Santa Clara University **Scholar Commons**

Civil Engineering Senior Theses

Engineering Senior Theses

6-1-2013

Caltrain bridging structure and commercial buildings

Anthony Navarrete Santa Clara Univeristy

Guadalupe Gonzalez Santa Clara Univeristy

Follow this and additional works at: http://scholarcommons.scu.edu/ceng_senior



Part of the Civil and Environmental Engineering Commons

Recommended Citation

Navarrete, Anthony and Gonzalez, Guadalupe, "Caltrain bridging structure and commercial buildings" (2013). Civil Engineering Senior Theses. Paper 5.

This Thesis is brought to you for free and open access by the Engineering Senior Theses at Scholar Commons. It has been accepted for inclusion in Civil Engineering Senior Theses by an authorized administrator of Scholar Commons. For more information, please contact rscroggin@scu.edu.

Caltrain Bridging Structure and Commercial Buildings

Senior Design Project Report by Anthony Navarrete Guadalupe Gonzalez Spring 2013

Department of Civil Engineering Santa Clara University

SANTA CLARA UNIVERSITY

Department of Civil Engineering

I hereby recommend that the SENIOR DESIGN PROJECT REPORT prepared under my supervision by

Anthony Navarrete &
Guadalupe Gonzalez

entitled

CALTRAIN BRIDGING STRUCTURE AND COMMERCIAL BUILDINGS

be accepted in partial fulfillment of the requirements for the degree of

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

Advisor	Date
Chairman of Department	
Chairman of Department	Bute

CALTRAIN BRIDGING STRUCTURE AND COMMERCIAL BUILDINGS

by

Anthony Navarrete & Guadalupe Gonzalez

SENIOR DESIGN PROJECT

submitted to the Department of Civil Engineering

of

SANTA CLARA UNIVERSITY

in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering

Santa Clara, California

Spring 2013

<u>ACKNOWLEDGEMENTS</u>

Dr. Reynaud Serrette: Structural and general advice through the development of the project. Project advisor.

Dr. Sukhmander Singh: Geotechnical advice for the proposed development.

Dr. Tanya Nilsson: Structural design advice.

Michael Loomis: Advising in the seismic design and analysis.

Noel Radley: Advice in the gathering of information, and writing of technical report.

Ziad Dweiri: Assistance throughout the drafting process.

Cities of San Jose and Santa Clara: Guidance through the design process and development of project.

CALTRAIN BRIDGING STRUCTURE AND COMMERCIAL BUILDINGS

Anthony Navarrete and Guadalupe Gonzalez

Department of Civil Engineering Santa Clara University, Spring 2013

ABSTRACT

The proposed project involves the design of three tower structures connecting a pedestrian bridge to help provide commuters, bicyclists, and pedestrians access to the east and west sides of the Santa Clara Caltrain rail system. Since the new San Jose Earthquakes stadium is currently being constructed on the east side of the tracks adjacent to Coleman Avenue, high business potential for a possible multi-use retail development exists. In addition to the three towers, three commercial structures will be designed in order to satisfy the need for a retail development. This project will serve as an attraction that will help attract commuters, travelers, and soccer fans. The combined development of the towers and the commercial structures will also allow commuters to access the San Jose Airport.

TABLE OF CONTENTS

Report Section	<u>Page</u>
CERTIFICATE OFAPPROVAL.	i
TITLE PAGE	ii
ACKNOWLEDGEMENTS	iii
ABSTRACT	iv
TABLE OF CONTENTS.	V
1.0 – INTRODUCTION AND BACKGROUND.	1
1.1 – PROJECT NEED.	2
2.0 – SUMMARY OF ALTERNATIVE ANALYSIS	3
2.1 – FINAL SOLUTION.	4
2.2 – DESIGN SCOPE	7
3.0 - APPLICABLE DESIGN CRITERIA AND STANDARDS	7
4.0 – DESCRIPTION OF PROPOSED FACILITY	8
5.0 – DESIGN LOADS.	10
5.1 – DEAD LOADS	10
5.2 – LIVE LOADS	11
5.3 – WIND LOADS	11
5.4 – SEISMIC LOADS	12
6.0 – GENERAL GRAVITY DESIGN	12
6.1 – TOWER GRAVITY DESIGN	13
6.2 – COMMERCIAL STRUCTURES GRAVITY DESIGN	14
7.0 – GENERAL LATERAL DESIGN	15

7.1 – TOWER LATERAL DESIGN	16
7.2 – COMMERCIAL STRUCTURES LATERAL DESIGN	18
8.0 – SOIL CONDITIONS AND FOUNDATION	20
9.0 – COST ANALYSIS	21
10.0 – RISK ASSESSMENT.	22
11.0 – CONCLUSION.	22
12.0 – REFERENCES.	23
13.0 – APPENDICES	
A. DESIGN VALUES AND STANDARDS	A-1
B. BEAM/GIRDER CALCULATIONS	B-1
C. COLUMN/LATERAL CALCULATIONS	C-1
D. WIND CALCULATIONS	D-1
E. SEISMIC CALCULATIONS	E-1
F. BANNAN ENGINEERING BORING LOG	F-1
G. VULCRAFT TRUSS SPECIFICATIONS	G-1
H. COST TABLES.	H-1
I. DETAILED DESIGN DRAWINGS	I-1

1.0 INTRODUCTION AND BACKGROUND

Adjacent to the San Jose Airport off Coleman Avenue are three vacant parcels, one of which is currently under development. The new San Jose Earthquakes stadium has broken ground and is currently under construction on the southern most lot. In order to access this site from the Santa Clara University campus, one must take either West Hedding Street, a three mile detour, or De La Cruz Boulevard, a two mile detour. However, pedestrians and bicyclists have no access through the De La Cruz Boulevard route. The presence of the Caltrain rail system limits students and other citizens around the Santa Clara campus to take one of these two routes. Figure 1 shows the vicinity map of the vacant area of interest.

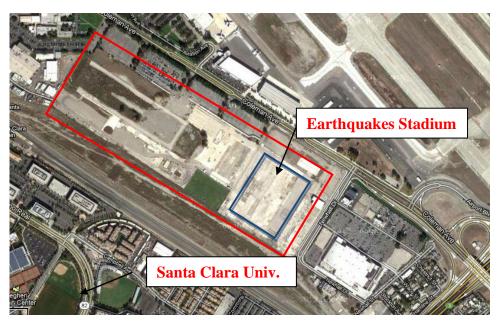


Figure 1: Aerial view of vacant lot

The Caltrain rail system runs as far south as Gilroy and as far north as downtown San Francisco. Some of the most popular attractions where the Caltrain makes stops are the HP Pavillion, the San Francisco Airport, and AT&T Park. Once the Earthquakes stadium is fully constructed, it will be located directly across the Santa Clara Transit Center. Yet, with the presence of such a major attraction, there is currently no access to the stadium site from the

transit station. Again, the only ways to access the site are through the aforementioned routes. There is also no access to the San Jose Airport from the transit center. Caltrain riders must currently stop at the Santa Clara station and take a Valley Transportation Authority (VTA) shuttle bus in order to reach the airport.

The area surrounding the Caltrain station and the proposed site consists mostly of residential and industrial development, with a small presence of commercial and mixed-use facilities. Nearby commercial development includes Costco, approximately a half mile north, and a shopping center approximately one mile south which contains: Target, Marshalls, Michaels, and various restaurants. Another popular destination available for the Santa Clara community is Santana Row and the Valley Fair Shopping Center, which are three miles away from the university campus. Although these are readily available options for the Santa Clara and San Jose areas, the Caltrain station does not stop near these sites, making them difficult for pedestrians, bicyclists, and commuters to reach by mode of mass transit.

1.1 PROJECT NEED

There is currently a need for a structural development that would bridge the gap between the east and west sides of the Santa Clara Caltrain rail system. Such a development would allow for easy access to opposite sides, connecting the Santa Clara Transit Center to the San Jose Airport and Earthquakes stadium as a result. By connecting the Santa Clara Transit Center to the airport and stadium, the need for a VTA shuttle from the transit center would be eliminated, resulting in the reduction of vehicle gas mileage and carbon emissions.

However, a bridging structure is not all that is needed for the area surrounding the transit center. When researching plans for the vacant land, it was discovered in the Draft

Environmental Impact Report (EIR) for the stadium that a planned development of residential complexes was proposed adjacent to the new stadium. Some agencies that were opposed to that development were VTA and the Public Utilities Commission. Both expressed their concerns in the EIR about the lack of transit supportive facilities and access to the Earthquakes stadium. A commercial development on the remaining vacant area would fulfill the need for an entertainment center near the transit center while also creating a point of interest along the Caltrain rail system, becoming a transit supportive facility in effect.

2.0 SUMMARY OF ALTERNATIVE ANALYSIS

The original intent of the project was to provide access to pedestrians and bicyclists between the west and the east sides of the Santa Clara Caltrain tracks. As the project evolved, a priority that arose was to implement a plan that would increase the potential of all of the surrounding businesses and also fulfill the need for an entertainment center. Several alternative solutions were taken into consideration.

A simple pedestrian bridge would be sufficient to bridge the gap between the east and west sides of the tracks and provide access to those using mass transit. It would also be of use to access the new Earthquakes stadium or to provide a faster way of accessing the San Jose Airport. The cost of this pedestrian bridge would be very minimal, as it would be built out of HSS steel sections, and would resemble pedestrian bridges seen across the Bay Area. An example of the pedestrian bridge that could be implemented was the bridge in the Mountain View Caltrain station, which can be seen in Figure 2. This proposed solution would grant access and would provide a fast solution to the aforementioned needs.



Figure 2: Mountain View Caltrain pedestrian bridge

Another solution discussed was the use of a tunnel system. The tunnel system would allow pedestrians to cross the tracks from El Camino Real to the Coleman Avenue side. Currently, the Santa Clara Caltrain has a tunnel system, which allows pedestrians going north to access the north terminal. However, these tunnels that exist are relatively short in length. The tunnel that would be proposed would be over five hundred feet in length. In terms of serviceability, this proposed idea was considered to be dangerous in nature. The length of the tunnel would present security issues. Also, aesthetically, it did not appeal towards tourists and mass crowds. One of the purposes of having this access to the east side of the tracks was to increase business potential around the area. Having a tunnel would not be beneficial to existing and future businesses.

The two alternative solutions were analyzed and were found to be relatively cost effective and would not be very disturbing to the surrounding businesses during construction. However, although they are cost effective, they do not provide the Santa Clara community with an entertainment center and do not appeal to visitors.

2.1 FINAL SOLUTION

In the end, the most appropriate and beneficial design was determined to be three tower structures that support a pedestrian bridge. The pedestrian bridge will span from the

west end of the current Caltrain station to the east side adjacent to Coleman Avenue, crossing over the active rail system. Running trains will funnel through the structures from both northbound and southbound directions. In conjunction with the towers, three commercial structures will also be designed in order to fulfill the need for a mixed use, transit supportive facility. Figure 3 illustrates the approximate location of these structures.

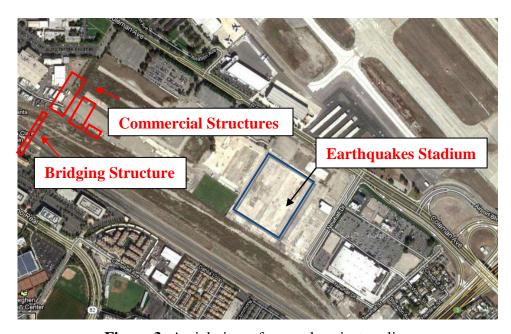


Figure 3: Aerial view of general project outline

The commercial structures will serve as a staging area for commuters trying to access the San Jose Airport and will consist of restaurants, bars, retail stores, and various other entertainment establishments. Train commuters, pedestrians, and bicyclists will be able to reach the new entertainment center from the transit center via the tower structures. They will eliminate the need for bicyclists and pedestrians to take the W. Hedding Street route by providing a short 0.3 mile access route. This proposal will also cater to the future development of the California High Speed Rail and Bart station, which will see extensions run adjacent to the current Caltrain tracks and proposed site in the near future. Figure 4 shows a model of the proposed towers and commercial structures.

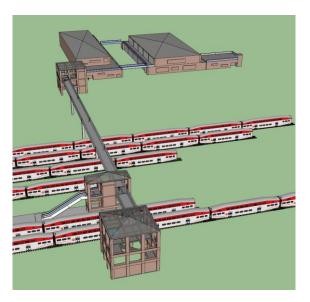


Figure 4: Proposed project looking east (not to scale)

The project will also draw significant commercial business opportunities for the neighboring communities. The Caltrain station could experience an increase in ridership because of its proximity to the airport. Commuters can board shuttles from a shuttle system on the east side of the tracks near Coleman Avenue incorporated into the commercial structures. This shuttle system will be a swift and convenient alternative to the current system provided by VTA through route ten from the Caltrain station, which must travel north on El Camino Real, over the De La Cruz Boulevard bridge to Coleman Avenue, and finally into Airport Boulevard. As a result, the mileage and carbon emissions experienced previously will be reduced or eliminated. A target for this project is to modify the current station so that it functions similarly to the Millbrae Caltrain/BART connection, which routes commuters directly into the San Francisco Airport.

This development will benefit all the neighboring communities. The new San Jose

Earthquakes soccer stadium is currently under construction at the corner of Coleman Avenue
and Newhall Drive, across from the San Jose Airport. The proposed structure will run and
end adjacent to this new stadium, making it easily accessible for not only the neighboring

community in the South Bay, but up to the North Bay as well. Since soccer games are major events, the potential for commercial business is soaring. Before and after these major events, attendees will be able to eat, shop, and interact comfortably through the use of the proposed facility. This soccer stadium also has the potential to increase Caltrain business in the ways that the San Jose Sharks' HP Pavilion and San Francisco Giants' AT&T Park do.

2.2 DESIGN SCOPE

Given the large scope of the project, only certain structural design processes were able to be accomplished. Because of intricate details, the steel bridge, structural connections, and foundations were excluded from the design scope. Included within the project are the structural design of the three towers and the three commercial structures. However, foundations and bridge interactions were taken into consideration because of their significant impact on design

3.0 APPLICABLE DESIGN CRITERIA AND STANDARDS

Because the San Jose and Santa Clara boundary line runs through the parcel of interest, contacting both jurisdictions was necessary in order to determine if any planning or building issues would apply. The Santa Clara jurisdiction stated that a structure could not be located on the physical boundary line. As a result, it was required that the structural layout avoid encroaching the boundary. Also, because of the presence of the city boundary line, both cities of San Jose and Santa Clara were contacted in order to determine the design wind speed.

Santa Clara provided a design wind speed of 75 mph while San Jose claimed a wind speed of 85 mph. For conservative purposes, an 85 mph wind speed was used for lateral design.

Given the project's close proximity to the San Jose Airport, height restrictions for airport clearance needed to be taken into consideration. The height limit around the Coleman Ave. area is 210 ft. Finally, vertical rail clearances needed to be taken into account. The 2011 Highway Design Manual states a minimum rail clearance of 26 ft. for an electric rail system. Although only the Caltrain and Amtrak train systems run through the area, BART and California High Speed Rail, electric systems, are expected to run through in the near future.

4.0 <u>DESCRIPTION OF DESIGNED FACILITY</u>

The three towers serve as entry and exit points for those using the bridging structure.

Towers one and three are identical for ease of construction. Towers one and three have a 45 ft. by 45 ft. footprint and a height of 50 ft. The bridge will be connecting the towers at an elevation of 30 ft, which will serve as a clearance for the Caltrain and other future systems. A 5 ft. mechanical level is included in the elevator framing to allow for a pulley system. Tower two is different in design because it needed to be incorporated with the newly remodeled Santa Clara Caltrain; as a result, the footprint could only be 15 ft. by 45 ft. Figure 5 details the south elevation of the tower structures.

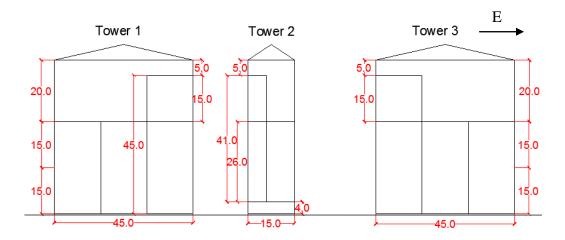


Figure 5: Tower structures - south elevation

A model of the south elevation of towers one and two can be seen in Figure 6 below. As mentioned previously, tower three is identical to tower one.



Figure 6: Model view of tower structures – south elevation

The three commercial structures were designed to be in close proximity to one another. All three commercial structures have story heights of 17 ft. and commercial structures A and B have 12 ft. walkways. Commercial structure A has a 34 ft. height at the bottom of the roof, an 82 ft. width, and a 27 ft. elevator. A 40 ft. walkway connects commercial structures A and B. Commercial structure B has a 124 ft. width. Structure C has only one story for a total height of 17 ft. and a width of 80 ft. Figure 7 details the west elevation of the commercial structures. More detailed AutoCAD drawings can be found in Appendix I.

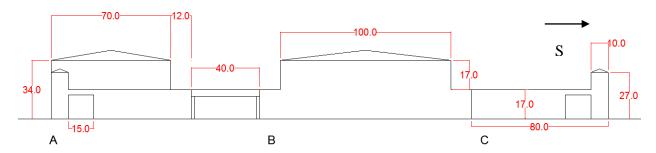


Figure 7: Commercial structures - west elevation

A model view of the west elevation of the commercial structures can be seen in Figure 8 below.

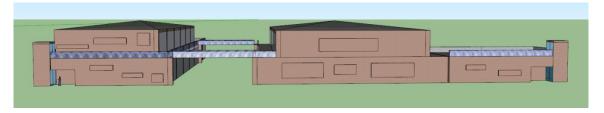


Figure 8: Model view of commercial structures – west elevation

5.0 <u>DESIGN LOADS</u>

All design loads were taken out of the 2010 Minimum Design Loads for Buildings and Other Structure (ASCE 1-10).

5.1 DEAD LOADS

The dead loads for the towers and the commercial structures were determined by contacting the jurisdiction to see what typical loads were for related structures in the area. Tables C3-1 and C3-2 from ASCE 7-10 were also referred to for approximate weights of construction materials such as Spanish clay tile, metal decking, and concrete decking. The roof dead loads were determined to be 20 psf while the floor dead loads were 80 psf. For tower two, loads due to the bearing connection of the bridge also had to be taken into consideration. A site visit to the Mountain View Caltrain station was conducted in order to record approximate sizes of the pedestrian bridge that crosses the rail system. Using these dimensions, a bridge model was created through Visual Analysis in order to determine an approximate bridge dead weight. Pioneer Bridges was also contacted. They provided typical weights of bridges used for similar applications. Included in the weight of the bridge was a 5 inch concrete deck, which was an estimate also provided by Pioneer Bridges. Weights due to

the elevator mechanical equipment and escalator also had to be taken into consideration.

These weights were provided by American Elevator Company.

5.2 LIVE LOADS

Live Loads were determined using Table 4-1 from ASCE 7-10 Minimum Design Loads. For a commercial retail space, the minimum design roof live load is 25 psf. The minimum design floor load is 100 psf. For conservative purposes, live load reduction was not considered.

5.3 WIND LOADS

Although Figure 26.5-1B from ASCE 7-10 states that the minimum design wind speeds for Occupancy Category II in California is 115 mph, it was deemed necessary to contact the jurisdictions for the implemented wind speed. After contacting the Santa Clara and San Jose jurisdictions, it was determined that the exposure category for the project was exposure B. Wind pressures for the towers and commercial structures were found using ASCE 7-10 Minimum Design Loads. The towers and the commercial structures were treated as rigid structures because their fundamental frequency was greater than one. Because the towers are not expected to have 80% total closure on all sides nor 80% total opening on all sides, the towers were treated as partially enclosed structures. For the retail development, the structures were treated as fully enclosed. For conservative estimations, the maximum net pressure experienced for each structure was uniformly distributed across the applicable face. However, the jurisdictions did notify that wind design does not govern over seismic design. As a result, for lateral design, it was assumed that the worst case wind situation would not

occur at the same time as the worst case seismic event. Wind load calculations and results can be found in Appendix D.

5.3 <u>SEISMIC LOADS</u>

Earthquake analysis was performed using ASCE 7-10 Minimum Design Loads. Using the United States Geological Survey (USGS), the (Ss) and (S_1) values were determined for our structures. After obtaining the boring log from Santa Clara Bannan Engineering building, the site class was determined to be site class D. The importance factor for a category II building was one and the response modification factor (R), over strength factor (R), and deflection amplification factors (R) were all determined based on a special moment frame design using Table 12.2-1 in ASCE 7-10. These values were used in conjunction with the ASCE 7-10 manual to determine fundamental periods of our structures (R). The (R) values were determined using the fundamental period. After determining the total seismic base shear of the structures, forces at each level were determined based on the level load. Seismic loads for individual structures can be found in Appendix E.

6.0 GENERAL GRAVITY DESIGN

All simple beams were analyzed with uniformly distributed gravity loads. The stiffness requirement was determined using the maximum allowable deflection, Δ_{LIM} , due to the live load. The deflection limit was taken as L/360 for the floors, and L/240 for the roof; where L is the length of the beam in inches. All members were designed using W-sections and were checked to comply with the deflection limits, lateral torsional buckling, shear, and yielding strength requirements. Girders were analyzed using point loads due to the beams framing into

the members. They too were checked to comply with the strength requirements previously mentioned. To maintain consistent column sizes throughout the structures, gravity column sizes were governed by the column sizes implemented in the moment resisting frame. Beam and girder calculations can be found in Appendix B.

6.1 TOWER GRAVITY DESIGN

The tower gravity design was governed by the fact that columns could not run through the middle of the structure because they would obstruct the desired open spacing. As a result, in towers one and three, a 45 ft. girder runs across the center of the structures, which presented uneven loadings across the span of the member. Figure 9 presents a cut-out of towers one and three which indicates the location of the 45 ft. girder. Some beam and girder sizes included in the second story of towers one and two are W18x76, W18x50, and for the 45 ft. member, W24x192.



Figure 9: Second story plan view—towers one and three

Unlike most of the beams implemented in towers one and three, the beams supporting the pedestrian bridge in tower two saw a significant increase in load. The reaction seen at each support was 35 kips, which can be seen in Figure 10. This resulted in an increase of 2.33 klf along the length of the 15 ft. supporting member.

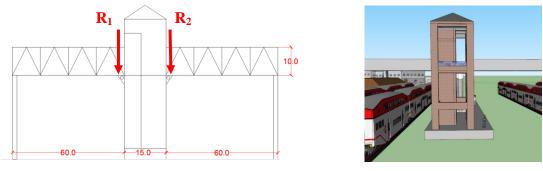


Figure 10: Tower two bridge supports

A feature all three towers share in common is the implementation of a pulley supported elevator system. This required a 5 ft. clearance between the top of the elevator shaft and the tower ceiling. A slab, supporting the pulley mechanical equipment, rests on the members and distributes half its load to the center supporting beam.

6.2 COMMERCIAL STRUCTURES GRAVITY DESIGN

Because prefabricated trusses allow for more serviceable construction, the initial gravity design of the commercial structures included truss joists on the second story and the roof. However, the loads seen on the second story were too large for the prefabricated truss sizes that were being considered. As a result, trusses were implemented only on the roof due to the relatively small loads experienced. Trusses allow for easy installation.

