MUSCATINE WELCOME CENTER

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BEST ENGINEERING

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Executive Summary

Best Engineering was contracted for the site plan and structural plan of a new Welcome Center in the City of Muscatine, Iowa. The proposed site was located near the Muscatine Soccer Complex which greatly influenced the design and buildings capacity.

The design implants south-facing floor to ceiling windows to follow the path of the sun and utilize as much natural light as possible. During the summer, this is not as much of a concern. However, in the winter months when the sun is lower in the sky, it will still allow for the utilization of natural light. The building has an open floor plan for flexibility in building use. The large open spaces allow for architectural walls to customize the space and allows light to penetrate further into the building. Movable partitions can divide and subdivided the open floor plan as desired to function however needed. In addition to the building a watchtower was designed as a local attraction.

The separation of foot and vehicular traffic was a key concept in placing the building and the watchtower with the goal of providing a more welcoming experience for visitors.

The location in Muscatine, Iowa provided a challenge for our firm, since it is based in Iowa City, Iowa. BEST Engineering took on the challenge of designing a building and site that would be usable year round. As mentioned above, the soccer complex has a big impact on the number of visitors. These visitors would only occupy the building during the summer where we want the building to be functional at other times of the year as well.

Design Objectives

The design of this Welcome Center provided many challenges in that it incorporated many different facets of both civil engineering and architecture. However, with our background in the civil engineering and architecture curriculum, we were able to design this Welcome Center and meet all pertinent design objectives for a successful project. Our main design objectives were to design a year round facility that reflected the history of Muscatine while encouraging the soccer park users to visit downtown.

Two main features in the designed Welcome Center will allow it to be utilized year round, an open floor plan and south facing floor to ceiling windows. The open floor plan allows for the division and redivision of space using architectural walls. The south facing windows will provide the most natural light for the longest amount of daylight hours while allowing light to penetrate far into the building.

The Muscatine Soccer Complex, located one half mile southeast of the proposed site is anticipated to be a large source for visitors. BEST Engineering collaborated with the Muscatine Trail Group to design easy access to the Welcome Center from the soccer complex. The Muscatine Trail Group is working on design a trail path that will cut through the Welcome Center property. The current Welcome Center site plan has a lot of open grassy areas for picnicking and camping out as well as a place for shelter and restrooms inside the building.

One main focus of the Welcome Center is to attracting visitors and encouraging them to visit downtown areas of Muscatine. Inside the building, there are many places for displays and advertisements.

Challenges

There were many challenges when designing the Welcome Center for Muscatine. The location of the proposed site posed an obvious challenge. With our firm operating mainly in Iowa City, we had about an hour-long commute to the site.
We designed out entrance/exit road to come in from Lucas or Houser St on the northern and east side of the site. This area was heavily wooded and on a steeply graded hill. To provide views of the Mississippi River, the watchtower had to be tall enough to see over the nearby trees. This provided a challenge for the design and height of the watchtower. It was difficult to assess the height of these trees. The city Engineer mentioned they were oak trees during a phone call. The tower was then built higher than 60 feet or the average height of oak trees.
As with any construction project, runoff must be accounted for pre-construction and post-construction. The Rational Method Approach was utilized for the runoff calculations. The calculations are shown in a later part of this document.
Our firm wanted to have a design that was sustainable, green, and good for the environment without going overboard on cost. In that, we had to use our design and site plan to do this as opposed to focusing on “green” materials that are more costly.

Assumptions

We received data with a peak number of visitors to the soccer complex during tournaments. We used this in our design but also researched other welcome centers to obtain an appropriate gross square footage (GSF) of the building and a number of parking spots. We looked closely at a Welcome Center in Council Bluffs, Iowa that was very similar to our project. It was located close to a soccer complex as well.

To incorporate the precedence of the Mississippi River on Muscatine’s history, we implemented a watchtower into our site plan. We obviously needed to design a tall enough watchtower to view overtop of the trees. And since we were an hour away from the proposed site, we had to assume a tree height.

Evaluation Criteria

BEST Engineering traveled to meet with the city of Muscatine on February 10, 2014. During the meeting, it was determined that the city needed a welcome center to display its rich history and proud heritage to all visitors. A site visit proved that the first part of the plan was to develop adequate access roads over the hilly terrain of Houser Street. Several important features of the center were also taken into account such as sunlight, flatland, and utility access. It was determined the entry roads to the center site would be off Lucas St. and head south. The building rests on flatland with a slope of less than 5%. Utilities for the welcome center will tap into westward sewer line and water lines, as well as the north for power. The size of the center was based off the size of other welcome centers and city halls. The welcome center will be visited by the many fans and families attending events and tournaments at the Muscatine Soccer Complex. From this came the idea for RV parking to accommodate patrons traveling long distances. RV parking designs were implemented into the parking lot. Adequate space and room for activities was provided thanks to the bountiful vacant properties on which the center lies. For attraction, the welcome center hosts a seven story watch tower with a view of the Mississippi River and also connects to the popular Muscatine recreational trails.

A long process of research and trial and error went into the architectural design of the building. Looking back on Muscatine's history with pearl buttons, we began to look into rounded shapes to resemble both the buttons and the shells from which they came from. We wanted to incorporate some wooden beams into the design to acknowledge the wooded site on which the building lies. Finally, we wanted to incorporate as much sunlight as efficiently as possible without being too overwhelming. Along with the building, a watchtower was added to our design to acknowledge the importance of the Mississippi River as well as the pearl button industry of Muscatine. The Mississippi River was not within a comfortable walking distance of the site so we had to come up with an alternate way to incorporate it.

Preliminary Design

First and foremost, the goal of BEST Engineering was to deliver an eye-catching design while accommodating for the needs of the city. Project Manager Jack Eckert designed the unique shape of the building. The idea of pearl buttons and they shells from which they came from was a major design and aesthetic on the architectural design. We wanted to incorporate a similar curved shape into the building. The final design incorporated this as a curved south-facing wall with floor to ceiling windows. This acknowledged Muscatine's history with pearl buttons with its shape. It also proved to be extremely functional letting in sunlight from dusk until dawn without overwhelming the space with direct light from sunrises to sunsets in the east and west. The wooded siding points to the wooded area of the site. Horizontally placed, it elongates the building which allows it to settle nicely into the landscape. A preliminary idea of the Welcome Center is shown in Figure XXXX.

