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FINAL DELIVERABLE

Title	Clinton Sawmill Museum - Event Center Design & Engineering
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Community Partners	Clinton Sawmill Museum

This project was supported by the Iowa Initiative for Sustainable Communities (IISC), a community engagement program at the University of Iowa. IISC partners with rural and urban communities across the state to develop projects that university students and IISC pursues a dual mission of enhancing quality of life in Iowa while transforming teaching and learning at the University of Iowa.

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SAWMILL EVENT CENTER DESIGN REPORT

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SECTION I: EXECUTIVE SUMMARY

The engineering project team is comprised of four senior civil engineering students from the University of Iowa. Our team values meeting our clients' needs through the utilization of each of member's strengths. As a team we provide unique solutions to challenging problems in order to create designs that satisfy clients' requests and positively impact their community. The client, the Sawmill Museum located in Clinton, IA, has expressed interest in a two level event space serving as a multi-purpose building to host traveling exhibits/shows and community events. In addition to the event space, the client requested additional areas within the new building including office spaces and miscellaneous use rooms to account for the lack of additional space at the current museum. The Sawmill Event Center will work alongside the existing Sawmill Museum and the proposed Museum Amphitheater to draw more tourist attention to the area and promote community events in Clinton, IA. The site will allow for future development of the area including the Discovery Trail and the river side road.

On the site, several parking lots will serve the existing museum, event center and amphitheater. The first floor of the event center will operate as an open, dividable space for exhibits and trade shows. The second floor of the building will be a dividable event space, including capacity for 300 people and will have rooms for office, storage and other miscellaneous uses. A balcony will be included on the second floor to overlook the Mississippi River. The total building area of the first and second floors is about 75,000 ft^2 of space. In the final stages of design, a report and plan drawings were prepared and contained information on all aspects of the building, site and parking lot designs. The design is complete with all requirements from the client, as listed above.

All design work followed a schedule described through the Gantt Chart in Appendix F. Encompassed in the project, the complete site, parking lot and building designs meet the requests of the client and maintain city, state, and safety requirements. To begin the design, preliminary design elements, like the preferred layout of the building as well as the land/soil and utilities, were considered while in contact with the client and the city engineer. Next, layout options were formulated for the site and the internal layout of the building, while choosing some of the external architecture features and aesthetics of the structure. The loading of the building was then determined. From this information, the layout and size of the structural framing members were selected through an iterative process. Design details and the foundation were designed to finish out the composition of the structure. While these steps were being completed, a stormwater management plan considered runoff and possible solutions to increased infiltration. During the site design process, a parking lot was designed using the City of Clinton, Iowa, Code of Ordinances while also considering what would be best for the site. Finally, the design was compiled, and a report, presentation, drawing set and poster were prepared to present to the client.

The constraints, challenges and societal impacts were analyzed for the museum event center.

The constraints of the project include providing accommodations for the primarily older patrons of the museum. In completing the design, all ADA Standards were met and additional resources were considered to help this demographic. Additionally, the client expressed interest in showcasing the railroad and the river as components of the design. This was considered in allocating the museum's properties between the event center project and the amphitheater project. The railroad also presents a challenge as the noise of the train going by could interrupt events, although soundproofing elements of the building can minimize this. Along with the railroad, the site presents a few challenges such as the height of the levee obstructing views; this can be solved using the second floor balcony of the event center. This was a challenge to design around because lot space was limited. The limited space presented an issue with the parking lot design as the required number of parking spots amounted to 300 spots according to SUDAS guidelines**.** These spots take up a lot of space, and it was difficult to fit parking for the event center and amphitheater in the allowed space that the museum owns. With this, our team believes the 168 spots designed will adequately provide parking for visitors.

The societal impacts of the event center appear to be mostly beneficial to the City of Clinton and the community around the site by drawing in tourists and creating a space for events. Sustainable practices, like a green roof, can be put in place on the site to improve aesthetics. A green roof would also reduce infiltration of water to the site, helping to decrease water runoff. Implementing a project like this in the area will promote growth in the community as well as for the Sawmill Museum. The attraction will increase the museum's revenue and create a space that the community can use for many different types of events.

The design alternatives take the following factors into consideration: the soil/groundwater, site layout options, floor plan and building framing options, external architecture, and site drainage options. With the groundwater challenge not being as present as initially thought, the options we considered to resolve it will not be necessary. In our foundation design, we assumed the allowable bearing capacity of the soil to be 3000 psf. This is a standard value for the soil type and bedrock at the site.

Several site layout designs were discussed for the museum event center with plan drawings included in Appendix G. In the initial designs, different options were created to see how the two projects could work together. Some of the options incorporated the event center and amphitheater on the same lot and other options kept the two separate. This decision was primarily based on the preference of the client, which wanted the two designs separate. In talks with the client, we have selected a building geometry to resemble that of a sawtooth, in homage to the Sawmill Museum. The client expressed interest for a design on the lot directly north of the museum which includes space for parking in the northern part of the building. This option requires the amphitheater to be on the lot to the north of the event center and parking to be to the west of the event center.

The internal layout will meet the expectation that the first floor of the event center will operate as exhibit and trade show space while the second floor will operate as an event space. In our design, the lobby has multiple entrances from Grant St and 23rd St while serving as a ticketing office, gift shop, and congregation space separate from the event space. A similar layout is used on the second floor. The framing was designed using long span flat trusses to ensure open areas in the event and showroom spaces. Structural analysis was completed for gravity and lateral loads and the framing members were designed to meet criteria according to the AISC Specification for Structural Steel Buildings. Several options for space partitioning on the first and second floor can be considered. While temporary walls provide a sturdy and visually appealing look, they would be more costly, difficult to set up, and require more built-in storage space. Room dividers would provide easier set up with lower costs, but would not completely close off rooms. Lastly, retractable temporary walls would provide easy set up and medium level cost, but would most likely require drop ceilings which would reduce the overall height of the ceilings.

The exterior architectural finishes chosen for this structure were selected by weighing different alternatives suggested by the client. Alternatives considered were steel siding with a metal or brick exterior that resembled the existing museum. It was also important to the client that the design included a lot of windows on the east side of the building to showcase the Mississippi River.

The last design alternative to be considered is the site drainage. To meet requirements, drainage away from the structure is needed. This alternative has been designed for in the stormwater management plan and can be found in the Appendix I. This plan details the runoff calculations and detention of runoff from the site and parking lot. From the calculations, flood plans have been developed using the return periods of potential flooding in the area based on the rainfall intensity and runoff coefficients. Overall, the proposed design alternatives are up to the decision of the client.

The construction cost for this project was estimated to be approximately $12,301,000.00 including material, construction, and overhead and profit costs. This cost was estimated using the “RSMeans” website. Primary elements for the cost estimate includes, the framing for the building, the building finishes, doors and windows, and the site grading as well as parking lot materials.

SECTION II: ORGANIZATION, QUALIFICATIONS, AND EXPERIENCE

Our engineering team is dedicated to customer service and community satisfaction with our projects being integrated into the surrounding areas. We are based out of Iowa City, Iowa. Our project manager is Libby Lorts. Our report production team consists of Jack Marchiori and Cade McNeill who manage all files pertaining to the project, review all communication with clients, and create models and construction drawings of the final design. Eric Vidhamali, our technology service expert, creates the graphics and generates computer models for the final project.

Our team has a wide background of structural and general civil experience. Ms. Lorts has experience using ArcGIS and Civil3D designing a multi-use trail while considering hydraulic flow properties to determine trends and track deficits. She also has experience in designing and sizing structural members to complete a safe analysis of structural integrity and stability. Mr. Marchiori has experience with land development, surveying, and stormwater drainage. Mr. McNeill has worked in structural analysis, specifically joist, footing, and decking member sizing for preliminary design of steel buildings. Mr. Vidhimali has extensive experience with graphic design, especially utilizing programs such as AutoCAD and 3DSMax to recreate parts of a machine and the interior of a home.

SECTION III: PROPOSED SERVICES

I. Project Scope

In designing the event center for the Sawmill Museum of Clinton, IA, talks with the client determined the items that encompass the project's scope. Motivated by a vision to develop more tourist attention to the area and facilitate city functions and events, the museum event center design will need to meet the requirements set by the client. The owner expressed the desire that the Event Center site design will need to work alongside the proposed amphitheatre while also accounting for future developments in the area. The parking lot will need to serve the existing museum, event center, and the amphitheatre. It is also desirable for the lot to have outlets onto Grant and Main Streets. For the building design, the owner envisioned an event space that can accommodate 300 people, and a total exhibit space between 14,000 ft^2 - 16,000 ft^2 allowing for 35-40 exhibit stands of 20 ft by 20 ft. The building will function mostly as dividable event space for exhibits. The support spaces that were included at the request of the client are as follows: offices, storage spaces, ticket office, gift shop area, kitchen/catering space, bathrooms on both sides of the building, bride and groom rooms, and first & second floor lobby area, and utility spaces. There will also be large overhead doors to help the accessibility of events coming into the event center. An elevator will be included in the lobby and a service elevator at the north end of the building by the storage room. The balcony will be included as the main feature of the second floor which will showcase the view of the river.

For the final design, a complete report with included drawings consists of the site, parking lot, and building designs. Each of these categories has subsets of drawings and plans within them. The site design includes the site location, construction boundaries, existing and future utilities locations, existing and final grading requirements, retaining walls if applicable, stormwater drainage, access roads, sidewalks, and other applicable improvements. Parking lot deliverable drawings includes location and size of lots, parking stall numbers, a swepth-path analysis, cross-sections, pavement type and thickness, and drainage. Finally, the building design includes information or drawings regarding the foundations and foundation walls, floor slabs, walls, roof beams/trusses, doors and windows located and sizes, lintels and/or beams above openings in walls, suspended floors, stairs and balustrades, insulation, utility entrance (water supply, wastewater, electrical supply), and preliminary HVAC systems.

