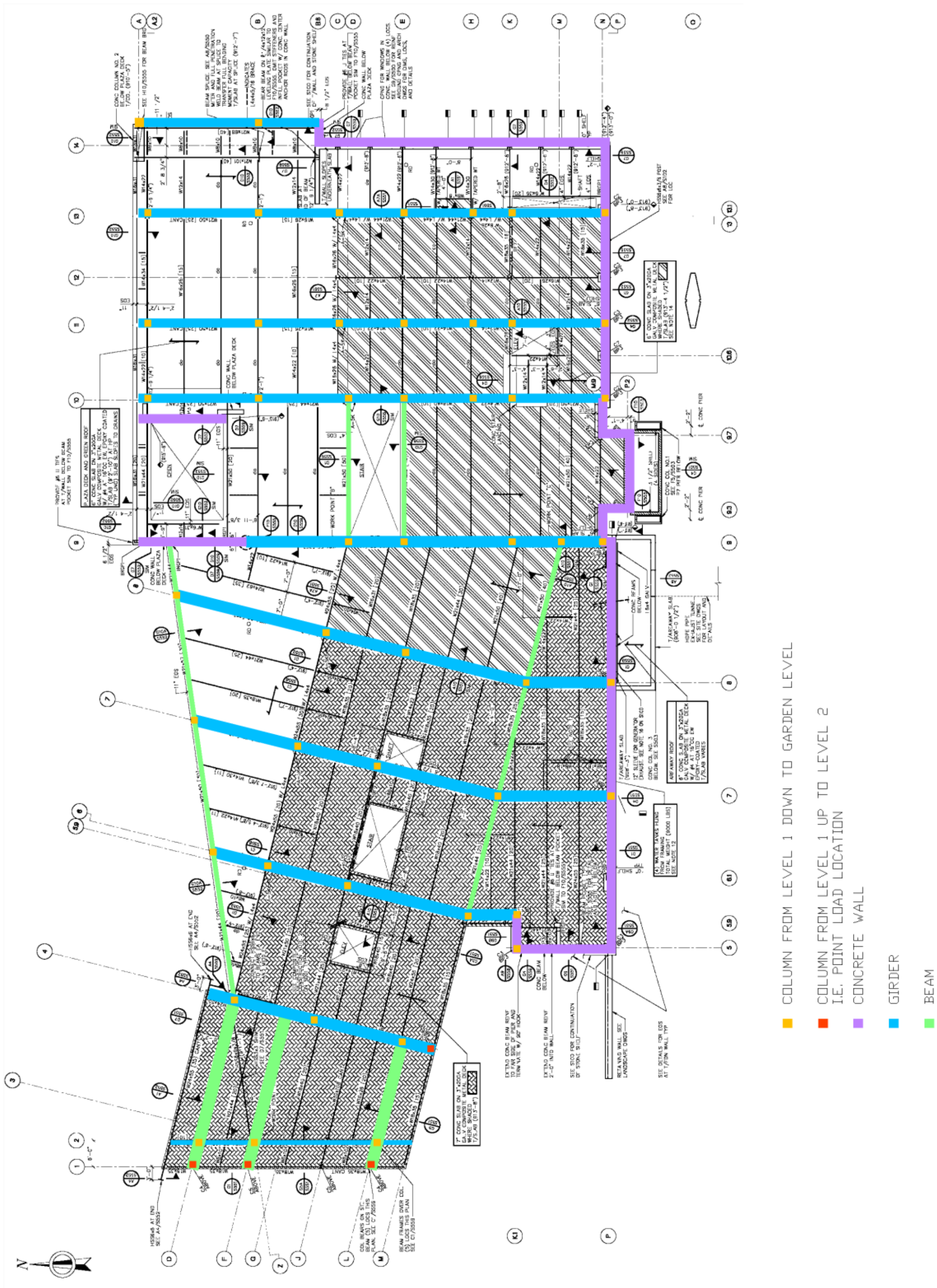


Figure 13: Gravity Framing for Level 1

Lateral System of the Building

The existing lateral system of the building consists of concentrically braced structural steel frames in both the North-South and East-West directions. By changing the building material to concrete, the braced steel frames were no longer the best option for the lateral system. As previously mentioned, since the building is only four stories, the gravity system had the potential to also perform as the lateral system for the building. The columns and girders would act as frames in the North-South direction and the columns and joists would act in the East-West direction. Therefore, every column line would essentially act as a lateral resisting frame. Once the gravity system for level one was designed, the system was then checked at level one for adequacy in resisting the lateral forces on the building. To allow for ease of analysis, only four concrete moment frames were considered in each the North-South and the East-West direction. It was determined that if these frames were found to be adequate to resist the lateral loads, then by allowing all of the frames of the building to help resist the load, the system would surely be adequate. The concrete moment frames considered are shown in red in Figure 14.

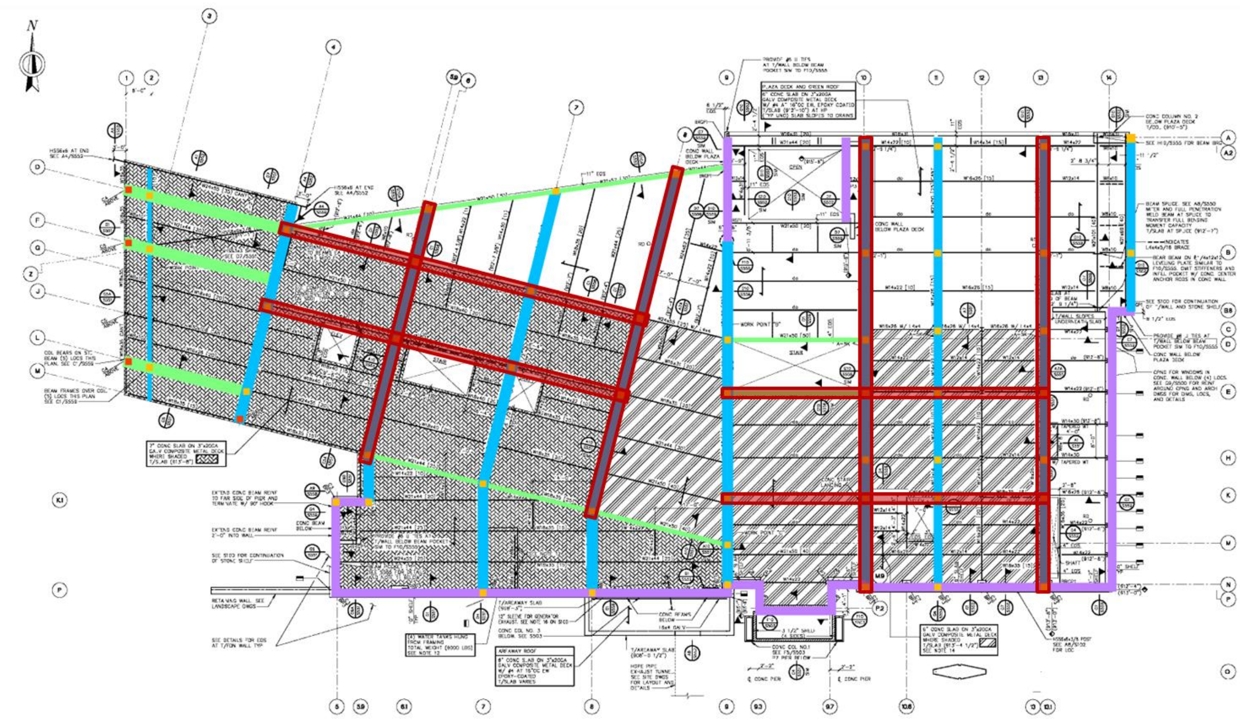


Figure 14: Framing for Level 1 Indicating the Frames Considered in Lateral Analysis

Lateral Load Determination

The existing lateral system of the building was governed by wind. However, since the building material was changed to concrete, both seismic and wind calculations needed to be completed to ensure that wind loads still controlled the design. ASCE7-10 was used to calculate the lateral loads. Because the building is Seismic Design Category A, the simplified procedure was able to be used, in which Fx = 0.01Wx. The wind loads were calculated using the Main Wind Force Resisting System (MWFRS) procedure. Through various hand calculations, which may be seen in Appendix B.1: Lateral Load Calculations, it was determined that wind loads still controlled the building's lateral system design. A summary of the seismic and wind loads may be seen below in Table 10, Table 11, and Table 12.

Seismic Load Base Shear			
	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Level 1	45.0	132.0	599.9
Level 2	29.0	87.0	773.5
Level 3	31.0	58.0	1240
Roof	27.0	27.0	1869.8
Total	132.0		4483.2

Table 10: Summary of Seismic Loads

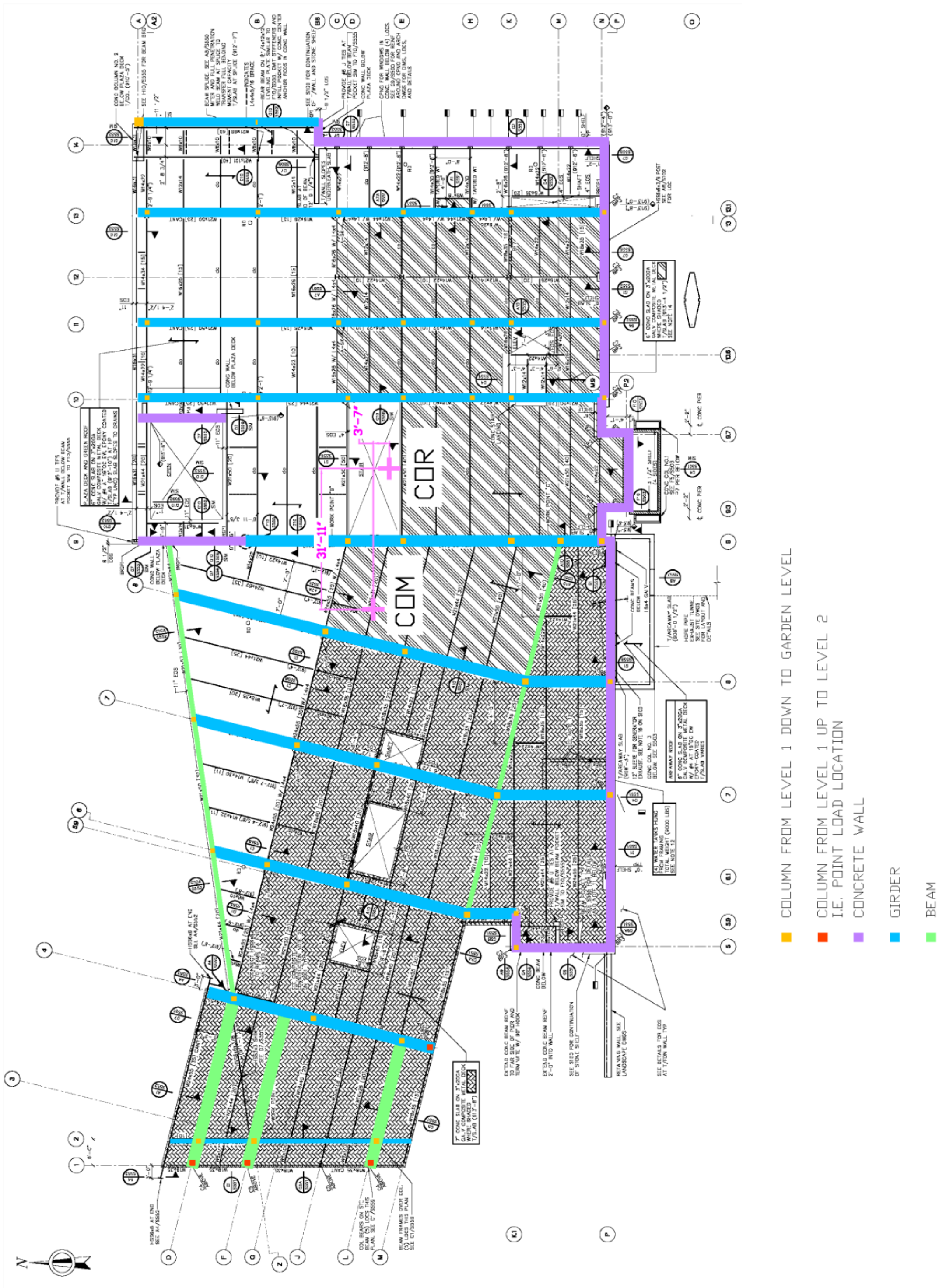
Wind Load Base Shear & Overturning Moment			
	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Garden Level	36.6	463.7	0.0
Level 1	73.2	427.0	976.4
Level 2	80.2	353.8	2139.8
Level 3	136.8	273.6	5471.3
Roof	136.8	136.8	9472.8
Total	463.7		18060.3

Table 11: Summary of Wind Loads in the North-South Direction

Wind Load Base Shear & Overturning Moment			
	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Garden Level	14.1	185.9	0.0
Level 1	28.1	171.9	374.5
Level 2	31.5	143.8	838.8
Level 3	54.4	112.3	2175.3
Roof	57.9	57.9	4011.7
Total	185.9		7400.3

Table 12: Summary of Wind Loads in the East-West Direction

Each of the frames being considered in the design were then modeled in RISA-2D. Through the use of member properties and by applying a 10 kip "dummy load" the stiffness of each frame was determined. Appendix B.2: Determination of Frame Stiffness's may be referenced for the stiffness calculations. Those stiffness's could then be used to calculate the center of rigidity of level one. Figure 15 below shows where the center of mass and center of rigidity are located on level 1. Detailed calculations of these centers may be seen in Appendix B.3: Center of Mass and Center of Rigidity.



Center of Rigidity		
Xr =	158.59	ft
Yr =	51.07	ft

Center of Mass	
X - Direction	126.7
Y - Direction	54.7

Figure 15: Center of Mass and Center of Rigidity of Level 1

Through the use of stiffnesses, the level one story shear was then distributed to each of the frames for all six wind load cases, including both positive and negative moments. Both direct shear and torsional shear were considered. Excel sheets containing these calculations are available in Appendix B.4: Wind Load Cases. Based on the total shear force, a worst load case was found for each frame. A summary of these results may be viewed in Table 13 below.

Determination of Worse Case on Each Frame

	Frame	WC 1: N-S	WC 1: E-W	WC 2: N-S + 0.15 By	WC 2: N-S - 0.15 By	WC 2: E-W + 0.15 Bx	WC 2: E-W - 0.15 Bx	WC 3: NS + EW	WC 4: (NS + 0.15By) + (EW + 0.15Bx)	WC 4: (NS + 0.15By) + (EW - 0.15Bx)	WC 4: (NS - 0.15By) + (EW + 0.15Bx)	WC 4: (NS - 0.15By) + (EW - 0.15Bx)	Worst Case Shear (kips)	Worst Case	Deflection Under Worst Case (in)
North-South	9	162.8	3.6	185.5	58.7	14.9	-9.5	124.8	150.4	132.1	55.3	36.9	185.5	WC 2: N-S + 0.15 By	0.58900
	8	112.7	1.4	109.6	59.4	5.9	-3.8	85.6	86.7	79.4	49.0	41.8	112.7	WC 1: N-S	0.37400
	10	125.1	-1.1	74.6	113.0	-4.5	2.9	93.0	52.6	58.2	81.5	87.0	125.1	WC 1: N-S	0.23900
	13	63.1	-3.9	-21.9	116.6	-16.3	10.4	44.4	-28.6	-8.6	75.3	95.3	116.6	WC 2: N-S - 0.15 By	0.22300
East-West	D	14.9	46.0	23.1	-0.9	36.8	32.2	45.6	45.0	41.5	27.0	23.5	46.0	WC 1: E-W	0.23900
	E	-2.0	48.7	-3.2	0.1	36.2	36.9	35.0	24.8	25.3	27.3	27.8	48.7	WC 1: E-W	0.21600
	G	4.1	45.5	6.4	-0.2	34.8	33.5	37.2	30.9	29.9	25.9	25.0	45.5	WC 1: E-W	0.23700
	K	-16.9	45.7	-26.3	1.0	31.6	36.9	21.6	4.0	7.9	24.5	28.4	45.7	WC 1: E-W	0.22800

Worst Deflection (North-South)	0.58900	inches
Worst Deflection (East-West)	0.23900	inches

Table 13: Determination of Worst Case Wind on Each Frame

Moment Frame Design

Using RISA, the worst case wind load for each frame was applied to their respective frames and their deflections were measured. The deflections may be seen in Table 13 above. Per ACI318-11, various columns were checked to see if they were sway or nonsway. In order to be conservative, when determining if the columns were sway, the worst case deflection was used for the story deflection. As seen in Table 14 below, all of the columns that were checked were found to be nonsway.

Sway vs. Nonsway							
Frame	Column	∑Pu (kip)	Δ (in)	V_{us} (kip)	L_c (in)	Q	Sway/ Nonsway
8	Z	168	0.589	463.7	160.0	0.0013	Nonsway
8	D	545	0.589	463.7	160.0	0.0043	Nonsway
8	G	580	0.589	463.7	160.0	0.0046	Nonsway
8	M	681	0.589	463.7	160.0	0.0054	Nonsway
8	P	247	0.589	463.7	160.0	0.0020	Nonsway
13	A.2	143	0.589	463.7	160.0	0.0011	Nonsway
13	B	250	0.589	463.7	160.0	0.0020	Nonsway
13	C	296	0.589	463.7	160.0	0.0023	Nonsway
13	E	256	0.589	463.7	160.0	0.0020	Nonsway
13	H	207	0.589	463.7	160.0	0.0016	Nonsway
13	K	290	0.589	463.7	160.0	0.0023	Nonsway
13	N	226	0.589	463.7	160.0	0.0018	Nonsway
D	8	545	0.239	185.9	160.0	0.0044	Nonsway
E	13	256	0.239	185.9	160.0	0.0021	Nonsway
G	8	580	0.239	185.9	160.0	0.0047	Nonsway
K	13	290	0.239	185.9	160.0	0.0023	Nonsway

NOTE: The deflections given above are based on the worst case deflection due to wind in the direction in which the frame acts.

Equation Used: $Q = \frac{\sum P_u * \Delta}{V_{us} * L_c} \leq 0.05 \rightarrow$ Nonsway

Table 14: Determination of Sway vs. Nonsway

The moments and axial forces on the columns, as a result of the worst case wind load being applied to their respective frames, were then taken into spColumn to complete the column designs. These reactions may be seen in Appendix B.5: Column Lateral Loadings to be Used in spColumn Analysis. Because RISA and spColumn do not use the same sign convention, the member forces provided by RISA were changed to match the sign convention used by spColumn. Because some of the axial forces in the columns were tension forces, which would counteract the gravity compressive forces, those tension forces were excluded from the spColumn analysis.

As previously mentioned, the gravity column sizes were all increased to 18" x 18" for constructability. This new size was used in the lateral system analysis. Because the columns were nonsway, slenderness did not need to be considered. The concrete was also cracked for the analysis. Each of the designed columns were checked for biaxial bending. This was particularly important since several of the designed columns participated in both a North-South frame and an East-West frame. However, the two reactions were not added. Since only one wind load case would occur at a time, the load cases were investigated separately. The final column designs may be seen in Figure 16 below. spColumn output is available in Appendix B.6: spColumn Output for Final Column Designs.

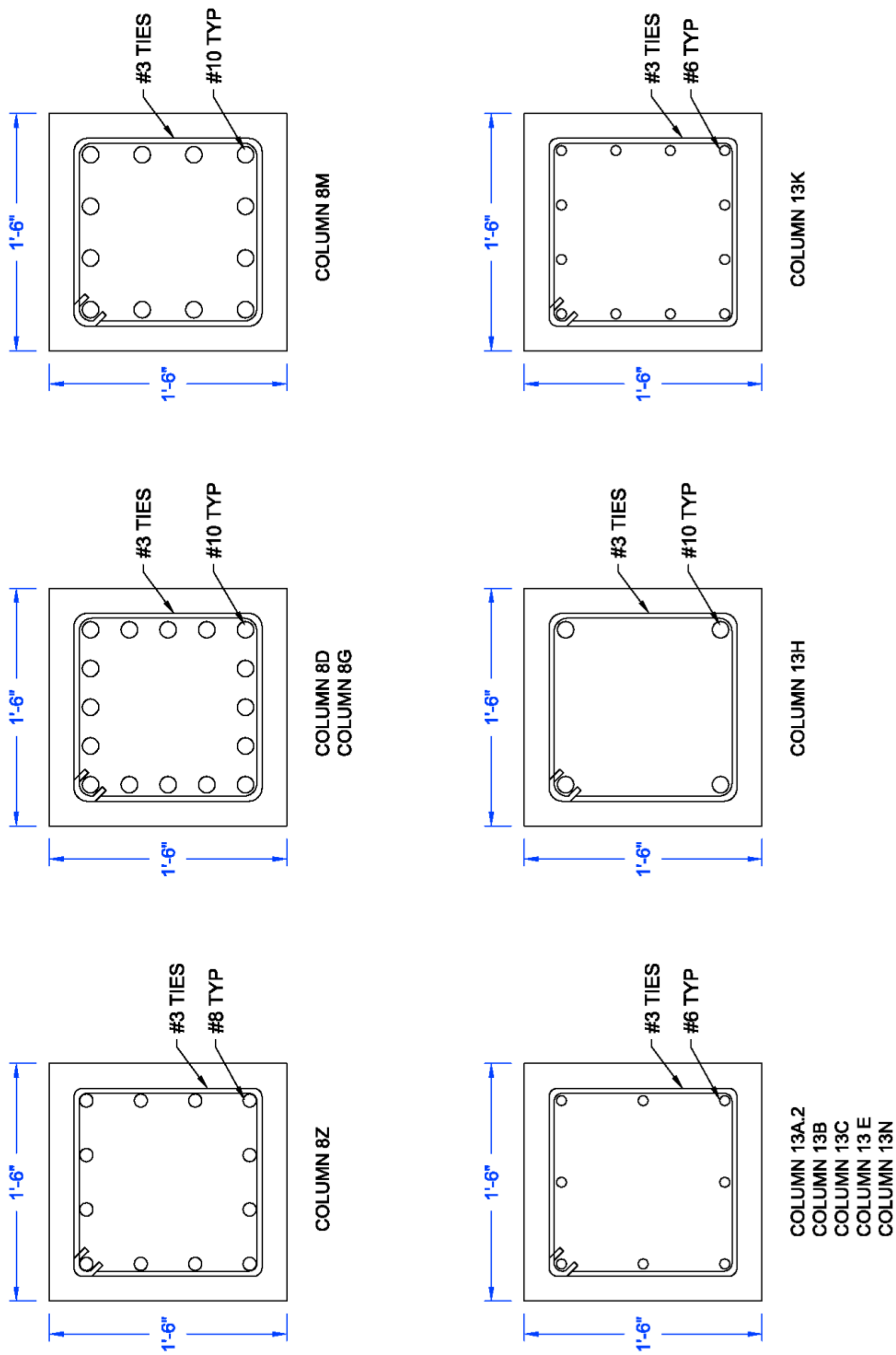


Figure 16: Final Column Designs

To ensure that the frames were adequate at resisting the lateral forces, a worst case girder and joist were checked for beam-column interaction. Through hand calculations, it was determined that both the joist and the girder were adequate. The interaction calculations may be viewed in Appendix B.7: Beam-Column Interaction Calculation.

In conclusion, the gravity system of the Peggy Ryan William Center also acts as the building's lateral system. The final gravity column size of 18" x 18" was used. The previously designed girders and joists were also found to be adequate in acting as the lateral system.

Gravity System of the Pedestrian Bridge

Early on in the semester, sketches were produced to determine if the bridge should play off of a historic covered bridge or the Golden Gate Bridge. Through reasoning that may be viewed in the Architectural Breadth, the covered bridge option was chosen. Therefore, the redesign consisted of a box truss similar to the existing configuration. However, the two bridge supports were moved out to open up the space and more closely mimic a covered bridge. A Warren truss was used in the design. This particular truss was chosen for architectural reasons. Because the gravity loads dictate the two side trusses, those two trusses were designed first.

Gravity Loads

Gravity Loads were first calculated which included dead loads, live loads, snow loads, and snow drift loads. These load calculations are available in Appendix C.1: Gravity Loads on the Bridge. A layout then had to be chosen for the truss before panel point loads could be determined. The chosen layout may be viewed below in Figure 17 below. Layouts were also developed for the top and bottom trusses. Their layouts were based on the side Warren Truss design. Extra members were also added in order to ensure that the panel point loads were transferring into the proper locations. These layouts may be viewed in Appendix D.1: Bridge Trusses.

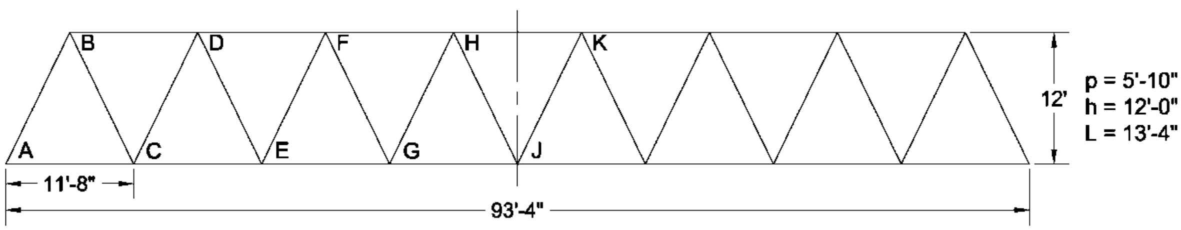


Figure 17: Truss Layout

Once the above layout was chosen, the panel point loads were calculated. The panel point load calculations may be viewed in Appendix C.2: Determination of Panel Point Loads and the final loads may be viewed in Appendix C.3: Panel Point Loads. Because the bridge must meet the requirements of ASCE7-10, the dead, live, and snow loads were kept separate so that load combinations could be considered. In the design of the two side trusses, only the gravity loads needed to be considered. The lateral loads would be taken by the top and bottom trusses, which will be designed time permitting. In considering gravity loads, only three different load combinations required consideration: 1.4 D; 1.2 D + 1.6 L + 0.5 S; and 1.2 D + 1.6 S + L. It was decided to factor the loads and then apply them to the truss. The loading conditions for these three load combinations are available in Appendix C.4: Panel Point Load Combinations. By factoring the loads first, it was determined that 1.4 D did not control the design.

Member Forces

Using the Indexing Method, the index for each member was then determined. The indices for the two different load combinations may be viewed in Appendix C.5: Member Indices. The indices, which are the vertical forces in the members, were then converted into axial forces through the use of geometry. The conversion may be seen in Appendix C.6: Conversion of Indices to Member Forces. The resultant forces may be viewed below in Figure 19 and Figure 20. A color coding key is available for reference in Figure 18 below.

Dead Loads
Live Loads
Snow Loads
Load Combination Loads
Index
Member Force

Figure 18: Color Coding Key

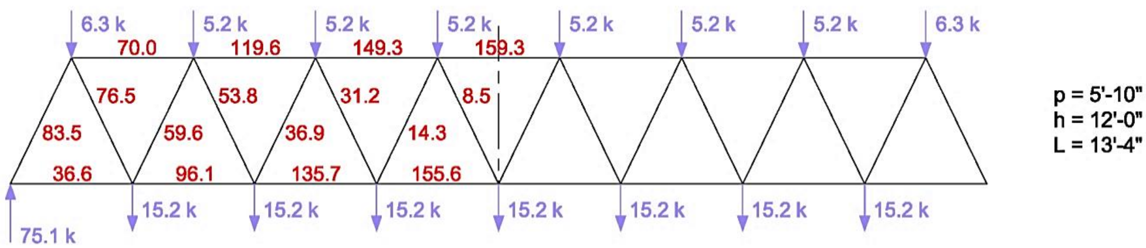


Figure 19: Member Forces for 1.2 D + 1.6 L + 0.5 S

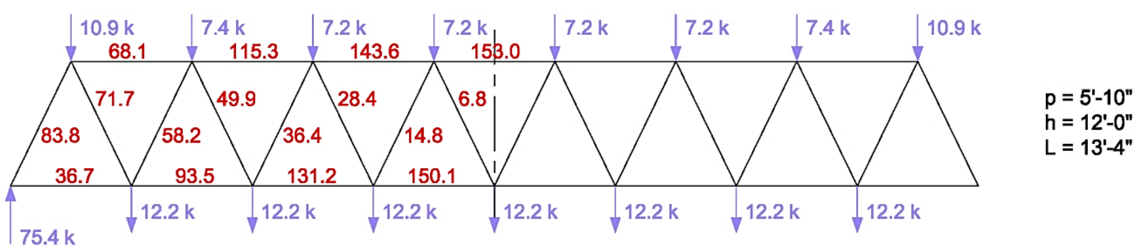


Figure 20: Member Forces for 1.2 D + 1.6 S + L

The member forces were then verified using the Method of Joints; those calculations may be viewed in Appendix C.7: Method of Joints. As seen below in Table 15, it was found that the Indexing Method is an accurate method of analysis.

Verify Forces for: 1.2 D + 1.6 L + 0.5 S			
Member	Indexing Method (k)	Method of Joints (k)	Variation (k)
AB	83.5	83.5	0.0
AC	36.5	36.6	-0.1
BC	76.5	76.5	0.0
BD	69.9	70.0	-0.1
CD	59.6	59.6	0.0
CE	96.0	96.1	-0.1
DE	53.8	53.8	0.0
DF	119.5	119.6	-0.1
EF	36.9	36.9	0.0
EG	135.6	135.7	-0.1
FG	31.1	31.2	-0.1
FH	149.2	149.3	-0.1
GH	14.2	14.3	-0.1
GJ	155.4	155.6	-0.2
HJ	8.4	8.5	-0.1
HK	159.1	159.3	-0.2

Table 15: Comparison Between the Indexing Method and the Method of Joints

Member Design

By loading all of the panel points (producing a uniform load), the worst case force in both the top and bottom chord was determined. Because the far left diagonal is a compression member, loading all of the panel points, also determined the worst case force in the diagonals. Since the top chord is a compression member, Table 4-4 of the Steel Manual was used to determine the size of the member. An HSS7x7x¼ was chosen for the top chord based on the worst axial force in the chord. For aesthetic purposes, the same size HSS was desired for the bottom chord. Using Table 5-5 of the Steel Manual, which is for the design of tension members, it was found that an HSS7x7x$^{3}/_{16}$ meets the strength requirements for the design of the worst case axial force in the chord. However, for constructability, an HSS7x7x¼ was chosen for the bottom chord. For the diagonals, it was desired to have an HSS size that was approximately half the size of the top and bottom chord. This would allow for a nice aesthetic of the truss. Therefore, using Table 4-4 of the Steel Manual, an HSS4x4x½ was chosen for the diagonals based on the worst case force in the far left diagonal. The design summary may be viewed in Appendix C.8: Member Design. The final truss design may be viewed in Figure 21 below.

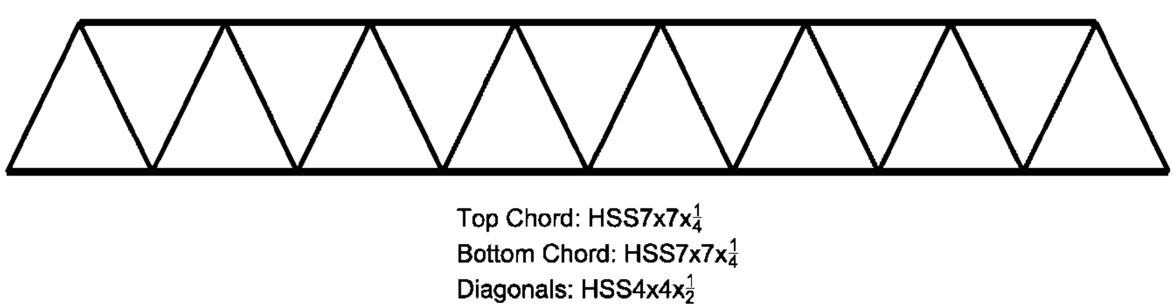


Figure 21: Final Design of the Side Trusses

Architectural Breadth – Bridge Façade Redesign

Initial Sketches

In the beginning of the semester, sketches were done to determine which redesign concept would be chosen. The first sketch was the covered bridge option. This option was inspired by New York's historical covered bridges, in particular that of the Newfield Bridge. The Newfield Bridge was built using a lattice truss. That truss type created an interesting diamond pattern on the interior, which may be seen in Figure 22 below. It was desired to mimic this diamond pattern in the bridge redesign. Therefore, if this redesign would be chosen, a truss type would be selected that allows for the incorporation of the diamond pattern. The covered bridge redesign would also consist of moving the supports closer to either adjacent building, thus creating a longer span to give the illusion of the bridge only being supported by either building. A gable roof would also be considered if this redesign option was chosen. The façade would incorporate some of the materials of the façade of the Peggy Ryan Williams Center. The first sketch of the covered bridge redesign concept may be seen in Figure 23 below.

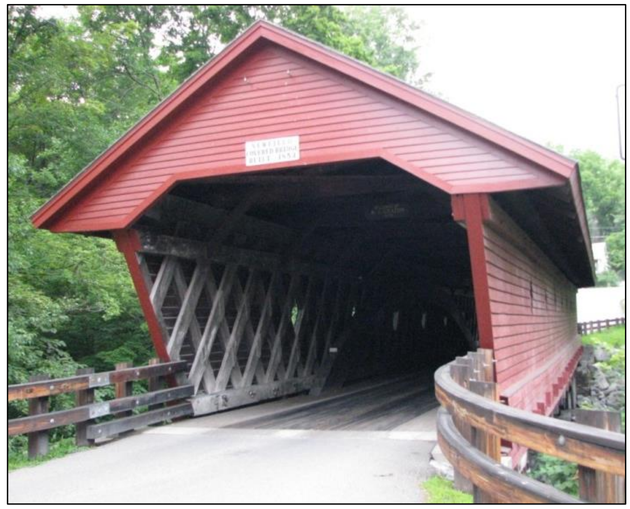


Figure 22: The Newfield Bridge | *Photo taken 07-31-13*

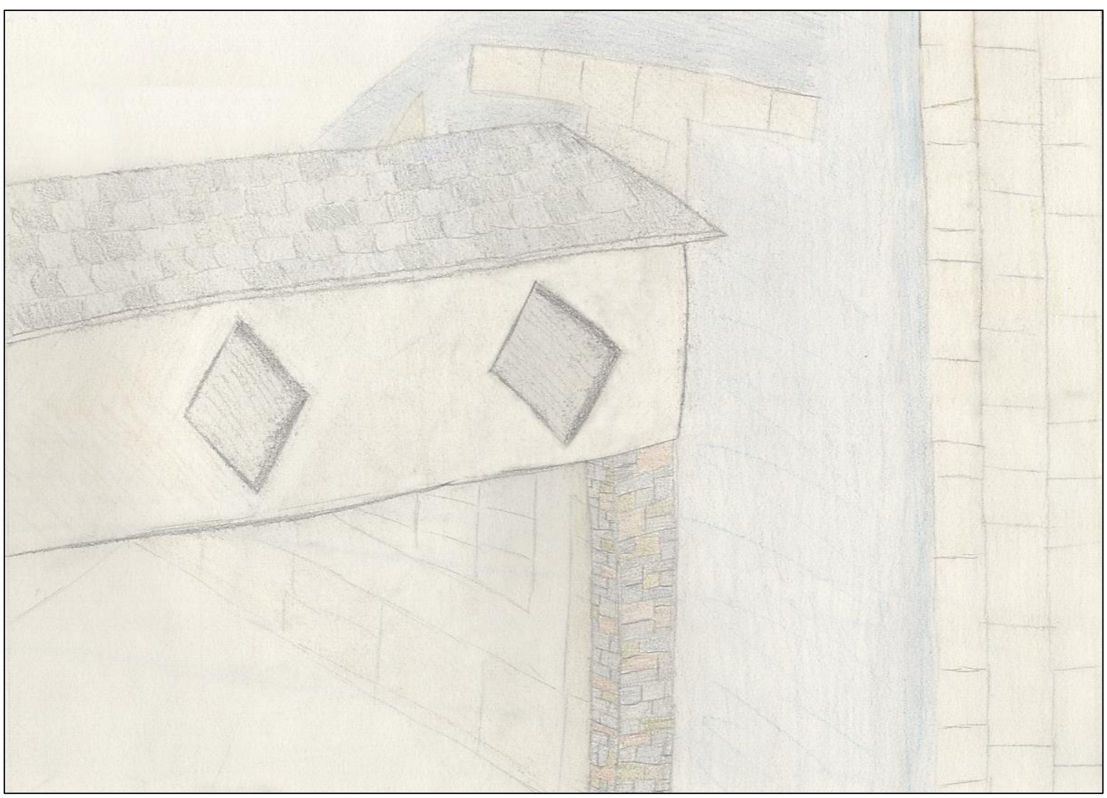


Figure 23: Covered Bridge Redesign Concept

The second redesign option reflected on the original name of the building, "The Gateway Building." Therefore, this redesign would reflect upon the Golden Gate Bridge. The redesigned box truss would be very similar to the original design, including a glass façade. However, instead of having the two original pier supports, the bridge would instead be suspended from two towers (similar to those of the Golden Gate Bridge). The towers would likely be located where the current supports reside. The size of the towers would need careful consideration so that they allow the bridge to stand out, yet not overpower the Peggy Ryan Williams Center. The second sketch, of the Golden Gate Bridge redesign concept, may be seen in Figure 24 below.

Figure 24: Golden Gate Bridge Redesign Concept

In comparing these two sketches, both redesigns would provide a good learning opportunity of bridge design while carefully considering the bridge's impact on its surroundings. While the Golden Gate Bridge option would be very interesting and provide a learning opportunity of suspension bridges, its box truss would not change much, if at all, from the original design. That option may also not appear in harmony with the existing adjacent buildings, due to the two large towers. The covered bridge option would allow for a complete redesign of the box truss and more options for the façade of the bridge. Careful consideration would need to be taken to ensure that this bridge does not look out-of-place next to the existing buildings. Through completing the two sketches it became evident that the covered bridge option was desired. This option would provide a wide range of opportunities for the bridge redesign. Upon choosing the covered bridge option, a third sketch was done. That sketch shows a more complete view of the bridge and the adjacent buildings. With the use of careful material consideration, it was determined that this redesign would tie in nicely with the Peggy Ryan Williams Center. The third sketch may be viewed below in Figure 25.

Figure 25: Covered Bridge Option - Redesign Concept Chosen

Truss Design

As previously stated, in choosing the covered bridge redesign option, a truss would be selected that would achieve a diamond pattern. Originally, a Double Intersection Warren Truss was chosen for the redesign. The diamond pattern of that truss would mimic that of the lattice truss of the Newfield Bridge. However, it was decided that a Warren Truss would be used in the redesign. The Warren Truss would be more economical since the truss would require fewer steel members. In order to preserve the concept of mimicking the Newfield Bridge, an applique would be applied to the façade of the bridge that suggests that a Double Intersection Warren Truss is within. The diamond design applique would not only mimic the Newfield Bridge; but also, the diamond pattern ties into the irregular roof angles of the Peggy Ryan Williams Center. In order to allow natural light into the bridge, every other diamond of the bridge would be a large window. The trusses were created using Autodesk Revit 2014. The complete box truss may be viewed below in Figure 26. The individual side, top, and bottom trusses may be viewed in Appendix D.1: Bridge Trusses.

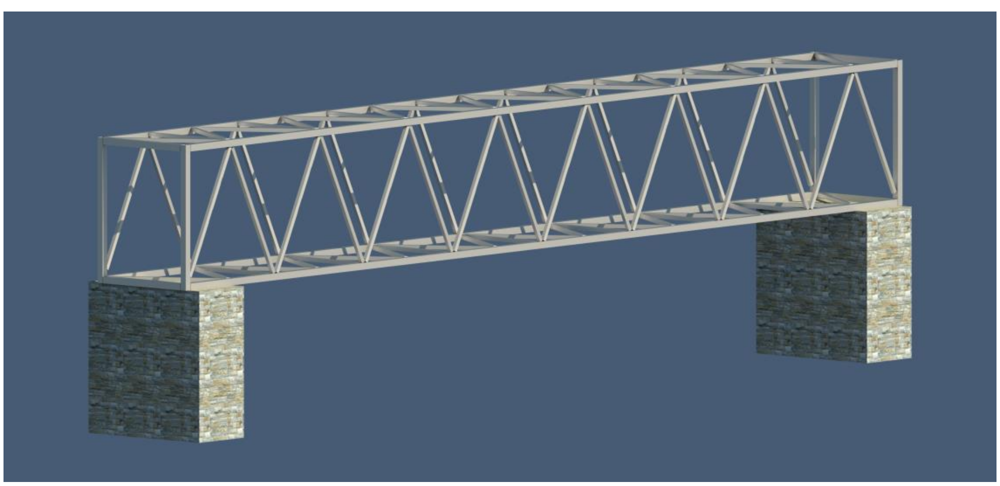


Figure 26: Bridge Box Truss

Gable Roof

Initially, the gable roof was chosen to more closely mimic a covered bridge. However, in order to attempt to not take the covered bridge idea too literal, other roof options were considered. A shed roof was taken into consideration. But, this option was eliminated due to both sides of the bridge being readily exposed to the public. Therefore, neither side would allow the shed roof design. A flat roof design was also considered. The downside of the flat roof design was that it appeared to be too similar to the original design. Also, the bridge did not give off the same vibe as it did with the gable roof. As a result, it was decided to use a gable roof for the bridge redesign.

Façade Diamond Design

The main façade of the redesigned bridge consists of a diamond pattern. This façade feature was inspired by the Yotel Building which is located in New York City. The façade of that building features various polygonal shapes which reflect the light and cast shadows when they are washed with light. Figure 27 below shows the Yotel Building's façade.

Figure 27: Yotel Building Façade | Photo Courtesy of ebayink

This type of façade was inspired by the decision to also complete a Lighting Breadth of the bridge. Various patterns and shapes were explored for the façade design. In the end, a diamond and half diamond pattern was chosen. This pattern would tie into the truss design and play off of the numerous irregular angles of the Peggy Ryan Williams Center. In order to avoid the façade becoming too busy, only alternating rows of diamonds have the half diamond extrusion. This pattern, like that of the Yotel Building, will allow light to be reflected and interesting shadows to be created when the façade is washed with light. An up-close render of the diamond pattern façade may be seen below in Figure 28.

Figure 28: Diamond Facade Pattern

Materials Chosen

Aluminum | Diamond Patterned Façade

- The aluminum ties in with the aluminum panels on the Peggy Ryan Williams Center
- Green tint was chosen to take the LEED status literally and to connect the bridge to the lush green landscape surrounding it.

Limestone | Lattice Applique

- The limestone lattice mimics the limestone panels on the PRWC.
- Limestone allows for a clear distinction of the lattice design.

Bluestone | Façade of the Supports

- Bluestone was used on the perimeter of the lower level of the PRWC. Therefore, by using it at the bottom of the bridge, it continues the pattern started by the building.
- Bluestone also helps the bridge supports to look like they are a part of the adjacent building and not simply there for the bridge.

Slate | Roof

- The slate again ties back to the bluestone used on both the building and the bridge.
- The slate also matches the overall color scheme and feel of the bridge's exterior.

Façade Comparison

The redesigned bridge was created using Autodesk Revit 2014. In the following four figures, the differences between the existing bridge façade and the redesigned bridge façade may be seen.

Figure 29: Existing Bridge Façade | Front View

Figure 30: Redesigned Bridge Façade | Front View

Figure 31: Existing Bridge Facade | Prospective View

Figure 32: Redesigned Bridge Facade | Prospective View

Architectural Breadth Conclusion

The architectural redesign of the bridge produced a design which is very different from the original design and commands attention, yet it is still in harmony with its surroundings. Through the redesign, a new truss type was used; the façade was designed for both architectural features and lighting features, and materials were selected to reflect upon the Peggy Ryan Williams Center. The bridge successfully mimics the Newfield Bridge, with its Warren Trusses and diamond design applique on the façade, without taking the covered bridge inspiration too literally.

Lighting Breadth – Exterior Lighting of the Bridge

As mentioned in the Architectural Breadth section, the façade of the bridge was inspired by the Yotel Building in New York City. In order to accomplish a similar lighting affect, the lighting fixture ColorGraze Powercore 30x60, manufactured by Philips Color Kinetics, was selected for the exterior lighting of the bridge. This luminaire was chosen for its high performance; including its linear form which enables the grazing of the façade and its superior ability at highlighting the texture of facades. Another reason for the selection of this luminaire was for its outdoor weather rating. The 30x60 was chosen because it allows for a more uniform effect. This product has been used in various successful façade projects such as the John E Jaqua Academic Center for Student Athletes at the University of Oregon. This luminaire has well defined color changing ability as well. When paired with an adequate control system, such as Philips LED Lighting Systems Controllers, the façade can be lit under colored light. This can become a pleasant visual element to the new bridge. In the following figures, the various lighting effects may be viewed. Figure 33 shows the original white LED. Figure 34 shows the façade grazed with green LED light, which further accents the green façade material of the bridge. Figure 35 illustrates a blue LED light graze, which is one of Ithaca College's school colors. The specification sheet for the luminaire is available in Appendix E.1: Luminaire Specification Sheet.

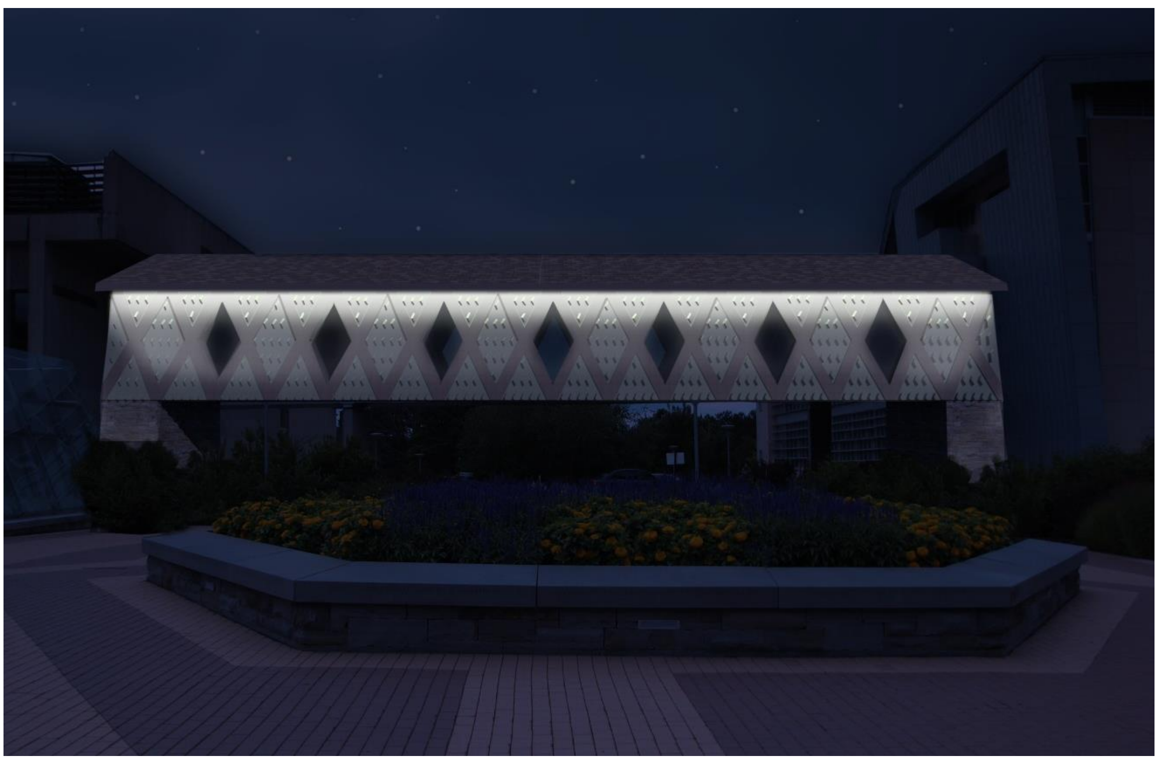


Figure 33: Exterior Lighting of the Bridge with Original White LED Light

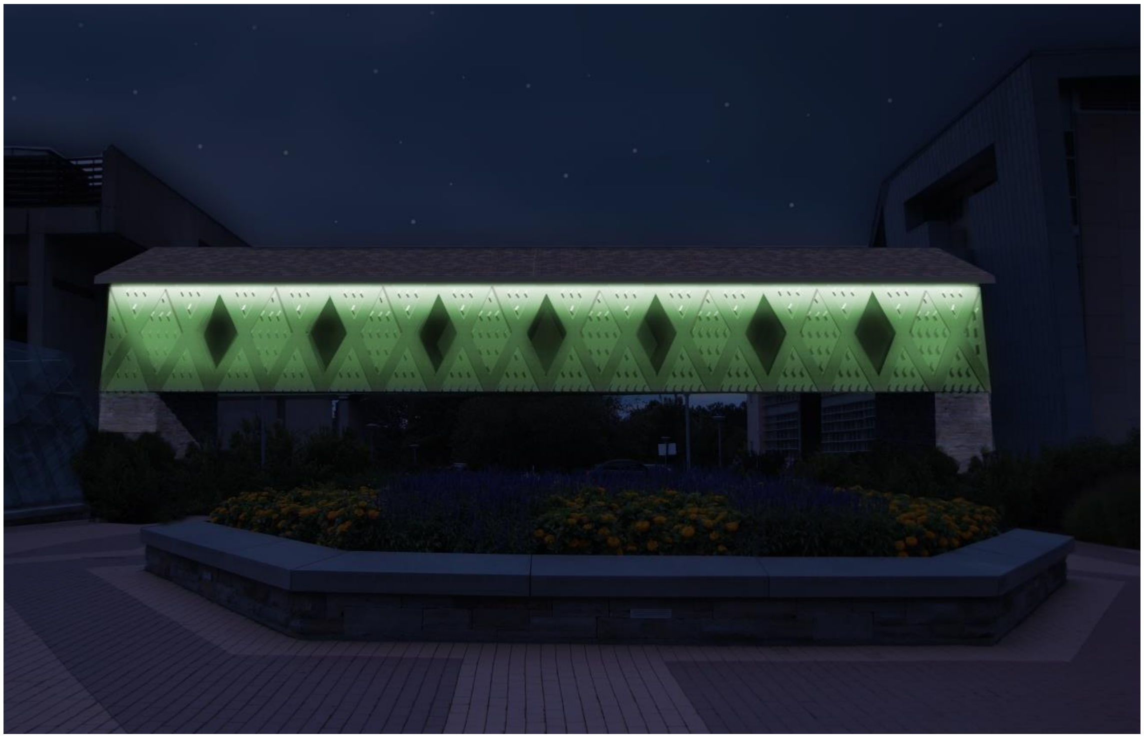


Figure 34: Exterior Lighting of the Bridge with Green LED Light

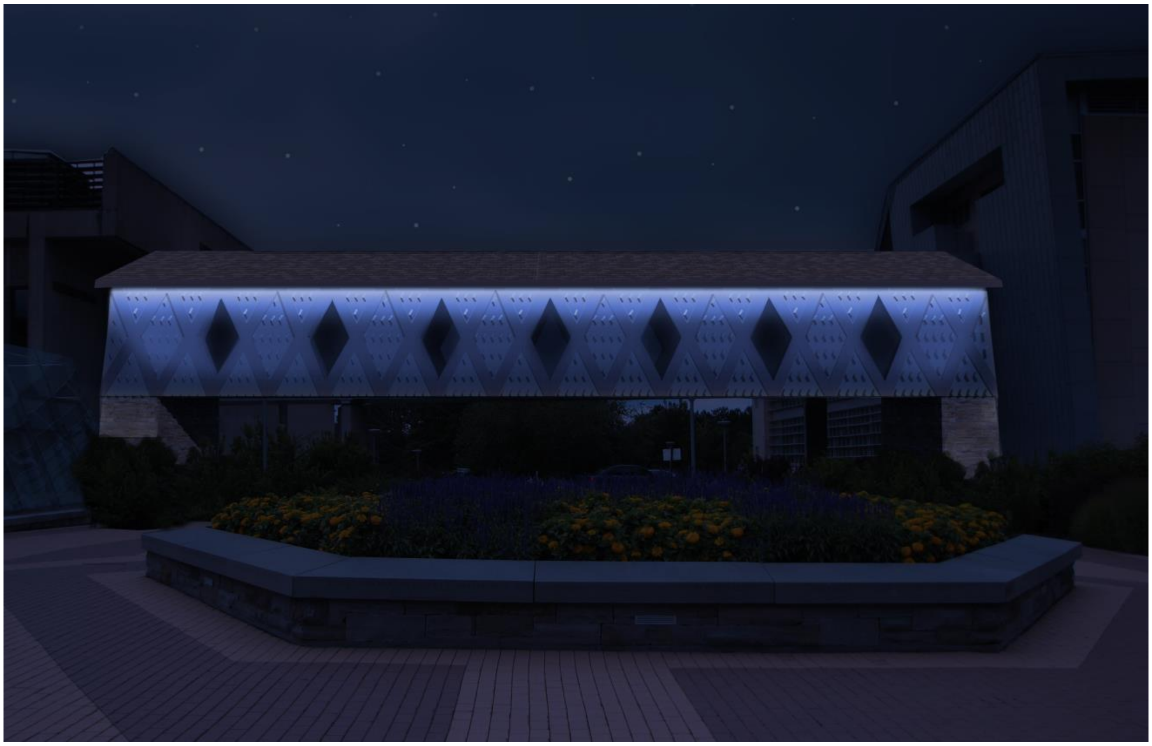


Figure 35: Exterior Lighting of the Bridge with Blue LED Light

Conclusion

This report provided an overview of both the analysis and the redesign of the Peggy Ryan Williams Center. The existing gravity and lateral system of the building were analyzed during the fall semester. Both of the systems were found to be adequate. A scenario was then created in which the schedule was no longer critical, thus allowing concrete to be explored as the building material. Through further investigation, it was determined to redesign the gravity system of the building to be a one way concrete slab system with pan joists, girder, and columns. The pan joists were designed using the CRSI Manual. After a joist system was selected, the same system depth (24-½") was used throughout the building. The beams and girders were then designed using spBeam. Finally, the loads were carried down through the building and the columns were designed using spColumn. Through the use of this system, the floor system depth was decreased by 6-⅝". This allowed for a larger floor to ceiling height, thus opening up the interior spaces. A few girders and columns were able to be removed from the existing framing of the building. Therefore, pending the owner's preference, a more open floor plan may be utilized.