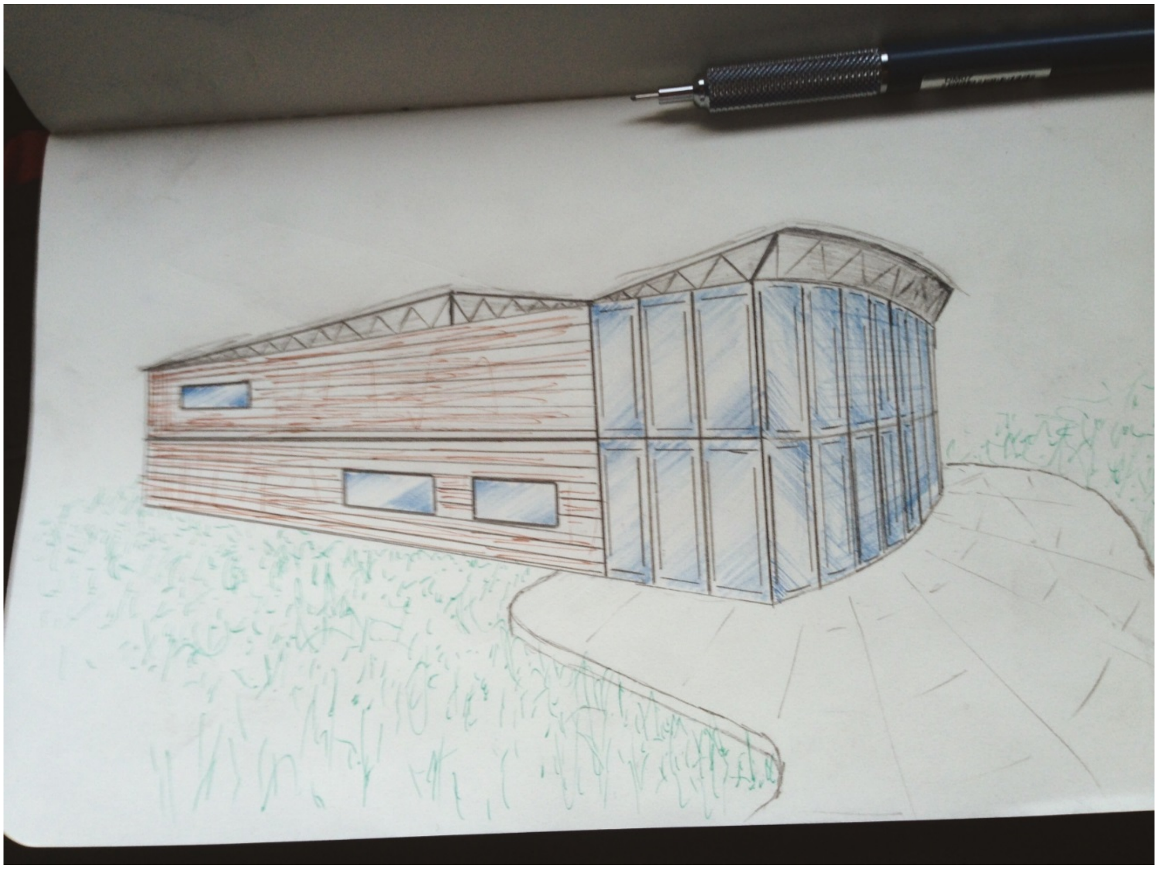


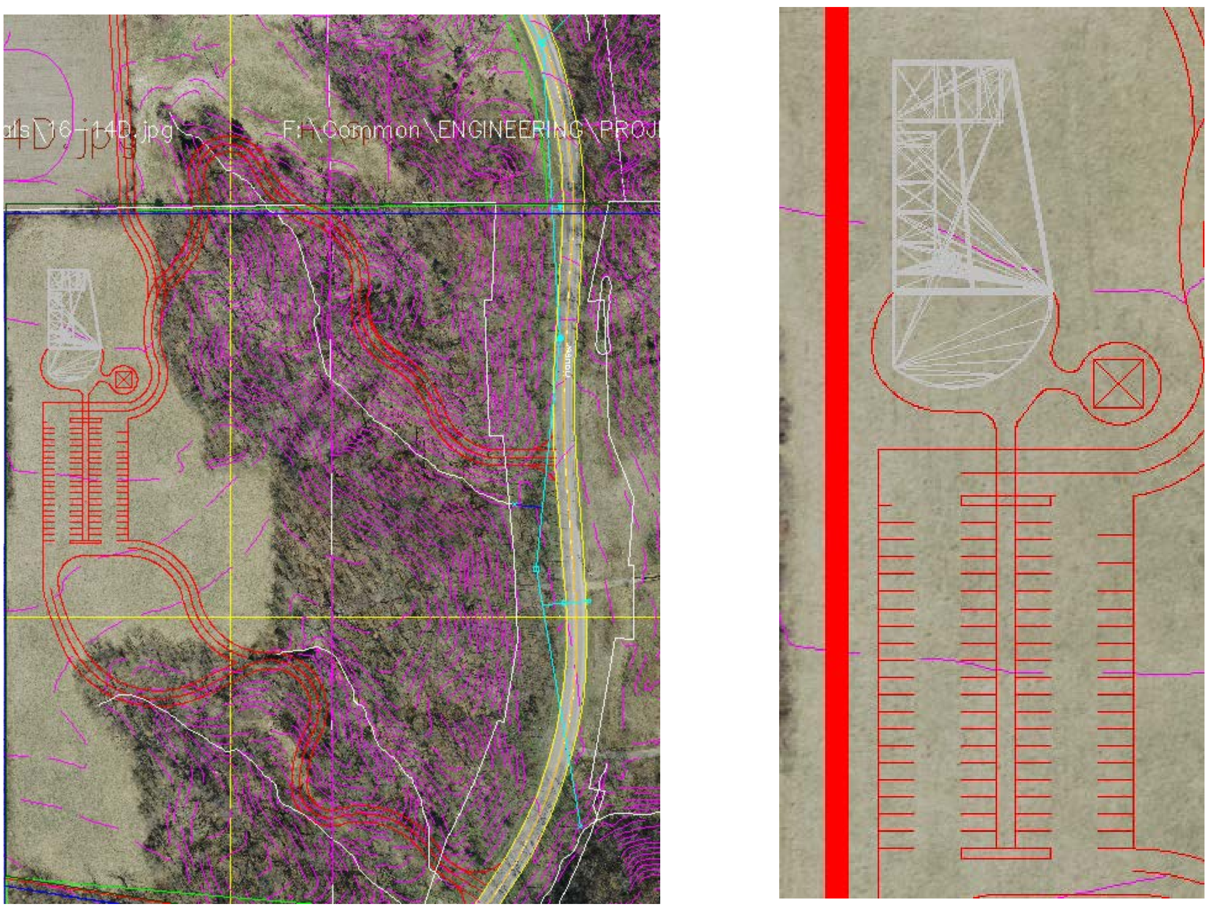
Figure 1 : Artist Rendering

The welcome center was designed as a celebration of the city and all of its prosperous industries. The city of Muscatine urged that the center should house displays and promote visitors to experience all the city has to offer. With this in mind, the second floor was designed to be entirely open. This provides for the maximum space possible for advertisements and displays to be utilized. The wall space can also be used for the same purpose. The lower level hosts three private rooms, one kitchen, one reception desk, restrooms, a utility closet, and one large storage room. With our design, the building is extremely flexible in its use and there are virtually no limits (other than size/capacity) to how it can be used.

Materials used in the center were chosen with the surrounding area in mind. Since the region around the building is heavily wooded, a wooden facade exterior was desired as mentioned above. For structural purposes, steel columns were used but are covered with wood to add to the aesthetic idea. Concrete was used as a base for both floors and covered with an oak floor finish. Second floor interior walls were fabricated with crimson brick to commemorate the downtown area and building industry of Muscatine.

Final Design Detail

The access road and parking lot design were completed after initial placement and design of the building and watchtower. The access roads are designed for a 15mph speed limit using inner city buses and motor coaches as the design vehicle since traveling sports teams are expected to utilize the vehicles. The design vehicle required all roads to have a minimum center line turning radius of 40.8 ft (AASHTO). Three access road options were designed for the site to allow the city a choice in placing the trails running through the site in conjunction with the building seen in Figure XXX . BEST Engineering formally recommends the northern most access road for the final design. This road cuts along the property line of the agricultural learning center from Lucas St, drives by the watchtower into the parking lot. The central road design acessing Houser St is ideal except for a small portion of it that leaves the tract of land owned by the city. The sourthern most road connecting the center to Houser St is not viable since it has areas where the slope is too steep. The environmental impact was of leveling and tree cutting was also considered in choosing a access road for the final design. The road with the least required leveling and tree cutting leads to Lucas St through the Agricultural center lan Muscatine is currently working with the Ag Center therefore this might be a feasible design even though the City does not own the land currently.