II. Work Plan

In completing the Museum Event Center project, deadlines were set in place for specific tasks to ensure effective and timely work. Tasks were assigned at each weekly team meeting and the schedule will be referenced throughout the project process. A complete summary of tasks and deadlines can be found in Appendix F, fully explained through a Gantt Chart. Main tasks include preliminary building design which was completed in the first few weeks of February, site analysis and land development which spanned from early February to the beginning of April, super and substructure design taking place from the beginning of March to the beginning of April, the parking lot design which ran from the beginning of March to the beginning of April, and finally, the compiling of the design report, plans, and presentation in the last few weeks of March and early April. Preliminary building design included initial site visits and calculating loadings for preliminary design. The site analysis and land development started with contacting the city engineer for information regarding the water table and other planning specifications, and eventually got into the runoff analysis as well as finalizing the layout of the building's interior. The super and substructure included working and completing the column schedule as well as the layout of structural members to be able to begin the computer model drawings. Finally, parking lot design included information from the runoff analysis and cut and fill to design the correct amount of spots for our project, as well as the amphitheater.

III. Methods and Design Guides

Several codes and specifications were used throughout the design process to assure that the design meets city, state and safety requirements. The following city and state codes were referenced: 2018 International Building Code (IBC), 2018 International Fire Code (IFC), 2010 ADA Standards, City of Clinton, Iowa, Code of Ordinances, and the SUDAS for working with the existing streets as well as the parking lot.

In addition, building loading and design follow procedures from ASCE 7-16, as well as AISC specifications. The event center will meet all safety requirements from these materials, and will include the qualifications discussed in the IBC, IRC, IFC, ADA Standards, City of Clinton Zoning Ordinance, City of Clinton Municipal Code and follow 2010 ADA Standards. The site will use the City of Clinton Zoning Ordinance, Tree Ordinance and Stormwater Management Ordinance in design to ensure proper runoff, aesthetic and environmental stipulations. Lastly, the parking lot design will utilize the City of Clinton Zoning Ordinance: Parking and Loading Standards, ADA Standards, City of Clinton Municipal Code and SUDAS to determine design and standards are met.

SECTION IV: CONSTRAINTS, CHALLENGES, AND SOCIETAL IMPACTS

I. Constraints

Constraints for this project can be broken down into care for the older demographic, the railroad, and allocation of space in the museum owned lots.

Accessibility for older citizens is emphasized as they are the main demographic using the event center and parking lot. Hallways, bathrooms, elevators and more will be designed to create a safe and inviting environment.

The railroad running alongside Grant Street will present an issue in the way traffic is routed for parking, especially for events like the Canadian-Pacific holiday train that passes through. This serves to be a constraint because space will be a factor with parking in the area, as well as other events that are put on by the town and the museum. Although the client has expressed the allowance of street parking in the area.

On the same site-location as the event center, an amphitheater project is also being proposed. Alternative designs and solutions must be changed according to the size and layout of the proposed amphitheater. Parking and allowing enough spaces to meet code will also be a constraint with limited space owned by the museum.

II. Challenges

Challenges for this project are construction on a site near the Mississippi River, noise of the neighboring trains that pass through, and the height of the levee preventing the view of the river. After our initial analysis and working through the design process, new challenges that arose during the design steps include long spans over the event spaces on each floor, the number of parking spaces not meeting city codes, and the frequent changes to the initial layout of the column schedule and client desires. Our initial challenges highlighted are still challenges, so they will still be mentioned in this section.

The groundwater table is an issue that we initially thought would increase costs and the duration of construction. During construction, unstable subgrade and excavation as well as water seepage may occur. After construction, the building can experience leaks leading to mold and cracking/uneven walls and floors. Solutions include dewatering methods during construction like slurry walls, sheet piles, and curtain grouting. Preventative measures can be included to lower the infiltration rate of water by using green roofs and permeable pavement on the parking lot enabling the collection of water for future use. However, we were told by the city engineer that this specific site was dominated by bedrock and some soil deposits. This is not as large of a challenge to design our foundation for as we initially thought.

The frequency of trains passing the site is expressed to be frequent and loud. Being conscious of the orientation of the structure and materials that will dampen the sound can change design and increase costs. This may influence and interfere some of the exhibits in the event center regarding noise and general traffic through the area.

The levee along the Mississippi River will make it difficult to oversee the river. Creating a structure tall enough to enjoy the river as a backdrop can change the whole design of the structure, materials used and increase construction costs to make that design feasible.

The long spans of our joists served to be a design constraint and challenge because they were very close to maxing out design parameters for safe design. We settled on a flat, 6 ft deep Howe truss for structural framing members with the longest span being 80 ft. Longer spans can create larger loads on these members, so they will need to be larger, and this will drive up the cost of the primary structural members. Optimizing these members to be the most cost effective, as well as sustaining the required loading.

In the design process of the parking lot, the main constraint was the size of the land plots available. Due to the location of the event center and amphitheater, there was one lot available that complied with the clients request to have a parking lot that supported both projects. Another major constraint was existing features such as the train tracks, homes, and restaurant. Not only did the parking lot require a setback from the surrounding roads, but it also had to be set back from the tracks and other features. The setback used was 10 ft which was found in the Iowa SUDAS manual for light industrial districts. From the setback, the lot size became smaller resulting in less overall spots. This led to concerns about meeting the required parking stall requirement as laid out by SUDAS. To help maximum the total number of stalls, two additional lots were designed on the lot of the building at the north and south ends. The functions of the lot north of the building was to create more stalls and provide access to the large overhead door. The overhead door was intended to provide access into the event center for large vehicles such as RVs. The function of the south end was to provide the required ADA stalls. This lot was kept within close proximity of the building to allow for easy access. A major problem the south lot ran into was that Grant Street cut into the original property line due to a railroad road easement. This meant that an entrance from the south end would likely not work. There were two main reasons for this entrance failing aside from the easement. The first reason being that it made crossing Grant Street not ADA accessible. The second being that the turn was not possible from a swept path analysis. Overall each of the lots were mainly constrained by the SUDAS requirements and ADA standards.

Throughout the initial design process, a lot of unexpected modifications had to be made to the building shape and internal layout. This was a challenge because we were trying to move forward with the column schedule, joist layouts, and the rest of the design process, but there were always steps backwards when it came to decisions that had to be made. Eventually, we got to the point where we ironed out a specific layout and it worked for all of the parameters we were designing at that point in time.

III. Societal Impact

Overall, the city of Clinton has a median income lower than the average in the U.S., predominantly Caucasian English speaking and between the ages of 18 to 65. The study area of this project includes some residential and business areas but does not infringe much on those properties. The west parking lot is shared by existing residents and their input on the proposed parking lot is to be scheduled to recognize potential questions and concerns. Future outreach programs will seek input from people ranging from current residences to annual event goers to best accommodate them and how they will use the proposed event center in their daily lives. Accommodations for elderly and disabled are important and provisions are provided, from having a compliant railroad cross walk from the west parking lot to the building, to wide entrances and exits in the building. Installing connecting pedestrian trails, installing street lighting and landscaping are to be considered to create a pedestrian friendly community.

Societal impacts are narrowed down into community resources, individual and family changes, and sustainable practices.

For community resources, the site area will be a community hub for both indoor and outdoor entertainment. The Discovery Trail along the Mississippi River is a long stretch used by many runners and cyclists. Outreach programs will help determine how important the implementation of bicycle storage, repair hubs, fountains, and other amenities are.

For individuals and families, the event center will encourage visitors, near and far, of different demographics and age groups to congregate and interact for a common interest and will facilitate education of various subjects during different events that are held there.

For sustainable practices, green roofs will create a cost-effective insulation for the structure in the long run, reduce infiltration rate of stormwater as to not add to the existing shallow water table problem, and promote not only sustainable practices but also be aesthetically pleasing.

The Guidelines and Principles for Social Impact Assessment set out by the NOAA define social impacts as, "...the consequences to human populations of any public or private actions-that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society."

For our structure, we need to define and identify the social impact assessment variables. This is highlighted in the NOAA guidelines by 1) Population Characteristics 2) Community and Institutional Structures 3) Political and Social Resources 4) Individual and Family Changes 5) Community Resources. By these standards, we can define the population that our structure will serve. This structure will mostly serve an older demographic from a smaller town in northeast Iowa. However, temporary residents and patrons may include multiple different age groups and ethnicities with events that the museum plans to put on.

In conjunction with the museum, religious groups, political affiliation, and different backgrounds will have an influence on the daily functions of the event center. There may need to be cultural awareness within the institution. Community resources will be poured into this center, so we must plan for the natural use of land and the resources it holds. The key to continuity and survival of human communities and their historical and cultural resources is the availability of housing and community services. This event center will serve to be a place for congregation and potential job growth for the surrounding area. It is a value of the museum to uphold the historical and cultural significance of its exhibits.

There will be a due consideration of land requirements, needs for ancillary facilities (roads, transmission lines, sewer and water lines), local services requirements, and the construction schedule. These factors will influence the public and surrounding area of this project in ways such as creating traffic or blocking off roadways, interrupting travel through nature trails and surrounding areas, and creating a demand for institutional resources for funding.

A social impact assessment not only forecasts impacts, it should identify means to mitigate adverse impacts. Mitigation includes avoiding the impact by not taking or modifying an action; minimizing, rectifying, or reducing the impacts through the design or operation of the project or policy; or compensating for the impact by providing substitute facilities, resources, or opportunities (see 40 CFR 1508.20). For this project, possible adverse influences on the surrounding area include crowding, runoff issues, and socioeconomic mitigation. Federal legislation has many executive orders for this mitigation, these are required for considering the human and community conditions present in this project. We include the diverse public that may be potentially affected by the construction of this event center, clearly identify who will be vulnerable by the construction and process of building, deal with issues and public concerns, clearly describe how the SIA was conducted, provide feedback to problems, mitigate adverse impacts, and evaluate missing information to develop a strategy for proceeding with construction.