The next section of the report focused on determining if the new gravity system would be adequate to act as both the building's gravity system and its lateral system. Seismic and wind loads were calculated per ASCE7-10, and RISA was used in order to determine the stiffness of the concrete frames. Once the forces were distributed accordingly, spColumn was used to design/analyze the columns. In the end, it was determined that the building's gravity system was adequate to act as the building's lateral system as well.

The pedestrian bridge was the focus of the remaining portion of the report. Two inspirational concepts were considered for the redesign, a reflection on the building's original name, "The Gateway Building," and a reflection of New York's historical covered bridges. It was decided to redesign the bridge using the covered bridge inspiration. Next, a Warren Truss was designed for the side truss of the redesigned bridge. The bridge was designed through the use of the historical Indexing Method and the Steel Manual. This structural redesign opened the door for both an architectural breadth of the bridge façade and a lighting breadth of the exterior of the bridge.

A detailed Autodesk Revit model served as the main feature of the architectural breadth. The Revit model shows the careful consideration that was taken into both the design and the materials chosen for the bridge façade. The bridge was then rendered to allow a nice comparison to be seen between the existing bridge and the redesigned bridge. While both designs allow the bridge to be cohesive with its surroundings, the redesign allows the pedestrian bridge to stand out more from its surroundings.
In order to complement the structural redesign of the bridge and the architectural breadth, an exterior lighting breadth was performed. The inspiration for the façade of the bridge and in turn the lighting of it was the Yotel Building in New York City. A luminaire from Philips Color Kinetics was selected in order to achieve a similar lighting affect. The report showcases various lighting effects which are possible with the high performance luminaire.

The structural depth of the bridge, architectural breadth, and lighting breadth all provided a great learning experience and a peak into the design process that goes into creating large scale bridges.

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Appendix A.1: Snow Drift

Angela Mincemoyer | Snow Drift | Tech Report 2 | 17/43

First Floor Roof - North Side - Green Roof & Plaza Deck:

Determine if drift load is required: (section 7.7.1)

$h_c/h_b < 0.2 \Rightarrow$ not required

$\gamma = 0.13 p_g + 14 < 30$ pcf
$= 0.13(45) + 14 = 19.85$ pcf < 30 ✓

$h_b = \frac{p_f}{\gamma} = \frac{35}{19.85} \rightarrow h_b = 1.76'$

$h_c = 45' - 1.76' = 43.24'$

$\frac{h_c}{h_b} = \frac{43.24}{1.76} = 24.6 \rightarrow$ drift is required

Leeward: (Fig. 7-9)

$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{p_g + 10} - 1.5$

$l_u = 98'$

$= 0.43 \sqrt[3]{98} \sqrt[4]{45+10} - 1.5$

$h_d = 3.90$ ft

Windward: (Fig. 7-9)

$l_u = 20$ ft

$h_d = (0.43 \sqrt[3]{20} \sqrt[4]{45+10} - 1.5) \, 3/4$

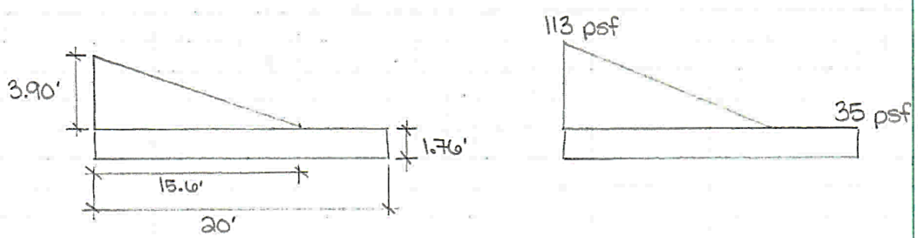
$h_d = 1.26$ ft

$\rightarrow h_d = 3.90$ ft should be used in design

$h_d < h_c \rightarrow w = 4h_d = 4(3.90) = 15.6$ ft

$h_d \gamma = 3.90'(19.85) = 78$ psf

Angela Mincemoyer	Snow Drift	Tech Report 2	18/43



First Floor Roof - East Side - Plaza Deck:

Determine if drift load is required: (section 7.7.1)

$h_c/h_b < 0.2 \Rightarrow$ not required

$\gamma = 19.85$ pcf (see calculation on previous page)

$h_b = 1.76'$ (see calculation on previous page)

$h_c = 47' - 1.76' = 45.24'$

$\frac{h_c}{h_b} = \frac{45.24}{1.76} = 25.7 \rightarrow$ drift is required

Leeward: (Fig. 7-9)

$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{p_g+10} - 1.5$

$l_u = 237'$

$h_d = 0.43 \sqrt[3]{237} \sqrt[4]{45+10} - 1.5$

$h_d = 5.75'$

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Windward:

$l_u = 14.5'$

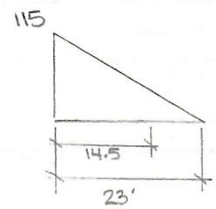
$h_d = (0.43 \sqrt[3]{14.5} \sqrt[4]{45+10} - 1.5)^{3/4}$

$h_d = 1.02'$

→ $h_d = 5.75$ ft should be used in design

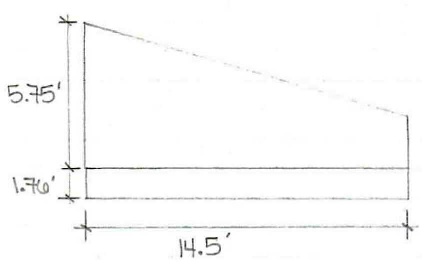
$h_d < h_c$ → $w = 4h_d = 4(5.75) = 23$ ft

$h_d \gamma = 5.75(19.85) = 115$ psf



$\frac{115}{23} = \frac{x}{23-14.5}$

$x = 43$ psf



Angela Mincemoyer | Snow Drift

Third Floor Roof - South Side   Section 7.7.1

$h_c/h_b < 0.2 \Rightarrow$ not required

$\gamma = 0.13 p_g + 14 < 30$ pcf

$= 0.13(45) + 14 = 19.85$ pcf < 30 pcf ✓

$h_b = \frac{p_s}{\gamma} = \frac{35}{19.85} = 1.76'$

$h_c = 18.33 - 1.76 = 10.41'$

$\frac{h_c}{h_b} = \frac{10.41}{1.76} = 5.9 \rightarrow$ drift required

Leeward: (figure 7-9)

$l_u = 50'$

$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{p_g + 10} - 1.5$

$= 0.43 \sqrt[3]{50} \sqrt[4]{45 + 10} - 1.5$

$h_d = 2.82$ ft

Windward: (figure 7-9)

$l_u = 35'$

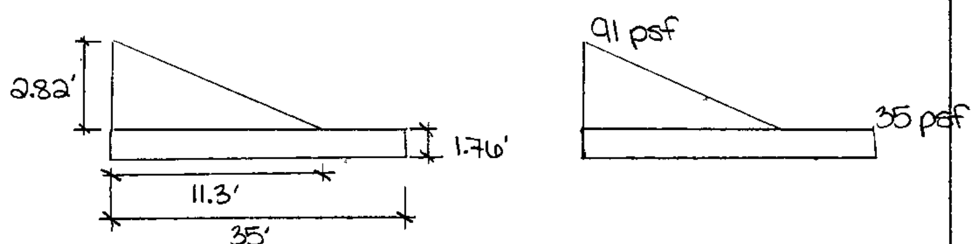
$h_d = [.43 \sqrt[3]{35} \sqrt[4]{45+10} - 1.5] (.75)$

$h_d = 1.75$ ft

$\rightarrow h_d = 2.82$ ft should be used in design

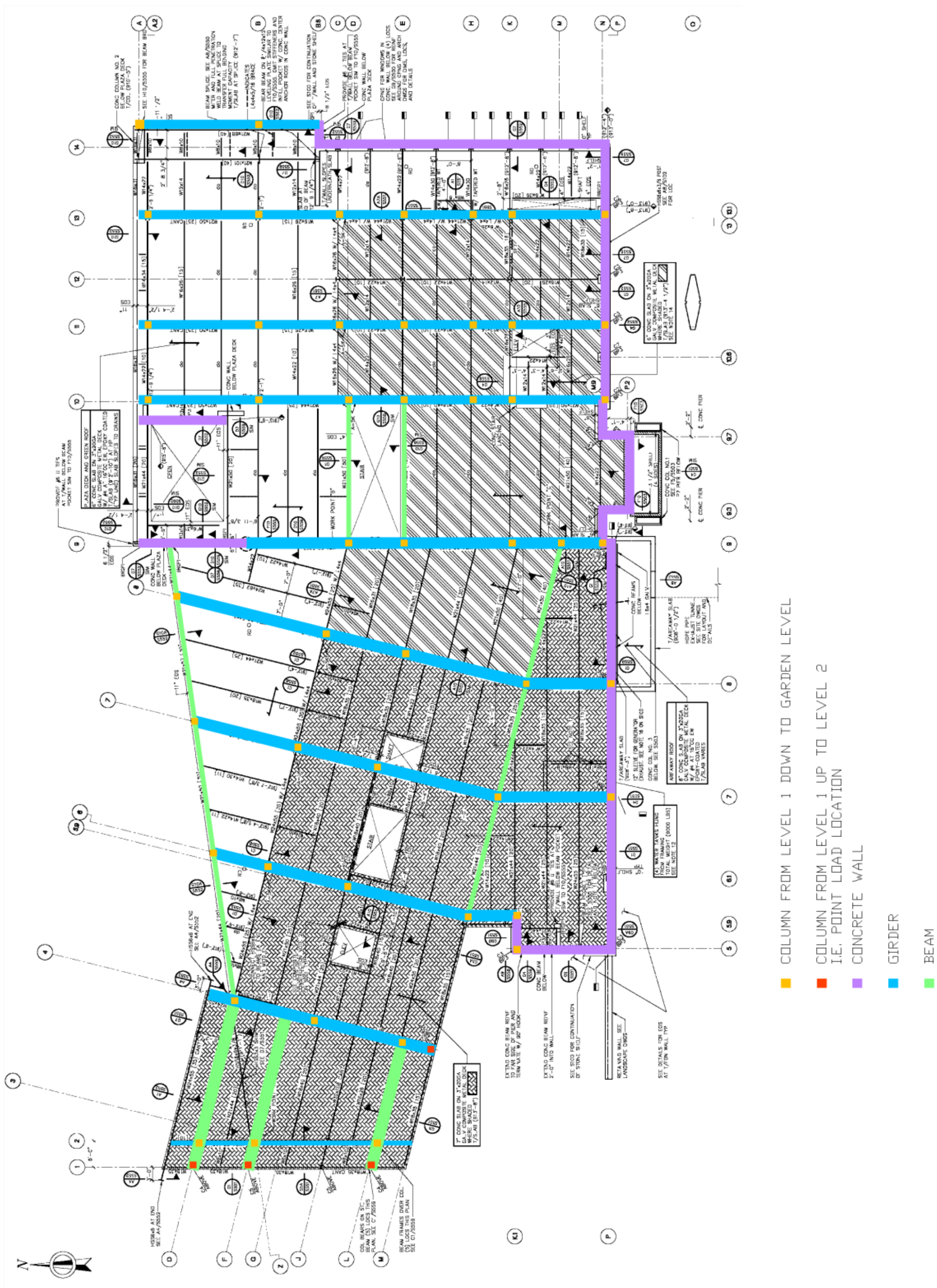
$h_d < h_c \rightarrow w = 4 h_d = 4(2.82) = 11.3$ ft

$h_d \gamma = 2.82 (19.85) = 56$ psf

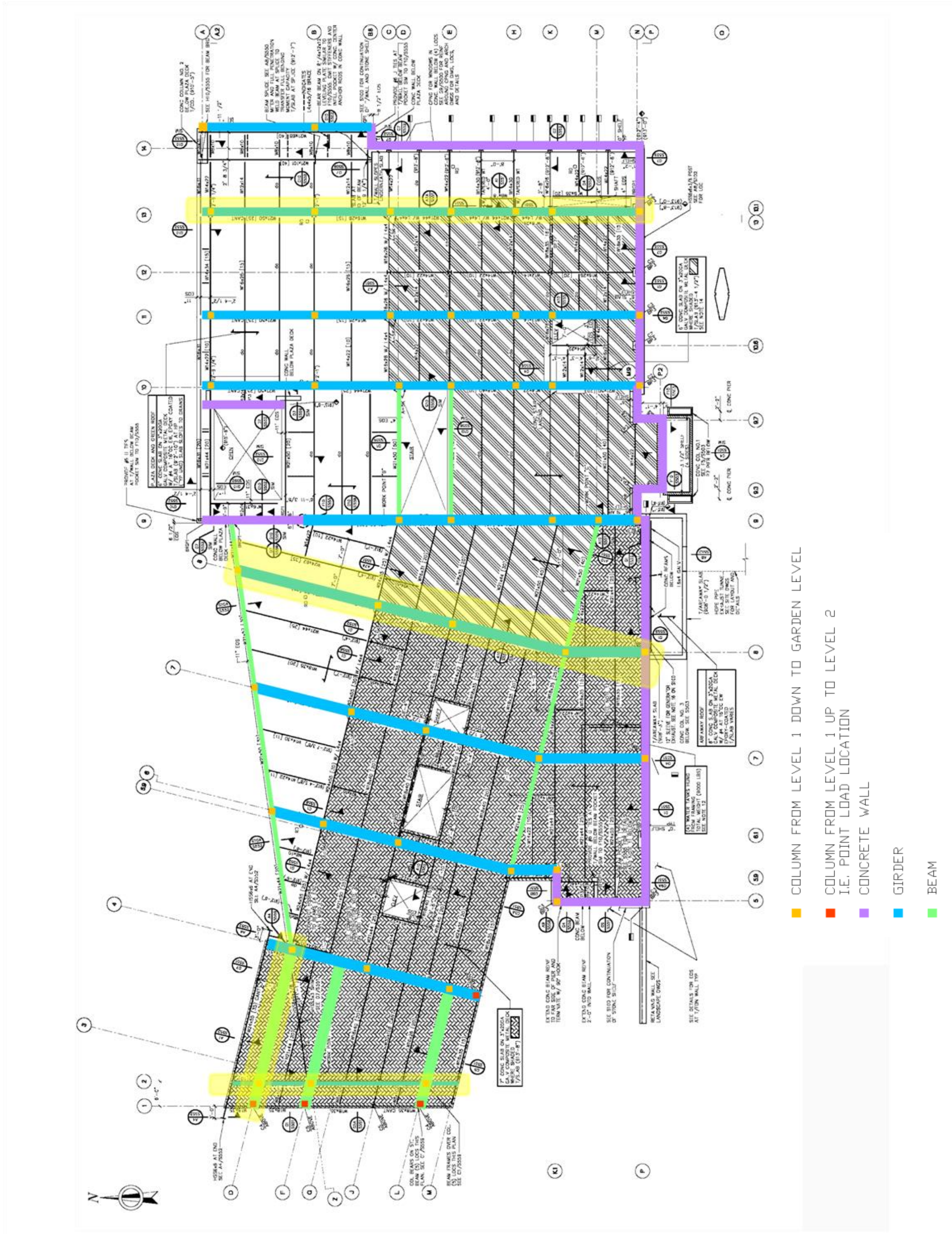


Appendix A.2: Framing Layouts

Gravity Framing for Level 1

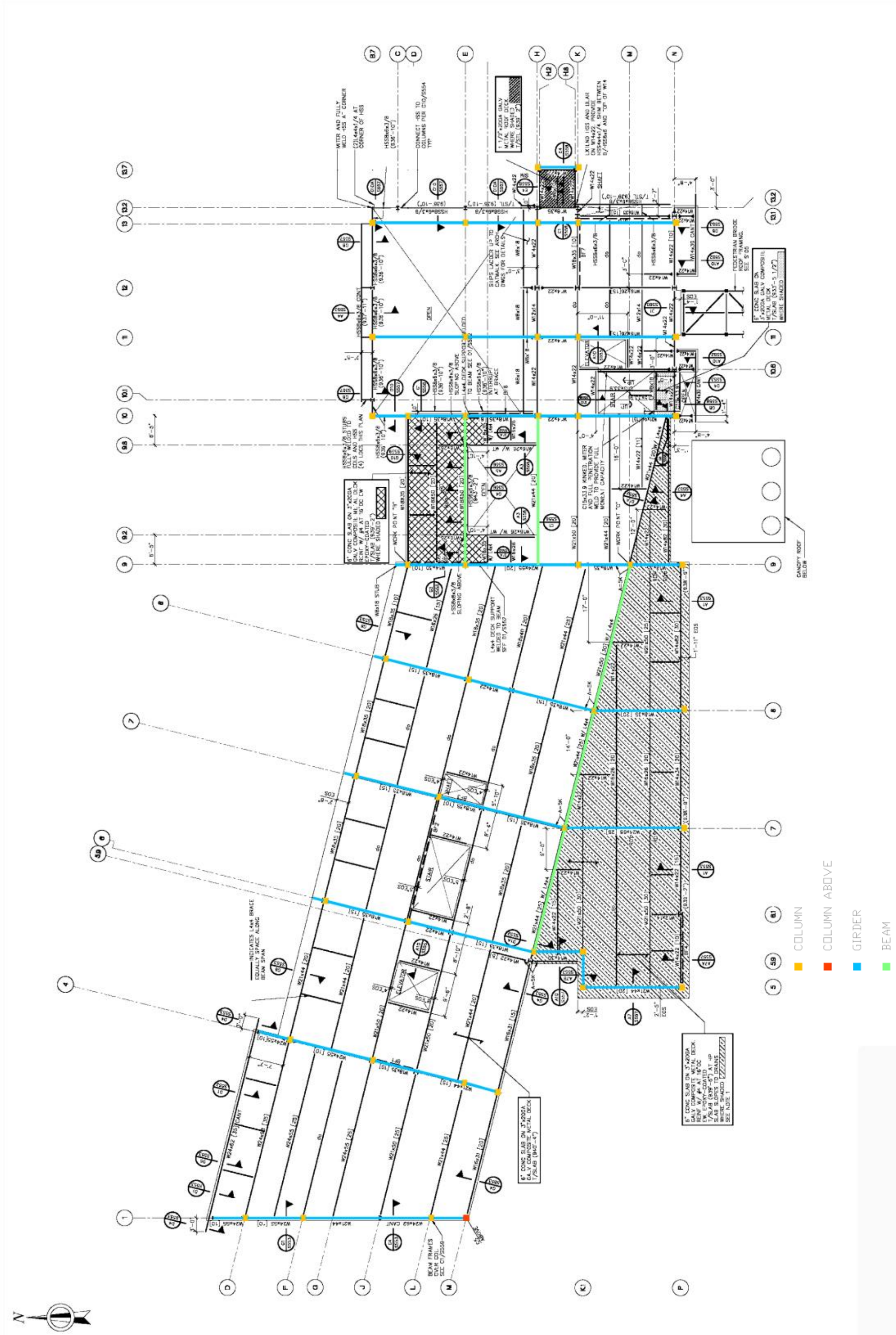


Gravity Framing for Level 1 with Designed Members Indicated



Framing Layout for Level 2

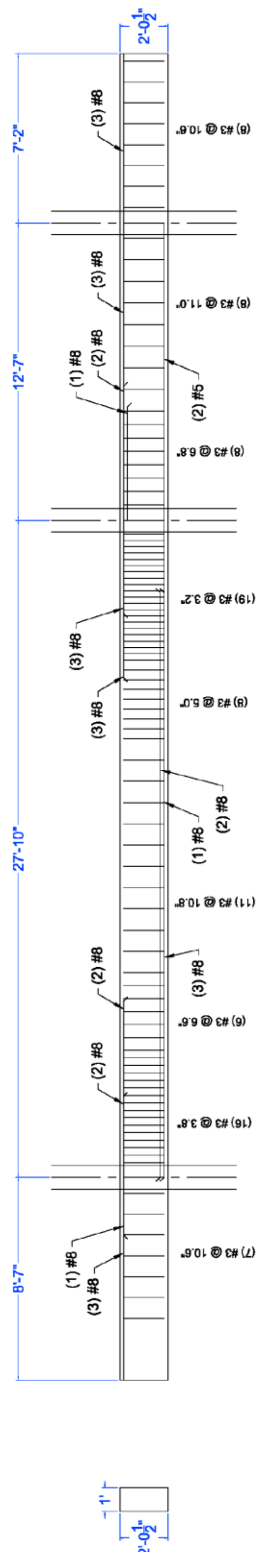
Framing Layout for Level 3



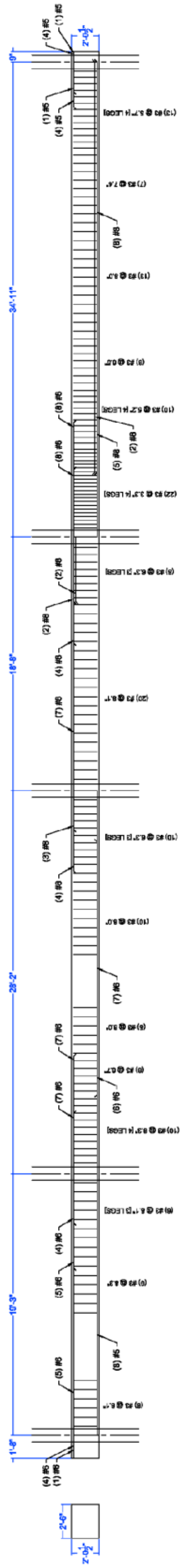
Framing Layout for Roof

Appendix A.3: Girder Designs

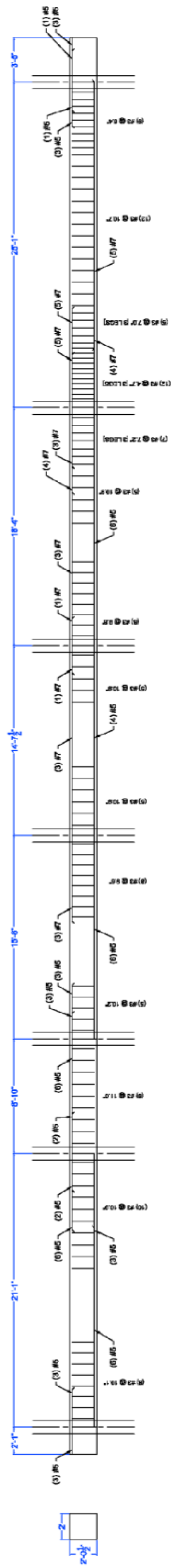
Level 1 Column Line 2 Girder



Level 1 Column Line 8 Girder



Level 1 Column Line 13 Girder



Appendix A.4: spBeam Output for Girders

Level 1 Column Line 2 Girder

spBeam v3.60 © StructurePoint 02-03-2014, 02:10:11 PM
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```
                    oooooo
                    oo   oo
   ooooo   oooooo   oo   oo    ooooo    ooooo   o oooooooooo
  oo    o  oo   oo  oo   oo   oo   oo  o    oo   oo   oo   oo
  oo       oo   oo  ooooooo   oo   oo   oooooo   oo   oo   oo
   ooooo   oo   oo  oo    oo  oo   oo  oo   oo   oo   oo   oo
       oo  oooooo   oo    oo  ooooo    oo   oo   oo   oo   oo
  o    oo  oo       oo    oo  oo    o  oo   oo   oo   oo   oo
   ooooo   oo       ooooooo    ooooo    ooooo o  oo   oo   oo  (TM)
```

===
spBeam v3.60 (TM)
A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams and One-way Slab Systems

===

===
[2] DESIGN RESULTS
===

Top Reinforcement
=================
Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Zone	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	Left	1.00	23.94	2.828	0.378	4.877	0.238	3.155	3-#8 *3
	Midspan	1.00	82.47	5.252	0.900	4.877	0.837	3.155	3-#8 *3
	Right	1.00	195.09	8.080	0.900	4.877	2.066	9.236	4-#8
2	Left	2.78	233.48	0.500	0.900	4.877	2.512	9.236	4-#8
	Midspan	2.78	0.00	13.915	0.000	4.877	0.000	1.645	---
	Right	2.78	375.86	27.330	0.900	4.877	4.323	5.541	6-#8
3	Left	1.26	348.88	0.500	0.887	4.805	4.039	2.352	6-#8 2L
	Midspan	1.26	201.92	4.553	0.900	4.877	2.145	4.703	3-#8
	Right	1.26	155.58	12.080	0.900	4.877	1.623	4.703	3-#8
4	Left	1.00	171.12	0.500	0.900	4.877	1.795	3.155	3-#8
	Midspan	1.00	72.36	2.834	0.900	4.877	0.732	3.155	3-#8 *3
	Right	1.00	21.02	4.835	0.378	4.877	0.209	3.155	3-#8 *3

NOTES:
*3 - Design governed by minimum reinforcement.

Top Bar Details
===============
Units: Length (ft)

Span	Left				Continuous		Right			
	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	---		---		3-#8	8.58	1-#8	2.44	---	
2	2-#8	7.47	2-#8	3.44	---		3-#8	6.67	3-#8	3.95
3	2-#8	5.67	1-#8	4.80	3-#8	12.58	---		---	
4	---		---		3-#8	7.17	---		---	

Bottom Reinforcement
====================
Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	1.00	0.00	4.040	0.000	8.421	0.000	0.000	---
2	1.00	399.45	12.842	0.873	22.962	4.149	2.104	6-#8 2L
3	1.00	18.14	7.152	0.381	11.481	0.178	6.576	2-#5 *3
4	1.00	0.00	3.835	0.000	7.343	0.000	0.000	---

NOTES:
*3 - Design governed by minimum reinforcement.

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Bottom Bar Details

Units: Start (ft), Length (ft)

Span	Long Bars: Bars	Start	Length	Short Bars: Bars	Start	Length
1	---			---		
2	3-#8	0.00	27.83	3-#8	0.00	24.77
3	2-#5	0.00	12.58	---		
4	---			---		

Flexural Capacity

Units: x (ft), As (in^2), PhiMn (k-ft)

Span	x	AsTop	AsBot	PhiMn-	PhiMn+
1	0.000	2.37	0.00	-221.38	0.00
	2.828	2.37	0.00	-221.38	0.00
	4.290	2.37	0.00	-221.38	0.00
	5.252	2.37	0.00	-221.38	0.00
	6.141	2.37	0.00	-221.38	0.00
	8.080	3.16	0.00	-286.91	0.00
	8.580	3.16	0.00	-286.91	0.00
2	0.000	3.16	4.74	-286.91	455.02
	0.500	3.16	4.74	-286.91	455.02
	1.078	3.16	4.74	-286.91	455.02
	3.435	1.58	4.74	-151.71	455.02
	5.116	1.58	4.74	-151.71	455.02
	7.473	0.00	4.74	0.00	455.02
	9.890	0.00	4.74	0.00	455.02
	13.915	0.00	4.74	0.00	455.02
	17.939	0.00	4.74	0.00	455.02
	19.831	0.00	4.74	0.00	455.02
	21.162	0.00	4.10	0.00	396.81
	23.866	2.37	2.80	-221.38	277.38
	23.881	2.37	2.79	-221.38	276.71
	24.765	3.15	2.37	-285.73	237.29
	26.585	4.74	2.37	-405.58	237.29
	27.330	4.74	2.37	-405.58	237.29
	27.830	4.74	2.37	-405.58	237.29
3	0.000	4.74	0.62	-398.47	62.89
	0.500	4.74	0.62	-398.47	62.89
	0.501	4.74	0.62	-398.47	62.89
	1.373	4.58	0.62	-388.63	62.89
	4.553	2.83	0.62	-259.25	62.89
	4.797	2.69	0.62	-248.46	62.89
	5.669	2.37	0.62	-221.38	62.89
	6.290	2.37	0.62	-221.38	62.89
	8.027	2.37	0.62	-221.38	62.89
	12.080	2.37	0.62	-221.38	62.89
	12.580	2.37	0.62	-221.38	62.89
4	0.000	2.37	0.00	-221.38	0.00
	0.500	2.37	0.00	-221.38	0.00
	2.834	2.37	0.00	-221.38	0.00
	3.585	2.37	0.00	-221.38	0.00
	4.835	2.37	0.00	-221.38	0.00
	7.170	2.37	0.00	-221.38	0.00

Longitudinal Beam Shear Reinforcement Required

Units: d (in), Start, End, Xu (ft), PhiVc, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Vu	Xu	Av/s
1	22.50	25.61	0.000	2.068	12.36	2.068	0.0000
			2.068	4.137	24.72	4.137	0.0100
			4.137	7.830	37.08	6.205	0.0113
2	21.83	24.86	0.750	5.632	78.82	2.319	0.0549
			5.632	8.945	55.34	5.632	0.0310
			8.945	12.258	31.86	8.945	0.0100
			12.258	15.572	20.40	15.572	0.0100
			15.572	18.885	43.88	18.885	0.0194
			18.885	22.198	67.36	22.198	0.0433
			22.198	27.080	90.84	25.511	0.0672
3	22.17	25.23	0.750	4.976	53.78	2.347	0.0286
			4.976	7.604	34.15	4.976	0.0100
			7.604	11.830	29.38	10.233	0.0100
4	22.50	25.61	0.750	4.773	36.89	2.375	0.0111

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4.773 7.170 18.44 4.773 0.0100

Longitudinal Beam Shear Reinforcement Details

Units: spacing & distance (in).

Span	Size	Stirrups (2 legs each unless otherwise noted)
1	#3	<-- 21.8 --> + 7 @ 10.6
2	#3	16 @ 3.8 + 6 @ 6.6 + 11 @ 10.8 + 8 @ 5.0 + 19 @ 3.2
3	#3	8 @ 6.8 + 8 @ 11.0
4	#3	8 @ 10.6

Beam Shear Capacity

Units: d, Sp (in), Start, End, Xu (ft), PhiVc, PhiVn, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Av/s	Sp	PhiVn	Vu	Xu
1	22.50	25.61	0.000	0.250	-----	-----	12.81	1.49	0.250
			0.250	2.068	-----	-----	12.81	12.36	2.068
			2.068	7.830	0.0207	10.6	46.56	37.08	6.205
			7.830	8.580	-----	-----	46.56	37.08	6.205
2	21.83	24.86	0.000	0.750	-----	-----	82.04	78.82	2.319
			0.750	5.632	0.0582	3.8	82.04	78.82	2.319
			5.632	8.945	0.0332	6.6	57.48	55.34	5.632
			8.945	18.885	0.0203	10.8	44.79	43.88	18.885
			18.885	22.198	0.0443	5.0	68.35	67.36	22.198
			22.198	27.080	0.0695	3.2	93.11	90.84	25.511
			27.080	27.830	-----	-----	93.11	90.84	25.511
3	22.17	25.23	0.000	0.750	-----	-----	57.69	53.78	2.347
			0.750	4.976	0.0325	6.8	57.69	53.78	2.347
			4.976	11.830	0.0201	11.0	45.25	34.15	4.976
			11.830	12.580	-----	-----	45.25	29.38	10.233
4	22.50	25.61	0.000	0.750	-----	-----	46.67	36.89	2.375
			0.750	6.920	0.0208	10.6	46.67	36.89	2.375
			6.920	7.170	-----	-----	46.67	1.92	6.920

Slab Shear Capacity

Units: b, d (in), Xu (ft), PhiVc, Vu(kip)

Span	b	d	Vratio	PhiVc	Vu	Xu
1	--- Not checked ---					
2	--- Not checked ---					
3	--- Not checked ---					
4	--- Not checked ---					

Deflections

Section properties

Units: Ig, Icr, Ie (in^4), Mcr, Mmax (k-ft)

Span	Ie,avg Dead	Ie,avg Dead+Live	Zone	Ig	Icr	Mcr	Load Level Dead Mmax	Load Level Dead Ie	Load Level Dead+Live Mmax	Load Level Dead+Live Ie
1	8135	7259	Right	14706	7061	47.45	-91.30	8135	-160.31	7259
2	13098	11954	Left	14706	7061	47.45	-115.53	7591	-203.38	7158
			Midspan	30610	13180	69.24	146.27	15029	259.03	13513
			Right	14706	9450	47.45	-157.50	9593	-278.88	9476
3	18954	18555	Left	14706	9130	47.45	-139.04	9351	-246.18	9170
			Midspan	23211	2102	60.86	0.00	23211	0.00	23211
			Right	14706	5676	47.45	-68.42	8689	-121.40	6215
4	7486	6000	Left	14706	5676	47.45	-81.09	7486	-143.86	6000

Maximum Instantaneous Deflections

Units: D (in)

Span	Ddead	Dlive	Dtotal
1	-0.091	-0.073	-0.164
2	0.261	0.233	0.494
3	-0.029	-0.024	-0.053
4	0.112	0.109	0.221

Maximum Long-term Deflections

Time dependant factor for sustained loads = 2.000
Units: D (in)

Span	Dsust	Lambda	Dcs	Dcs+lu	Dcs+l	Dtotal
1	-0.091	2.000	-0.183	-0.256	-0.256	-0.347
2	0.261	2.000	0.522	0.755	0.755	1.016
3	-0.029	2.000	-0.058	-0.082	-0.082	-0.111
4	0.112	2.000	0.223	0.332	0.332	0.444

```
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Material Takeoff
================
   Reinforcement in the Direction of Analysis
   ------------------------------------------
   Top Bars:       419.8 lb   <=>   7.48 lb/ft   <=> 0.334 lb/ft^2
   Bottom Bars:    447.5 lb   <=>   7.97 lb/ft   <=> 0.356 lb/ft^2
   Stirrups:       173.9 lb   <=>   3.10 lb/ft   <=> 0.138 lb/ft^2
   Total Steel:   1041.3 lb   <=>  18.54 lb/ft   <=> 0.828 lb/ft^2
   Concrete:       565.2 ft^3 <=>  10.06 ft^3/ft <=> 0.449 ft^3/ft^2
```

Level 1 Column Line 8 Girder

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A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams and One-way Slab Systems

[2] DESIGN RESULTS

Top Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Zone	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	Left	2.50	0.85	0.409	0.950	12.260	0.008	8.162	4-#6 *3 *5
	Midspan	2.50	2.80	0.760	0.950	12.260	0.027	8.162	4-#6 *3 *5
	Right	2.50	6.51	1.170	0.950	12.260	0.064	6.122	5-#6 *3 *5
2	Left	2.50	1.93	0.500	0.950	12.260	0.019	6.122	5-#6 *3
	Midspan	2.50	134.17	12.363	1.784	12.260	1.341	6.122	5-#6 *3
	Right	2.50	564.66	18.750	2.263	12.260	6.017	1.884	14-#6
3	Left	2.82	575.93	0.500	2.263	12.260	6.148	2.176	14-#6
	Midspan	2.82	0.00	14.085	0.000	12.294	0.000	0.000	---
	Right	2.82	369.43	27.670	2.250	12.192	3.842	4.052	7-#8
4	Left	2.50	361.75	0.500	2.250	12.192	3.757	4.052	7-#8
	Midspan	2.50	483.61	11.986	2.250	12.192	5.119	4.052	7-#8
	Right	2.50	949.30	18.170	2.236	12.115	11.039	2.587	15-#8
5	Left	3.49	987.87	0.500	2.250	12.192	11.479	2.587	15-#8
	Midspan	3.49	0.00	17.460	0.000	12.294	0.000	0.000	---
	Right	3.49	92.02	34.420	1.213	12.294	0.912	9.120	5-#5 *3 *5
6	Left	2.50	0.37	0.500	0.953	12.294	0.004	9.120	5-#5 *3
	Midspan	2.50	0.17	0.588	0.953	12.294	0.002	8.192	4-#5 *3
	Right	2.50	0.06	0.662	0.953	12.294	0.001	8.192	4-#5 *3

NOTES:
*3 - Design governed by minimum reinforcement.
*5 - Number of bars governed by maximum allowable spacing.

Top Bar Details

Units: Length (ft)

Span	Left				Continuous		Right			
	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	---		---		4-#6	1.67	1-#6	1.67	---	
2	---		---		5-#6	19.25	5-#6	6.94	4-#6	3.64
3	7-#6	8.63	7-#6	4.45	---		4-#8	5.91	3-#8	2.87
4	---		---		7-#8	18.67	4-#8	7.83	4-#8	4.77
5	8-#8	8.39	8-#8	4.94	---		4-#5	3.30	1-#5	2.19
6	1-#5	0.75	---		4-#5	0.75	---		---	

Bottom Reinforcement

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Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	2.50	0.00	0.585	0.000	12.294	0.000	0.000	---
2	2.50	245.99	7.500	2.269	19.370	2.450	3.511	8-#5
3	2.50	536.71	15.172	2.263	26.160	5.406	2.041	13-#6
4	2.50	0.00	9.335	0.000	18.926	0.000	0.000	---
5	2.50	1077.77	19.495	2.223	30.408	11.266	2.026	15-#8 2L
6	2.50	0.00	0.625	0.000	12.294	0.000	0.000	---

Bottom Bar Details

Units: Start (ft), Length (ft)

	Long Bars			Short Bars		
Span	Bars	Start	Length	Bars	Start	Length
1	---			---		
2	8-#5	0.00	19.25	---		
3	7-#6	0.00	28.17	6-#6	5.79	18.62
4	---			---		
5	8-#8	0.00	34.92	7-#8	4.73	30.19
6	---			---		

Flexural Capacity

Units: x (ft), As (in^2), PhiMn (k-ft)

Span	x	AsTop	AsBot	PhiMn-	PhiMn+
1	0.000	2.20	0.00	-217.58	0.00
	0.409	2.20	0.00	-217.58	0.00
	0.760	2.20	0.00	-217.58	0.00
	0.835	2.20	0.00	-217.58	0.00
	1.000	2.20	0.00	-217.58	0.00
	1.170	2.20	0.00	-217.58	0.00
	1.670	2.20	0.00	-217.58	0.00
2	0.000	2.20	2.48	-217.58	248.96
	0.500	2.20	2.48	-217.58	248.96
	6.887	2.20	2.48	-217.58	248.96
	9.625	2.20	2.48	-217.58	248.96
	12.307	2.20	2.48	-217.58	248.96
	12.363	2.24	2.48	-221.82	248.96
	15.074	4.40	2.48	-422.35	248.96
	15.615	4.40	2.48	-422.35	248.96
	18.382	6.16	2.48	-576.94	248.96
	18.750	6.16	2.48	-576.94	248.96
	19.250	6.16	2.48	-576.94	248.96
3	0.000	6.16	3.08	-576.94	309.13
	0.500	6.16	3.08	-576.94	309.13
	2.001	6.16	3.08	-576.94	309.13
	4.448	3.08	3.08	-301.03	309.13
	5.789	3.08	3.08	-301.03	309.13
	6.187	3.08	3.51	-301.03	351.10
	8.261	0.47	5.72	-47.59	567.00
	8.635	0.00	5.72	0.00	567.00
	10.009	0.00	5.72	0.00	567.00
	14.085	0.00	5.72	0.00	567.00
	18.161	0.00	5.72	0.00	567.00
	21.937	0.00	5.72	0.00	567.00
	22.263	0.00	5.37	0.00	533.42
	24.322	3.16	3.17	-306.73	318.29
	24.409	3.16	3.08	-306.73	309.13
	25.298	3.16	3.08	-306.73	309.13
	27.358	5.53	3.08	-519.44	309.13
	27.670	5.53	3.08	-519.44	309.13
	28.170	5.53	3.08	-519.44	309.13
4	0.000	5.53	0.00	-519.44	0.00
	0.500	5.53	0.00	-519.44	0.00
	6.684	5.53	0.00	-519.44	0.00
	9.335	5.53	0.00	-519.44	0.00
	10.839	5.53	0.00	-519.44	0.00
	11.986	6.38	0.00	-591.97	0.00
	13.898	7.79	0.00	-708.74	0.00
	15.109	9.59	0.00	-844.93	0.00

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	18.169	11.85	0.00	-999.74	0.00
	18.170	11.85	0.00	-999.74	0.00
	18.670	11.85	0.00	-999.74	0.00
5	0.000	12.64	6.32	-1039.64	624.35
	0.500	12.64	6.32	-1039.64	624.35
	0.501	12.64	6.32	-1039.64	624.35
	3.945	7.74	6.32	-704.24	624.35
	4.733	5.50	6.32	-516.62	624.35
	4.942	4.90	6.53	-464.51	643.83
	8.386	0.00	9.95	0.00	959.62
	10.298	0.00	11.85	0.00	1130.93
	12.372	0.00	11.85	0.00	1130.93
	17.460	0.00	11.85	0.00	1130.93
	22.548	0.00	11.85	0.00	1130.93
	31.622	0.00	11.85	0.00	1130.93
	32.622	1.24	11.85	-124.56	1130.93
	32.731	1.24	11.85	-124.56	1130.93
	33.731	1.55	11.85	-155.07	1130.93
	34.420	1.55	11.85	-155.07	1130.93
	34.920	1.55	11.85	-155.07	1130.93
6	0.000	1.55	0.00	-155.07	0.00
	0.375	1.55	0.00	-155.07	0.00
	0.500	1.55	0.00	-155.07	0.00
	0.588	1.55	0.00	-155.07	0.00
	0.662	1.55	0.00	-155.07	0.00
	0.750	1.55	0.00	-155.07	0.00

Longitudinal Beam Shear Reinforcement Required
===

Units: d (in), Start, End, Xu (ft), PhiVc, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Vu	Xu	Av/s
1	22.63	64.39	0.000	0.920	0.00	0.000	0.0000
2	22.63	64.39	0.750	4.454	50.39	2.385	0.0250
			4.454	6.522	30.26	4.454	0.0000
			6.522	8.591	22.23	8.591	0.0000
			8.591	10.659	41.48	10.659	0.0250
			10.659	12.728	61.61	12.728	0.0250
			12.728	14.796	81.74	14.796	0.0250
			14.796	18.500	101.87	16.865	0.0368
3	22.50	64.04	0.750	5.721	125.19	2.375	0.0604
			5.721	9.066	92.63	5.721	0.0282
			9.066	12.412	60.07	9.066	0.0250
			12.412	15.758	27.50	12.412	0.0000
			15.758	19.104	45.39	19.104	0.0250
			19.104	22.449	77.95	22.449	0.0250
			22.449	27.420	110.51	25.795	0.0459
4	22.50	64.04	0.750	4.695	47.12	2.375	0.0250
			4.695	7.015	38.58	7.015	0.0250
			7.015	9.335	48.99	9.335	0.0250
			9.335	11.655	68.54	11.655	0.0250
			11.655	13.975	88.66	13.975	0.0250
			13.975	17.920	108.78	16.295	0.0442
5	22.23	63.28	0.750	6.669	191.95	2.353	0.1286
			6.669	10.985	142.69	6.669	0.0794
			10.985	15.302	95.11	10.985	0.0318
			15.302	19.618	48.66	15.302	0.0250
			19.618	23.935	46.21	23.935	0.0250
			23.935	28.251	92.10	28.251	0.0288
			28.251	34.170	137.99	32.567	0.0747
6	22.69	64.57	0.750	0.750	0.00	0.750	0.0000

Longitudinal Beam Shear Reinforcement Details
===

Units: spacing & distance (in).

Span	Size	Stirrups (2 legs each unless otherwise noted)
1	#5	--- None ---
2	#3	6 @ 8.1 + <-- 49.6 --> + 9 @ 8.3 + 6 @ 8.1 [3L]
3	#3	10 @ 6.3 [4L] + 6 @ 6.7 + 5 @ 8.0 + <-- 40.1 --> + 10 @ 8.0 + 10 @ 6.3 [3L]
4	#3	20 @ 8.1 + 8 @ 6.3 [3L]
5	#3	22 @ 3.3 [4L] + 10 @ 5.2 [4L] + 8 @ 6.5 + 13 @ 8.0 + 7 @ 7.4 + 13 @ 5.7 [4L]
6	#5	--- None ---

Beam Shear Capacity
===================

Units: d, Sp (in), Start, End, Xu (ft), PhiVc, PhiVn, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Av/s	Sp	PhiVn	Vu	Xu
1	22.63	64.39	0.000	1.670	-----	-----	32.20	0.00	0.000

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2	22.63	64.39	0.000	0.750	-----	-----	92.11	50.39	2.385
			0.750	4.454	0.0272	8.1	92.11	50.39	2.385
			4.454	8.591	-----	-----	32.20	30.26	4.454
			8.591	14.796	0.0266	8.3	91.46	81.74	14.796
			14.796	18.500	0.0408	8.1	105.97	101.87	16.865
			18.500	19.250	-----	-----	105.97	101.87	16.865
3	22.50	64.04	0.000	0.750	-----	-----	134.99	125.19	2.375
			0.750	5.721	0.0701	6.3	134.99	125.19	2.375
			5.721	9.066	0.0329	6.7	97.32	92.63	5.721
			9.066	12.412	0.0274	8.0	91.78	60.07	9.066
			12.412	15.758	-----	-----	32.02	27.50	12.412
			15.758	22.449	0.0274	8.0	91.78	77.95	22.449
			22.449	27.420	0.0526	6.3	117.25	110.51	25.795
			27.420	28.170	-----	-----	117.25	110.51	25.795
4	22.50	64.04	0.000	0.750	-----	-----	91.41	47.12	2.375
			0.750	13.975	0.0270	8.1	91.41	88.66	13.975
			13.975	17.920	0.0523	6.3	116.97	108.78	16.295
			17.920	18.670	-----	-----	116.97	108.78	16.295
5	22.23	63.28	0.000	0.750	-----	-----	196.53	191.95	2.353
			0.750	6.669	0.1332	3.3	196.53	191.95	2.353
			6.669	10.985	0.0849	5.2	148.27	142.69	6.669
			10.985	15.302	0.0340	6.5	97.27	95.11	10.985
			15.302	23.935	0.0276	8.0	90.90	48.66	15.302
			23.935	28.251	0.0297	7.4	93.02	92.10	28.251
			28.251	34.170	0.0774	5.7	140.75	137.99	32.567
			34.170	34.920	-----	-----	140.75	137.99	32.567
6	22.69	64.57	0.000	0.750	-----	-----	32.28	0.00	0.750

Slab Shear Capacity
===================

Units: b, d (in), Xu (ft), PhiVc, Vu(kip)

Span	b	d	Vratio	PhiVc	Vu	Xu
1	--- Not checked ---					
2	--- Not checked ---					
3	--- Not checked ---					
4	--- Not checked ---					
5	--- Not checked ---					
6	--- Not checked ---					

Deflections
===========

Section properties

Units: Ig, Icr, Ie (in^4), Mcr, Mmax (k-ft)

	Ie,avg						Load Level			
							Dead		Dead+Live	
Span	Dead	Dead+Live	Zone	Ig	Icr	Mcr	Mmax	Ie	Mmax	Ie
1	36765	36765	Right	36765	6377	118.63	-5.67	36765	-9.70	36765
2	41350	41146	Left	36765	6377	118.63	-10.94	36765	-19.36	36765
			Midspan	47650	7731	137.46	71.57	47650	125.95	47650
			Right	36765	14804	118.63	-276.61	16537	-462.93	15174
3	28101	18467	Left	36765	14804	118.63	-287.56	16346	-480.37	15135
			Midspan	55571	16767	148.90	220.21	28763	359.72	19519
			Right	36765	13448	118.63	-106.12	36765	-224.49	16889
4	41922	39300	Left	36765	13448	118.63	-81.26	36765	-187.43	19361
			Midspan	47059	47059	136.54	0.00	47059	0.00	47059
			Right	36765	22983	118.63	-577.64	23102	-796.60	23028
5	31046	29103	Left	36765	24698	118.63	-632.29	24777	-870.21	24728
			Midspan	59799	30728	154.40	626.36	31164	859.42	30897
			Right	36765	4731	118.63	-100.53	36765	-137.95	25107
6	36765	36765	Left	36765	4731	118.63	-1.91	36765	-2.66	36765

Maximum Instantaneous Deflections

Units: D (in)

Span	Ddead	Dlive	Dtotal
1	-0.004	-0.003	-0.008
2	0.010	0.009	0.019
3	0.192	0.219	0.411
4	-0.117	-0.057	-0.174
5	0.851	0.385	1.236
6	-0.058	-0.026	-0.085

Maximum Long-term Deflections

Time dependant factor for sustained loads = 2.000
Units: D (in)

Span	Dsust	Lambda	Dcs	Dcs+lu	Dcs+l	Dtotal
1	-0.004	2.000	-0.009	-0.012	-0.012	-0.017

2	0.010	2.000	0.021	0.029	0.029	0.040
3	0.192	2.000	0.384	0.604	0.604	0.796
4	-0.117	2.000	-0.233	-0.291	-0.291	-0.408
5	0.851	2.000	1.702	2.087	2.087	2.938
6	-0.058	2.000	-0.117	-0.143	-0.143	-0.201