<u>Figure 2 ,3 : Site locations</u>

All of the roads, sidewalks and entire parking lot will be constructed using PaveDrain concrete pavers. Pavedrain builds permeable pavements that allow water to infiltrate in between instead of running off. The pavers ware to pursue the goal of sustainability and low ecological impact. A schematic of the PaveDrain can be seen in Figure 4.

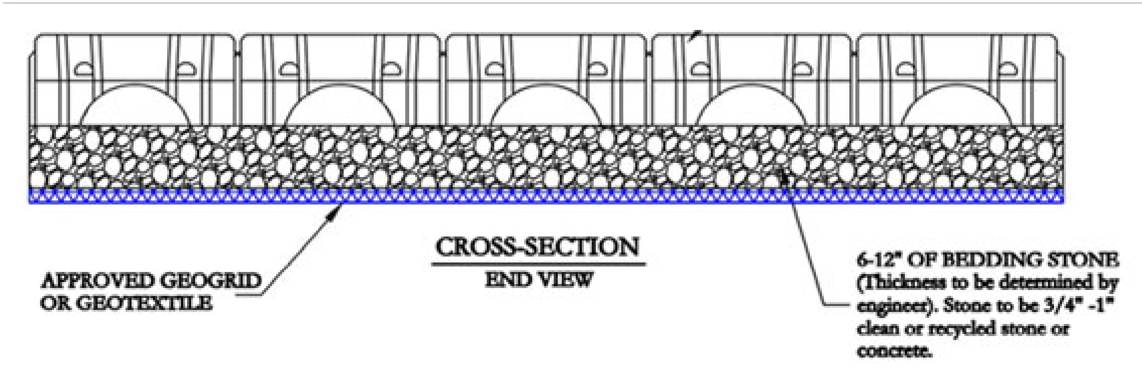


Figure 4: PaveDrain Cross-Section

Structural analysis of the welcome center was conducted using various software including Autodesk AutoCAD, Autodesk Revit, Autodesk Robot Structural Analysis, and Trimble SketchUp. The preliminary stages began with a rough floor plan created in AutoCAD. This allowed for the placement of the building's rooms, walls, stairs, elevators, and entrance. The floor plan proved the welcome center would have sufficient space to house partitions and displays. Using SketchUp, the welcome center came to life and the first 3D model of the interior was generated. The next step was to complete the exterior of the building using Revit. The Revit model completed the 3D rendering of the building.

The structure itself is composed of two ten foot tall stories. The structure spans 160' on the west side. 60' on the north. Approximately 120' on the east. From the north wall, the east wall extends eastward at an angle. The south side is a curved curtain wall connected the west wall with the east. The roof descends/rises one foot for every lateral span of ten feet. The layout of the structure's first floor is comprised of three small office rooms, a kitchen, two utility/closet rooms, and female and male bathrooms on the first floor. The second is designed with no interior walls and has a balcony that overlooks the south. Dimensions and renderings of the building and floors can be seen in Appendix D.

Once modeling was completed, analysis of the structure came next. Using the 3D model as a guide, column, beams, and bars made up the frame of the building using Robot. Load Resistance Factor Design (LRFD) was the design method used. Timber was selected as the main element for the roof truss. Concrete was chosen for the strip column footings, as well as the first and second floors. During the analysis, it was determined that some column members could not meet the required strength and were replaced with stronger members. Beams used in the design are A992 W14x109 steel and all columns are of W12x136 shape. The glass facade was constructed of one inch thick glass and HHSQ 5.5x5.5.1875 steel supports. 18x24 Timber beams are used to support the roof south of the balcony. The roof is supported by glue-lam timber truss composed of 3.5.5 and 5x5.5 wooden beams. The truss spans every 10'. Robot determined the maximum deformation of the building was 1.4 inches vertically. Exterior columns were exposed to a load of 225 kip and 530 kips for the interior columns.

The Robot Structural Analysis results can be seen in Table??maxx. The three different steel beams in the table show the maximum force value of each beam. The allowable strengths of the beams are shown below each. These values are obtained from the AISC Steel Manual in Sections 3-6. Below are tables showing the highest beam forces for the entire structure as well as the max deflections and displacements.

Table 1: Maximum beam forces and Maximum Available

Beam Type	Max Flexure (kip -ft)	Max Axial Strength in Tension (kips)	Max Axial Strength in Compression (kips)	
W12x136	183	N/A	354	
	Available Flexure (kip -ft)	Available Axial Strength in Tension (kips)	Available Axial Strength in Compression (kips)	Available Combination Flexure and Axial
	720	N/A	391	720, 430
Beam Type	Max Flexure (kip -ft)	Max Axial Strength in Tension (kips)	Max Axial Strength in Compression (kips)	
W14x109	443	42	N/A	
	Available Flexure (kip -ft)	Available Axial Strength in Tension (kips)	Available Axial Strength in Compression (kips)	Available Combination Flexure and Axial
	>450	1140 (yielding), 1170 (rupture)	N/A	582, 430
Beam Type	Max Flexure (kip -ft)	Max Axial Strength in Tension (kips)	Max Axial Strength in Compression (kips)	
HSSQ 5x5x3/16	7.57	N/A	11.8	
	Available Flexure (kip -ft)	Available Axial Strength in Tension (kips)	Available Axial Strength in Compression (kips)	Available Combination Flexure and Axial
	24.6	N/A	33.9	N/A

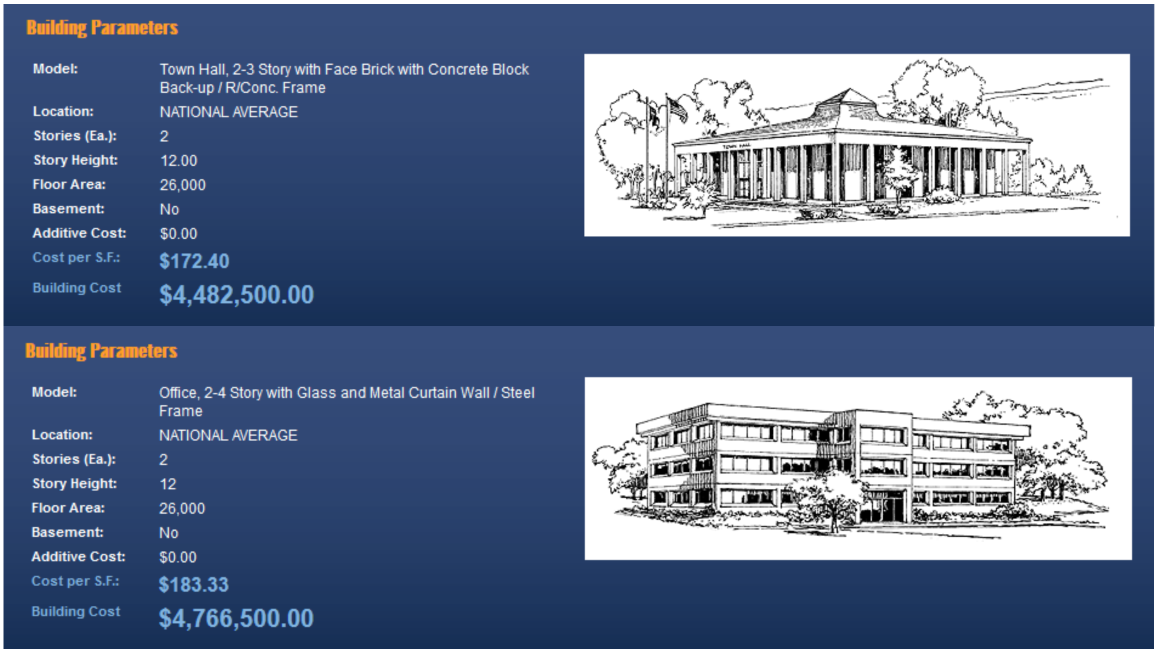
Tabulated values of maximum deflections, displacements, and force values can be found in Appendix B.