SECTION V: ALTERNATIVE SOLUTIONS CONSIDERED

The design process presented a lot of decisions and options that needed to be considered to meet the client's requests. The alternative solutions began with considering the site layout and the building shape. Next, the internal layout of the first and second floor were determined and framing options were considered. Then, architecture style options were analyzed to determine the best fit for the event center. Finally, the parking lot details were investigated to complete the site design for the project. These steps will be highlighted in the sections below.

I. Site Layout and Building Shape

From initial meetings with the client, a few options for potential building shapes were proposed based on the wants and needs for the project. These initial layouts were not used in the end, but they did lay a path for finding the final layout. The all initial options can be found in Appendix G. After talking with the client, a design similar to the option in Figure 5.1 was considered.

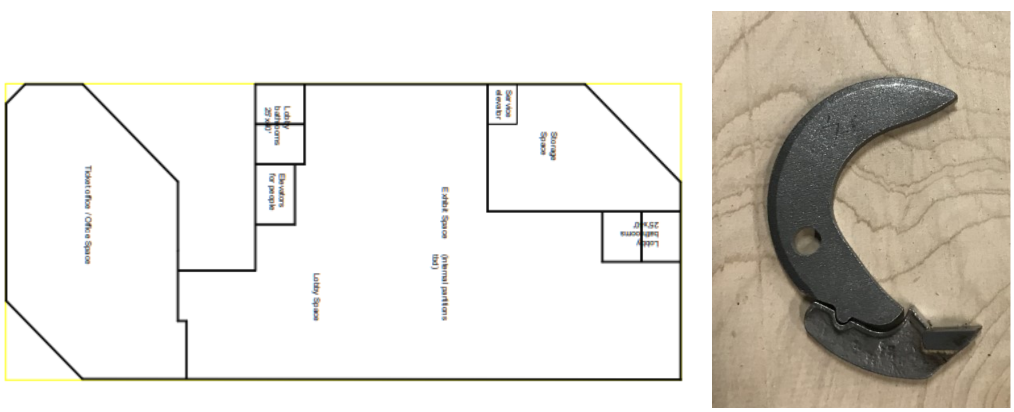


Figure 5.1: Initial building shape layout (left) selected in comparison to the Museum's sawtooth (right).

II. Floor Plan Layout and Structural Framing System

With the shape of the building and site layout finalized, options for the internal layout of the building were presented to the client. We proposed many options that had variances in square footage and sizes of the building. This was done to give the client options of larger spaces, more green space, or different entry methods for the lobby. These preliminary options are shown in Figure 5.2.

Option 1

Option 2

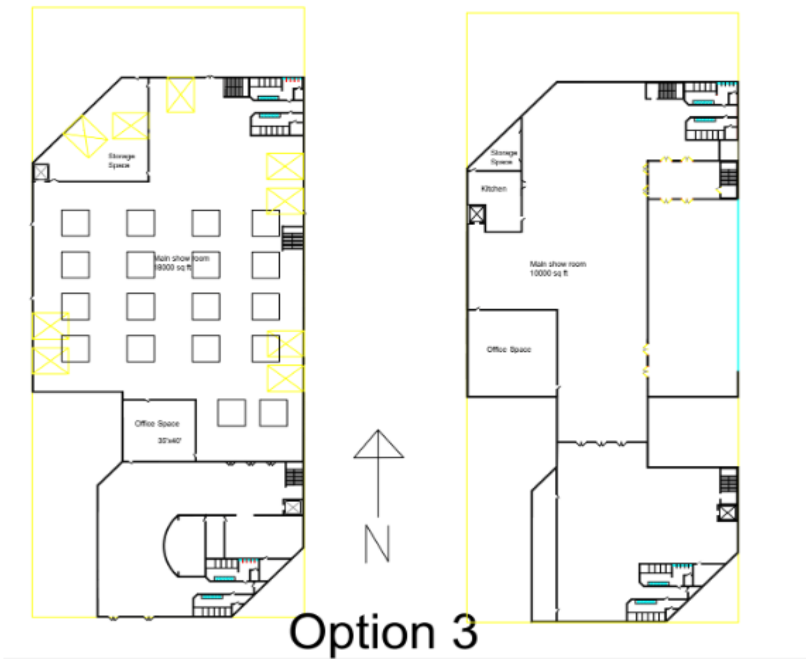


Figure 5.2: Initial floor plan options for first (left) and second (right).

Figure 5.3: Three options for first floor partitioning.

Preliminary member sizing met a challenge with the shape of the building. Small modifications had to be made to the layouts to fit a structural grid. Through this the shape and dimensions of the building were modified to begin the preliminary design of framing. The final grid is shown and detailed in Section VI-III. This ultimately grid helped to lay out the columns and begin to figure out span lengths and loads for our primary framing members.

The selection of our primary framing members came from the detailed calculations in Appendix K. In selecting the most economic and sturdiest layout for the long spans over the event space on both floors, several load paths were considered. To determine the best options to meet the long span criteria, “Building Structures Illustrated” by Francis Ching was utilized. From the text, long span, flat, Howe trusses were determined to be the best option to minimize failures and deflection. From here, a one-way spanning metal deck and joist configurations were analyzed using the Vulcraft Design Manual. These options were decided upon by their cost effectiveness, strength to withstand loading, and their appearance from the spaces in the museum where they would be visible. Next, the AISC Design Manual was utilized in determining the preliminary design for all other framing members including the components of the Howe Trusses. Round HSS tubes were used for webbing and bottom chords in the trusses because of the type of loading they would withstand and because that add an element to the design that would be more appealing as the trusses will be exposed. In considering different elements for the framing, a complete preliminary design was used in performing final calculations for the structure.

III. Architectural Style

Regarding potential options for the style of architecture to be used, many options were examined for the siding. This included corrugated metal siding, stone, brick, masonry brick, stucco, and shiplap wood siding. In talks with the client, we decided upon a corrugated aluminum siding with slatted wood finishes, while also incorporating a lot of windows to fit the client's request. This decision was made to match similar buildings in the area, while also giving a modern look to the newer structure.

IV. Parking Lot Design

In designing the parking lot, the SUDAS manual was used for setbacks and size requirements of the parking lots. The 2010 ADA accessible design manual was also used to determine ADA stall requirements. Since the parking lots needed to support the museum and amphitheatre, the amphitheater group was contacted to determine where the parking lots could go. The project is located in a light commercial district and so setbacks of 10 ft were used. Several different layouts were created at angles of 45, 60, and 90 degree parking stalls to find a maximum number of stalls for the given area. Ultimately the maximum number of stalls was reached by using the 90 degree parking stalls. The main constraint in designing the parking lot was the size available on the site.

SECTION VI: FINAL DESIGN DETAILS

Several aspects make up the final design of the Sawmill Event Center. The components of the final design considered all alternatives as well as advocated for the clients requests as mentioned in the project scope. Through in depth calculations and following codes and standards, full design details were determined and described for the site, parking lot and building designs as highlighted in this section.

I. Groundwater and Drainage

When initially receiving the project for the Sawmill Museum it was noted that the groundwater table in the area of the future build(s) is close to the surface. This creates a possibility of flooding of the structure if the foundation is below the groundwater table. Foundation footings and basement slabs should sit above the water table so that groundwater will not put pressure on the foundation or cause a dampness problem. On a site with a high water table, it may be preferable to pump water out and build a shallow foundation, or bring in fill to raise the grade. Digging down for a deep foundation will cause the holes to fill with water and not be adequate for the foundation of the structure. In this condition, a slab foundation is recommended because of its relative simplicity and cost effectiveness. More precautions can be taken to make the fill work, but this option will significantly complicate the project, through our initial analysis.

Following initial information received about the situation, the city engineer expressed the ground water should not be an issue on this site. The site is dominated by soil and bedrock that we assume to have a psf of 3000.

Following the determination of the soil on the site, the drainage was considered. As a normal consideration, the soil around the structure must slope at least 5 feet away from the foundation. Part of our initial analysis needs the existing plumbing in the area, which we do not currently have access to. Generally, installing a sump pump system around the foundation will help drainage away from the structure. This is done by digging a trench around the foundation, lining it with gravel, placing a drain to pull away water, then covering it with gravel and soil. This option is the most conventional and the most common option. Another option would be installing an underground drainage system towards the river. This would require more work and caution when it comes to the surrounding areas and existing features.

To control the runoff of the site, analysis was performed to ensure proper drainage. The rational method was used considering the area of the site and assumptions were made to determine the pre-development and post-development conditions. In the pre-development assumptions, concrete/asphalt was used for the parking lots in order to make the estimate conservative. The primary goal was to make sure the post-development would meet the pre-development conditions or be better. To do this we considered rain gardens to counteract the space taken up by the new structure as well as utilized a permeable pavement option for the parking lots. A summary of the runoff calculations can be found in Table 6.1. All runoff calculations can be found in Appendix I.

Table 6.1: Stormwater runoff Summary Using the Rational Method

Parking Lot Option (POST)		
Combined Runoff Coeff. With Soil Group C		
5 yr	10 yr	100 yr
0.84	0.85	0.90

Parking Lot Option (PRE)		
Combined Runoff Coeff. With Soil Group C		
5 yr	10 yr	100 yr
0.64	0.70	0.77

Peak Runoff		
POST-DEVELOPMENT		
Rainfall Duration (hr)	Soil Group C	
	5 yr	100 yr
0.25	7.7988	14.96958
24	0.3015	0.6471
PRE-DEVELOPMENT		
Rainfall Duration (hr)	Soil Group C	
	5 yr	100 yr
0.25	5.9364	12.88758
24	0.2295	0.5571

The rain gardens as seen in Figure 6.1, were placed around the building in the open corners to provide a minimal solution for the runoff. The larger factor in reducing the runoff and possible ponding on the site was utilizing a permeable paver system. The pavers selected came from True Grid^{TM}, where they use detention in the sediment of the system to reduce the runoff. In this system, ponding is prevented by the pavers and there would be low maintenance to the parking lots.