For truss specifications and strength capacities, Vulcraft Group was consulted. Using their product catalog, a truss model was selected. The trusses were spaced at 5 ft. with lengths that varied from 25 ft. to 35 ft. The required truss strength was an LRFD load of 310 plf, resulting in the implementation of the 14K3 and 18K7 joists from the K-series. Each had strength capacities of 339 plf and 367 plf and depths of 14 in. and 18 in. respectively. This allows for mechanical and electrical run-through as well as fast installation. The K-series catalog with LRFD strength capacities can be found in Appendix G. A typical Vulcraft joist

detail can be seen in Figure 11 below and a plan view of the joist system can be seen in the detailed drawings of commercial structures A and B in Appendix I.

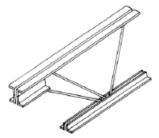


Figure 11: Vulcraft K-series joist

No unusual loading patterns were experienced throughout the rest of the commercial structures. The smallest and largest sizes implemented in the commercial buildings were W12x26 and W18x130 respectively.

7.0 GENERAL LATERAL DESIGN

Because steel ordinary moment frames are only permitted for single story structures and intermediate moment frames for heights 35 ft. or less in site class D, steel special moment frames were implemented in all structures. Since the project is located in a high seismic region, only seismic forces were used for lateral design.

Preliminary sizes for the moment frames were done using force and stiffness equations. The maximum inelastic interstory drift allowed was 2.5% of the story height. Given this maximum inelastic response, the maximum allowable elastic drift was determined using equation 12.12-1 from ASCE 7-10. Using the maximum allowable interstory elastic drift, a preliminary sized member was chosen using a required moment of inertia based on the stifness of a given frame. The moment of intertia was isolated from the equation. The force acted on the frame was found by dividing the earthquake shear forces by the number of resisting frames in the plane of the force. Using the discovered moment of inertia, a

preliminary sized member was chosen out of the AISC Steel Construction Manual and modeled in Visual Analysis. After introducing lateral and gravity loads into the model frame, column and beam sizes were sized up until adequate strength, deflection, and drift limits were satisfied

Because moment frames were implemented for the lateral resistance, significant drift is expected to occur. Because various structures interact with each other, such as commercial building B and C, the use of seismic joints was vital to allow for sufficient drift without structural damage. Using the maximum allowable inelastic drift, 2.5% of the story height, seismic spacing and joints were determined through the use of equation 12.12-2 from ASCE 7-10. Equation 12.12-2 takes the sum of the squares of the maximum inelastic interstory drifts. This spacing was used to size the expansion joints, which were found by consulting EMSEAL Joint Systems. The largest required size was 7.5". Lateral calculations, column sizing, and maximum inelastic drifts can be found in Appendix E.

7.1 TOWER LATERAL DESIGN

Given the towers' limited space and open interior area, certain members experienced strong and weak axis bending. In designing the lateral system for the towers, a challenge was encountered for tower two. The design for tower two was restricted by the fact that the newly remodeled Santa Clara Caltrain was to be incorporated. The incorporation did not allow for the bridge to have its own foundation. Two bridge sections had to rest at level two of tower two and introduced some dead load to the structure. The total dead load for the bridge was estimated at 70 kips. The 70 kip dead load of the bridging structure introduced two 35 kip reactions in the south face of tower two.

A bearing load connection was used to transfer very minimal lateral forces. However, because steel rests on steel, the surface area will allow for some lateral load transfer. A steel on steel static friction coefficient was used for the lateral load transfer. AISC 2011 suggests two different values for static friction depending on the finish of the connection. For conservative purposes, class B surfaces were used. Class B has a static friction of 0.5 (AISC 16.1-126). The static friction was assumed to allow some lateral load transfer from the bridging structure. In a seismic event, the reactions of 35 kips transferred a lateral load due to the static friction of 17.5 kips. Figure 12 illustrates the lateral force created by the simple bearing connection of the pedestrian bridge onto tower two. For conservative design, worst case scenario was assumed, which saw the lateral forces due to the pedestrian bridge act in the same direction, creating twice the resultant.

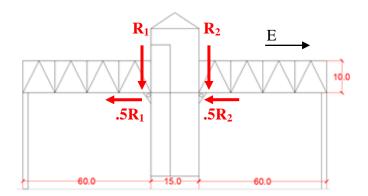


Figure 12: Tower two lateral reactions – south elevation

The two frames supporting the bridge were designed to take the entire lateral load due to the bridge. By separating the two south frames from the two north frames, seen in Figure 13, torsional effects due to the bridge were minimalized.

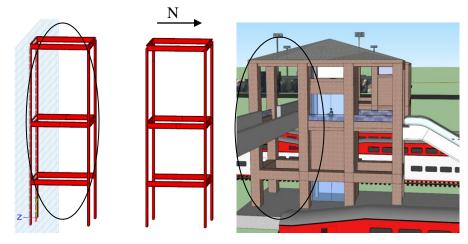


Figure 13: Tower two lateral resistance – east elevation

Since the pedestrian bridge is supported on its own foundation when it reaches towers one and three, seismic joints were necessary to allow for drift between the two towers and the pedestrian bridge. A 6.4 in. seismic joint is required in the locations illustrated in Figure 14.

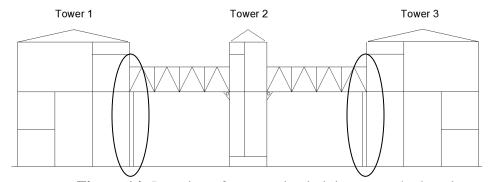


Figure 14: Location of tower seismic joints – south elevation

7.2 COMMERCIAL STRUCTURES LATERAL DESIGN

Unlike the towers, the lateral system for the commercial structures was separated into north-south resistances and east-west resistances, allowing the columns to be oriented along their strong axis and preventing weak axis bending. Figure 15 illustrates the separation of the lateral resistance for commercial structure A.

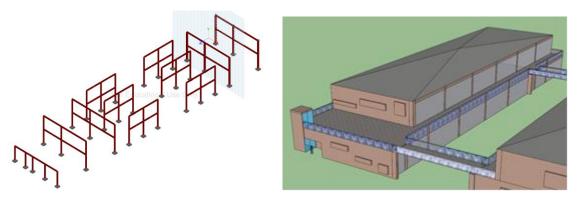


Figure 15: Commercial structure A lateral resistance

Commercial buildings A and C have 27 ft. elevators that span 10 ft. above the first floor walkway. This was necessary to access their respective second floor walkways, which can be seen in Figure 16. As a result, the upper 10 ft. of the elevators are vulnerable to lateral forces that cannot be withstood by the large commercial structure itself. In order to provide sufficient lateral strength, the elevators were designed as separate structures in order to implement moment frames and allow for some lateral drift.

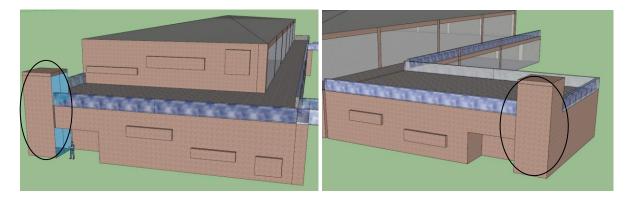


Figure 16: Commercial elevator A (left) and commercial elevator C (right)

Figure 17 demonstrates where seismic joint are necessary to accommodate for lateral drift.

The pedestrian walkway connecting commercial buildings A and B was treated as a separate structure. 7.1 in. seismic joints are required at these locations.

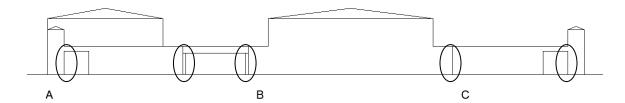


Figure 17: Location of commercial structure seismic joints – west elevation

8.0 SOIL CONDITIONS AND FOUNDATION

Because a soils report for the project site was not available, other means of obtaining soil records needed to be taken. Given Santa Clara University's close proximity to the project site, the soils report for the Bannan Engineering building was used to approximate soil conditions. Assuming the same site conditions applied, foundation recommendations were based off the boring logs for the engineering building. The presence of expansive and liquefiable soils presented the possibility of two site classes, D and E. Site class D was determined by the fact that the compressive strength for the clay was far greater than the 500 psf threshold and the clay layer was less than 10 ft. in thickness. The moisture content, however, was 40 %, which would trigger site class E if all the previously mentioned soil conditions also fell under site class E. ASCE 7-10 was referred to determine site class.

The boring logs show that there is a clay layer at 6 ft. and a sand layer at 20 ft. Naturally, this presents settlement and liquefactions issues respectively. The logs of boring can be found in Appendix F. On the basis of which, it was recommended that the engineering building be built on shallow spread footing placed in engineered fill. Given the commercial building's open area, the same recommendations were applicable. However, given the limited space of the towers within the railway lines, shallow footings were not feasible. Accordingly, pile foundations were recommended.

Piles will not only reduce periodic vibrations from the rails and increase stability, but they also allow for ease of constructability within the confines of the tracks. By the use of a mechanical auger, piles can be drilled into the soil without making significant disturbances to the soil or the rails.

9.0 COST ANALYSIS

A material cost estimate was performed for the proposed development. The total estimated material cost is approximately \$3.2 million. Table 1 shows the cost of individual materials and a complete breakdown of specific building material costs can be found in Appendix H.

Total Cost	
Slab on metal deck	\$166,000.00
Slab on grade	\$162,000.00
Steel	\$2,900,000.00
Total	\$3,228,000.00

 Table 1: Total Material Cost

In order to be sustainable and promote green building, quotes from local providers were taken in order to decrease gas emissions due to transportation. For concrete, Central Concrete provided a quote for normal weight concrete of \$150 per cubic yard of concrete. For steel, Schuff Steel provided gave a quote of \$1.75 per pound of steel. The quantities for the slab on metal deck were increased by 10% because of the fact that deflection of the metal deck is expected to occur. In turn, this increases the quantity of concrete needed to meet required floor elevation. For complete takeoff, see Appendix H.

10.0 RISK ASSESSMENT

There were many assumptions that took place during the design of the three tower structures and three commercial buildings. Being aware of uncertainties, worse case scenarios were assumed for many structural cases. An example, as mentioned earlier, would be the beam design or wind design. For beam design, the heaviest loaded beam governed design. For wind, the maximum wind pressure was uniformly distributed. The reason for doing so is to compensate for the lack of professional knowledge and experience in certain situations.

11.0 CONCLUSION

This is a project that would be very beneficial to not only the Santa Clara community, but the Bay Area as well. The proposed development would encourage the use of public transportation, and would serve as an example in developing sustainable mass transit. Since the proposed project also includes a commercial development, the facilities would provide a great business potential. The commercial structures would also serve the entertainment needs of the Santa Clara community by housing restaurants, movie theatres, and restaurants.

In exploring different solutions and alternatives for the site, much knowledge was acquired in the process of developing a city project. Working with different jurisdictions and organizations made it apparent that much planning and communication is needed for a successful project that benefits everyone. The designing and analysis of different loading scenarios was also a challenge but allowed for much industry exposure. Navigating through codes and manuals such as the ASCE 7-10 were just small parts of the design process.

12.0 REFERENCES

American Elevator Company. (2013, May). Telephone interview.

California Building Standards Commission and the California State Legislature (2010)

The California Code of Regulations Title 24, Part 02, 2010 California Building code

California Highway Design Manual. (2011). California Department of Transportation

Website, California

City of San Jose. (2013). Telephone interview.

City of Santa Clara. (2013). Telephone interview.

Draft Environmental Impact Report for the Airport West Stadium. (2009). San Jose Government Website, California

EMSEAL Joint Systems. (2013 May). Telephone interview.

Lindeburg, Michael R., and Kurt M. McMullin. (2011). Seismic Design of Building

Structures: A Professional's Introduction to Earthquake Forces and Design Details.

Belmont, CA: Professional Publications. Print.

Minimum Design Loads for Buildings and Other Structures. (2010). Reston, VA: American Society of Civil Engineers. Print.

Pioneer Bridges (2013, May). Telephone interview.

Steel Construction Manual. . (2011). [Chicago, Ill.]: American Institute of Steel Steel Constructions. Print.

Windus, Walter B. Comprehensive Land Use Plan Santa Clara County. (2011). Santa Clara County Government Website, Santa Clara.

APPENDIX A

DESIGN VALUES AND STANDARDS

Project: Caltrain Bridging Structure and Commercial Buildings

Coleman Ave., San Jose and Santa Clara, CA

Designers: Anthony Navarrete

Guadalupe Gonzalez

Project Number: CENG 193 – Spring 2013

Jurisdictions: State of California, Cities of Santa Clara and San Jose

Codes, Specifications,

and Standards:

Department of Transportation 2011 Highway Design Manual, 2011 ASCE 7-10 Minimum Design Loads, 2010

California Building Code, AISC 14th edition

Software Used: 2011 Microsoft Excel, Visual Analysis 6.0

Basic Loads: 1. Gravity Loads:

Roof Live	25 PSF
Roof Dead	20 PSF
-Metal Deck	4 PSF
-Spanish Clay Tile	12 PSF
Floor Live	100 PSF

Floor Dead

-Metal Deck	4 PSF
-Concrete Deck	45 PSF
-Miscellaneous	30 PSF
-Elevator	7 kips
-Escalator	6 kips
-Bridge	32 kips

2. Deflection Limits:

Roof Deflection L/240 Floor Deflection L/360

3. Lateral Loads:

Wind Criteria:

Wind Speed	85 MPH
Wind Exposure	В
Category	II

Seismic Criteria

c Criteria	
Zone	4
Site Class	D
Drift	0.025h
R	6
Ω	3
C_d	5.5

Soils: Per Bannan Engineering soils report.

Materials:

Structural Steel

W-sections

A992

HSS-sections

Vulcraft prefabricated trusses

Decking Concrete Deck

APPENDIX B

BEAM/GIRDER CALCULATIONS

TOWER 1/3 FIRST FLOOR

Design Requirements		l _{req'd} (in ⁴)) 243.52			Be	Beam Design GL Q,X,13-2,15-2	n GL Q,	(,13-2,15	7-5										
Max. Deflection (in)	0.75																			
Floor Live Load, w _L (psf)	100	W18X50	008 (
Floor Dead Load, w _D (psf)	125																			
Beam Length (ft)	15	Nominal				Web	Flange		***************************************	cincain) acid		Axis X-X)		Ax	Axis Y-Y				Torsional Properties
Tributary Area (ft)	15	Weight	Area, A	Depm, a	Thickness, t _w	t_/2	Width, b	Width, b _f Thickness, t _f	Compact section unteria	zion cuteria	-	S	r Z	ı	S		7	مع	r °u	ზ
Total Dead Load (klf)	2.25	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t.,	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in) (in ⁴)	(in ⁶)
Total Live Load (klf)	2.4	20	14.7	18	0.355	0.1775	7.5	0.57	6.57	45.2	800	88.9	7.38 101	40.1	10.7	16.6	20	1.98	17.4 1.24	4 3040
Total Load (KIf)	4.65																			
Required Moment, M _r (kip-ft)	130.7813	Flexure																		
Required Shear, V _r (kips)	34.875	Flange	Flange Slenderness		Web Slenderness		Unbraced Length	Length		Yielding	JE SE		LTB							
Shear with Self Weight	35.25	γ,	9.15	γ	90.55		L _p	5.83		M _p (kip-in)	2050.00		∦ ኤ< ሌ< Ļ	If L _b > L						
		γ,	24.08	γ	137.27		1	16.90		cb	1.14	M	(kip-ft) 326.16	5 3495.12						
		b/t	6.57	h/t	45.20		£	15.00		M _o (kip-ft)	420.83		Values must be < M _o	be < M _o						
		Shear																		
			h/t _w	45.2		If h/t _w <2.24 (E/F _y)	24 (E/F _y)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		If h/t _w <	If h/t _w < 1.10 (k _v E/Fy)		If 1.10 k	f 1.10 k,E/F, <h 1.37 k,e="" <="" f,<="" t,="" td=""><td>.37 lk,E/F,</td><td></td><td>If h/t_w> 1.37 (k_vE/Fy)</td><td>/ (k_vE/Fy)</td></h>	.37 lk,E/F,		If h/t _w > 1.37 (k _v E/Fy)	/ (k _v E/Fy)
		Case 1:	2.2	, 53.95		÷	1		1.10 k _v E/Fy	59.24		ڻ	1		ۍ	1.31	1		ڻ	2.14
		Case 2:				'ኃ	1		1.37 lk _v E/Fy	73.78		Ť	6.0		ě	06'0	0		φ	06:0
		Case 3:				φ^ν,	191.7					φ _v V _n	172.53		φ _ν ν	226.11	11	•	φ _v V _n	369.80
		φ _v V _n	191.70																	
		φ _b M _n	293.54																	
		Check fo	Check for Self-Weight	+																
		M. (kip-ft)	t) 132.19	v	293.54															
		V (kine)	35.25	,	101 70										L					

TOWER 1/3 SECOND FLOOR

800 Area, A Depth, d Web (in²) (in) (in) 14.7 18 0.355 0.1775 14.7 18 0.355 0.1775 24.08 λ _γ 137.27 6.57 h/t _w 45.20 tř h/t _w 19.1.70 0.055 φ _V n 19.1.70 0.055 φ _V n 19.1.70 0.055 0.055 19.1.70 0.055 0.055 19.1.70 0.055 0.055 19.1.70 0.055 0.055 132.19 0.055 0.055 132.19 0.055 0.055 13.2.19 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 0.055 13.1.70 0.055 <th>Design Requirements</th> <th></th> <th>I_{req'd} (in⁴)</th> <th>243.52</th> <th></th> <th></th> <th></th> <th>Beam D</th> <th>Beam Design GL 14,15</th> <th>.14,15</th> <th></th>	Design Requirements		I _{req'd} (in ⁴)	243.52				Beam D	Beam Design GL 14,15	.14,15												
Number N	Max. Deflection (in)	0.75																				
Normal N	_	100	W18X50																			
Notice N		125																				
Weight Fig. Weight Meight Mei	Beam Length (ft)	15	Nominal		_		eb	Flan		400	of the state of the		Axis X-	×			Axis Y-Y				Torsiona	Properties
Figure F	Tributary Area (ft)	15	Weight			Thickne		Width, b		Compact sec	Tion Criteria	-	s	r	2	_					ſ	ზ
File		2.25	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b₄/2t₁	h/t,,	(in ⁴)	(in³)								(in ⁴)	(in ⁶)
Figure F		2.4	20	14.7	18	0.355	0.1775	7.5	0.57	6.57	45.2	800	88.9									3040
Floating Standarders Web S		4.65																				
1 1 1 1 1 1 1 1 1 1	Required Moment, M, (kip-ft) 13	30.7813	Flexure																			
S.		34.875	Flange S	lenderness		Slenderness		Unbraced	Length		Yieldir	g,			LTB							
λ, 45.20 t, 45.20 t, 40.88 (b) (kp-ft) 420.88 Values must be κ M _p h/t _u 45.20 t, 15.00 m _p (kp-ft) 420.88 Values must be κ M _p 46.2 ff h/t _u <2.24[lEF _p] ff h/t _u <2.24[lEF _p] ff h/t _u <2.24[lEF _p] ff h/t _u <2.10[lt, EF _p] ff h/t _u <1.10[lt, EF _p] f		35.25	γ	9.15	γ	90.55		ځ_	5.83			5050.00		If t _p <t<sub>b<</t<sub>		,>',						
h/t _w 45.20			γ̈́	24.08	۲	137.27		1	16.90		පි	1.14	Σ	h (kip-ft) 3		5.12						
45.2 If h/k _u <2.24 (EF _y) If h/k _u >2.24 (EF _y) If h/k _u <1.10 (k,EF _y) If h/k _u <1.10 (k,EF _y) If h/k _u <1.13 (k,EF			p/t	6.57	h/t _w	45.20		£	15.00		M _o (kip-ft)	420.83		Values n	nust be < M _o							
45.2 if hV _u <22al(E/F _u) if hV _u <1.2al(E/F _u) if hV _u <1.1al(k, E/F _u) if hV _u <1.1al(k, E																						
45.2 (if h/k _u <224 (E/k _y) (if h/k _u <1.10 (k,E/k _u) (if h/k _u <1.10 (k																						
45.2			Shear																			
53.55 4,				h/t _w	45.2		If h/t _w <2.	24 (E/F _y)		If h/t _w > 2.	24 (E/Fy)		If h/t _w <	1.10 (k,E/F)	()	If 1.1	O k,E/F, <h< td=""><td>/t_w<1.37 k</td><td>ÇE/F,</td><td>If</td><td>h/t_w> 1.37 (I</td><td>ς,E/Fy)</td></h<>	/t _w <1.37 k	ÇE/F,	If	h/t _w > 1.37 (I	ς,E/Fy)
C, φVa 1371k, EfPy 73.78 φ, φ 0.9 φ, φ 0.9 φ, φ, φ φ, φ φ, φ φ, φ φ, φ φ, φ, φ, φ, φ, φ, φ, φ φ, φ			Case 1:				Ť	1		1.10 k _v E/Fy	59.24		ڻ	1		_	.^.	1.31		Ç	•	.14
φ,ν _n 191.7 φ,ν _n 172.53 φ,ν _n 226.11 φ,ν _n 1 4,ν _n 191.7 4,ν _n 172.53 4,ν _n 226.11 4,ν _n			Case 2:				Ç	1		1.37 k _v E/Fy	73.78		Ą	0.9		<i>y</i>	ρ^	0.90		ð)	.90
v v			Case 3:				φ^N _n	191.7					φ^N _n	172.53		-6	y,	226.11		ν,φ		08.60
vv																						
v v																						
v v			φ _v V _n	191.70																		
v v			φ _b M _n																			
v v																						
132.19 < 35.25 <			Check for	Self-Weigh	1																	
35.25 <			M, (kip-ft	.) 132.19		293.54																
			V _r (kips)		v	191.70																