Final Design Cost Estimate

BEST engineering developed a preliminary estimate using the RS Means Square Foot Cost Estimator. The anticipated welcome center will cost between $4.5 and 4.8 million for a two story building. The parameters for the estimate can be seen in Figure XXX. BEST believes the Office Building estimate is a more accurate cost since it reflects the Welcome Center wall and framing type design choice. The sidewalk and pavements are PaveDrain permeable pavement to assist in water infiltration. The cost for the PaveDrain was calculates per square foot and added to the building cost for a total construction cost which can be seen in Table XXX

Table 2: Cost Estimate

	Cost ($)	Unit	# of Units	Subtotal
Building	4500000	1	1	4,800,000
Pavements				
Permeable Pavers	3.5	sf	19250	67,375
Geogrid	0.34	sf	19250	6,545
Bedding Stone	16	per ton	19250	92,400
			Total	4,966,320



Building Parameters

Model:	Town Hall, 2-3 Story with Face Brick with Concrete Block Back-up / R/Conc. Frame
Location:	NATIONAL AVERAGE
Stories (Ea.):	2
Story Height:	12.00
Floor Area:	26,000
Basement:	No
Additive Cost:	$0.00
Cost per S.F.:	$172.40
Building Cost	$4,482,500.00

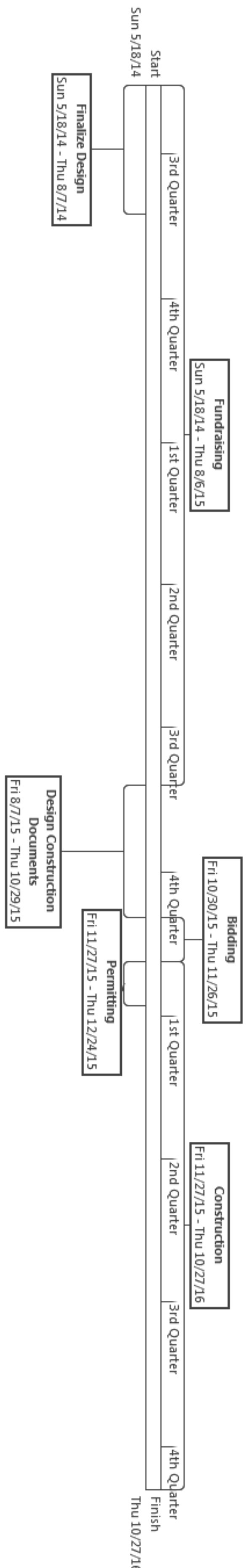
Building Parameters

Model:	Office, 2-4 Story with Glass and Metal Curtain Wall / Steel Frame
Location:	NATIONAL AVERAGE
Stories (Ea.):	2
Story Height:	12
Floor Area:	26,000
Basement:	No
Additive Cost:	$0.00
Cost per S.F.:	$183.33
Building Cost	$4,766,500.00

Figure 5: Building Cost Parameters

Project Timeline

BEST Engineering estimates the total time until project completion to be a little over two years. The site location is within a rural undeveloped area therefore does not require phasing. The city however requires time to gather funding for final design and construction. A preliminary timeline can be seen in Figure XXX.


Start
Sun 5/18/14
Finalize Design
Sun 5/18/14 - Thu 8/7/14
3rd Quarter
4th Quarter
Fundraising
Sun 5/18/14 - Thu 8/6/15
1st Quarter
2nd Quarter
3rd Quarter
Design Construction Documents
Fri 8/7/15 - Thu 10/29/15
4th Quarter
Bidding
Fri 10/30/15 - Thu 11/26/15
Permitting
Fri 11/27/15 - Thu 12/24/15
1st Quarter
2nd Quarter
Construction
Fri 11/27/15 - Thu 10/27/16
3rd Quarter
4th Quarter
Finish
Thu 10/27/16

Works Cited

American Association of State Highway and Transportation Officials (AASHTO). 2004.

American Institute of Steel Construction, Manual of Steel Construction, 14th Edition (AISC). Chicago: AISC, 2011

ASCE Standards Minimum Design Loads for Buildings and Other Structures. (2000).

American Society for Testing and Materials (ASTM). 2005.

http://www.pavedrain.com/pavedrain-difference/

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm (NRCS)

Appendix A: Rational Method Calculations

Q=ciA
Area of Building = 14,190ft^2 = 0.326 acres = 17%
Area of Parking =12,250ft^2 = 1.42 acres = 75%
Area of Sidewalks = 7000ft^2 = 0.161 acres = 8%
Area Total = 1.907 acres

From Table 3.5 of the Urban Design Standards Manual
Intensity (Sec 6, 100 yr storm, 24hr) = 7.13 inches
i-7.13 in/24 hr=0.297 in/hr

From Table 3.1 of the Urban Design Standards Manual
Hydrologic Group C
Permeable pavement C= .25-.35
Lawn (good condition) C = .3
Roof C = 0.3

Preconstruction
100% Lawn
Q=ciA=(.3)(.297 in/hr)(1.907 acres)=0.171 acre-in/hr=0.171 cfs
Q = 0.171 cfs

Post Construction
17% = Roof
83% = Permeable pavement
Q=ciA=(.3)(.297 in/hr)(1.42 acres)=0.127 acre-in/hr=0.127 cfs (parking lot)
Q=ciA=(.95)(.297 in/hr)(0.326+0.161 acres)=0.137 acre-in/hr=0.137 cfs (sidewalks and building)

ΣQ = 0.264 cfs

Appendix B: Robot Analysis

Methodology

Basic Load combinations are adopted from Section 2.3.2 of the ASCE Minimum Design Loads for Buildings and Structures using LRFD strength design. An estimated live loads were estimated from Table 4.1 of ASCE. Loads were are estimated to be nearest an office building setting. Applied loading of .1kip/ft^2 was applied to first floor lobby and corridors and a .05kip/ft^2 load was applied to the offices. The second floor has an applied .1 kip/ft^2 live load. An overestimate made to incorporate an unforeseen uses on the second floor. A live roof road of .018kip/ft^2 is applied to the roof of the structure and is in accordance to Section 4.9.2 of ASCE. A positive wind pressure load of 11 and negative pressure load of 12 are applied to either side of the building's exterior walls. Alternations of positive and negative pressures were made on all four sides. Wind loads were taken from Table 6-3A of ASCE assuming a basic wind speed of 90 mph (attained from Figure 6-1 of ASCE) and an effective wind area of 500 square feet. An applied snow load of .01575 kip/ft^2 was applied to the roof of the building. The snow load was made assuming a flat-roof snow loading described in Section 7.3 of ASCE. A rain is excluded as the roof is not flat enough to have sufficient ponding. Earthquake loads were omitted. Loads were applied as one way directional loading for the structures floor and roof panels. Two way loading was applied to the exterior walls and curtain wall panels.