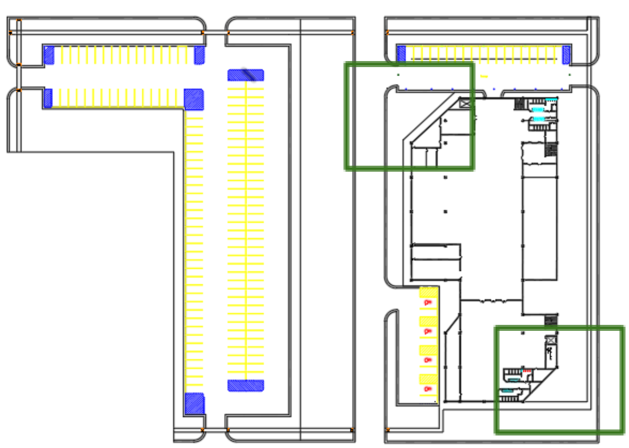


Figure 6.1: Rain gardens on event center site.

II. Site and Parking Lot Design

After initially gaining information on the client's wants and needs for this new structure, our team went to work on potential layouts of the plots of land that are for use on this project. The drawings produced are potential options for the layout of the future structure, amphitheatre, and parking lot. A few options were presented with the amphitheatre and event center combined, while some options were presented with the two separate. With the two projects apart, it will provide more square footage, while the other will provide more green space, land, and compaction of the area. The client has chosen the option of having the event center and amphitheater separate after further design options. The final site layout plan can be found in Figure 6.2.

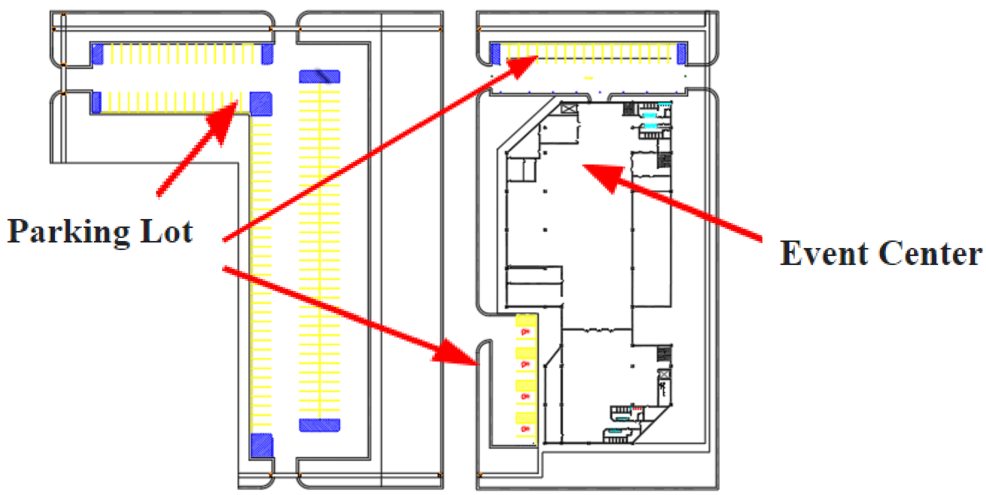


Figure 6.2: The final layout for the event center with the parking lot to the west

After determining the layout of the site, the parking lot design was completed. Data from Beacon on Clinton County was utilized to create a model of the parcels on which the site is located. The data was used to measure relative locations and distances in order to size the parking lots. In designing the parking lots, Chapter 8 of the Iowa Statewide Urban Design and Specifications (SUDAS) manual was referenced along with 2010 ADA standards for accessible design. To determine the required number of parking stalls both the event center gross floor area and amphitheater capacity needed to be considered. Before considering the capacity requirements for the amphitheater, analysis was completed for the building first. The gross area of the building was used to determine the required quantity of total parking stalls as well as ADA stalls. According to SUDAS, there would need to be 300 total parking stalls with 8 ADA stalls. Another key requirement from SUDAS was that for a light industrial district a setback of 10 ft must be used. With these requirements in mind all three orientations of the stalls were tested within the provided area at 90, 60, and 45 degrees. Each orientation required different aisle widths as well as stall projections. After analyzing each of the three orientations within each of the lots, a design angle was determined. The 90 degree orientation provided the most effective use of the land while also providing easy driving access for all three lots. Using a 90 degree orientation resulted in having 2-way driveways throughout with a 24-'0" wide aisle. The design dimensions, per SUDAS, of the stalls were 18'0" deep and 8'-6" wide. Using these dimensions, a total of 168 stalls were designed and fitted accordingly on the west and north lots. For the South ADA stalls were designed as this lot would be the closest to the front entrance. This lot included the required 8 ADA stalls as stated before. A swept path analysis was completed with the design vehicle to ensure the stalls were possible. The design vehicles specifications per SUDAS were 17'-3" long and 6'-7" wide. After analysis it was concluded all three lots could be parked in by the design vehicle.

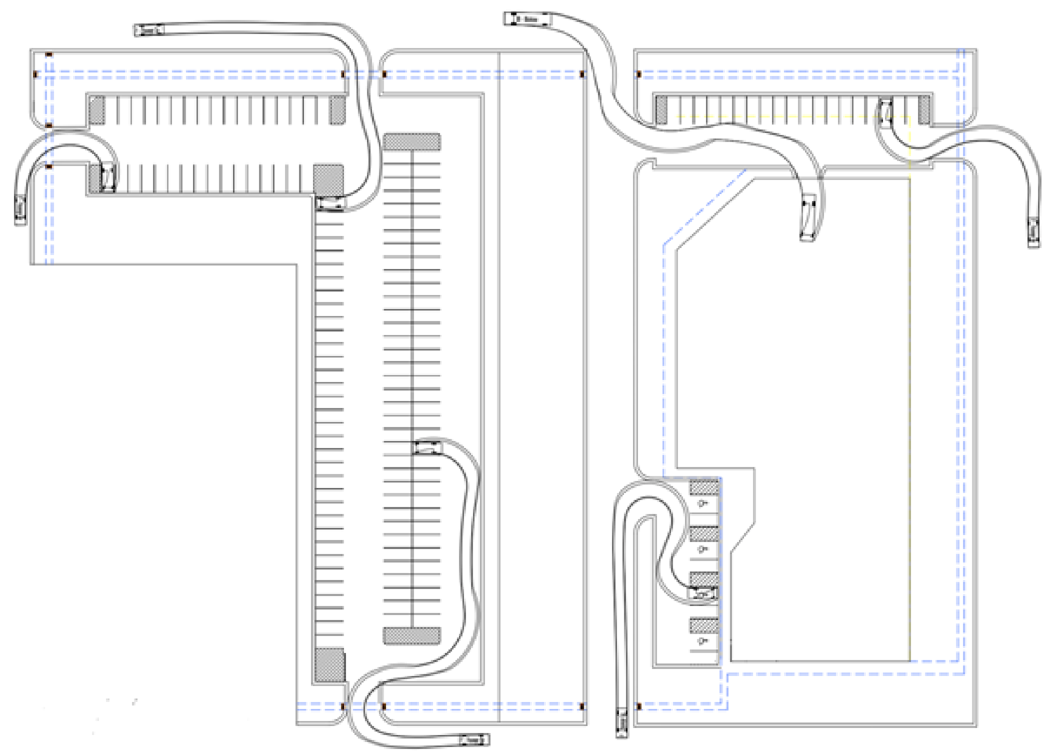


Figure 6.3: Swept-Path Analysis of All three parking lots

In concluding analysis of the parking lot, it was clear that the parking lot was well under the required parking stall quantity requirement from SUDAS. One main solution offered by the client was to provide more on street parking along Grant Street. This would allow the site to gain more stalls, but likely still fall short of the required 300 parking stalls. Another possible solution would be to build a parking garage. This solution would likely be more costly and require more design time. This design could possibly be considered later as the operations of the event center are more steady. The optimal solution with cost in consideration would be an exemption granted by the City of Clinton to be under the requirement.

In completing the parking lot design, the utilities were considered in completing the site design. Several assumptions were made about the site's utilities after not being able to receive detailed information from the utility companies. In information given by the American Water Association, a water main runs along Grant St. with a dead end along 23rd Ave. It is assumed that the new event center will utilize a connection at the dead end main. Additionally, in information given by Alliant Energy, the event center will have the capability to hook-up to electricity in the area. Lastly, in considering stormwater runoff for the site, it was assumed that there is no existing stormwater system. In this case, a septic system will need to be designed and installed. The completion of the site and parking lot design followed the Clinton City Ordinance, SUDAS, and ADA Standards.

III. Floor Plan Layout and Structural Framing System

The floor plan of the future structure was dependent on several factors in the design process. Using the desires of the client, we began the initial design layout of the interior partitions of the structure. We used the information to determine the rooms and their corresponding floors to create a seamless flow for the layout of the building. Beginning the design of the building, several options of building shapes and layouts were considered and narrowed down. Initial design suggested a rectangular or "L-shaped" building, but in pursuit of a more artistic structure, a shape resembling the Sawmill Museum's sawtooth was formulated. In considering the building shape, alternatives were created with varying building areas and layouts. The alternative selected optimized the area of the open spaces on the ground level and second floor, while also being conservative to the size needed to fit the use of the community. The IBC and the 2010 ADA Standards were used in selecting the locations of the doors, staircases, and elevators.

As stated from the initial client meeting, it was desired that the structure have some customization when it comes to the walls of the exhibit areas. To accommodate this request, a few options were explored for partitioning areas off. First, temporary walls could be utilized. This will create a need for more storage space to store these walls, which can be accommodated in the building's floor plan layout. The benefits of this would be having a sturdier wall between areas than a wall divider and it is more permanent. The drawbacks being it will cost more, require more storage space, and will require a more intense setup. The second option to consider would be room dividers. This option will require less storage space, cost less, and be easier to set up. However, it will not be as strong, it does not fully close off an area, and it will not look as professional. The last potential option to consider for this structure is installing retractable temporary walls. These could be hidden and retracted into the wall, but would most likely require a drop ceiling or different accommodation to work correctly. Benefits of this option are that the walls can be easily set up, will close off the desired areas, and are relatively inexpensive. On the downside, installation may be more expensive, installing drop ceilings will take away from the tall/open feel of the room, and you will have to install the channels for the wall to slide upon, so the customization of the space is not as complete.