```
Material Takeoff
================
   Reinforcement in the Direction of Analysis
   ------------------------------------------
   Top Bars:      1242.9 lb   <=>  12.02 lb/ft   <=>  0.444 lb/ft^2
   Bottom Bars:   1934.7 lb   <=>  18.71 lb/ft   <=>  0.692 lb/ft^2
   Stirrups:       699.0 lb   <=>   6.76 lb/ft   <=>  0.250 lb/ft^2
   Total Steel:   3876.7 lb   <=>  37.48 lb/ft   <=>  1.386 lb/ft^2
   Concrete:      1480.1 ft^3 <=>  14.31 ft^3/ft <=>  0.529 ft^3/ft^2
```

Level 1 Column Line 13 Girder

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 ooooo   oo   oo  oo    oo  oo   oo  oo   oo   oo   oo   oo
     oo  oooooo   oo    oo  ooooo    oo   oo   oo   oo   oo
o    oo  oo       oo    oo  oo    o  oo   oo   oo   oo   oo
 ooooo   oo       ooooooo    ooooo    ooooo o  oo   oo   oo  (TM)
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spBeam v3.60 (TM)
A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams and One-way Slab Systems

[2] DESIGN RESULTS

Top Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Zone	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	Left	2.00	1.11	0.553	0.762	9.835	0.011	9.288	3-#5 *3
	Midspan	2.00	3.71	1.027	0.762	9.835	0.036	9.288	3-#5 *3
	Right	2.00	8.67	1.580	0.762	9.835	0.085	9.288	3-#5 *3
2	Left	2.11	15.82	0.500	0.762	9.835	0.155	9.936	3-#5 *3
	Midspan	2.11	0.00	10.540	0.000	9.835	0.000	0.000	---
	Right	2.11	216.69	20.580	1.815	9.835	2.201	2.839	8-#5
3	Left	2.00	214.44	0.500	1.815	9.835	2.177	2.654	8-#5
	Midspan	2.00	126.66	3.240	1.685	9.835	1.267	3.715	6-#5 *3
	Right	2.00	82.66	5.590	1.091	9.835	0.821	3.715	6-#5 *3
4	Left	2.00	70.43	0.500	0.928	9.835	0.698	3.715	6-#5 *3
	Midspan	2.00	0.00	7.835	0.000	9.835	0.000	0.000	---
	Right	2.00	126.36	15.170	1.690	9.781	1.271	9.200	3-#7 *3
5	Left	2.00	126.72	0.500	1.695	9.781	1.275	9.200	3-#7 *3
	Midspan	2.00	35.98	9.360	0.758	9.781	0.356	9.200	3-#7 *3 *5
	Right	2.00	159.62	14.130	1.805	9.781	1.615	6.133	4-#7 *3
6	Left	2.00	151.87	0.500	1.805	9.781	1.534	6.133	4-#7 *3
	Midspan	2.00	85.50	11.765	1.136	9.781	0.854	9.200	3-#7 *3 *5
	Right	2.00	501.25	17.830	1.805	9.781	5.415	2.044	10-#7
7	Left	2.51	512.63	0.500	1.805	9.781	5.551	2.722	10-#7
	Midspan	2.51	0.00	12.540	0.000	9.835	0.000	0.000	---
	Right	2.51	70.28	24.580	0.926	9.835	0.696	8.224	4-#5 *3 *5
8	Left	2.00	42.62	0.500	0.762	9.835	0.420	8.224	4-#5 *3
	Midspan	2.00	18.06	1.522	0.762	9.835	0.177	9.288	3-#5 *3
	Right	2.00	5.27	2.398	0.762	9.835	0.052	9.288	3-#5 *3

NOTES:
*3 - Design governed by minimum reinforcement.
*5 - Number of bars governed by maximum allowable spacing.

Top Bar Details

Units: Length (ft)

	Left				Continuous		Right			
Span	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	---		---		3-#5	2.08	---		---	
2	3-#5	2.89	---		---		6-#5	5.86	2-#5	2.80
3	2-#5	3.03	---		6-#5	8.83	---		---	

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4	3-#5	4.13	3-#5	1.94	---		3-#7	6.61	---	
5	---		---		3-#7	14.63	1-#7	2.08	---	
6	1-#7	2.07	---		3-#7	18.33	4-#7	6.50	3-#7	4.51
7	5-#7	7.59	5-#7	4.08	---		3-#5	3.38	1-#5	2.17
8	1-#5	2.39	---		3-#5	3.42	---		---	

Bottom Reinforcement
====================

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	2.00	0.00	0.790	0.000	9.835	0.000	0.000	---
2	2.00	252.07	9.177	1.815	19.841	2.508	2.322	9-#5
3	2.00	0.00	4.415	0.000	10.470	0.000	0.000	---
4	2.00	125.68	7.462	1.654	15.703	1.244	3.715	6-#5 *3
5	2.00	84.94	7.687	1.115	14.907	0.838	6.192	4-#5 *3
6	2.00	166.26	7.680	1.815	17.737	1.648	3.715	6-#5 *3
7	2.00	484.10	14.154	1.805	22.847	4.892	2.300	9-#7
8	2.00	0.00	1.960	0.000	9.835	0.000	0.000	---

NOTES:
*3 - Design governed by minimum reinforcement.

Bottom Bar Details
==================

Units: Start (ft), Length (ft)

	Long Bars			Short Bars		
Span	Bars	Start	Length	Bars	Start	Length
1	---			---		
2	6-#5	0.00	21.08	3-#5	0.00	15.38
3	---			---		
4	6-#5	0.00	15.67	---		
5	4-#5	0.00	14.63	---		
6	6-#5	0.00	18.33	---		
7	5-#7	0.00	25.08	4-#7	4.57	20.51
8	---			---		

Flexural Capacity
=================

Units: x (ft), As (in^2), PhiMn (k-ft)

Span	x	AsTop	AsBot	PhiMn-	PhiMn+
1	0.000	0.93	0.00	-93.52	0.00
	0.553	0.93	0.00	-93.52	0.00
	1.027	0.93	0.00	-93.52	0.00
	1.040	0.93	0.00	-93.52	0.00
	1.580	0.93	0.00	-93.52	0.00
	2.080	0.93	0.00	-93.52	0.00
2	0.000	0.93	2.79	-93.52	279.95
	0.500	0.93	2.79	-93.52	279.95
	1.886	0.93	2.79	-93.52	279.95
	2.886	0.00	2.79	0.00	279.95
	7.528	0.00	2.79	0.00	279.95
	10.540	0.00	2.79	0.00	279.95
	13.552	0.00	2.79	0.00	279.95
	13.946	0.00	2.79	0.00	279.95
	15.219	0.00	1.97	0.00	198.19
	15.381	0.26	1.86	-26.44	187.72
	16.377	1.86	1.86	-184.17	187.72
	18.275	1.86	1.86	-184.17	187.72
	19.434	2.48	1.86	-243.02	187.72
	20.580	2.48	1.86	-243.02	187.72
	21.080	2.48	1.86	-243.02	187.72
3	0.000	2.48	0.00	-243.02	0.00
	0.500	2.48	0.00	-243.02	0.00
	1.802	2.48	0.00	-243.02	0.00

	3.028	1.86	0.00	-184.17	0.00
	3.240	1.86	0.00	-184.17	0.00
	4.415	1.86	0.00	-184.17	0.00
	5.590	1.86	0.00	-184.17	0.00
	8.330	1.86	0.00	-184.17	0.00
	8.830	1.86	0.00	-184.17	0.00
4	0.000	1.86	1.86	-184.17	186.97
	0.500	1.86	1.86	-184.17	186.97
	0.940	1.86	1.86	-184.17	186.97
	1.940	0.93	1.86	-93.52	186.97
	3.131	0.93	1.86	-93.52	186.97
	4.131	0.00	1.86	0.00	186.97
	5.635	0.00	1.86	0.00	186.97
	7.835	0.00	1.86	0.00	186.97
	9.063	0.00	1.86	0.00	186.97
	10.036	1.06	1.86	-105.60	186.97
	10.717	1.80	1.86	-177.40	186.97
	15.170	1.80	1.86	-177.40	186.97
	15.670	1.80	1.86	-177.40	186.97
5	0.000	1.80	1.24	-177.40	125.21
	0.500	1.80	1.24	-177.40	125.21
	5.271	1.80	1.24	-177.40	125.21
	7.315	1.80	1.24	-177.40	125.21
	9.360	1.80	1.24	-177.40	125.21
	12.554	1.80	1.24	-177.40	125.21
	14.130	2.40	1.24	-234.15	125.21
	14.630	2.40	1.24	-234.15	125.21
6	0.000	2.40	1.86	-234.15	187.40
	0.500	2.40	1.86	-234.15	187.40
	0.570	2.40	1.86	-234.15	187.40
	2.068	1.80	1.86	-177.40	187.40
	6.565	1.80	1.86	-177.40	187.40
	9.165	1.80	1.86	-177.40	187.40
	11.765	1.80	1.86	-177.40	187.40
	11.831	1.80	1.86	-177.40	187.40
	13.821	2.99	1.86	-288.93	187.40
	15.839	5.11	1.86	-475.31	187.40
	17.829	6.00	1.86	-549.63	187.40
	17.830	6.00	1.86	-549.63	187.40
	18.330	6.00	1.86	-549.63	187.40
7	0.000	6.00	3.00	-549.63	299.84
	0.500	6.00	3.00	-549.63	299.84
	0.995	6.00	3.00	-549.63	299.84
	4.081	3.00	3.00	-289.70	299.84
	4.507	3.00	3.00	-289.70	299.84
	4.572	2.94	3.00	-283.87	299.84
	7.593	0.00	5.03	0.00	497.07
	8.149	0.00	5.40	0.00	532.88
	8.928	0.00	5.40	0.00	532.88
	12.540	0.00	5.40	0.00	532.88
	16.152	0.00	5.40	0.00	532.88
	21.696	0.00	5.40	0.00	532.88
	22.696	0.93	5.40	-93.52	532.88
	22.910	0.93	5.40	-93.52	532.88
	23.910	1.24	5.40	-124.05	532.88
	24.580	1.24	5.40	-124.05	532.88
	25.080	1.24	5.40	-124.05	532.88
8	0.000	1.24	0.00	-124.05	0.00
	0.500	1.24	0.00	-124.05	0.00
	1.391	1.24	0.00	-124.05	0.00
	1.522	1.20	0.00	-120.06	0.00
	1.710	1.14	0.00	-114.33	0.00
	2.391	0.93	0.00	-93.52	0.00
	2.398	0.93	0.00	-93.52	0.00
	3.420	0.93	0.00	-93.52	0.00

Longitudinal Beam Shear Reinforcement Required
==

Units: d (in), Start, End, Xu (ft), PhiVc, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Vu	Xu	Av/s
1	22.69	51.66	0.000	1.330	0.00	0.000	0.0000
2	22.69	51.66	0.750	4.719	47.21	2.391	0.0200
			4.719	7.047	31.04	4.719	0.0200
			7.047	9.376	14.87	7.047	0.0000
			9.376	11.704	18.41	11.704	0.0000
			11.704	14.033	34.59	14.033	0.0200
			14.033	16.361	50.76	16.361	0.0200
			16.361	20.330	66.93	18.689	0.0200
3	22.69	51.66	0.750	8.080	39.53	2.391	0.0200

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4	22.56	51.37	0.750	4.562	36.57	2.380	0.0200
			4.562	6.744	21.41	4.562	0.0000
			6.744	8.926	13.15	8.926	0.0000
			8.926	11.108	28.31	11.108	0.0200
			11.108	14.920	43.47	13.290	0.0200
5	22.56	51.37	0.750	4.848	37.18	2.380	0.0200
			4.848	7.315	20.04	4.848	0.0000
			7.315	9.782	23.45	9.782	0.0000
			9.782	13.880	40.59	12.250	0.0200
6	22.56	51.37	0.750	4.642	59.95	2.380	0.0200
			4.642	6.903	35.29	4.642	0.0200
			6.903	9.165	25.41	9.165	0.0000
			9.165	11.427	48.34	11.427	0.0200
			11.427	13.688	71.21	13.688	0.0200
			13.688	17.580	93.92	15.950	0.0419
7	22.56	51.37	0.750	5.283	120.81	2.380	0.0684
			5.283	8.186	91.78	5.283	0.0398
			8.186	11.089	62.76	8.186	0.0200
			11.089	13.991	33.74	11.089	0.0200
			13.991	16.894	27.41	16.894	0.0200
			16.894	19.797	56.43	19.797	0.0200
			19.797	24.330	85.45	22.700	0.0336
8	22.69	51.66	0.750	3.420	10.29	2.391	0.0000

Longitudinal Beam Shear Reinforcement Details
===
Units: spacing & distance (in).

Span	Size	Stirrups (2 legs each unless otherwise noted)
1	#5	--- None ---
2	#3	8 @ 10.1 + <-- 55.9 --> + 10 @ 10.9
3	#3	9 @ 11.0
4	#3	5 @ 10.2 + <-- 52.4 --> + 8 @ 9.6
5	#3	5 @ 10.9 + <-- 59.2 --> + 5 @ 10.9
6	#3	8 @ 9.8 + <-- 27.1 --> + 5 @ 10.9 + 7 @ 7.2 [3L]
7	#3	12 @ 4.7 [3L] + 5 @ 7.0 [3L] + 13 @ 10.7 + 9 @ 6.4
8	#5	--- None ---

Beam Shear Capacity
===================
Units: d, Sp (in), Start, End, Xu (ft), PhiVc, PhiVn, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Av/s	Sp	PhiVn	Vu	Xu
1	22.69	51.66	0.000	2.080	-----	-----	25.83	0.00	0.000
2	22.69	51.66	0.000	0.750	-----	-----	73.95	47.21	2.391
			0.750	7.047	0.0218	10.1	73.95	47.21	2.391
			7.047	11.704	-----	-----	25.83	18.41	11.704
			11.704	20.330	0.0202	10.9	72.27	66.93	18.689
			20.330	21.080	-----	-----	72.27	66.93	18.689
3	22.69	51.66	0.000	0.750	-----	-----	72.08	39.53	2.391
			0.750	8.080	0.0200	11.0	72.08	39.53	2.391
			8.080	8.830	-----	-----	72.08	18.02	6.439
4	22.56	51.37	0.000	0.750	-----	-----	73.34	36.57	2.380
			0.750	4.562	0.0216	10.2	73.34	36.57	2.380
			4.562	8.926	-----	-----	25.69	21.41	4.562
			8.926	14.920	0.0229	9.6	74.66	43.47	13.290
			14.920	15.670	-----	-----	74.66	43.47	13.290
5	22.56	51.37	0.000	0.750	-----	-----	71.81	37.18	2.380
			0.750	4.848	0.0201	10.9	71.81	37.18	2.380
			4.848	9.782	-----	-----	25.69	23.45	9.782
			9.782	13.880	0.0201	10.9	71.81	40.59	12.250
			13.880	14.630	-----	-----	71.81	40.59	12.250
6	22.56	51.37	0.000	0.750	-----	-----	74.06	59.95	2.380
			0.750	6.903	0.0223	9.8	74.06	59.95	2.380
			6.903	9.165	-----	-----	25.69	25.41	9.165
			9.165	13.688	0.0203	10.9	71.95	71.21	13.688
			13.688	17.580	0.0459	7.2	98.00	93.92	15.950
			17.580	18.330	-----	-----	98.00	93.92	15.950
7	22.56	51.37	0.000	0.750	-----	-----	122.21	120.81	2.380
			0.750	5.283	0.0698	4.7	122.21	120.81	2.380
			5.283	8.186	0.0474	7.0	99.46	91.78	5.283
			8.186	19.797	0.0205	10.7	72.21	62.76	8.186
			19.797	24.330	0.0344	6.4	86.28	85.45	22.700
			24.330	25.080	-----	-----	86.28	85.45	22.700
8	22.69	51.66	0.000	3.420	-----	-----	25.83	10.29	2.391

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Slab Shear Capacity

Units: b, d (in), Xu (ft), PhiVc, Vu(kip)

Span	b	d	Vratio	PhiVc	Vu	Xu
1	--- Not checked ---					
2	--- Not checked ---					
3	--- Not checked ---					
4	--- Not checked ---					
5	--- Not checked ---					
6	--- Not checked ---					
7	--- Not checked ---					
8	--- Not checked ---					

Deflections

Section properties

Units: Ig, Icr, Ie (in^4), Mcr, Mmax (k-ft)

	Ie,avg						Load Level			
							Dead		Dead+Live	
Span	Dead	Dead+Live	Zone	Ig	Icr	Mcr	Mmax	Ie	Mmax	Ie
1	29412	29412	Right	29412	2931	94.91	-6.96	29412	-11.40	29412
2	37649	18083	Left	29412	2931	94.91	-21.64	29412	-35.41	29412
			Midspan	43290	8671	117.53	113.53	43290	185.74	17443
			Right	29412	6861	94.91	-114.92	19562	-188.40	9744
3	29165	27346	Left	29412	6861	94.91	-107.11	22548	-175.65	10418
			Midspan	30531	30531	97.04	0.00	30531	0.00	30531
			Right	29412	5381	94.91	-27.07	29412	-42.79	29412
4	35697	34295	Left	29412	5381	94.91	-31.38	29412	-49.72	29412
			Midspan	38391	5849	110.39	51.31	38391	82.47	38391
			Right	29412	5171	94.91	-65.01	29412	-111.64	20065
5	34956	32138	Left	29412	5171	94.91	-62.78	29412	-108.53	21384
			Midspan	37331	4029	108.73	12.87	37331	28.04	37331
			Right	29412	6596	94.91	-84.35	29412	-117.37	18659
6	35165	33357	Left	29412	6596	94.91	-87.86	29412	-121.01	17603
			Midspan	40920	5943	114.17	82.86	40920	105.59	40920
			Right	29412	13670	94.91	-324.48	14064	-447.09	13821
7	19644	18025	Left	29412	13670	94.91	-337.77	14020	-466.31	13803
			Midspan	46364	15609	121.64	260.05	18756	364.16	16755
			Right	29412	3784	94.91	-69.01	29412	-96.49	28173
8	29412	29412	Left	29412	3784	94.91	-33.73	29412	-47.01	29412

Maximum Instantaneous Deflections

Units: D (in)

Span	Ddead	Dlive	Dtotal
1	-0.017	-0.029	-0.046
2	0.052	0.092	0.145
3	-0.007	-0.007	-0.013
4	0.013	0.009	0.022
5	-0.002	0.003	0.002
6	-0.012	-0.007	-0.019
7	0.264	0.132	0.396
8	-0.112	-0.055	-0.166

Maximum Long-term Deflections

Time dependant factor for sustained loads = 2.000
Units: D (in)

Span	Dsust	Lambda	Dcs	Dcs+lu	Dcs+l	Dtotal
1	-0.017	2.000	-0.033	-0.062	-0.062	-0.079
2	0.052	2.000	0.104	0.197	0.197	0.249
3	-0.007	2.000	-0.013	-0.020	-0.020	-0.026
4	0.013	2.000	0.026	0.035	0.035	0.048
5	-0.000	2.000	-0.000	0.002	0.002	0.002
6	-0.012	2.000	-0.024	-0.031	-0.031	-0.043
7	0.264	2.000	0.528	0.660	0.660	0.924
8	-0.112	2.000	-0.223	-0.278	-0.278	-0.389

Material Takeoff

Reinforcement in the Direction of Analysis

Top Bars:	615.9 lb	<=>	5.64 lb/ft	<=>	0.263 lb/ft^2
Bottom Bars:	877.8 lb	<=>	8.04 lb/ft	<=>	0.375 lb/ft^2
Stirrups:	322.3 lb	<=>	2.95 lb/ft	<=>	0.138 lb/ft^2
Total Steel:	1816.0 lb	<=>	16.64 lb/ft	<=>	0.776 lb/ft^2
Concrete:	1241.4 ft^3	<=>	11.38 ft^3/ft	<=>	0.530 ft^3/ft^2

Appendix A.5: Assumed Column Loads From Above

Column Line 2 Loading From Above to Apply to Cantilevered Beam

COLUMN LOADING FROM ABOVE

Frame 2

		Live Load				Dead Load							Exterior Wall Load				
	Location	Live Load (psf)	Live Load (ksf)	Area (sf)	Point LL (kip)	Misc Dead Load (psf)	Misc Dead Load (ksf)	Area (sf)	Misc Point DL (kip)	Pan Joist Pt DL (kip)	Girder Pt DL (kip)	Column Pt DL (kip)	Dead Load (psf)	Dead Load (ksf)	Height (ft)	Width (ft)	Point DL (kip)
Roof	1D	35	0.035	335.6	11.8	31.0	0.031	335.6	10.5	14.0	4.6	0.0	28	0.028	9.5	14.8	4.0
	1F	35	0.035	490.4	17.2	31.0	0.031	490.4	15.3	20.5	7.3	0.0	28	0.028	9.5	6.2	1.7
													14	0.014	9.5	17.7	2.4
	1L	35	0.035	524	18.4	31.0	0.031	524.0	16.3	21.9	8.0	0.0	14	0.014	9.5	25.8	3.5
Level 3	1D	80	0.080	286.7	23.0	21.0	0.021	286.7	6.1	12.0	4.5	2.8	28	0.028	16.3	14.5	6.6
	1F	80	0.080	348.3	27.9	21.0	0.021	348.3	7.4	14.6	6.2	2.8	28	0.028	16.3	6.3	2.9
													14	0.014	16.3	13.8	3.2
	1L	80	0.080	346	27.7	21.0	0.021	346.0	7.3	14.5	6.8	2.8	14	0.014	16.3	22.0	5.1
Level 2	1D	80	0.080	271.1	21.7	21.0	0.021	271.1	5.7	11.4	4.2	2.8	28	0.028	13.3	13.8	5.2
	1F	80	0.080	348.8	28.0	21.0	0.021	348.8	7.4	14.6	6.2	2.8	28	0.028	13.3	6.0	2.3
													14	0.014	13.3	14.0	2.7
	1L	80	0.080	344.8	27.6	21.0	0.021	344.8	7.3	14.4	6.8	2.8	14	0.014	13.3	22.0	4.2
Level 1	2D	-	-	-	-	-	-	-	-	-	-	-	28	0.028	13.3	13.0	4.9
	2F	-	-	-	-	-	-	-	-	-	-	-	28	0.028	13.3	6.3	2.4
		-	-	-	-	-	-	-	-	-	-	-	14	0.014	13.3	14.0	2.7
	2L	-	-	-	-	-	-	-	-	-	-	-	14	0.014	13.3	21.8	4.1

Point Load to Apply to Cantilevered Beam

	Point LL (kip)	Point DL (kip)	Point Snow (kip)
2D	44.7	99.3	11.8
2F	55.9	125.4	17.2
2L	55.3	125.8	18.4

Column Line 8 Loading From Above

COLUMN LOADING FROM ABOVE

Frame 8

	Location	Live Load (psf)	Live Load (ksf)	Area (sf)	Point LL (kip)	Misc Dead Load (psf)	Misc Dead Load (ksf)	Area (sf)	Dead Load: Misc Point DL (kip)	Pan Joist Pt DL (kip)	Girder Pt DL (kip)	Column Pt DL (kip)	Exterior Wall Load: Dead Load (psf)	Dead Load (ksf)	Height (ft)	Width (ft)	Point DL (kip)
Roof	8D	35	0.035	436.1	15.3	31.0	0.031	436.1	13.6	18.2	13.6	0.0	14	0.014	9.5	24.2	3.3
	8G	35	0.035	611.7	21.5	31.0	0.031	611.7	19.0	25.6	18.0	0.0	0	0	9.5	0.0	0.0
	8M	35	0.035	657.5	23.1	31.0	0.031	657.5	20.4	27.5	17.1	0.0	14	0.014	9.5	29.8	4.0
Level 3	8D	80	0.080	284.3	22.8	21.0	0.021	284.3	6.0	11.9	9.2	2.8	14	0.014	16.3	23.8	5.5
	8G	80	0.080	611.7	49.0	21.0	0.021	611.7	12.9	25.6	18.0	2.8	0	0	16.3	0.0	0.0
	8M	80	0.080	417.8	33.5	21.0	0.021	417.8	8.8	17.5	10.8	2.8	14	0.014	8.1	29.8	3.4
		91	0.091	261.2	23.8	99.0	0.099	261.2	25.9	10.9	7.5	2.8					
	8P	35	0.035	323.5	11.4	99.0	0.099	323.5	32.1	13.5	8.7	2.8	14	0.014	16.3	28.8	6.6
Level 2	8D	80	0.080	284.3	22.8	21.0	0.021	284.3	6.0	11.9	9.2	2.8	14	0.014	13.3	23.8	4.5
	8G	80	0.080	611.7	49.0	21.0	0.021	611.7	12.9	25.6	18.2	2.8	0	0	13.3	0.0	0.0
	8M	80	0.080	679.1	54.4	21.0	0.021	679.1	14.3	28.4	18.2	2.8	0	0	13.3	0.0	0.0
	8P	80	0.080	276.2	22.1	21.0	0.021	276.2	5.9	11.6	7.5	2.8	14	0.014	13.3	28.8	5.4
Level 1	8Z	-	-	-	-	-	-	-	-	-	-	-	14	0.014	13.3	20.7	3.9
	8D	-	-	-	-	-	-	-	-	-	-	-	0	0	13.3	0.0	0.0
	8G	-	-	-	-	-	-	-	-	-	-	-	0	0	13.3	0.0	0.0
	8M	-	-	-	-	-	-	-	-	-	-	-	0	0	13.3	0.0	0.0
	8P	-	-	-	-	-	-	-	-	-	-	-	14	0.014	13.3	28.8	5.4

Column Line 13 Loading From Above

COLUMN LOADING FROM ABOVE

Frame 13

	Location	Live Load (psf)	Live Load (ksf)	Area (sf)	Point LL (kip)	Misc Dead Load (psf)	Misc Dead Load (ksf)	Area (sf)	Dead Load: Misc Point DL (kip)	Pan Joist Pt DL (kip)	Girder Pt DL (kip)	Column Pt DL (kip)	Exterior Wall Load: Dead Load (psf)	Dead Load (ksf)	Height (ft)	Width (ft)	Point DL (kip)
Roof	13C	35	0.035	288.5	10.1	31.0	0.031	288.5	9.0	12.1	12.6	0.0	28	0.028	9.5	34.8	9.3
	13E	35	0.035	207.6	7.3	31.0	0.031	207.6	6.5	8.7	9.3	0.0	28	0.028	9.5	15.0	4.0
	13H	35	0.035	163.1	5.8	31.0	0.031	163.1	5.1	6.9	7.6	0.0	28	0.028	9.5	12.3	3.3
	13K	35	0.035	194.1	6.8	31.0	0.031	194.1	6.1	8.1	9.2	0.0	28	0.028	9.5	15.0	4.0
	13N	35	0.035	208.5	7.3	31.0	0.031	208.5	6.5	8.7	10.3	0.0	28	0.028	9.5	16.7	4.5
													14	0.014	9.5	12.3	1.7
Level 3	13C	80	0.080	146.7	11.8	21.0	0.021	146.7	3.1	6.2	7.9	2.8	28	0.028	16.3	25.0	11.4
	13E	80	0.080	153.2	12.3	21.0	0.021	153.2	3.3	6.4	9.3	2.8	28	0.028	16.3	15.0	6.9
	13H	80	0.080	124.1	10.0	21.0	0.021	124.1	2.7	5.2	7.6	2.8	28	0.028	16.3	12.3	5.6
	13K	80	0.080	151.5	12.2	21.0	0.021	151.5	3.2	6.4	9.2	2.8	28	0.028	16.3	15.0	6.9
	13N	80	0.080	152.9	12.3	21.0	0.021	152.9	3.3	6.4	9.3	2.8	28	0.028	16.3	15.0	6.9
													14	0.014	16.3	10.0	2.3
Level 2	13C	80	0.080	148.5	11.9	21.0	0.021	148.5	3.2	6.2	8.3	2.8	28	0.028	13.3	25.0	9.4
	13E	80	0.080	167.9	13.5	21.0	0.021	167.9	3.6	7.1	9.3	2.8	28	0.028	13.3	15.0	5.6
	13H	80	0.080	170.9	13.7	21.0	0.021	170.9	3.6	7.2	7.6	2.8	28	0.028	13.3	20.3	7.6
	13K	80	0.080	202.1	16.2	21.0	0.021	202.1	4.3	8.5	9.2	2.8	28	0.028	13.3	22.8	8.5
	13N	80	0.080	156.3	12.6	21.0	0.021	156.3	3.3	6.6	8.6	2.8	28	0.028	13.3	14.0	5.3
													14	0.014	13.3	11.3	2.1
Level 1	13A.2	-	-	-	-	-	-	-	-	-	-	-	28	0.028	6.7	22.8	4.3
	13B	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0
	13C	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0
	13E	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0
	13H	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0
	13K	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0
	13N	-	-	-	-	-	-	-	-	-	-	-	0	0	6.7	0.0	0.0

Appendix A.6: spBeam Output

Column Line D Beam

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spBeam v3.60 (TM)
A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams and One-way Slab Systems

[2] DESIGN RESULTS

Top Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Zone	Width	Mmax	Xmax	AsPrime	AsMin	AsMax	AsReq	SpProv	Bars
1	Left	2.67	434.11	2.188	0.000	2.400	13.005	4.540	2.024	19-#8
	Midspan	2.67	812.71	4.063	0.000	2.400	13.005	9.025	2.024	19-#8
	Right	2.67	1261.98	6.250	2.295	2.344	12.701	14.996	2.024	19-#8 2L
2	Left	3.33	1178.08	0.500	0.772	2.400	13.005	13.777	2.012	19-#8 2L
	Midspan	3.33	547.39	11.788	0.000	2.400	13.005	5.822	4.887	8-#8
	Right	3.33	180.00	21.463	0.000	2.400	13.005	1.818	10.760	15-#8 *3
3	Left	13.45	0.03	0.500	0.000	1.307	7.288	0.003	10.760	15-#8 *3 *5
	Midspan	13.45	0.02	0.588	0.000	1.307	7.288	0.001	10.760	15-#8 *3 *5
	Right	13.45	0.01	0.662	0.000	1.307	7.288	0.001	10.760	15-#8 *3 *5

NOTES:
*3 - Design governed by minimum reinforcement.
*5 - Number of bars governed by maximum allowable spacing.

Top Bar Details

Units: Length (ft)

Span	Left				Continuous		Right			
	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	---		---		19-#8	6.75	---		---	
2	6-#8	13.20	5-#8	6.12	8-#8	33.25	7-#8	2.52	---	
3	---		---		15-#8	0.75	---		---	

Bottom Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Width	Mmax	Xmax	AsPrime	AsMin	AsMax	AsReq	SpProv	Bars
1	2.67	0.00	3.125	0.000	2.420	13.113	2.295	3.797	8-#5 *3
2	2.67	46.58	32.750	0.000	1.026	30.390	0.772	8.859	4-#5 *3
3	13.45	0.00	0.625	0.000	0.000	7.835	0.000	0.000	---

NOTES:
*3 - Design governed by minimum reinforcement.

Bottom Bar Details

Units: Start (ft), Length (ft)

Span	Long Bars			Short Bars		
	Bars	Start	Length	Bars	Start	Length

```
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      1    8-#5    0.00    6.75     ---

      2    4-#5    0.00   33.25     ---

      3     ---                     ---

Flexural Capacity
=================
   Units: x (ft), As (in^2), PhiMn (k-ft)
   Span         x AsTop AsBot       PhiMn-       PhiMn+
   ---- --------- ----- ----- ------------ ------------
      1     0.000 15.01  2.48     -1265.93       279.75
            2.188 15.01  2.48     -1265.93       279.75
            3.375 15.01  2.48     -1265.93       279.75
            4.063 15.01  2.48     -1265.93       279.75
            6.250 15.01  2.48     -1265.93       279.75
            6.750 15.01  2.48     -1265.93       279.75

      2     0.000 15.01  1.24     -1207.53       167.88
            0.500 15.01  1.24     -1207.53       167.88
            0.747 15.01  1.24     -1207.53       167.88
            6.125 11.06  1.24      -988.91       159.11
            7.827 11.06  1.24      -988.91       159.11
           11.788  7.57  1.24      -704.41       157.11
           13.205  6.32  1.24      -595.65       156.03
           16.625  6.32  1.24      -595.65       156.03
           21.463  6.32  1.24      -595.65       156.03
           30.735  6.32  1.24      -595.65       156.03
           31.735 11.85  1.24     -1048.74       159.44
           32.750 11.85  1.24     -1048.74       159.44
           33.250 11.85  1.24     -1048.74       159.44

      3     0.000 11.85  0.00       -70.23         0.00
            0.375 11.85  0.00       -70.23         0.00
            0.500 11.85  0.00       -70.23         0.00
            0.588 11.85  0.00       -70.23         0.00
            0.662 11.85  0.00       -70.23         0.00
            0.750 11.85  0.00       -70.23         0.00

Longitudinal Beam Shear Reinforcement Required
==============================================
   Units: d (in), Start, End, Xu (ft), PhiVc, Vu (kip), Av/s (in^2/in)
   Span        d    PhiVc    Start      End       Vu       Xu     Av/s
   ---- -------- -------- -------- -------- -------- -------- --------
      1    21.97    66.71    0.000    2.209   200.35    2.209   0.1352
                             2.209    6.000   204.13    4.419   0.1390

      2    21.97    66.71    0.750    6.415    62.39    2.331   0.0267
                             6.415   10.499    55.41    6.415   0.0267
                            10.499   14.583    48.44   10.499   0.0267
                            14.583   18.667    41.46   14.583   0.0267
                            18.667   22.751    34.49   18.667   0.0267
                            22.751   26.835    27.51   22.751   0.0000
                            26.835   32.500    20.54   26.835   0.0000

      3 --- No beam ---
Longitudinal Beam Shear Reinforcement Details
=============================================
   Units: spacing & distance (in).
   Span Size Stirrups (2 legs each unless otherwise noted)
   ---- ---- ---------------------------------------------
      1   #3 8 @ 3.1 [4L] + 15 @ 3.1 [4L]
      2   #3 34 @ 7.9 + <-- 117.0 -->
      3 --- No beam ---

Beam Shear Capacity
===================
   Units: d, Sp (in), Start, End, Xu (ft), PhiVc, PhiVn, Vu (kip), Av/s (in^2/in)
   Span        d    PhiVc    Start      End     Av/s       Sp    PhiVn       Vu       Xu
   ---- -------- -------- -------- -------- -------- -------- -------- -------- --------
      1    21.97    66.71    0.000    0.250    -----    -----   205.48   197.01    0.250
                             0.250    2.209   0.1403      3.1   205.48   200.35    2.209
                             2.209    6.000   0.1403      3.1   205.40   204.13    4.419
                             6.000    6.750    -----    -----   205.40   204.13    4.419

      2    21.97    66.71    0.000    0.750    -----    -----    94.31    62.39    2.331
                             0.750   22.751   0.0279      7.9    94.31    62.39    2.331
                            22.751   30.919    -----    -----    33.35    27.51   22.751
                            30.919   32.500    -----    -----    33.35    13.56   30.919
                            32.500   33.250    -----    -----    33.35    13.56   30.919

      3 --- No beam ---
Slab Shear Capacity
===================
   Units: b, d (in), Xu (ft), PhiVc, Vu(kip)
   Span        b        d   Vratio        PhiVc           Vu           Xu
   ---- -------- -------- -------- ------------ ------------ ------------
```

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      1 --- Not checked ---
      2 --- Not checked ---
      3   161.40     2.50    1.000        38.28         0.04         0.71

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       27765       27735 Right          39216       27717  126.54  -782.35       27765 -1084.07       27735
      2       53344       53338 Left           39216       28498  126.54  -701.74       28561  -962.45       28523
                                Midspan        61682        4280  162.01    22.71       61682    39.71       61682
                                Right          39216        3993  126.54    21.43       39216    39.71       39216
      3        1226        1226 Left            1226         244   21.53    -0.21        1226    -0.21        1226

   Maximum Instantaneous Deflections
   ---------------------------------
   Units:  D (in)
   Span    Ddead    Dlive   Dtotal
   ---- -------- -------- --------
      1    0.482    0.224    0.707
      2   -0.222   -0.142   -0.363
      3    0.009    0.008    0.016

   Maximum Long-term Deflections
   -----------------------------
   Time dependant factor for sustained loads = 2.000
   Units:  D (in)
   Span    Dsust Lambda      Dcs   Dcs+lu    Dcs+l   Dtotal
   ---- -------- ------ -------- -------- -------- --------
      1    0.482  1.708    0.824    1.048    1.048    1.531
      2   -0.220  1.753   -0.386   -0.529   -0.529   -0.749
      3    0.009  2.000    0.018    0.025    0.025    0.034

Material Takeoff
================
   Reinforcement in the Direction of Analysis
   ------------------------------------------
   Top Bars:      1423.0 lb   <=>  34.92 lb/ft   <=>  2.596 lb/ft^2
   Bottom Bars:    195.0 lb   <=>   4.79 lb/ft   <=>  0.356 lb/ft^2
   Stirrups:       253.2 lb   <=>   6.21 lb/ft   <=>  0.462 lb/ft^2
   Total Steel:   1871.2 lb   <=>  45.92 lb/ft   <=>  3.414 lb/ft^2
   Concrete:       383.3 ft^3 <=>   9.41 ft^3/ft <=>  0.699 ft^3/ft^2
```

Appendix A.7: Load to Apply to Level 1 Columns

Column Line 2 Column Loads

Breakdown of Loads to Apply to Columns

Due to:

Column	Beam D						Girder 2							
	Axial Load (kip)			Moment @ Top (k-ft)			Axial Load (kip)				Moment @ Top (k-ft)			
	Live Load	Dead Load	Snow Load	Live Load	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
2D	53.09	152.1	14.01	17.58	29.9	4.64	36.58	12.97	36.28	0	-1.19	-6.92	-5.43	0
2F	53.09	152.1	14.01	17.58	29.9	4.64	61.37	39.02	66.99	0	6.12	8.93	7.91	0
2L	53.09	152.1	14.01	17.58	29.9	4.64	46.32	27.92	60.36	0	-8.35	-14.3	-10.38	0

*NOTE: The loads due the Beam D account for the column loadings from the upper floors.

*NOTE: Positive axial forces denote compression.

*NOTE: Positive moments denote that the left hand face of the upper column is in tension and the right hand face of the bottom column is in tension.

Loads to Apply to Columns

Column	Axial Load (kip)				Moment X-dirn @ Top (k-ft)				Moment Y-dirn @ Top (k-ft)			
	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
2D	89.67	66.06	188.38	14.01	17.58	17.58	29.90	4.64	-1.19	-6.92	-5.43	0.00
2F	114.46	92.11	219.09	14.01	17.58	17.58	29.90	4.64	6.12	8.93	7.91	0.00
2L	99.41	81.01	212.46	14.01	17.58	17.58	29.90	4.64	-8.35	-14.30	-10.38	0.00

Column Line 8 Column Loads

Breakdown of Loads to Apply to Columns											
	Due to:										
	Floors Above			Girder 8							
Column	Axial Load (kip)			Axial Load (kip)				Moment @ Top (k-ft)			
	Live Load	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
8Z	0.00	3.90	0.00	38.36	37.10	84.93	14.72	16.15	16.98	35.40	6.87
8D	45.60	118.50	15.30	85.84	51.62	160.21	36.46	-6.58	-10.91	-18.89	-4.54
8G	98.00	181.40	21.50	77.12	34.67	68.22	-7.84	3.42	8.35	9.39	1.28
8M	87.90	223.10	46.90	82.29	50.49	117.37	1.38	-2.69	-6.69	-4.39	-0.31
8P	22.10	102.30	11.40	30.68	26.22	33.30	-0.33	-4.66	-5.09	-2.40	0.14

*NOTE: Positive axial forces denote compression.

*NOTE: Positive moments denote that the left hand face of the upper column is in tension and the right hand face of the bottom column is in tension.

Loads to Apply to Columns								
Column	Axial Load (kip)				Moment @ Top (k-ft)			
	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
8Z	38.36	37.10	88.83	14.72	16.15	16.98	35.40	6.87
8D	131.44	97.22	278.71	51.76	-6.58	-10.91	-18.89	-4.54
8G	175.12	132.67	249.62	13.66	3.42	8.35	9.39	1.28
8M	170.19	138.39	340.47	48.28	-2.69	-6.69	-4.39	-0.31
8P	52.78	48.32	135.60	11.07	-4.66	-5.09	-2.40	0.14

Column Line 13 Column Loads

Breakdown of Loads to Apply to Columns											
	Due to:										
	Floors Above			Girder 13							
Column	Axial Load (kip)			Axial Load (kip)				Moment @ Top (k-ft)			
	Live Load	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
13A.2	0.00	4.30	0.00	33.42	25.23	70.45	10.89	6.94	7.76	13.26	1.86
13B	0.00	0.00	0.00	60.11	36.91	128.26	24.47	-2.50	-4.91	-5.42	-0.28
13C	23.70	104.30	10.10	41.25	22.40	55.57	19.29	-0.80	-2.20	-0.66	-0.85
13E	25.80	85.60	7.30	34.87	14.83	46.92	2.51	0.10	1.72	0.69	0.27
13H	23.70	75.60	5.80	30.06	10.84	25.25	2.97	-0.64	-1.74	-1.65	-0.20
13K	28.40	89.20	6.80	43.35	29.51	56.44	5.18	1.89	2.60	3.05	0.30
13N	24.90	91.40	7.30	23.11	18.89	33.03	3.16	-4.04	-4.41	-5.74	-0.55

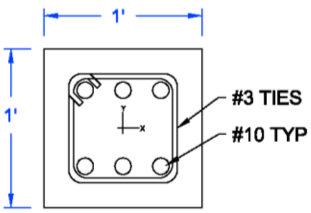
*NOTE: Positive axial forces denote compression.

*NOTE: Positive moments denote that the left hand face of the upper column is in tension and the right hand face of the bottom column is in tension.