Table 3 : Load Case Names

	Case name	Nature
1	DL1	dead
2	LL1	live
3	DL2ndFloor	dead
4	RoofLiveAndsnow	Roof live
5	WIND1	wind

Table 3 refers to the loads applied to the building. DL1 is the applied dead load that accounts for the mass of the structure itself. LL1 is the live loads, changed at appropriate levels and locations. DL2ndFloor is the addition dead weight of the 2nd floor and interior walls. RoofLiveAndsnow is the highest value of either applied snow or live roof loading. WIND1 is the applied wind loading.

Table 4: Load Combinations with Reference to Case Names

Combinations	Name	Analysis type	Combi nation	Case nature	Definition
17 (C)	COMB1	ar Combination	ULS		(1+3)*1.40
18 (C)	COMB2roof	ar Combination	ULS		(1+3)*1.20+4*0.50+2*1.60
19 (C)	COMB3	ar Combination	ULS		(1+3)*1.20+4*1.60+2*0.50
20 (C)	COMB4	ar Combination	ULS		(1+3)*1.20+5*1.60+(2+4)*0.50
21 (C)	COMB5	ar Combination	ULS		(1+3)*1.20+2*0.50+4*0.20
22 (C)	COMB6	ar Combination	ULS		(1+3)*0.90+5*1.60

Results

Global Extreme Forces

Fx = Axial force

Fy = Shear force for weak axis bending of the beam

Fz = Shear force for strong axis bending of the beam

Mx = Twisting moment

My = Bending moment force for strong axis bending of the beam

Mz = Bending moment for weak axis bending of the beam

Curtain Wall - HSSQ 5.5x5.5x.1875

	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
MAX	11.81	1.69	4.81	0.26	7.53	5.27
Bar	691	1571	1571	765	1535	834
Node	1452	1552	1552	1480	1521	1522
Case	ULS/11	20 (C)	ULS/9	22 (C)	22 (C)	22 (C)
MIN	-4.71	-2.32	-2.15	-0.55	-6.32	-4.88
Bar	1665	750	1535	1611	1535	835
Node	1466	1528	1522	1465	1522	1522
Case	ULS/9	20 (C)	20 (C)	ULS/9	20 (C)	22 (C)

Columns - W12x136

	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
MAX	354.02	17.75	31.26	0.58	183.92	132.47
Bar	351	769	145	819	145	59
Node	443	453	140	1521	141	93
Case	ULS/2	ULS/1	ULS/3	20 (C)	ULS/3	ULS/5
MIN	-11.32	-27.30	-23.00	-0.54	-166.69	-143.87
Bar	2	59	52	820	250	468
Node	3	92	82	440	141	473
Case	5	20 (C)	ULS/3	22 (C)	ULS/2	20 (C)

Columns - W14x109

	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
MAX	39.72	6.72	117.62	0.72	268.05	47.43
Bar	400	271	285	264	256	271
Node	1563	16	151	132	113	16
Case	ULS/9	22 (C)	ULS/3	ULS/2	ULS/2	22 (C)
MIN	-28.68	-5.40	-115.56	-10.91	-443.34	-28.32
Bar	424	212	284	201	285	212
Node	52	6	151	49	151	6
Case	ULS/9	20 (C)	ULS/2	ULS/10	ULS/3	20 (C)

Max Deflections

	UX (in)	UY (in)	UZ (in)
MAX	0.0002	0.0603	0.4807
Bar	203	769	107
Case	20 (C)	17 (C)	18 (C)
MIN	-0.0003	-0.1336	-1.7518
Bar	127	169	120
Case	20 (C)	20 (C)	18 (C)

Max Displacements

	UX (in)	UY (in)	UZ (in)	RX (Rad)	RY (Rad)	RZ (Rad)
MAX	0.1574	0.8761	0.0	0.015	0.003	0.002
Node	1478	409	3	132	132	16
Case	22 (C)	20 (C)	17 (C)	18 (C)	18 (C)	20 (C)
MIN	-0.0642	-0.0241	-0.7945	-0.008	-0.003	-0.003
Node	1462	52	1027	113	1598	416
Case	19 (C)	19 (C)	17 (C)	18 (C)	19 (C)	20 (C)

Precision and Forces Acquired from each Load Case Analysis

Node/Case	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
Case 17 (C)	COMB1					
Sum of val.	-0.00	-0.00	4699.71	-0.00	0.00	-0.00
Sum of reac.	-0.00	-0.00	4699.71	165059.39	-302113.43	0.02
Sum of forc.	-0.00	-0.00	-4699.71	-165060.01	302112.88	0.00
Check val.	-0.00	-0.00	-0.00	-0.62	-0.55	0.02
Precision	3.42775e-009		1.23447e-011			
Case 18 (C)	COMB2roof					
Sum of val.	-0.00	-0.00	5465.24	-0.00	-0.00	0.00
Sum of reac.	-0.00	-0.00	5465.24	192286.87	-350514.75	0.01
Sum of forc.	-0.00	-0.00	-5465.24	-192287.49	350514.16	-0.00
Check val.	-0.00	-0.00	-0.00	-0.62	-0.58	0.01
Precision	3.90754e-009		4.68302e-011			
Case 19 (C)	COMB3					
Sum of val.	-0.00	-0.00	4745.64	-0.00	0.00	-0.00
Sum of reac.	-0.00	-0.00	4745.64	166942.95	-308024.54	0.02
Sum of forc.	-0.00	-0.00	-4745.64	-166943.62	308023.88	-0.00
Check val.	-0.00	-0.00	-0.00	-0.67	-0.66	0.02
Precision	3.62525e-009		1.23956e-010			
Case 20 (C)	COMB4					
Sum of val.	-0.00	-354.18	4541.24	0.00	0.00	-0.00
Sum of reac.	-0.00	-354.18	4541.24	163951.77	-292437.84	-19306.70
Sum of forc.	0.00	354.18	-4541.24	-163952.35	292437.29	19306.70
Check val.	-0.00	-0.00	-0.00	-0.58	-0.55	-0.00
Precision	1.69685e-007		4.70597e-011			

Case 21 (C)	COMB5					
Sum of val.	-0.00	-0.00	4485.49	-0.00	0.00	-0.00
Sum of reac.	-0.00	-0.00	4485.49	157647.27	-288186.91	0.01
Sum of forc.	-0.00	-0.00	-4485.49	-157647.84	288186.40	-0.00
Check val.	-0.00	-0.00	-0.00	-0.56	-0.51	0.01
Precision	3.25267e-009		2.50013e-011			

Case 22 (C)	COMB6					
Sum of val.	-0.00	-354.18	3021.24	0.00	0.00	-0.00
Sum of reac.	-0.00	-354.18	3021.24	110422.17	-194215.78	-19306.70
Sum of forc.	0.00	354.18	-3021.24	-110422.57	194215.42	19306.70
Check val.	-0.00	-0.00	-0.00	-0.40	-0.36	-0.00
Precision	1.68556e-007		8.78971e-012			

Appendix C: Watch Tower Analysis

Methodology:

A combination of only live and dead loads was used for the analysis of the watch tower. A dead load of material weight and an additional .05kips/ft^2 applied to the top floor to account for floor material weight. A live load of .1 kips/ft^2 was also applied to the top floor. Because the system has no walls or roof, no other load cases were applied. The only combination used was 1.2DL + 1.6 LL.