The final floor plan layout includes an entrance lobby with ticket office, offices for the museum, storage spaces, a gift shop, a kitchen/catering space, bathrooms on both sides of the building, bride and groom rooms, and utility spaces. The areas are partitioned off between the lobby and event space for the flow of the exhibit spaces to not be inhibited. The final floor plans for the first and second floors with columns can be seen in Figures 6.4 and 6.5.

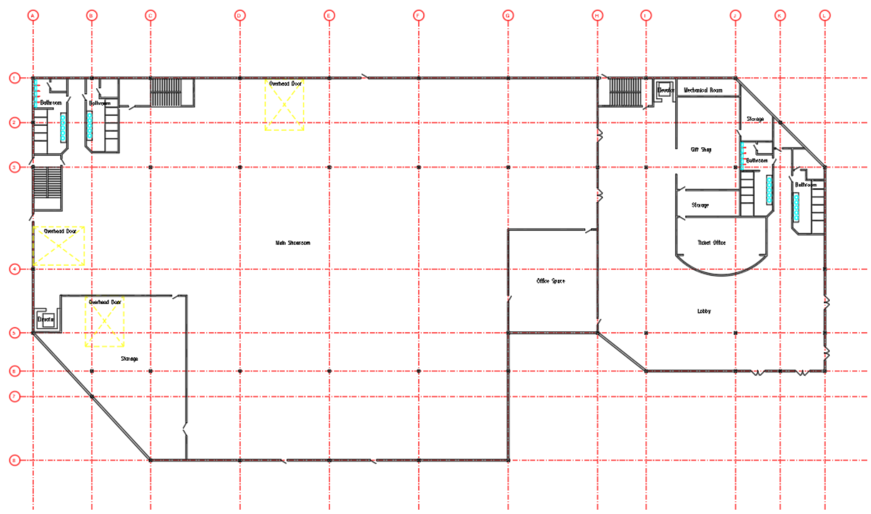


Figure 6.4: The first floor layout with columns

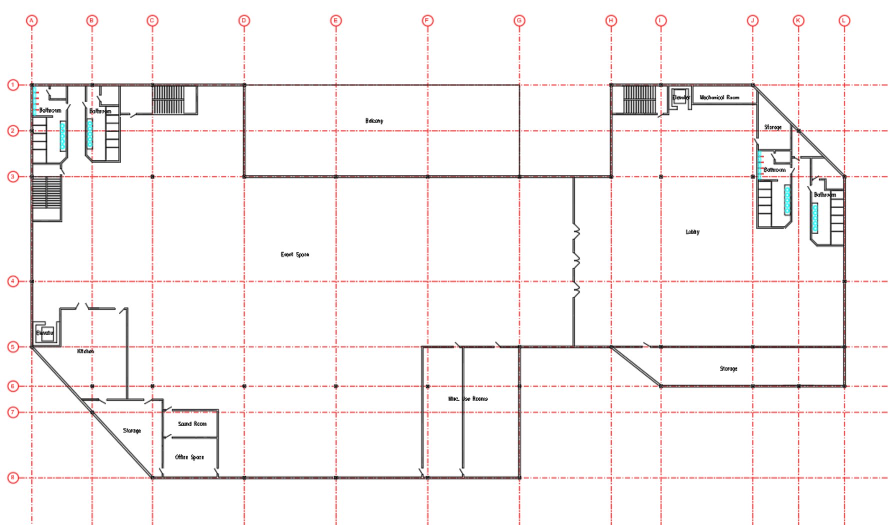


Figure 6.5: The second floor layout with columns

After completing the floor plan design, a structural grid was determined. Internal partitions and functional uses of the building were considered in the formation of the structural grid. The reference “Building Structures Illustrated” was used in deciding on span length and possible load paths for the design. To maximize the open space, a span length of 80 ft in the short direction of the building was used for the center framing with shorter spans of around 35 ft completing the framing in the short direction. In the long direction 35 ft bays were used to complete the span, with a few exceptions to account for the slanted walls. A complete grid and framing plan of final member sizes for the first and second floor can be seen in Figure 6.6 and 6.7 below.

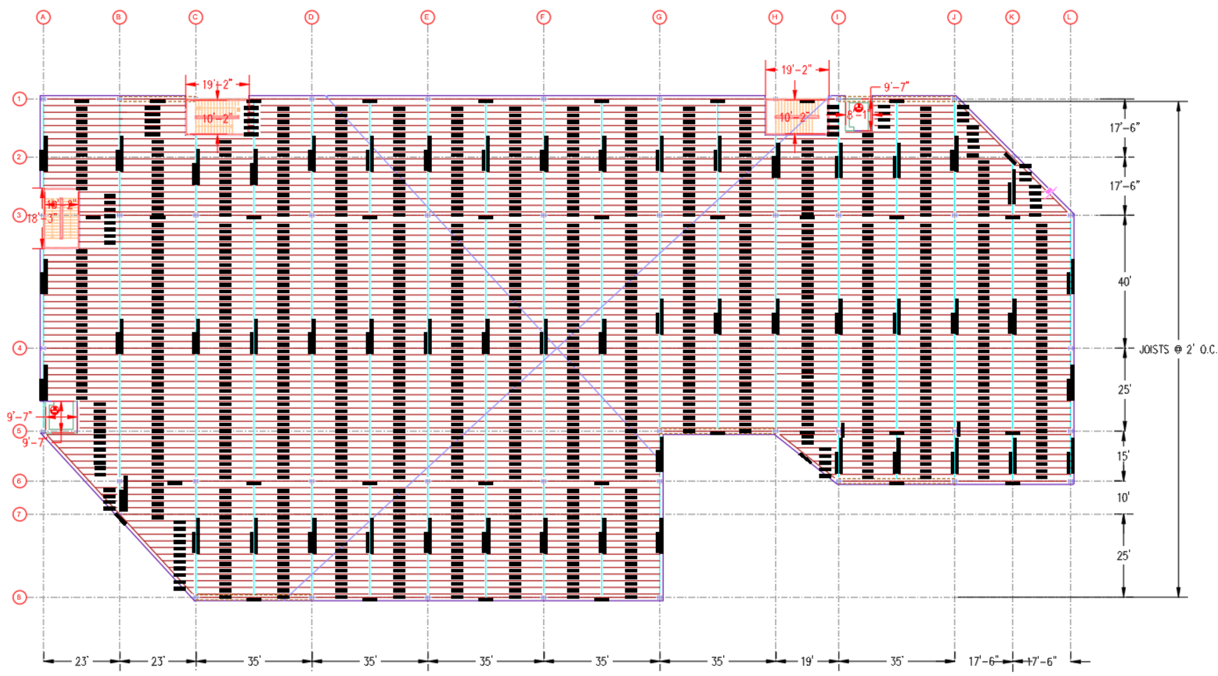


Figure 6.6: Completed framing on irregular grid with rectangular bays for the first floor

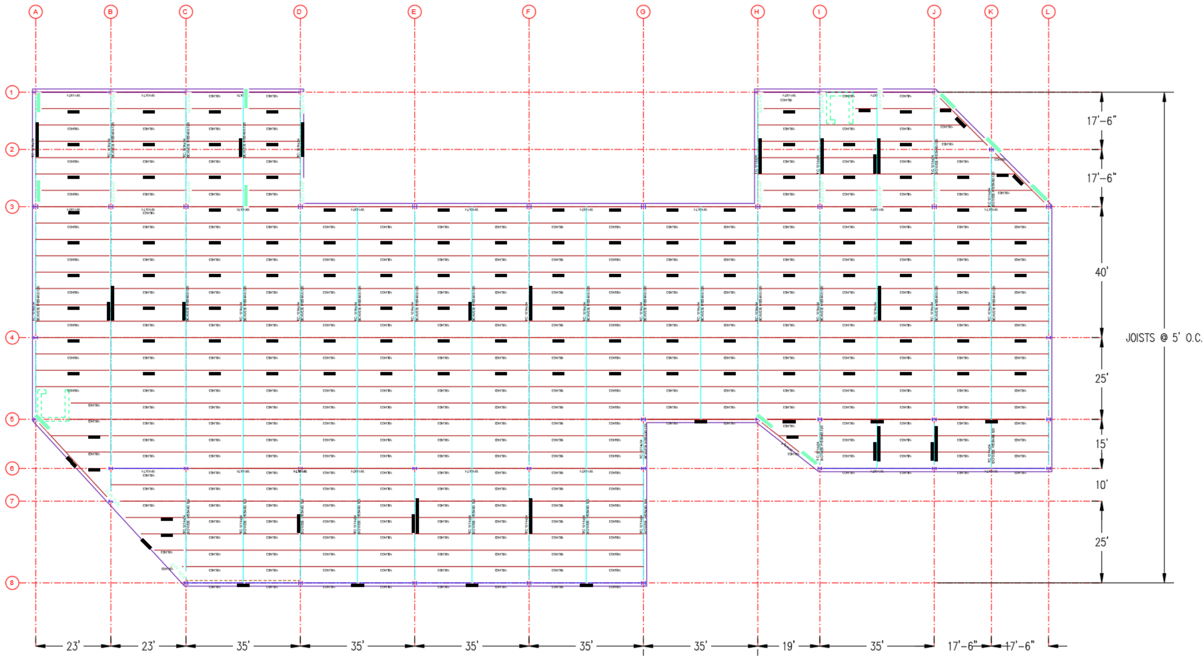


Figure 6.7: Completed framing on irregular grid with rectangular bays for the second floor

Following the selection of the structural grid, the framing system was developed. Dead loads of materials and live loads selected from "ASCE 7-16 Design Loading Criteria" were calculated and used to determine the required strength of the framing members. Superimposed uniform dead loads were determined to be 17.54 psf for the roof system and 33.904 psf for the second floor system. A live load of 100 psf was used across the structure for the second floor framing to fit the event space criteria. A snow load of 24.55 psf and roof live load of 20 psf were compared to completed the roof loading. All loads were analyzed using ASD load combinations. All dead load and live load calculations can be found in Appendix K. Preliminary selection of the deck and joists was completed using the Vulcraft^{TM} Design Manuals. The load path was then traced from the top following the path of the deck, joists, trusses, girders, columns and then to the ground as seen in Figure 6.6. A preliminary spacing of the trusses were then selected at 2 ft for the second level framing and 5 ft for the roof level framing. The rest of the framing members were then chosen based on the strength requirements found in the AISC Manual.