Resu, A Depth A Thickness, L, L/2 Width, b Thickness, L/2 Width,	Design Requirements		I _{req} b (in ⁴)	446.46				Beam	Beam Design GL 13.1	L 13.1												
Marchine	Max. Deflection (in)	0.75																				
Normal N	Floor Live Load, w _L (psf)	100	W18X50																			
Woming Week Week Michaes Week Michaes Mich	Floor Dead Load, w _D (psf)	125																				
Wheight Week, Care Car	Beam Length (ft)	15	Nominal				,ep	Flan		100	of other		Axis X	X-		,	xis Y-Y		,	4	Torsional	Torsional Properties
Figure F	Tributary Area (ft)	27.5	Weight			Thickness, t _w		Width, b _f		compact sec	tion Criteria	_	S		_	S		7	a	°	-	ზ
Since Sinc		4.125	(Ib/ft)	(in²)	(in)	(ii)	(in)	(in)	(in)	b _t /2t _t	h/t.,	(in ⁴)	(in³)					(in³)	(in)	(in)	(in ⁴)	(in ⁶)
Figure F	Total Live Load (klf)	4.4	20	14.7	18	0.355	0.1775	7.5	0.57	6.57	45.2	800	88.9					20	1.98	17.4	1.24	3040
Flate Flat		8.525																				
Figure 3 Figure Standariness Muchos of Length	Required Moment, M _r (kip-ft) 2.	39.7656	Flexure																			
High 1, b 1, c		53.9375	Flange S	lenderness		Slenderness		Unbrace	Length		Yieldi	JE SL		5	8							
λ, 45.20 L, 15.00 (b) (lip-ft) 42.038 Vialues must be κly, (lip-ft) 335.16 3495.12 45.20 L, 15.00 M _p (lip-ft) 42.038 Vialues must be κly, (lip-ft) Night lip-ft) Night lip-ft, (lip-ft) 11.00 k Eft, (lip-ft) Night lip-ft, (lip-ft) <		54.3125	γ ^b	9.15	γ	90.55		٦	5.83		M _p (kip-in)	5050.00		If Lp < Lb < L		<u>.</u>						
h/t _u 45.20			۲,	24.08	γ,	137.27		1	16.90		භ	1.14	Σ	n (kip-ft) 326.		12						
45.2			ΨΨ	6.57	4/4	45.20		<u>-</u>	15.00		M (kin-ft)	420.83		Value	t he < M							
45.2 If h/h_s<224 EF, If h/h_s>224 EF, If h/h_s>224 EF, If h/h_s<1.10 k,EF, If h/h_s<1.10 k,EF, C, 1 1.31 C 1.31 C I.31 I.31 C I.31																						
45.2 If th https://diceler.com																-						
45.2 if hΛ _u <224 [EF _i) if hΛ _u <130 k _E F _i y if hΛ _u <130 k _E F _i y if in hΛ _u <130 k _E F _i y if in hΛ _u <130 k _E F _i y if in hΛ _u <130 k _E F _i y if in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y in hΛ _u <130 k _E F _i y			Shear																			
5.3.55 φ, φ 1 1.10 κ, E/γ 59.24 C, 131 C, 131 <td></td> <td></td> <td></td> <td>h/t_w</td> <td>45.2</td> <td></td> <td>If h/t_w<2</td> <td>.24 (E/F_y)</td> <td></td> <td>If h/t_w > 2.</td> <td>24 (E/Fy)</td> <td></td> <td>If h/t_w<</td> <td>< 1.10 (k_e/Fy)</td> <td></td> <td>If 1.10</td> <td>ζ.Ε/F, <h b="" t,<=""></h></td> <td>< 1.37 k_vE/</td> <td>π_ν</td> <td>If h</td> <td>'t_w>1.37 (k</td> <td>,E/Fy)</td>				h/t _w	45.2		If h/t _w <2	.24 (E/F _y)		If h/t _w > 2.	24 (E/Fy)		If h/t _w <	< 1.10 (k _e /Fy)		If 1.10	ζ.Ε/F, <h b="" t,<=""></h>	< 1.37 k _v E/	π _ν	If h	't _w >1.37 (k	,E/Fy)
C, φ, N ₀ 1371k, E/Py 73.78 φ, φ, φ, 172.53 φ, φ, 0.90 φ, φ, φ, φ, 172.53 φ, φ, 0.90 φ, φ, 0.90 <t< td=""><td></td><td></td><td>Case 1:</td><td></td><td>_</td><td></td><td>φ</td><td>1</td><td></td><td>1.10 k_vE/Fy</td><td>59.24</td><td></td><td>ፘ</td><td>1</td><td></td><td>ď</td><td></td><td>1.31</td><td></td><td>Ĉ</td><td>2</td><td>2.14</td></t<>			Case 1:		_		φ	1		1.10 k _v E/Fy	59.24		ፘ	1		ď		1.31		Ĉ	2	2.14
φ, V _n 191.7 φ, V _n 172.53 φ, V _n 226.11 φ, V _n Φ, V _n 1 4, V _n 191.7 4, V _n 172.53 4, V _n 226.11 4, V _n			Case 2:				C,	1		1.37 k _v E/Fy	73.78		φ	6:0		ð	-	0.90		ð	0	0.90
v			Case 3:				φ^ν,	191.7					φ^N,	172.53		φV _r		26.11		ъ́	36	369.80
v v																						
v																						
v v			φ _ν ν _n	191.70																		
v v			φ _b M _n																			
v v																						
241.17 <			Check for	· Self-Weigh	اب																	
64.31 <			M, (kip-fi			293.54																
			V, (kips)		v	191.70																

Design Requirements	l _{req'd} (in ⁴)	5421.11				Girder [Girder Design GL X,W,R,Q	LX,W,R,	ď											
Max. Deflection (in) 2.25																				
Beam Length (ft) 45	W24X192	5 6260																		
Required Moment, Mr (kip-ft) 935.064																				
Point Load P1 (kips) 62.4	Nominal				Web	ᄑ	Flange				Axi	Axis X-X			Axis Y-Y				•	Torsional Properties
Point Load P2 (kips) 28.8	Weight	Area, A	u Depth, d	Thickness, t _w	., t.,/2	Width, b	Width, b _f Thickness, t _f		Compact Section Unteria	-	s		Z	_	S	_	Z	r _s	_	ڻ
	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b _t /2t _t	h/t,,	(in ⁴)	(in³)	(in)	(in³) ((in ⁴) ((in³) ((in)	(in³) (i	(in) (in)) (in ⁴)	(jul)
	192	56.5	25.5	0.81	0.405	13	1.46	4.43	56.6	979	491	10.5	229	230	81.8	126 1	192 3	3.6 24	30.8	26300
	Flexure		_																	
	Flange 5	Flange Slenderness		Web Slenderness		Unbrac	Unbraced Length		Yielding	ling			LTB							
	~°	9.15	~°	90.55		_6	10.80		M _p (kip-in) 27950.00	27950.00		If Lp < Lp < L		If Lb > Lr						
	γ	24.08	γ	137.27		4	39.70		දා	1.67		Mn (kip-ft)	3671.99 93	93781.08						
	b/t	4.43	h/t _w	26.60		ኅ	15.00		M _p (kip-ft)	2329.17		Values m	Values must be < M _p							
	φ _b M _n	2096.25																		
	Shear																			
		μţ	26.60		If h/t,,	If h/t _w < 2.24 (E/F _y)		If h/t _w >	If h/t _w > 2.24 (E/Fy)		If h/	If h/t _w <1.10 (k,E/Fy)		£	ff 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	h/t _w < 1.37	lk,E/F,		If h/t _w > 1.37 (k _v E/Fy)	(k,E/Fy)
	Case 1:	2.24 (E/F _y)	; ,) 53.95		ð	1.00		1.10 k _v E/Fy	y 59.24		ď	1			ر ر	2.23		Ĵ		6.19
	Case 2:				Ç	1.00		1.37 k _v E/Fy	y 73.78		φ̂	6:0			φ	0.90		ð		0.90
	Case 3:				φ _ν ν	619.65					φ^N _n	557.69			φ _ν ν _n	1241.94		φ _v ν _n		3451.44
	φ^N	619.65																		
	Check for	Check for Self-Weight	+																	
	M, (kip-ft	Mr (kip-ft) 983.66	~	2096.25																
	V _r (kips)	31.20	~	619.65																
														-	-	-	-	-	-	

Max. Delection (in) 0.75 Floor Live Load, w, (psf) 100 Floor Dead Load, w ₀ (psf) 125 Beam Length (it) 15 Tributary Area (it) 7.5 Total Dead load (kff) 1.12 Total Load (kff) 1.2 Total Load (kff) 2.325 Required Moment, M, (kip-ft) 56.39063 Required Shear, V, (kips) 17.4375 Shear with Self Weight 18.0075	W18X76 Nominal Weight	ļ L							•											
Floor Live Load, w, (psf) 100	W18X76 Nominal Weight	000,																		
Floor Dead Load, w ₀ (psf) 125 Beam Length (H) 15 Tributary Area (ft) 7.5 Total Dead Load (klf) 1.125 Total Load (klf) 1.2 Total Load (klf) 2.325 Required Moment, M, (kip-ft) 65.39063 Required Shear V, (kips) 17.4375 Shear with Self Weight 18.0075	Nominal Weight	1330																		
Beam Length (ft) 15 Tributary Area (ft) 7.5 Total Dead Load (kff) 1.125 Total Load (kff) 1.2 Total Load (kff) 2.325 Required Moment, M, (kip-ft) 65.39063 Required Shear V, (kips) 17.4375 Shear with Self Weight 18.0075	Nominal Weight																			
Tributary Area (ft) 7.5 Total Dead Load (kff) 1.125 Total Load (kff) 1.2 Total Load (kff) 2.325 Required Moment, M, (kip-ft) 65.39063 Required Shear V, (kips) 17.4375 Shear with Self Weight 18.0075	Weight			Web	٩	Flange	3e				Axis X-X	X		A	Axis Y-Y			-	Torsional Properties	ropertie
Total Dead Load (kff) 1.125 Total Live Load (kff) 1.2 Total Load (kff) 2.325 Required Moment, M, (kip-ft) 65,39063 Required Shear V, (kip5) 17,4375 Shear with Self Weight 18,0075		Area, A	uepm, a	Thickness, t _w	t,//2	Width, b _f Thickness, t	Thickness, t	Compact Section Criteria	tion Criteria	-	S	r Z	1	S	ı	7	Ta	°	ſ	ڻ
Total Live Load (kff) 1.2 Total Load (kff) 2.325 Required Moment, M. (kip-ft) 65.39063 Required Shear, V. (kips) 17.4375 Shear with Seff Weight 18.0075	(Ib/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b ₄ /2t ₄	h/t,,	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
Total Load (Kf) 2.325 Required Moment, M. (kip-ft) 65.39083 Required Shear, V. (kips) 17.4375 Shear with Self Weight 18.0075	9/	22.3	18.2	0.425	0.2125	11	99:0	8.11	37.8	1330	146	7.73 163	152	27.6	42.2	9/	3.02	17.5	2.83	11700
Required Moment, M, [kip-ft] 65.39063 Required Shear, V, (kips) 17.4375 Shear with Self Weight 18.0075																				
	Flexure																			
	Flange Sle	Flange Slendemess	WebSleı	Web Slenderness		Unbraced Length	Length		Yielding	JE BL		ELTB								
	γь	9.15	⁶ γ	90.55		4	5.83		M _p (kip-in)	8150.00		If Lp < Lp < L,	∦ t ₆ >L,	-						
	γ	24.08	γ,	137.27		.	16.90		දා	1.14	Ž	In (kip-ft) 533.31	1 13353.54	4						
	b/t	8.11	h/t	37.80		ئـ	15.00		M. (kip-ft)	679.17		Values must be < M.	t be < M.							
	Suear																			
		h/t _w	37.8		If h/t,,<2.24 (E/F,	:4 (E/F _y)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		If h/t _w <	If h/t _w <1.10 (k,E/Fy)		lf 1.10 k	If 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	:1.37 k _v E/F,		If h/t	If h/t _w > 1.37 (k _v E/Fy)	/Fy)
	Case 1:	2.24 (E/F _y)	53.95		φ	1		1.10 k _v E/Fy	59.24		Ç	1		ď	1	1.57		C,	3.06	9
	Case 2:				ሪ	1		1.37 k _v E/Fy	73.78		ð	6:0		ð	J	0.90		ð	06:0	0
	Case 3:				φ^V _n	232.05					φ _v V _n	208.85		φ _v V _n		327.28		φ _ν ν _n	640.05	90
	φ _ν ν _n	232.05																		
	φ _b M _n	479.98																		
	Check for Self-Weight	elf-Weight																		
	M, (kip-ft)	67.53	~	479.98																
	V, (kips)	18.01	>	232.05																

TOWER 1/3 MECHANICAL LEVEL

		l _{eq'd} (in ⁴)	490.19			Ω	Beam Design GL 13-05, 15-1	ign GL 1	3-05, 15-	Ļ											
Max. Deflection (in)	0.75																				
Floor Live Load, w _L (psf)	300	W12X65	533																		
Floor Dead Load, w _D (psf)	120																				
Beam Length (ft)	15	Nominal			Web	q	Flange					Axis X-X	X-X			Axis Y-Y			1	Torsional	Torsional Properties
Tributary Area (ft)	15	Weight	Area, A	Deptn, d	Thickness, t _w	t,//2	Width, b _f	Width, b _f Thickness, t _f	compact se	Compact Section Criteria	-	s		1 Z	S	-	Z	Ta	c °	7	ზ
Total Dead Load (klf)	2.16	(Ib/ft)	(in²)	(ii)	(ii)	(in)	(in)	(in)	b ₄ /2t ₄	h/t"	(in ⁴)	(in³)	(in)	(in³) (in⁴)	4) (in³)	(ii)	(in³)	(ii)	(ii)	(in ⁴)	(ju)
Total Live Load (kif)	7.2	65	19.1	12.1	0.39	0.195	12	0.605	9.92	24.9	533	87.9	5.28	96.8 174	4 29.1	44.1	1 65	3.38	11.5	2.18	2780
Total Load (KIf)	9:36																				
Required Moment, Mr (kip-ft)	263.25	Flexure																			
Required Shear, V _r (kips)	70.2	Flange Sle	Flange Slendemess	WebSle	Web Slenderness		Unbraced Length	Length		Yielding	Bu		_	E1							
Shear with Self Weight	70.6875	γь	9.15	ďγ	90.55		4	11.90		M _p (kip-in)	4840.00		If Lp < Lb < L,	, If t _b >L	Ļ						
		γ'	24.08	γ	137.27		ጎ	35.10		cp	1.14		An (kip-ft) 436.02 10070.52	5.02 10070).52						
		b/t	9.92	h/t	24.90		ئـ	15.00		M, (kip-ft)	403.33		Values m	Values must be < M.							
							•					1									
		Shear																			
			h/t _w	24.9		If h/t _w <2.24 (E/F _y)	.24 (E/F _y)		If h/t _w >2.	If h/t _w > 2.24 (E/Fy)		If h/t _w	If h/t _w <1.10 (k,E/Fy)		If 1.10	If 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	t"<1.37 lk _v	:/F,	IF.	If h/t _w > 1.37 (k _v E/Fy)	,E/Fy)
		Case 1:	2.24 (E/F _y)	53.95		φ	1		1.10 k _v E/Fy	59.24		ۍ	1		Č		2.38		ď	7	7.06
		Case 2:				ሪ	1		1.37 k _v E/Fy	73.78		ф	0.0		Ŷ		0.90		ð	0	0.90
		Case 3:				$\varphi_v V_n$	141.57					φ _v V _n	127.41		φ^N	_	303.11		φ _ν ν	88	836.89
		Ψ.V.	141.57																		
		W +	טער נוויר																		
		φ _b ivi _n	297.42																		
		Check for S	Check for Self-Weight																		
		M, (kip-ft) 265.08	265.08	v	392.42																
		V, (kips)	70.69	~	141.57																

Real	Design Requirements		l _{eqd} (in ⁴)	705.10				Girder Design GL R,S,V,W	esign GL	R,S,V,W											
Muchicity 355 Muchicity	Max. Deflection (in)	1																			
Muchinal	Beam Length (ft)	20	W12X96																		
1	Required Moment, Mr (kip-ft)	355																			
Figure F	Point Load P1 (kips)	71	Nominal	_			qa	Fla	nge				Axis	X-X:		Ax	s Y-Y				Torsional Properties
Lin (in) (in) (in) (in) (in) b _b /2t, b _b /2t, (in)			Weight			Thickness,		Width, b	Thickness, t	Compact Se	ction Criteria	-	s	r 2	-	S	_	Z	۳	e°	ڻ
127 0.55 0.275 12.2 0.9 6.76 17.7 883 131 5.44 147 270			(lb/ft)	(in²)	(ii)	(in)	(ii)	(in)	(in)	b ₄ /2t ₄	h/t.,	(in ⁴)	(in³)			(in³)	(in)	(in³)	(in)	(in)	(in ⁴) (in ⁶)
We b Sendemess Unbraced length Yielding Tissuo If t _b c _t c _t train If t _b c _t c _t tra			96	28.2	12.7	0.55	0.275	12.2	6:0	6.76	17.7	833	131			44.4	67.5	96	3.49	11.8 6.	6.85 9410
λ _p 90.55 L _p 2.66 M _p (kip-in) 735000 If L _p c L _p c L _p If L _p s L _p </td <td></td>																					
Veb Slandemess Unbraced Length Yielding Title Line LTB TITLE LTB TITLE LTB TITLE LTB TITLE LTB TITLE LTB TITLE TITLE </td <td></td> <td></td> <td>Flexure</td> <td></td>			Flexure																		
λ _c 90.55 L _c 2.66 M _c lúp-in) 7350.00 If L _c -L _c -			Flange S	lenderness	WebS	lendemess		Unbrace	d Length		Yield	ing		ETB							
λ, 137.27 L, 23.80 CD 167 Mp/(kip+t) 612.50 Values must be < Mp. 17.70 If h/k, <2.2a {E/F},			γ°	9.15	æ	90.55		ځ	2.66		M _p (kip-in)	7350.00		If Lp < Lp < L	If lb > 1	-					
h/k _w 17.70 L _b 7.50 M _b (kip-ft) 512.50 Values must be κM _p 17.70 Hfh/k _w <2.24 (E/F ₁) Hfh/k _w <2.24 (E/F ₁) Hfh/k _w <2.24 (E/F ₁) Hfh/k _w <2.24 (E/F ₂) Hfh/k _w <2.24 (E/F ₃) Hfh/k _w <2.10 (k,E/F ₁) Hfh/k _w <1.10 (k,E/F ₂) Hfh/k _w <1.10 (k,E/F ₁) Hfh/k _w <1.10 (k,E/F ₂			γ'	24.08	γ,	137.27		4	23.80		Cb	1.67			78 94061.2	δύ.					
17.70			p/t	97.9	h/t _w	17.70		J.	7.50		M _p (kip-ft)			Values must	be < M _p						
17.70																					
17.70			φ _b M _n	551.25																	
17.70																					
17.70 If h/k_<2.24 (E/Fy) If h/k_<2.24 (E/Fy) If h/k_<2.14 (E/Fy) If h/k_<2.24 (E/Fy) If h/k_<2.24 (E/Fy) If h/k_<2.15 (K_E/Fy) If h/k_<2.24 (E/Fy) If h/k_<2.			Shear			ſ									Ţ						
53.95 φ, 1.00 L1.01 k, E/Py 59.24 C, 1.00 C, 1.37 k, E/Py 73.78 φ, 0.9 φ, C, φ, φ, φ, φ, ω,				h/t _w	17.70		If h/t _w <.	2.24 (E/F _y)		If h/t _w >2	.24 (E/Fy)		If h/t	"<1.10 (k,E/Fy)		If 1.10 k, i	:/F, <h t,,<1<="" td=""><td>.37 k,E/F,</td><td></td><td>If h/t_w> 1.3</td><td>If h/t_w> 1.37 (k_vE/Fy)</td></h>	.37 k,E/F,		If h/t _w > 1.3	If h/t _w > 1.37 (k _v E/Fy)
C _v 1.00 1.371k, E/P _y 73.78 φ _ν 0.9 φ _ν φ _ν φ,ν _n 209.55 φ,ν _n 188.60 φ,ν _n φ,ν _n φ,ν _n φ,ν _n γ,ν _n			Case 1:				φ	1.00		1.10 k,E/Fy			C,	1		ۍ	3.3	2		Ć,	13.98
φ,ν,n 209.55 φ,ν,n 188.60 φ,ν,n -			Case 2:				ď	1.00		1.37 k,E/Fy			ð	0.9		ð	0.9	0		φ,	0.90
v v			Case 3:				φ _ν ν	209.55					φ _ν ν	188.60		φ^V	631.	17		φ'N"	2636.08
v v																					
v v																					
v v			φ^N"	209.55																	
~ ~																					
~ ~			:	_																	
v v			Check for	Self-Weigh											-						
35.50 <			M, (kip-ft,	359.80	v	551.25															
			V _r (kips)		v	209.55															

TOWER 1/3 ROOF

Max. Deflection (in) 0.7 Floor Live Load, w _L (psf) 20		I _{req'd} (in ⁴)	48.70				Beam Design GL Q,R,X,W	sign GL	Q,R,X,W												
	0.75																				
	20	W12X30	238																		
Floor Dead Load, w _D (psf)	25																				
Beam Length (ft)	15	Nominal		1	Web	q	Flange		4.0	a franchista de la		Axis X-X	×		A;	Axis Y-Y				Torsional Properties	operties
Tributary Area (ft)	15	Weight	Area, A	Depth, d	Depth, d Thickness, t _w	t"/2	Width, b	Width, b _f Thickness, t _f	Compact Section Criteria	ion Criteria -	_	s	r Z	_	s		Z	₽ E	L د°	-	C _w
Total Dead Load (kif) 0.4	0.45	(lb/ft)	(in²)	(in)	(in)	(in)	(ii)	(in)	b _t /2t _f	h/t"	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(ii)	(ii)	(in ⁴)	(jue)
	0.48	30	8.79	12.3	0.26	0.13	6.52	0.44	7.41	41.8	238	38.6	5.21 43.1	1 20.3	6.24	9.26	30	1.77	11.9	0.457	720
Total Load (KIF) 0.9	0.93																				
Required Moment, M, (kip-ft) 26.15625	5625	Flexure																			
Required Shear, V _r (kips) 6.975	575	Flange Sle	Flange Slenderness	Web Sle	Web Slenderness		Unbraced Length	1 Length		Yielding	J Bu		ET1	-							
Shear with Self Weight 7.	7.2	γ ^b	9.15	م	90.55		- 5	5.37		M _p (kip-in)	2155.00		If Lp < Lb < L	Ift _b >t,	F						
		γ,	24.08	~	137.27		٠.	15.60		g.	1.14	Ā	n (kip-ft) 132.40	40 1212.73	ĵ,						
		b/t	7.41	h/t _w	41.80		ئد	15.00		M _b (kip-ft)	179.58		Values must be < M _o	t be < M _p							
		Shear																			
			h/t _w	41.8		If h/t _w < 2.24 (E/F _y)	24 (E/F _y)		If h/t _w > 2.24 (E/Fy)	!4 (E/Fy)		If h/t _w <	If h/t _w < 1.10 (k,E/Fy)		f 1.10 k	ff 1.10 k,E/F, < h/t, < 1.37 k,E/F,	1.37 K,E/F,		If h/t _w	If h/t _w > 1.37 (k,E/Fy)	F,
		Case 1:	2.24 (E/F _y)	53.95		ð	1		1.10 k _v E/Fy	59.24		ڻ	1		ڻ	1.	1.42		ۍ	2.51	
		Case 2:				C^	1		1.37 k _v E/Fy	73.78		φ	6.0		φ	0.	06:0		φ	0.90	
-		Case 3:				φ _ν ν _n	95.94					φ _v V _n	86.35		φ _ν ν	12.	122.37		φ _v V _n	216.40	0
		φ _v V _n	95.94																		
		φ _b M _n	119.16																		
		Check for Self-Weight	elf-Weight																		
		M, (kip-ft)	27.00	~	119.16																
		V, (kips)	7.20	~	95.94																