Table 5: Max deflections

	UX (in)	UY (in)	UZ (in)	RX (Rad)	RY (Rad)	RZ (Rad)
MAX	0.0058	0.0072	0.0	0.000	0.000	0.000
Node	16	26	1	39	7	12
Case	1	1	1	1	1	1
MIN	-0.0497	-0.0368	-0.0826	-0.001	-0.000	-0.000
Node	12	12	12	12	5	22
Case	1	1	1	1	1	1

Table 6: Max Forces

	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
MAX	45.08	0.28	1.86	0.53	9.91	3.12
Bar	150	51	94	94	150	150
Node	5	23	14	14	5	16
Case	1	1	1	1	1	1
MIN	-9.64	-0.56	-2.31	-0.40	-17.25	-5.34
Bar	15	150	41	86	94	150
Node	16	5	50	12	14	5
Case	1	1	1	1	1	1

Appendix D: Dimensions and Renderings

Part 1: Welcome Center Dimensions

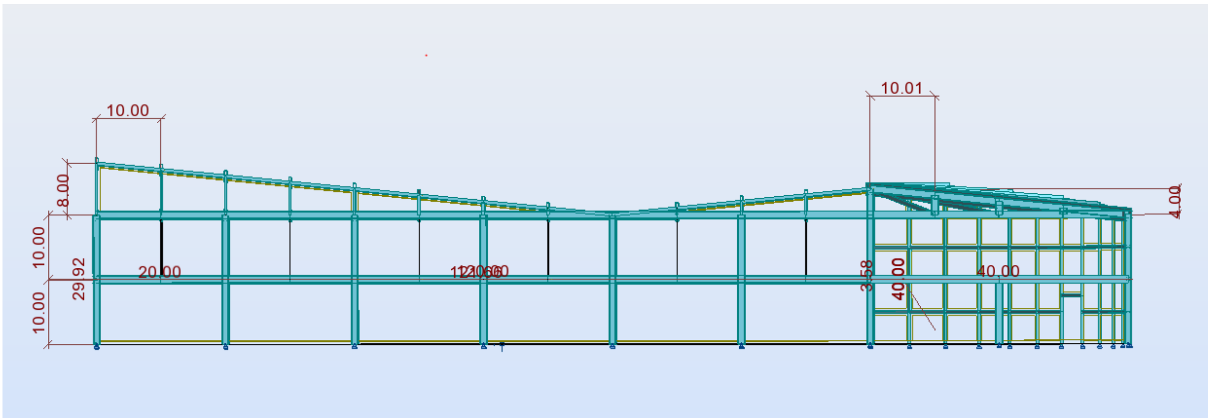


Figure 6: Elevation View

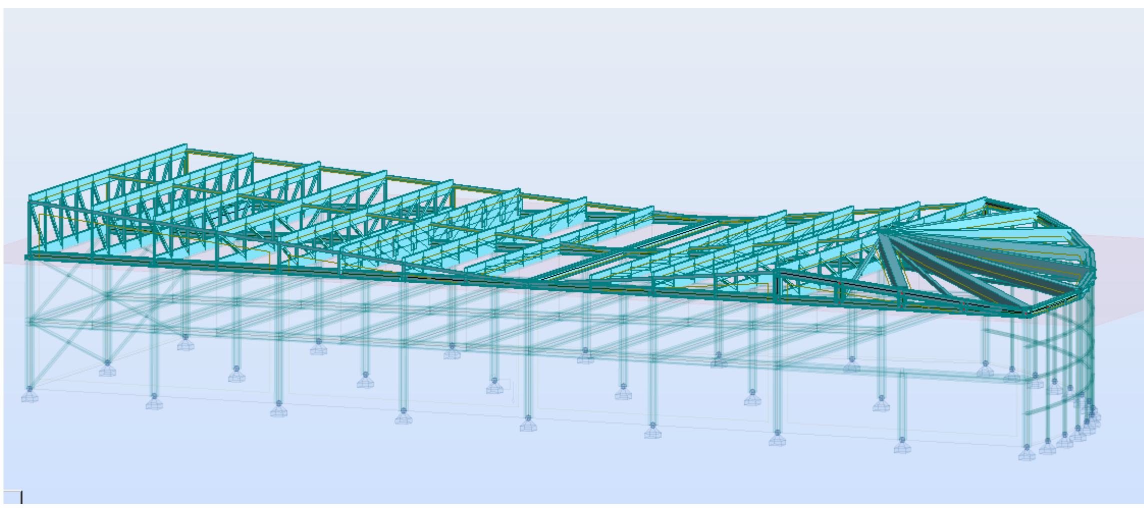


Figure 7: Roof Truss Support System

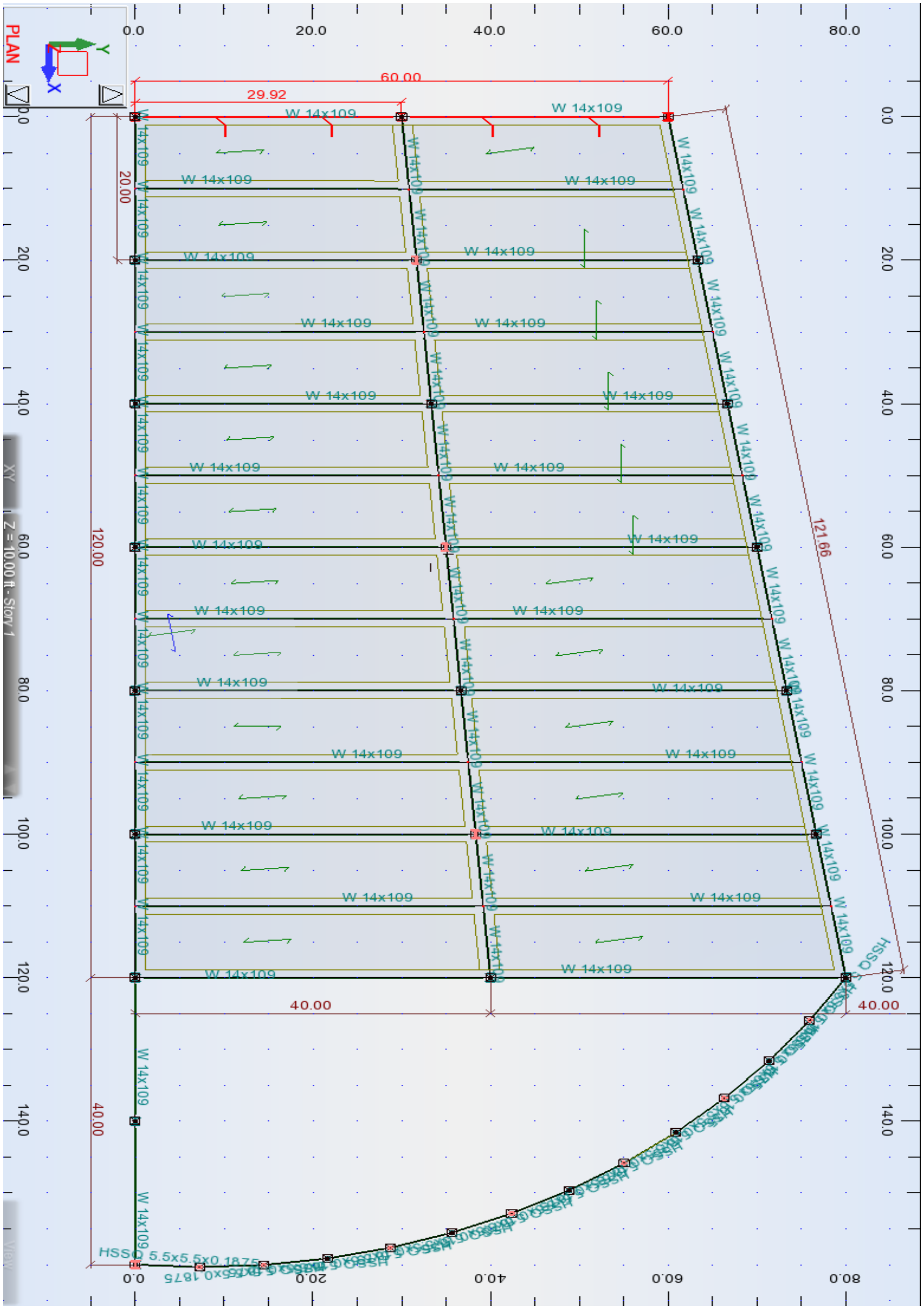


Figure 8 :Plan View

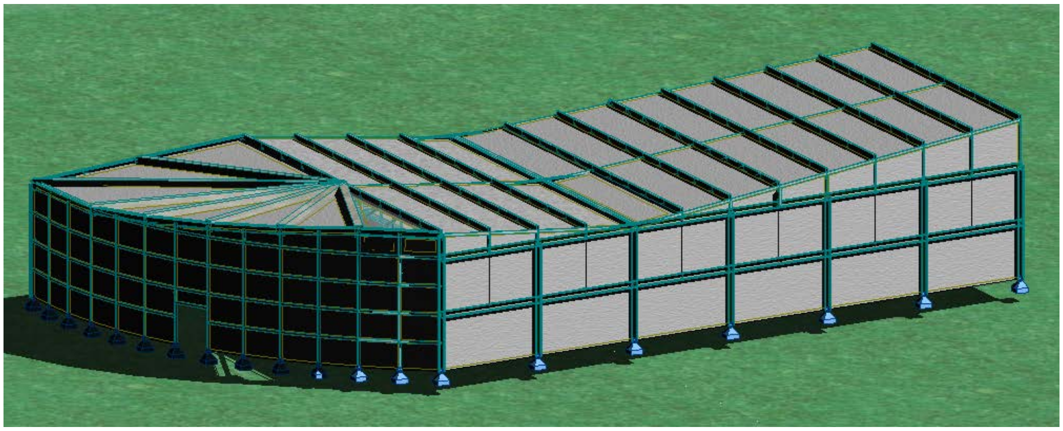


Figure 9: 3-D View of Structure and Claddings for loading Applications

Part 2: Tower Dimensions