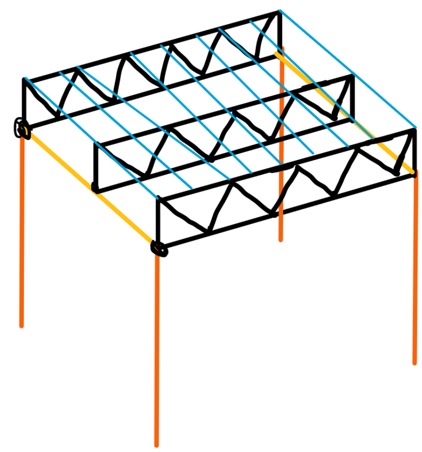


Figure 6.8: Isometric view of the preliminary structural framing

After the preliminary framing members were identified, lateral load analysis was performed to test the framing. Wind loads were calculated in the North-South and East-West directions and values were determined as seen in Figure 6.9.

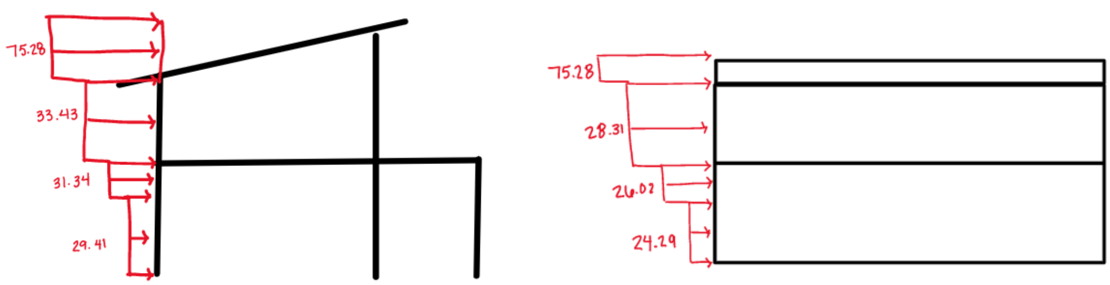


Figure 6.9: Net wind loading in the E-W (left) and N-S (right) directions

The roof and second floor diaphragms were then analyzed. Preliminary moment frame bracing was placed at every other truss-column frame spanning E-W in the structure, while cross bracing was placed at the corners of the building running in the N-S direction. The roof diaphragm was analyzed as a flexible diaphragm in both the N-S and E-W directions and shear loads were found in each floor, where the greatest value for each frame was taken as governing. The second floor diaphragm was analyzed as a rigid diaphragm in both wind directions and the greatest values applied to each shear collector were used in analysis. After calculating the loads at each moment frame and bracing system, the framing systems were individually put into AutoDesk Robot and analyzed under the lateral loading and load path loading. From here, the framing members were determined to have adequate or inadequate strength through an interactive process. The top chord of the trusses were analyzed in combined loading of flexure and compression. The bottom chord and web members were analyzed in tension and compression. The girders were examined under flexure. Lastly, the columns were analyzed under combined loading of compression and flexure.

From here the corresponding loading conditions were compared to values in specific tables from the AISC design manual to ensure that the members had adequate strength. Additional moment frames and bracing were added through the process and the final lateral force resisting system was selected as seen in Figure 6.10. All AutoDesk Robot outputs can be seen in Appendix K. The lateral force resisting system design calculations and testing can be found in the Appendix K.

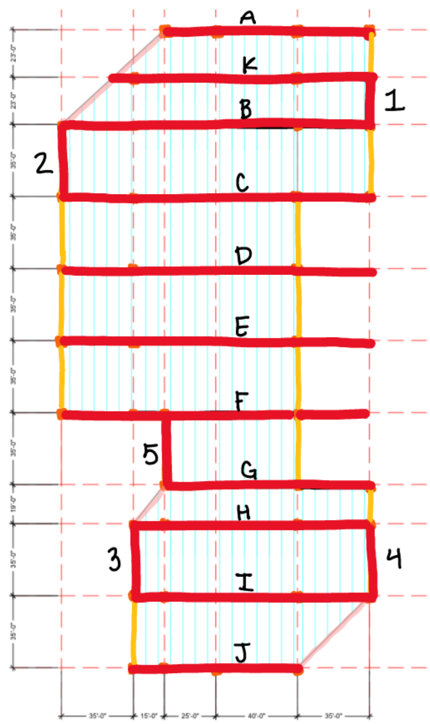


Figure 6.10: Lateral force resisting system components, with lettered elements being moment frames and numbered elements being braced frames.

The final selection of materials was based on adequate loading in the trusses and girders, and deflection in the girders. A summary of elements can be seen in Table 6.2 and the final framing can be referenced in Figures 6.4 and 6.5. The roof elements slope at 1.909 degrees from West to East to create a monoslope roof style, allowing the water runoff to travel in the opposite direction of the second floor balcony.

Table 6.2: Summary of Framing Elements

Framing Component	Steel Shape
Roof Deck	B24
Roof Joist	18LH03
Roof Truss - Top Chord	W14x34
Roof Truss - Bottom Chord/Web	HSS4x1/8
Roof Girder	W14x74
Second Floor Deck	1.0C24
Second Floor Joist	20LH10
Second Floor Truss - Top Chord	W19x106
Second Floor Truss - Bottom Chord/Web	HSS4x1/8
Second Floor Girder	W16x57
Columns at Bay "2"	W14x120
All Other Columns	W12x120
Bracing	HSS4 1/2x4 1/2x 1/4

For the foundation, final design calculations were made from column analysis. We assumed a soil bearing capacity of 3000 psf for the supporting soil and bedrock combination. This is a conservative estimate as we could have bumped it to 4000 psf, but we chose to air on the side of caution for footing design. The average column applied force is 28 kips and this was included in the design loading for the floor depending on the room above each column. There was also a supporting foundation wall designed around the perimeter of the building for foundation wall support. We decided upon 24” steel piers to extend down 7’ to the footings below the foundation. This is conservatively below the frostline in the area and to meet Iowa code. A final footing layout can be found in Figure 6.11. All calculations for the foundation design can be found in Appendix K.

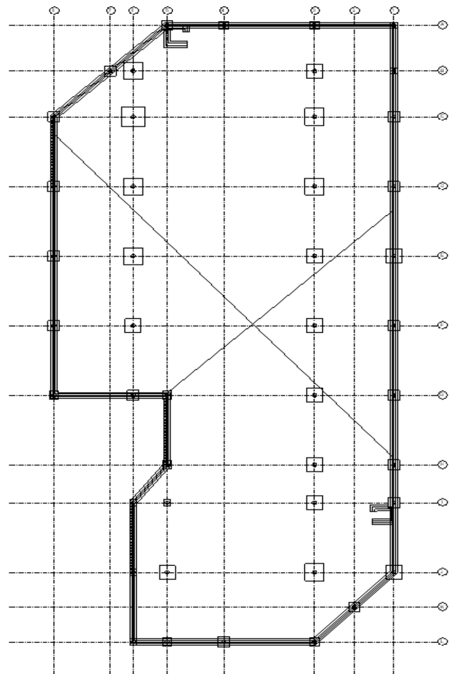


Figure 6.11: Column and footing schedule for the foundation

Final design details were decided, including specifics on the elevator, stairs and moment frame connections. The elevator was chosen to be an ORION Model 4854 (1L) - LU/LA serving as a good fit for the two floor system and meeting 2010 ADA Standards. The structural design of the elevator meets the requirements by the elevator company; the specific requirements from the elevator company can be found in the Appendix K. The three stairwells meet IBC standards and two of the stairwells provide adequate access to the outside to meet fire regulations. A typical moment frame connection was chosen using specifics from the AISC manual, where a general stud-plate design was decided on.

To complete the structural design, a 3D model of the framing including the elevator shaft, stairs, and the foundation was completed in Revit, as seen in Figure 6.12. The framing was then used to create a set of structural drawings that can be found in the Appendix K. These drawings include floor plans for all levels, detailed sheets of structural elements and floor plan layouts for the ground and second floors.

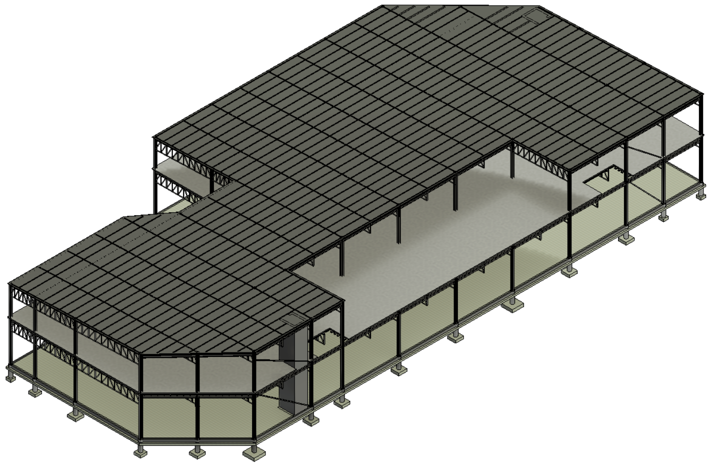


Figure 6.12: Final 3D rendering of event center from Revit.