Design Requirements						Girder [Girder Design GL 14,15	. 14,15												
	I _{reqd} (in ⁴)	1245.81																		
Max. Deflection (in) 2.25																				
Beam Length (ft) 45	W24X68	1830																		
Required Moment, Mr (kip-ft) 214.8849	61																			
Point Load P1 (kips) 14.34	Nominal			Web	,	Flange		70	circuit, Out it		Axis X-X	X-X			Axis Y-Y			4	Torsional Properties	Prope
Point Load P2 (kips) 14.34	Weight	Area, A	Deptin, a	Thickness, t _w	t,//2	Width, b _f	Width, b _f Thickness, t _f	сотраст эес	compact section criteria	-	S	r	Z		S	7	g S	οu	ſ	ۍ"
	(lb/ft)	(in²)	(in)	(ui)	(in)	(in)	(in)	b _t /2t _t	h/t _w	(in ⁴)	(in³)	(in)	(in³) (in⁴)	¹) (in³)	3) (in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
	89	20.1	23.7	0.415	0.2075	8.97	0.585	7.66	52	1830	154	9.55	177 70.4		15.7 24.5	89 9	2.3	23.1	1.87	9430
	Flexure																			
	Flange 9	Flange Slenderness	WebSi	Web Slendemess		Unbraced Length	Length		Yielding	Bu		5	LTB							
	γ°	9.15	ۍ	90.55		<u>_</u> °	6.61		M _p (kip-in)	8850.00		If tp <tb< td=""><td>If Lb > Lr</td><td>×</td><td></td><td></td><td></td><td></td><td></td><td></td></tb<>	If Lb > Lr	×						
	γ.	24.08	٠,	137.27		ť	18.90		cb	1.67		Mn (kip-ft) 90	902.91 12006.19	5.19						
	b/t	7.66	h/t _w	52.00		4	15.00		M _p (kip-ft)	737.50		Values mu	Values must be < M _p							
	φ _b M _n	663.75																		
	3																			
	Shear																			ļ
		h/t _w	52.00		If h/t _w < 2.24 (E/F _y)	24 (E/F _y)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		If h/t,	If h/t _w < 1.10 (k _v E/Fy)		f1.1	k,E/F, <h <="" td=""><td>If 1.10 k, E/F_y < h/t_w < 1.37 k_vE/F_y</td><td>, ,</td><td>If h/</td><td>If h/t_w>1.37 (k,E/Fy)</td><td>,E/Fy)</td></h>	If 1.10 k, E/F _y < h/t _w < 1.37 k _v E/F _y	, ,	If h/	If h/t _w >1.37 (k,E/Fy)	,E/Fy)
	Case 1:	2.24 (E/F _y)	53.95		φ	1.00		1.10 k _v E/Fy	59.24		۲,	1		_	Ć,	1.14		ჯ	1.	1.62
	Case 2:				ς,	1.00		1.37 k _v E/Fy	73.78		φ	0.9		_	φ.	0.90		ð	0	0.90
	Case 3:				φ _v V _n	295.07					φ^V _n	265.56		Ð	φ^Λ,	302.52		φ _v ν _n	430	430.06
	φ [^] Λ	295.07																		
	Check for	Check for Self-Weight																		
	M, (kip-ft)	t) 232.10	v	663.75																
	V _r (kips)	7.17	>	295.07																

Max. Deflection (in) 0.75 Floor Live Load, w, (psf) 20 Floor Dead Load, w ₀ (psf) 25 Beam Length (ft) 15 Tributary dreaf (ft) 75	(in_)	24.35				Girder Design Perimeter	esign Pe	rimeter												
	W18X76	1330																		
	Nominal		1	Web	٩	Flange	3e				Axis X-X	X		Axi	Axis Y-Y		,		Torsional Properties	operties
	Weight	Area, A	Deptin, a	Thickness, t _w	t _w /2	Width, b _f	hickness, t	Width, b_t Thickness, t_t	tion Criteria	-	S	r Z	-	S	ı	7	۳	°	-	ڻ
Total Dead Load (kif) 0.225	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t _w	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
Total Live Load (klf) 0.24	9/	22.3	18.2	0.425	0.2125	11	89:0	8.11	37.8	1330	146	7.73 163	152	27.6	42.2	9/	3.02	17.5	2.83	11700
Total Load (KIf) 0.465																				
Required Moment, M _r (kip-ft) 13.07813	Flexure																			
Required Shear, V _r (kips) 3.4875	Flange Slk	Flange Slenderness	Web SI	Web Slenderness		Unbraced Length	Length		Yielding	8		EII								
Shear with Self Weight 4.0575	γ	9.15	γ	90.55		4	5.37		M _p (kip-in) 8150.00	8150.00		# \p < \p < \p	Ift _b > t,							
	γ'	24.08	γ	137.27		.	15.60		cb	1.14		In (kip-ft) 500.79	9 13353.54							
	b/t	8.11	h/t	37.80		£	15.00		M _n (kip-ft)	679.17	_	Values must be < M _n	be < M,							
	Shear																			
		h/t _w	37.8		If h/t _w <2.24 (E/F _v)	24 (E/F _y)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		If h/t _w <	If h/t _w < 1.10 (k _v E/Fy)		If 1.10 k, l	If 1.10 k, E/F, < h/t, < 1.37 k, E/F,	1.37 k _v E/F _v		If h/t,	If h/t _w > 1.37 (k, E/Fy)	/Fy)
	Case 1:	2.24 (E/F _y)	53.95		φ.	1		1.10 k _v E/Fy	59.24		C,	1		ć	1.	1.57		۲	3.06	
	Case 2:				ሪ	1		1.37 k _v E/Fy	73.78		φ	0.9		ð	0.5	0.90		φ	0.90)
	Case 3:				φ^N _n	232.05					φ _v ν _n	208.85		φ _v V _n	327	327.28		φ^N _n	640.05)5
	φ _v V _n	232.05																		
	φ _b M _n	450.71																		
	Check for S	Check for Self-Weight																		
	M, (kip-ft)	15.22	~	450.71																
	V _r (kips)	4.06	>	232.05																

TOWER 2 SECOND FLOOR

800	Design Requirements		l _{req'd} (in ⁴)	243.52				Beam L	Beam Design GL 14,15	. 14,15												
March Marc		.75																				
Norminal Area A Depth Area A Area A Depth A		00	W18X50																			
Non-inferior Non-		25																				
Weight Meight M		15	Nominal	-			qe	Flan					Axis X-	×		A	xis Y-Y			1	Torsional F	ropertie
		15	Weight					Width, b		Compact sec	tion Criteria	-	S		-	S	_	Z	ھ	°	ſ	ڻ
Figure State Sta		.25	(Ib/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b _f /2t _f	h/t,,	(in ⁴)	(in³)				(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
File		2,4	20	14.7	18	0.355	0.1775	7.5	0.57	6.57	45.2	800						20	1.98	17.4	1.24	3040
Fleque Standaries Mail Mail Standaries Mail Standaries Mail Mail Standaries Mail Mail Standaries Mail Mail Standaries Mail Mail Mail Mail Mail Mail Mail Mail		.65																				
3.457 Finage Stendeness Meb Stende	equired Moment, M, (kip-ft) 130.	.7813	Flexure																			
3.5.2 A _p 9.15 A _p 9.05 A _p		.875	Flange S	lenderness		lenderness		Unbracec	Length		Yieldi	8		U	В							
24.08 3, 137.27 1, 16.90 1, 4.00.83		5.25	γ	9.15	γ	90.55		4	5.83			5050.00		If Lp < Lb < L		4						
6.57 h/t, 45.20 L, 15.00 M, (4t)p-ft 420.83 Values must be < M,			γ,	24.08	γ̈́	137.27		1	16.90		ප	1.14	N	h (kip-ft) 326.	16 3495.1	71						
19170 1917			# 4	6.57	+ /4	45.20			15.00		M (kin-ft)	420.83		Values	the < M							
19170 1235 1616 1617																						
19170 2.9354 2.																						
12.24 [ℓF], 53.55 45.2 ifh λ _v < 224 [ℓF], 53.55 ifh λ _v < 130 (kE)F, γ λ _v < 131 c, 131 c, 131 c, 131 c d c i i i i i i i i i i i i i i i i i i i			Shear																			
2.24[[F/L] 5.35 ф, 1.10[k,E/P] 5.24 C, 1.10[k,E/P] 5.24 1.23[k,E/P] 5.24 1.23[k,E/P] 5.24 1.23[k,E/P] 5.24 1.23[k,E/P] 5.24 1.23[k,E/P] 5.24 1.23[k,E/P] 6, v, 1.72[k,E/P] 6, v, 1.72[k,E/P] 6, v, 0.99 6, v, 0.50 6, v, 1.23[k,E/P] 6, v, 1.72[k,E/P] 1				h/t _w	45.2		If h/t _w <2	24 (E/F _y)		If h/t _w >2	24 (E/Fy)		If h/t _w <	1.10 (k,E/Fy)		If 1.10 k	,E/F, < h/t, <	: 1.37 k _v E/F	>	If h/t	">1.37 (k,	E/Fy)
1			Case 1:				φ	1		1.10 k _v E/Fy			°C	1		Ĉ	1	.31		C^	2.3	14
4, 4, 4, 1917 4, 4, 4, 1917 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,			Case 2:				C _v	1		1.37 k _v E/Fy	73.78		ф	6.0		ð)	.90		Ŷ	0.9	30
293.54 293.54 291.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 201.70 20			Case 3:				φ _ν ν _n	191.7					φ _v v _n	172.53		φ _ν ν		6.11		φ′۷	369	.80
293.54 2elf-Weight < 293.35.53 < 191.																						
293.54 Self-Weight < 293.53 35.25 < 191.																						
Self-Weight 293.25 < 191.			φ^N _n	191.70																		
Seff-Weight			φ _b M _n	293.54																		
Self-Weight 132.19 293 35.25 191																						
132.19 <			Check for	Self-Weigh	ارب																	
35.25 < 191.			M, (kip-ft	132.19		293.54																
			V, (kips)		v	191.70																

Particularization 12	Design Requirements		l _{req'd} (in ⁴)	,) 245.09	6			Girder	Girder Design Perimeter	rimeter												
Mighton Mighor	Max. Deflection (in)	0.75																				
Norminal	Floor Live Load, w _L (psf)	300	W18X76																			
Monimal Notation Monimal Not	Floor Dead Load, w ₀ (psf)	120																				
	Beam Length (ft)	15	Nomina				Web		ange				Axis	X-X			Axis Y-Y				Torsiona	Torsional Properties
	Tributary Area (ft)	7.5	Weight					Width, b	Thickness, t		ction Criteria	_	S		Z	_		2	1		-	ڻ
Figure F	Total Dead Load (klf)	1.08	(lb/ft)				(in)	(in)	(in)	b4/2t4	h/t _w	(in ⁴)	(in³)								(in ⁴)	(in ⁶)
Finale Standards	Total Live Load (klf)	3.6	76	22.3					0.68	8.11	37.8	1330	146								2.83	11700
Flowing Single Signoteness Web Sienderness	Total Load (KIf)	7.31																				
Signature Flançe shemeters Mak Stendermess	Required Moment, M _r (kip-ft)	205.6641	Flexure																			
1		54.84375	Flange :	Slenderne		b Slenderness		Unbrac	ed Length		Yieldi	ju g			ELIB							
42 24.0 24		55.41375	γ	9.15				<u>-</u> c	11.90			8150.00		If Lp < Lp <		۲,						
34.96 b/R 8.11 b/L, 37.80 L, b/L, 57.81 b/L, 5	Bridge Weight (kips)	42	γ̈́	24.08				7	35.10		Cb	1.14			33.31 133.	53.54						
2.63 Shear	Bridge Load + Concrete (kips)	39.49	b/t	8.11				_f	15.00		M _p (kip-ft)	679.17		Values r	nust be < M _p							
37.8	Addition klf due to bridge	2.63																				
37.8																						
37.8			Shear																			
53.55 \$\phi_0\$ \$						8	If h/t _w	< 2.24 (E/F _y)		If h/t _w >2	2.24 (E/Fy)		If h/t,	, < 1.10 (k,E/F)	(/	If 1.1	O k,E/F, <h,< td=""><td>/t_w<1.37 k</td><td>,E/F,</td><td>H.</td><td>If h/t_w > 1.37 (k_vE/Fy)</td><td>k,E/Fy)</td></h,<>	/t _w <1.37 k	,E/F,	H.	If h/t _w > 1.37 (k _v E/Fy)	k,E/Fy)
C _v 1 1371k, ξl·fγ 73.78 Φ _v 0.9 Φ _v 0.90			Case 1:			35	Ť	1		1.10 k _v E/Fy			Ĉ	1			ح,	1.57		ۍ		3.06
φ,ν,α 232.05 φ,ν,α 208.85 φ,ν,α 327.38 8 1 4,ν,α 232.05 4,ν,α 327.38 327.38 327.38 2 4,ν,α 208.85 4,ν,α 327.38 327.38 327.38 3 4,ν,α 208.85 4,ν,α 327.38 327.38 327.38 4 65.98 4,ν,α 208.85 4,ν,α 327.38 327.38 327.38 5 65.98 4,ν,α 4,ν,α 4,ν,α 4,ν,α 327.38			Case 2:				ď	1		1.37 k _v E/Fy			Ŷ	0.9		<i>3</i>	ځ.	0.90		Ą		0.90
v v			Case 3:		-		ν,ν	232.05					φ'v	208.85		€	^	327.28		φ		640.05
v v																						
v v																						
v v			φ^N	232.0	15																	
v v			φ _b M _n		81																	
v v																						
55.41 <			Check fo	r Self-Wei	ght																	
55.41 <			Mr (kip-f				~															
			V _r (kips)				.=															

TOWER 2 ROOF

Table Tabl	Design Requirements		l _{req'd} (in ⁴)	48.70				Beam L	Beam Design GL 14,15	L 14,15												
Maintain	Max. Deflection (in)	0.75																				
1	oor Live Load, w _L (psf)	20	W12X30																			
Main	oor Dead Load, w _o (psf)	25																				
1	Beam Length (ft)	15	Nominal				ep	Flai	ıge		1000		Axis	X-X			Axis Y-	,				al Propertie
0.63 1.08 1.09 1.09 1.00 1.	Tributary Area (ft)	15	Weight			Thickness, t _w		Width, b _f	Thickness, t		ction criteria	1	S	ľ	Z	1	S	r			ſ	C _w
1	Fotal Dead Load (kif)	0.45	(lp/ft)	(in ²)	(in)	(in)	(in)	(in)	(in)	b _f /2t _f	h/t.,	(in ⁴)	(in³)	(ii)	(in³)	(in ⁴)	(in³)					(in ⁶)
10.50 2.00	Total Live Load (klf)	0.48	30	8.79	12.3	0.26	0.13	6.52	0.44	7.41	41.8	238	38.6	5.21	43.1	20.3	6.24	9:26				720
Sample Figure F	Total Load (Klf)	0.93																				
Figure Standaments Victorial Length Victorial		26.15625	Flexure																			
7.2 A, b 9.15 A, b 9.055 A, b 137.27 A, b 13	quired Shear, V _r (kips)	6.975	Flange SI	endemess	Web S	le nderne ss		Unbrace	d Length		Yield	Jing			TIB							
λ, 4180 t, 4180 <	ear with Self Weight	7.2	γ	9.15	γ	90.55		۴.	5.37		M _p (kip-in)			If Lp<1		, , , ,						
h/t _w 41.80 t _p 15.00 t _p 15.00 m _p (kip-ft) 179.58 values must be < M _p valu			Ą	24.08	γ,	137.27		4	15.60		පි	1.14		Mn (kip-ft)		212.73						
418 Ifh/t _v <224 EF _s) Ifh/t _v >224 EF _s) Ifh/t _v >224 EF _s) Ifh/t _v <1.10 (kE/Fy)			b/t	7.41	h/t	41.80		£	15.00		M _o (kip-ft)	-		Value	s must be < f	η°						
418																						
418			Shear																			
53.95 4, 1 1.30 k, E/Py 59.24 C, 1 1.42 C, 1.4				h/t,	41.8		If h/t _w <2	.24 (E/F _y)		If h/t _w > 2	2.24 (E/Fy)		If h/t	"< 1.10 (k,E	/Fy)	<u>=</u>	L.10 k,E/F,	< h/t _w < 1.37	Ik,E/F,		f h/t _w > 1.37	(k,E/Fy)
C, φVo. 1371k, E/Py 73.78 Φ, φ 0.99 Φ, φ 0.99 Φ, φ			Case 1:		_		ð	1		1.10 k,E/Fy			ۍ	1			ۯ	1.42		J		2.51
φVn 95.94 φVn 66.0 φVn 122.37 φVn 122.37 φVn N			Case 2:				ን	1		1.37 k _v E/Fy			φ	0.9			φ	0.90		•		0.90
v v			Case 3:				φ^Λ,	95.94					φ^Λ,	:98	35		φ^Λ,	122.37		Ð		216.40
v v																						
v v																						
v v			φ^N	95.94																		
v v			φ _b M _n	119.16																		
v v																						
27.00 < 7.20 <			Check for	Self-Weight																		
7.20 <			M, (kip-ft)		>	119.16																
			V _r (kips)	7.20	v	95.94																

		l _{req'd} (in ⁴)	24.35				Girder Design Perimeter	sign Per	imeter												
	0.75																				
Floor Live Load, w _L (psf)	20	W18X76	1330																		
Floor Dead Load, w ₀ (psf)	25																				
Beam Length (ft)	15	Nominal			Web	,	Flange					Axis X-X			A	Axis Y-Y			7	Torsional Properties	operties
Tributary Area (ft)	7.5	Weight	Area, A	Deptn, d	Thickness, t.,	t,,/2	Width, b _f Thickness, t _f		Compact Section Criteria	non Criteria	-	S	r z	1 Z	S	-	2	TD.	°	Г	ڻ
Total Dead Load (kif)	0.225	(lp/ft)	(in²)	(ii)	(in)	(in)	(in)	(ii)	b ₄ /2t _f	h/t,,	(in ⁴)	(in³)	(in) (in³)	اً) (in ⁴)	(in³)	(ii)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
Total Live Load (klf) (0.24	9/	22.3	18.2	0.425	0.2125	11	89:0	8.11	37.8	1330	146 7	7.73 16	163 152	27.6	42.2	76	3.02	17.5	2.83	11700
Total Load (KIf)	0.465																				
Required Moment, M _r (kip-ft) 13.07813	3.07813	Flexure																			
Required Shear, V _r (kips) 3.	3.4875	Flange Sle	Flange Slenderness	Web Sle	Web Slenderness		Unbraced Length	Length		Yielding	g,		5	118							
Shear with Self Weight 4.	4.0575	γ	9.15	γ ^b	90.55		L _p	5.37		M _p (kip-in)	8150.00		ዘ ኴ<ቴ<	, Ift _b >L	_3-						
		γ,	24.08	γ	137.27		4	15.60		පි	1.14	Mn	// (kip-ft) 500	500.79 13353.54	74						
		b/t	8.11	h/t	37.80		ئـ	15.00		M. (kip-ft)	679.17		Values mu	Values must be < M,							
		Shear																			
			h/t.,	37.8		If h/t _w < 2.24 (E/F _y)	74 (E/F _y)		If h/t _w > 2.24 (E/Fy)	γ4 (E/Fy)		If h/t,,<1	If $h/t_w < 1.10 (k_vE/Fy)$		lf 1.10 k,	E/F, <h t,,<="" td=""><td>If 1.10 k,E/F, <h <1.37 k,e="" f,<="" t,,="" td=""><td></td><td>lf h/t</td><td>If h/t_w > 1.37 (k_vE/Fy)</td><td>/Fy)</td></h></td></h>	If 1.10 k,E/F, <h <1.37 k,e="" f,<="" t,,="" td=""><td></td><td>lf h/t</td><td>If h/t_w > 1.37 (k_vE/Fy)</td><td>/Fy)</td></h>		lf h/t	If h/t _w > 1.37 (k _v E/Fy)	/Fy)
		Case 1:	2.24 (E/F _y)	53.95		φ	1	Ţ	1.10 k _v E/Fy	59.24		C,	1		'n	Ţ	1.57		°)	3.06	9
		Case 2:				ζ.	1	,1	1.37 k _v E/Fy	73.78		φ	6.0		Ť		0.90		φ	0.90	0
		Case 3:				φ _ν ν _n	232.05					φ^N	208.85		φ _ν ν	3,	327.28		φ _ν ν	640.05	35
		:	1000																		
		φ^N	737.05																		
		φ _b M _n	450.71																		
		Check for S	Check for Self-Weight																		
		M _r (kip-ft)	15.22	v	450.71																
		V _r (kips)	4.06	~	232.05																

COMMERCIAL BUILDING A – FIRST FLOOR

Design Requirements		I _{req'd} (in ⁴)	620.69				Beam	Beam Design Bay B-C	ay B-C											
Max. Deflection (in)	1.25																			
Floor Live Load, w _L (psf)	100	W18X76	1330																	
Floor Dead Load, w _D (psf)	80																			
Beam Length (ft)	25	Nominal	_	_		Web	Fla	Flange				Axis X-X	X-)		Axi	Axis Y-Y				Torsional Properties
Tributary Area (ft)	10	Weight	Area, A	Depth, a	Thickness, t _w	t_//2	Width, b	Width, b _f Thickness, t _f		Compact section Criteria	ı	S	r Z	-	S	ı	Z	ھ_	ر س	ر"
Total Dead Load (kIf) 0	96:0	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b _t /2t _t	h/t _w	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in) (in ⁴)	(ui) (
Total Live Load (kif)	1.6	76	22.3	18.2	0.425	0.2125	11	89:0	8.11	37.8	1330	146	7.73 163	152	27.6	42.2	9/2	3.02	17.5 2.83	3 11700
Total Load (KIf) 2	2.56																			
(kip-ft)	200:00	Flexure																		
Required Shear, V _r (kips)	32	Flange SI	Flange Slenderness		Web Slendemess		Unbrace	Unbraced Length		Yielding	ing		E							
Shear with Self Weight 3:	32.95	γ	9.15		90.55		٦	9.22		M _p (kip-in)	8150		If Lp < Up < Up	If L _b >L,						
		۲	24.08	۲	137.27		4	27.10		ප	1.14		In (kip-ft) 517.71	4807.27						
		p/t	8.11	h/t _w	37.80		å	25		M _o (kip-ft)	679.17		Values must be < M _o	e < M _p						
		, cod																		
		B	7/1	27.00		, 4/43	1 241/11/11		1, 4, 4, 1, 1,	241/11/11		47 7 31	44 401/1. 1/1)		101101	/r , h h , 1	7/1 r/r		16 14 14 21	111. 111.
				4		M L _W	II n/ tw< 4.24 (E/ ry)		II II/L _W > 2	7		۳/u II	II II/ t _w < ⊥.⊥U (K,⊑/ r y)		II T.TUJK,E	II 1.10 Κ,Ε/Γγ < Π/Γω < 1.37 ΚγΕ/Γγ 	3/ IK _v E/Fy		пп/t _w > д.з/ (К _v E/FY)	(KvE/FY)
		Case 1:	2.24 (E/F _{y.}	,) 53.95		ð	1.00		1.10 k _v E/Fy	59.24		Ĵ	1		ۍ	1.57			ۍ	3.06
		Case 2:				Ç	1.00		1.37 k _v E/Fy	73.78		φ.	6.0		ð	0.90		_	φ'	0.90
		Case 3:				φ^N _n	232.05					φ _v V _n	208.85		φ _v V _n	327.28	8:	Ð	φ^N"	640.05
		φ^N	232.05																	
		φ _b M _n	465.94																	
		:																		
		Check for	a)																	
		M, (kip-ft)	205.94	~	465.94															
		V (kine)	32 OF	`	232 OF															