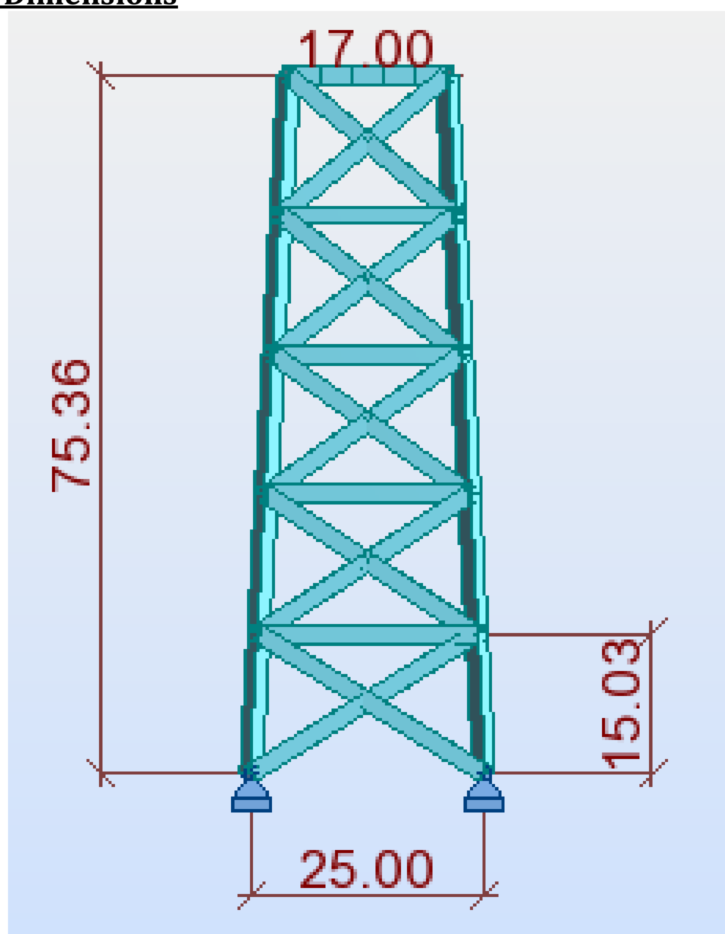


Figure 10: Plan view of Watch Out Tower

Part 5: Interior Dimensions

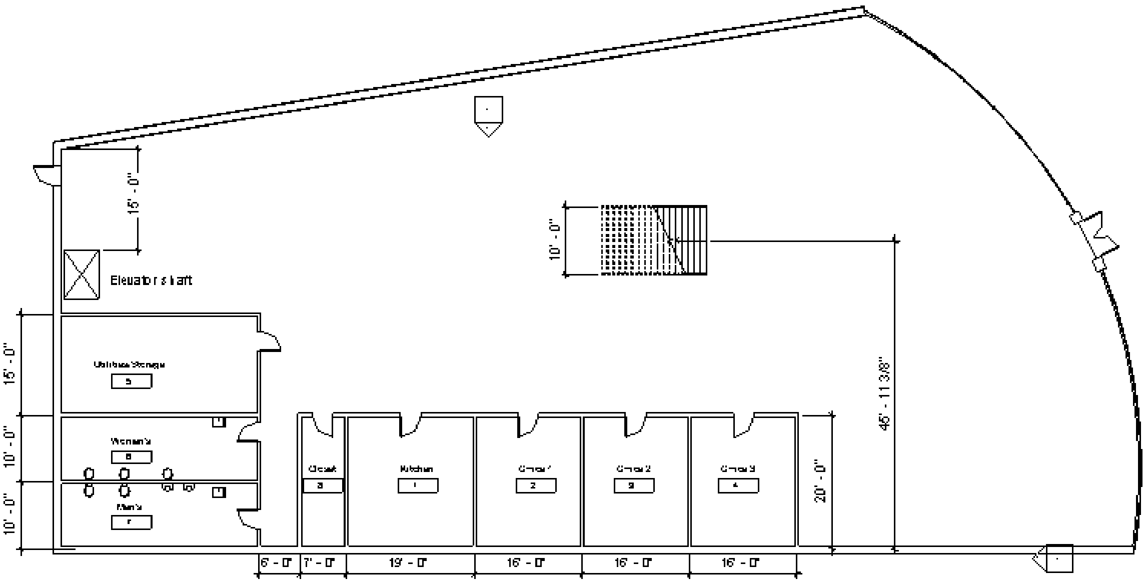


Figure 11: First Floor Plan View

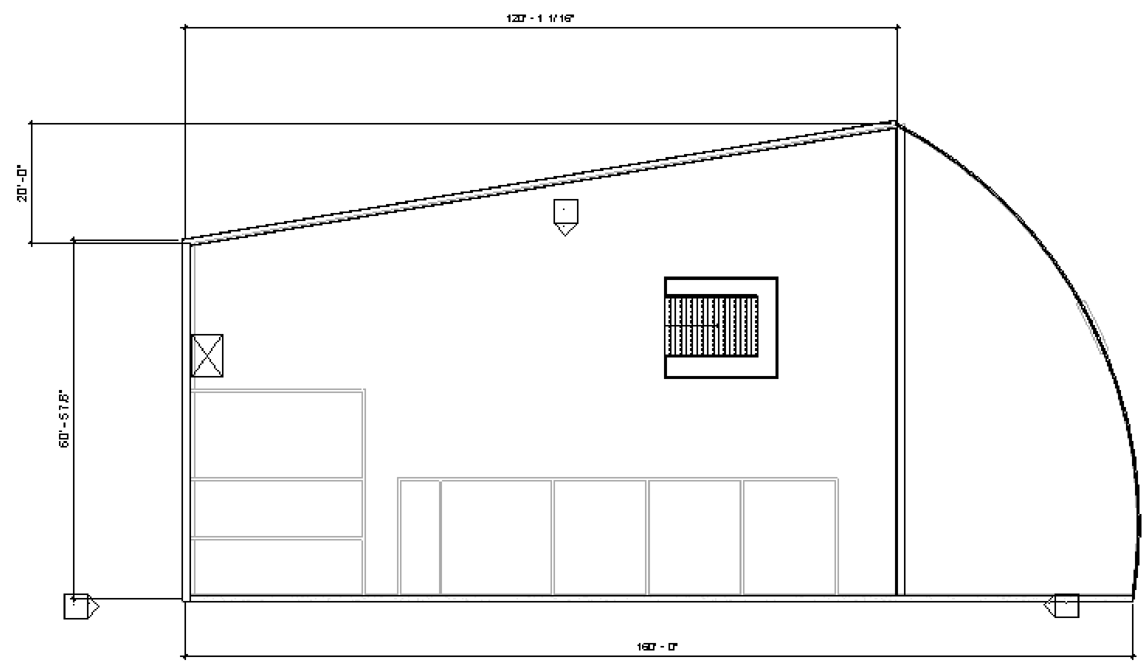


Figure 12: Second Floor Plan View

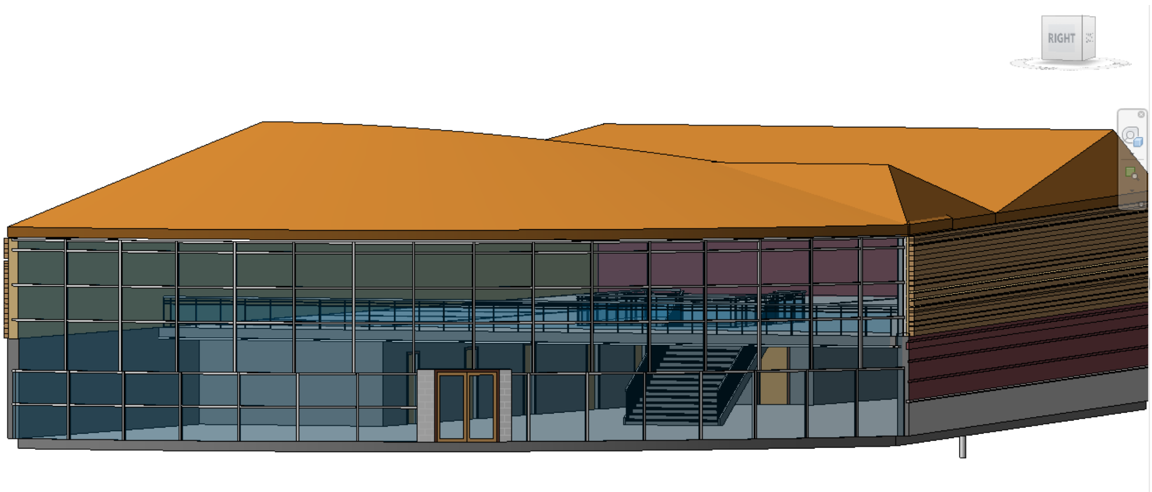


Figure 13 : Rendered View 1

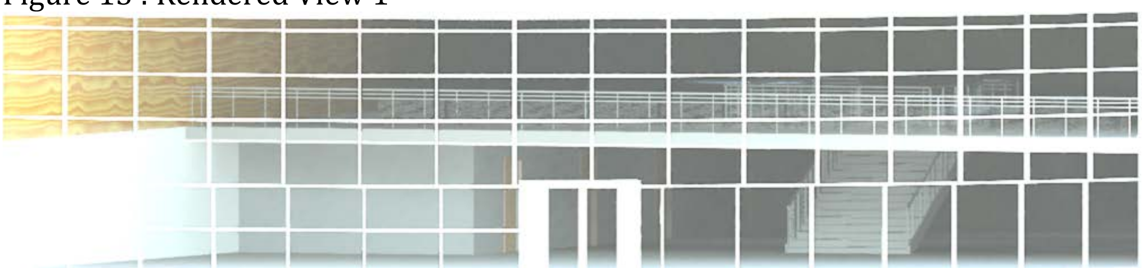


Figure 13 : Rendered View 2

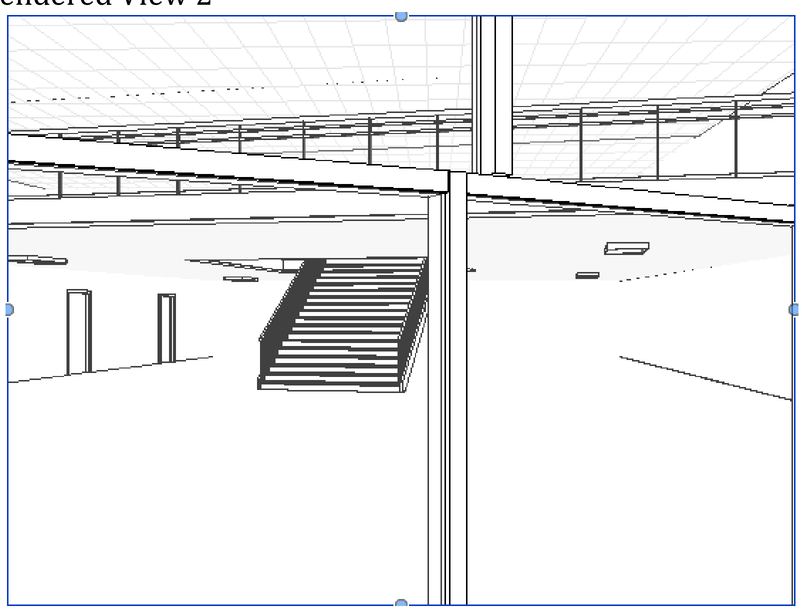


Figure 14: Rendered View 3