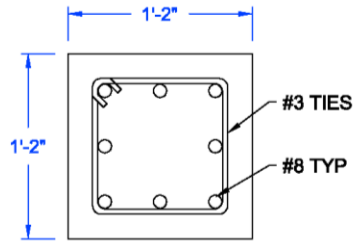
Loads to Apply to Columns								
Column	Axial Load (kip)				Moment @ Top (k-ft)			
	LL Case 1	LL Case 2	Dead Load	Snow Load	LL Case 1	LL Case 2	Dead Load	Snow Load
13A.2	33.42	25.23	74.75	10.89	6.94	7.76	13.26	1.86
13B	60.11	36.91	128.26	24.47	-2.50	-4.91	-5.42	-0.28
13C	64.95	46.10	159.87	29.39	-0.80	-2.20	-0.66	-0.85
13E	60.67	40.63	132.52	9.81	0.10	1.72	0.69	0.27
13H	53.76	34.54	100.85	8.77	-0.64	-1.74	-1.65	-0.20
13K	71.75	57.91	145.64	11.98	1.89	2.60	3.05	0.30
13N	48.01	43.79	124.43	10.46	-4.04	-4.41	-5.74	-0.55

Appendix A.8: Column Designs

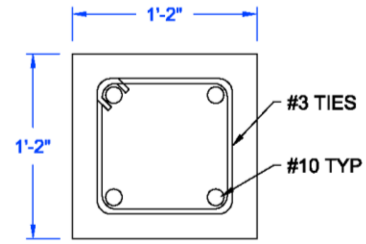
Column Line 2 Columns



COLUMN 2D

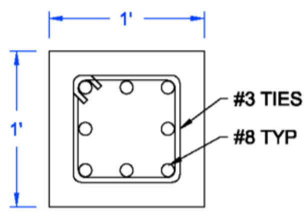


COLUMN 2F

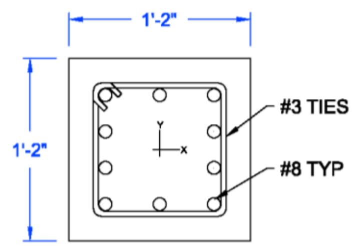


COLUMN 2L

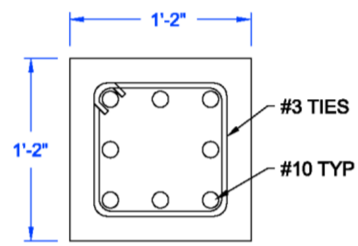
Column Line 8 Columns



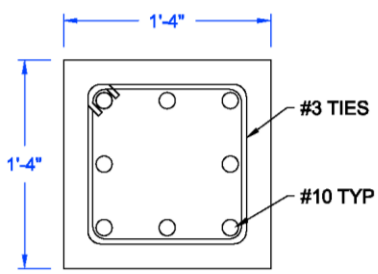
COLUMN 8Z



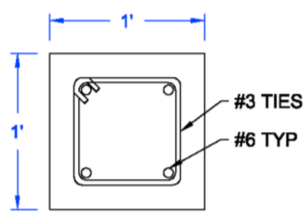
COLUMN 8D



COLUMN 8G

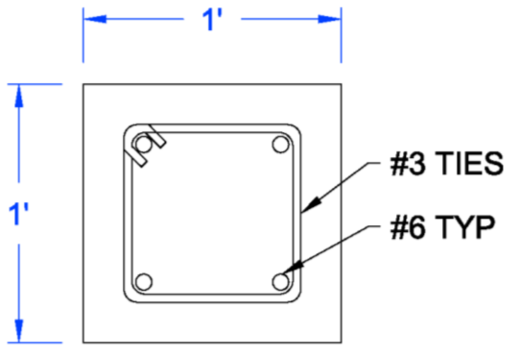


COLUMN 8M

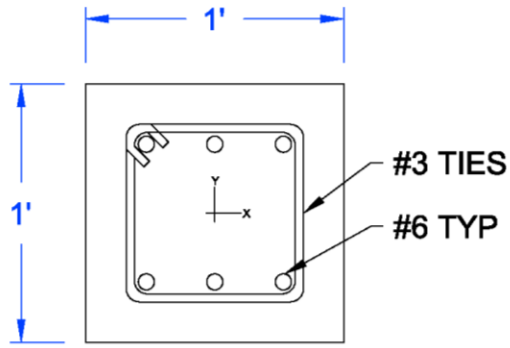


COLUMN 8P

Column Line 13 Columns



COLUMN 13A.2
COLUMN 13B
COLUMN 13E
COLUMN 13H
COLUMN 13K
COLUMN 13N

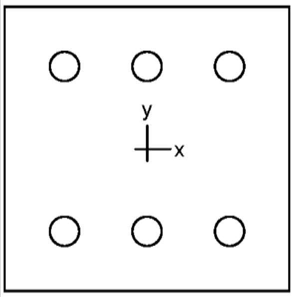


COLUMN 13C

Appendix A.9: spColumn Output

Column Line 2 Columns

Column 2D



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

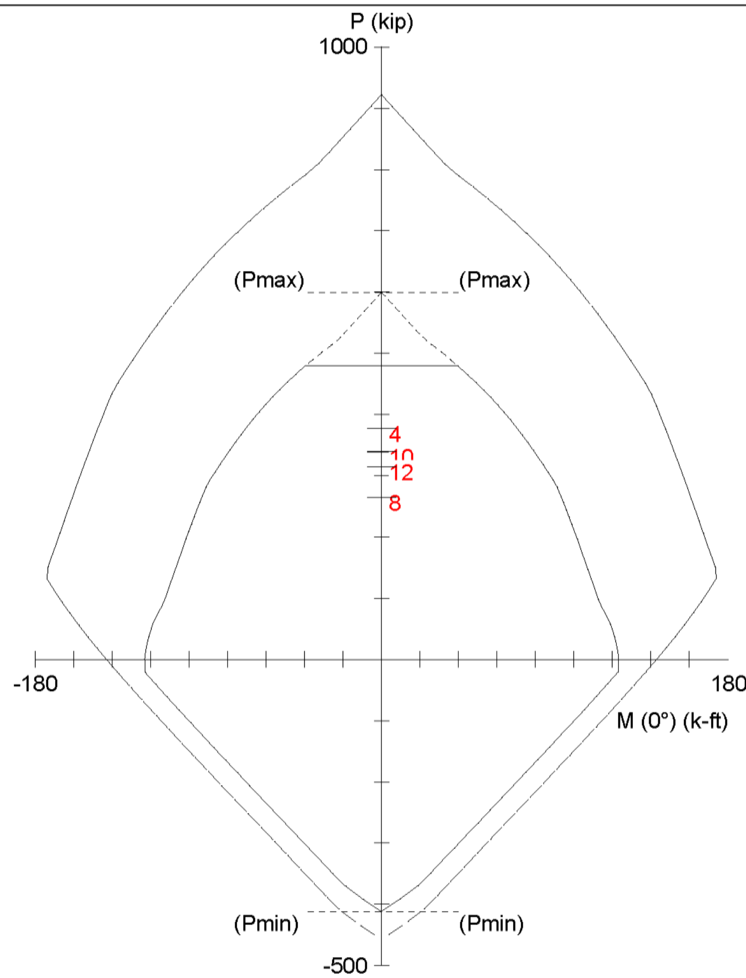
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:59:47



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File: F:\SPRING\Gravity\Column Design\Frame 2\2D.col

Project: Gravity System

Column: 2D | Engineer: ahm

f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	6 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 7.62 in^2	rho = 5.29%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 2.22 in	Clear cover = 1.87 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                         Page   1
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F:\SPRING\Gravity\Column Design\Frame 2\2D.col                                                               09:57 AM
```

```
                     oooooo               o
                    oo    oo             oo
 ooooo    oooooo    oo          ooooo    oo      oo   oo   o oooooooooo    o ooooo
oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
oo        oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
 ooooo    oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo   oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
=========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                      Page   2
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F:\SPRING\Gravity\Column Design\Frame 2\2D.col                                            09:57 AM

General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 2\2D.col
  Project:  Gravity System
  Column:   2D                             Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in               Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                          Iy =  1728 in^4
  rx =  3.4641 in                          ry =  3.4641 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 7.62 in^2 at rho = 5.29%
  Minimum clear spacing = 2.22 in

  6 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       188.38        29.90         0.00        -5.43         0.00
      Live        89.67        17.58         0.00        -1.19         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00
    2 Dead       188.38        29.90         0.00        -5.43         0.00
      Live        66.06        17.58         0.00        -6.92         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                              Page   3
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F:\SPRING\Gravity\Column Design\Frame 2\2D.col                                    09:57 AM

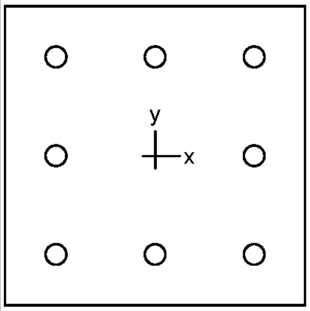
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
```

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	263.73	41.86	-7.60	81.01	-14.71	1.935	9.35	11.53	0.00070	0.650
2		263.73	0.00	0.00	93.36	0.00	999.999	7.75	9.49	0.00067	0.650
3	1 U2	376.53	66.33	-8.42	67.15	-8.52	1.012	11.17	11.04	-0.00003	0.650
4		376.53	0.00	0.00	70.45	0.00	999.999	10.00	9.49	-0.00015	0.650
5	1 U3	338.14	60.88	-7.71	74.02	-9.37	1.216	10.35	11.04	0.00020	0.650
6		338.14	0.00	0.00	79.44	0.00	999.999	9.14	9.49	0.00011	0.650
7	2 U1	263.73	41.86	-7.60	81.01	-14.71	1.935	9.35	11.53	0.00070	0.650
8		263.73	0.00	0.00	93.36	0.00	999.999	7.75	9.49	0.00067	0.650
9	2 U2	338.76	66.33	-17.59	67.24	-17.83	1.014	11.25	12.14	0.00024	0.650
10		338.76	0.00	0.00	79.30	0.00	999.999	9.16	9.49	0.00011	0.650
11	2 U3	314.53	60.88	-13.44	72.84	-16.08	1.196	10.51	11.83	0.00038	0.650
12		314.53	0.00	0.00	84.55	0.00	999.999	8.66	9.49	0.00029	0.650

*** End of output ***

Column 2F



14 x 14 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

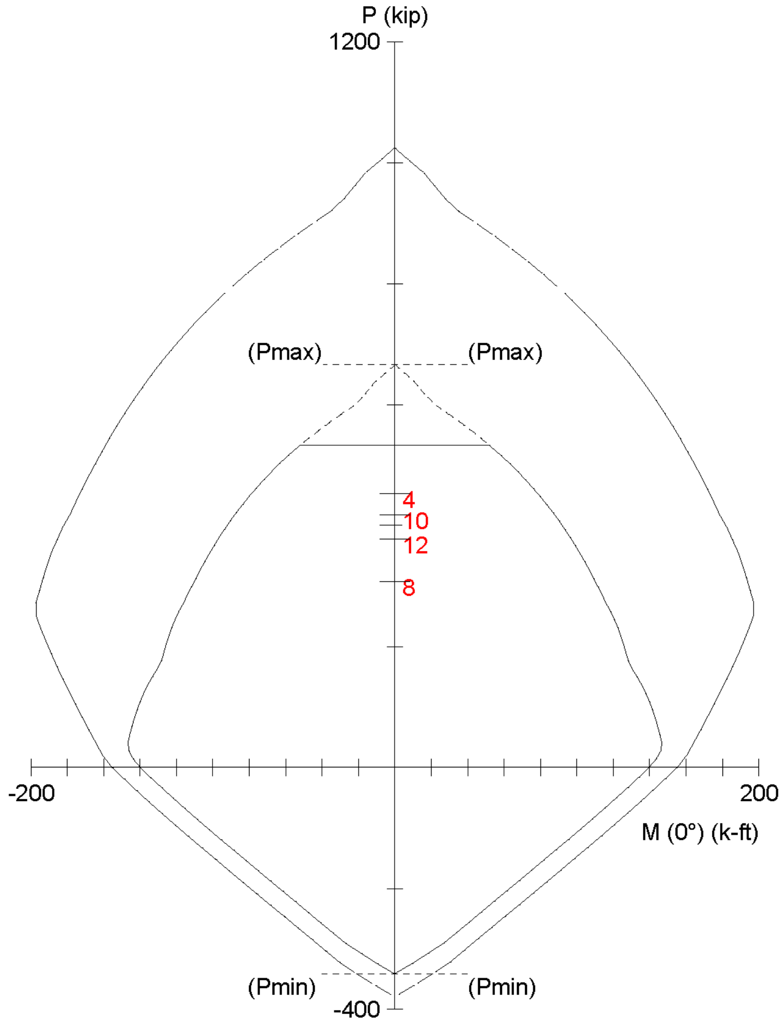
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 10:07:38



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File: F:\SPRING\Gravity\Column Design\Frame 2\2F.col

Project: Gravity System

Column: 2F		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 196 in^2	8 #8 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 6.32 in^2	rho = 3.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 3201.33 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 3201.33 in^4
Beta1 = 0.85		Min clear spacing = 3.62 in	Clear cover = 1.87 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
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spColumn v4.81 (TM)
Computer program for the Strength Design of Reinforced Concrete Sections

```
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F:\SPRING\Gravity\Column Design\Frame 2\2F.col                                                              10:05 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 2\2F.col
  Project:  Gravity System
  Column:   2F                          Engineer: ahm
  Code:     ACI 318-11                  Units: English

  Run Option: Design                    Slenderness: Not considered
  Run Axis:   Biaxial                   Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                         fy   = 60 ksi
  Ec    = 3605 ksi                      Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 14 in            Depth = 14 in

  Gross section area, Ag =  196 in^2
  Ix =  3201.33 in^4                    Iy =  3201.33 in^4
  rx =  4.04145 in                      ry =  4.04145 in
  Xo =  0 in                            Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.96 in^2,  Asmax = 0.08 * Ag = 15.68 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 6.32 in^2 at rho = 3.22%
  Minimum clear spacing = 3.62 in

  8 #8   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       219.09        29.90         0.00         7.91         0.00
      Live       114.46        17.58         0.00         6.12         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00
    2 Dead       219.09        29.90         0.00         7.91         0.00
      Live        92.11        17.58         0.00         8.93         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   3
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F:\SPRING\Gravity\Column Design\Frame 2\2F.col                                          10:05 AM

  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu         Mux        Muy      PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip        k-ft       k-ft        k-ft       k-ft                in       in
  --- ------- ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      306.73      41.86      11.07      97.71      25.85    2.334    11.21    14.66  0.00092  0.650
    2            306.73       0.00       0.00     110.36       0.00  999.999     9.11    11.63  0.00083  0.650
    3  1 U2      453.05      66.33      19.28      72.15      20.98    1.088    14.36    14.54  0.00004  0.650
    4            453.05       0.00       0.00      78.55       0.00  999.999    12.30    11.63 -0.00016  0.650
    5  1 U3      399.78      60.88      15.61      84.61      21.70    1.390    13.02    14.43  0.00032  0.650
    6            399.78       0.00       0.00      92.14       0.00  999.999    11.04    11.63  0.00016  0.650
    7  2 U1      306.73      41.86      11.07      97.71      25.85    2.334    11.21    14.66  0.00092  0.650
    8            306.73       0.00       0.00     110.36       0.00  999.999     9.11    11.63  0.00083  0.650
    9  2 U2      417.29      66.33      23.78      77.37      27.74    1.166    13.85    15.05  0.00026  0.650
   10            417.29       0.00       0.00      87.99       0.00  999.999    11.45    11.63  0.00005  0.650
   11  2 U3      377.43      60.88      18.42      86.64      26.22    1.423    12.83    14.84  0.00047  0.650
   12            377.43       0.00       0.00      97.07       0.00  999.999    10.55    11.63  0.00031  0.650

  *** End of output ***
```
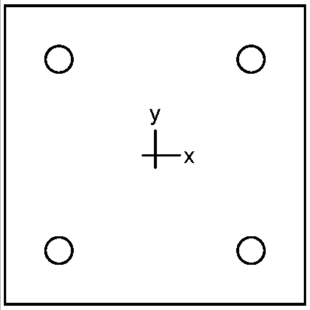

Column 2L



14 x 14 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

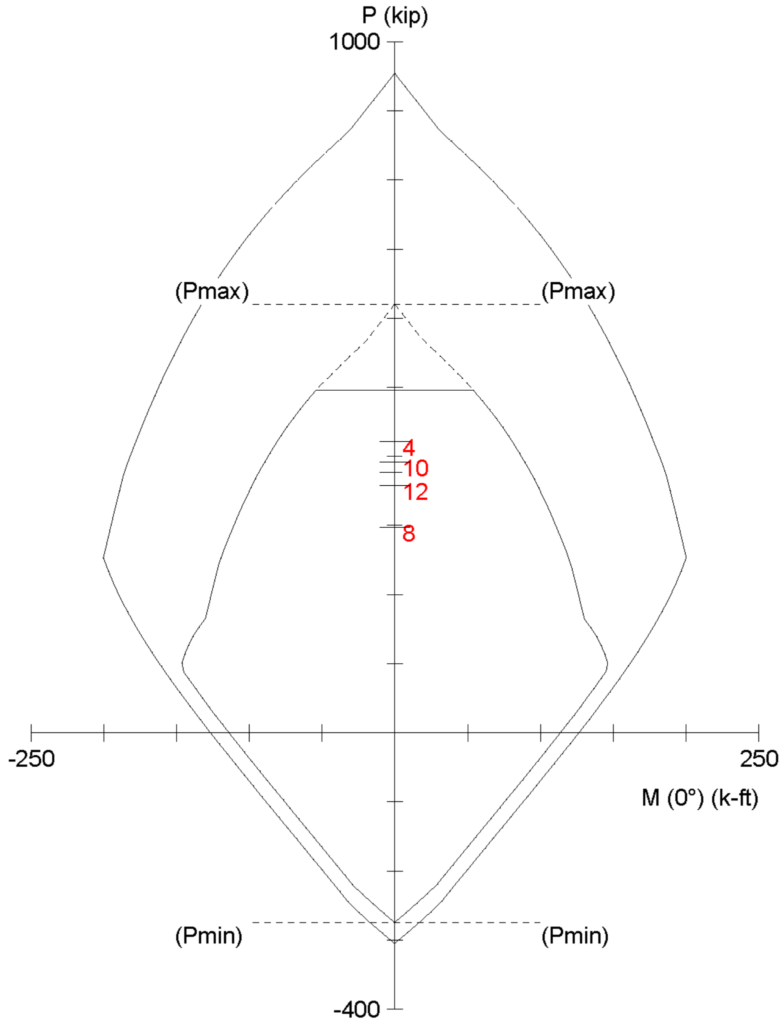
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 10:16:59



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 2\2L.col

Project: Gravity System

Column: 2L		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 196 in^2	4 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 5.08 in^2	rho = 2.59%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 3201.33 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 3201.33 in^4
Beta1 = 0.85		Min clear spacing = 7.71 in	Clear cover = 1.87 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                  Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68      02/07/14
F:\SPRING\Gravity\Column Design\Frame 2\2L.col                                        10:14 AM
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
=========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                    Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                       02/07/14
F:\SPRING\Gravity\Column Design\Frame 2\2L.col                                                          10:14 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 2\2L.col
  Project:  Gravity System
  Column:   2L                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 14 in                Depth = 14 in

  Gross section area, Ag =  196 in^2
  Ix =  3201.33 in^4                        Iy =  3201.33 in^4
  rx =  4.04145 in                          ry =  4.04145 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.96 in^2,  Asmax = 0.08 * Ag = 15.68 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 5.08 in^2 at rho = 2.59%
  Minimum clear spacing = 7.71 in

  4 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       212.46        29.90         0.00       -10.38         0.00
      Live        99.41        17.58         0.00        -8.35         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00
    2 Dead       212.46        29.90         0.00       -10.38         0.00
      Live        81.01        17.58         0.00       -14.30         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.01         4.64         0.00         0.00         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/07/14
F:\SPRING\Gravity\Column Design\Frame 2\2L.col 10:14 AM

U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:

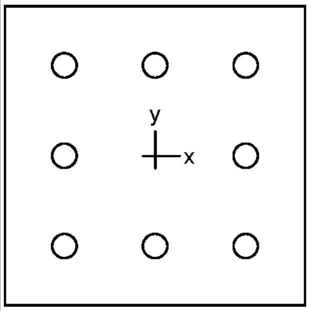
Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	297.44	41.86	-14.53	93.72	-32.54	2.239	11.65	14.97	0.00086	0.650
2		297.44	0.00	0.00	111.08	0.00	999.999	9.15	11.49	0.00077	0.650
3	1 U2	421.01	66.33	-25.82	69.56	-27.07	1.049	14.64	15.00	0.00007	0.650
4		421.01	0.00	0.00	80.86	0.00	999.999	12.16	11.49	-0.00016	0.650
5	1 U3	376.78	60.88	-20.81	81.26	-27.77	1.335	13.41	14.87	0.00033	0.650
6		376.78	0.00	0.00	93.29	0.00	999.999	11.01	11.49	0.00013	0.650
7	2 U1	297.44	41.86	-14.53	93.72	-32.54	2.239	11.65	14.97	0.00086	0.650
8		297.44	0.00	0.00	111.08	0.00	999.999	9.15	11.49	0.00077	0.650
9	2 U2	391.57	66.33	-35.34	70.97	-37.81	1.070	14.30	15.67	0.00029	0.650
10		391.57	0.00	0.00	89.37	0.00	999.999	11.39	11.49	0.00003	0.650
11	2 U3	358.38	60.88	-26.76	80.53	-35.39	1.323	13.33	15.39	0.00046	0.650
12		358.38	0.00	0.00	97.86	0.00	999.999	10.56	11.49	0.00027	0.650

*** End of output ***

Column Line 8 Columns

Column 8Z



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

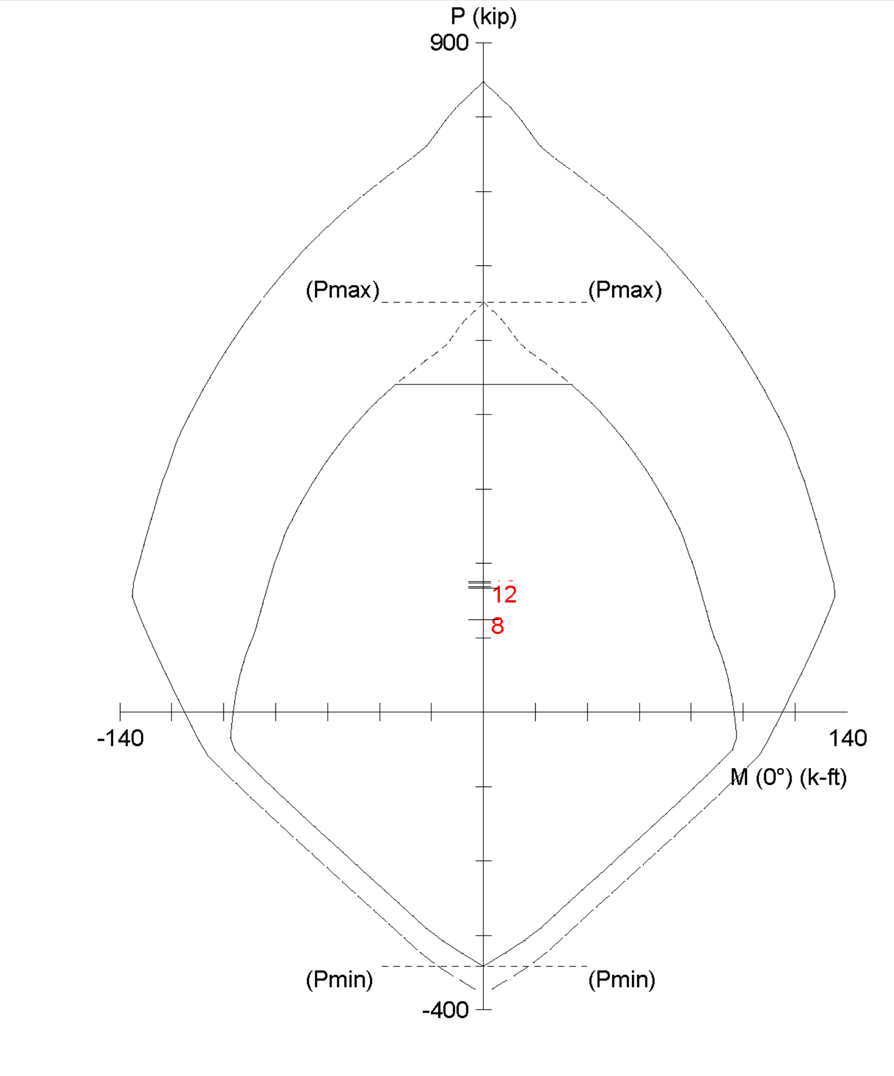
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:24:06



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 8\8Z.col

Project: Gravity System

Column: 8Z		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	8 #8 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 6.32 in^2	rho = 4.39%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 2.62 in	Clear cover = 1.87 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                                         Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                             02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8Z.col                                                               09:23 AM
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

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=========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
=========================================================================================================
```

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                      Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68          02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8Z.col                                            09:23 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 8\8Z.col
  Project:  Gravity System
  Column:   8Z                         Engineer: ahm
  Code:     ACI 318-11                 Units: English

  Run Option: Design                   Slenderness: Not considered
  Run Axis:   Biaxial                  Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                        fy   = 60 ksi
  Ec    = 3605 ksi                     Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in           Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                      Iy =  1728 in^4
  rx =  3.4641 in                      ry =  3.4641 in
  Xo =  0 in                           Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 6.32 in^2 at rho = 4.39%
  Minimum clear spacing = 2.62 in

  8 #8   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead        88.83         0.00         0.00        35.40         0.00
      Live        38.36         0.00         0.00        16.15         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.72         0.00         0.00         6.87         0.00
    2 Dead        88.83         0.00         0.00        35.40         0.00
      Live        37.10         0.00         0.00        16.98         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.72         0.00         0.00         6.87         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM)   Page 3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68   02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8Z.col   09:23 AM

U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

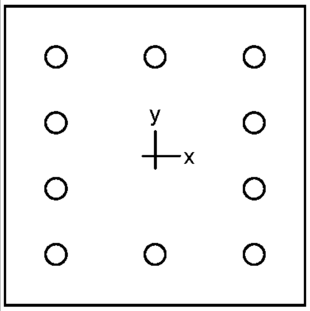
Factored Loads and Moments with Corresponding Capacities:

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

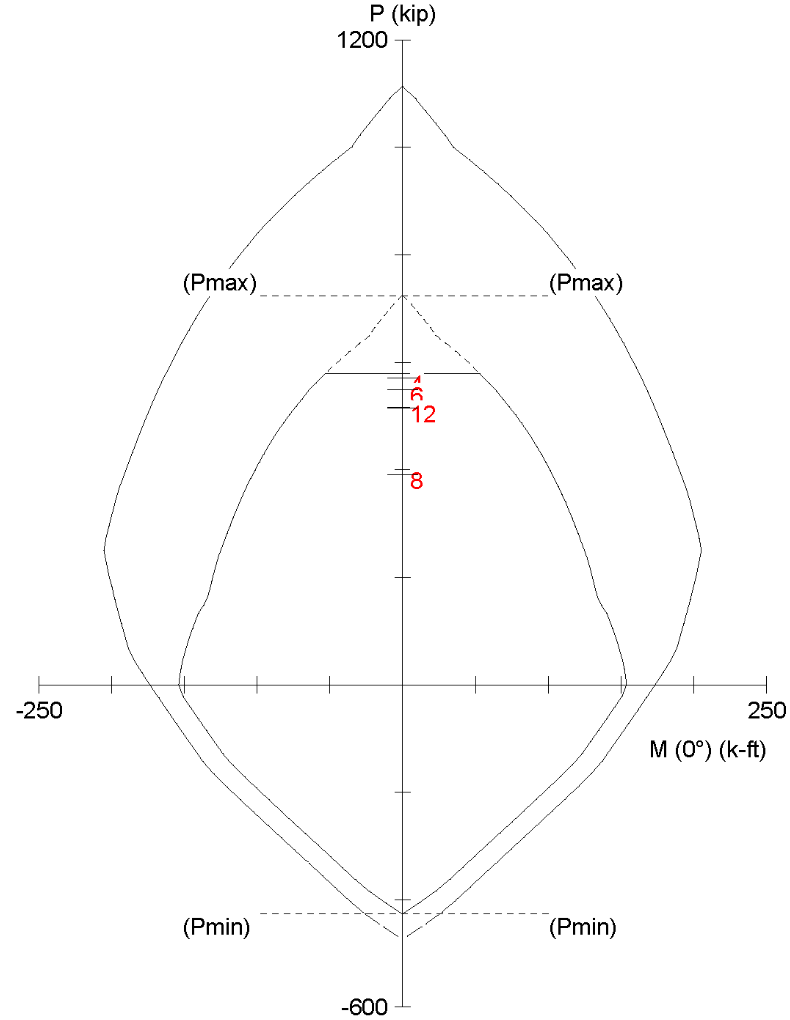
No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	124.36	0.00	49.56	-0.00	86.67	1.749	5.93	9.63	0.00187	0.650
2		124.36	0.00	0.00	86.67	0.00	999.999	5.93	9.63	0.00187	0.650
3	1 U2	175.33	0.00	71.76	-0.00	82.56	1.151	6.59	9.63	0.00138	0.650
4		175.33	0.00	0.00	82.56	0.00	999.999	6.59	9.63	0.00138	0.650
5	1 U3	168.51	0.00	69.62	-0.00	83.12	1.194	6.50	9.63	0.00144	0.650
6		168.51	0.00	0.00	83.12	0.00	999.999	6.50	9.63	0.00144	0.650
7	2 U1	124.36	0.00	49.56	-0.00	86.67	1.749	5.93	9.63	0.00187	0.650
8		124.36	0.00	0.00	86.67	0.00	999.999	5.93	9.63	0.00187	0.650
9	2 U2	173.32	0.00	73.08	-0.00	82.73	1.132	6.56	9.63	0.00140	0.650
10		173.32	0.00	0.00	82.73	0.00	999.999	6.56	9.63	0.00140	0.650
11	2 U3	167.25	0.00	70.45	-0.00	83.23	1.181	6.48	9.63	0.00146	0.650
12		167.25	0.00	0.00	83.23	0.00	999.999	6.48	9.63	0.00146	0.650

*** End of output ***

Column 8D



14 x 14 in



Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:36:01

spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 8\8D.col

Project: Gravity System

Column: 8D		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 196 in^2	10 #8 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 7.90 in^2	rho = 4.03%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 3201.33 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 3201.33 in^4
Beta1 = 0.85		Min clear spacing = 2.08 in	Clear cover = 1.87 in
Confinement: Tied			
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65			

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                   Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                       02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8D.col                                                         09:35 AM
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spColumn v4.81 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                          Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68              02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8D.col                                                09:35 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 8\8D.col
  Project:  Gravity System
  Column:   8D                                Engineer: ahm
  Code:     ACI 318-11                        Units: English

  Run Option: Design                          Slenderness: Not considered
  Run Axis:   Biaxial                         Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                               fy   = 60 ksi
  Ec    = 3605 ksi                            Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 14 in                  Depth = 14 in

  Gross section area, Ag =  196 in^2
  Ix =  3201.33 in^4                          Iy =  3201.33 in^4
  rx =  4.04145 in                            ry =  4.04145 in
  Xo =  0 in                                  Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.96 in^2,  Asmax = 0.08 * Ag = 15.68 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 7.90 in^2 at rho = 4.03%
  Minimum clear spacing = 2.08 in

  10 #8   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       278.71         0.00         0.00       -18.89         0.00
      Live       131.44         0.00         0.00        -6.58         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        51.76         0.00         0.00        -4.54         0.00
    2 Dead       278.71         0.00         0.00       -18.89         0.00
      Live        97.22         0.00         0.00       -10.91         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        51.76         0.00         0.00        -4.54         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

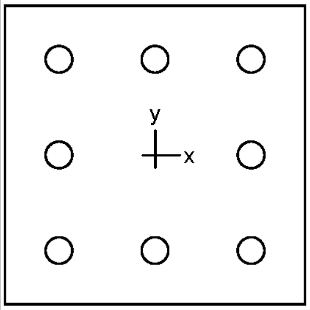
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                   Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68       02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8D.col                                         09:35 AM


  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft               in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      390.19       0.00     -26.45       0.00    -112.66    4.260    10.32    11.63  0.00038  0.650
    2            390.19       0.00       0.00     103.05       0.00  999.999    10.28    11.63  0.00039  0.650
    3  1 U2      570.64       0.00     -35.47       0.00     -59.71    1.684    14.55    11.63 -0.00060  0.650
    4            570.64       0.00       0.00      56.15       0.00  999.999    14.38    11.63 -0.00058  0.650
    5  1 U3      548.71       0.00     -36.51       0.00     -68.12    1.866    13.99    11.63 -0.00051  0.650
    6            548.71       0.00       0.00      63.82       0.00  999.999    13.84    11.63 -0.00048  0.650
    7  2 U1      390.19       0.00     -26.45       0.00    -112.66    4.260    10.32    11.63  0.00038  0.650
    8            390.19       0.00       0.00     103.05       0.00  999.999    10.28    11.63  0.00039  0.650
    9  2 U2      515.88       0.00     -42.39       0.00     -79.18    1.868    13.03    11.63 -0.00032  0.650
   10            515.88       0.00       0.00      73.72       0.00  999.999    12.93    11.63 -0.00030  0.650
   11  2 U3      514.49       0.00     -40.84       0.00     -79.63    1.950    12.99    11.63 -0.00032  0.650
   12            514.49       0.00       0.00      74.13       0.00  999.999    12.90    11.63 -0.00030  0.650

  *** End of output ***
```

Column 8G



14 x 14 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

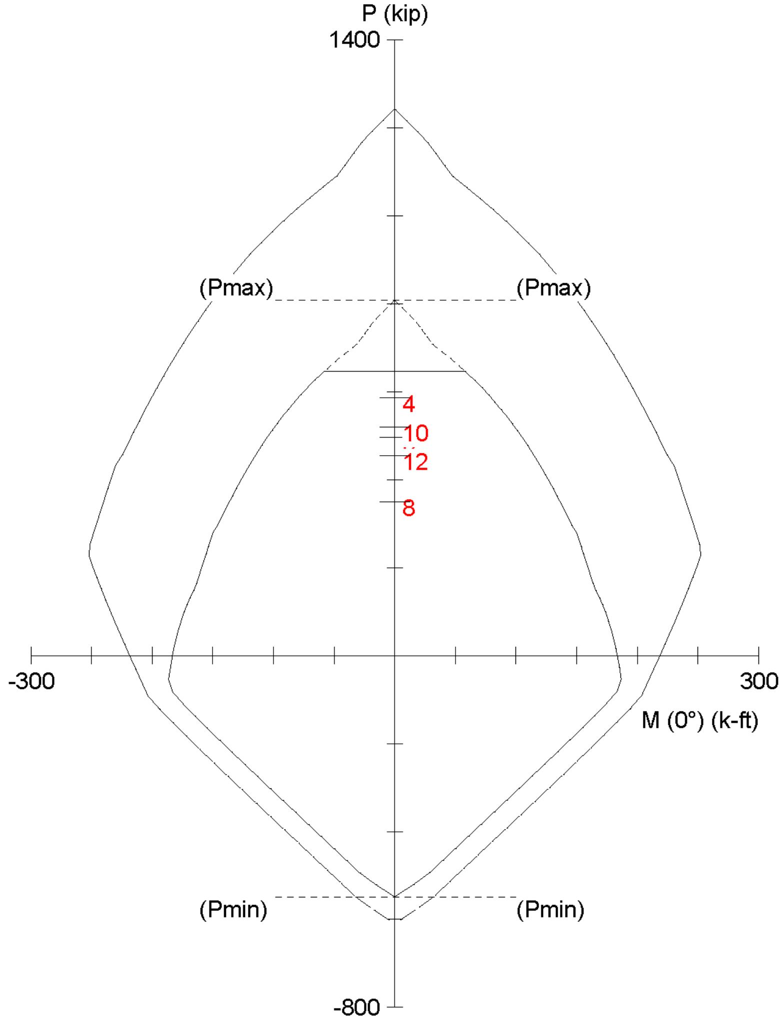
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:43:54



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 8\8G.col

Project: Gravity System

Column: 8G		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 196 in^2	8 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 10.16 in^2	rho = 5.18%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 3201.33 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 3201.33 in^4
Beta1 = 0.85		Min clear spacing = 3.22 in	Clear cover = 1.87 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

STRUCTUREPOINT - spColumn v4.81 (TM) Page 1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8G.col 09:39 AM

```
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
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===

spColumn v4.81 (TM)
Computer program for the Strength Design of Reinforced Concrete Sections

===

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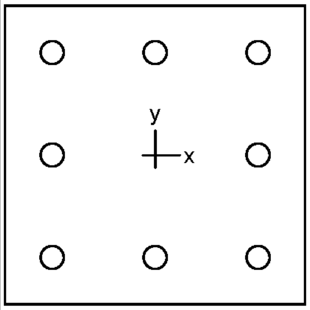
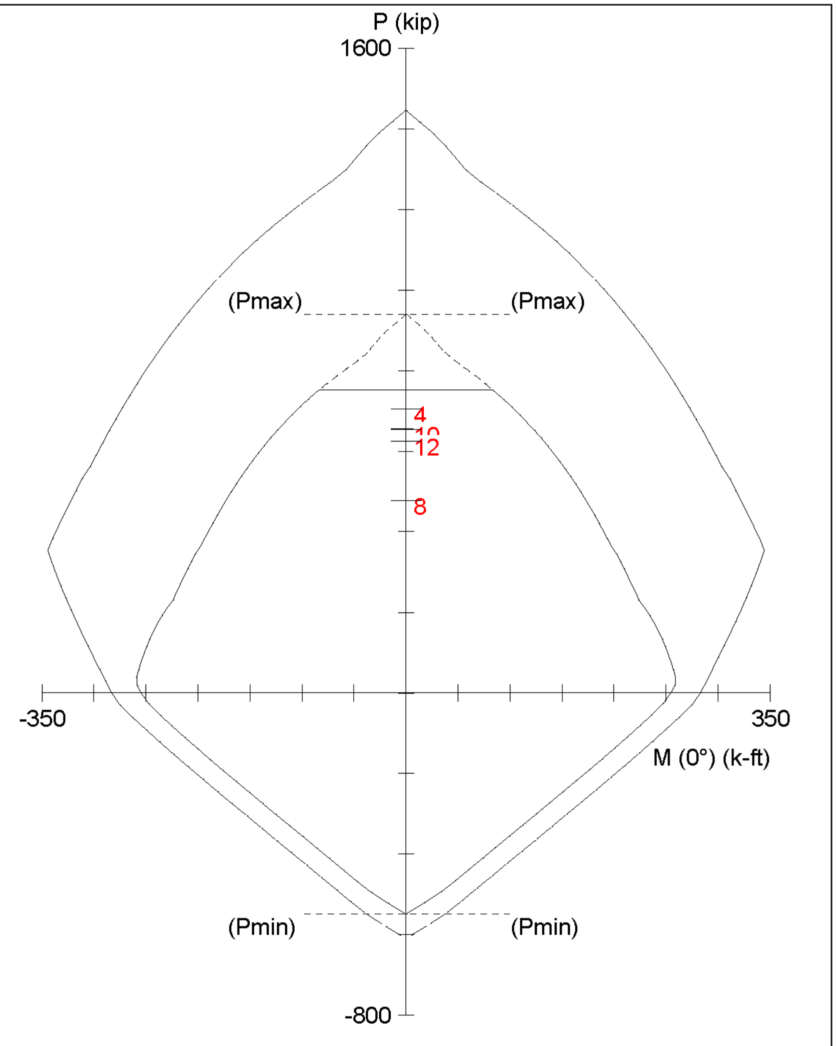
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68       02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8G.col                                          09:39 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 8\8G.col
  Project:  Gravity System
  Column:   8G                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 14 in                Depth = 14 in

  Gross section area, Ag =  196 in^2
  Ix =  3201.33 in^4                        Iy =  3201.33 in^4
  rx =  4.04145 in                          ry =  4.04145 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.96 in^2,  Asmax = 0.08 * Ag = 15.68 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 10.16 in^2 at rho = 5.18%
  Minimum clear spacing = 3.22 in

  8 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       249.62         0.00         0.00         9.39         0.00
      Live       175.12         0.00         0.00         3.42         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        13.66         0.00         0.00         1.28         0.00
    2 Dead       249.62         0.00         0.00         9.39         0.00
      Live       132.67         0.00         0.00         8.35         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        13.66         0.00         0.00         1.28         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                      Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68          02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8G.col                                            09:39 AM


  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      349.47       0.00      13.15      -0.00     136.27   10.366     9.09    11.49  0.00079  0.650
    2            349.47       0.00       0.00     136.27       0.00  999.999     9.09    11.49  0.00079  0.650
    3  1 U2      586.57       0.00      17.38      -0.00      79.58    4.579    13.59    11.49 -0.00046  0.650
    4            586.57       0.00       0.00      79.58       0.00  999.999    13.59    11.49 -0.00046  0.650
    5  1 U3      496.52       0.00      16.74      -0.00     104.83    6.264    11.56    11.49 -0.00002  0.650
    6            496.52       0.00       0.00     104.83       0.00  999.999    11.56    11.49 -0.00002  0.650
    7  2 U1      349.47       0.00      13.15      -0.00     136.27   10.366     9.09    11.49  0.00079  0.650
    8            349.47       0.00       0.00     136.27       0.00  999.999     9.09    11.49  0.00079  0.650
    9  2 U2      518.65       0.00      25.27      -0.00      99.12    3.923    11.99    11.49 -0.00013  0.650
   10            518.65       0.00       0.00      99.12       0.00  999.999    11.99    11.49 -0.00013  0.650
   11  2 U3      454.07       0.00      21.67      -0.00     114.93    5.305    10.78    11.49  0.00020  0.650
   12            454.07       0.00       0.00     114.93       0.00  999.999    10.78    11.49  0.00020  0.650

  *** End of output ***
```

Column 8M



16 x 16 in



Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:48:33

spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 8\8M.col

Project: Gravity System

Column: 8M		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 256 in^2	8 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 10.16 in^2	rho = 3.97%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 5461.33 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 5461.33 in^4
Beta1 = 0.85		Min clear spacing = 4.22 in	Clear cover = 1.87 in
Confinement: Tied			

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                        Page   1
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F:\SPRING\Gravity\Column Design\Frame 8\8M.col                                                              09:46 AM
```

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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
==========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
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                                          All rights reserved
==========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                    Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                        02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8M.col                                                          09:46 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 8\8M.col
  Project:  Gravity System
  Column:   8M                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 16 in                Depth = 16 in

  Gross section area, Ag =  256 in^2
  Ix =  5461.33 in^4                        Iy =  5461.33 in^4
  rx =  4.6188 in                           ry =  4.6188 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 2.56 in^2,  Asmax = 0.08 * Ag = 20.48 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 10.16 in^2 at rho = 3.97%
  Minimum clear spacing = 4.22 in

  8 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       340.47         0.00         0.00        -4.39         0.00
      Live       170.19         0.00         0.00        -2.69         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        48.28         0.00         0.00        -0.31         0.00
    2 Dead       340.47         0.00         0.00        -4.39         0.00
      Live       138.39         0.00         0.00        -6.69         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        48.28         0.00         0.00        -0.31         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   3
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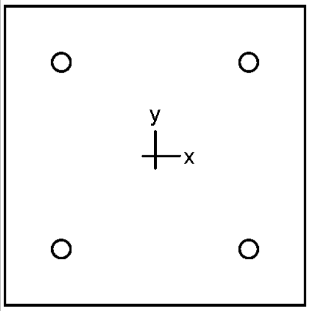
F:\SPRING\Gravity\Column Design\Frame 8\8M.col                                              09:46 AM


  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      476.66       0.00      -6.15       0.00    -173.19   28.179    11.34    13.49  0.00057  0.650
    2            476.66       0.00       0.00     173.19       0.00  999.999    11.34    13.49  0.00057  0.650
    3  1 U2      705.01       0.00      -9.73       0.00    -103.33   10.623    15.65    13.49 -0.00041  0.650
    4            705.01       0.00       0.00     103.33       0.00  999.999    15.65    13.49 -0.00041  0.650
    5  1 U3      656.00       0.00      -8.45       0.00    -121.81   14.408    14.63    13.49 -0.00023  0.650
    6            656.00       0.00       0.00     121.81       0.00  999.999    14.63    13.49 -0.00023  0.650
    7  2 U1      476.66       0.00      -6.15       0.00    -173.19   28.179    11.34    13.49  0.00057  0.650
    8            476.66       0.00       0.00     173.19       0.00  999.999    11.34    13.49  0.00057  0.650
    9  2 U2      654.13       0.00     -16.13       0.00    -122.47    7.594    14.59    13.49 -0.00023  0.650
   10            654.13       0.00       0.00     122.47       0.00  999.999    14.59    13.49 -0.00023  0.650
   11  2 U3      624.20       0.00     -12.45       0.00    -132.59   10.647    13.99    13.49 -0.00011  0.650
   12            624.20       0.00       0.00     132.59       0.00  999.999    13.99    13.49 -0.00011  0.650

  *** End of output ***
```

Column 8P



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

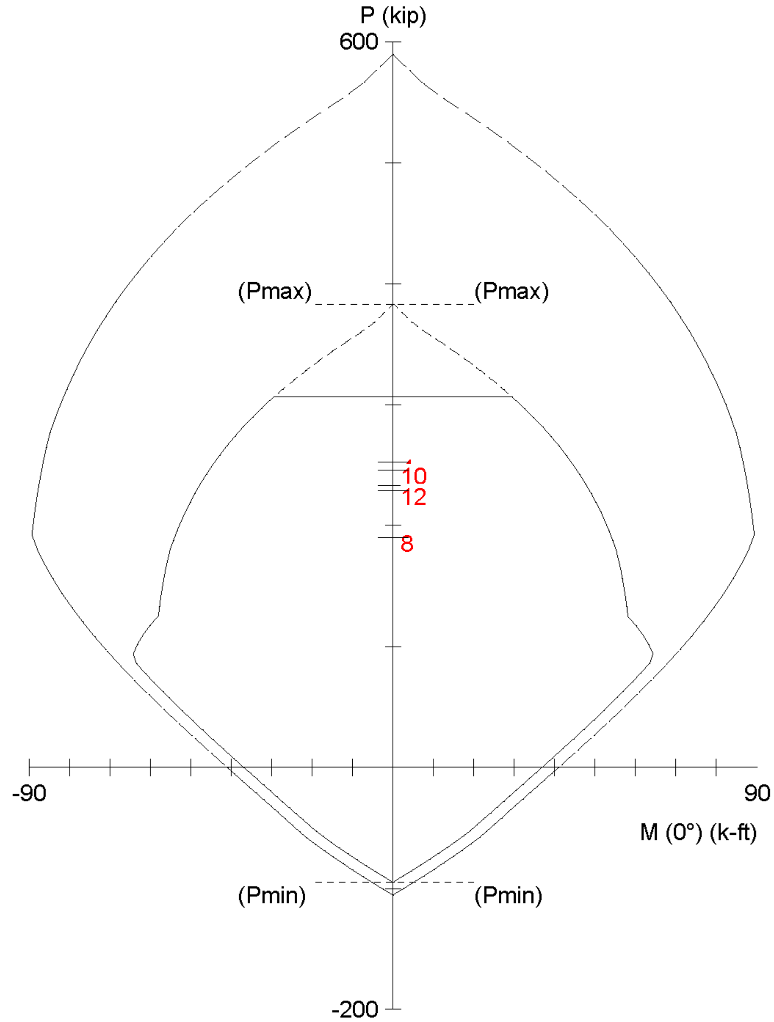
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 09:51:36



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 8\8P.col

Project: Gravity System

Column: 8P		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in
Confinement: Tied			
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65			

STRUCTUREPOINT - spColumn v4.81 (TM) Page 1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8P.col 09:51 AM

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                    oo    oo             oo
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==

spColumn v4.81 (TM)
Computer program for the Strength Design of Reinforced Concrete Sections

==

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```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                         Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68             02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8P.col                                               09:51 AM


General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 8\8P.col
  Project:  Gravity System
  Column:   8P                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in                Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                           Iy =  1728 in^4
  rx =  3.4641 in                           ry =  3.4641 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,   Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       135.60         0.00         0.00        -2.40         0.00
      Live        52.78         0.00         0.00        -4.66         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.07         0.00         0.00         0.14         0.00
    2 Dead       135.60         0.00         0.00        -2.40         0.00
      Live        48.32         0.00         0.00        -5.09         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.07         0.00         0.00         0.14         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                       Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68          02/07/14
F:\SPRING\Gravity\Column Design\Frame 8\8P.col                                            09:51 AM

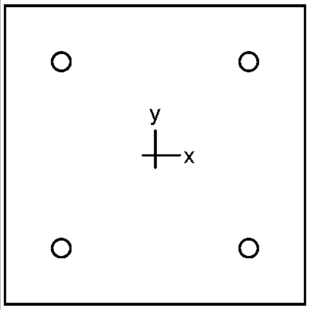
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      189.84       0.00      -3.36       0.00     -54.04   16.082     7.61     9.75  0.00084  0.650
    2            189.84       0.00       0.00      54.04       0.00  999.999     7.61     9.75  0.00084  0.650
    3  1 U2      252.70       0.00     -10.27       0.00     -44.00    4.286     9.77     9.75 -0.00001  0.650
    4            252.70       0.00       0.00      44.00       0.00  999.999     9.77     9.75 -0.00001  0.650
    5  1 U3      233.21       0.00      -7.32       0.00     -47.81    6.534     9.08     9.75  0.00022  0.650
    6            233.21       0.00       0.00      47.81       0.00  999.999     9.08     9.75  0.00022  0.650
    7  2 U1      189.84       0.00      -3.36       0.00     -54.04   16.082     7.61     9.75  0.00084  0.650
    8            189.84       0.00       0.00      54.04       0.00  999.999     7.61     9.75  0.00084  0.650
    9  2 U2      245.57       0.00     -10.95       0.00     -45.47    4.151     9.51     9.75  0.00007  0.650
   10            245.57       0.00       0.00      45.47       0.00  999.999     9.51     9.75  0.00007  0.650
   11  2 U3      228.75       0.00      -7.75       0.00     -48.58    6.272     8.92     9.75  0.00028  0.650
   12            228.75       0.00       0.00      48.58       0.00  999.999     8.92     9.75  0.00028  0.650

  *** End of output ***
```

Column Line 13 Columns

Column 13A.2



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

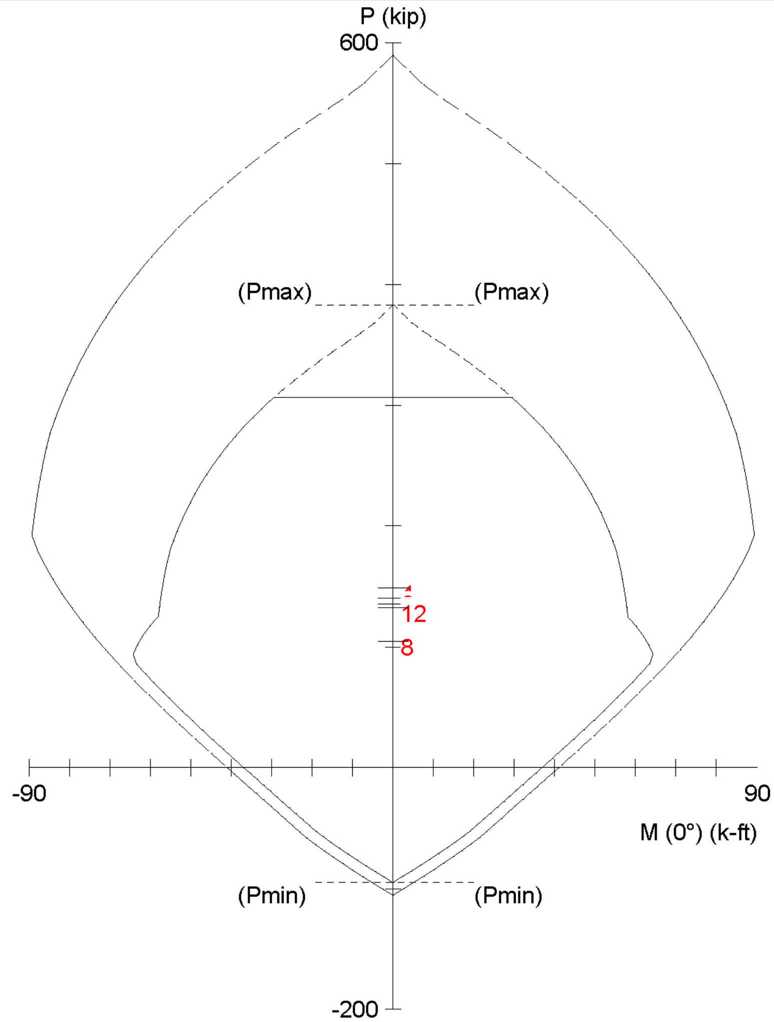
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 15:42:22



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: E:\SPRING\Gravity\Column Design\Frame 13\13A.2.col

Project: Gravity System

Column: 13A.2		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                            02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13A.2.col                                                          03:42 PM
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```

```
==========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
==========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                  Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68     02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13A.2.col                                    03:42 PM

General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13A.2.col
  Project:  Gravity System
  Column:   13A.2                           Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in                Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                           Iy =  1728 in^4
  rx =  3.4641 in                           ry =  3.4641 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead        74.75         0.00         0.00        13.26         0.00
      Live        33.42         0.00         0.00         6.94         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.89         0.00         0.00         1.86         0.00
    2 Dead        74.75         0.00         0.00        13.26         0.00
      Live        25.23         0.00         0.00         7.76         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.89         0.00         0.00         1.86         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

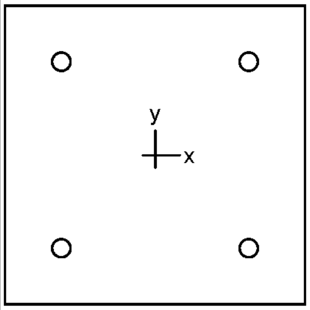
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                  Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                      02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13A.2.col                                                    03:42 PM

  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu         Mux        Muy      PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip        k-ft       k-ft        k-ft       k-ft               in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      104.65       0.00      18.56      -0.00      62.70    3.378     4.36     9.75  0.00370  0.789
    2            104.65       0.00       0.00      62.70       0.00  999.999     4.36     9.75  0.00370  0.789
    3  1 U2      148.62       0.00      27.95      -0.00      57.04    2.041     6.40     9.75  0.00157  0.650
    4            148.62       0.00       0.00      57.04       0.00  999.999     6.40     9.75  0.00157  0.650
    5  1 U3      140.54       0.00      25.83      -0.00      57.42    2.223     6.19     9.75  0.00173  0.650
    6            140.54       0.00       0.00      57.42       0.00  999.999     6.19     9.75  0.00173  0.650
    7  2 U1      104.65       0.00      18.56      -0.00      62.70    3.378     4.36     9.75  0.00370  0.789
    8            104.65       0.00       0.00      62.70       0.00  999.999     4.36     9.75  0.00370  0.789
    9  2 U2      135.51       0.00      29.26      -0.00      57.63    1.970     6.06     9.75  0.00183  0.650
   10            135.51       0.00       0.00      57.63       0.00  999.999     6.06     9.75  0.00183  0.650
   11  2 U3      132.35       0.00      26.65      -0.00      57.75    2.167     5.98     9.75  0.00189  0.650
   12            132.35       0.00       0.00      57.75       0.00  999.999     5.98     9.75  0.00189  0.650

  *** End of output ***
```

Column 13B



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

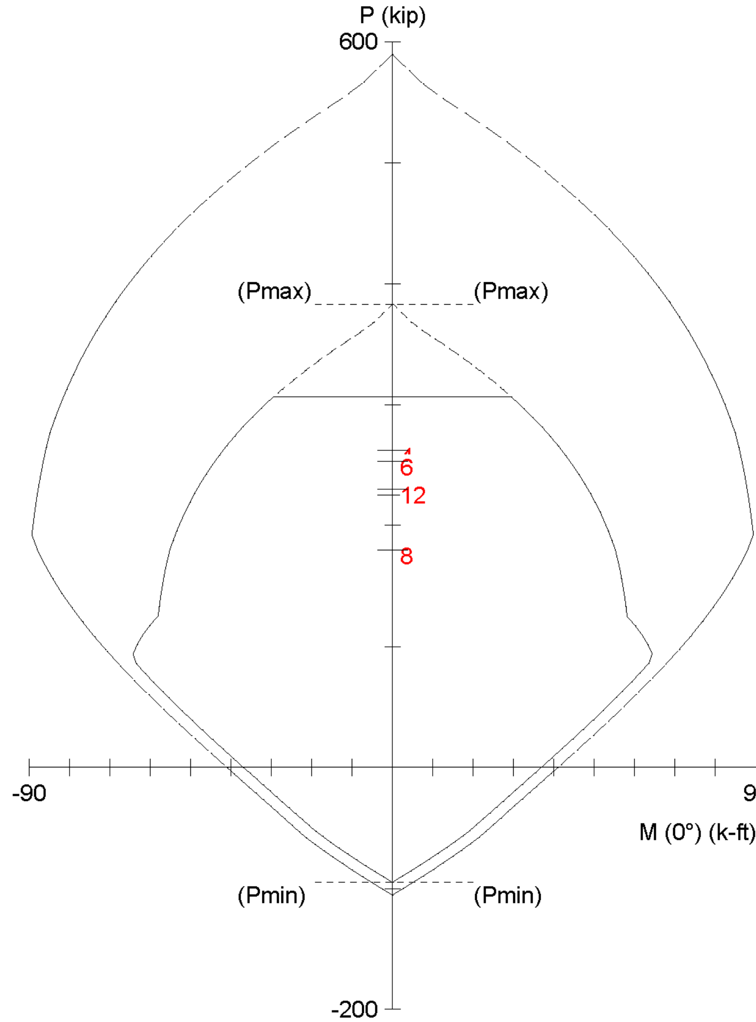
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 15:53:13