2560 Aug.	Design Requirements		I _{req'd} (in ⁴)	1703.17				Beam [Beam Design Bays C-D	ys C-D											
Maintenant Mai	Max. Deflection (in)	1.75																			
March Marc	Floor Live Load, w _L (psf)	100	W18X130	2460																	
Nominal Nomi	Floor Dead Load, w _D (psf)	80																			
1	Beam Length (ft)	35	Nominal	Į.	_		eb	Flar					Axis X->	v		Axi	Y-Y			Ť	Torsional Properties
135 125	Tributary Area (ft)	10	Weight	Area, A				Width, b		Compact Sect.	on Criteria	-	S		-	S	ı	Z	تع	e°	ر ر
1.6 1.50 1.50 1.50 1.50 1.10 1	Total Dead Load (kif)	96'0	(lp/ft)	(in ²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t.,	(in ⁴)				(in³)	(ui)	(in³)	(in)		(in ⁴) (in ⁶)
256 256 256 256 256 257	Total Live Load (klf)	1.6	130	38.3	19.3	29'0	0.335	11.2	1.2	4.65	23.9	2460				49.9	76.7	130			14.5 22700
35.20 Eleune A B B B B B B B B B	Total Load (KIf)	2.56																			
448 Finnge Standermess Web Standermess W	Required Moment, M _r (kip-ft)	392.00	Flexure																		
47.08 A. 2.40 A. 2.4	Required Shear, V _r (kips)	44.8	Flange Sle	sudemess		lenderness		Unbrace	Length		Yieldin	5.0		ELTB							
4.65 h/v, 23.9 L, 3.50 L, 3.	Shear with Self Weight	47.08	γ ^b	9.15	γ	90.55		۴.	9.54	_		14500		ዘ ኴ < ኴ < L	If L _b > L						
4.65 hV _w 23.9 l _b 35 M _b (kip-ft) 1.208.33 Values must be <m<sub>p Values must be <m<sub>p 2.24 (Ff_s) 1.20 (Ff_s) 1.20 (Ff_s) 1.20 (Ff_s) 1.10 (F_s) 0.90 Φ, 0.90 Φ 0.90</m<sub></m<sub>			γ,	24.08	γ̈́	137.27		-	36.6	J	q	1.14	Mn								
1.00 1.00			h/4	4.65	h/4	23.9		_	£		1	1208 33		Values must	N > dd						
h/t_w 23.90																					
1,1 1,2 1,2 2,3			Shear																		
2.24((E/f _u) 53.55 ф, 1.00 1.10(k,E/f _y) 53.24 0,0 1.00 (k,E/f _y) 1.37(k,E/f _y) 73.78 ф, 0.90 ф, 0.90 Ф, 0.90 Ph 0.90 0.90 Ph 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.9				h/t _w	23.90		If h/t _w <2	1.24 (E/F _y)		If h/t _w > 2.2	4 (E/Fy)		If h/t _w < :	1.10 (k,E/Fy)		If 1.10 k,E	/F, < h/t,, < 1	.37 k,E/F,		If h/t _w >1.	If h/t _w > 1.37 (k _c E/Fy)
Color Colo			Case 1:	2.24 (E/F _y)	_		ð	1.00		1.10 k _v E/Fy	59.24		ۍ	1.00		ڻ	7.2	8		ڻ	79.7
4,V _n 387.39 4,V _n 387.39 4,V _n 349.14 4,V _n 865.35 4,V _n 349.14 4,V _n 865.35 4,V _n 8			Case 2:				ᢗ	1.00		1.37 k _v E/Fy	73.78		φ	0.90		φ	5'0	0		φ	0.90
387.93 791.55 791.54 411.91 < 47.08 <			Case 3:				4^ν"	387.93					φ^ν,	349.14		φ^N,	598	35		þ,V,	2676.55
387.93 791.55 Self Weight 411.91 < 47.08 <																					
387.93 791.55 Self-Weight 411.91 < 47.08 <																					
791.55 Self-Weight 411.91 < 47.08 <			φ^N"	387.93																	
Self-Weight			φ _b M _n	791.55																	
Self-Weight 411.91 < 47.08 <																					
411.91 47.08			Check for S	elf-Weight																	
47.08 <			M, (kip-ft)		٧	791.55															
			V _r (kips)	47.08	v	387.93															

Noticide 16 17 18 18 18 18 18 18 18	Design Requirements		I _{eq'd} (in ⁴)	68.64				Beam [Beam Design Bays D-E	ays D-E												
Monitor Maria Ma	Max. Deflection (in)	9.0																				
March Area Pepth Area Pepth Area Pepth Area Area Pepth Area Ar	Floor Live Load, w _L (psf)	100	W12X26																			
Model Mode	Floor Dead Load, w _D (psf)	80																				
1	Beam Length (ft)	12	Nominal		_		q	Flan)ge				Axis)	Y-)			Axis Y-Y			_	Torsiona	l Properti
1.50 1.0	Tributary Area (ft)	10	Weight			Thickness,		Width, b	Thickness, t _f	Compact Se	ction Cnteria	_	s	ı	Z		,	Z	ه_	e°	-	ر"
1.6 1.6 1.6 1.2	Total Dead Load (klf)	96:0	(lb/ft)	(in²)	(ii)	(in)	(in)	(in)	(in)	b _t /2t _f	h/t _w	(in ⁴)	(in³)								(in ⁴)	(in ⁶)
15.56 Figure Fi	Total Live Load (klf)	1.6	26	7.65	12.2	0.23	0.115	6.49	0.38	8.54	47.2	204	33.4								0.3	209
15.52 A 15.54 A 15.5	Total Load (KIf)	2.56																				
15.5 Figure Standarmess Neb Standarmess	Required Moment, M _r (kip-ft)	46.08	Flexure																			
15.2 A, b 2.15 A, b	Required Shear, V _r (kips)	15.36	Flange S	lenderness		enderness		Unbrace	d Length		Yield	gui			E1							
2.4.08 λ, 137.27 L, 149 CD 114 Mn/klp-ft 155.00 Mn/klp-ft 155.00 Values must be < Mp 8.54 h/k _w 47.2 t, 0 L, 0 1.2 m/klp-ft 155.00 Talues must be < Mp	Shear with Self Weight	15.52	γ ^b	9.15	ላ	90.55		4	5.33		M _p (kip-in)	1860		r c, <ue>t,</ue>		۲,						
8.54 h/t, 47.2 h/t, 47.2 L, b 1.2 M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p M _p (kip-ft) 1.55.0 Values must be < M _p M _p M _p (kip-ft) M			Ą	24.08	γ.	137.27		ή.	14.9		cp	1.14	2			2.77						
h/t _w 4720 h/t _w 224 (E/F _s) Hfh/t _w 214 (E/F _s			b/t	8.54	h/t	47.2		ď	12		M _o (kip-ft)	155.00		Values r	nust be < M _n							
hft, 240 4720 ifht, 224[E/F _s) ifht, 224[E/F _s) if hft, 224[E/F _s) if hft, 2131[k, E/F _s			Ţ.																			
h/t, 4720			Shear																			
224(EVF) 53.95				h/t _w	47.20		If h/t _w <2	.24 (E/F _y)		If h/t _w >2	24 (E/Fy)		If h/t,	< 1.10 (k _v E/F	(-	If 1.1	Olk,E/F, <h <="" td=""><td>t_v < 1.37 k_</td><td>E/F,</td><td>ıĘР</td><td>/t_w>1.37 (I</td><td>ķ.Ε/Fy)</td></h>	t_v < 1.37 k_	E/F,	ıĘР	/t _w >1.37 (I	ķ.Ε/Fy)
84.18 45.0 1371k, Efv 73.78 φ, v 0.90 φ, v φ, v φ, v 95.08 φ, v φ, v <td></td> <td></td> <td>Case 1:</td> <td></td> <td>_</td> <td></td> <td>Ŷ</td> <td>1.00</td> <td></td> <td>1.10 k,E/Fy</td> <td></td> <td></td> <td>'n</td> <td>1.00</td> <td></td> <td>_</td> <td>, ></td> <td>1.26</td> <td></td> <td></td> <td>•</td> <td>1.97</td>			Case 1:		_		Ŷ	1.00		1.10 k,E/Fy			'n	1.00		_	, >	1.26			•	1.97
84.18 φ,V _n 84.18 φ,V _n 75.76 φ,V _n 95.08 φ,V _n 11.748 φ,V _n 11.74			Case 2:				ر,	1.00		1.37 k _v E/Fy			ð	0.90			حبر	0.90		ð)	0.60
84.18 117.48 ef-Weight 46.55 <			Case 3:				φ _ν ν _n	84.18					φ _v ν _a	75.76		-6	N,	95.08		φ^Λ	14	48.92
84.18 117.48 elf-Weight 46.55 <																						
117.48 elf-Weight 46.55 <			φ^Λ,	84.18																		
elf-Weight 46.55 <			φ _b M _n	117.48																		
46.55 <			Chock for	Colf Woight																		
40.33			An (line for	1 46 FF		117 40																
-			I'r (NI)		,	117.40												+				

Design Requirements	I _{req'd} (in ⁴)) 186.31			ច	Girder Design GL A and E/0-24	gn GL A	and E/0	-24										
Max. Deflection (in)																			
Beam Length (ft) 20	W12X50	391																	
Required Moment, Mr (kip-ft) 93.8																			
Point Load P1 (kips) 18.76	Nominal		_		Web	Flange	ıge		all a Cultural		Axis X-X	X-X		1	Axis Y-Y				Torsional Properties
	Weight	Area, A	n Depth, a	Thickness, t _w	t_//2	Width, b	Width, b _f Thickness, t _f		сотраст зестоп сптепа	_	S	r Z	-	S		Z	ī,	°	ſ
	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t _w	(in ⁴)	(in³)	(in) (in ³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴) (in ⁶)
	20	14.6	12.2	0.37	0.185	8.08	0.64	6.31	26.8	391	64.2	5.18 71.9	9 56.3	13.9	21.3	20	2.25	11.6	1.71
	Flexure																		
	Flange	Flange Slendemess		Web Slenderness		Unbraced Length	ا Length		Yielding	ng		LTB							
	γ°	9.15	γ ^b	90.55		4	2.66		M _p (kip-in) 3595.00	3595.00		/ ነ ነ ነ ነ	If Lb > Lr	-					
	χ,	24.08	γ,	137.27		<u>.</u>	23.80		පි	1.67		Mn (kip-ft) 435.	435.17 10777.33	æ					
	b/t	6.31	h/t,	26.80		-3°	10.00		M _p (kip-ft)	299.58		Values must be < M _p	be < M _p						
											1								
	φ _b M _n	269.63																	
	Shear																		
		h/t _w	26.80		If h/t _w <.	If h/t _w < 2.24 (E/F _y)		If h/t _w > 2.	If h/t _w > 2.24 (E/Fy)		If h/t,	If h/t _w < 1.10 (k _v E/Fy)		If 1.10	If 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	1.37 k,E/F,		If h/t _w >	If h/t _w > 1.37 (k,E/Fy)
	Case 1:	2.24 (E/F _y	F _y) 53.95		φ	1.00		1.10 k _v E/Fy	59.24		C,	1		ን	2	2.21		ሪ	6.10
	Case 2:				ۍ	1.00		1.37 k _e /Fy	73.78		φ	6:0		ð	0	0.90		φ	0.90
	Case 3:				φ^Λ _n	135.42					φ _v V _n	121.88		φ _v V _n	56	269.39		φ^N _n	743.07
	,V. .	135.42																	
							No	Note: Use Yeilding	ing										
	Check fo	Check for Self-Weight	푀																
	Mr (kip-ft)	t) 96.30	*	269.63															
	V _r (kips)	9:38	~	135.42															

Design Requirements	I _{req'd} (in ⁴)		953.38			Jirder D	Girder Design GL BCD/8-25 and 25-28	. BCD/8	-25 and	25-28											
Max. Deflection (in)																					
Beam Length (ft) 20	0 W18X65		1070																		
Required Moment, Mr (kip-ft) 480	08																				
Point Load P1 (kips) 96	6 Nominal			1	Web		Flange	٠				Axis X-X	X-X		A	Axis Y-Y			7	Torsional Properties	roperties
	Weight	_	Area, A De	Depth, d Thic	Thickness, t _w	t _w /2 V	Width, b _f Thickness, t _f Compact Section Criteria	ickness, t	compact sec	tion Criteria	-	S	r Z	-	S		Z	హ	°	ſ	ზ
	(lb/ft)		(in²) ((in)	(in)	(in)	(in)	(in)	b _i /2t _i	h/t.,	(in ⁴)	(in³)	(in) (in ³)	³) (in⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
	99		19.1	18.4	0.45	0.225	7.59	0.75	2.06	35.7	1070	117	7.49 133	3 54.8	14.4	22.5	99	2.03	17.7	2.73	4240
	Flexure	re																			
	Flang	Flange Slenderness		Web Slendemess	mess		Unbraced Length	ength		Yielding	Bu		ETB.								
	γ		9.15	j - 4γ	90.55		4	5.97		M _p (kip-in) 6650.00	9920.00		If t, < t, < t,	ग < qा म	5						
	¥	2	24.08	λ 1	137.27			18.80		Cb	1.67		Mn (kip-ft) 813.77	.77 15987.82	82						
	b/t		2.06 h	h/t,	35.70		ď	10.00		M _p (kip-ft)	554.17		Values must be < M _p	:be < M _p							
	φ _b M _n		498.75																		
	Shear	*																			
		_	h/t,, 35	35.70		If h/t _w < 2.24 (E/F _y)	· (E/F,)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		lf h/t,	If h/t _w < 1.10 (k _v E/Fy)		If 1.10 k	If 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	1.37 k,E/F,		If h/t	If h/t _w > 1.37 (k _v E/Fy)	/Fy)
	Case 1:		2.24 (E/F _y) 53	53.95		φ,	1.00	1	1.10 k _v E/Fy	59.24		ሪ	1		ک	1	1.66		C,	3.44	4
	Case 2:	2:				ሪ	1.00	1	1.37 k _e /Fy	73.78		φ	0.9		ф	0	0.90		φ^	0.90	0
	Case 3:	÷				φ^Λ°	248.40					φ'ν	223.56		φ^Λ	37	370.95		φ _ν ν	768.13	13
		-	9																		
	φ^Λ"		748.40																		
	Check 1	Check for Self-Weight	/eight																		
	M, (kip	M _r (kip-ft) 483.25	3.25	4	498.75																
	V _r (kips)		48.00	< 2	48.40																

Design Requirements	I _{req'd} (in ⁴)	953.38			Girc	ler Des	Girder Design GL BCD/0-3, 5-7, 9-14	D/0-3,	5-7, 9-1	4										
Max. Deflection (in)																				
Beam Length (ft) 20	W18X65	1070																		
Required Moment, Mr (kip-ft) 480																				
Point Load P1 (kips) 96	Nominal				Web		Flange		, , , , , , ,	-		Axis X-X			Axis Y-Y	γ- γ				Torsional Properties
	Weight	Area, A	Deptin, a	Thickness, t _w	t _w t _w /2	Width	Width, b _f Thickness, t _f		Compact Section Unteria	ıteria	S 1		Z	-	S	_	Z	۳_	°	ر د
	(lb/ft)	(in²)	(in)	(in)	(in)	(ii)	(in)	b _f /2t _f	t, h/t,,		(in ⁴) (in ³)	(in)	(in³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴) (in ⁶)
	99	19.1	18.4	0.45	0.225	7.59	9 0.75	2.06	6 35.7		1070 117	7.49	133	54.8	14.4	22.5	92	2.03	17.7	2.73 4240
	ī					-														
	Hexure							+					į							
	Flange S.	Flange Slenderness	-	Web Slenderness		5	Unbraced Length		1			•	8E .	;						
	γ _p	9.15	ď	90.55		_°	2.97		M _p (ki	M _p (kip-in) 6650.00	0.00	Ŧ	If Lp < L,	flb>r						
	γ·	24.08	γ	137.27		ተ	18.80		cp	1.	1.67	Mn (kip-ft)	t) 813.77	15987.82						
	b/t	2.06	h/t.,	35.70		-4°	10.00		M _p (kip-ft)		554.17	Val	Values must be < M _p	· M _ρ						
	φ _b M _n	498.75																		
	Shear			ĺ						1										
		h/t _w	35.70		If h/t _w ·	If h/t _w <2.24 (E/F _y)	Ţ,	If h/:	If h/t _w > 2.24 (E/Fy)	(/		If h/t _w < 1.10 (k _v E/Fy)	ι _ν Ε/Fy)		If 1.10 k _v E/	If 1.10 k,E/F, < h/t,,, < 1.37 k,E/F,	17 K,E/F,		If h/t _w >1.	If $h/t_w > 1.37$ ($k_v E/Fy$)
	Case 1:	2.24 (E/F _y)	,) 53.95		ð	1.00		1.10 k _v E/Fy	, E/Fy 59.24	24	ک		1		۲,	1.66			۲,	3.44
	Case 2:				ď	1.00		1.37 k _v E/Fy	, E/Fy 73.78	78	ф		6.0		φ	0.90			φ.	0.90
	Case 3:				φ _ν ν _n	248.40	01				φ^V _n		223.56		φ^Vn	370.95	2	•	φ^Λ°n	768.13
	**	ON ONC																		
	"A^A	240.40				-														
	Check for	Check for Self-Weight	#																	
	M _r (kip-ft)	483.25	v	498.75																
	V _r (kips)	48.00	~	248.40																

COMMERCIAL BUILDING A – ROOF

204 Web Area, A Depth, d meb (in²) (in) (in) 7.65 12.2 0.23 0.115 9.15 λ _p 90.55 0.115 2.408 λ _r 137.27 47.20 8.54 h/t _w 47.20 47.20 h/t _w 47.2 47.20 40.40 2.24(lE/r _s) 53.95 40.40 40.40 8.4.18 40.40 40.40 40.40 1.29.78 40.40 40.40 40.40 3.23 < 84.18 84.18	Design Requirements		l _{req'd} (in ⁴)	9.62			ă	Beam Design Bay A-B / 0-12	gn Bay A	\-B / 0-1.	2											
Multiple	Max. Deflection (in)	0.5																				
10 Nominal Area, Neght, and Neght Nominal Nomi	Floor Live Load, w _L (psf)	20	W12X26																			
10 Nominal Area A	Floor Dead Load, w _D (psf)	25																				
10.0 Weight Area A Meth. Dirich Meth. Diric	Beam Length (ft)	10	Nominal		_		q	Flan			of the state of the		Axis X-	×		'	Axis Y-Y			-	Torsional	Torsional Properties
10.3 10.9 10.9 10.0	Tributary Area (ft)	10	Weight			Thickness, t _w		Width, b _f		compact sec	ction Criteria	-	S		-	8	r	Z	₁ 2	u°	1	۳,
10.32 26 16.5 12.2	Total Dead Load (kif)	0.3	(lb/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t.,	(in ⁴)	(in³)					(in³)	(in)	(in)	(in ⁴)	(in ⁶)
1	Total Live Load (kif)	0.32	26	7.65	12.2	0.23	0.115	6.49	0.38	8.54	47.2	204	33.4						1.75	11.8	0.3	209
1.15 File Nume File Num	Total Load (KIf)	0.62																				
3.1 Flange Stendenness Web Stendenness W	Required Moment, Mr (kip-ft)	7.75	Flexure																			
3.23 A _p 9.15 A _p 9.055 A _p 9.055	Required Shear, V _r (kips)	3.1	Flange S	lendemess	-	lenderness		Unbraced	Length		Yieldiı	g,		5	9.							
λ, a ₇₂₀ t, a ₇₂₀ ta ₇₂₀ </td <td>Shear with Self Weight</td> <td>3.23</td> <td>γ</td> <td>9.15</td> <td>γ</td> <td>90.55</td> <td></td> <td>4</td> <td>5.33</td> <td></td> <td>_</td> <td>1860.00</td> <td></td> <td>If Lp < Lb < L</td> <td></td> <td>ب</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Shear with Self Weight	3.23	γ	9.15	γ	90.55		4	5.33		_	1860.00		If Lp < Lb < L		ب						
hV _w 4720 1 ₆ 10.00 M ₉ (kip-th) 155.00 Values must be < M _p 47.2 1 1 1 1 1 1 1 1 1			ď	24.08	۲	137.27		4	14.90		cp	1.14	Σ	n (kip-ft) 144	_	66						
47.2			ρ¥	8.54	h/t	47.20		£	10.00		M _b (kip-ft)	155.00		Values mu	st be < M _p							
47.2																						
47.2																						
47.2			Shear																			
53.95 φ, 1 1.10 κ, k/γ 59.24 C, 1 C, 0.9 φ, C, 0 Φ, D,				h/t _w	47.2		If h/t _w <2.	24 (E/F _y)		If h/t _w >2.	.24 (E/Fy)		If h/t _w <	1.10 (k,E/Fy)		If 1.10	k,E/F, < h/t,	, < 1.37 k,E	/F	Ifh	If h/t _w > 1.37 (k, E/Fy)	,E/Fy)
C _c 1 1371k, ξf/γ 7378 Φ _c 0.9 Φ _c Φ _V n 84.18 1371k, ξf/γ 7376 Φ _c Φ _c c 129.78 c c c c			Case 1:		_		φ	1		1.10 k _v E/Fy			ر,	1		۲,		1.26		Ç	1	1.97
φ,Vn 84.18 φ,Vn 75.76 φ,Vn <			Case 2:				۲	1		1.37 k _v E/Fy	73.78		φ	6:0		ð		0.90		ф	0	0.90
v v			Case 3:				φ _ν ν _n	84.18					φ _v V _n	75.76		γ,ν,φ		92:08		φ^ν,	14	148.92
v																						
V																						
v			φ^N"	84.18																		
v v			φ _b M _n	129.78																		
v v																						
8.08 < 3.23 <			Check for	Self-Weigh																		
3.23 <			M, (kip-ft		>	129.78																
			V _r (kips)	3.23	~	84.18																

Design Requirements		I _{req'd} (in ⁴)	32.08				Gird	ક્r Desigા	Girder Design GL A/ 0-12	1.12											
Max. Deflection (in)	1																				
Beam Length (ft)	20	W12X50	391																		
Required Moment, Mr (kip-ft)	16.15																				
Point Load P1 (kips)	3.23	Nominal				Web		Flange			100.00		Axis X-X			Axis Y-Y	λ-,				Torsional Properties
		Weight	Area, A	A Deptin, a	, ^a Thickness,	ss, t _w t _w /2		, b, Thickn	Width, b _f Thickness, t _f Compact section Criteria	act section CI	ntena	S 1	r	Z	1	S	r	Z	Le Le	l on	C _w
		(lb/ft)	(in ²)	(in)	(in)	(in)		(in)) b _t /2t _t	λ, h/		(in ⁴) (in ³)		(in³)	(in ⁴)	(in³)	(in)	(in³) () (ui)	(in) (in ⁴)	(in ⁶)
		20	14.6	12.2	0.37	7 0.185	8.08	8 0.64	4 6.31		26.8 39	391 64.2	5.18	71.9	56.3	13.9	21.3	50 2	2.25 1	11.6 1.71	1880
		Flexure																			
		Flange S.	Flange Slendemess		Web Slenderness	SS	'n	Unbraced Length	4		Yielding			LTB							
		γ	9.15	γ	90.55	2	ή P	2.66	9	M _p (ki	M _p (kip-in) 3595.00	2.00	If	ነት<ሴ<ኒ	1f lb > L						
		γ	24.08	~	137.27	73	4	23.80	30	g	1.	1.67	Mn (kip-ft)	ft) 435.17	10777.33						
		p/t	6.31	h/t _w	, 26.80		J.	10.00	00	M _p (kip-ft)	ip-ft) 299.58	.58	Na Na	Values must be < M _p	Μ×						
											-										
		φ _b M _n	269.63																		
		Shear																			
			h/t _w	26.80	(If h/t	If h/t _w < 2.24 (E/F _y)	('	If h,	If h/t _w > 2.24 (E/Fy)	Fy)		If h/t _w < 1.10 (k,E/Fy)	(k,E/Fy)		f 1.10 k,E/F	If 1.10 k, E/F, < h/t,, < 1.37 k,E/F,	/lk,E/F,		If h/t _w >1.37 (k _v E/Fy)	' (k _. E/Fy)
		Case 1:	2.24 (E/F _y)	F _y) 53.95	15	ф	1.00)	1.10 k _v E/Fy		59.24	ን		1		ć	2.21			Ć,	6.10
		Case 2:				ۍ	1.00		1.37 k _v E/Fy		73.78	ð		6.0		φ	0.90		_	φ	0.90
		Case 3:				φ^Λ	135.42	12				φ^N		121.88		φ^N	269.39		0	φ^V _n	743.07
		φ'Λ'	135.42																		
		Olevel 6	1	3																	
		Check for Seif-Weignt	Seir-Wei	E)																	
		M, (kip-ft)	18.65	v	269.63	33															
		V, (kips)	1.62	_	135.42	1,7															