IV. Architectural Style

For the outside of the building, we wanted to match the architecture of similar buildings around the area with a more modern look. To do this, metal siding was considered as well as wood siding to link back to the Sawmill Museum. Towards the river, we utilized a lot of floor to ceiling windows to showcase the scenery and make the space open to the natural light. After further meeting with the client, the shape of saw blades, steel and wood were important points of inspiration. The final design of the building shape takes inspiration from a saw tooth and materials used for the structural and exterior elements mimic that of an old lumber mill. Because there are two large showrooms, lighting was an important factor to create an inviting space that is not claustrophobic. We chose to use monolithic, double glazed, glass panels with a spider fitting system so that panels may span from the ground to the ceiling without obstruction of typical window framing. It was also important to have an open view of the Mississippi River and windmill across the way and this type of system achieves the best viewing experience. A final rendering of the building with finishes can be seen in Figure 6.13.

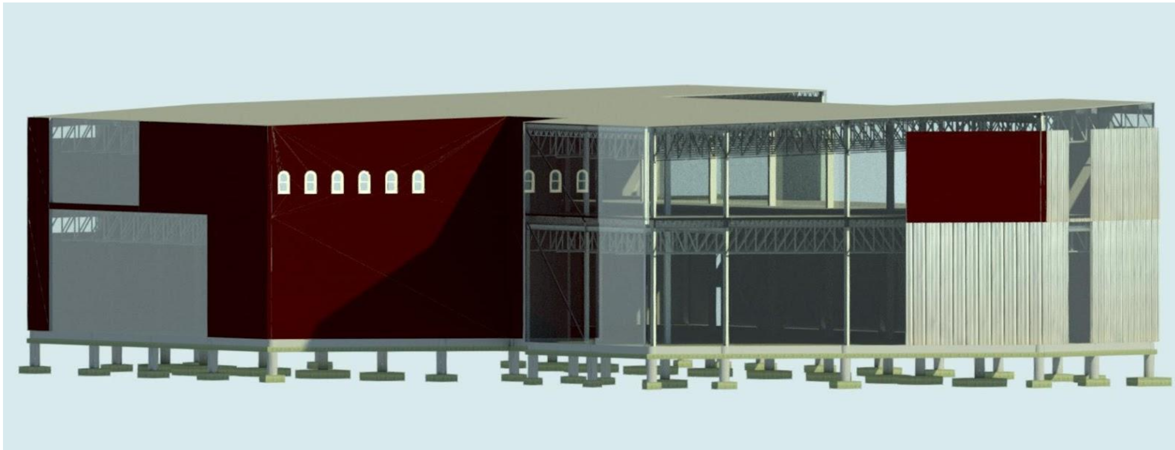


Figure 6.13: Final rendering of the Sawmill Event Center

SECTION VII: Final Construction Cost Estimate

The total construction cost of the Sawmill Event Center comes to approximately $12,301,000. The final cost estimate was based on the site, parking lot and building designs, including material costs as well as overhead and profit costs. Cost estimates taken from “RSMeans.com” were employed to calculate total project cost in a detailed breakdown of materials. A detailed breakdown of all elements totaled can be found in Table 7.1. Parking lot costs were estimated using the cost of the permeable pavers, and the driveway, curb and sidewalk costs included the cost of concrete and installation. In the site estimate, cut and fill, grading and rain gardens were taken into account. Finally, the cost of the building materials for roofing, insulation, finishes and ductwork was calculated by each item and added to the total framing cost of the steel and concrete for the building.

Table 7.1: Total Project Cost

QTY	Parking Lot/Site			
16632.89	Fine grading, slopes, gentle, finish grading	SY	$ 2,162.28	$ 2,993.92
11000	Excavating, large volume projecs, 200 BCY, 8CY, bucket bad	LCY	$ 5,280.00	$ 6,380.00
7468	Sidewalks, driveways, and patios, sidewalks, concrete, excludes base, for 4" thick bank run gravel base, add	SF	$ 1.10	$ 8,214.80
2162	Cast-in place concrete curbs & gutters, straight, wood forms, 0.055 C.Y. per L.F., 6" high curb, 6" thick gutter, 24" wide, includes concrete	LF	$ 22.30	$ 48,212.60
2000	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	SF	$ 4.20	$ 8,400.00
80000	True Grid paver, pro plus	SF	$ 6.50	$ 520,000.00
QTY	Building			
1428.385417	W12x120	LF	$ 169.54	$ 242,168.46
503.8229167	W14x120	LF	$ 171.73	$ 86,521.51
981.9583333	W14x120	LF	$ 171.73	$ 168,631.70
1153.6875	W14x74	LF	$ 95.85	$ 110,580.95
2146.510417	W14x34	LF	$ 54.25	$ 116,448.19
3127.479167	W18x106	LF	$ 153.42	$ 479,817.85
19810.03125	HSS4x1/4	LF	$ 26.04	$ 515,853.21
389.4270833	HSS4-1/2X4-1/2X1/4	LF	$ 26.04	$ 10,140.68
6997.5	18LH03	LF	$ 15.45	$ 108,111.38
18289.17708	20LH10	LF	$ 20.90	$ 382,243.80
389.4270833	HSS4-1/2X4-1/2X1/4	LF	$ 26.04	$ 10,140.68
3792.84937	wall conrete	LF	$ 127.00	$ 481,691.87
34829.82	deck, B24	SF	$ 1.40	$ 48,761.75
34829.82	deck, 1.0C24	SF	$ 142.40	$ 4,959,766.37
732.0024	Concrete forms, stairs, (slant length x width), 2 use, includes shoring, erecting, bracing, stipping and cleaning	SF	$ 21.07	$ 15,423.29
2	Elevators	Ea	$ 43,000.00	$ 86,000.00
74559.47	Foam Board Insulation, Polystyrene, expanded, 1" thick, R4	SF	$ 59,647.58	$ 82,015.42
34829.82	Green roof systems, fluid applied rubber membrane,215 mil thick, reinforced, not including insulation	SF	$ 157,779.08	$ 247,988.32
34829.82	Membrane Waterproofing, on walls, felt, 1-ply,mopped	SF	$ 38,661.10	$ 54,682.82
34829.82	Gypsum wallboard, on ceilings, standard, 1/2" thick, finish excluded	SF	$ 21,246.19	$ 29,257.05
18639.87	Metal Ductwork, fabricated rectangular, under 100 lb	lb	$ 352,479.94	$ 509,986.84
1695	Partition walls, interior, 2x4, tapped	SF	$ 5,763.00	$ 7,983.45
584	Windows, wood, casement, vinyl clad, custom, double insulated glass	Ea	$1,005,064.00	$ 1,121,572.00
68	Ceramic bathroom accessories, average	Ea	$ 1,227.40	$ 1,523.20
54	Doors, wood, architectural, flush, interior, hollow core, 7 ply, oak face	Ea	$ 9,558.00	$ 11,556.00
6	Doors & Frames, aluminum, enterance, narrow stile, clear finsh, 5'-0"	Ea	$ 10,440.00	$ 12,960.00
	Subtotal			**$ 10,496,028.12**
Total O&P	Contigency, for estimate at final working drawing stage	Project	3.00%	
Total O&P	Engineering Fees, mechical (plumbing and HVAC)	Contract	7.10%	
Total O&P	Engineering Fees, electrical	Contract	7.10%	
	Total			**$ 12,301,344.95**

SECTION VIII: ATTACHMENTS

Crossed out appendices were removed for the online version of the report.

Appendix B - Task Form

UNIVERSITY OF IOWA
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
Project Design & Management
(CEE:4850:0001)

RFP # 01-spring2021

Museum Event Center Tasks Form

Bidder's Organization Name:
Hawkeye Worx

Task Description	**Task Hours**
Task 1: Preliminary building design and project proposal	20
Task 2: Site analysis and land development	100
Task 3: Superstructure/substructure design	150
Task 4: Parking lot design	100
Task 5: Design report and presentation	50
TOTAL HOURS	420

Appendix D - Client Contact Information and Work Products

Contact

Matt Parbs, Executive Director Sawmill Museum director@thesawmillmuseum.org

Work products:

Site design is to be completed in Civil 3D. The design is to be generated and shown in plan and cross section views and rendered in 3D. The final plan drawings are to be used to generate a plan set that is printable both electronically and on paper.

The design shall include as a minimum the following elements:

Site Location
Construction boundaries
Existing and future utilities location
Existing and final grading (cut and fill requirements)
Retaining walls (if applicable)
Stormwater drainage
Access road
Sidewalks

Parking lot design is to be completed in Civil 3D. The design is to be generated and shown in plan and cross section views, rendered in 3D and a visual drive through generated. The final plan drawings are to be used to generate a plan set that is printable both electronically and on paper*.

The design shall include as a minimum the following elements:

Location and size
Parking stall number, size and location using Civil 3D Vehicle Tracking
Swept-path Analysis using Civil 3D Vehicle Tracking
Cross-section
Pavement type and thickness
Drainage

Building design is to be completed using applicable building standards and codes. The design is to be shown in plan and cross section views and rendered in 3D. The rendering shall be created using AutoCAD Revit (3D Max or comparable software). The final plan drawings are to be used to generate a plan set that is printable both electronically and on paper*.