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: E:\SPRING\Gravity\Column Design\Frame 13\13B.col

Project: Gravity System

Column: 13B		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in
Confinement: Tied			

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                         Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                             02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13B.col                                                             03:51 PM
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spColumn v4.81 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

===

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68            02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13B.col                                            03:51 PM


General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13B.col
  Project:  Gravity System
  Column:   13B                             Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in                Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                           Iy =  1728 in^4
  rx =  3.4641 in                           ry =  3.4641 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       128.26         0.00         0.00        -5.42         0.00
      Live        60.11         0.00         0.00        -2.50         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        24.47         0.00         0.00        -0.28         0.00
    2 Dead       128.26         0.00         0.00        -5.42         0.00
      Live        36.91         0.00         0.00        -4.91         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        24.47         0.00         0.00        -0.28         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68           02/06/14
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  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      179.56       0.00      -7.59       0.00     -55.14    7.266     7.28     9.75  0.00102  0.650
    2            179.56       0.00       0.00      55.14       0.00  999.999     7.28     9.75  0.00102  0.650
    3  1 U2      262.32       0.00     -10.64       0.00     -41.85    3.931    10.12     9.75 -0.00011  0.650
    4            262.32       0.00       0.00      41.85       0.00  999.999    10.12     9.75 -0.00011  0.650
    5  1 U3      253.17       0.00      -9.45       0.00     -43.90    4.644     9.79     9.75 -0.00001  0.650
    6            253.17       0.00       0.00      43.90       0.00  999.999     9.79     9.75 -0.00001  0.650
    7  2 U1      179.56       0.00      -7.59       0.00     -55.14    7.266     7.28     9.75  0.00102  0.650
    8            179.56       0.00       0.00      55.14       0.00  999.999     7.28     9.75  0.00102  0.650
    9  2 U2      225.20       0.00     -14.50       0.00     -49.18    3.391     8.80     9.75  0.00033  0.650
   10            225.20       0.00       0.00      49.18       0.00  999.999     8.80     9.75  0.00033  0.650
   11  2 U3      229.97       0.00     -11.86       0.00     -48.37    4.078     8.96     9.75  0.00026  0.650
   12            229.97       0.00       0.00      48.37       0.00  999.999     8.96     9.75  0.00026  0.650

  *** End of output ***
```
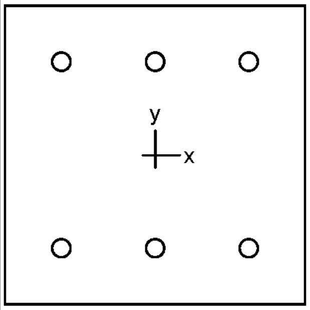

Column 13C



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

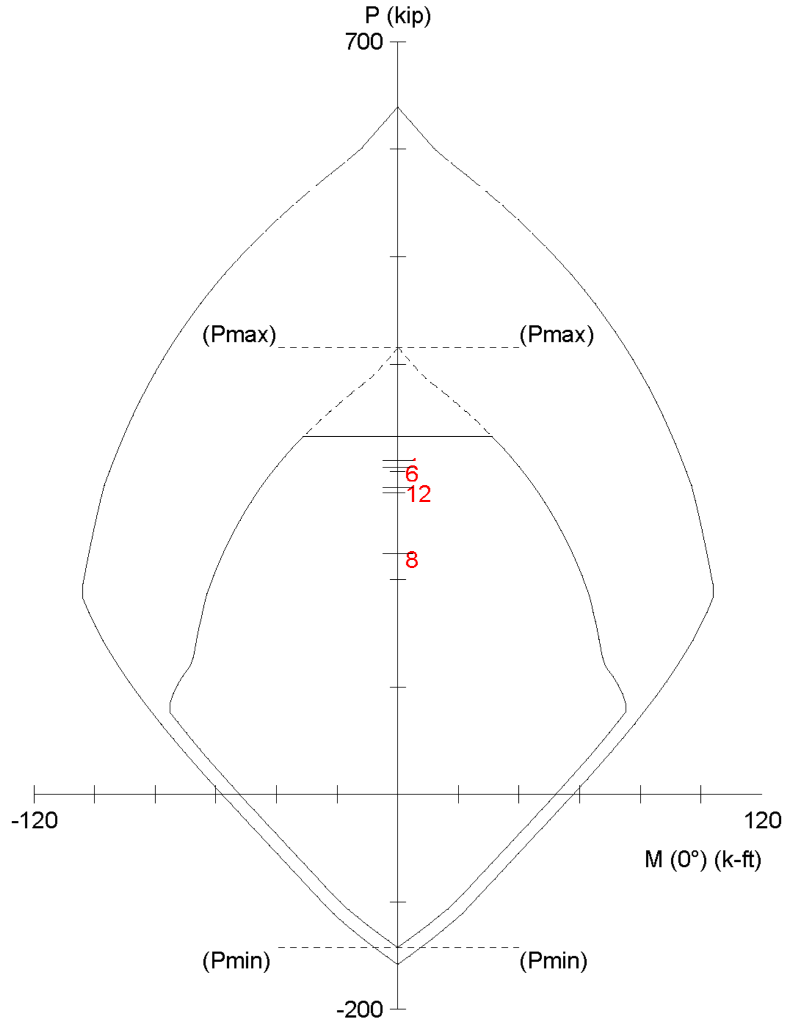
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/07/14

Time: 10:24:44



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Gravity\Column Design\Frame 13\13C.col

Project: Gravity System

Column: 13C

Engineer: ahm

f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	6 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 2.64 in^2	rho = 1.83%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 3.00 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                            02/07/14
F:\SPRING\Gravity\Column Design\Frame 13\13C.col                                                            10:24 AM
```

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```

```
=========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
=========================================================================================================
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/07/14
F:\SPRING\Gravity\Column Design\Frame 13\13C.col 10:24 AM

```
General Information:
====================
  File Name: F:\SPRING\Gravity\Column Design\Frame 13\13C.col
  Project:  Gravity System
  Column:   13C                         Engineer: ahm
  Code:     ACI 318-11                  Units: English

  Run Option: Design                    Slenderness: Not considered
  Run Axis:   Biaxial                   Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                         fy   = 60 ksi
  Ec    = 3605 ksi                      Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in            Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                       Iy =  1728 in^4
  rx =  3.4641 in                       ry =  3.4641 in
  Xo =  0 in                            Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 2.64 in^2 at rho = 1.83%
  Minimum clear spacing = 3.00 in

  6 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load    Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip        k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       159.87         0.00         0.00        -0.66         0.00
      Live        64.95         0.00         0.00        -0.80         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        29.39         0.00         0.00        -0.85         0.00
    2 Dead       159.87         0.00         0.00        -0.66         0.00
      Live        46.10         0.00         0.00        -2.20         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        29.39         0.00         0.00        -0.85         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

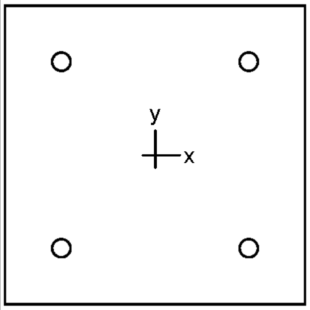
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68       02/07/14
F:\SPRING\Gravity\Column Design\Frame 13\13C.col                                       10:24 AM


  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      223.82       0.00      -0.92       0.00     -51.24   55.450     8.34     9.75  0.00051  0.650
    2            223.82       0.00       0.00      57.61       0.00  999.999     8.34     9.75  0.00051  0.650
    3  1 U2      310.46       0.00      -2.50       0.00     -34.73   13.908    11.13     9.75 -0.00037  0.650
    4            310.46       0.00       0.00      38.31       0.00  999.999    11.19     9.75 -0.00039  0.650
    5  1 U3      303.82       0.00      -2.95       0.00     -36.46   12.351    10.90     9.75 -0.00032  0.650
    6            303.82       0.00       0.00      40.24       0.00  999.999    10.96     9.75 -0.00033  0.650
    7  2 U1      223.82       0.00      -0.92       0.00     -51.24   55.450     8.34     9.75  0.00051  0.650
    8            223.82       0.00       0.00      57.61       0.00  999.999     8.34     9.75  0.00051  0.650
    9  2 U2      280.30       0.00      -4.74       0.00     -41.92    8.849    10.11     9.75 -0.00011  0.650
   10            280.30       0.00       0.00      46.41       0.00  999.999    10.15     9.75 -0.00012  0.650
   11  2 U3      284.97       0.00      -4.35       0.00     -40.91    9.401    10.26     9.75 -0.00015  0.650
   12            284.97       0.00       0.00      45.26       0.00  999.999    10.31     9.75 -0.00016  0.650

  *** End of output ***
```

Column 13E



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

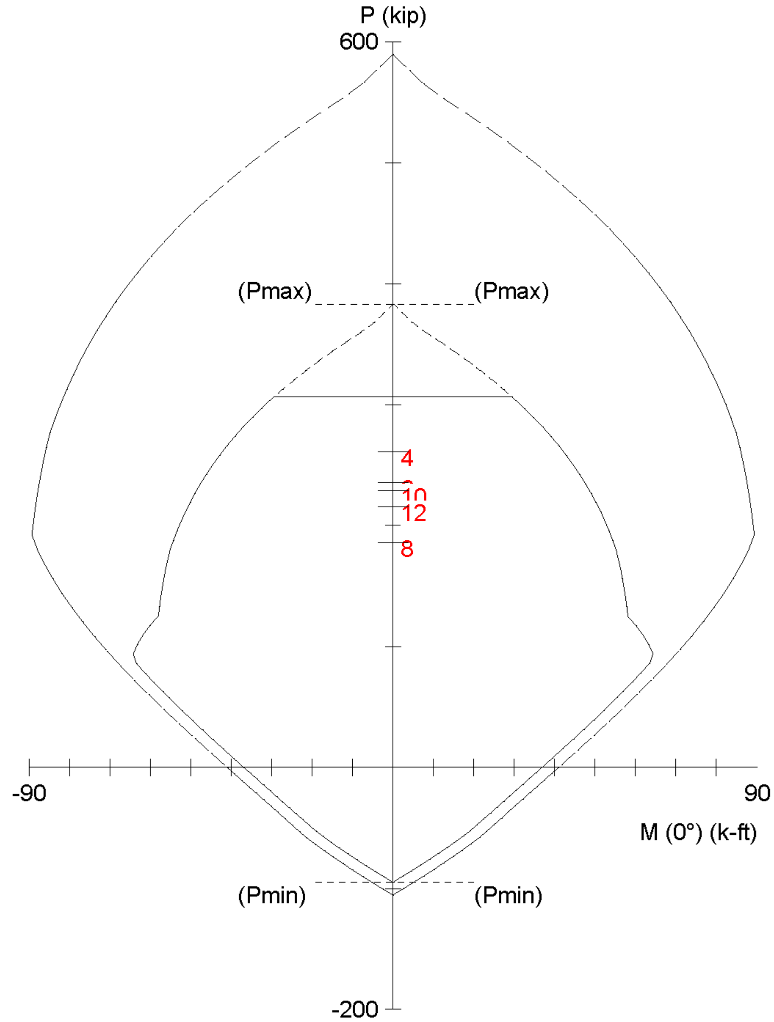
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 16:11:11



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: E:\SPRING\Gravity\Column Design\Frame 13\13E.col

Project: Gravity System

Column: 13E		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                            02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13E.col                                                            04:09 PM
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spColumn v4.81 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                          Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68             02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13E.col                                              04:09 PM


General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13E.col
  Project:  Gravity System
  Column:    13E                          Engineer: ahm
  Code:      ACI 318-11                   Units: English

  Run Option: Design                      Slenderness: Not considered
  Run Axis:   Biaxial                     Column Type: Structural

Material Properties:
====================
  f'c    = 4 ksi                          fy    = 60 ksi
  Ec     = 3605 ksi                       Es    = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in              Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                         Iy =  1728 in^4
  rx =  3.4641 in                         ry =  3.4641 in
  Xo =  0 in                              Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       132.52         0.00         0.00         0.69         0.00
      Live        60.67         0.00         0.00         0.10         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         9.81         0.00         0.00         0.27         0.00
    2 Dead       132.52         0.00         0.00         0.69         0.00
      Live        40.63         0.00         0.00         1.72         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         9.81         0.00         0.00         0.27         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68        02/06/14
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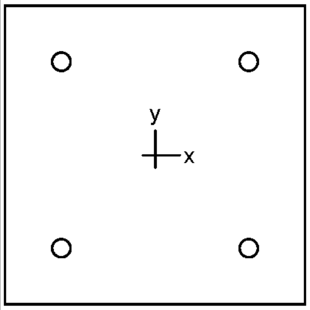
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy      PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo        kip       k-ft       k-ft        k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      185.53       0.00       0.97       -0.00      54.51   56.432     7.47     9.75  0.00092  0.650
    2            185.53       0.00       0.00       54.51       0.00  999.999     7.47     9.75  0.00092  0.650
    3  1 U2      261.00       0.00       1.12       -0.00      42.15   37.536    10.07     9.75 -0.00010  0.650
    4            261.00       0.00       0.00       42.15       0.00  999.999    10.07     9.75 -0.00010  0.650
    5  1 U3      235.39       0.00       1.36       -0.00      47.41   34.864     9.15     9.75  0.00020  0.650
    6            235.39       0.00       0.00       47.41       0.00  999.999     9.15     9.75  0.00020  0.650
    7  2 U1      185.53       0.00       0.97       -0.00      54.51   56.432     7.47     9.75  0.00092  0.650
    8            185.53       0.00       0.00       54.51       0.00  999.999     7.47     9.75  0.00092  0.650
    9  2 U2      228.94       0.00       3.72       -0.00      48.55   13.069     8.93     9.75  0.00028  0.650
   10            228.94       0.00       0.00       48.55       0.00  999.999     8.93     9.75  0.00028  0.650
   11  2 U3      215.35       0.00       2.98       -0.00      50.72   17.019     8.46     9.75  0.00046  0.650
   12            215.35       0.00       0.00       50.72       0.00  999.999     8.46     9.75  0.00046  0.650

  *** End of output ***
```

Column 13H



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

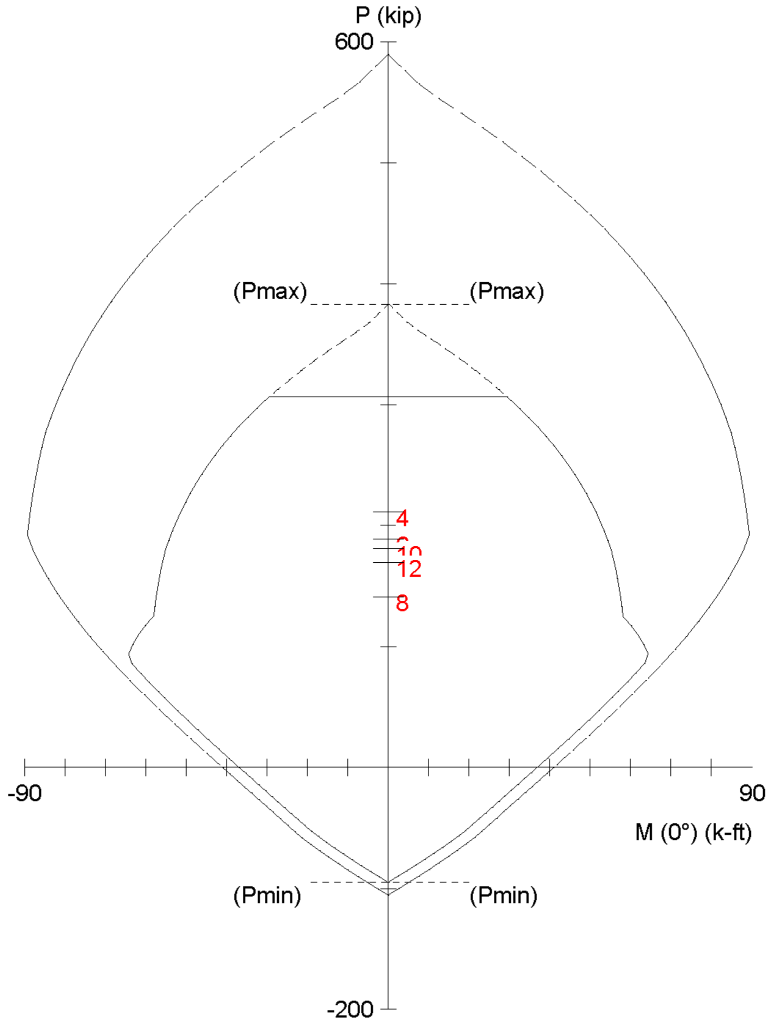
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 16:30:55



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: E:\SPRING\Gravity\Column Design\Frame 13\13H.col

Project: Gravity System

Column: 13H		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                            02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13H.col                                                            04:30 PM
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spColumn v4.81 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

==

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```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68        02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13H.col                                         04:30 PM


General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13H.col
  Project:  Gravity System
  Column:   13H                             Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in                Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                           Iy =  1728 in^4
  rx =  3.4641 in                           ry =  3.4641 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       100.85         0.00         0.00        -1.65         0.00
      Live        53.76         0.00         0.00        -0.64         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         8.77         0.00         0.00        -0.20         0.00
    2 Dead       100.85         0.00         0.00        -1.65         0.00
      Live        34.54         0.00         0.00        -1.74         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         8.77         0.00         0.00        -0.20         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68            02/06/14
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  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo         kip       k-ft       k-ft       k-ft       k-ft               in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      141.19       0.00      -2.31       0.00     -57.39   24.843     6.21     9.75  0.00171  0.650
    2            141.19       0.00       0.00      57.39       0.00  999.999     6.21     9.75  0.00171  0.650
    3  1 U2      211.42       0.00      -3.10       0.00     -51.29   16.523     8.32     9.75  0.00051  0.650
    4            211.42       0.00       0.00      51.29       0.00  999.999     8.32     9.75  0.00051  0.650
    5  1 U3      188.81       0.00      -2.94       0.00     -54.15   18.419     7.57     9.75  0.00086  0.650
    6            188.81       0.00       0.00      54.15       0.00  999.999     7.57     9.75  0.00086  0.650
    7  2 U1      141.19       0.00      -2.31       0.00     -57.39   24.843     6.21     9.75  0.00171  0.650
    8            141.19       0.00       0.00      57.39       0.00  999.999     6.21     9.75  0.00171  0.650
    9  2 U2      180.67       0.00      -4.86       0.00     -55.03   11.313     7.31     9.75  0.00100  0.650
   10            180.67       0.00       0.00      55.03       0.00  999.999     7.31     9.75  0.00100  0.650
   11  2 U3      169.59       0.00      -4.04       0.00     -55.86   13.827     6.99     9.75  0.00119  0.650
   12            169.59       0.00       0.00      55.86       0.00  999.999     6.99     9.75  0.00119  0.650

  *** End of output ***
```
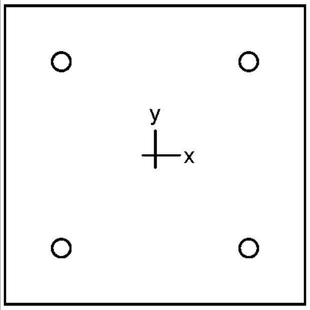

Column 13K



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

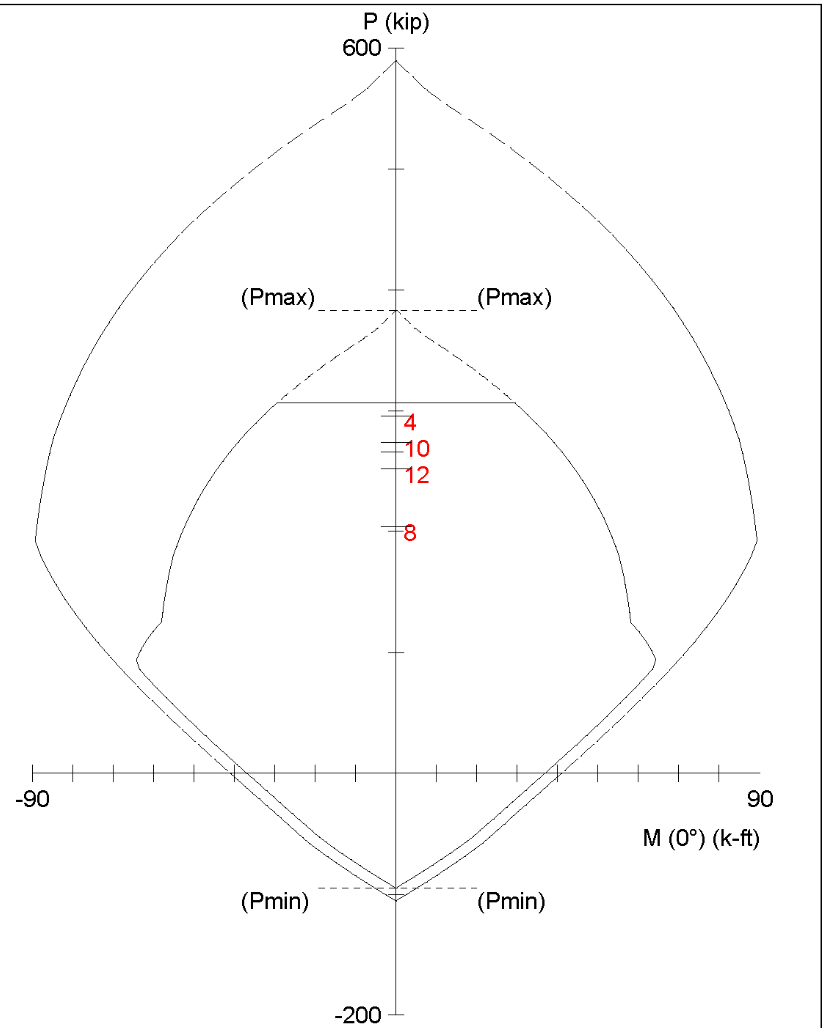
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 16:34:35



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File: E:\SPRING\Gravity\Column Design\Frame 13\13K.col

Project: Gravity System

Column: 13K		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                       Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68           02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13K.col                                           04:34 PM
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
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=========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                     Page   2
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E:\SPRING\Gravity\Column Design\Frame 13\13K.col                                         04:34 PM


General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13K.col
  Project:  Gravity System
  Column:   13K                              Engineer: ahm
  Code:     ACI 318-11                       Units: English

  Run Option: Design                         Slenderness: Not considered
  Run Axis:   Biaxial                        Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                              fy   = 60 ksi
  Ec    = 3605 ksi                           Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in                 Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                            Iy =  1728 in^4
  rx =  3.4641 in                            ry =  3.4641 in
  Xo =  0 in                                 Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       145.64         0.00         0.00         3.05         0.00
      Live        71.75         0.00         0.00         1.89         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.98         0.00         0.00         0.30         0.00
    2 Dead       145.64         0.00         0.00         3.05         0.00
      Live        57.91         0.00         0.00         2.60         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.98         0.00         0.00         0.30         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/06/14
E:\SPRING\Gravity\Column Design\Frame 13\13K.col 04:34 PM

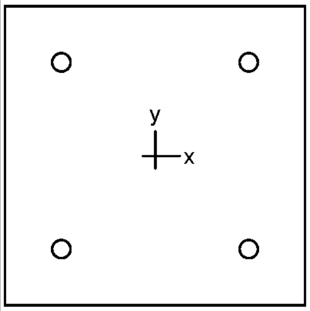
U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
===
Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	203.90	0.00	4.27	-0.00	52.32	12.253	8.07	9.75	0.00062	0.650
2		203.90	0.00	0.00	52.32	0.00	999.999	8.07	9.75	0.00062	0.650
3	1 U2	295.56	0.00	6.83	-0.00	32.89	4.813	11.36	9.75	-0.00043	0.650
4		295.56	0.00	0.00	32.89	0.00	999.999	11.36	9.75	-0.00043	0.650
5	1 U3	265.69	0.00	6.03	-0.00	41.05	6.807	10.24	9.75	-0.00014	0.650
6		265.69	0.00	0.00	41.05	0.00	999.999	10.24	9.75	-0.00014	0.650
7	2 U1	203.90	0.00	4.27	-0.00	52.32	12.253	8.07	9.75	0.00062	0.650
8		203.90	0.00	0.00	52.32	0.00	999.999	8.07	9.75	0.00062	0.650
9	2 U2	273.41	0.00	7.97	-0.00	39.13	4.909	10.53	9.75	-0.00022	0.650
10		273.41	0.00	0.00	39.13	0.00	999.999	10.53	9.75	-0.00022	0.650
11	2 U3	251.85	0.00	6.74	-0.00	44.18	6.555	9.74	9.75	0.00000	0.650
12		251.85	0.00	0.00	44.18	0.00	999.999	9.74	9.75	0.00000	0.650

*** End of output ***

Column 13N



12 x 12 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

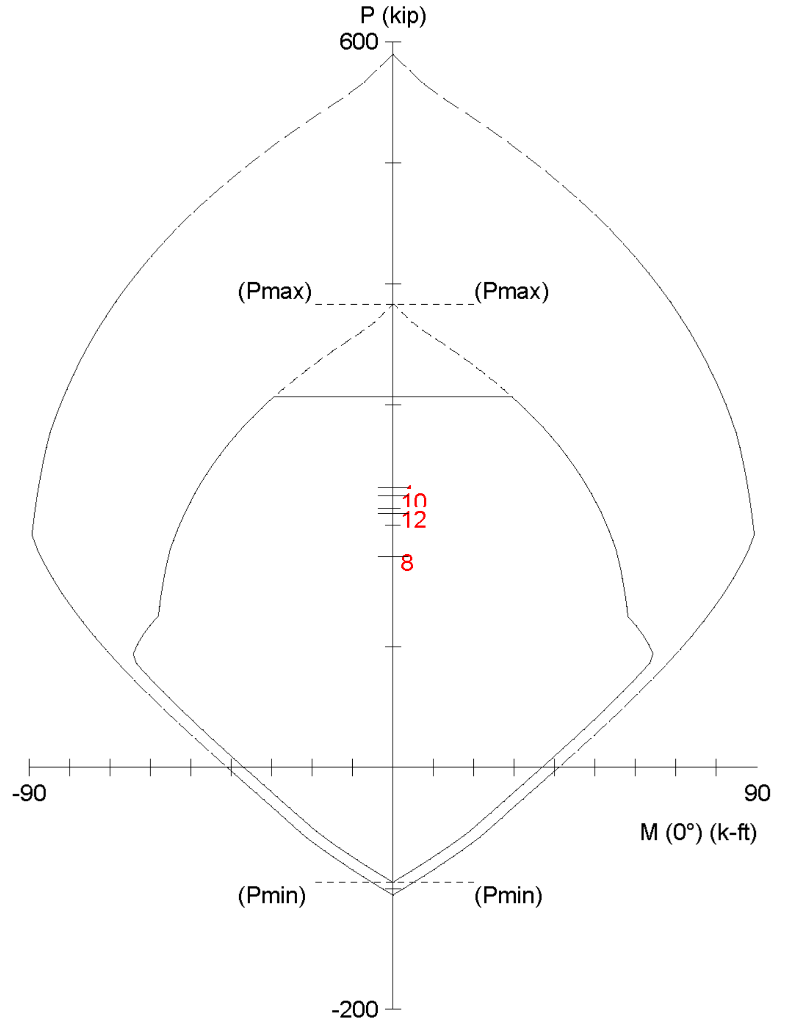
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/06/14

Time: 16:38:35



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File: E:\SPRING\Gravity\Column Design\Frame 13\13N.col

Project: Gravity System

Column: 13N

Engineer: ahm

f'c = 4 ksi	fy = 60 ksi	Ag = 144 in^2	4 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 1.76 in^2	rho = 1.22%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 1728 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 1728 in^4
Beta1 = 0.85		Min clear spacing = 6.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                       Page   1
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 ooooo    oo         oooooo     ooooo     ooo      ooooo o   oo   oo   oo    oo   oo (TM)
```

```
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                Computer program for the Strength Design of Reinforced Concrete Sections
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```

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                   Page   2
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E:\SPRING\Gravity\Column Design\Frame 13\13N.col                                       04:37 PM


General Information:
====================
  File Name: E:\SPRING\Gravity\Column Design\Frame 13\13N.col
  Project:  Gravity System
  Column:   13N                          Engineer: ahm
  Code:     ACI 318-11                   Units: English

  Run Option: Design                     Slenderness: Not considered
  Run Axis:   Biaxial                    Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                          fy   = 60 ksi
  Ec    = 3605 ksi                       Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 12 in             Depth = 12 in

  Gross section area, Ag =  144 in^2
  Ix =  1728 in^4                        Iy =  1728 in^4
  rx =  3.4641 in                        ry =  3.4641 in
  Xo =  0 in                             Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 1.44 in^2,  Asmax = 0.08 * Ag = 11.52 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: Equal Bar Spacing  (Cover to transverse reinforcement)
  Total steel area: As = 1.76 in^2 at rho = 1.22%
  Minimum clear spacing = 6.75 in

  4 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       124.43         0.00         0.00        -5.74         0.00
      Live        48.01         0.00         0.00        -4.04         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.46         0.00         0.00        -0.55         0.00
    2 Dead       124.43         0.00         0.00        -5.74         0.00
      Live        43.79         0.00         0.00        -4.41         0.00
      Wind         0.00         0.00         0.00         0.00         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.46         0.00         0.00        -0.55         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68        02/06/14
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  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
```

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	174.20	0.00	-8.04	0.00	-55.55	6.913	7.12	9.75	0.00111	0.650
2		174.20	0.00	0.00	55.55	0.00	999.999	7.12	9.75	0.00111	0.650
3	1 U2	231.36	0.00	-13.63	0.00	-48.13	3.532	9.01	9.75	0.00025	0.650
4		231.36	0.00	0.00	48.13	0.00	999.999	9.01	9.75	0.00025	0.650
5	1 U3	214.06	0.00	-11.81	0.00	-50.91	4.311	8.41	9.75	0.00048	0.650
6		214.06	0.00	0.00	50.91	0.00	999.999	8.41	9.75	0.00048	0.650
7	2 U1	174.20	0.00	-8.04	0.00	-55.55	6.913	7.12	9.75	0.00111	0.650
8		174.20	0.00	0.00	55.55	0.00	999.999	7.12	9.75	0.00111	0.650
9	2 U2	224.61	0.00	-14.22	0.00	-49.27	3.465	8.78	9.75	0.00033	0.650
10		224.61	0.00	0.00	49.27	0.00	999.999	8.78	9.75	0.00033	0.650
11	2 U3	209.84	0.00	-12.18	0.00	-51.51	4.230	8.27	9.75	0.00054	0.650
12		209.84	0.00	0.00	51.51	0.00	999.999	8.27	9.75	0.00054	0.650

```
  *** End of output ***
```

Appendix B.1: Lateral Load Calculations

Seismic Loads

Seismic Design Values

A.Mincemoyer | Seismic | Final Report

§ 11.1.2
- seismic design is required

Site Class: B

using usgs.gov: $S_s = 0.124g$ $S_1 = 0.056g$

$S_{MS} = 0.124g$ $S_{M1} = 0.056g$

$S_{DS} = 0.083$ $S_{D1} = 0.037g$

$T_L = 6$ seconds

Table 11.6-1

$S_{DS} = 0.083 < 0.167 \rightarrow$ SDC A

Table 11.6-2

$S_{D1} = 0.037 < 0.067 \rightarrow$ SDC A

→ § 11.7 Design Requirements for seismic design category A pg.68

→ according to § 1.4.3 Lateral Forces

$F_x = 0.01 W_x$ (equation 1.4-1)

Determination of Building Weight

Seismic Load Calculations

	Floor Area			Misc Dead Load		Partition Load		Slab Load		Joist Load		Girder Loads				Beam Loads				Column Loads					Exterior Wall Load (k)	Total Load (k)
	Total Floor Area (sf)	Green Roof Area (sf)	Indoor Floor Area (sf)	Misc Dead (psf)	Misc Dead (k)	Partitions (psf)	Partitions (k)	Slab (psf)	Slab (k)	Joists (psf)	Joists (k)	Girder Width (in)	Girder Length (ft)	Girder Depth (in)	Girder Load (k)	Beam Width (in)	Beam Length (ft)	Beam Depth (in)	Beam Load (k)	Column Qty Per Size	Column Width (in)	Column Depth (in)	Column Length (ft)	Column Load (k)		
Level 1	21292	7369	13923	21	292.4	20	278.5	56.25	1197.7	41.7	887.9	12	54.7	24.5	16.7	32.0	105.0	24.5	85.8	4	14	14	6.67	5.4	193	4414
				99	729.5							30	400	24.5	306.3	12.0	254.0	24.5	77.8	29	12	12	13.33	58.0		
												24	356	24.5	218.1					15	14	14	13.33	40.8		
																				5	16	16	13.33	17.8		
																				1	24	24	13.33	8.0		
Level 2	15136	0	15136	21	317.9	20	302.7	56.25	851.4	41.7	631.2	12	55.67	24.5	17.0	12	121	24.5	37.1	7	14	14	6.67	9.5	133.8	2896
												30	353	24.5	270.3	30	129	24.5	98.8	16	12	12	13.33	32.0		
												24	198.9	24.5	121.8					20	14	14	13.33	54.4		
																				5	16	16	13.33	17.8		
Level 3	15067	2394	12673	21	266.1	20	253.5	56.25	847.5	41.7	628.3	12	55.67	24.5	17.0	12	151	24.5	46.2	1	14	14	9.58	2.0	169.3	3002
				99	237.0							30	351.3	24.5	269.0					16	12	12	16.25	39.0		
												24	209.8	24.5	128.5					23	14	14	16.25	76.3		
																				5	16	16	16.25	21.7		
Roof	15887	0	0	31	492.5	0	0	56.25	893.6	41.7	662.5	12	65	24.5	19.9	12	97.6	24.5	29.9	16	12	12	9.58	23.0	96.4	2654
												30	322	24.5	246.5					16	14	14	9.58	31.3		
												24	236.7	24.5	145.0					5	16	16	9.58	12.8		

Summary of Seismic Forces

	Floor Area			Loads								Total Load, W_x (k)	Force at Level, Fx (k)
	Total Floor Area (sf)	Green Roof Area (sf)	Indoor Floor Area (sf)	Misc Dead (k)	Partitions (k)	Slab (k)	Joists (k)	Girder Load (k)	Beam Load (k)	Column Load (k)	Exterior Wall Load (k)		
Level 1	21292	7369	13923	1021.9	278.5	1197.7	887.9	541.0	163.5	130.0	193	**4414**	**45**
Level 2	15136	0	15136	317.9	302.7	851.4	631.2	409.1	135.8	113.7	133.8	**2896**	**29**
Level 3	15067	2394	12673	503.1	253.5	847.5	628.3	414.5	46.2	138.9	169.3	**3002**	**31**
Roof	15887	0	0	492.5	0.0	893.6	662.5	411.4	29.9	67.1	96.4	**2654**	**27**

$Fx = 0.01W_x$

Seismic Load Base Shear	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Level 1	45.0	132.0	599.9
Level 2	29.0	87.0	773.5
Level 3	31.0	58.0	1240
Roof	27.0	27.0	1869.8
Total	132.0		4483.2

Wind Loads

Wind Design Values

Wind Load Calculations Per ASCE7-10

*Using MWFRS Procedule

Risk Category		III	
Basic Wind Speed	V	120	mph
Wind Directionality Factor	K_d	0.85	
Exposure Category		B	
Topographic Factor	K_{zt}	1.0	
Rigid Structure			
$n_a = 43.5/(h\text{^}0.9)$		1.0	Hz
Gust Effect Factor	G	0.85	(conservative)
Internal Pressure Coefficient	GC_{pi}	0.18	
		-0.18	

Determining K_z and q_z						
	Height above ground, z (ft)	z_g	α	K_z	q_z	q_h
Garden Level	0	1200	7.0	0.57	17.86	27.88
Level 1	13.33	1200	7.0	0.57	17.86	27.88
Level 2	26.67	1200	7.0	0.68	21.23	27.88
Level 3	40.00	1200	7.0	0.76	23.83	27.88
Roof	69.25	1200	7.0	0.89	27.88	27.88

Equations Used:

$p = qGC_p - q_i(GC_{pi})$ (psf)

Force = p*Area (k)

North-South Direction

Windward Wall	C_p =	0.80	L =	110	ft
Leeward Wall	C_p =	-0.50	B =	229	ft
			L/B =	0.48	

		q	G	C_p	q_i	GC_{pi}	p (psf)	Area (sf)	Force (k)
WINDWARD	Garden Level	17.86	0.85	0.80	-	-	12.15	1527.4	18.6
	Level 1	17.86	0.85	0.80	-	-	12.15	3052.6	37.1
	Level 2	21.23	0.85	0.80	-	-	14.43	3052.6	44.1
	Level 3	23.83	0.85	0.80	-	-	16.21	4875.4	79.0
	Roof	27.88	0.85	0.80	27.88	-0.18	23.98	3349.1	80.3
LEEWARD	Garden Level	27.88	0.85	-0.50	-	-	-11.85	1527.4	-18.1
	Level 1	27.88	0.85	-0.50	-	-	-11.85	3052.6	-36.2
	Level 2	27.88	0.85	-0.50	-	-	-11.85	3052.6	-36.2
	Level 3	27.88	0.85	-0.50	-	-	-11.85	4875.4	-57.8
	Roof	27.88	0.85	-0.50	27.88	0.18	-16.87	3349.1	-56.5

Wind Load Base Shear & Overturning Moment

	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Garden Level	36.6	463.7	0.0
Level 1	73.2	427.0	976.4
Level 2	80.2	353.8	2139.8
Level 3	136.8	273.6	5471.3
Roof	136.8	136.8	9472.8
Total	463.7		18060.3

East-West Direction

Windward Wall	C_p =	0.80	L =	229	ft
Leeward Wall	C_p =	-0.30	B =	110	ft
			L/B =	2.08	

		q	G	C_p	q_i	GC_{pi}	p (psf)	Area (sf)	Force (k)
WINDWARD	Garden Level	17.86	0.85	0.80	-	-	12.15	733.7	8.9
	Level 1	17.86	0.85	0.80	-	-	12.15	1466.3	17.8
	Level 2	21.23	0.85	0.80	-	-	14.43	1466.3	21.2
	Level 3	23.83	0.85	0.80	-	-	16.21	2341.9	38.0
	Roof	27.88	0.85	0.80	27.88	-0.18	23.98	1608.8	38.6
LEEWARD	Garden Level	27.88	0.85	-0.30	-	-	-7.01	733.7	-5.1
	Level 1	27.88	0.85	-0.30	-	-	-7.01	1466.3	-10.3
	Level 2	27.88	0.85	-0.30	-	-	-7.01	1466.3	-10.3
	Level 3	27.88	0.85	-0.30	-	-	-7.01	2341.9	-16.4
	Roof	27.88	0.85	-0.30	27.88	0.18	-12.03	1608.8	-19.4

Wind Load Base Shear & Overturning Moment

	Force (k)	Story Shear (k)	Overturning Moment (ft-k)
Garden Level	14.1	185.9	0.0
Level 1	28.1	171.9	374.5
Level 2	31.5	143.8	838.8
Level 3	54.4	112.3	2175.3
Roof	57.9	57.9	4011.7
Total	185.9		7400.3

Appendix B.2: Determination of Frame Stiffness's

Determination of Stiffness				
	Frame	In-Plane		
		P (k)	Δ (in)	k = P/Δ (k/in)
North-South	6	10	0.03	333.33
	8	10	0.031	322.58
	10	10	0.017	588.24
	13	10	0.017	588.24
East-West	D	10	0.042	238.10
	E	10	0.039	256.41
	G	10	0.042	238.10
	K	10	0.041	243.90

Appendix B.3: Center of Mass and Center of Rigidity

Center of Mass

Center of Mass

	Weight (pcf) [or psf if no thickness]	Thickness (ft)	Width (ft)	Length (ft)	Area (sf)	Weight (k)	Dist in X-dirn from (0,0) (ft)	Dist in Y-dirn from (0,0) (ft)	Weight*Dx	Weight*Dy
Slab	150.0	0.4	-	-	1863.4	104.8	10.1	70.9	1056.9	7428.7
	150.0	0.4	-	-	1651.9	92.9	42.2	63.0	3918.0	5849.8
	150.0	0.4	-	-	7692.2	432.7	101.3	47.4	43845.6	20516.6
	150.0	0.4	-	-	9951.8	559.8	189.5	55.8	106080.0	31231.6
Slab Openings	150.0	0.4	-	-	-70.0	-3.9	50.3	59.3	-197.9	-233.7
	150.0	0.4	-	-	-134.3	-7.6	74.2	53.4	-560.6	-403.6
	150.0	0.4	-	-	-67.8	-3.8	94.0	48.7	-358.7	-185.7
	150.0	0.4	-	-	-387.9	-21.8	158.5	96.7	-3458.2	-2109.8
	150.0	0.4	-	-	-406.9	-22.9	158.5	54.2	-3628.1	-1240.6
	150.0	0.4	-	-	-69.8	-3.9	188.2	18.5	-739.2	-72.7
	150.0	0.4	-	-	-65.1	-3.7	218.3	13.2	-798.6	-48.3
Joists	41.7	-	-	-	1863.4	77.7	10.1	70.9	783.5	5507.1
	41.7	-	-	-	1651.9	68.9	42.2	63.0	2904.5	4336.7
	41.7	-	-	-	7692.2	320.8	101.3	47.4	32504.2	15209.6
	41.7	-	-	-	9951.8	415.0	189.5	55.8	78640.6	23153.0
Joist Openings	41.7	-	-	-	-70.0	-2.9	50.3	59.3	-146.7	-173.2
	41.7	-	-	-	-134.3	-5.6	74.2	53.4	-415.6	-299.2
	41.7	-	-	-	-67.8	-2.8	94.0	48.7	-265.9	-137.7
	41.7	-	-	-	-387.9	-16.2	158.5	96.7	-2563.7	-1564.1
	41.7	-	-	-	-406.9	-17.0	158.5	54.2	-2689.6	-919.7
	41.7	-	-	-	-69.8	-2.9	188.2	18.5	-548.0	-53.9
	41.7	-	-	-	-65.1	-2.7	218.3	13.2	-592.0	-35.8
Columns	150.0	1.5	1.5	6.7	10.0	2.2	1.1	95.8	2.4	215.4
	150.0	1.5	1.5	6.7	10.0	2.2	1.1	83.3	2.4	187.3
	150.0	1.5	1.5	6.7	10.0	2.2	1.1	55.3	2.4	124.5
	150.0	1.5	1.5	13.3	20.0	4.5	6.0	94.4	27.0	424.8
	150.0	1.5	1.5	13.3	20.0	4.5	6.0	81.8	27.0	367.8
	150.0	1.5	1.5	13.3	20.0	4.5	6.0	54	27.0	242.9
	150.0	1.5	1.5	13.3	20.0	4.5	38.3	86.3	172.4	388.4
	150.0	1.5	1.5	13.3	20.0	4.5	33.8	68.3	152.2	307.0
	150.0	1.5	1.5	13.3	20.0	4.5	28.8	48.3	129.7	217.1
	150.0	1.5	1.5	6.7	10.0	2.2	27.3	41.8	61.3	94.1
	150.0	1.5	1.5	13.3	20.0	4.5	71.8	91.2	323.2	410.1
	150.0	1.5	1.5	13.3	20.0	4.5	68.8	78.8	309.3	354.3
	150.0	1.5	1.5	13.3	20.0	4.5	64.3	60.8	289.1	273.3
	150.0	1.5	1.5	13.3	20.0	4.5	57.3	33.4	257.9	150.3
	150.0	1.5	1.5	13.3	20.0	4.5	57.7	22.3	259.5	100.5
	150.0	1.5	1.5	13.3	20.0	4.5	49.9	22.3	224.6	100.5
	150.0	1.5	1.5	13.3	20.0	4.5	101.7	95.4	457.4	429.3
	150.0	1.5	1.5	13.3	20.0	4.5	95.8	72.0	431.1	323.9
	150.0	1.5	1.5	13.3	20.0	4.5	91.3	54.0	410.9	242.9
	150.0	1.5	1.5	13.3	20.0	4.5	84.4	26.7	379.8	120.0
	150.0	1.5	1.5	13.3	20.0	4.5	84.5	1.0	380.2	4.5
	150.0	1.5	1.5	13.3	20.0	4.5	130.0	99.4	584.9	447.3
	150.0	1.5	1.5	13.3	20.0	4.5	121.5	65.5	546.6	294.7
	150.0	1.5	1.5	13.3	20.0	4.5	117.0	47.5	526.4	213.7
	150.0	1.5	1.5	13.3	20.0	4.5	110.1	20.3	495.3	91.1
	150.0	1.5	1.5	13.3	20.0	4.5	110.2	1.0	495.6	4.5
	150.0	1.5	1.5	13.3	20.0	4.5	142.0	60.5	638.8	272.2
	150.0	1.5	1.5	13.3	20.0	4.5	142.0	47.9	638.8	215.6
	150.0	1.5	1.5	13.3	20.0	4.5	142.0	23.4	638.8	105.4
	150.0	1.5	1.5	13.3	20.0	4.5	142.0	12.3	638.8	55.1
	150.0	1.5	1.5	13.3	20.0	4.5	142.0	2.9	638.8	13.1
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	106.0	785.1	476.9
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	80.9	785.1	364.0
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	60.5	785.1	272.2
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	47.9	785.1	215.6
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	32.3	785.1	145.1
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	23.4	785.1	105.4
	150.0	1.5	1.5	13.3	20.0	4.5	174.5	2.3	785.1	10.5
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	106.0	861.5	476.9
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	80.9	861.5	364.0
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	60.5	861.5	272.2
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	47.9	861.5	215.6
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	32.3	861.5	145.1
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	23.4	861.5	105.4
	150.0	1.5	1.5	13.3	20.0	4.5	191.5	2.3	861.5	10.5
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	106.0	974.0	476.9
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	80.9	974.0	364.0
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	60.5	974.0	272.2
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	47.9	974.0	215.6
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	32.3	974.0	145.1
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	23.4	974.0	105.4
	150.0	1.5	1.5	13.3	20.0	4.5	216.5	2.3	974.0	10.5

	150.0	1.5	1.5	13.3	20.0	4.5	237.0	107.8	1066.2	485.1
	150.0	1.5	1.5	13.3	20.0	4.5	237.0	80.9	1066.2	364.0
Beams	150.0	2.0	2.7	39.0	104.0	31.9	19.2	91.2	610.5	2903.7
	150.0	2.0	2.7	36.5	97.3	29.8	17.7	79.0	526.6	2354.9
	150.0	2.0	2.7	29.2	77.8	23.8	14.2	52.0	337.5	1238.6
	150.0	2.0	1.0	104.8	104.8	32.1	90.2	93.8	2894.8	3009.9
	150.0	2.0	1.0	86.8	86.8	26.6	99.5	22.9	2643.4	608.8
	150.0	2.0	1.0	32.0	32.0	9.8	158.3	60.5	1551.6	592.9
	150.0	2.0	1.0	32.0	32.0	9.8	158.3	47.9	1551.6	469.6
Girders	150.0	2.0	1.0	54.6	54.6	16.7	6.0	73.5	100.3	1228.6
	150.0	2.0	2.5	52.8	131.9	40.4	33.3	66.5	1346.1	2685.7
	150.0	2.0	2.5	59.5	148.8	45.6	64.6	62.3	2942.1	2835.8
	150.0	2.0	2.5	11.0	27.5	8.4	57.6	27.9	485.0	235.1
	150.0	2.0	2.5	70.8	177.1	54.2	93.0	61.0	5043.5	3308.1
	150.0	2.0	2.5	25.1	62.7	19.2	84.5	14.0	1622.8	268.9
	150.0	2.0	2.5	81.6	204.0	62.5	120.0	59.8	7495.4	3737.3
	150.0	2.0	2.5	18.8	46.9	14.4	110.2	10.9	1581.5	156.7
	150.0	2.0	2.5	80.2	200.4	61.4	142.0	43.5	8715.7	2669.9
	150.0	2.0	2.0	105.8	211.5	64.8	174.5	55.2	11302.7	3573.3
	150.0	2.0	2.0	105.2	210.3	64.4	191.5	55.4	12335.4	3569.7
	150.0	2.0	2.0	105.8	211.5	64.8	216.5	55.2	14023.1	3573.3
	150.0	2.0	2.0	39.7	79.3	24.3	237.0	87.0	5758.2	2113.8
Exterior Walls										
North Walls										
	13.9	-	-	-	648.7	9.0	20.3	97.9	183.1	882.8
	12.9	-	-	-	639.4	8.2	138.5	99.1	1142.3	817.4
	12.0	-	-	-	1712.0	20.5	138.5	99.1	2845.3	2035.9
	28.0	-	-	-	103.6	2.9	158.2	72.1	458.9	209.2
	176.5	-	-	-	34.3	6.1	232.4	109.4	1406.6	662.1
East Walls										
	12.0	-	-	-	121.9	1.5	236.4	87.9	345.8	128.6
	12.9	-	-	-	341.4	4.4	234.4	55.6	1032.3	244.9
	176.5	-	-	-	178.7	31.5	232.9	32.1	7347.0	1012.6
	28.0	-	-	-	267.8	7.5	232.9	17.1	1746.1	128.2
South Walls										
	12.9	-	-	-	231.2	3.0	202.7	1.4	604.6	4.2
	12.0	-	-	-	193.6	2.3	157.9	1.4	366.9	3.3
	28.0	-	-	-	463.0	13.0	96.2	1.3	1247.1	16.9
	12.0	-	-	-	307.6	3.7	96.2	1.3	355.1	4.8
	12.0	-	-	-	627.8	7.5	27.9	41.0	210.2	308.9
West Walls										
	12.9	-	-	-	482.3	6.2	0.3	65.6	1.9	408.1
	28.0	-	-	-	225.2	6.3	0.3	92.8	1.9	585.1
	28.0	-	-	-	209.3	5.9	49.7	12.2	291.2	71.5
	176.5	-	-	-	120.3	21.2	49.7	12.2	1054.9	258.9
Totals						3054.3			386925.5	167082.0

Center of Mass	
X - Direction	126.7
Y - Direction	54.7

Center of Rigidity

Center of Rigidity						
	Frame	Stiffness, k (k/in)	Dist in X-dirn from (0,0) (ft)	Dist in Y-dirn from (0,0) (ft)	k*Dx	k*Dy
North-South	6	333.3	64.8	-	21583.3	-
	8	322.6	120.2	-	38776.8	-
	10	588.2	174.7	-	102763.5	-
	13	588.2	216.7	-	127469.4	-
East-West	D	238.1	-	75.9	-	18082.9
	E	256.4	-	47.9	-	12286.4
	G	238.1	-	57.9	-	13784.8
	K	243.9	-	23.4	-	5711.5