20 W12X50 391	Design Requirements						G	irder De	Girder Design GL B,C,D/0-12	,C,D/0-1	12											
1.	Inputs																					
1875 Norticing Area Ar		20	W12X50	391																		
Mail		3.68																				
1		3.68	Nominal	4 60.4	P 44***********************************	WE	q	Fla	nge	203420000	circuit.		Axis X-	×		A	xis Y-Y			4	Torsional F	Properties
1		3.68	Weight	Area, A	nepm, a	Thickness, t _w		Width, b _f	Thickness, t	compact set	cuon Cuteria	-	S		_	S	-	Z	ط	e°	ſ	°.
1		36.8	(Ib/ft)	(in²)		(in)		(in)	(in)	b₄/2t₁	h/t.,	(in ⁴)	(in³)						(in)	(in)	(in ⁴)	(jue)
1.00 1.00	Max. Deflection all (in)	1	20	14.6	12.2	0.37	0.185	8.08	0.64	6.31	26.8	391	64.2						2.25	11.6	1.71	1880
236 Flage Siendemes Web Siendemes Web Siendemes Web Siendemes Siendemes Web Sien		5.92																				
Signature Figure		23.8	Flexure																			
3.0.66 A _p 3.15 A _p A _p	qı	2	Flange SI	endemess	Web Sl	sudemess		Yiel	ding			ETB										
24.08 λλ 35.27 (c) 1.11 (μη/μγ) 30.08 3 (28.53.51) (c) 1.11 (μη/μγ) 30.08 3 (28.53.51) (c) 1.11 (μη/μγ) 4 (2.24 E/μγ) 2.24 E/μγ 2.24		56.06	γ	9.15	γ	90.55		M _p (kip-in)			ዘ ጐ< ቴ		flb>Lr									
Fig. 10 Fig.			٧٠	24.08	¥	137.27		g	1.11			309.68 2	8653.51									
December			p/t	6.31	h/t _w	26.8		M _o (kip-ft)	269.63		Values	must be < M	-									
1.224 E/F ₂ 53.95 4°, 1 1.20 E/F ₂ 1.10 E/F																						
1.224 EF ₁ 33.95 40, 1.35.42 42.44 EF ₁ 42.43.14 EF ₁ 43.43.14 EF			Shear																			
224 FF ₁ 53.55 4,			Case 1:	h/t,,	26.8		If h/t _w <;	24 (E/F _y)		If h/t _w >2.	.24 (E/Fy)		If h/t _w <	1.10 (k,E/Fy)		If 1.10 k	ς Ε/F, < h/t.	, < 1.37 k _v E/i	اخي	If h/t	">1.37 (k,	E/Fy)
4, b (3.0)			Case 2:		_		ð	1		1.10 k _v E/Fy			ڻ	1.00		ა		2.21		Ç	6.3	10
4,ν _n 135.42 φ,ν _n 135.42 φ,ν _n 135.42 φ,ν _n 135.42 φ,ν _n 269.39 φ			Case 3:				ሪ	1		1.37 k _v E/Fy			φ	06:0		ð		0.90		ð	5''0	90
242.66 135.42 ffor Self -Weight 139.30 < 6.84 <							4,ν	135.42					φ^۷,	121.88		φ^Λ		269.39		φ^ν"	743	:07
242.66 135.42 (for Self-Weight 139.30 < 6.84 <																						
242.66 135.42 rfor Self-Weight 139.30 < 6.84 <																						
135.42 (for Self-Weight 139.30 < 6.84 <			φ _b M _n	242.66																		
190 Self-Weight 139.30 < 6.84 <			φ^N	135.42																		
for Self-Weight 139.30 c 6.84 c																						
s			Chec	k for Self-W	eight																	
6.84 <			M _r (kip-ft)		v	242.66																
			V _r (kips)	6.84	v	135.42																

COMMERCIAL BUILDING B – FIRST FLOOR

Floor Live Load, w, (psf) 100 1.25 130 130 140	Thickness, t Compact Sec	Compact Section Criteria b./2t, b./t, b./t, 13.8 8.11 37.8 Yielding M _b (kip-in)	1 (in4) 1330 2150 114	Axis X-X S r S r 146 7.73 MM (kip-ft Whi (kip-ft Vall	1	(in ⁴)	Axis Y-Y S (in³) (27.6 4	r r (in) 42.2	2 (in³) (
100 Wilsy76 1330 Web 25 Web 4 Thickness, t _µ Web 45 Sep 50 Sep	Thickness, t Compact Sec	ction Criteria h/t _w 37.8 Yielding M _p (kip-in)		Kir K.X			Axis Y S S (in³) 27.6	(in) 42.2				
Nominal Area, A Depth, d Thickness, t _m t _m /2 1.0	Thickness, t Compact Sec	ction Criteria h/w 37.8 Yrelding M _p (kip+in)	1	(ir / 7.7		(in ⁴) 152 152 	Axis Y S (in³) 27.6	r r (in) (in) 42.2			H	
10 Nominal Area, A Depth, d Hickness, t, a L/2 Hickness	Thickness, t Compact Sec	ction Criteria h/t_w 37.8 Yielding Mp(kip-in)		(ir (ir / 7.7.7.7.7.7.7.7.7.7.7.7.7.7.7.7.7.7.7	· · · · · · · · · · · · · · · · · · ·	(in ⁴) 152 152 161 _b > L, 161 _b > L,	S (in³) 27.6	r (in) 42.2				
10 Weight Area, A 182 Depth a 1 Hiddress, t _w t _w t _w 2	Thickness, t, Compartise (in) bb/2t, 0.68 8.11 ed Length	h/t _w 37.8 Yielding M _p (kip-in)	1 (in4) 1330 1330 114	(ir (ir / 7.7)		(in ⁴) 152 152 16 _{1b} > L _r 4807.27	(in³)	(in) 42.2				Torsional Properties
0.96 (lb/lt) (in/lt) (in)		1 h/t	[in*) 1330 1330 1330 1130 114 79.17	(ir		(in ⁴) 152 152 1f _b >L, 4807.27 M _p	(in³) 27.6	(in) 42.2			<u>-</u>	₹
1.6 76 22.3 18.2 0.425 11 2.56 Heavure 1.2.5 0.425 1.1 200.00 Heavure 1.2.4.08 N/h 1.0.5 1.p 32.95 N _p 9.15 N _p 1.0.5 1.p 1.p 32.95 N _p 24.08 N _p 137.27 1.p 1.p bh 8.11 h/h _w 37.83 1.p 1.p 1.p Case 1 2.241(E/f _p) 33.59 4p 1.00 1.00 1.00 Case 2 2.241(E/f _p) 33.55 4p 1.00 4p/h _p 232.05 4p/h _p 232.05		37.	1330 8150 1.14 79.17	Mn (k		152 If l _b >L, 4807.27 Mp	27.6	42.2		(II)	(in ⁴)	(in ⁶)
2.56 Hexure Hex	ed Length	<u>[</u>	8150 1.14 679.17	If L _p . Mn (kip-f						3.02 17.5	5 2.83	11700
200.00 Flaxure Neb Slenderness Web Slenderness Unbraced Leg 32.95 λ _p 9.15 λ _p 90.55 μ _p 32.95 λ _r 24.08 λ _r 137.27 μ _p b/t 8.11 h/t _m 37.80 μ _p 5/hear h/t _m 37.80 φ _p 100 Case 1: 224 E/F _s 33.95 φ _p 100 Case 2: Case 3: Case 3: 100 23.05 φ _p /h 46.594 46.594 23.05 100	ed Length	[호	8150 1.14 679.17	If L _p . Mn (kip-f	i i i	If L _b > L _r 4807.27 Mp						
32.95 Hange Sle nderness Web Sienderness Wibhaced Lea 32.95 λ _p 9.15 λ _p 9.055 1 _p λ _r 24.08 λ _r 137.27 1 _r b/t 8.11 h/t _w 37.8 1 _p Shear Shear 1.00 Case 1: 2.24 [E/f _*] 53.95 4 _p , 1.00 Case 2: Case 2: Case 3:	ed Length	(ki	8150 1.14 679.17	If L _p -f	ň	If L _b > L _r 4807.27 M _p						
32.95 A _p 9.15 A _p 90.55 P _p P _p A _f 24.08 A _f 137.27 P _f b/f 8.11 h/f _s 37.8 P _f 5hear h/f _s 37.80 H h/f _s 224 [E/f _s) Case 2:	9.22	M _p (kip-in)	8150 1.14 679.17	If L _p ·	i i	If L _b > L _r 4807.27 M _p						
24.08 λ, 137.27 l, 8.1.1 h/l _w 37.8 l _b 1.2.24 [<i>F</i> _F] 53.95 φ, 1.00 2.24 [<i>F</i> _F] 6.3.95 φ, 1.00 2.24 [<i>F</i> _F] 6.3.95 φ, 1.00 2.24 [<i>F</i> _F] 6.3.95 φ, 1.00 4, ν _α 7.22.05		į	1.14 679.17	Mn (kip-ft	i i	4807.27 M _p						
22a [E/F ₂] 53.95	27.1	5	679.17	Vali	ues must be < l	Μ						
224 [E/F ₂) 53.95 H; h/t _w < 2.24 E/F ₂) 53.95 Φ ₄ , C ₄ C ₄	25	M _o (kip-ft)										
2.24 [E/F ₂] 53.95												
2.24[EF_2] 53.95												
2.24 [£F ₂] 53.95	If h/t _w >2	If h/t _w > 2.24 (E/Fy)		If h/t _w < 1.10 (k,E/Fy)	ςE/Fy)	<u>+</u>	If 1.10 k,E/F, < h/t,, < 1.37 k,E/F,	, < h/t, < 1.	37 Ik,E/F,		If h/t _w > 1.37 (k _v E/Fy)	ςE/Fγ)
23.05 465.94	1.10 k,E/Fy	59.24		C, 1.	1.00		ر	1.57		ď		3.06
4,V ₁ 232.05 465.94	1.37 k,E/Fy	73.78		φ 0	0.90		φ	0.90		ф		0.90
			-	φ,V _n 20	208.85		φ^N _n	327.28	8	φ^ν,		640.05
-												
-									-		-	
Check for Self-Weight												
$M_r(kip-ft)$ 205.94 < 465.94												
V. (kins) 32.95 < 232.05												

Area, A Depth, d Thickness (in.) 765 122 0.23 0.23 0.15 24.08 λ, 137.27 8.54 h/t,, 47.20 h/t,, 47.20 h/t,, 47.20 h/t,, 47.20 117.48 elf-Weight		Seam Des	Beam Design GL A,0,G (Perimeter)	.G (Perim	eter)											
100 W12X26 204 80 Nominal Area, A Depth, d Thidtness 1152 (Ib/ft) (in) (in) (in) (in) 1152 26 7.65 1.22 0.23 0.23 0.23 0.23 0.23 0.23 0.23 0.23 0.23 0.25 0.23 0.25 0.23 0.25																
12 Nominal Area, A Depth, d Thickness 1.132 (1b/ft) (1in) (in) (in) (1in) (1in																
12 Nominal Area, A Depth, d Thickness 1132 (1b/ft) (1in) (in) (in) (1in)																
1152 (lb/ft) (in²) (in) 1152 (lb/ft) (in²) (in) 1152 3.07	Web		Flange		alication and the		Axis X-X	×		Axis	Axis Y-Y			-	Torsional Properties	roperties
1.152 (1b/ft) (in²) (in) 1.92	_		Width, b _f Thickness, t _f		Compact Section Criteria	_	S	r Z	-	S	r	Z	ភ្ន	°	-	ر"
1.92 26 7.65 12.2 3.072 Hexure 12.3 Hexure 55.30 Harge Stenderness Web Sten 18.59 λ _γ 9.15 λ _γ b/t 8.54 h/t _w 47.20 Shear h/t _w 47.20 6.26 E. Case 1: 2.24 (E/F _γ) 33.95 6.28 E. Case 2: Case 3: 6.40 84.18 4.40 Φ _P Mn 117.48 4.40 4.40 4.40		(in) (in)	(in)	b _t /2t _t	h/t,,	(in ⁴)	(in³)	(in) (in³)	(in ⁴)	(in³)	(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
3.072 55.30 Havure 18.432 Harge Slenderness Web Slenderness 18.59 λ _p 9.15 λ _p λ _t 24.08 λ _t λ _t byt 8.54 h/t _w 47.20 Case 1: 2.24 [E/F _t) 53.95 Case 2: Case 3: Case 3: Case 3: Case 3: Case 3: Case 3: Case 3: Case 3:		15 6.49	0.38	8.54	47.2	204	33.4	5.17 37.2	17.3	5.34	8.17	56	1.75	11.8	0.3	209
55.30 Flexure 18.432 Flange Slendemess Web Slent 18.59 λ _p 9.15 λ _p h/t 2.4.08 λ _t λ _t b/t 8.54 h/t _w η/t _w Shear h/t _w 47.20 Case 1: 2.24[E/F _t) 53.95 Case 2: Case 3: Case 3: Aphm 117.48 Check for Self-Weight																
18.59 A _b 9.15 A _b 9.15 A _b 18.54 A _b 18.54 A _b Shear Shear A _b Shear Case 1: 2.24 E _p 53.95 Case 2: Case 3: Case 3: Case 3: Check for Self-Weight																
18.59	Web Slenderness	Unk	Unbraced Length		Yielding	18		LTB								
1, http://www.min.edu.com/	λ _p 90.55	Гþ	5.33		M _p (kip-in)	1860		If t _p < t _b < t,	If L _b >Ļ							
10 M/w 47.20 53.55		1	14.9		cp	1.14	Ā	In (kip-ft) 130.53	1602.77							
83.55		ئد	12		M _o (kip-ft)	155.00		Values must be < M _o	s < M _o							
47.20 53.55																
47.20 53.95																
33.95		If h/t _w <2.24 (E/F _y)		If h/t _w >2	If h/t _w > 2.24 (E/Fy)		If h/t _w <	If h/t _w < 1.10 (k,E/Fy)		If 1.10 k,E,	if 1.10 k,E/F, < h/t,, < 1.37 k,E/F.	1.37 k _v E/F _v		If h/t _w	If h/t _w > 1.37 (k,E/Fy)	/Fy)
	53.95 ф	1.00		1.10 k _v E/Fy	59.24		۲	1.00		C^	1.	1.26		۲	1.97	7
	Ϋ́ .	1.00		1.37 k _, E/Fy	73.78		φ	0.90		φ	0.	0.90		φ	0.90	0
	φ _v ν _n	/ _n 84.18	~				φ^N _n	75.76		φ _ν ν	95	95.08		φ _v v _n	148.92	92
M _r (kip-ft) 55.76 < 117.48	< 117.48															
V, (kips) 18.59 < 84.18																

COMMERCIAL BUILDING B – ROOF

Headengy 14 28 19 19 19 19 19 19 19 1	Design Requirements							Girder L	esign G	Girder Design GL B-F/8-16	9:											
Naminary Naminary	Inputs																					
6.38 Non-risk Aria National Months Months Flange Compati Science Control of Page National	Beam Length (ft)	25	W12X50	391																		
Non-column Non	Point Load P1 (kips)	6.38																				
Multiple Marke M	Point Load P2 (kips)	6.38	Nominal	V V			,ep	E	ange	3	cineting acite		Ax	is X-X			Axis Y-Y				Torsion	al Propertie
1	Point Load P3 (kips)	6.38	Weight	Area, A		Thickness, t ₄		Width, b _f	Thickness,		ection Criteria	-	S		Z	-	S	ı			_	ر"
135 146 127 137		79.6875	(lb/ft)	(in²)	(in)	(in)		(in)	(in)	b ₄ /2t ₄	h/t,	(in ⁴)	(in³)	(in)								(in ⁶)
12.04 1.0 1.		1.25	20	14.6	12.2	0.37	0.185	8.08	0.64	6.31	26.8	391	64.2	5.18								1880
2374 Figure Standards Methods Methods		6.92																				
Signature Sign	5	23.8	Flexure																			
1274 24.08 24.0 24.08	qı	5	Flange Sl	enderness		endemess		Yie	lding			巴										
24.08 λ, 5.58 λ, 5.58 (c) 1.11 Nn k(kp-k) 36.72 286.83 s.1 All k(kp-k) 36.72 36.83 s.1 All k(kp-k)		237.41	γ	9.15	γ	90.55		M _p (kip-in)			If Lp <	L _b <l,< td=""><td>If Lb > Lr</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></l,<>	If Lb > Lr									
F. S. S. S. My, (kip-tit) 29.58 Walue's must be < My, S. S. S. S. Walue's must be < My, S.			γ̈́	24.08	չ	137.27		e e	1.11		Mn (kip-ft)		28653.51									
Phys. 258			b/t	6.31	h/t.	26.8		M. (kip-ft)			Valu	es must be	<m,< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></m,<>									
h/t, sss sss if h/t, <2.24 (E/F)			Shear																			
2.24 (E/F) 53.55 46, 1 1.10 (k/F) 59.4 C, 100 C, 120 C, 1.20 (k/F) 73.78 C, 100 C, 20.31 C, 1.20 C, 1.20 (k/F) 73.78 C, 11.21.88 C, 121.88 C, 10.90 C, 0.90 C,			Case 1:	h/t,	26.8		If h/t _w <	2.24 (E/F _y)		If h/t _w >	2.24 (E/Fy)		f h∕	t"< 1.10 (k,E/F	(A	∓	.10 k,E/F, <	h/t _w <1.37	k,E/F _v		h/t _w >1.37	(k _v E/Fy)
1			Case 2:		_		Ą	1		1.10 k,E/F ₁			ۍ	1.00			ۍ	2.21		ď		6.10
Ay Ay 135.42 Ay 135.42 Ay Ay Ay Ay Ay Ay Ay A			Case 3:				ᢗ	1		1.37 K _, E/F ₁			φ,	0.90			φ.	0.90		ф		0.90
269.63 135.42 for Self-Weight 83.59 < 3.19 <							φ _ν ν _n	135.42					φ _v V _n	121.88			φ^N,	269.39		γ		743.07
269.63 135.42 100.5elf.Weight 83.59 < 3.19 <																						
203-03 135-42 for Self-Weight 83-59 < 3.19 <			M	69 096																		
135.42 for Self-Weight 83.59 < 3.19 <			φρινι _η	507.03																		
.for Self-Weight 83.59 < 3.19 <			φ _ν ν _n	135.42																		
i for Self-Weight 83.59 < 3.19 <																						
83.59 < 3.19 <			Chec	k for Self-V	/eight																	
3.19 <			M _r (kip-ft)		>	269.63																
			V _r (kips)	3.19	v	135.42																

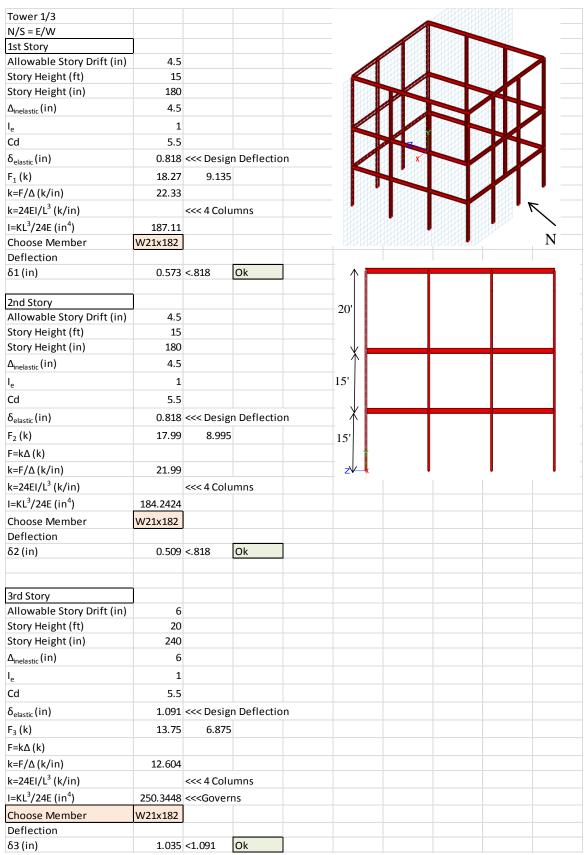
COMMERCIAL BUILDING C

1300 According to the control of	Design Requirements		l _{eq'd} (in ⁴)	620.69				Beam D	Beam Design Building C	Iding C												
Maintenant Mai	Max. Deflection (in)	1.25																				
State March Marc	Floor Live Load, w _L (psf)	100	W18X76																			
1	Floor Dead Load, w _D (psf)	80																				
10.55 1.0	Beam Length (ft)	25	Nominal	4	-		ep	Flan			Alexa Culturals		Axis	X-)			Axis Y-Y			_	Torsiona	Torsional Properties
1. 1. 1. 1. 1. 1. 1. 1.	Tributary Area (ft)	10	Weight			Thickne		Width, b _f		Compact sec	tion Criteria	-	S		_	S		Z	ភ	e°	-	ڻ
156 76 223 182 0.425 0.125 11 0.68 8.11 3.78 13.9 146 7.73 15.9 17 14.5 12.0 1		96.0	(Ib/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t,,	(in ⁴)	(in³)							(in)	(in ⁴)	(in ⁶)
255 Figure Fig	Total Live Load (klf)	1.6	76	22.3	18.2	0.425	0.2125	11	0.68	8.11	37.8	1330	146								2.83	11700
Since Flexion State Standardeness St		2.56																				
32.5 Flange Standerness Web Standerness		200.00	Flexure																			
1.0 1.0	Required Shear, V _r (kips)	32	Flange S.	enderness		lenderness		Unbrace	Length		Yieldi	Bu		5	В							
λ _c 37.8 L _c 25 M _p [klp-lt] 679.17 × m (klp-lt] 57.17 4807.27 37.80 tfr/L _c ≥ 234[E/F _γ) tfr/L _c ≤ 1.00 tfr/L _c ≤ 1.10[K E/F _γ) tfr/L _c ≤ 1.10[E/F _γ) tfr/L _c ≤ 1.10[E/F _γ) tfr/L _c ≤ 1.1		32.95	ď	9.15	γ	90.55		4	9.22		M _p (kip-in)	8150		If Lp < Lb < L		بد						
hV _w 37.8 L _b 25 M _b k p-pt 679.17 Values must be cM _p Applies must be cM _p A			Ϋ́	24.08	γ	137.27		ή.	27.1		cp	1.14	2			72						
37.80			b/t	8.11	h/t	37.8		ئ	25		M. (kip-ft)	679.17		Values mu	st be < M.							
37.80																						
37.80																						
37.80			Shear																			
53.55 4, 1.00 1.00 1.00 1.00 5, 24 C, 1.00 C, 1.57 C 1.00				h/t _w	37.80		If h/t _w <2	.24 (E/F _y)		If h/t _w > 2.	.24 (E/Fy)		If h/t _w	< 1.10 (k,E/Fy)		If 1.10	k,E/F, <h t,<="" td=""><td>"<1.37 k_ul</td><td>:/F,</td><td>Ift</td><td>If h/t_w> 1.37 (k, E/Fy)</td><td>k,E/Fy)</td></h>	"<1.37 k _u l	:/F,	Ift	If h/t _w > 1.37 (k, E/Fy)	k,E/Fy)
C _v 1.00 1.371k, kf ky 73.78 Φ _v 0.90 0.90 Φ _v			Case 1:		_		φ	1.00		1.10 k _v E/Fy			C,	1.00		ς.		1.57		°C	,	3.06
φ,ν,α 232.05 φ,ν,α 208.85 φ,ν,α 327.28			Case 2:				ۍ	1.00		1.37 k _v E/Fy			φ	0.90		ф		0.90		ф)	0.90
v			Case 3:				φ^ν,	232.05					φ _v V _n	208.85		Λ^Φ	-	327.28		φ^ν,	79	640.05
v																						
v																						
v v			φ^N _n	232.05																		
v v			φ _b M _n	462.94																		
v v																						
32.95 <			Check for	Self-Weigh																		
32.95 <			M, (kip-ft,			465.94																
			V _r (kips)		v	232.05																