$\sum k*Dx =$	290593.0
$\sum k_{NS} =$	1832.4
$\sum k*Dy =$	49865.5
$\sum k_{EW} =$	976.5

Center of Rigidity		
Xr =	158.59	ft
Yr =	51.07	ft

Appendix B.4: Wind Load Cases

Wind Load Input Values

Distribution of Level 1 Story Shear Force				
	N-S		E-W	
Center of Rigidity	158.6	ft	51.1	ft
Center of Mass	126.7	ft	54.7	ft
|CR-CM| =	31.9	ft	3.6	ft
By	229.0	ft		
0.15 By	34.4	ft		
Bx	110.0	ft		
0.15 Bx	16.5	ft		

Wind Case 1

North-South

Wind Case 1: North-South			
F_{NS} (kip)	463.7	e_{NS} (ft)	31.9
F_{EW} (kip)	0.0	e_{EW} (ft)	0.0
M_{NS} (k-ft)	14787.2		
M_{EW} (k-ft)	0.0		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	84.4	93.84	2935150.7	5896874.7	78.4	162.8
	8	322.6	1832.4	-	81.6	38.38	475153.6	5896874.7	31.0	112.7
	10	588.2	1832.4	-	148.9	-16.11	152677.9	5896874.7	-23.8	125.1
	13	588.2	1832.4	-	148.9	-58.11	1986379.6	5896874.7	-85.7	63.1
East-West	D	238.1	-	976.5	0.0	24.88	147415.6	5896874.7	14.9	14.9
	E	256.4	-	976.5	0.0	-3.15	2541.6	5896874.7	-2.0	-2.0
	G	238.1	-	976.5	0.0	6.83	11108.9	5896874.7	4.1	4.1
	K	243.9	-	976.5	0.0	-27.65	186446.9	5896874.7	-16.9	-16.9

East-West

Wind Case 1: East-West			
F_{NS} (kip)	0.0	e_{NS} (ft)	0.0
F_{EW} (kip)	185.9	e_{EW} (ft)	3.6
M_{NS} (k-ft)	0.0		
M_{EW} (k-ft)	674.9		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	0.0	93.84	2935150.7	5896874.7	3.6	3.6
	8	322.6	1832.4	-	0.0	38.38	475153.6	5896874.7	1.4	1.4
	10	588.2	1832.4	-	0.0	-16.11	152677.9	5896874.7	-1.1	-1.1
	13	588.2	1832.4	-	0.0	-58.11	1986379.6	5896874.7	-3.9	-3.9
East-West	D	238.1	-	976.5	45.3	24.88	147415.6	5896874.7	0.7	46.0
	E	256.4	-	976.5	48.8	-3.15	2541.6	5896874.7	-0.1	48.7
	G	238.1	-	976.5	45.3	6.83	11108.9	5896874.7	0.2	45.5
	K	243.9	-	976.5	46.4	-27.65	186446.9	5896874.7	-0.8	45.7

Wind Case 2

North-South + 0.15By

Wind Case 2: North-South + 0.15 By			
0.75 F_{NS} (kip)	347.8	e_{NS} (ft)	66.2
0.75 F_{EW} (kip)	0.0	e_{EW} (ft)	0.0
M_{NS} (k-ft)	23036.4		
M_{EW} (k-ft)	0.0		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	63.3	93.84	2935150.7	5896874.7	122.2	185.5
	8	322.6	1832.4	-	61.2	38.38	475153.6	5896874.7	48.4	109.6
	10	588.2	1832.4	-	111.6	-16.11	152677.9	5896874.7	-37.0	74.6
	13	588.2	1832.4	-	111.6	-58.11	1986379.6	5896874.7	-133.5	-21.9
East-West	D	238.1	-	976.5	0.0	24.88	147415.6	5896874.7	23.1	23.1
	E	256.4	-	976.5	0.0	-3.15	2541.6	5896874.7	-3.2	-3.2
	G	238.1	-	976.5	0.0	6.83	11108.9	5896874.7	6.4	6.4
	K	243.9	-	976.5	0.0	-27.65	186446.9	5896874.7	-26.3	-26.3

North-South - 0.15By

Wind Case 2: North-South - 0.15 By			
0.75 F_{NS} (kip)	347.8	e_{NS} (ft)	-2.5
0.75 F_{EW} (kip)	0.0	e_{EW} (ft)	0.0
M_{NS} (k-ft)	-855.5		
M_{EW} (k-ft)	0.0		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	63.3	93.84	2935150.7	5896874.7	-4.5	58.7
	8	322.6	1832.4	-	61.2	38.38	475153.6	5896874.7	-1.8	59.4
	10	588.2	1832.4	-	111.6	-16.11	152677.9	5896874.7	1.4	113.0
	13	588.2	1832.4	-	111.6	-58.11	1986379.6	5896874.7	5.0	116.6
East-West	D	238.1	-	976.5	0.0	24.88	147415.6	5896874.7	-0.9	-0.9
	E	256.4	-	976.5	0.0	-3.15	2541.6	5896874.7	0.1	0.1
	G	238.1	-	976.5	0.0	6.83	11108.9	5896874.7	-0.2	-0.2
	K	243.9	-	976.5	0.0	-27.65	186446.9	5896874.7	1.0	1.0

East-West + 0.15By

Wind Case 2: East-West + 0.15 Bx			
0.75 F_{NS} (kip)	0.0	e_{NS} (ft)	0.0
0.75 F_{EW} (kip)	139.4	e_{EW} (ft)	20.1
M_{NS} (k-ft)	0.0		
M_{EW} (k-ft)	2806.8		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	0.0	93.84	2935150.7	5896874.7	14.9	14.9
	8	322.6	1832.4	-	0.0	38.38	475153.6	5896874.7	5.9	5.9
	10	588.2	1832.4	-	0.0	-16.11	152677.9	5896874.7	-4.5	-4.5
	13	588.2	1832.4	-	0.0	-58.11	1986379.6	5896874.7	-16.3	-16.3
East-West	D	238.1	-	976.5	34.0	24.88	147415.6	5896874.7	2.8	36.8
	E	256.4	-	976.5	36.6	-3.15	2541.6	5896874.7	-0.4	36.2
	G	238.1	-	976.5	34.0	6.83	11108.9	5896874.7	0.8	34.8
	K	243.9	-	976.5	34.8	-27.65	186446.9	5896874.7	-3.2	31.6

East-West - 0.15By

Wind Case 2: East-West - 0.15 Bx			
0.75 F_{NS} (kip)	0.0	e_{NS} (ft)	0.0
0.75 F_{EW} (kip)	139.4	e_{EW} (ft)	-12.9
M_{NS} (k-ft)	0.0		
M_{EW} (k-ft)	-1794.5		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	0.0	93.84	2935150.7	5896874.7	-9.5	-9.5
	8	322.6	1832.4	-	0.0	38.38	475153.6	5896874.7	-3.8	-3.8
	10	588.2	1832.4	-	0.0	-16.11	152677.9	5896874.7	2.9	2.9
	13	588.2	1832.4	-	0.0	-58.11	1986379.6	5896874.7	10.4	10.4
East-West	D	238.1	-	976.5	34.0	24.88	147415.6	5896874.7	-1.8	32.2
	E	256.4	-	976.5	36.6	-3.15	2541.6	5896874.7	0.2	36.9
	G	238.1	-	976.5	34.0	6.83	11108.9	5896874.7	-0.5	33.5
	K	243.9	-	976.5	34.8	-27.65	186446.9	5896874.7	2.1	36.9

Wind Case 3

North-South and East-West

Wind Case 3: NS + EW			
0.75 F_{NS} (kip)	347.8	e_{NS} (ft)	31.9
0.75 F_{EW} (kip)	139.4	e_{EW} (ft)	3.6
M_{NS} (k-ft)	11090.4		
M_{EW} (k-ft)	506.1		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	63.3	93.84	2935150.7	5896874.7	61.5	124.8
	8	322.6	1832.4	-	61.2	38.38	475153.6	5896874.7	24.3	85.6
	10	588.2	1832.4	-	111.6	-16.11	152677.9	5896874.7	-18.6	93.0
	13	588.2	1832.4	-	111.6	-58.11	1986379.6	5896874.7	-67.2	44.4
East-West	D	238.1	-	976.5	34.0	24.88	147415.6	5896874.7	11.7	45.6
	E	256.4	-	976.5	36.6	-3.15	2541.6	5896874.7	-1.6	35.0
	G	238.1	-	976.5	34.0	6.83	11108.9	5896874.7	3.2	37.2
	K	243.9	-	976.5	34.8	-27.65	186446.9	5896874.7	-13.3	21.6

Wind Case 4

(North-South + 0.15By)+(East-West + 0.15Bx)

Wind Case 4: (N-S + 0.15 By) + (E-W + 0.15 Bx)			
0.563 F_{NS} (kip)	261.1	e_{NS} (ft)	66.2
0.563 F_{EW} (kip)	104.7	e_{EW} (ft)	20.1
M_{NS} (k-ft)	17292.6		
M_{EW} (k-ft)	2107.0		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	47.5	93.84	2935150.7	5896874.7	102.9	150.4
	8	322.6	1832.4	-	46.0	38.38	475153.6	5896874.7	40.7	86.7
	10	588.2	1832.4	-	83.8	-16.11	152677.9	5896874.7	-31.2	52.6
	13	588.2	1832.4	-	83.8	-58.11	1986379.6	5896874.7	-112.5	-28.6
East-West	D	238.1	-	976.5	25.5	24.88	147415.6	5896874.7	19.5	45.0
	E	256.4	-	976.5	27.5	-3.15	2541.6	5896874.7	-2.7	24.8
	G	238.1	-	976.5	25.5	6.83	11108.9	5896874.7	5.4	30.9
	K	243.9	-	976.5	26.1	-27.65	186446.9	5896874.7	-22.2	4.0

(North-South + 0.15By)+(East-West - 0.15Bx)

Wind Case 4: (N-S + 0.15 By) + (E-W - 0.15 Bx)			
0.563 F_{NS} (kip)	261.1	e_{NS} (ft)	66.2
0.563 F_{EW} (kip)	104.7	e_{EW} (ft)	-12.9
M_{NS} (k-ft)	17292.6		
M_{EW} (k-ft)	-1347.1		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	47.5	93.84	2935150.7	5896874.7	84.6	132.1
	8	322.6	1832.4	-	46.0	38.38	475153.6	5896874.7	33.5	79.4
	10	588.2	1832.4	-	83.8	-16.11	152677.9	5896874.7	-25.6	58.2
	13	588.2	1832.4	-	83.8	-58.11	1986379.6	5896874.7	-92.4	-8.6
East-West	D	238.1	-	976.5	25.5	24.88	147415.6	5896874.7	16.0	41.5
	E	256.4	-	976.5	27.5	-3.15	2541.6	5896874.7	-2.2	25.3
	G	238.1	-	976.5	25.5	6.83	11108.9	5896874.7	4.4	29.9
	K	243.9	-	976.5	26.1	-27.65	186446.9	5896874.7	-18.2	7.9

(North-South - 0.15By)+(East-West + 0.15Bx)

Wind Case 4: (N-S - 0.15 By) + (E-W + 0.15 Bx)			
0.563 F_{NS} (kip)	261.1	e_{NS} (ft)	-2.5
0.563 F_{EW} (kip)	104.7	e_{EW} (ft)	20.1
M_{NS} (k-ft)	-642.2		
M_{EW} (k-ft)	2107.0		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	47.5	93.84	2935150.7	5896874.7	7.8	55.3
	8	322.6	1832.4	-	46.0	38.38	475153.6	5896874.7	3.1	49.0
	10	588.2	1832.4	-	83.8	-16.11	152677.9	5896874.7	-2.4	81.5
	13	588.2	1832.4	-	83.8	-58.11	1986379.6	5896874.7	-8.5	75.3
East-West	D	238.1	-	976.5	25.5	24.88	147415.6	5896874.7	1.5	27.0
	E	256.4	-	976.5	27.5	-3.15	2541.6	5896874.7	-0.2	27.3
	G	238.1	-	976.5	25.5	6.83	11108.9	5896874.7	0.4	25.9
	K	243.9	-	976.5	26.1	-27.65	186446.9	5896874.7	-1.7	24.5

(North-South - 0.15By)+(East-West - 0.15Bx)

Wind Case 4: (N-S - 0.15 By) + (E-W - 0.15 Bx)			
0.563 F_{NS} (kip)	261.1	e_{NS} (ft)	-2.5
0.563 F_{EW} (kip)	104.7	e_{EW} (ft)	-12.9
M_{NS} (k-ft)	-642.2		
M_{EW} (k-ft)	-1347.1		

	Frame	k (k/in)	$\sum k_{NS}$ (k/in)	$\sum k_{EW}$ (k/in)	Direct Shear (kip)	d (in)	kd^2	$J = \sum kd^2$	Torsional Shear (kip)	Total Shear (kip)
North-South	6	333.3	1832.4	-	47.5	93.84	2935150.7	5896874.7	-10.6	36.9
	8	322.6	1832.4	-	46.0	38.38	475153.6	5896874.7	-4.2	41.8
	10	588.2	1832.4	-	83.8	-16.11	152677.9	5896874.7	3.2	87.0
	13	588.2	1832.4	-	83.8	-58.11	1986379.6	5896874.7	11.5	95.3
East-West	D	238.1	-	976.5	25.5	24.88	147415.6	5896874.7	-2.0	23.5
	E	256.4	-	976.5	27.5	-3.15	2541.6	5896874.7	0.3	27.8
	G	238.1	-	976.5	25.5	6.83	11108.9	5896874.7	-0.5	25.0
	K	243.9	-	976.5	26.1	-27.65	186446.9	5896874.7	2.3	28.4

Appendix B.5: Column Lateral Loadings to be Used in spColumn Analysis

RISA Lateral Results to be Used in spColumn Analysis				
	Column	P (kip)	M (ft-k)	Direction
Frame 8	Z	6.887	-141.789	y
	D	3.532	-197.876	y
	G	-0.857	-203.875	y
	M	-9.563	-159.903	y
Frame 13	A.2	5.524	-80.339	y
	B	-0.201	-106.708	y
	C	2.752	-108.529	y
	E	-1.436	-111.652	y
	H	7.706	-117.023	y
	K	-6.849	-121.915	y
	N	-7.495	-96.467	y
Frame D	8	3.083	-43.415	x
Frame E	13	3.135	-42.596	x
Frame G	8	3.05	-42.943	x
Frame K	13	3.094	-42.275	x

*NOTE: Positive axial forces denote compression.

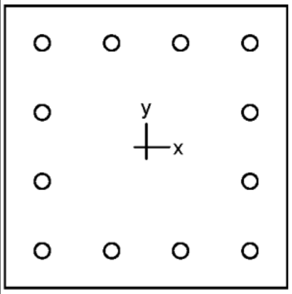
*NOTE: Because negative axial forces denote tension, thus helping to resist some of the compressive forces, these forces will not be considered during analysis of the columns.

*NOTE: Positive moments denote that the left hand face of the upper column is in tension and the right hand face of the bottom column is in tension.

Appendix B.6: spColumn Output for Final Column Designs

Column Line 8 Columns

Column 8Z



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

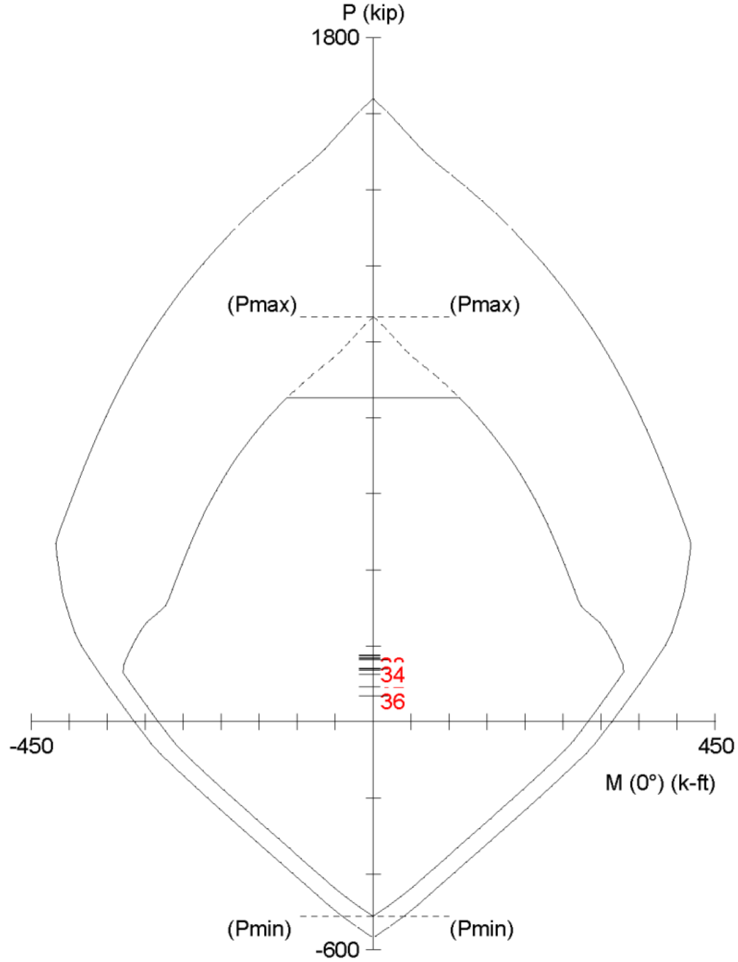
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 12:33:31



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

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Project: Lateral System

Column: 8Z		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	12 #8 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 9.48 in^2	rho = 2.93%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 3.42 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                                       Page   1
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                     oooooo               o
                    oo    oo             oo
 ooooo    oooooo    oo          ooooo    oo      oo   oo   o oooooooooo    o ooooo
oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo  oo     oo   oo
oo        oo   oo   oo         oo   oo   oo      oo   oo    oo   oo  oo     oo   oo
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     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo  oo     oo   oo
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=================================================================================================================
                                          spColumn v4.81 (TM)
                    Computer program for the Strength Design of Reinforced Concrete Sections
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STRUCTUREPOINT - spColumn v4.81 (TM)                                                            Page   2
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General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 8 - 8Z.col
  Project:  Lateral System
  Column:   8Z                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in                Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                           Iy =  8748 in^4
  rx =  5.19615 in                          ry =  5.19615 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 9.48 in^2 at rho = 2.93%
  Minimum clear spacing = 3.42 in

  12 #8   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead        88.83         0.00         0.00        35.40         0.00
      Live        38.36         0.00         0.00        16.15         0.00
      Wind         6.89         0.00         0.00      -141.79         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.72         0.00         0.00         6.87         0.00
    2 Dead        88.83         0.00         0.00        35.40         0.00
      Live        37.10         0.00         0.00        16.98         0.00
      Wind         6.89         0.00         0.00      -141.79         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        14.72         0.00         0.00         6.87         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

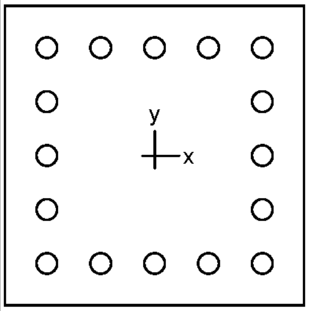
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68            02/18/14
F:\SPRING\Lateral\Column Designs\Frame 8 - 8Z.col                                           12:32 PM

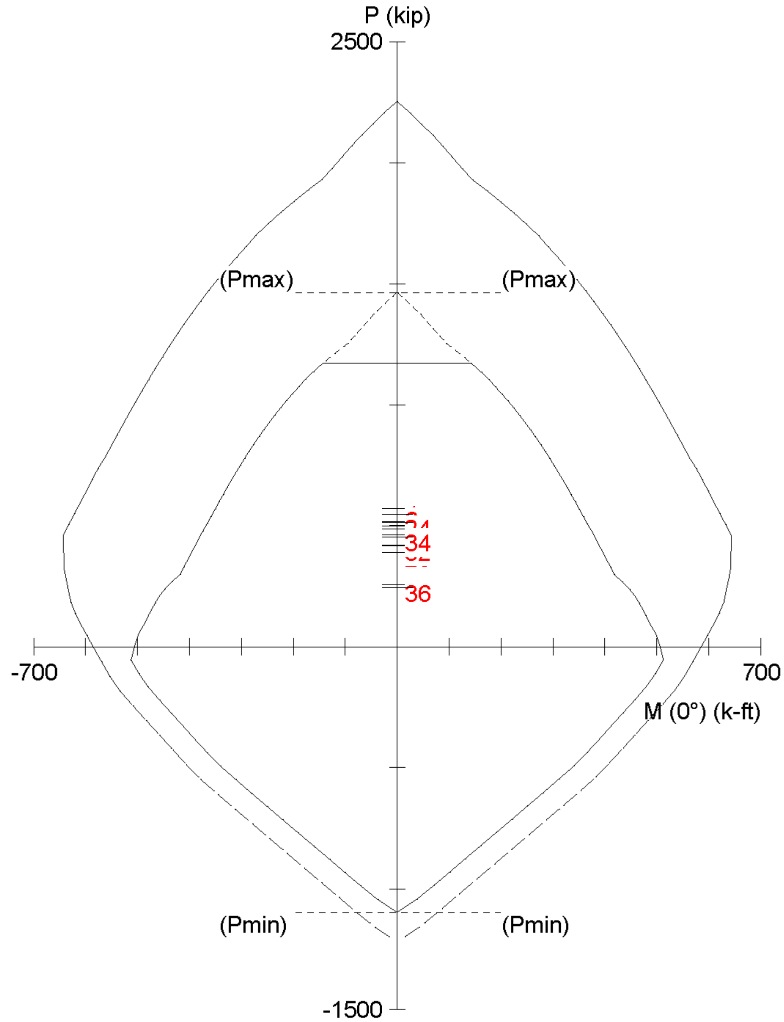
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
  U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
  U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load           Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo         kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      124.36       0.00      49.56      -0.00     327.03    6.599     5.73    15.63  0.00518  0.900
    2            124.36       0.00       0.00     327.03       0.00  999.999     5.73    15.63  0.00518  0.900
    3  1 U2      175.33       0.00      71.76      -0.00     322.53    4.495     6.49    15.63  0.00422  0.834
    4            175.33       0.00       0.00     322.53       0.00  999.999     6.49    15.63  0.00422  0.834
    5  1 U3      168.51       0.00      69.62      -0.00     324.18    4.656     6.37    15.63  0.00436  0.846
    6            168.51       0.00       0.00     324.18       0.00  999.999     6.37    15.63  0.00436  0.846
    7  1 U4      135.66       0.00     -59.96       0.00    -330.85    5.518     5.85    15.63  0.00501  0.900
    8            135.66       0.00       0.00     330.85       0.00  999.999     5.85    15.63  0.00501  0.900
    9  1 U5      163.34       0.00    -164.80       0.00    -325.38    1.974     6.28    15.63  0.00447  0.854
   10            163.34       0.00       0.00     325.38       0.00  999.999     6.28    15.63  0.00447  0.854
   11  1 U6       90.97       0.00    -195.00       0.00    -315.47    1.618     5.37    15.63  0.00573  0.900
   12             90.97       0.00       0.00     315.47       0.00  999.999     5.37    15.63  0.00573  0.900
   13  1 U7      124.64       0.00     166.90      -0.00     327.12    1.960     5.73    15.63  0.00518  0.900
   14            124.64       0.00       0.00     327.12       0.00  999.999     5.73    15.63  0.00518  0.900
   15  1 U8      141.30       0.00     288.93      -0.00     330.01    1.142     5.93    15.63  0.00490  0.891
   16            141.30       0.00       0.00     330.01       0.00  999.999     5.93    15.63  0.00490  0.891
   17  1 U9       68.93       0.00     258.72      -0.00     307.62    1.189     5.15    15.63  0.00611  0.900
   18             68.93       0.00       0.00     307.62       0.00  999.999     5.15    15.63  0.00611  0.900
   19  2 U1      124.36       0.00      49.56      -0.00     327.03    6.599     5.73    15.63  0.00518  0.900
   20            124.36       0.00       0.00     327.03       0.00  999.999     5.73    15.63  0.00518  0.900
   21  2 U2      173.32       0.00      73.08      -0.00     323.03    4.420     6.45    15.63  0.00426  0.837
   22            173.32       0.00       0.00     323.03       0.00  999.999     6.45    15.63  0.00426  0.837
   23  2 U3      167.25       0.00      70.45      -0.00     324.48    4.606     6.35    15.63  0.00439  0.848
   24            167.25       0.00       0.00     324.48       0.00  999.999     6.35    15.63  0.00439  0.848
   25  2 U4      135.66       0.00     -59.96       0.00    -330.85    5.518     5.85    15.63  0.00501  0.900
   26            135.66       0.00       0.00     330.85       0.00  999.999     5.85    15.63  0.00501  0.900
   27  2 U5      162.08       0.00    -163.97       0.00    -325.67    1.986     6.26    15.63  0.00449  0.857
   28            162.08       0.00       0.00     325.67       0.00  999.999     6.26    15.63  0.00449  0.857
   29  2 U6       90.97       0.00    -195.00       0.00    -315.47    1.618     5.37    15.63  0.00573  0.900
   30             90.97       0.00       0.00     315.47       0.00  999.999     5.37    15.63  0.00573  0.900
   31  2 U7      124.64       0.00     166.90      -0.00     327.12    1.960     5.73    15.63  0.00518  0.900
   32            124.64       0.00       0.00     327.12       0.00  999.999     5.73    15.63  0.00518  0.900
   33  2 U8      140.04       0.00     289.76      -0.00     330.25    1.140     5.92    15.63  0.00492  0.894
   34            140.04       0.00       0.00     330.25       0.00  999.999     5.92    15.63  0.00492  0.894
   35  2 U9       68.93       0.00     258.72      -0.00     307.62    1.189     5.15    15.63  0.00611  0.900
   36             68.93       0.00       0.00     307.62       0.00  999.999     5.15    15.63  0.00611  0.900

  *** End of output ***
```

Column 8D





Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 13:45:44

spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\Frame 8 - 8D.col

Project: Lateral System

Column: 8D		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	16 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 20.32 in^2	rho = 6.27%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 1.98 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68            02/18/14
F:\SPRING\Lateral\Column Designs\Frame 8 - 8D.col                                           01:42 PM
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                    oo    oo             oo
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=============================================================================================================
                                          spColumn v4.81 (TM)
                          Computer program for the Strength Design of Reinforced Concrete Sections
                                        Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
=============================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                             Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                 02/18/14
F:\SPRING\Lateral\Column Designs\Frame 8 - 8D.col                                                01:42 PM

General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 8 - 8D.col
  Project:  Lateral System
  Column:   8D                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in                Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                           Iy =  8748 in^4
  rx =  5.19615 in                          ry =  5.19615 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 20.32 in^2 at rho = 6.27%
  Minimum clear spacing = 1.98 in

  16 #10   Cover = 1.5 in

Service Loads:
==============
       Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case           kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead        278.71         0.00         0.00       -18.89         0.00
      Live        131.44         0.00         0.00        -6.58         0.00
      Wind          3.53         0.00         0.00      -197.88         0.00
      EQ            0.00         0.00         0.00         0.00         0.00
      Snow         51.76         0.00         0.00        -4.54         0.00
    2 Dead        278.71         0.00         0.00       -18.89         0.00
      Live         97.22         0.00         0.00       -10.91         0.00
      Wind          3.53         0.00         0.00      -197.88         0.00
      EQ            0.00         0.00         0.00         0.00         0.00
      Snow         51.76         0.00         0.00        -4.54         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

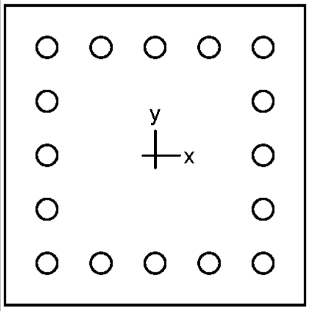
```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                     Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                         02/18/14
F:\SPRING\Lateral\Column Designs\Frame 8 - 8D.col                                                        01:42 PM

  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
  U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
  U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load         Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No.  Combo       kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1     390.19       0.00     -26.45       0.00    -395.81   14.967     9.83    15.49  0.00173  0.650
    2           390.19       0.00       0.00     395.81       0.00  999.999     9.83    15.49  0.00173  0.650
    3  1 U2     570.64       0.00     -35.47       0.00    -349.85    9.865    11.41    15.49  0.00107  0.650
    4           570.64       0.00       0.00     349.85       0.00  999.999    11.41    15.49  0.00107  0.650
    5  1 U3     548.71       0.00     -36.51       0.00    -355.40    9.734    11.20    15.49  0.00115  0.650
    6           548.71       0.00       0.00     355.40       0.00  999.999    11.20    15.49  0.00115  0.650
    7  1 U4     420.09       0.00    -188.23       0.00    -388.55    2.064    10.06    15.49  0.00162  0.650
    8           420.09       0.00       0.00     388.55       0.00  999.999    10.06    15.49  0.00162  0.650
    9  1 U5     497.42       0.00    -348.12       0.00    -368.20    1.058    10.75    15.49  0.00132  0.650
   10           497.42       0.00       0.00     368.20       0.00  999.999    10.75    15.49  0.00132  0.650
   11  1 U6     256.49       0.00    -333.60       0.00    -438.59    1.315     8.52    15.49  0.00245  0.683
   12           256.49       0.00       0.00     438.59       0.00  999.999     8.52    15.49  0.00245  0.683
   13  1 U7     414.44       0.00     128.37      -0.00     389.93    3.038    10.02    15.49  0.00164  0.650
   14           414.44       0.00       0.00     389.93       0.00  999.999    10.02    15.49  0.00164  0.650
   15  1 U8     486.12       0.00     285.08      -0.00     370.99    1.301    10.65    15.49  0.00136  0.650
   16           486.12       0.00       0.00     371.00       0.00  999.999    10.65    15.49  0.00136  0.650
   17  1 U9     245.19       0.00     299.60      -0.00     443.86    1.482     8.37    15.49  0.00256  0.691
   18           245.19       0.00       0.00     443.86       0.00  999.999     8.37    15.49  0.00256  0.691
   19  2 U1     390.19       0.00     -26.45       0.00    -395.81   14.967     9.83    15.49  0.00173  0.650
   20           390.19       0.00       0.00     395.81       0.00  999.999     9.83    15.49  0.00173  0.650
   21  2 U2     515.88       0.00     -42.39       0.00    -363.62    8.577    10.91    15.49  0.00126  0.650
   22           515.88       0.00       0.00     363.62       0.00  999.999    10.91    15.49  0.00126  0.650
   23  2 U3     514.49       0.00     -40.84       0.00    -363.97    8.912    10.90    15.49  0.00126  0.650
   24           514.49       0.00       0.00     363.97       0.00  999.999    10.90    15.49  0.00126  0.650
   25  2 U4     420.09       0.00    -188.23       0.00    -388.55    2.064    10.06    15.49  0.00162  0.650
   26           420.09       0.00       0.00     388.55       0.00  999.999    10.06    15.49  0.00162  0.650
   27  2 U5     463.20       0.00    -352.45       0.00    -378.02    1.073    10.41    15.49  0.00146  0.650
   28           463.20       0.00       0.00     378.02       0.00  999.999    10.41    15.49  0.00146  0.650
   29  2 U6     256.49       0.00    -333.60       0.00    -438.59    1.315     8.52    15.49  0.00245  0.683
   30           256.49       0.00       0.00     438.59       0.00  999.999     8.52    15.49  0.00245  0.683
   31  2 U7     414.44       0.00     128.37      -0.00     389.93    3.038    10.02    15.49  0.00164  0.650
   32           414.44       0.00       0.00     389.93       0.00  999.999    10.02    15.49  0.00164  0.650
   33  2 U8     451.90       0.00     280.75      -0.00     380.79    1.356    10.32    15.49  0.00150  0.650
   34           451.90       0.00       0.00     380.79       0.00  999.999    10.32    15.49  0.00150  0.650
   35  2 U9     245.19       0.00     299.60      -0.00     443.86    1.482     8.37    15.49  0.00256  0.691
   36           245.19       0.00       0.00     443.86       0.00  999.999     8.37    15.49  0.00256  0.691

  *** End of output ***
```

Column 8G



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

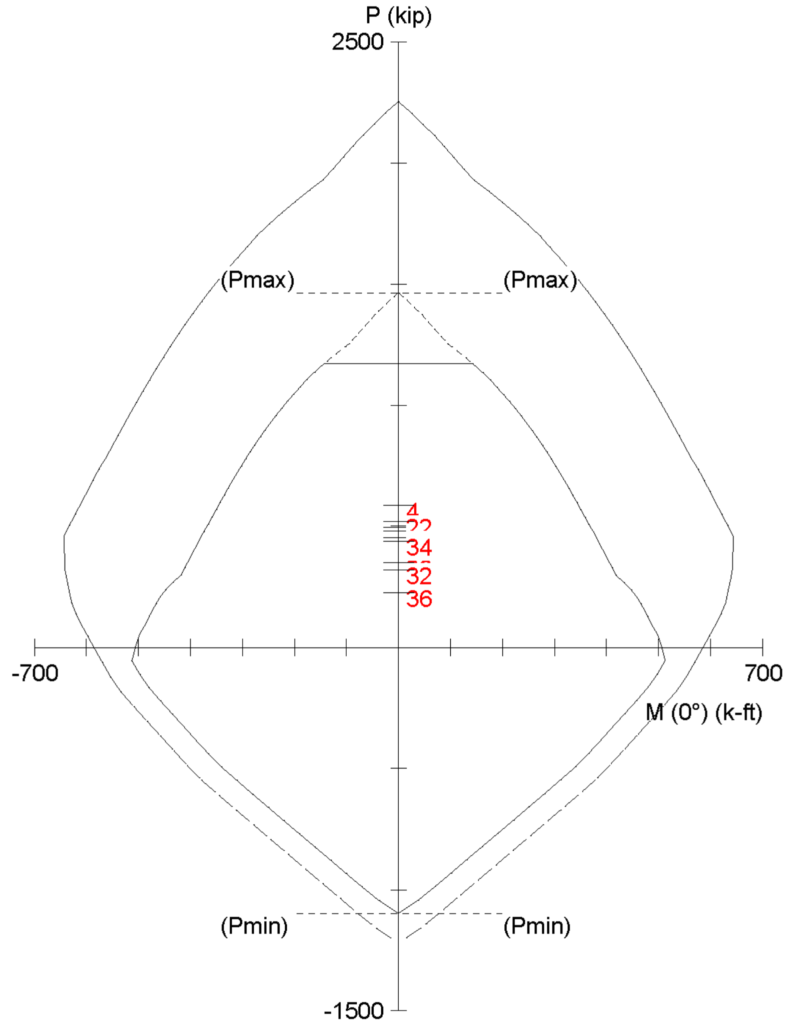
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 14:06:03



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\8G\Frame 8 - 8G.col

Project: Lateral System

Column: 8G		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	16 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 20.32 in^2	rho = 6.27%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 1.98 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68            02/18/14
F:\SPRING\Lateral\Column Designs\8G\Frame 8 - 8G.col                                        02:05 PM
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                    oo    oo             oo
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oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
oo        oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
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     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo   oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=========================================================================================================
                                         spColumn v4.81 (TM)
                   Computer program for the Strength Design of Reinforced Concrete Sections
                                Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                           All rights reserved
=========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68        02/18/14
F:\SPRING\Lateral\Column Designs\8G\Frame 8 - 8G.col                                    02:05 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\8G\Frame 8 - 8G.col
  Project:  Lateral System
  Column:   8G                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in                Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                           Iy =  8748 in^4
  rx =  5.19615 in                          ry =  5.19615 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 20.32 in^2 at rho = 6.27%
  Minimum clear spacing = 1.98 in

  16 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       249.62         0.00         0.00         9.39         0.00
      Live       175.12         0.00         0.00         3.42         0.00
      Wind         0.00         0.00         0.00      -203.88         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        13.66         0.00         0.00         1.28         0.00
    2 Dead       249.62         0.00         0.00         9.39         0.00
      Live       132.67         0.00         0.00         8.35         0.00
      Wind         0.00         0.00         0.00      -203.88         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        13.66         0.00         0.00         1.28         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/18/14
F:\SPRING\Lateral\Column Designs\8G\Frame 8 - 8G.col 02:05 PM

```
U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
```

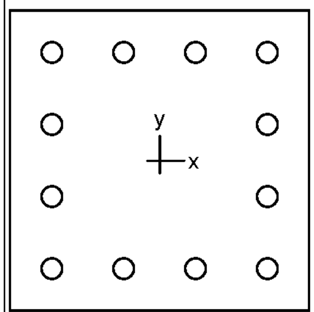
Factored Loads and Moments with Corresponding Capacities:
==

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	349.47	0.00	13.15	-0.00	405.69	30.861	9.53	15.49	0.00188	0.650
2		349.47	0.00	0.00	405.69	0.00	999.999	9.53	15.49	0.00188	0.650
3	1 U2	586.57	0.00	17.38	-0.00	345.80	19.896	11.56	15.49	0.00102	0.650
4		586.57	0.00	0.00	345.80	0.00	999.999	11.56	15.49	0.00102	0.650
5	1 U3	496.52	0.00	16.74	-0.00	368.43	22.014	10.74	15.49	0.00133	0.650
6		496.52	0.00	0.00	368.43	0.00	999.999	10.74	15.49	0.00133	0.650
7	1 U4	321.40	0.00	-149.78	0.00	-412.49	2.754	9.33	15.49	0.00198	0.650
8		321.40	0.00	0.00	412.49	0.00	999.999	9.33	15.49	0.00198	0.650
9	1 U5	481.49	0.00	-310.87	0.00	-372.13	1.197	10.61	15.49	0.00138	0.650
10		481.49	0.00	0.00	372.13	0.00	999.999	10.61	15.49	0.00138	0.650
11	1 U6	224.66	0.00	-317.75	0.00	-453.15	1.426	8.10	15.49	0.00273	0.707
12		224.66	0.00	0.00	453.15	0.00	999.999	8.10	15.49	0.00273	0.707
13	1 U7	321.40	0.00	176.42	-0.00	412.49	2.338	9.33	15.49	0.00198	0.650
14		321.40	0.00	0.00	412.49	0.00	999.999	9.33	15.49	0.00198	0.650
15	1 U8	481.49	0.00	341.53	-0.00	372.13	1.090	10.61	15.49	0.00138	0.650
16		481.49	0.00	0.00	372.13	0.00	999.999	10.61	15.49	0.00138	0.650
17	1 U9	224.66	0.00	334.65	-0.00	453.15	1.354	8.10	15.49	0.00273	0.707
18		224.66	0.00	0.00	453.15	0.00	999.999	8.10	15.49	0.00273	0.707
19	2 U1	349.47	0.00	13.15	-0.00	405.69	30.861	9.53	15.49	0.00188	0.650
20		349.47	0.00	0.00	405.69	0.00	999.999	9.53	15.49	0.00188	0.650
21	2 U2	518.65	0.00	25.27	-0.00	362.93	14.363	10.93	15.49	0.00125	0.650
22		518.65	0.00	0.00	362.93	0.00	999.999	10.93	15.49	0.00125	0.650
23	2 U3	454.07	0.00	21.67	-0.00	380.25	17.551	10.34	15.49	0.00150	0.650
24		454.07	0.00	0.00	380.25	0.00	999.999	10.34	15.49	0.00150	0.650
25	2 U4	321.40	0.00	-149.78	0.00	-412.49	2.754	9.33	15.49	0.00198	0.650
26		321.40	0.00	0.00	412.49	0.00	999.999	9.33	15.49	0.00198	0.650
27	2 U5	439.04	0.00	-305.94	0.00	-383.93	1.255	10.21	15.49	0.00155	0.650
28		439.04	0.00	0.00	383.93	0.00	999.999	10.21	15.49	0.00155	0.650
29	2 U6	224.66	0.00	-317.75	0.00	-453.15	1.426	8.10	15.49	0.00273	0.707
30		224.66	0.00	0.00	453.15	0.00	999.999	8.10	15.49	0.00273	0.707
31	2 U7	321.40	0.00	176.42	-0.00	412.49	2.338	9.33	15.49	0.00198	0.650
32		321.40	0.00	0.00	412.49	0.00	999.999	9.33	15.49	0.00198	0.650
33	2 U8	439.04	0.00	346.46	-0.00	383.93	1.108	10.21	15.49	0.00155	0.650
34		439.04	0.00	0.00	383.93	0.00	999.999	10.21	15.49	0.00155	0.650
35	2 U9	224.66	0.00	334.65	-0.00	453.15	1.354	8.10	15.49	0.00273	0.707
36		224.66	0.00	0.00	453.15	0.00	999.999	8.10	15.49	0.00273	0.707

*** End of output ***

Column 8M



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

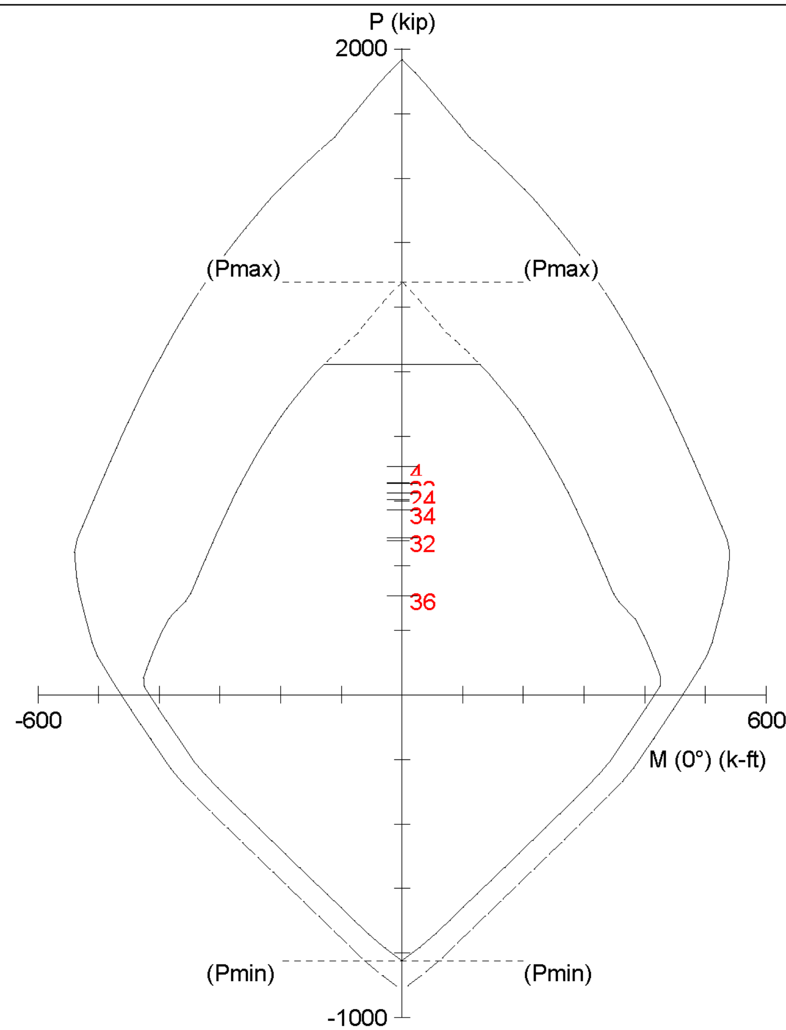
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 12:51:32



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\Frame 8 - 8M.col

Project: Lateral System

Column: 8M		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	12 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 15.24 in^2	rho = 4.70%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 3.06 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                            Page   1
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F:\SPRING\Lateral\Column Designs\Frame 8 - 8M.col                                               12:46 PM
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```
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                    oo    oo             oo
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 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
==========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
                               Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                          All rights reserved
==========================================================================================================
```

```
General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 8 - 8M.col
  Project:  Lateral System
  Column:   8M                              Engineer: ahm
  Code:     ACI 318-11                      Units: English

  Run Option: Design                        Slenderness: Not considered
  Run Axis:   Biaxial                       Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                             fy   = 60 ksi
  Ec    = 3605 ksi                          Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in                Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                           Iy =  8748 in^4
  rx =  5.19615 in                          ry =  5.19615 in
  Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 15.24 in^2 at rho = 4.70%
  Minimum clear spacing = 3.06 in

  12 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       340.47         0.00         0.00        -4.39         0.00
      Live       170.19         0.00         0.00        -2.69         0.00
      Wind         0.00         0.00         0.00      -159.90         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        48.28         0.00         0.00        -0.31         0.00
    2 Dead       340.47         0.00         0.00        -4.39         0.00
      Live       138.39         0.00         0.00        -6.69         0.00
      Wind         0.00         0.00         0.00      -159.90         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        48.28         0.00         0.00        -0.31         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                    Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68       02/18/14
F:\SPRING\Lateral\Column Designs\Frame 8 - 8M.col                                        12:46 PM

  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
  U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
  U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
       Load          Pu        Mux        Muy     PhiMnx     PhiMny PhiMn/Mu NA depth Dt depth    eps_t    Phi
  No. Combo         kip       k-ft       k-ft       k-ft       k-ft                in       in
  --- ------ ---------- ---------- ---------- ---------- ---------- -------- -------- -------- -------- ------
    1  1 U1      476.66       0.00      -6.15       0.00    -310.45   50.512    10.88    15.49  0.00127  0.650
    2            476.66       0.00       0.00     310.45       0.00  999.999    10.88    15.49  0.00127  0.650
    3  1 U2      705.01       0.00      -9.73       0.00    -250.71   25.775    13.77    15.49  0.00037  0.650
    4            705.01       0.00       0.00     250.71       0.00  999.999    13.77    15.49  0.00037  0.650
    5  1 U3      656.00       0.00      -8.45       0.00    -265.24   31.374    13.02    15.49  0.00057  0.650
    6            656.00       0.00       0.00     265.24       0.00  999.999    13.02    15.49  0.00057  0.650
    7  1 U4      485.81       0.00    -133.69       0.00    -308.29    2.306    10.97    15.49  0.00123  0.650
    8            485.81       0.00       0.00     308.29       0.00  999.999    10.97    15.49  0.00123  0.650
    9  1 U5      602.89       0.00    -263.96       0.00    -279.40    1.059    12.34    15.49  0.00077  0.650
   10            602.89       0.00       0.00     279.40       0.00  999.999    12.34    15.49  0.00077  0.650
   11  1 U6      306.42       0.00    -259.80       0.00    -349.46    1.345     9.24    15.49  0.00203  0.650
   12            306.42       0.00       0.00     349.46       0.00  999.999     9.24    15.49  0.00203  0.650
   13  1 U7      485.81       0.00     122.16      -0.00     308.29    2.524    10.97    15.49  0.00123  0.650
   14            485.81       0.00       0.00     308.29       0.00  999.999    10.97    15.49  0.00123  0.650
   15  1 U8      602.89       0.00     247.73      -0.00     279.40    1.128    12.34    15.49  0.00077  0.650
   16            602.89       0.00       0.00     279.40       0.00  999.999    12.34    15.49  0.00077  0.650
   17  1 U9      306.42       0.00     251.89      -0.00     349.46    1.387     9.24    15.49  0.00203  0.650
   18            306.42       0.00       0.00     349.46       0.00  999.999     9.24    15.49  0.00203  0.650
   19  2 U1      476.66       0.00      -6.15       0.00    -310.45   50.512    10.88    15.49  0.00127  0.650
   20            476.66       0.00       0.00     310.45       0.00  999.999    10.88    15.49  0.00127  0.650
   21  2 U2      654.13       0.00     -16.13       0.00    -265.75   16.479    13.00    15.49  0.00057  0.650
   22            654.13       0.00       0.00     265.75       0.00  999.999    13.00    15.49  0.00057  0.650
   23  2 U3      624.20       0.00     -12.45       0.00    -273.81   21.986    12.61    15.49  0.00069  0.650
   24            624.20       0.00       0.00     273.81       0.00  999.999    12.61    15.49  0.00069  0.650
   25  2 U4      485.81       0.00    -133.69       0.00    -308.29    2.306    10.97    15.49  0.00123  0.650
   26            485.81       0.00       0.00     308.29       0.00  999.999    10.97    15.49  0.00123  0.650
   27  2 U5      571.09       0.00    -267.96       0.00    -287.52    1.073    11.95    15.49  0.00089  0.650
   28            571.09       0.00       0.00     287.52       0.00  999.999    11.95    15.49  0.00089  0.650
   29  2 U6      306.42       0.00    -259.80       0.00    -349.46    1.345     9.24    15.49  0.00203  0.650
   30            306.42       0.00       0.00     349.46       0.00  999.999     9.24    15.49  0.00203  0.650
   31  2 U7      485.81       0.00     122.16      -0.00     308.29    2.524    10.97    15.49  0.00123  0.650
   32            485.81       0.00       0.00     308.29       0.00  999.999    10.97    15.49  0.00123  0.650
   33  2 U8      571.09       0.00     243.73      -0.00     287.52    1.180    11.95    15.49  0.00089  0.650
   34            571.09       0.00       0.00     287.52       0.00  999.999    11.95    15.49  0.00089  0.650
   35  2 U9      306.42       0.00     251.89      -0.00     349.46    1.387     9.24    15.49  0.00203  0.650
   36            306.42       0.00       0.00     349.46       0.00  999.999     9.24    15.49  0.00203  0.650

  *** End of output ***
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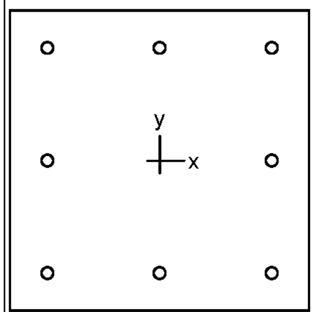
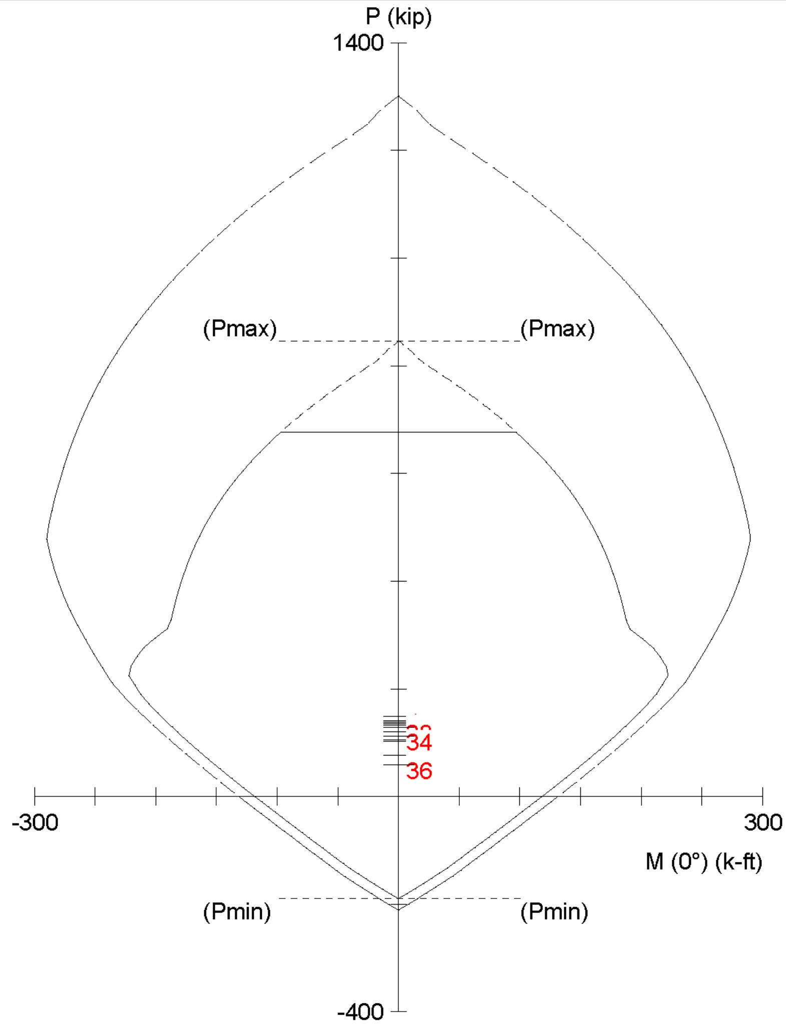
Column Line 13 Columns

Column 13A.2



18 x 18 in



Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 12:37:17

spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\Frame 13 - 13A.2.col

Project: Lateral System

Column: 13A.2		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	8 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 3.52 in^2	rho = 1.09%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 6.00 in	Clear cover = 1.88 in
Confinement: Tied			
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65			

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                  Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68      02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13A.2.col                                 12:36 PM
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                    oo    oo             oo
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oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
oo        oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
 ooooo    oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo   oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
==========================================================================================================
                                         spColumn v4.81 (TM)
                     Computer program for the Strength Design of Reinforced Concrete Sections
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                                           All rights reserved
==========================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                 Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                     02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13A.2.col                                                12:36 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 13 - 13A.2.col
  Project:  Lateral System
  Column:   13A.2                          Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in               Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                          Iy =  8748 in^4
  rx =  5.19615 in                         ry =  5.19615 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 3.52 in^2 at rho = 1.09%
  Minimum clear spacing = 6.00 in

  8 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead        74.75         0.00         0.00        13.26         0.00
      Live        33.42         0.00         0.00         6.94         0.00
      Wind         5.52         0.00         0.00       -80.34         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.89         0.00         0.00         1.86         0.00
    2 Dead        74.75         0.00         0.00        13.26         0.00
      Live        25.23         0.00         0.00         7.76         0.00
      Wind         5.52         0.00         0.00       -80.34         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.89         0.00         0.00         1.86         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                     Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68         02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13A.2.col                                    12:36 PM
```

```
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
  U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
  U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
```