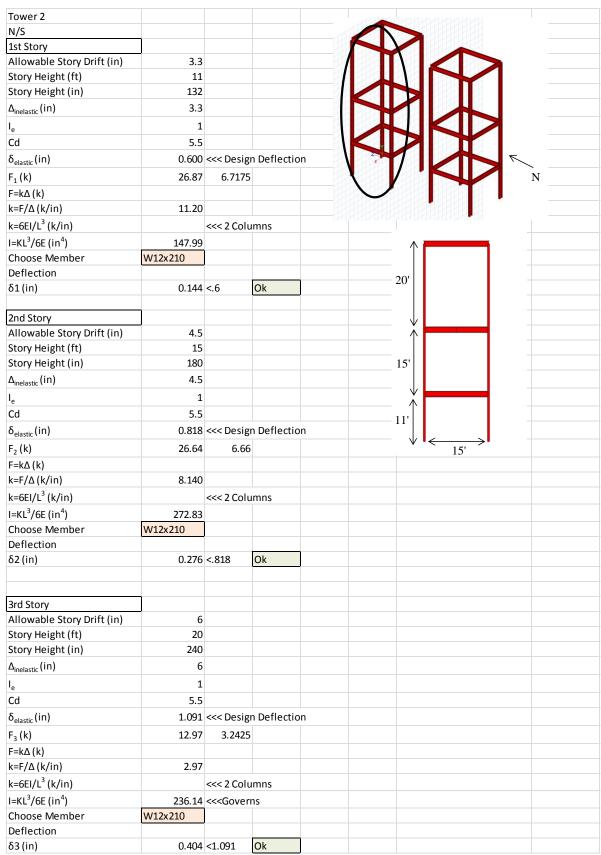
(c	/)p,bai	2129.0152				Girder	Girder Design GL A-D	GL A-D												
Beam Length (ft) 25	W18X130	2460																		
Required Moment, Mr (kip-ft) 496.25																				
Point Load P1 (kips) 79.4	Nominal	4	441.0	Web		Flange	ge	100	of other		Axis X-X	x-x			Axis Y-Y		,	_	Torsional Properties	ropertie
Point Load P2 (kips) 79.4	Weight	Area, A	Deptn, a	Thickness, t _w	t"/2	Width, b _f Thickness, t _f	Thickness, t _f	Compact section criteria	tion Criteria	-	S	_	Z	8 1	-	Z	ع	e°	ſ	ڻ
	(Ib/ft)	(in²)	(in)	(in)	(in)	(in)	(in)	b,/2t,	h/t.,	(in ⁴)	(in³)	(in)	(in³) (in⁴)	(in³) (in³)	(in)	(in³)	(in)	(in)	(in ⁴)	(in ⁶)
	130	38.3	19.3	29.0	0.335	11.2	1.2	4.65	23.9	2460	526	8.03	290 278		49.9 76.7	130	3.13	18.1	14.5	22700
	Flexure																			
	Flange SI	Flange Slenderness	Web Sle	Web Slendemess		Unbraced Length	Length		Yielding	Bu		-	ETB							
	γ°	9.15	γ°	90.55		4	9.54		M _p (kip-in)	14500.00		ዘ ኴ<ሴ<나	ıfıb>r	٦ <u>٠</u>						
	γ̈́	24.08	γ	137.27		.	36.60		cp	1.67		Mn (kip-ft) 20	2076.04 147848.66	18.66						
	p/t	4.65	h/t _w	23.90		£	7.50		M _p (kip-ft)	1208.33		Values m	Values must be < M _p							
	φ _b M _n	1087.50																		
	Shear																			
		h/t.,	23.90		If h/t _w < 2.24 (E/F _y)	24 (E/F _y)		If h/t _w > 2.24 (E/Fy)	24 (E/Fy)		If h/t,	If h/t,, < 1.10 (k,E/Fy)		If 1.1k	If 1.10 k,E/F, <h <1.37 k,e="" f,<="" t,,="" td=""><td>,<1.37 k,E/l</td><td>></td><td>If h/t</td><td>If h/t_w> 1.37 (k,E/Fy)</td><td>E/Fy)</td></h>	,<1.37 k,E/l	>	If h/t	If h/t _w > 1.37 (k,E/Fy)	E/Fy)
	Case 1:	2.24 (E/F _y)	53.95		ð	1.00	_	1.10 k _v E/Fy	59.24		ۍ	1		ď	-	2.48		ڻ	7.67	25
	Case 2:				ۍ	1.00		1.37 k _v E/Fy	73.78		ě	6.0		Ť	>	06.0		ð	0.90	06
	Case 3:				φ _v V _n	387.93					φ^N _n	349.14		ð	φ _v V _n	865.35		φ _v V _n	2676	2676.55
	φ^N _n	387.93																		
	Check for	Check for Self-Weight																		
	M, (kip-ft)	506.41	v	1087.50																
	V _r (kips)	39.70	>	387.93																

APPENDIX C

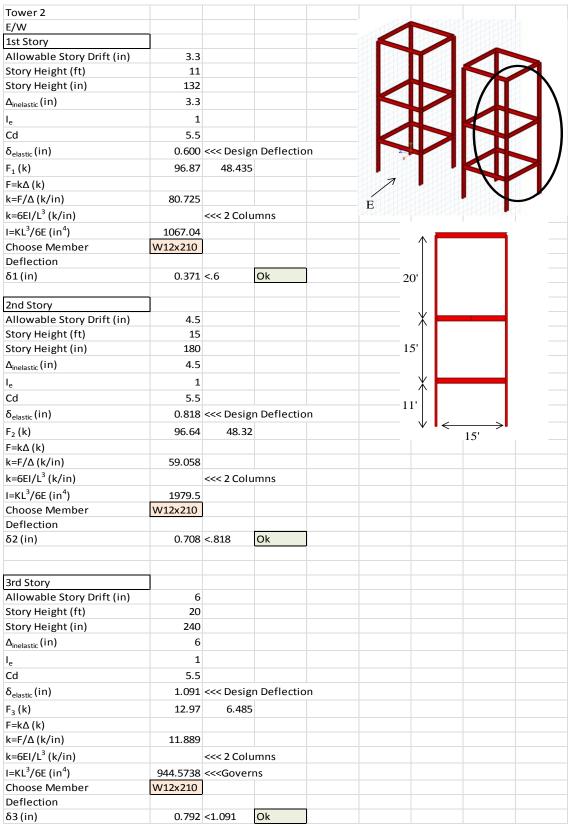
LATERAL DESIGN CALCULATIONS



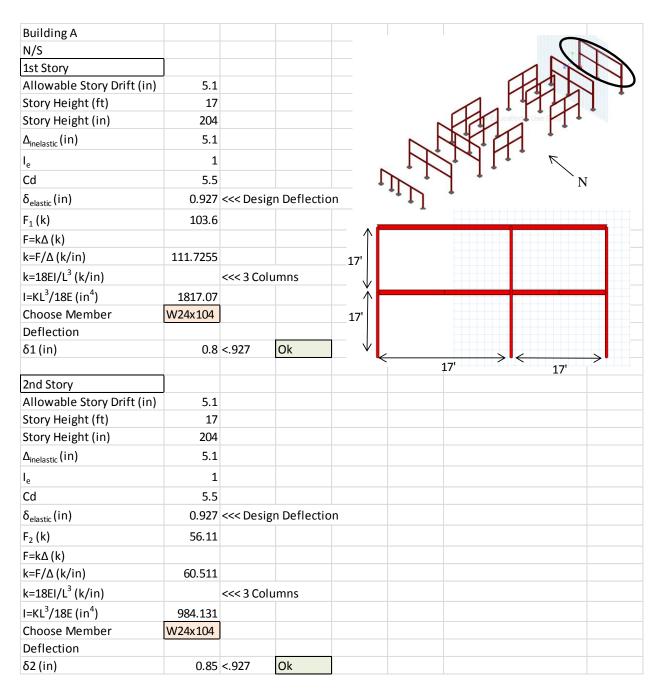
Tower 2 N/S - E/W lateral frame



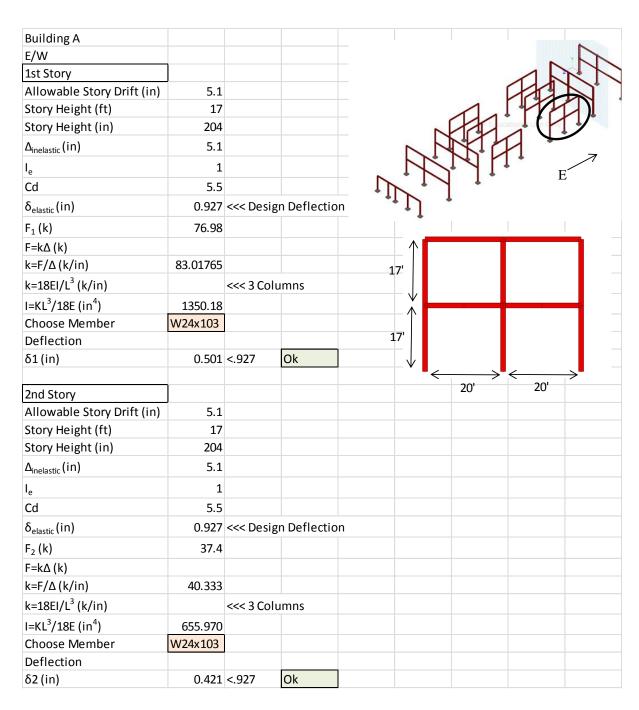
Tower 2 N/S lateral frame



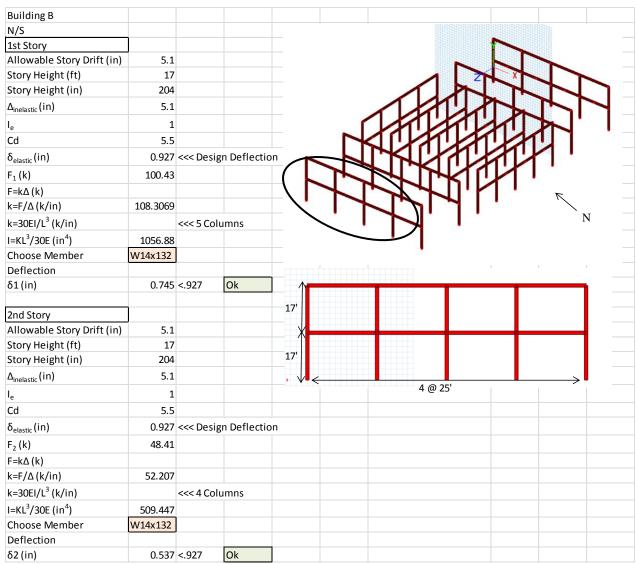
Tower 2 E/W lateral frame



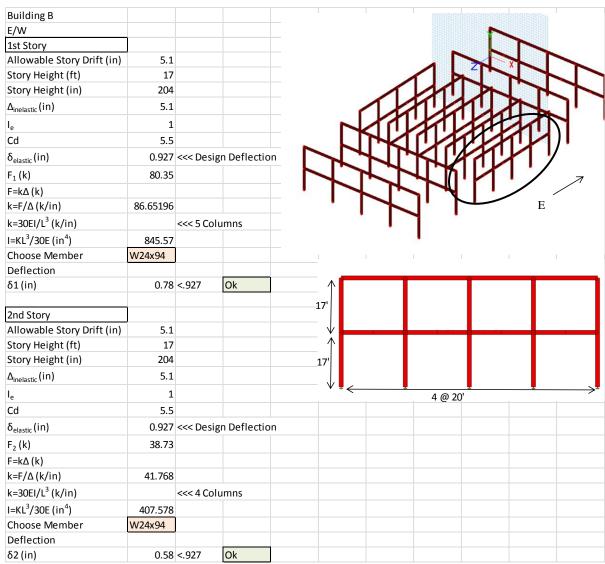
Building A N/S lateral frame



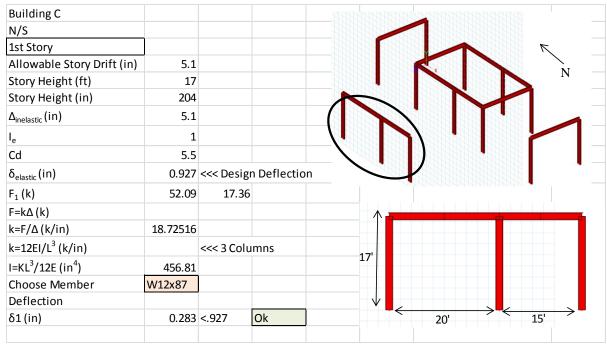
Building A E/W lateral frame



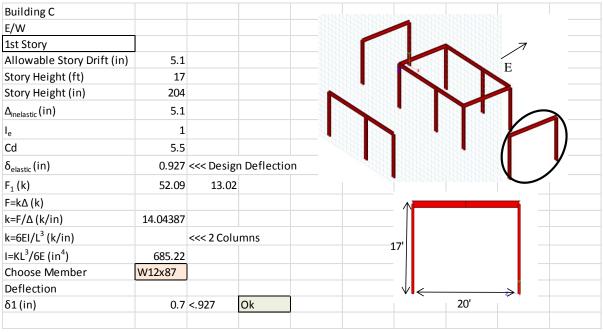
Building B N/S lateral frame



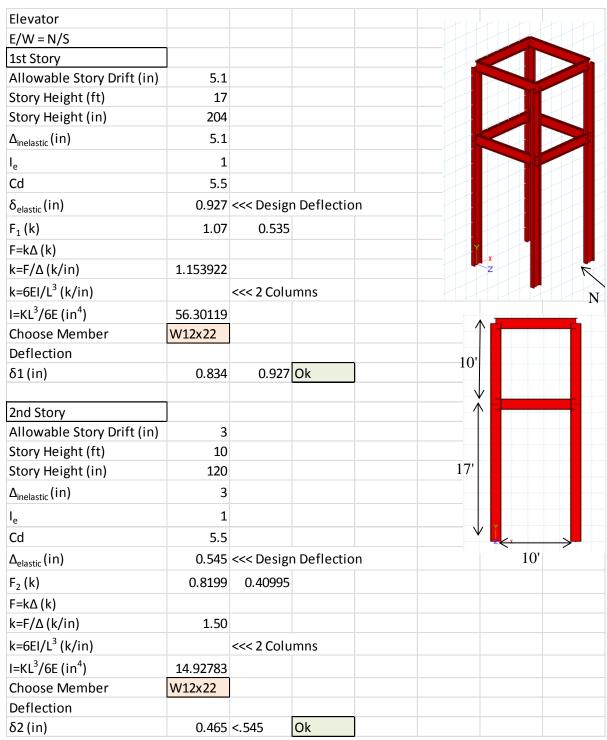
Building B E/W lateral frame



Building C N/S lateral frame



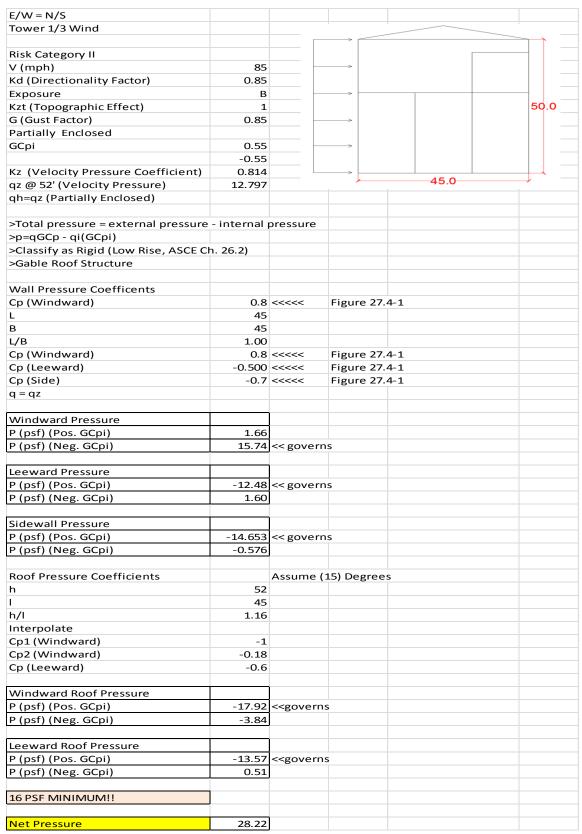
Building C E/W lateral frame



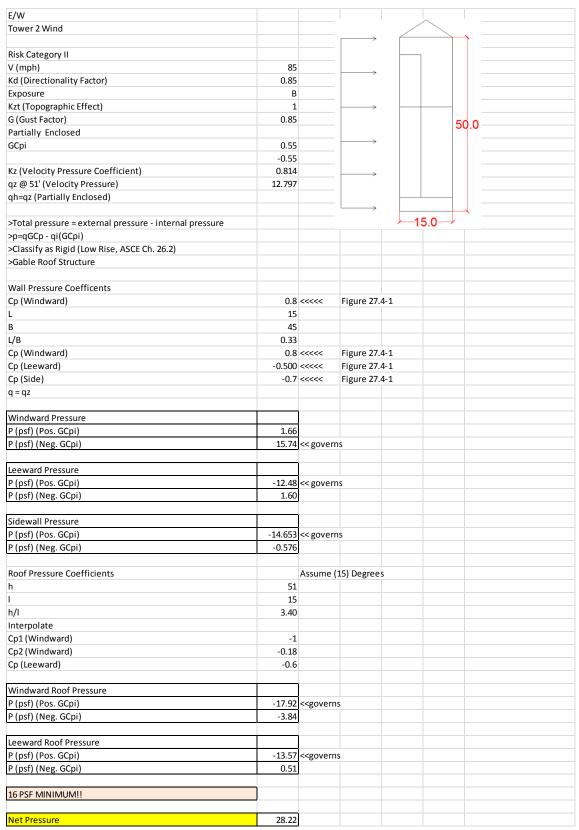
Elevator N/S – E/W lateral frame

APPENDIX D

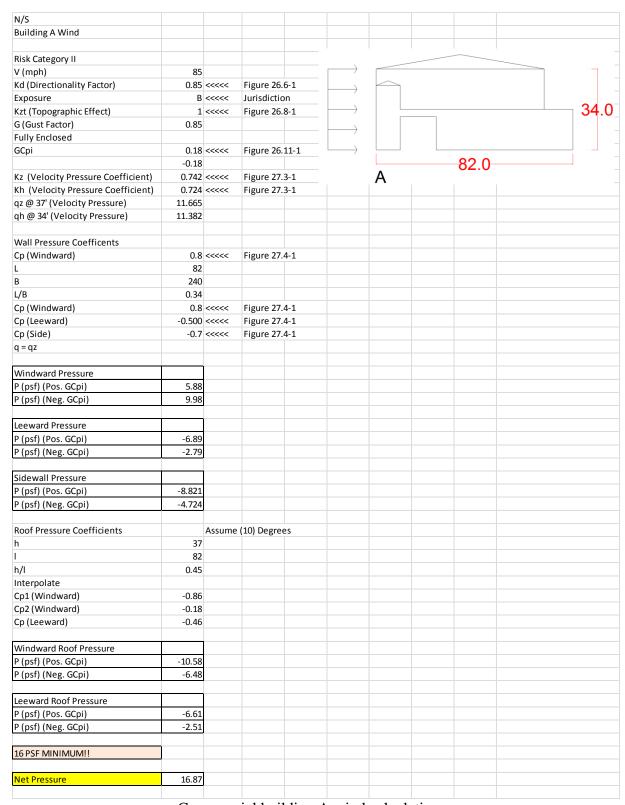
WIND CALCULATIONS



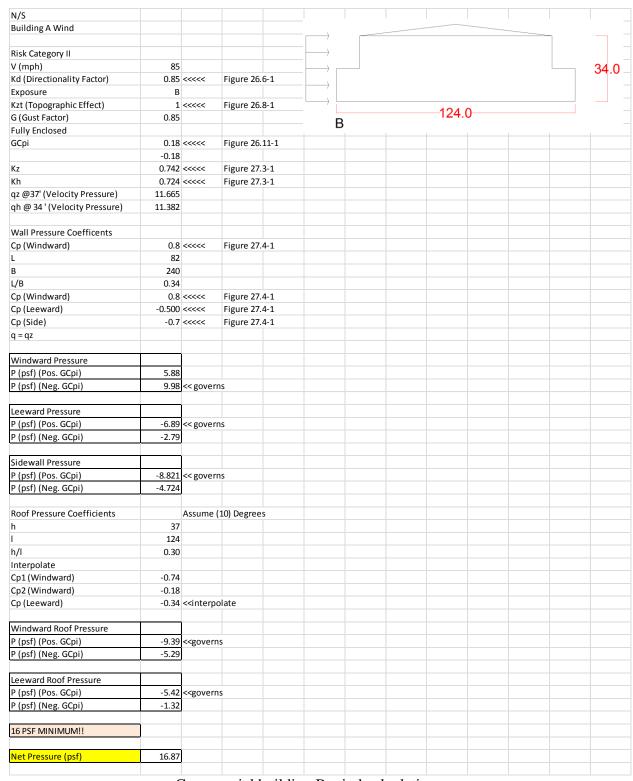
Towers 1 and 3 wind calculations



Tower 2 wind calculations



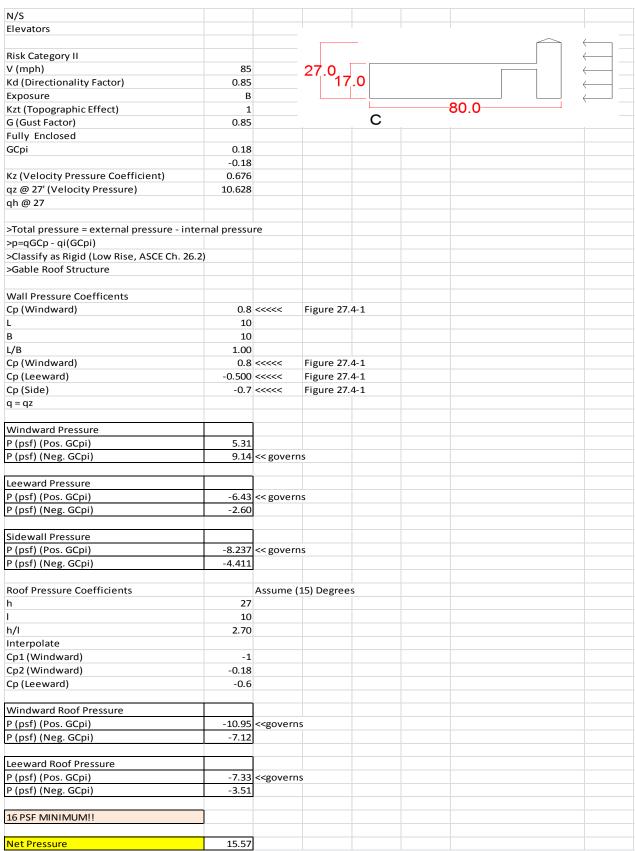
Commercial building A wind calculations



Commercial building B wind calculations

								
								
85			27.0				- -	
	:<<<	Figure 26.6-1	- 17	′,.0				-
		1.84.6 20.0 1		<u>_</u>				
	:<<<	Figure 26.8-1		_		80.0		
		1.84.6 20.0 1		C	;			
0.03								
0.10		Fig. 20 11 1			* -	1 t \ \		
	.<<<<	Figure 26.11-1				levator wind Governs		
		F: 27.2.4						
		-						
	<<<<	Figure 27.3-1						
9.276								
internal pre	ssure							
0.8 <	:<<<	Figure 27.4-1						
		1.80.0 2711 2						
	:<<<	Figure 27.4-1						
0.7								
4.64								
7.98 <	< govern	ns						
	Ū							
-5.61 <	< govern	ns						
-2.27								
-7.189 <	< govern	ns						
-3.849								
13.59								
13.33					_			
	B 1 < 0.85 0.18 0.18 0.59 0.59 9.276 internal presentation of the control of the con	0.85 <*** B 1 <*** 0.85 0.18 <*** -0.18 0.59 <*** 9.276 internal pressure 0.8 <*** 50 80 0.63 0.8 <*** -0.500 <*** -0.7 <*** 4.64 7.98 <**govern -2.27 -7.189 -3.849 **govern -3.849	0.85	B	0.85 <*** B	B 1 < 1 1	B 1	8 1

Commercial building C wind calculations



Elevator Wind Calculations

APPENDIX E

SEISMIC CALCULATIONS

			Seisn	nic Design			
Building:	Tower 1 and 3	}					
	S _s	1.5					
	S ₁	0.6					
	Site Class	D					
	F _a	1					
	F _v	1.5					
	S _{Ms}	1.5					
	S _{M1}	0.9					
	S _{Ds}	1					
	S _{D1}	0.6					
	Risk Category	II					
	Importance Factor	1					
Building	R	8					
Specific	Ω	3					
	Cd	5.5					
	Weight (lb)	311960					
	C _s	0.125					
	C _t	0.028					
	X	0.8					
	h _n (ft)	50					
	T=C _t h _n ^x	0.64					
•							
0.125	Cs not exceed		0.12	T <tl< td=""><td></td><td></td><td></td></tl<>			
0.123	Cs Shall be greater	than	0.12	INIE			
	es shan se greater	criari	0.01				
Where S1 is g	reater than or equal	to 0.6					
Cs							
0.125	Cs shall not be less	than	0.0375				
Base Shear							
Dase Sileai	C _s	0.12					
	W	311960					
	V (lb)	36544.85					
	V(kips)	36.54					
Level	vel Weight wx (kip	hx (ft)	К	w _x h _x ^k	C _{vx}	Fx (kips)	
Roof	146.125	50	2	365312.5	0.742974159	27.15	
2	132.03	30	2	118827	0.241670872	8.83	
1	33.555	15	2	7549.875	0.015354969	0.56	

Towers 1 and 3 Seismic Calculations

Building:								
	Iower 2							
	-							
	S _s	1.5						
	S ₁	0.6						
	Site Class	D						
	F _a	1						
	F _v	1.5						
	S _{Ms}	1.5						
	S _{M1}	0.9						
	S _{Ds}	1						
	S _{D1}	0.6						
	Risk Category	II						
	Importance Factor	1						
Building	R	8						
Specific	Ω	3						
	Cd	5.5						
	Weight (lb)	214605						
	C _s	0.125						
İ	C _t	0.028						
	X	0.8						
İ	h _n (ft)	46						
	T=C _t h _n ^x	0.60						
Cs								
0.125	Cs not exceed		0.13	T <t<sub>L</t<sub>				
	Cs Shall be greater	than	0.01					
Where S1 is gr	reater than or equal	to 0.6						
Cs								
0.125	Cs shall not be less	than	0.0375					
Base Shear								
	C_s	0.13						
	W	214605						
	V (lb)	26874.28						
	V(kips)	26.87						
		1. (6:)		ı k				
Level	Level Weight wx (k		K	w _x h _x ^k	C _{vx}	Fx (kips)		
Roof	34.875 115	46 26	2	73795.5	0.482656878	12.97	40.66	
		ı /h	2	77740	0.508455742	13.66	48.66	
2	11.23	11	2	1358.83	0.00888738	0.24		

Tower 2 Seismic Calculations

Building:	Commercial A	1							
	S _s	1.5							
	S_1	0.6							
	Site Class	D							
	F _a	1							
	F _v	1.5							
	S _{Ms}	1.5							
	S _{M1}	0.9							
	S _{Ds}	1							
		0.6							
	S _{D1}								
	Risk Category	11							
Building	Importance Factor R	1 8							
Specific	Ω	3							
эрести	Cd	5.5							
	Weight (lb)	2896140							
	C _s	0.125							
	C _t	0.028							
	X X	0.028							
	h _n (ft)	34							
	T=C _t h _n ^x	0.47							
Cs									
0.125	Cs not exceed		0.16	T <tl< td=""><td></td><td></td><td></td><td></td><td></td></tl<>					
0.125	Cs Shall be greater	than	0.10	INIE					
			0.02						
Where S1 is g	reater than or equal	to 0.6							
Cs									
0.125	Cs shall not be less	than	0.0375						
Base Shear	_								
	C _s	0.16							
	W	2896140							
	V (lb)	461891.16							
	V(kips)	461.89				V	sual Analys	is	
Level	vel Weight wx (kip	hx (ft)	K	w _x h _x ^k	C _{vx}		Per Frame	Total	Per Node
Roof	510.36	34	2	589976.16	0.49	224.45	56.11	. 5	18.70
1	2159.60	17	2	624124.40	0.51	237.44	47.49	103.60	34.53
_	2203.00			02 .22 10	0.51	207.44	.,	200.00	555

Commerical Building A Seismic Calculations

Building:	Commercial B									
ounanig.	Commercial D									
	S _s	1.5								
	S ₁	0.6								
	Site Class	D								
	Fa	1								
	F _v	1.5								
	S _{Ms}	1.5								
		0.9								
	S _{M1}									
	S _{Ds}	1								
	S _{D1}	0.6								
	Risk Category	II .								
Quildin~	Importance Factor	1								
Building Specific	R Ω	8								
респс	Cd	5.5								
	Weight (Ib)	3208200								
	C _s	0.125								
	C _t	0.028								
	x	0.8								
	h _n (ft)	46								
	T=C _t h _n ^x	0.60								
	I=C _t II _n	0.60								
Cs										
0.125	Cs not exceed		0.13							
	Cs Shall be greater	than	0.01							
	reater than or equal	to 0.6								
Cs										
0.125	Cs shall not be less	than	0.0375							
Base Shear										
ase sileai	C	0.13								
	C _s	3208200								
	V (lb)	401752.33								
	V(kips)	401.75								
	(1-7						Visual			
							Analysis			
Level	vel Weight wx (kip	hx (ft)	К	w _x h _x ^k	C _{vx}	Fx (kips)	Per frame	Total	Per node	
Roof	561	34	2	648516.00	0.48	193.68	38.74		7.75	
1	2410.8	17	2	696721.20	0.52	208.07	41.61	80.35	16.07	

Commercial Building B Seismic Calculations

Building:	Commercial C					
	S _s	1.5				
	S_1	0.6				
	Site Class	D				
	F _a	1				
	F _v	1.5				
	S _{Ms}	1.5				
	S _{M1}	0.9				
	S _{Ds}	1				
	S _{D1}	0.6				
	Risk Category	II				
	Importance Factor	1				
Building	R	8				
Specific	Ω	3				
	Cd	5.5				
	Weight (lb)	416000				
	C _s	0.125				
	C _t	0.028				
	Х	0.8				
	h _n (ft)	46				
	T=C _t h _n ^x	0.60				
Cs						
0.125	Cs not exceed		0.13			
	Cs Shall be greater	than	0.01			
	reater than or equal	to 0.6				
0.125	Cs shall not be less	than	0.0375			
0.123	C5 Shall flot be less	cran	0.0373			
ase Shear						
	C_s	0.13				
	W	416000				
	V (lb)	52094.31				
	V(kips)	52.09				
Level	vel Weight wx (kip	hx (ft)	K	w _x h _x ^k	C _{vx}	Fx (kips)
		17	2	112854.5	1	52.09
Roof	390.5	1 1/				

Commercial Building C Seismic Calculations

_								
@ commercia	l buildin	igs						
S _s	1.5							
S ₁	0.6							
Site Class	D							
Fa	1							
	1.5							
	1.5							
Ω	3							
	0.125							
	0.028							
	0.8							
h _n (ft)	46							
	0.60							
Cs not exceed		0.13						
Cs Shall be greater	than	0.01						
reater than or equal	to 0.6							
Cs shall not be less	than	0.0375						
C	0.12							
C _S								
v (Ki þ3)	1.40				Vi	isual Analysi	s	
vel Weight wx (kin	hx (ft)	К	wh ^k	C				1
8.36	27	2	6094.44	0.865397395	1.26	0.630718	0.819933984	1
		1	0054.44	0.003337333	1.20	5.050710	3.013333504	
	S _s S ₁ Site Class F _a F _v S _{Ms} S _{M1} S _{Ds} S _{D1} Risk Category Importance Factor R Ω Cd Weight (Ib) C _s C _t x h _n (ft) T=C _t h _n ^x Cs not exceed Cs Shall be greater greater than or equal Cs shall not be less C _s W V (Ib) V(kips)	S _s 1.5 S ₁ 0.6 Site Class D F _a 1 F _V 1.5 S _{Ms} 1.5 S _{Ms} 1.5 S _{M1} 0.9 S _{Ds} 1 S _{D1} 0.6 Risk Category II Importance Factor 1 R 8 Ω 3 Cd 5.5 Weight (Ib) 11640 C _s 0.125 C _t 0.028 x 0.8 h _n (ft) 46 T=C _t h _n 0.60 Cs not exceed Cs Shall be greater than reater than or equal to 0.6 Cs shall not be less than C _s 0.13 W 11640 V (Ib) 1457.64 V(kips) 1.46	S1 0.6 Site Class D Fa 1 Fv 1.5 S _{Ms} 1.5 S _{M1} 0.9 S _{Ds} 1 S _{D1} 0.6 Risk Category II Importance Factor 1 R 8 Ω 3 Cd 5.5 Weight (lb) 11640 Cs 0.125 Ct 0.028 x 0.8 hn (ft) 46 T=Cthnx 0.60 Cs not exceed 0.13 Cs Shall be greater than 0.01 greater than or equal to 0.6 Cs shall not be less than 0.0375 Cs 0.13 W 11640 V(lb) 1457.64 V(kips) 1.46	S _s	S _s	S	S	S₁ 1.5 S₁ 0.6 Site Class D F₂ 1 F₂ 1.5 SM₁ 0.9 S₀₁ 1.5 S₁ 0.6 Risk Category II Importance Factor 1 R 8 Q 3 Cd 5.5 Weight (ib) 11640 C₂ 0.125 C₁ 0.028 x 0.8 h₂(ft) 46 T=C₂(h₀² 0.60 Cs shall be greater than 0.01 greater than or equal to 0.6 1640 W 11640 V(lib) 1457.64 V(kips) 1.46 Vel Weight wx (kip hx (ft) K w, h₂* C₂x Fx (kips) Per fram Shear

Commercial Building Elevator Seismic Calculations

APPENDIX F

BANNAN ENGINEERING BORING LOGS

Project: UNIVERSITY OF SANTA CLARA of Boring No. 3 Log ENGINEERING BUILDING Remarks: See Figure 4A for Sampler Type Oct. 14, 1983 Date Drilled:_ 6" Auger Type of Boring:_ 140 Lbs. Hammer Weight: LABORATORY TESTS Jows/F1 Ť Samples Moisture Content, % Unconfined Compressive Strength, psf Density, pcf Depth, MATERIAL DESCRIPTION Surface Elevation: CLAYEY SILT FILL (ML) Poorly to moderately compacted, moist, brown, with some gravel Becoming light brown Gravelly Clay (CL) 1 6 Becoming black Silty Clay, with traces 14 24 94 of sand and gravel (Fill) 3 12 2680 22 102 CLAYEY SILT (ML) Stiff, moist, light gray 10-SAND (SP-SM) 22 4 Medium dense, moist, brown, fine to very fine Water at Time of Drilling SILTY CLAY (CL-CH) Medium stiff, brown-gray 15-5 - Changing to Clayey Silt 80 1070 6 40 SILTY CLAY (CL-CH) Stiff, greenish-gray SAND (SP-SM) Loose, brown, very fine to fine, traces 20of gravel 9 6 Proj. No. 16086V Figure 4 Woodward-Clyde Consultants

Project:	UNIVERSITY OF S	ANTA CLARA BUILDING	Log o	f Boring	ſ	Vo.	(Co	ntinued)
Depth, Ft. Samples	Ft.	MATERIAL D	ESCRIPTION	ı		Moisture Content, %	Dry Density,	Unconfined Compressive Strength,
25 7		CLAY (CL)	ish-gray and brown			29	95	1170
30 - 8	12					23	102	1660
35—		— Bottom of Boring at 3	31.5 feet					
40-		R SAMPLER TYPE Modified California San	npler					
45—								
-					-			

APPENDIX G

VULCRAFT TRUSS SPECIFICATIONS

LRFD

	Ba	sed On .							EEL JO wn In Po				(plf)		
Joist Designation	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (In.)	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.)															
10	825 550														
11	825 542 825														
12	825 455 718	825 550	825 550	825 550											
13	363	825 510	825 510	825 510											
14	618 289 537	750 425	825 463	825 463	825 550 766	825 550	825 550 825	825 550 825							
15	537 234	651 344	814 428	825 434	766 475	825 507	825 507	825 507							
16	469 192	570 282	714 351	825	672 390	825 467	825 467	825 467	825	825 550	825	825	825 550	825 550	825
17	415 159	504 234	630 291	396 825 366	592 324	742 404	825 443	825 443	550 768 488	825 526	550 825 526	550 825 526	825 526	825 526	550 825 526
18	369 134	448 197	561 245	760 317	528 272	661 339	795 397	825 408	684 409	762 456	825 490	825 490	825 490	825 490	825 490
19	331 113	402 167	502 207	681 269	472 230	592 287	712 336	825 383	612 347	682 386	820 452	825 455	825 455	825 455	825 455
20	298 97	361 142	453 177	613 230	426 197	534 246	642 287	787 347	552 297	615 330	739 386	825 426	825 426	825 426	825 426
21		327 123	409 153	555 198	385 170	483 212	582 248	712 299	499 255	556 285	670 333	754 373	822 405	825 406	825 406
22		123 298 106	153 373 132	198 505 172	351 147	439 184	248 529 215	299 648 259	255 454 222	285 505 247	333 609 289	373 687 323	405 747 351	406 825 385	406 825 385
23		271 93	340 116	462 150	321 128	402 160	483 188	592 226	415 194	462 216	556 252	627 282	682 307	760 339	825 363
24		249 81	312 101	423 132	294 113	367 141	442 165	543 199	381 170	424 189	510 221	576 248	627 269	697 298	825 346
25					270 100	339 124	408 145	501 175	351 150	390 167	469 195	529 219	576 238	642 263	771 311
26					249 88	313 110	376 129	462 156	324 133	360 148	433 173	489 194	532 211	592 233	711 276
27					231 79	289 98	349 115	427 139	300 119	334 132	402 155	453 173	493 188	549 208	658 246
28					214 70	270 88	324 103	397 124	279 106	310 118	373 138	421 155	459 168	510 186	612 220
29									259 95	289 106	348 124	391 139	427 151	475 167	570 198
30									241 86	270 96	324 112	366 126	399 137	444 151	532 178
31									226 78	252 87	304 101	342 114	373 124	415 137	498 161
32									213 71	237 79	285	321 103	349 112	388 124	466 147
										10	V.E.	100	112	124	170

LRFD

										KI											
			Based											ISTS, K ounds F			oot (p	lf)			
Joist Designation	18K3	18K4	18K5	18K6	18K7	18K9	18K10	20K3	20K4	20K5	20K6	20K7	20K9	20K10	22K4	22K5	22K6	22K7	22K9	22K10	22K11
Depth (In.)	18	18	18	18	18	18	18	20	20	20	20	20	20	20	22	22	22	22	22	22	22
Approx. Wt. (lbs./ft.)	6.4	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6	7.3	7.7	8.5	9.0	10.2	11.7	11.9
Span (ft.)																					
18	825 550	825 550	825 550	825 550	825 550	825 550	825 550														
19	771	825	825	825	825	825	825	825	825	825	825	825	825	825							
20	494 694	523 825	523 825	523 825	523 825	523 825	523 825	550 775	550 825	550 825	550 825	550 825	550 825	550 825							
21	423 630	490 759	490 825	490 825	490 825	490 825	490 825	517 702	550 825	550 825	550 825	550 825	550 825	550 825	825	825	825	825	825	825	825
22	364 573	426 690	460 777	460 825	460 825	460 825	460 825	453 639	520 771	520 825	520 825	520 825	520 825	520 825	550 825	550 825	550 825	550 825	550 825	550 825	550 825
	316	370	414	438	438	438	438	393	461	490	490	490	490	490	548	548	548	548	548	548	548
23	523 276	630 323	709 362	774 393	825 418	825 418	825 418	583 344	703 402	793 451	825 468	825 468	825 468	825 468	777 491	825 518	825 518	825 518	825 518	825 518	825 518
24	480	577	651 318	709	789	825	825	535	645 353	727	792	825	825	825	712	804 483	825 495	825 495	825	825 495	825
25	441	532	600	652	727	825	825	493	594	669	729	811	825	825	657	739	805	825	825	825	825
26	214 408	250 492	281 553	305 603	337 672	377 807	377 825	266 456	312 549	350 618	380 673	421 750	426 825	426 825	381 606	427 682	464 744	474 825	474 825	474 825	474 825
	190	222	249	271	299	354	361	236	277	310	337	373	405	405	338	379	411	454	454	454	454
27	378 169	454 198	513 222	558 241	622 267	747 315	825 347	421 211	508 247	573 277	624 301	694 333	825 389	825 389	561 301	633 337	688 367	768 406	825 432	825 432	825 432
28	351 151	423 177	477 199	519 216	577 239	694 282	822 331	391 189	472 221	532 248	579 269	645 298	775 353	825 375	522 270	588 302	640 328	712 364	825 413	825 413	825 413
29	327 136	394	444	483 194	538	646	766	364	439 199	495	540	601	723	825 359	486	547 272	597	664	798	825	825
30	304	159 367	179 414	451	215 502	603	715	170 340	411	462	504	561	317 675	799	453	511	556	619	745	825	825
31	123 285	343	161 387	175 421	194 469	229 564	269 669	153 318	179 384	201 433	218 471	242 525	286 631	336 748	219 424	245 478	266 520	295 580	349 697	385 825	385 825
32	111 267	130 322	146 363	158 396	175 441	207 529	243 627	138 298	162 360	182 406	198 442	219 492	259 592	304 702	198 397	222 448	241 489	267 544	316 654	369 775	369 823
	101	118	132	144	159	188	221	126	147	165	179	199	235	276	180	201	219	242	287	337	355
33	252 92	303 108	342 121	372 131	414 145	498 171	589 201	280 114	339 134	381 150	415 163	463 181	556 214	660 251	373 164	421 183	459 199	511 221	615 261	729 307	798 334
34	237	285	321 110	349 120	390 132	468 156	555 184	264	318	358 137	391 149	435 165	523 195	621 229	352 149	397 167	432 182	481 202	579 239	687 280	774 314
35	223	268	303	330	367	441	523	249	300	339	369	411	493	585	331	373	408	454	546	648	741
36	211	90 253	101 286	110 312	121 348	143 417	168 495	96 235	112 283	126 319	137 348	151 388	179 466	210 553	137 313	153 354	167 385	185 429	219 516	257 612	292 700
37	70	82	92	101	111	132	154	88 222	103 268	115 303	125 330	139 367	164 441	193 523	126 297	141 334	153 364	169 406	201 487	236 579	269 663
								81	95	106	115	128	151	178	116	130	141	156	185	217	247
38								211 74	255 87	286 98	312 106	348 118	418 139	496 164	280 107	316 119	345 130	384 144	462 170	549 200	628 228
39								199 69	241 81	271 90	297 98	330 109	397 129	471 151	267 98	300 110	327 120	364 133	438 157	520 185	595 211
40								190	229 75	258 84	282 91	313 101	376 119	447 140	253 91	285 102	310	346 123	417 146	495 171	565 195
41															241	271	295	330	396	471 159	538 181
42															229	259	282	313	378	448 148	513 168
43															219	247	268	300	360	427	489
44															73 208	82 235	89 256	99 286	117 343	138 408	157 466
															68	76	83	92	109	128	146

APPENDIX H

COST TABLES

Slab On Metal Deck				
Building	Area	CY	Price	
1	1650.00	23.81	\$4,761.57	
2	675.00	9.74	\$1,947.92	
3	1650.00	23.81	\$4,761.57	
Α	22960.00	331.29	\$66,258.02	
В	26660.00	384.68	\$76,935.49	
С	4000.00	57.72	\$11,543.21	
		Total Price	\$166,207.79	

Slab On Grade				
Building	Area	CY	Price	
1	2025.00	37.50	\$5,625.00	
2	675.00	12.50	\$1,875.00	
3	2025.00	37.50	\$5,625.00	
Α	22960.00	425.19	\$63,777.78	
В	26660.00	493.70	\$74,055.56	
C	4000.00	74.07	\$11,111.11	
		Total Price	\$162,069.44	

Steel Pricing				
Building	Weight of steel(Kips)	Price		
1	129.34	\$226,336.25		
2	70.74	\$123,786.25		
3	129.34	\$226,336.25		
А	639.34	\$1,118,845.00		
В	575.40	\$1,006,950.00		
С	96.00	\$168,000.00		
	Total Price	\$2,870,253.75		

APPENDIX I

DETAILED DESIGN DRAWINGS