Factored Loads and Moments with Corresponding Capacities:

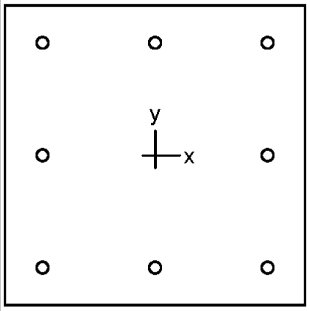
Design/Required ratio PhiMn/Mu >= 1.00

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	104.65	0.00	18.56	-0.00	174.74	9.413	3.92	15.75	0.00905	0.900
2		104.65	0.00	0.00	174.74	0.00	999.999	3.92	15.75	0.00905	0.900
3	1 U2	148.62	0.00	27.95	-0.00	195.45	6.994	4.66	15.75	0.00714	0.900
4		148.62	0.00	0.00	195.45	0.00	999.999	4.66	15.75	0.00714	0.900
5	1 U3	140.54	0.00	25.83	-0.00	191.80	7.426	4.52	15.75	0.00746	0.900
6		140.54	0.00	0.00	191.80	0.00	999.999	4.52	15.75	0.00746	0.900
7	1 U4	111.54	0.00	-45.38	0.00	-178.11	3.925	4.03	15.75	0.00872	0.900
8		111.54	0.00	0.00	178.11	0.00	999.999	4.03	15.75	0.00872	0.900
9	1 U5	137.40	0.00	-104.76	0.00	-190.36	1.817	4.46	15.75	0.00758	0.900
10		137.40	0.00	0.00	190.36	0.00	999.999	4.46	15.75	0.00758	0.900
11	1 U6	76.11	0.00	-116.61	0.00	-160.23	1.374	3.47	15.75	0.01061	0.900
12		76.11	0.00	0.00	160.23	0.00	999.999	3.47	15.75	0.01061	0.900
13	1 U7	102.70	0.00	83.16	-0.00	173.78	2.090	3.89	15.75	0.00915	0.900
14		102.70	0.00	0.00	173.78	0.00	999.999	3.89	15.75	0.00915	0.900
15	1 U8	119.73	0.00	152.32	-0.00	182.06	1.195	4.17	15.75	0.00834	0.900
16		119.73	0.00	0.00	182.06	0.00	999.999	4.17	15.75	0.00834	0.900
17	1 U9	58.44	0.00	140.48	-0.00	150.88	1.074	3.21	15.75	0.01171	0.900
18		58.44	0.00	0.00	150.88	0.00	999.999	3.21	15.75	0.01171	0.900
19	2 U1	104.65	0.00	18.56	-0.00	174.74	9.413	3.92	15.75	0.00905	0.900
20		104.65	0.00	0.00	174.74	0.00	999.999	3.92	15.75	0.00905	0.900
21	2 U2	135.51	0.00	29.26	-0.00	189.49	6.476	4.43	15.75	0.00766	0.900
22		135.51	0.00	0.00	189.49	0.00	999.999	4.43	15.75	0.00766	0.900
23	2 U3	132.35	0.00	26.65	-0.00	188.03	7.056	4.38	15.75	0.00779	0.900
24		132.35	0.00	0.00	188.03	0.00	999.999	4.38	15.75	0.00779	0.900
25	2 U4	111.54	0.00	-45.38	0.00	-178.11	3.925	4.03	15.75	0.00872	0.900
26		111.54	0.00	0.00	178.11	0.00	999.999	4.03	15.75	0.00872	0.900
27	2 U5	129.21	0.00	-103.94	0.00	-186.56	1.795	4.32	15.75	0.00793	0.900
28		129.21	0.00	0.00	186.56	0.00	999.999	4.32	15.75	0.00793	0.900
29	2 U6	76.11	0.00	-116.61	0.00	-160.23	1.374	3.47	15.75	0.01061	0.900
30		76.11	0.00	0.00	160.23	0.00	999.999	3.47	15.75	0.01061	0.900
31	2 U7	102.70	0.00	83.16	-0.00	173.78	2.090	3.89	15.75	0.00915	0.900
32		102.70	0.00	0.00	173.78	0.00	999.999	3.89	15.75	0.00915	0.900
33	2 U8	111.54	0.00	153.14	-0.00	178.11	1.163	4.03	15.75	0.00872	0.900
34		111.54	0.00	0.00	178.11	0.00	999.999	4.03	15.75	0.00872	0.900
35	2 U9	58.44	0.00	140.48	-0.00	150.88	1.074	3.21	15.75	0.01171	0.900
36		58.44	0.00	0.00	150.88	0.00	999.999	3.21	15.75	0.01171	0.900

*** End of output ***

Column 13B



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

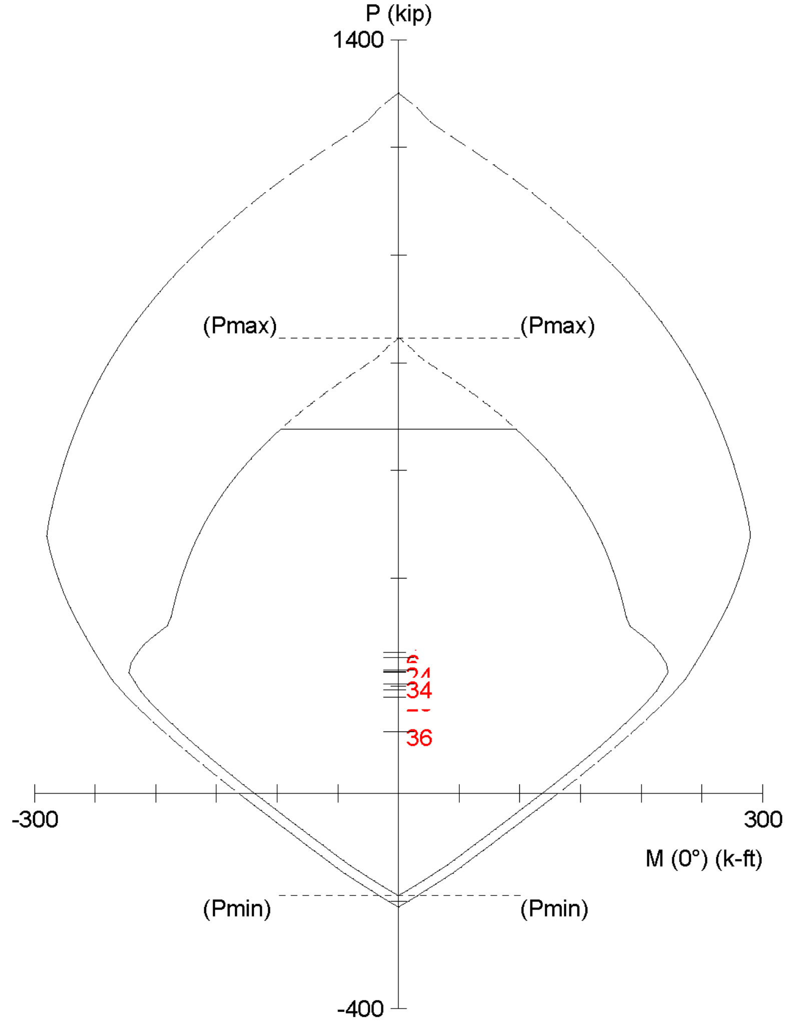
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 13:16:58



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File: F:\SPRING\Lateral\Column Designs\Frame 13 - 13B.col

Project: Lateral System

Column: 13B		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	8 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 3.52 in^2	rho = 1.09%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 6.00 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                      Page   1
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F:\SPRING\Lateral\Column Designs\Frame 13 - 13B.col                                       01:14 PM
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```
                    oooooo             o
                   oo    oo           oo
 ooooo   oooooo    oo         ooooo   oo      oo   oo   o oooooooooo    o ooooo
oo    o  oo   oo   oo        oo   oo  oo      oo   oo    oo   oo   oo    oo   oo
oo       oo   oo   oo        oo   oo  oo      oo   oo    oo   oo   oo    oo   oo
 ooooo   oo   oo   oo        oo   oo  oo      oo   oo    oo   oo   oo    oo   oo
     oo  oooooo    oo        oo   oo  oo      oo   oo    oo   oo   oo    oo   oo
o    oo  oo        oo    oo  oo   oo  oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo   oo         oooooo    ooooo    ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=============================================================================================================
                                         spColumn v4.81 (TM)
                      Computer program for the Strength Design of Reinforced Concrete Sections
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=============================================================================================================
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 2
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F:\SPRING\Lateral\Column Designs\Frame 13 - 13B.col 01:14 PM

General Information:
====================

File Name: F:\SPRING\Lateral\Column Designs\Frame 13 - 13B.col
Project: Lateral System
Column: 13B Engineer: ahm
Code: ACI 318-11 Units: English

Run Option: Design Slenderness: Not considered
Run Axis: Biaxial Column Type: Structural

Material Properties:
====================

f'c = 4 ksi fy = 60 ksi
Ec = 3605 ksi Es = 29000 ksi
Ultimate strain = 0.003 in/in
Beta1 = 0.85

Section:
========

Rectangular: Width = 18 in Depth = 18 in

Gross section area, Ag = 324 in^2
Ix = 8748 in^4 Iy = 8748 in^4
rx = 5.19615 in ry = 5.19615 in
Xo = 0 in Yo = 0 in

Reinforcement:
==============

Bar Set: ASTM A615

Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

Bar selection: Minimum number of bars
Asmin = 0.01 * Ag = 3.24 in^2, Asmax = 0.08 * Ag = 25.92 in^2

Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Layout: Rectangular
Pattern: All Sides Equal (Cover to transverse reinforcement)
Total steel area: As = 3.52 in^2 at rho = 1.09%
Minimum clear spacing = 6.00 in

8 #6 Cover = 1.5 in

Service Loads:
==============

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	128.26	0.00	0.00	-5.42	0.00
	Live	60.11	0.00	0.00	-2.50	0.00
	Wind	0.00	0.00	0.00	-106.71	0.00
	EQ	0.00	0.00	0.00	0.00	0.00
	Snow	24.47	0.00	0.00	-0.28	0.00
2	Dead	128.26	0.00	0.00	-5.42	0.00
	Live	36.91	0.00	0.00	-4.91	0.00
	Wind	0.00	0.00	0.00	-106.71	0.00
	EQ	0.00	0.00	0.00	0.00	0.00
	Snow	24.47	0.00	0.00	-0.28	0.00

Sustained Load Factors:
=======================

Load Case	Factor (%)
Dead	100
Live	0
Wind	0
EQ	0
Snow	0

Load Combinations:
==================

U1 = 1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
U2 = 1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
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F:\SPRING\Lateral\Column Designs\Frame 13 - 13B.col 01:14 PM

U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

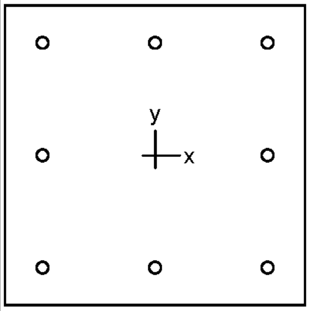
Factored Loads and Moments with Corresponding Capacities:
===

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	179.56	0.00	-7.59	0.00	-208.69	27.503	5.21	15.75	0.00608	0.900
2		179.56	0.00	0.00	208.69	0.00	999.999	5.21	15.75	0.00608	0.900
3	1 U2	262.32	0.00	-10.64	0.00	-214.62	20.163	6.84	15.75	0.00390	0.807
4		262.32	0.00	0.00	214.62	0.00	999.999	6.84	15.75	0.00390	0.807
5	1 U3	253.17	0.00	-9.45	0.00	-217.30	22.989	6.56	15.75	0.00421	0.832
6		253.17	0.00	0.00	217.30	0.00	999.999	6.56	15.75	0.00421	0.832
7	1 U4	193.06	0.00	-92.32	0.00	-213.35	2.311	5.42	15.75	0.00572	0.900
8		193.06	0.00	0.00	213.35	0.00	999.999	5.42	15.75	0.00572	0.900
9	1 U5	226.26	0.00	-179.88	0.00	-222.59	1.237	5.87	15.75	0.00505	0.900
10		226.26	0.00	0.00	222.59	0.00	999.999	5.87	15.75	0.00505	0.900
11	1 U6	115.43	0.00	-175.61	0.00	-180.00	1.025	4.09	15.75	0.00854	0.900
12		115.43	0.00	0.00	180.00	0.00	999.999	4.09	15.75	0.00854	0.900
13	1 U7	193.06	0.00	78.41	-0.00	213.35	2.721	5.42	15.75	0.00572	0.900
14		193.06	0.00	0.00	213.35	0.00	999.999	5.42	15.75	0.00572	0.900
15	1 U8	226.26	0.00	161.59	-0.00	222.59	1.377	5.87	15.75	0.00505	0.900
16		226.26	0.00	0.00	222.59	0.00	999.999	5.87	15.75	0.00505	0.900
17	1 U9	115.43	0.00	165.85	-0.00	180.00	1.085	4.09	15.75	0.00854	0.900
18		115.43	0.00	0.00	180.00	0.00	999.999	4.09	15.75	0.00854	0.900
19	2 U1	179.56	0.00	-7.59	0.00	-208.69	27.503	5.21	15.75	0.00608	0.900
20		179.56	0.00	0.00	208.69	0.00	999.999	5.21	15.75	0.00608	0.900
21	2 U2	225.20	0.00	-14.50	0.00	-222.31	15.331	5.85	15.75	0.00507	0.900
22		225.20	0.00	0.00	222.31	0.00	999.999	5.85	15.75	0.00507	0.900
23	2 U3	229.97	0.00	-11.86	0.00	-223.15	18.813	5.93	15.75	0.00497	0.897
24		229.97	0.00	0.00	223.15	0.00	999.999	5.93	15.75	0.00497	0.897
25	2 U4	193.06	0.00	-92.32	0.00	-213.35	2.311	5.42	15.75	0.00572	0.900
26		193.06	0.00	0.00	213.35	0.00	999.999	5.42	15.75	0.00572	0.900
27	2 U5	203.06	0.00	-182.29	0.00	-216.17	1.186	5.55	15.75	0.00552	0.900
28		203.06	0.00	0.00	216.17	0.00	999.999	5.55	15.75	0.00552	0.900
29	2 U6	115.43	0.00	-175.61	0.00	-180.00	1.025	4.09	15.75	0.00854	0.900
30		115.43	0.00	0.00	180.00	0.00	999.999	4.09	15.75	0.00854	0.900
31	2 U7	193.06	0.00	78.41	-0.00	213.35	2.721	5.42	15.75	0.00572	0.900
32		193.06	0.00	0.00	213.35	0.00	999.999	5.42	15.75	0.00572	0.900
33	2 U8	203.06	0.00	159.18	-0.00	216.17	1.358	5.55	15.75	0.00552	0.900
34		203.06	0.00	0.00	216.17	0.00	999.999	5.55	15.75	0.00552	0.900
35	2 U9	115.43	0.00	165.85	-0.00	180.00	1.085	4.09	15.75	0.00854	0.900
36		115.43	0.00	0.00	180.00	0.00	999.999	4.09	15.75	0.00854	0.900

*** End of output ***

Column 13C



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

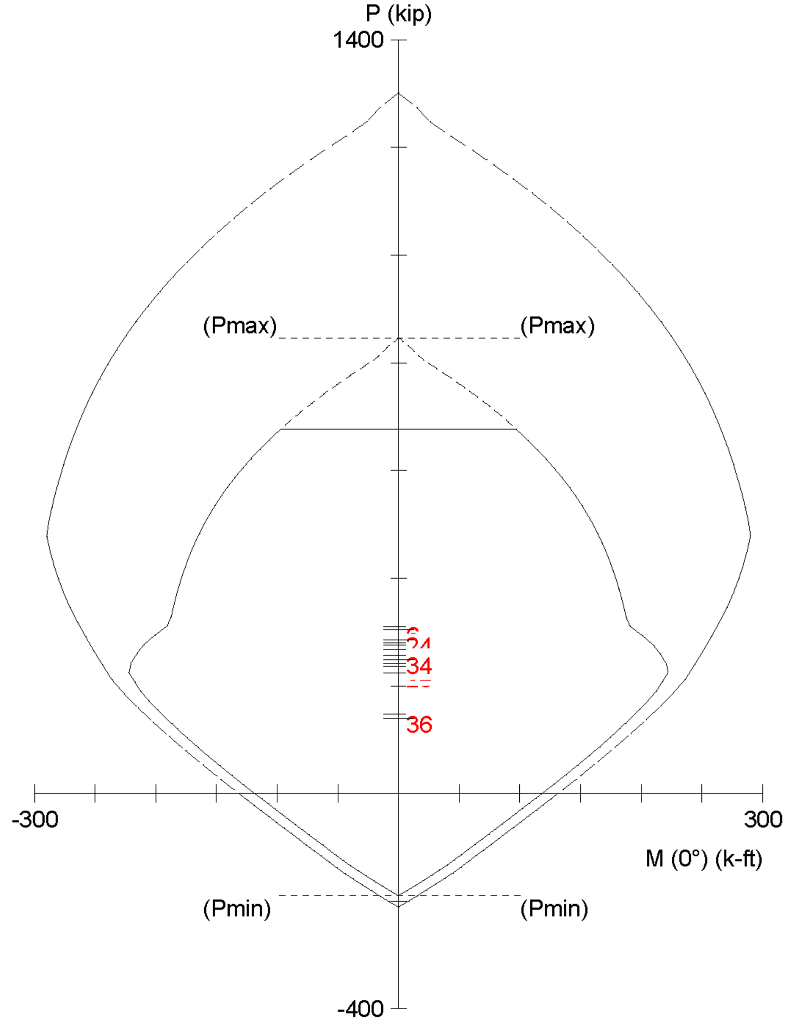
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 13:34:01



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File: F:\SPRING\Lateral\Column Designs\Frame 13 - 13C.col

Project: Lateral System

Column: 13C		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	8 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 3.52 in^2	rho = 1.09%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 6.00 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                       Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68                           02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13C.col                                                        01:32 PM
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oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
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     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo   oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=========================================================================================================
                                          spColumn v4.81 (TM)
                Computer program for the Strength Design of Reinforced Concrete Sections
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=========================================================================================================
```

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STRUCTUREPOINT - spColumn v4.81 (TM)                                                      Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68          02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13C.col                                       01:32 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 13 - 13C.col
  Project:  Lateral System
  Column:   13C                            Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in               Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                          Iy =  8748 in^4
  rx =  5.19615 in                         ry =  5.19615 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 3.52 in^2 at rho = 1.09%
  Minimum clear spacing = 6.00 in

  8 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       159.87         0.00         0.00        -0.66         0.00
      Live        64.95         0.00         0.00        -0.80         0.00
      Wind         2.75         0.00         0.00      -108.53         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        29.39         0.00         0.00        -0.85         0.00
    2 Dead       159.87         0.00         0.00        -0.66         0.00
      Live        46.10         0.00         0.00        -2.20         0.00
      Wind         2.75         0.00         0.00      -108.53         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        29.39         0.00         0.00        -0.85         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM)
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F:\SPRING\Lateral\Column Designs\Frame 13 - 13C.col

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U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

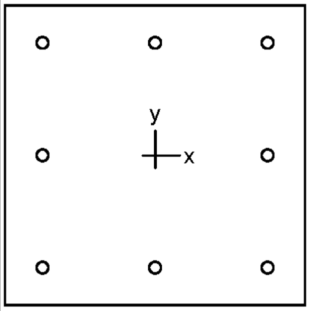
Factored Loads and Moments with Corresponding Capacities:
==

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	223.82	0.00	-0.92	0.00	-221.93	240.181	5.83	15.75	0.00510	0.900
2		223.82	0.00	0.00	221.93	0.00	999.999	5.83	15.75	0.00510	0.900
3	1 U2	310.46	0.00	-2.50	0.00	-190.78	76.404	9.11	15.75	0.00218	0.660
4		310.46	0.00	0.00	190.78	0.00	999.999	9.11	15.75	0.00218	0.660
5	1 U3	303.82	0.00	-2.95	0.00	-194.78	65.983	8.73	15.75	0.00241	0.679
6		303.82	0.00	0.00	194.78	0.00	999.999	8.73	15.75	0.00241	0.679
7	1 U4	241.07	0.00	-88.98	0.00	-220.51	2.478	6.21	15.75	0.00461	0.867
8		241.07	0.00	0.00	220.51	0.00	999.999	6.21	15.75	0.00461	0.867
9	1 U5	275.89	0.00	-175.66	0.00	-209.89	1.195	7.34	15.75	0.00344	0.767
10		275.89	0.00	0.00	209.89	0.00	999.999	7.34	15.75	0.00344	0.767
11	1 U6	148.29	0.00	-174.24	0.00	-195.30	1.121	4.65	15.75	0.00716	0.900
12		148.29	0.00	0.00	195.30	0.00	999.999	4.65	15.75	0.00716	0.900
13	1 U7	236.67	0.00	84.67	-0.00	221.59	2.617	6.10	15.75	0.00475	0.879
14		236.67	0.00	0.00	221.59	0.00	999.999	6.10	15.75	0.00475	0.879
15	1 U8	267.09	0.00	171.63	-0.00	213.12	1.242	7.01	15.75	0.00374	0.793
16		267.09	0.00	0.00	213.12	0.00	999.999	7.01	15.75	0.00374	0.793
17	1 U9	139.48	0.00	173.05	-0.00	191.31	1.106	4.50	15.75	0.00750	0.900
18		139.48	0.00	0.00	191.31	0.00	999.999	4.50	15.75	0.00750	0.900
19	2 U1	223.82	0.00	-0.92	0.00	-221.93	240.181	5.83	15.75	0.00510	0.900
20		223.82	0.00	0.00	221.93	0.00	999.999	5.83	15.75	0.00510	0.900
21	2 U2	280.30	0.00	-4.74	0.00	-207.67	43.840	7.53	15.75	0.00327	0.753
22		280.30	0.00	0.00	207.67	0.00	999.999	7.53	15.75	0.00327	0.753
23	2 U3	284.97	0.00	-4.35	0.00	-205.26	47.164	7.75	15.75	0.00310	0.738
24		284.97	0.00	0.00	205.26	0.00	999.999	7.75	15.75	0.00310	0.738
25	2 U4	241.07	0.00	-88.98	0.00	-220.51	2.478	6.21	15.75	0.00461	0.867
26		241.07	0.00	0.00	220.51	0.00	999.999	6.21	15.75	0.00461	0.867
27	2 U5	257.04	0.00	-177.06	0.00	-216.20	1.221	6.67	15.75	0.00408	0.822
28		257.04	0.00	0.00	216.20	0.00	999.999	6.67	15.75	0.00408	0.822
29	2 U6	148.29	0.00	-174.24	0.00	-195.30	1.121	4.65	15.75	0.00716	0.900
30		148.29	0.00	0.00	195.30	0.00	999.999	4.65	15.75	0.00716	0.900
31	2 U7	236.67	0.00	84.67	-0.00	221.59	2.617	6.10	15.75	0.00475	0.879
32		236.67	0.00	0.00	221.59	0.00	999.999	6.10	15.75	0.00475	0.879
33	2 U8	248.24	0.00	170.23	-0.00	218.65	1.284	6.41	15.75	0.00437	0.846
34		248.24	0.00	0.00	218.65	0.00	999.999	6.41	15.75	0.00437	0.846
35	2 U9	139.48	0.00	173.05	-0.00	191.31	1.106	4.50	15.75	0.00750	0.900
36		139.48	0.00	0.00	191.31	0.00	999.999	4.50	15.75	0.00750	0.900

*** End of output ***

Column 13E



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

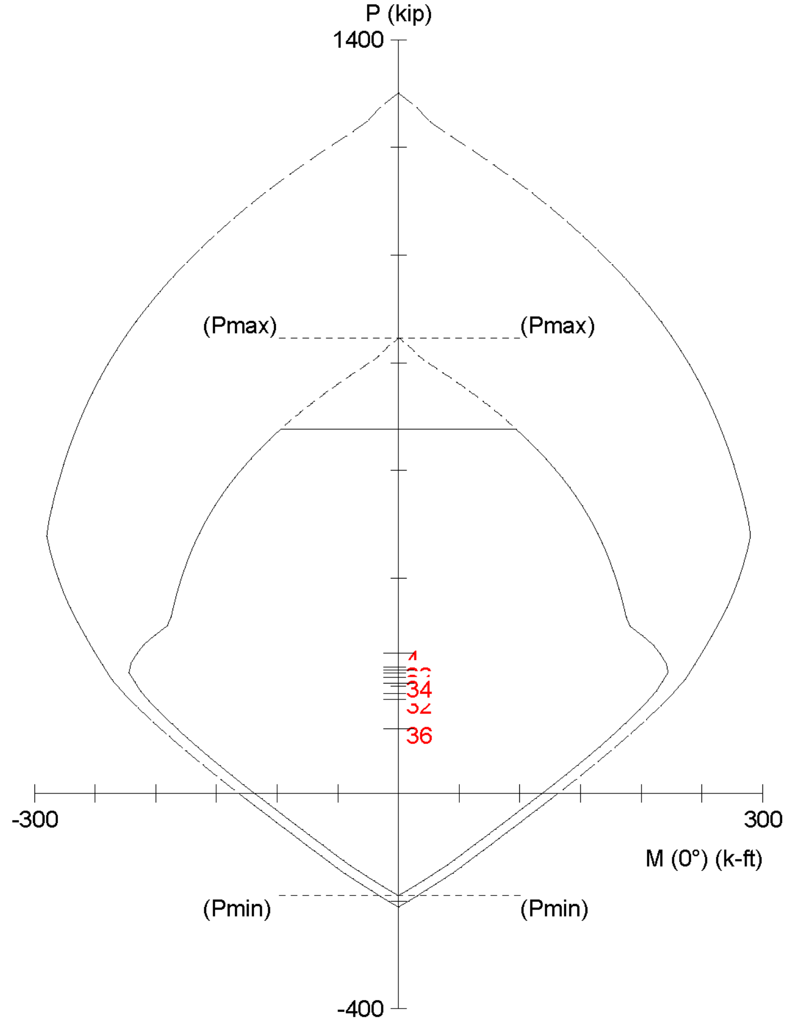
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 14:18:35



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File: F:\SPRING\Lateral\Column Designs\13E\Frame 13 - 13E.col

Project: Lateral System

Column: 13E		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	8 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 3.52 in^2	rho = 1.09%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 6.00 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

STRUCTUREPOINT - spColumn v4.81 (TM) Page 1
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F:\SPRING\Lateral\Column Designs\13E\Frame 13 - 13E.col 02:17 PM

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===
spColumn v4.81 (TM)
Computer program for the Strength Design of Reinforced Concrete Sections

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STRUCTUREPOINT - spColumn v4.81 (TM)                                              Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68  02/18/14
F:\SPRING\Lateral\Column Designs\13E\Frame 13 - 13E.col                           02:17 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\13E\Frame 13 - 13E.col
  Project:  Lateral System
  Column:   13E                               Engineer: ahm
  Code:     ACI 318-11                        Units: English

  Run Option: Design                          Slenderness: Not considered
  Run Axis:   Biaxial                         Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                               fy   = 60 ksi
  Ec    = 3605 ksi                            Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in                  Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                             Iy =  8748 in^4
  rx =  5.19615 in                            ry =  5.19615 in
  Xo =  0 in                                  Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 3.52 in^2 at rho = 1.09%
  Minimum clear spacing = 6.00 in

  8 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       132.52         0.00         0.00         0.69         0.00
      Live        60.67         0.00         0.00         0.10         0.00
      Wind         0.00         0.00         0.00      -111.65         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         9.81         0.00         0.00         0.27         0.00
    2 Dead       132.52         0.00         0.00         0.69         0.00
      Live        40.63         0.00         0.00         1.72         0.00
      Wind         0.00         0.00         0.00      -111.65         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         9.81         0.00         0.00         0.27         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
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U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

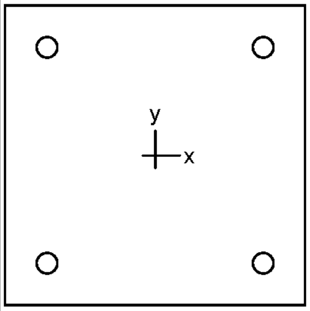
Factored Loads and Moments with Corresponding Capacities:
===

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	185.53	0.00	0.97	-0.00	211.10	218.532	5.31	15.75	0.00589	0.900
2		185.53	0.00	0.00	211.10	0.00	999.999	5.31	15.75	0.00589	0.900
3	1 U2	261.00	0.00	1.12	-0.00	215.02	191.469	6.80	15.75	0.00395	0.810
4		261.00	0.00	0.00	215.02	0.00	999.999	6.80	15.75	0.00395	0.810
5	1 U3	235.39	0.00	1.36	-0.00	221.89	163.158	6.06	15.75	0.00479	0.882
6		235.39	0.00	0.00	221.89	0.00	999.999	6.06	15.75	0.00479	0.882
7	1 U4	174.72	0.00	-88.06	0.00	-206.69	2.347	5.12	15.75	0.00623	0.900
8		174.72	0.00	0.00	206.69	0.00	999.999	5.12	15.75	0.00623	0.900
9	1 U5	224.60	0.00	-177.58	0.00	-222.14	1.251	5.84	15.75	0.00509	0.900
10		224.60	0.00	0.00	222.14	0.00	999.999	5.84	15.75	0.00509	0.900
11	1 U6	119.27	0.00	-178.02	0.00	-181.84	1.021	4.16	15.75	0.00836	0.900
12		119.27	0.00	0.00	181.84	0.00	999.999	4.16	15.75	0.00836	0.900
13	1 U7	174.72	0.00	90.58	-0.00	206.69	2.282	5.12	15.75	0.00623	0.900
14		174.72	0.00	0.00	206.69	0.00	999.999	5.12	15.75	0.00623	0.900
15	1 U8	224.60	0.00	179.71	-0.00	222.14	1.236	5.84	15.75	0.00509	0.900
16		224.60	0.00	0.00	222.14	0.00	999.999	5.84	15.75	0.00509	0.900
17	1 U9	119.27	0.00	179.26	-0.00	181.84	1.014	4.16	15.75	0.00836	0.900
18		119.27	0.00	0.00	181.84	0.00	999.999	4.16	15.75	0.00836	0.900
19	2 U1	185.53	0.00	0.97	-0.00	211.10	218.532	5.31	15.75	0.00589	0.900
20		185.53	0.00	0.00	211.10	0.00	999.999	5.31	15.75	0.00589	0.900
21	2 U2	228.94	0.00	3.72	-0.00	223.32	60.113	5.90	15.75	0.00500	0.900
22		228.94	0.00	0.00	223.32	0.00	999.999	5.90	15.75	0.00500	0.900
23	2 U3	215.35	0.00	2.98	-0.00	219.60	73.692	5.72	15.75	0.00527	0.900
24		215.35	0.00	0.00	219.60	0.00	999.999	5.72	15.75	0.00527	0.900
25	2 U4	174.72	0.00	-88.06	0.00	-206.69	2.347	5.12	15.75	0.00623	0.900
26		174.72	0.00	0.00	206.69	0.00	999.999	5.12	15.75	0.00623	0.900
27	2 U5	204.56	0.00	-175.96	0.00	-216.59	1.231	5.57	15.75	0.00548	0.900
28		204.56	0.00	0.00	216.59	0.00	999.999	5.57	15.75	0.00548	0.900
29	2 U6	119.27	0.00	-178.02	0.00	-181.84	1.021	4.16	15.75	0.00836	0.900
30		119.27	0.00	0.00	181.84	0.00	999.999	4.16	15.75	0.00836	0.900
31	2 U7	174.72	0.00	90.58	-0.00	206.69	2.282	5.12	15.75	0.00623	0.900
32		174.72	0.00	0.00	206.69	0.00	999.999	5.12	15.75	0.00623	0.900
33	2 U8	204.56	0.00	181.33	-0.00	216.59	1.195	5.57	15.75	0.00548	0.900
34		204.56	0.00	0.00	216.59	0.00	999.999	5.57	15.75	0.00548	0.900
35	2 U9	119.27	0.00	179.26	-0.00	181.84	1.014	4.16	15.75	0.00836	0.900
36		119.27	0.00	0.00	181.84	0.00	999.999	4.16	15.75	0.00836	0.900

*** End of output ***

Column 13H



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

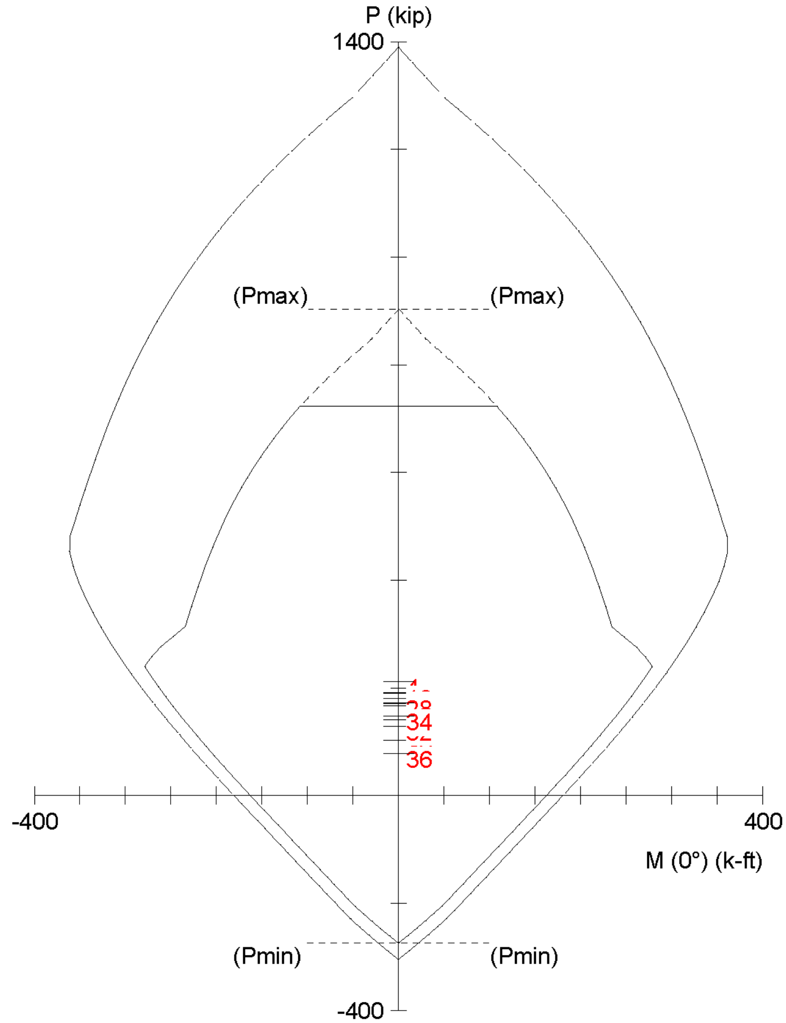
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 13:21:24



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\Frame 13 - 13H.col

Project: Lateral System

Column: 13H		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	4 #10 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 5.08 in^2	rho = 1.57%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 11.71 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                   Page   1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68       02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13H.col                                    01:20 PM
```

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  ooooo    oo           oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

```
=====================================================================================================
                                    spColumn v4.81 (TM)
                 Computer program for the Strength Design of Reinforced Concrete Sections
                              Copyright © 1988-2012, STRUCTUREPOINT, LLC.
                                         All rights reserved
=====================================================================================================
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                        Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68           02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13H.col                                         01:20 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 13 - 13H.col
  Project:  Lateral System
  Column:   13H                            Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in               Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                          Iy =  8748 in^4
  rx =  5.19615 in                         ry =  5.19615 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 5.08 in^2 at rho = 1.57%
  Minimum clear spacing = 11.71 in

  4 #10   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       100.85         0.00         0.00        -1.65         0.00
      Live        53.76         0.00         0.00        -0.64         0.00
      Wind         7.71         0.00         0.00      -117.02         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         8.77         0.00         0.00        -0.20         0.00
    2 Dead       100.85         0.00         0.00        -1.65         0.00
      Live        34.54         0.00         0.00        -1.74         0.00
      Wind         7.71         0.00         0.00      -117.02         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow         8.77         0.00         0.00        -0.20         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/18/14
F:\SPRING\Lateral\Column Designs\Frame 13 - 13H.col 01:20 PM

U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

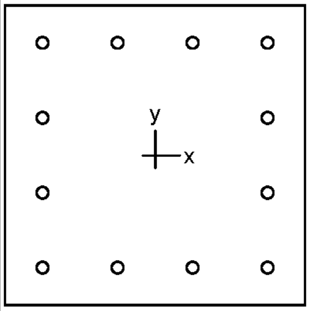
Factored Loads and Moments with Corresponding Capacities:
==

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	141.19	0.00	-2.31	0.00	-236.06	102.192	4.33	15.49	0.00774	0.900
2		141.19	0.00	0.00	236.06	0.00	999.999	4.33	15.49	0.00774	0.900
3	1 U2	211.42	0.00	-3.10	0.00	-267.61	86.213	5.36	15.49	0.00568	0.900
4		211.42	0.00	0.00	267.61	0.00	999.999	5.36	15.49	0.00568	0.900
5	1 U3	188.81	0.00	-2.94	0.00	-257.94	87.734	5.01	15.49	0.00628	0.900
6		188.81	0.00	0.00	257.94	0.00	999.999	5.01	15.49	0.00628	0.900
7	1 U4	141.22	0.00	-95.92	0.00	-236.08	2.461	4.33	15.49	0.00774	0.900
8		141.22	0.00	0.00	236.08	0.00	999.999	4.33	15.49	0.00774	0.900
9	1 U5	191.49	0.00	-189.96	0.00	-259.11	1.364	5.05	15.49	0.00620	0.900
10		191.49	0.00	0.00	259.11	0.00	999.999	5.05	15.49	0.00620	0.900
11	1 U6	103.09	0.00	-188.72	0.00	-217.30	1.151	3.83	15.49	0.00913	0.900
12		103.09	0.00	0.00	217.30	0.00	999.999	3.83	15.49	0.00913	0.900
13	1 U7	128.89	0.00	91.32	-0.00	230.11	2.520	4.16	15.49	0.00816	0.900
14		128.89	0.00	0.00	230.11	0.00	999.999	4.16	15.49	0.00816	0.900
15	1 U8	166.84	0.00	184.52	-0.00	248.07	1.344	4.69	15.49	0.00692	0.900
16		166.84	0.00	0.00	248.07	0.00	999.999	4.69	15.49	0.00692	0.900
17	1 U9	78.44	0.00	185.75	-0.00	204.68	1.102	3.54	15.49	0.01014	0.900
18		78.44	0.00	0.00	204.68	0.00	999.999	3.54	15.49	0.01014	0.900
19	2 U1	141.19	0.00	-2.31	0.00	-236.06	102.192	4.33	15.49	0.00774	0.900
20		141.19	0.00	0.00	236.06	0.00	999.999	4.33	15.49	0.00774	0.900
21	2 U2	180.67	0.00	-4.86	0.00	-254.33	52.289	4.89	15.49	0.00651	0.900
22		180.67	0.00	0.00	254.33	0.00	999.999	4.89	15.49	0.00651	0.900
23	2 U3	169.59	0.00	-4.04	0.00	-249.34	61.717	4.73	15.49	0.00683	0.900
24		169.59	0.00	0.00	249.34	0.00	999.999	4.73	15.49	0.00683	0.900
25	2 U4	141.22	0.00	-95.92	0.00	-236.08	2.461	4.33	15.49	0.00774	0.900
26		141.22	0.00	0.00	236.08	0.00	999.999	4.33	15.49	0.00774	0.900
27	2 U5	172.27	0.00	-191.06	0.00	-250.56	1.311	4.77	15.49	0.00675	0.900
28		172.27	0.00	0.00	250.56	0.00	999.999	4.77	15.49	0.00675	0.900
29	2 U6	103.09	0.00	-188.72	0.00	-217.30	1.151	3.83	15.49	0.00913	0.900
30		103.09	0.00	0.00	217.30	0.00	999.999	3.83	15.49	0.00913	0.900
31	2 U7	128.89	0.00	91.32	-0.00	230.11	2.520	4.16	15.49	0.00816	0.900
32		128.89	0.00	0.00	230.11	0.00	999.999	4.16	15.49	0.00816	0.900
33	2 U8	147.62	0.00	183.42	-0.00	239.13	1.304	4.42	15.49	0.00752	0.900
34		147.62	0.00	0.00	239.13	0.00	999.999	4.42	15.49	0.00752	0.900
35	2 U9	78.44	0.00	185.75	-0.00	204.68	1.102	3.54	15.49	0.01014	0.900
36		78.44	0.00	0.00	204.68	0.00	999.999	3.54	15.49	0.01014	0.900

*** End of output ***

Column 13K



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

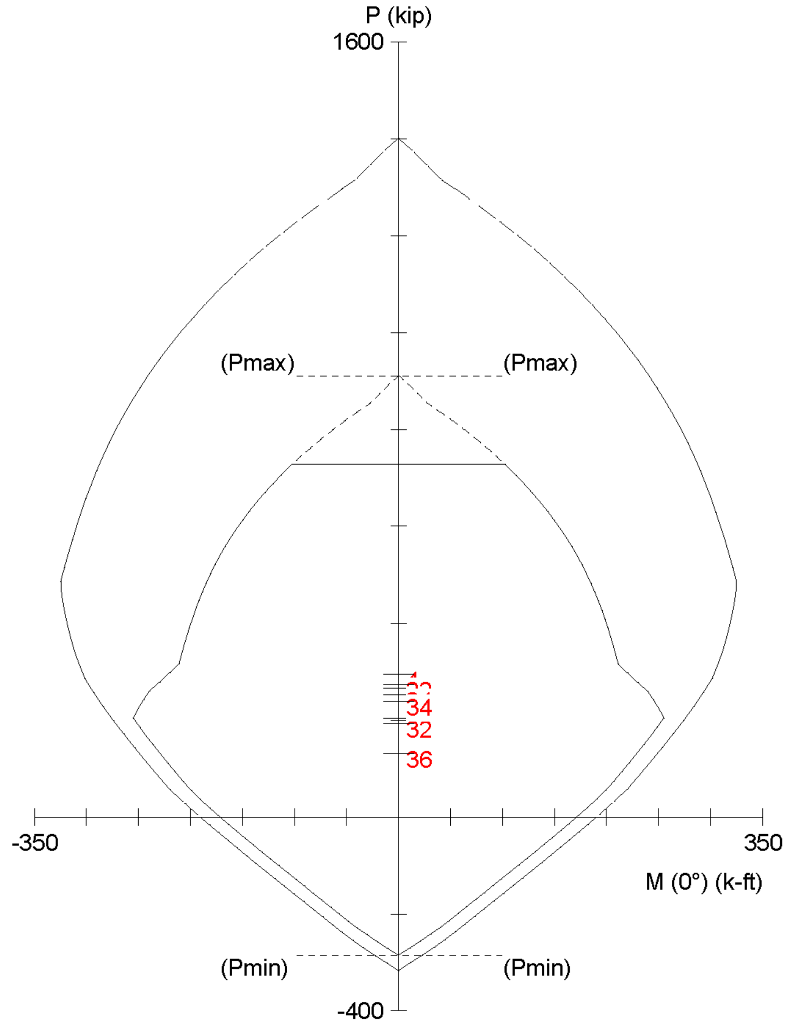
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 14:33:41



spColumn v4.81. Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68

File: F:\SPRING\Lateral\Column Designs\13K\Frame 13 - 13K.col

Project: Lateral System

Column: 13K		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	12 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 5.28 in^2	rho = 1.63%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 3.75 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

STRUCTUREPOINT - spColumn v4.81 (TM) Page 1
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68 02/18/14
F:\SPRING\Lateral\Column Designs\13K\Frame 13 - 13K.col 02:31 PM

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spColumn v4.81 (TM)
Computer program for the Strength Design of Reinforced Concrete Sections

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                              Page   2
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68  02/18/14
F:\SPRING\Lateral\Column Designs\13K\Frame 13 - 13K.col                           02:31 PM


General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\13K\Frame 13 - 13K.col
  Project:  Lateral System
  Column:   13K                            Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in               Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                          Iy =  8748 in^4
  rx =  5.19615 in                         ry =  5.19615 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 5.28 in^2 at rho = 1.63%
  Minimum clear spacing = 3.75 in

  12 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       145.64         0.00         0.00         3.05         0.00
      Live        71.75         0.00         0.00         1.89         0.00
      Wind         0.00         0.00         0.00      -121.92         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.98         0.00         0.00         0.30         0.00
    2 Dead       145.64         0.00         0.00         3.05         0.00
      Live        57.91         0.00         0.00         2.60         0.00
      Wind         0.00         0.00         0.00      -121.92         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        11.98         0.00         0.00         0.30         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                              Page   3
Licensed to: Penn State University Park. License ID: 59919-1033951-4-22545-2CF68  02/18/14
F:\SPRING\Lateral\Column Designs\13K\Frame 13 - 13K.col                           02:31 PM

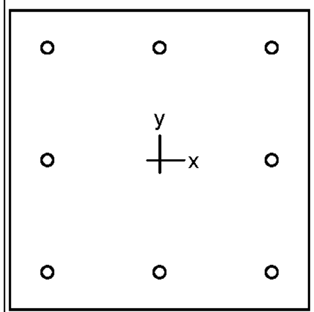
  U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
  U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
  U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
  U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
  U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

Factored Loads and Moments with Corresponding Capacities:
=========================================================
  Design/Required ratio PhiMn/Mu >= 1.00
  NOTE: Each loading combination includes the following cases:
        First line  - at column top
        Second line - at column bottom
```

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	203.90	0.00	4.27	-0.00	254.99	59.717	5.90	15.75	0.00500	0.900
2		203.90	0.00	0.00	254.99	0.00	999.999	5.90	15.75	0.00500	0.900
3	1 U2	295.56	0.00	6.83	-0.00	220.93	32.328	8.59	15.75	0.00250	0.687
4		295.56	0.00	0.00	220.93	0.00	999.999	8.59	15.75	0.00250	0.687
5	1 U3	265.69	0.00	6.03	-0.00	236.88	39.284	7.46	15.75	0.00333	0.758
6		265.69	0.00	0.00	236.88	0.00	999.999	7.46	15.75	0.00333	0.758
7	1 U4	193.94	0.00	-93.39	0.00	-251.63	2.694	5.76	15.75	0.00520	0.900
8		193.94	0.00	0.00	251.63	0.00	999.999	5.76	15.75	0.00520	0.900
9	1 U5	252.51	0.00	-189.36	0.00	-241.89	1.277	7.10	15.75	0.00365	0.785
10		252.51	0.00	0.00	241.89	0.00	999.999	7.10	15.75	0.00365	0.785
11	1 U6	131.08	0.00	-192.32	0.00	-229.05	1.191	4.91	15.75	0.00661	0.900
12		131.08	0.00	0.00	229.05	0.00	999.999	4.91	15.75	0.00661	0.900
13	1 U7	193.94	0.00	101.67	-0.00	251.63	2.475	5.76	15.75	0.00520	0.900
14		193.94	0.00	0.00	251.63	0.00	999.999	5.76	15.75	0.00520	0.900
15	1 U8	252.51	0.00	200.76	-0.00	241.89	1.205	7.10	15.75	0.00365	0.785
16		252.51	0.00	0.00	241.89	0.00	999.999	7.10	15.75	0.00365	0.785
17	1 U9	131.08	0.00	197.81	-0.00	229.05	1.158	4.91	15.75	0.00661	0.900
18		131.08	0.00	0.00	229.05	0.00	999.999	4.91	15.75	0.00661	0.900
19	2 U1	203.90	0.00	4.27	-0.00	254.99	59.717	5.90	15.75	0.00500	0.900
20		203.90	0.00	0.00	254.99	0.00	999.999	5.90	15.75	0.00500	0.900
21	2 U2	273.41	0.00	7.97	-0.00	233.33	29.276	7.71	15.75	0.00313	0.741
22		273.41	0.00	0.00	233.33	0.00	999.999	7.71	15.75	0.00313	0.741
23	2 U3	251.85	0.00	6.74	-0.00	242.09	35.919	7.09	15.75	0.00367	0.786
24		251.85	0.00	0.00	242.09	0.00	999.999	7.09	15.75	0.00367	0.786
25	2 U4	193.94	0.00	-93.39	0.00	-251.63	2.694	5.76	15.75	0.00520	0.900
26		193.94	0.00	0.00	251.63	0.00	999.999	5.76	15.75	0.00520	0.900
27	2 U5	238.67	0.00	-188.65	0.00	-245.86	1.303	6.79	15.75	0.00396	0.811
28		238.67	0.00	0.00	245.86	0.00	999.999	6.79	15.75	0.00396	0.811
29	2 U6	131.08	0.00	-192.32	0.00	-229.05	1.191	4.91	15.75	0.00661	0.900
30		131.08	0.00	0.00	229.05	0.00	999.999	4.91	15.75	0.00661	0.900
31	2 U7	193.94	0.00	101.67	-0.00	251.63	2.475	5.76	15.75	0.00520	0.900
32		193.94	0.00	0.00	251.63	0.00	999.999	5.76	15.75	0.00520	0.900
33	2 U8	238.67	0.00	201.47	-0.00	245.86	1.220	6.79	15.75	0.00396	0.811
34		238.67	0.00	0.00	245.86	0.00	999.999	6.79	15.75	0.00396	0.811
35	2 U9	131.08	0.00	197.81	-0.00	229.05	1.158	4.91	15.75	0.00661	0.900
36		131.08	0.00	0.00	229.05	0.00	999.999	4.91	15.75	0.00661	0.900

*** End of output ***

Column 13N



18 x 18 in

Code: ACI 318-11

Units: English

Run axis: Biaxial

Run option: Design

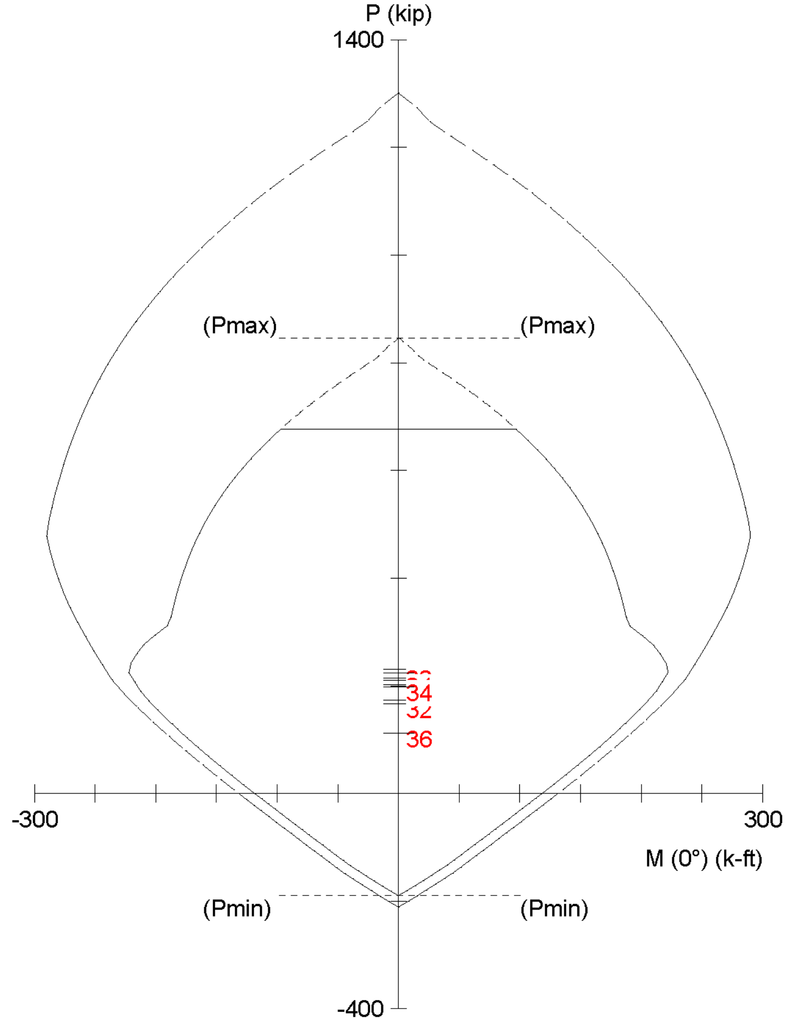
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 02/18/14

Time: 13:28:29



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Project: Lateral System

Column: 13N		Engineer: ahm	
f'c = 4 ksi	fy = 60 ksi	Ag = 324 in^2	8 #6 bars
Ec = 3605 ksi	Es = 29000 ksi	As = 3.52 in^2	rho = 1.09%
fc = 3.4 ksi		Xo = 0.00 in	Ix = 8748 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 8748 in^4
Beta1 = 0.85		Min clear spacing = 6.00 in	Clear cover = 1.88 in

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                                 Page   1
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```
                     oooooo                o
                    oo    oo              oo
 ooooo    oooooo    oo          ooooo     oo      oo   oo   o oooooooooo    o ooooo
oo    o   oo   oo   oo         oo   oo    oo      oo   oo    oo   oo   oo    oo   oo
oo        oo   oo   oo         oo   oo    oo      oo   oo    oo   oo   oo    oo   oo
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     oo   oooooo    oo         oo   oo    oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo    oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo      ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

==

spColumn v4.81 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

==

```
STRUCTUREPOINT - spColumn v4.81 (TM)                                                     Page   2
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General Information:
====================
  File Name: F:\SPRING\Lateral\Column Designs\Frame 13 - 13N.col
  Project:  Lateral System
  Column:   13N                            Engineer: ahm
  Code:     ACI 318-11                     Units: English

  Run Option: Design                       Slenderness: Not considered
  Run Axis:   Biaxial                      Column Type: Structural

Material Properties:
====================
  f'c   = 4 ksi                            fy   = 60 ksi
  Ec    = 3605 ksi                         Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 18 in               Depth = 18 in

  Gross section area, Ag =  324 in^2
  Ix =  8748 in^4                          Iy =  8748 in^4
  rx =  5.19615 in                         ry =  5.19615 in
  Xo =  0 in                               Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

  Bar selection: Minimum number of bars
  Asmin = 0.01 * Ag = 3.24 in^2,  Asmax = 0.08 * Ag = 25.92 in^2

  Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
  phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

  Layout: Rectangular
  Pattern: All Sides Equal  (Cover to transverse reinforcement)
  Total steel area: As = 3.52 in^2 at rho = 1.09%
  Minimum clear spacing = 6.00 in

  8 #6   Cover = 1.5 in

Service Loads:
==============
      Load   Axial Load     Mx @ Top     Mx @ Bot     My @ Top     My @ Bot
  No. Case          kip         k-ft         k-ft         k-ft         k-ft
  --- ---- ------------ ------------ ------------ ------------ ------------
    1 Dead       124.43         0.00         0.00        -5.74         0.00
      Live        48.01         0.00         0.00        -4.04         0.00
      Wind         0.00         0.00         0.00       -96.47         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.46         0.00         0.00        -0.55         0.00
    2 Dead       124.43         0.00         0.00        -5.74         0.00
      Live        43.79         0.00         0.00        -4.41         0.00
      Wind         0.00         0.00         0.00       -96.47         0.00
      EQ           0.00         0.00         0.00         0.00         0.00
      Snow        10.46         0.00         0.00        -0.55         0.00

Sustained Load Factors:
=======================
   Load       Factor
   Case          (%)
   ---- ------------
   Dead          100
   Live            0
   Wind            0
   EQ              0
   Snow            0

Load Combinations:
==================
  U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake + 0.000*Snow
  U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow
```

STRUCTUREPOINT - spColumn v4.81 (TM) Page 3
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U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake + 1.600*Snow
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake + 0.000*Snow
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake + 1.600*Snow
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.500*Snow
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake + 0.000*Snow

Factored Loads and Moments with Corresponding Capacities:
===

Design/Required ratio PhiMn/Mu >= 1.00
NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	174.20	0.00	-8.04	0.00	-206.48	25.694	5.11	15.75	0.00625	0.900
2		174.20	0.00	0.00	206.48	0.00	999.999	5.11	15.75	0.00625	0.900
3	1 U2	231.36	0.00	-13.63	0.00	-222.84	16.353	5.96	15.75	0.00493	0.894
4		231.36	0.00	0.00	222.84	0.00	999.999	5.96	15.75	0.00493	0.894
5	1 U3	214.06	0.00	-11.81	0.00	-219.25	18.568	5.70	15.75	0.00529	0.900
6		214.06	0.00	0.00	219.25	0.00	999.999	5.70	15.75	0.00529	0.900
7	1 U4	166.05	0.00	-84.94	0.00	-203.05	2.390	4.96	15.75	0.00652	0.900
8		166.05	0.00	0.00	203.05	0.00	999.999	4.96	15.75	0.00652	0.900
9	1 U5	202.56	0.00	-165.55	0.00	-216.03	1.305	5.54	15.75	0.00553	0.900
10		202.56	0.00	0.00	216.03	0.00	999.999	5.54	15.75	0.00553	0.900
11	1 U6	111.99	0.00	-159.51	0.00	-178.33	1.118	4.04	15.75	0.00870	0.900
12		111.99	0.00	0.00	178.33	0.00	999.999	4.04	15.75	0.00870	0.900
13	1 U7	166.05	0.00	69.41	-0.00	203.05	2.926	4.96	15.75	0.00652	0.900
14		166.05	0.00	0.00	203.05	0.00	999.999	4.96	15.75	0.00652	0.900
15	1 U8	202.56	0.00	143.14	-0.00	216.03	1.509	5.54	15.75	0.00553	0.900
16		202.56	0.00	0.00	216.03	0.00	999.999	5.54	15.75	0.00553	0.900
17	1 U9	111.99	0.00	149.18	-0.00	178.33	1.195	4.04	15.75	0.00870	0.900
18		111.99	0.00	0.00	178.33	0.00	999.999	4.04	15.75	0.00870	0.900
19	2 U1	174.20	0.00	-8.04	0.00	-206.48	25.694	5.11	15.75	0.00625	0.900
20		174.20	0.00	0.00	206.48	0.00	999.999	5.11	15.75	0.00625	0.900
21	2 U2	224.61	0.00	-14.22	0.00	-222.14	15.623	5.84	15.75	0.00509	0.900
22		224.61	0.00	0.00	222.14	0.00	999.999	5.84	15.75	0.00509	0.900
23	2 U3	209.84	0.00	-12.18	0.00	-218.07	17.907	5.64	15.75	0.00538	0.900
24		209.84	0.00	0.00	218.07	0.00	999.999	5.64	15.75	0.00538	0.900
25	2 U4	166.05	0.00	-84.94	0.00	-203.05	2.390	4.96	15.75	0.00652	0.900
26		166.05	0.00	0.00	203.05	0.00	999.999	4.96	15.75	0.00652	0.900
27	2 U5	198.34	0.00	-165.92	0.00	-214.85	1.295	5.49	15.75	0.00561	0.900
28		198.34	0.00	0.00	214.85	0.00	999.999	5.49	15.75	0.00561	0.900
29	2 U6	111.99	0.00	-159.51	0.00	-178.33	1.118	4.04	15.75	0.00870	0.900
30		111.99	0.00	0.00	178.33	0.00	999.999	4.04	15.75	0.00870	0.900
31	2 U7	166.05	0.00	69.41	-0.00	203.05	2.926	4.96	15.75	0.00652	0.900
32		166.05	0.00	0.00	203.05	0.00	999.999	4.96	15.75	0.00652	0.900
33	2 U8	198.34	0.00	142.77	-0.00	214.85	1.505	5.49	15.75	0.00561	0.900
34		198.34	0.00	0.00	214.85	0.00	999.999	5.49	15.75	0.00561	0.900
35	2 U9	111.99	0.00	149.18	-0.00	178.33	1.195	4.04	15.75	0.00870	0.900
36		111.99	0.00	0.00	178.33	0.00	999.999	4.04	15.75	0.00870	0.900

*** End of output ***

Appendix B.7: Beam-Column Interaction Calculations

Girder Interaction

A. Mincemoyer | Lateral | Final Report

Check Girder Strength Adequacy for Interaction:

- worst case loading was found to be on Girder 8, Span 5. (at midspan)

from spBeam:

$M_u = 1077.7'^k$
$\phi M_n = 1130.9'^k$

$f'_c = 4$ ksi
$\beta_1 = 0.85$
$b = 30"$

$f_y = 60$ ksi
(15) #8 bars
#3 ties

$\phi P_n = \phi\, 0.85 f'_c \cdot \beta_1 \cdot c \cdot b + \sum A_{si} f_{si}$ *it is conservative to not include reinforcement

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{15(0.79)(60)}{0.85(4)(30)} \rightarrow a = 6.97"$

$c = a/\beta_1 = 6.97/0.85 \rightarrow c = 8.2"$

$\varepsilon_t = \frac{\varepsilon_u}{c}(d_t - c) = \frac{.003}{8.2}[(24.5-1.5-.375-.5)-8.2]$

$\rightarrow \varepsilon_t = 0.0051 \geq .005 \rightarrow \phi = 0.90$

$\phi P_n = (0.90)(0.85)(4)(0.85)(8.2)(30)$

$\phi P_n = 640^k$

$P_u = 112.7^k$ (due to wind)

Interaction:

$\frac{P_u}{\phi P_n} = \frac{112.7}{640} = 0.18 < 0.2$

$\rightarrow \frac{1}{2}\frac{P_u}{\phi P_n} + \frac{9}{8}\left(\frac{8}{9}\frac{M_u}{\phi M_n}\right) \leq 1.0$

$\frac{1}{2}\frac{112.7}{640} + \frac{9}{8}\left(\frac{8}{9}\frac{1077.7}{1130.9}\right) = 1.0 \leq 1.0$ ✓ok

→ Girder Strength is adequate for Interaction

Joist Interaction

A. Mincemoyer | Lateral | Final Report

Check Joist Strength Adequacy for Interaction:

- Joists along column line D
- Span 1
- midspan

from spBeam:

$M_u = 54.73'^k$

$\phi M_n = 104.52'^k$

$f'_c = 4$ ksi $f_y = 60$ ksi

$\beta_1 = 0.85$ (1) #6 and (1) #7

$b = 6$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(.44+.6)(60)}{.85(4)(6)} = 3.06''$$

$$c = a/\beta = 3.06/.85 = 3.6''$$

$$\varepsilon_t = \frac{\varepsilon_u}{c}(d_t - c) = \frac{.003}{3.6}\left[(24.5 - 1.5 - .75/2) - 3.6\right]$$

$$\varepsilon_t = 0.016 \geq .005 \rightarrow \phi = 0.90$$

$$\phi P_n = \phi\, 0.85 f'_c (bh - \Sigma A_{si}) + \Sigma A_{si} f_y$$

$$= (.90)(.85)(4)\left[(6)(24.5) - (.44+.6)\right] + (.44+.6)(60)$$

$\phi P_n = 509^k$ $P_u = 46.0^k$ (due to wind)

Interaction:

$$\frac{P_u}{\phi P_n} = \frac{46.0}{509} = 0.09 < 0.2$$

$$\frac{1}{2}\frac{P_u}{\phi P_n} + \frac{9}{8}\left(\frac{8}{9}\frac{M_u}{\phi M_n}\right) \leq 1.0$$

$$\frac{1}{2}\frac{46.0}{509} + \frac{54.73}{104.52} = 0.57 \leq 1.0 \quad \checkmark ok$$

→ Joist strength is adequate for interaction

Appendix C.1: Gravity Loads on the Bridge

Dead and Live Loads

A. Mincemoyer | Bridge Loads | Final Report

Floor Dead Load:

Linear Metal Ceiling = 3 psf
3/4" Plywood Sheathing = 2.4 psf (ASCE 7-10)
Sprayed Plastic Foam Insulation = 1 psf
3 5/8" Metal Studs @ 16" o.c. = 3 psf
6" concrete slab on 3" composite deck = 57 psf
carpet pad & adhesive = 1.5 psf
carpet = 1 psf
Misc. & superimposed
mep = 5 psf
lighting = 5 psf
framing allowance = 10 psf

→ Total Floor Dead Load = 88.9 psf

Floor Live Load:

uniform pedestrian loading = 90 psf
* per LRFD Guide Specifications for the Design of Pedestrian Bridges

Exterior Wall Load:

Aluminum Storefront = 12.0 psf
Composite Aluminum Panel = 13.0 psf
} use 15.0 psf conservatively
(calculated in Technical Report 2)

Roof Dead Load:

Roof Type RS-1 = 43.2 psf
(calculated in Technical Report 2)

Snow Loads

A. Mincemoyer | Bridge Loads | Final Report

Snow Drift onto Roof: Section 7.7.1

$h_c/h_b < 0.2 \Rightarrow$ not required

$\gamma = 0.13 p_g + 14 < 30$ pcf

$= 0.13(45) + 14 = 19.85$ pcf < 30 pcf ✓

$h_b = \frac{p_s}{\gamma} = \frac{35}{19.85} = 1.76'$

$h_c = 16.92 - 1.76 = 15.16'$

$h_c/h_b = 15.16/1.76 = 8.6 \rightarrow$ drift required

Leeward: (figure 7-9)

$l_u = 80.75'$

$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{p_g + 10} - 1.5$

$= 0.43 \sqrt[3]{80.75} \sqrt[4]{45 + 10} - 1.5$

$h_d = 3.56'$

Windward: (figure 7-9)

$l_u = 90'$

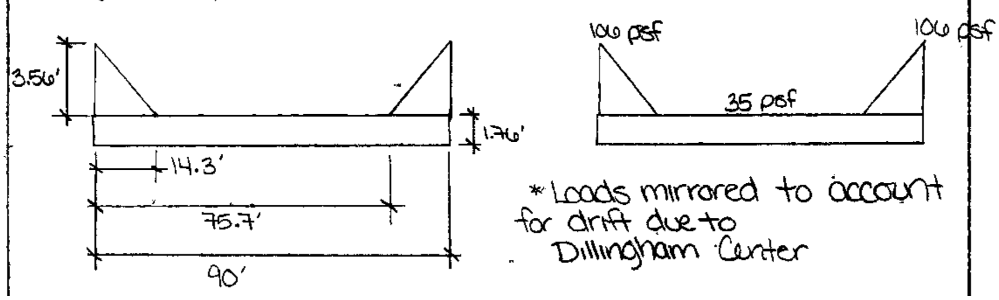
$h_d = [.43 \sqrt[3]{90} \sqrt[4]{45+10} - 1.5](.75)$

$h_d = 2.81'$

$\rightarrow h_d = 3.56$ ft should be used in design

$h_d < h_c \rightarrow w = 4h_d = 4(3.56) = 14.3$ ft

$h_d \gamma = 3.56(19.85) = 71$ psf



*Loads mirrored to account for drift due to Dillingham Center

Appendix C.2: Determination of Panel Point Loads

A. Mincemoyer | Bridge Loads | Final Report

Panel Point Loads:

Bridge Width = 9.5'
8 spans @ 11'-8" = 93'-4"
12' tall side trusses

Bottom Chord:

Tributary Area = 55.4 ft^2

Dead Load:

$(88.9 \text{ psf})(55.4 \text{ ft}^2) = 4.9^k$

Live Load:

$(90 \text{ psf})(55.4 \text{ ft}^2) = 5.0^k$

Top Chord:

Tributary Area = 55.4 ft^2

Dead Load:

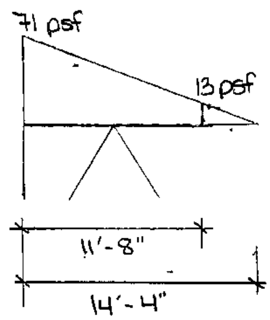
$(43.2 \text{ psf})(55.4 \text{ ft}^2) = 2.4^k$

Snow Load:

uniform load:

$(35 \text{ psf})(55.4 \text{ ft}^2) = 1.9^k$

load due to drift:



$\frac{71}{14.33} = \frac{x}{2.67}$ $\quad x = 13 \text{ psf}$

A. Mincemoyer	Bridge Loads	Final Report

load due to drift: (continued)

$(13\ psf)(9.5'/2)(11.67') = 0.7^k$

$(\frac{1}{2})(71-13)(9.5'/2)(11.67') = 1.6^k$

2.3^k on first panel point

$(\frac{1}{2})(13)(9.5'/2)(2.67') = 0.1^k$ on second panel point

Exterior Wall Load:

Tributary Area = 70 ft²

$(15\ psf)(70\ ft^2) = 1.1^k$ on every panel point

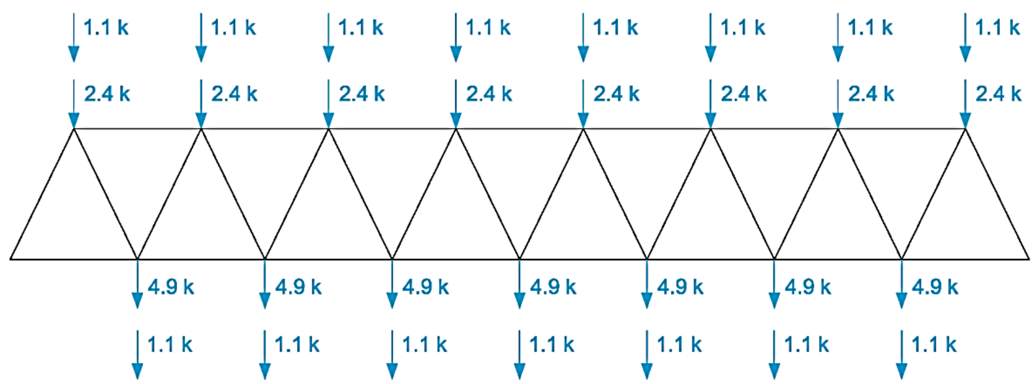
* See AutoCAD drawing for load summary *

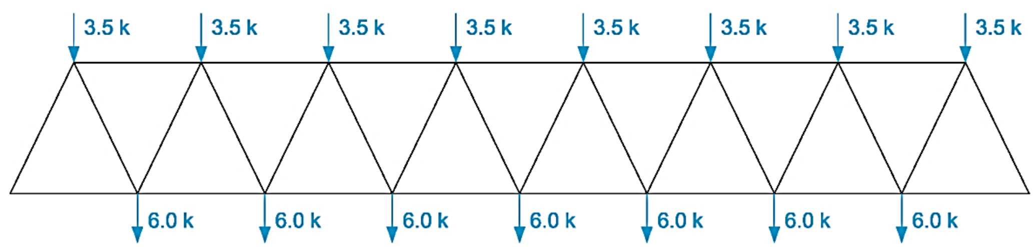
Appendix C.3: Panel Point Loads

Color Coding Key

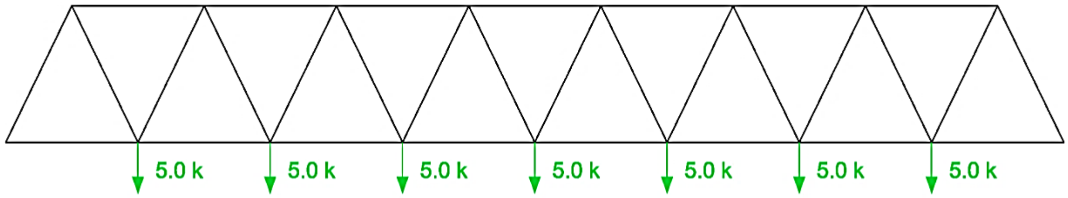
Dead Loads
Live Loads
Snow Loads
Load Combination Loads
Index
Member Force

Dead Loads

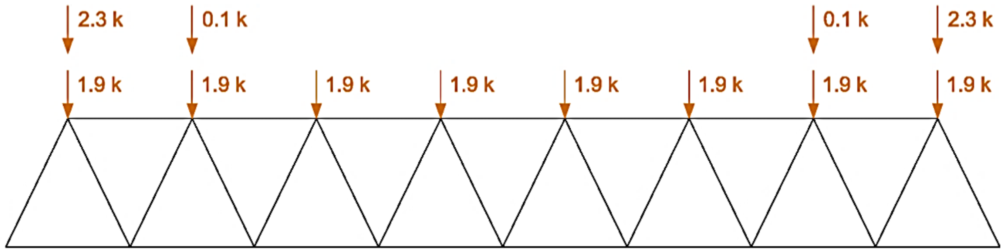


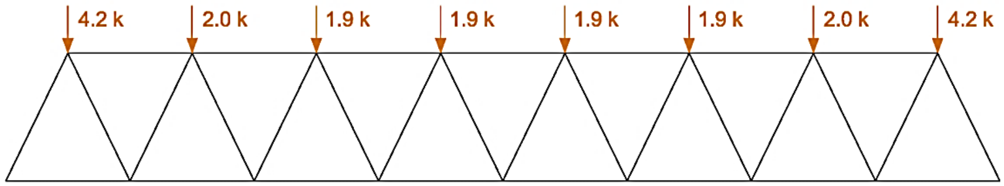


Live Loads



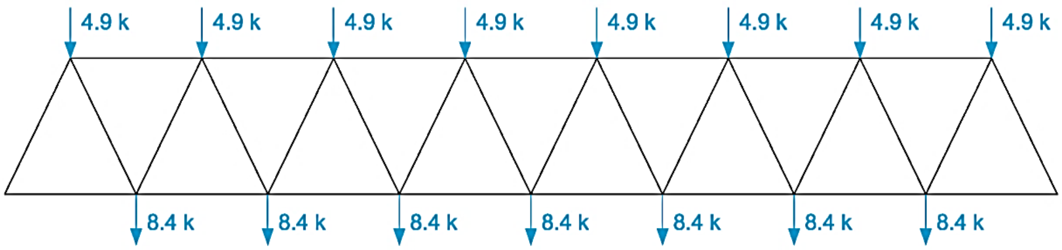
Snow Loads



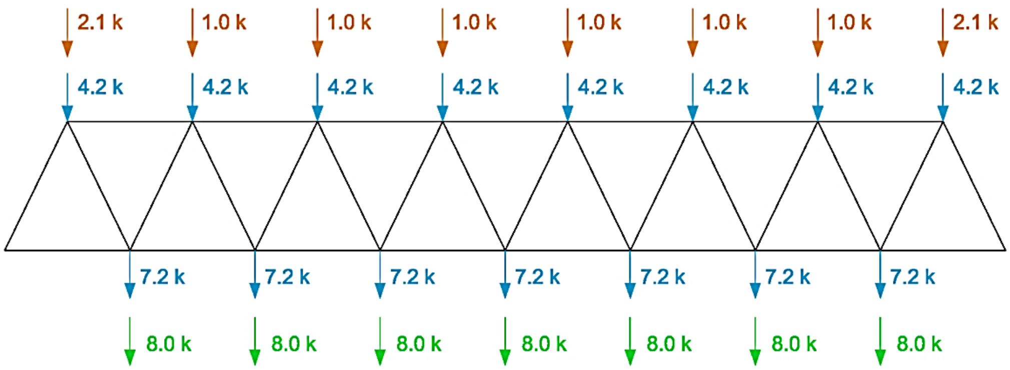


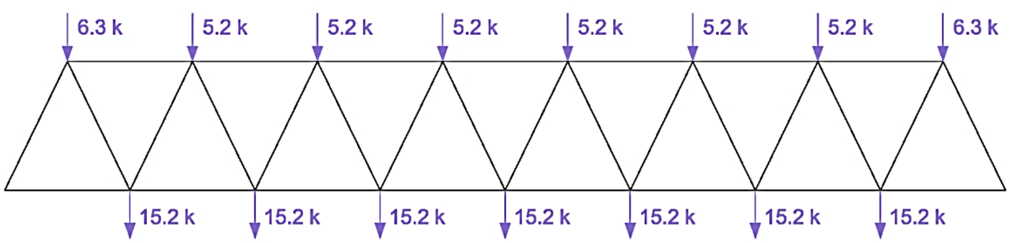
Appendix C.4: Panel Point Load Combinations

1.4 D

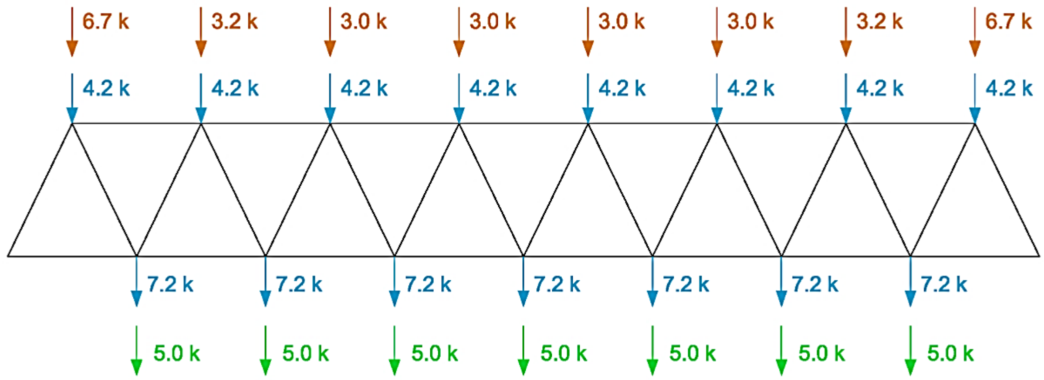


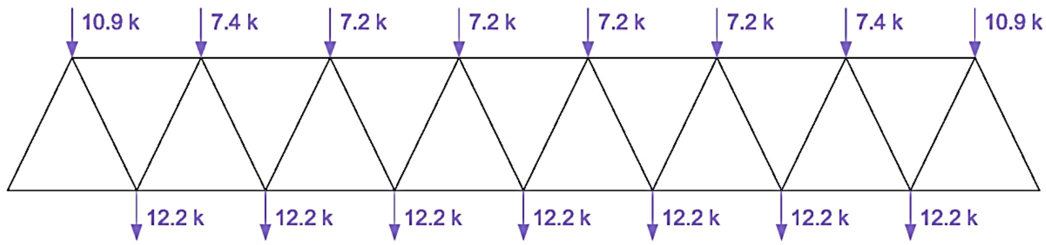
1.2 D + 1.6 L + 0.5 S





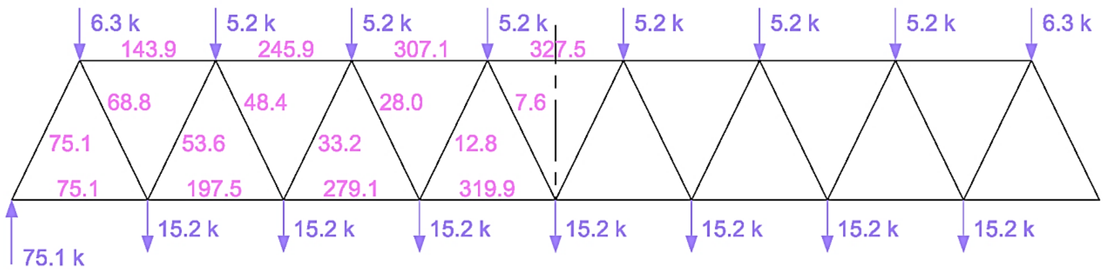
1.2 D + 1.6 S + L


6.7 k
3.2 k
3.0 k
3.0 k
3.0 k
3.0 k
3.2 k
6.7 k
4.2 k
4.2 k
4.2 k
4.2 k
4.2 k
4.2 k
4.2 k
4.2 k
7.2 k
7.2 k
7.2 k
7.2 k
7.2 k
7.2 k
7.2 k
5.0 k
5.0 k
5.0 k
5.0 k
5.0 k
5.0 k
5.0 k

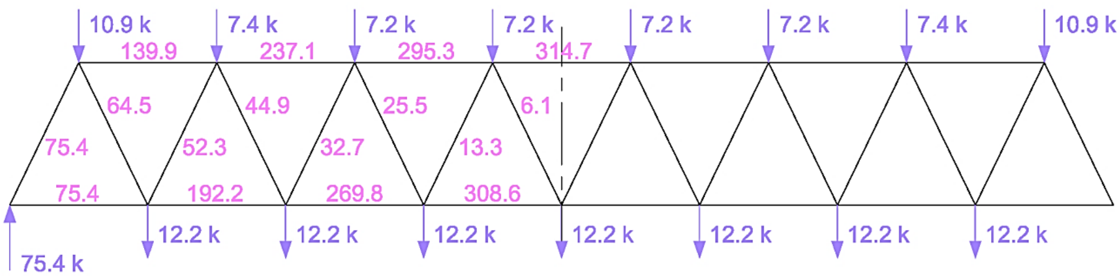

10.9 k
7.4 k
7.2 k
7.2 k
7.2 k
7.2 k
7.4 k
10.9 k
12.2 k
12.2 k
12.2 k
12.2 k
12.2 k
12.2 k
12.2 k

Appendix C.5: Member Indices

1.2 D + 1.6 L + 0.5 S



1.2 D + 1.6 S + L



Appendix C.6: Conversion of Indices to Member Forces

Converting Indexes to Forces

p =	5.8	ft			
h =	12.0	ft		p/h =	0.49
L =	13.3	ft		L/h =	1.11

	1.2 D + 1.6 L + 0.5 S				1.2 D + 1.6 S + L				Max Member Force (k)
	Index	Ratio	Force (k)		Index	Ratio	Force (k)		
Top Chord	143.9	0.49	70.0	Top Chord	139.9	0.49	68.1	Top Chord	70.0
	245.9	0.49	119.6		237.1	0.49	115.3		119.6
	307.1	0.49	149.3		295.3	0.49	143.6		149.3
	327.5	0.49	159.3		314.7	0.49	153.0		159.3
Diagonals	75.1	1.11	83.5	Diagonals	75.4	1.11	83.8	Diagonals	83.8
	68.8	1.11	76.5		64.5	1.11	71.7		76.5
	53.6	1.11	59.6		52.3	1.11	58.2		59.6
	48.4	1.11	53.8		44.9	1.11	49.9		53.8
	33.2	1.11	36.9		32.7	1.11	36.4		36.9
	28	1.11	31.2		25.5	1.11	28.4		31.2
	12.8	1.11	14.3		13.3	1.11	14.8		14.8
	7.6	1.11	8.5		6.1	1.11	6.8		8.5
Bottom Chord	75.1	0.49	36.6	Bottom Chord	75.4	0.49	36.7	Bottom Chord	36.7
	197.5	0.49	96.1		192.2	0.49	93.5		96.1
	279.1	0.49	135.7		269.8	0.49	131.2		135.7
	319.9	0.49	155.6		308.6	0.49	150.1		155.6

Appendix C.7: Method of Joints

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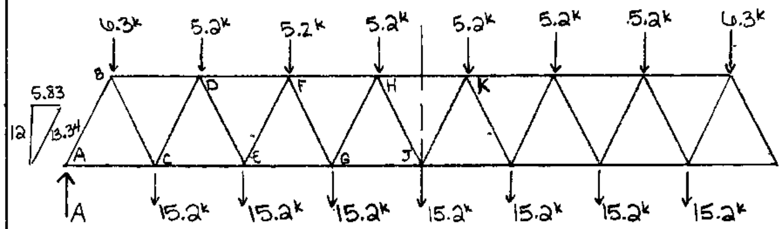
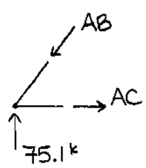
Verify Member Forces Using Method of Joints:

$1.2D + 1.6L + 0.5S$



$\Sigma F_y = 0 = -6.3 - 3(5.2) - 3.5(15.2) + A \quad \rightarrow \quad A = 75.1^k \uparrow$

Joint A:



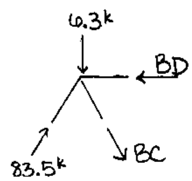
$\Sigma F_y = 0 = -(12/13.34)AB + 75.1$

$\rightarrow AB = 83.5^k \quad C$

$\Sigma F_x = 0 = -(5.83/13.34)\,83.5 + AC$

$\rightarrow AC = 36.5^k \quad T$

Joint B:



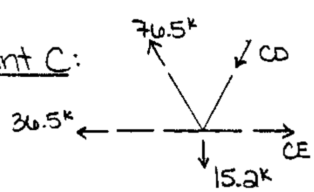
$\Sigma F_y = 0 = -6.3 + 83.5(12/13.34) - (12/13.34)BC$

$\rightarrow BC = 76.5^k \quad T$

$\Sigma F_x = 0 = 83.5(5.83/13.34) + (5.83/13.34)(76.5) - BD$

$\rightarrow BD = 69.9^k \quad C$

Joint C:



$\Sigma F_y = 0 = -15.2 + 76.5(12/13.34) - (12/13.34)CD$

$\rightarrow CD = 59.6^k \quad C$

$\Sigma F_x = 0 = -36.5 - 76.5(5.83/13.34) - 59.6(5.83/13.34) + CE$

$\rightarrow CE = 96.0^k \quad T$

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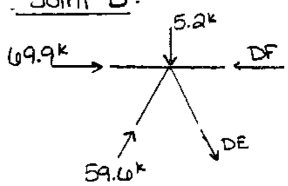
Joint D:



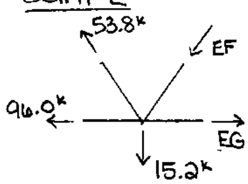
$\Sigma F_y = 0 = -5.2 + 59.6(12/13.34) - DE(12/13.34)$

$\rightarrow DE = 53.8^k$ T

$\Sigma F_x = 0 = 69.9 + 59.6(5.83/13.34) + 53.8(5.83/13.34) - DF$

$\rightarrow DF = 119.5^k$ C

Joint E:



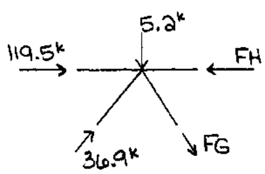
$\Sigma F_y = 0 = -15.2 + 53.8(12/13.34) - EF(12/13.34)$

$\rightarrow EF = 36.9^k$ C

$\Sigma F_x = 0 = -96 - 53.8(5.83/13.34) - 36.9(5.83/13.34) + EG$

$\rightarrow EG = 135.6^k$ T

Joint F:



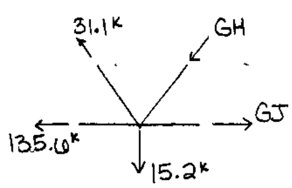
$\Sigma F_y = 0 = -5.2 + 36.9(12/13.34) - FG(12/13.34)$

$\rightarrow FG = 31.1^k$ T

$\Sigma F_x = 0 = 119.5 + 36.9(5.83/13.34) + 31.1(5.83/13.34) - FH$

$\rightarrow FH = 149.2^k$ C

Joint G:



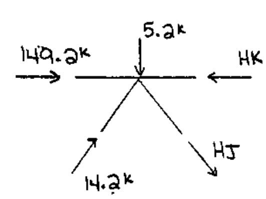
$\Sigma F_y = 0 = -15.2 + 31.1(12/13.34) - GH(12/13.34)$

$\rightarrow GH = 14.2^k$ C

$\Sigma F_x = -135.6 - 31.1(5.83/13.34) - 14.2(5.83/13.34) + GJ$

$\rightarrow GJ = 155.4^k$ T

Joint H:



$\Sigma F_y = 0 = -5.2 + 14.2(12/13.34) - HJ(12/13.34)$

$\rightarrow HJ = 8.4^k$ T

$\Sigma F_x = 0 = 149.2 + 14.2(5.83/13.34) + 8.4(5.83/13.34) - HK$

$\rightarrow HK = 159.1^k$ C

Appendix C.8: Member Design

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Member Design:

Top Chord:

maximum member force = 159.3^k Compression

KL = 11.67 ft

using Table 4-4 of the Steel Manual:

HSS7×7×1/4 $\Phi P_c = 212^k > P_u = 159.3^k$ ✓ok

Bottom Chord:

maximum member force = 155.6^k Tension

KL = 11.67 ft

* for aesthetics, use HSS7×7

using Table 5-5 of the Steel Manual:

HSS7×7×1/4 $\Phi P_n = 255^k > 155.6^k$ ✓ok

* HSS7×7×3/16 would work. But, HSS7×7×1/4 was chosen for constructibility.

Diagonals:

maximum member force = 83.8^k Compression

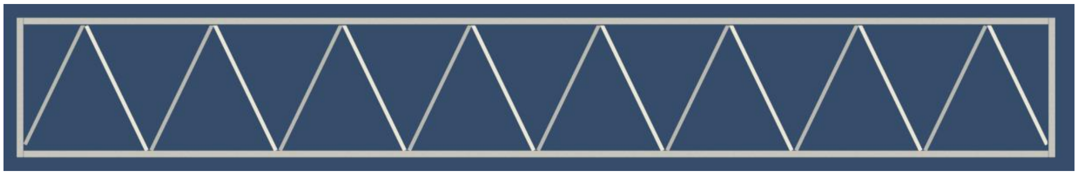
KL = 13.33 ft

using Table 4-4 of the Steel Manual:

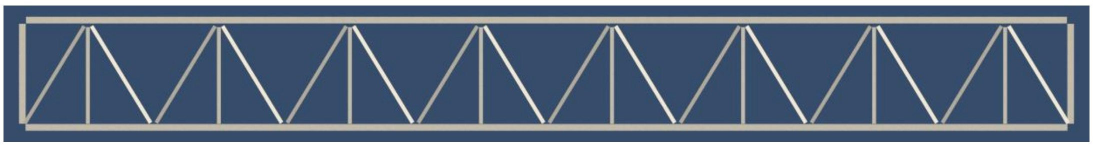
HSS4×4×1/2 $\Phi P_o = 95.8^k > 83.8^k$ ✓ok

Appendix D.1: Bridge Trusses

Side Trusses



Top Truss



Bottom Truss

Appendix E.1: Luminaire Specification Sheet

Date: ____________________ Type: ____________________

Firm Name: ____________________________________

Project: ______________________________________

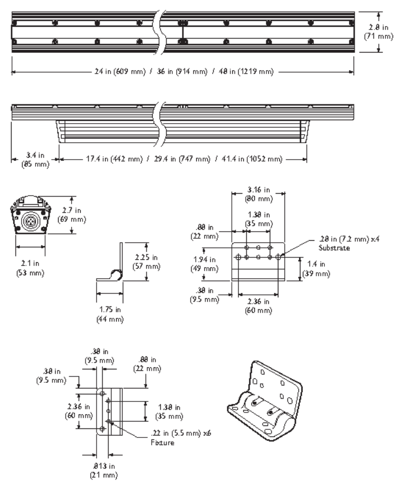
ColorGraze Powercore

30° x 60° beam angle

Linear exterior LED wall grazing fixture with intelligent color light

ColorGraze Powercore linear LED lighting fixtures are optimized for surface grazing, wall-wash lighting, and efficient signage illumination. Superior light quality offers uniform beam saturation as close as 6 in (152 mm). A compact, low-profile design combined with flexible mounting options allows for discreet placement within a wide range of architectural features. Intelligent, controllable fixtures are available in standard full-color configurations. Custom configurations with additional beam angles and custom LED channels are also available to support special applications.

- Tailor light output to specific applications — Available in three standard lengths, with standard 10° x 60° and 30° x 60° beam angles. Individually addressable 1 ft (305 mm) segments accommodate fine control of color-changing effects and pre-programmed light shows.
- High-performance illumination and beam quality — ColorGraze Powercore delivers up to 368 lumens of color-changing light per foot. Superior beam quality offers striation-free saturation as close as 6 in (152 mm) from fixture placement with no visible light scalloping between fixtures.
- Integrates Powercore technology — Powercore technology rapidly, efficiently, and accurately controls power output to fixtures directly from line voltage. The Philips Data Enabler Pro merges line voltage with control and delivers them to the fixture over a single standard cable, dramatically simplifying installation and lowering total system cost.
- Versatile installation options — Constant torque locking hinges offer simple and consistent position control from various angles. The low-profile aluminum housing accommodates placement within most architectural niches.
- Superior color consistency — Optibin, a proprietary binning optimization process developed by Philips Color Kinetics, guarantees consistency of hue across LEDs, fixtures, and manufacturing runs.



- Industry-leading controls — ColorGraze Powercore works seamlessly with the complete Philips Color Kinetics line of controllers, including Light System Manager, iPlayer 3, and ColorDial Pro, as well as third-party controllers.
- Support for installations requiring conduit to fixtures — ColorGraze Powercore Conduit fixtures have flying leads and threaded openings for 1/2 in NPT conduit to support installations in North America where conduit is required.
- Custom configurations for special applications — You can create custom configurations by exchanging the LED sources in any channel. Options include seven color temperatures ranging from 2700 K to 6500 K, Royal Blue, Blue, Green, Amber, and Red. Additional beam angles (including 9° x 9°, 10° x 30°, and 90° x 60°) are also available. Refer to the ColorGraze Powercore Ordering Information specification sheet for complete details.

For detailed product information, please refer to ColorGraze Powercore Product Guide at www.philipscolorkinetics.com/ls/rgb/colorgraze/

PHILIPS

Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	2 ft (610 mm)	3 ft (914 mm)	4 ft (1219 mm)
	Lumens*	736	1104	1472
	LED Channels	Red / Green / Blue		
	Mixing Distance	6 in (152 mm) to uniform beam saturation		
	Lumen Maintenance†	100,000 hours L_{50} @ 25° C 90,000 hours L_{50} @ 50° C		
Electrical	Input Voltage	100 – 240 VAC, auto-switching, 50 / 60 Hz		
	Power Consumption *at full output, steady state*	35 W maximum	52.5 W maximum	70 W maximum
Control	Interface	Data Enabler Pro (DMX or Ethernet) Fixture firmware addressable 8- or 16-bit control		
	Control System	Philips full range of controllers, including Light System Manager, iPlayer 3, and ColorDial Pro, or third-party controllers		
Physical	Dimensions *(Height x Width x Depth)*	2.7 x 24 x 2.8 in (69 x 610 x 71 mm)	2.7 x 36 x 2.8 in (69 x 914 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	4.9 lb (2.2 kg)	8.1 lb (3.6 kg)	10.8 lb (4.9 kg)
	Housing	Extruded anodized aluminum		
	Lens	Clear polycarbonate		
	Fixture Connectors	Integral male / female waterproof connectors		
	Temperature	-40° – 122° F (-40° – 50° C) Operating -4° – 122° F (-20° – 50° C) Startup -40° – 176° F (-40° – 80° C) Storage		
	Humidity	0 – 95%, non-condensing		
	Fixture Run Lengths	To calculate fixture run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.philipscolorkinetics.com/support/install_tool/		
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, PSE, CCC		
	Environment	Dry / Damp / Wet Location, IP66		

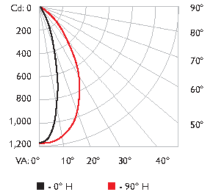
* Measurements comply with IES LM-79-08 testing procedures.

† L_{50} = 50% lumen maintenance (when light output drops below 50% of initial output). Ambient luminaire temperatures specified. Lumen maintenance calculations are based on lifetime prediction graphs supplied by LED source manufacturers. Calculations for white-light LED fixtures are based on measurements that comply with IES LM-80-08 testing procedures. Refer to www.philipscolorkinetics.com/support/appnotes/lm-80-08.pdf for more information.

Photometrics

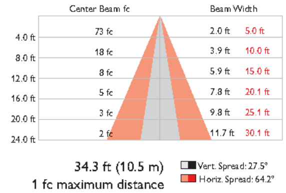
ColorGraze Powercore 2 ft, 30° x 60° beam angle

Polar Candela Distribution



	0.0	22.5	45.0	67.5	90.0
0	1174	1174	1174	1174	1174
5	1079	1088	1118	1146	1160
15	515	565	721	936	1048
25	156	184	304	586	806
35	62	70	109	275	497
45	35	38	52	110	239
55	20	22	30	49	96
65	11	11	15	24	37
75	5	5	6	10	12
85	2	1	1	1	1
90	1	1	1	0	0

Illuminance at Distance



LED	Lumens	Efficacy
RGB	736	16.1

For lux multiply fc by 10.7

CHROMACORE CKTECHNOLOGY | OPTIBIN CKTECHNOLOGY | POWERCORE CKTECHNOLOGY

Accessories

Item	Type	Size	Item Number	Philips 12NC
Leader Cable	UL / cUL	50 ft (15.2 m)	108-000042-00	910503700322
	CE / PSE	50 ft (15.2 m)	108-000042-01	910503700323
Jumper Cable	UL / cUL	End-to-End	108-000039-00	910503700314
		1 ft (305 mm)	108-000039-01	910503700315
		5 ft (1.5 m)	108-000039-02	910503700316
	CE / PSE	End-to-End	108-000040-00	910503700317
		1 ft (305 mm)	108-000040-01	910503700318
		5 ft (1.5 m)	108-000040-02	910503700319
Glare Shield		1 ft (305 mm)	120-000081-00	910503700745
		2 ft (610 mm)	120-000081-01	910503700746
		3 ft (914 mm)	120-000081-02	910503700747
		4 ft (1.2 m)	120-000081-03	910503700748
Additional Terminators		Quantity 10	120-000074-00	910503700580
Additional Hinge		Quantity 1	120-000098-00	910503700772

Use Item Number when ordering in North America.

Fixtures and Data Enabler Pro

Item	Type	Size	Item Number	Philips 12NC
ColorGraze Powercore	10° x 60°	2 ft (610 mm)	123-000030-00	910503700308
		3 ft (914 mm)	123-000030-01	910503700309
		4 ft (1219 mm)	123-000030-02	910503700310
	30° x 60°	2 ft (610 mm)	123-000030-03	910503700311
		3 ft (914 mm)	123-000030-04	910503700312
		4 ft (1219 mm)	123-000030-05	910503700313
ColorGraze Powercore Conduit (UL / cUL only)	10° x 60°	2 ft (610 mm)	123-000020-06	910503701833
		3 ft (914 mm)	123-000020-11	910503701838
		4 ft (1219 mm)	123-000020-16	910503701843
	30° x 60°	2 ft (610 mm)	123-000020-08	910503701835
		3 ft (914 mm)	123-000020-13	910503701840
		4 ft (1219 mm)	123-000020-18	910503701845
Data Enabler Pro	3/4 in / 1/2 in NPT (US trade size conduit)		106-000004-00	910503701210
	PG21 / PG13 (metric size conduit)		106-000004-01	910503701211

Use Item Number when ordering in North America.

PHILIPS

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Burlington, Massachusetts 01803 USA
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Tel 617.423.9999
Fax 617.423.9998
www.philipscolorkinetics.com

 DAS-000010-02 R09 07-12