The design shall include as a minimum the following elements:

Foundations
Foundation wall
Floor Slab(s)
Walls
Roof beams/trusses
Doors and windows located and sized
Lintels and / or beams above openings in walls.
Suspended floors, stairs and balustrades Insulation
Utility entrance (Water supply, Wastewater, Electrical supply)
Preliminary HVAC systems designs are required for cost estimation

Appendix F - Gantt Chart

Muesum Event Center

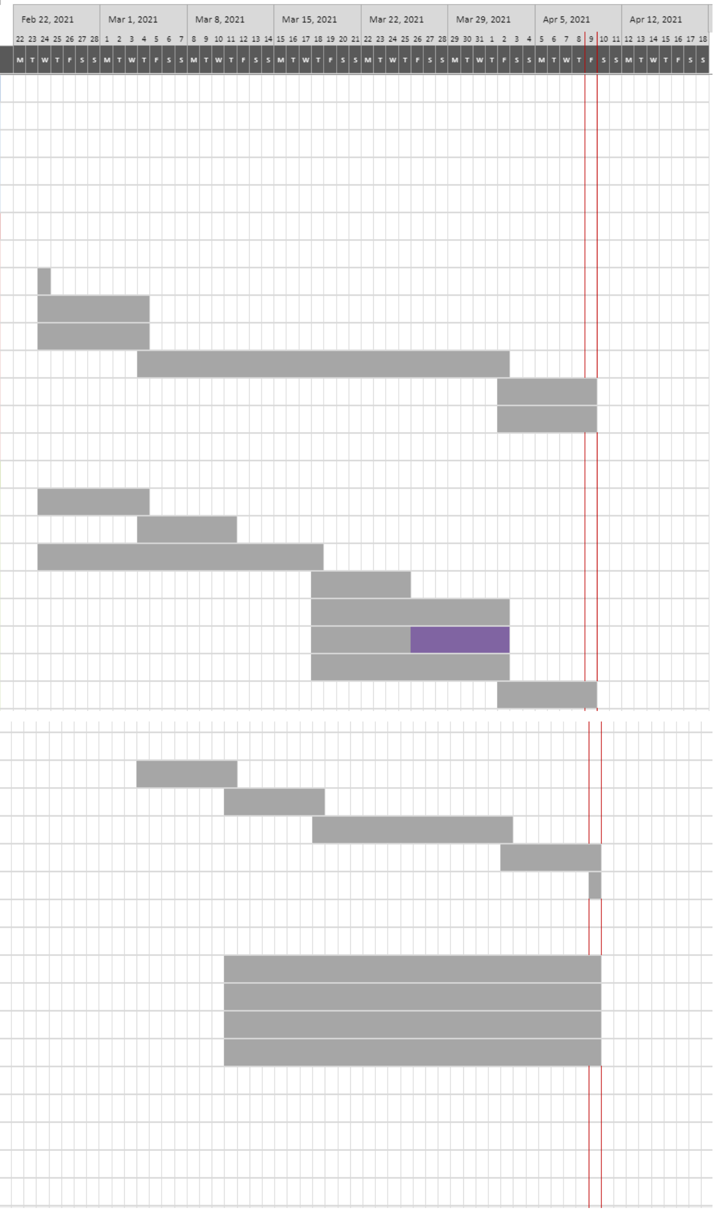
Hawkeye Worx
Libby Lorts

SIMPLE GANTT CHART by Vertex42.com
https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

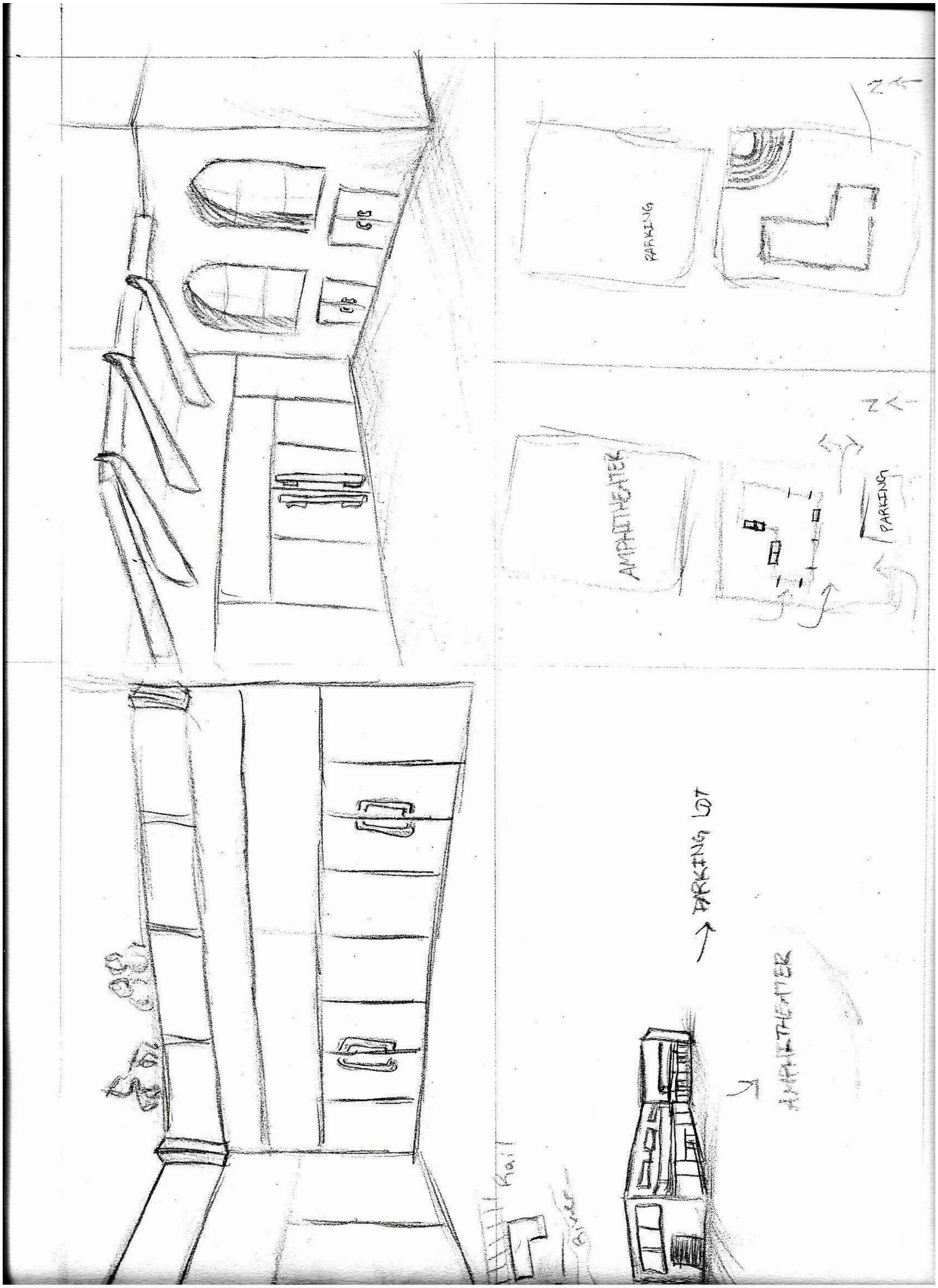
Project Start: Tue, 2/9/2021

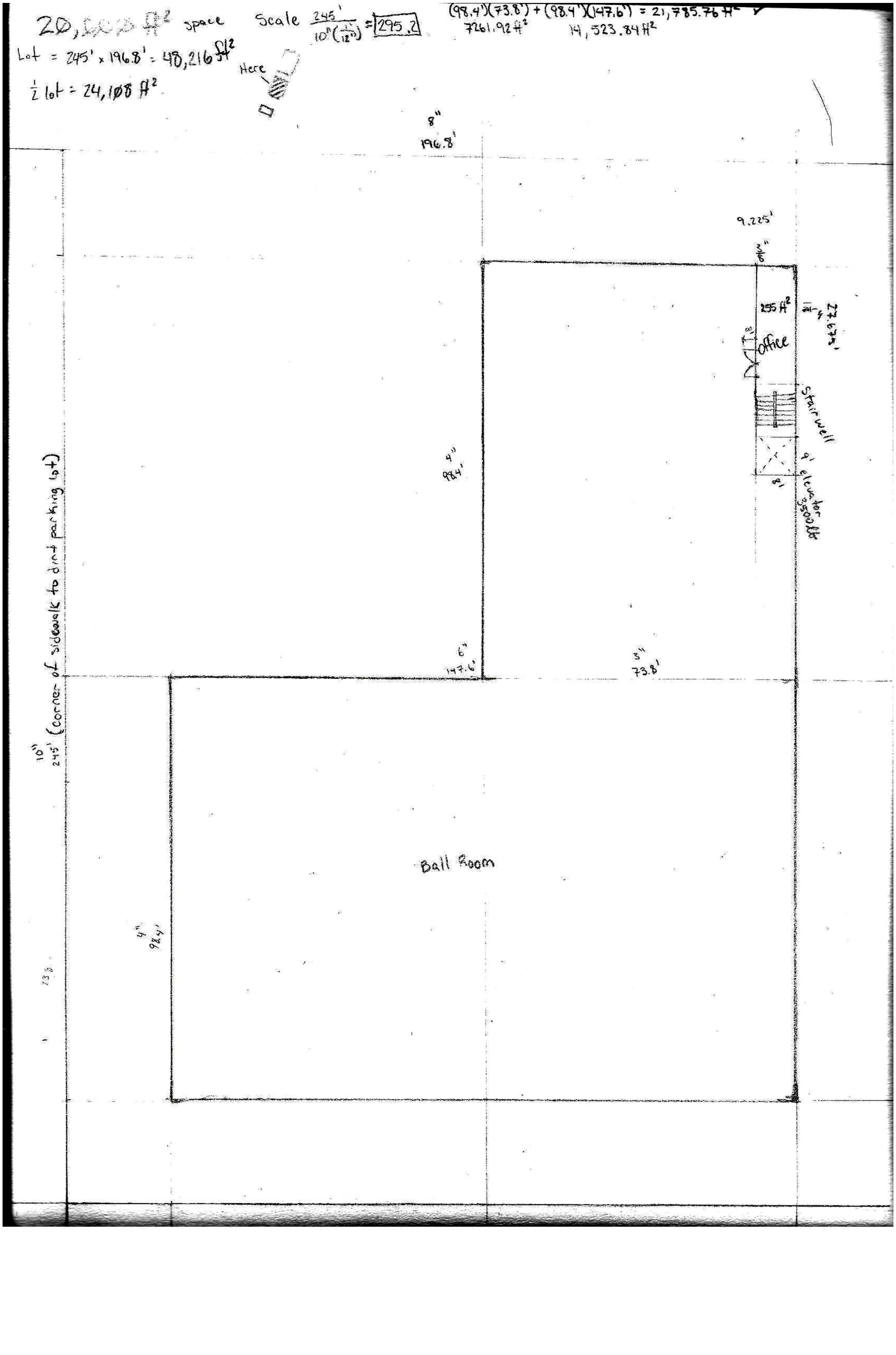
Display Week: 3

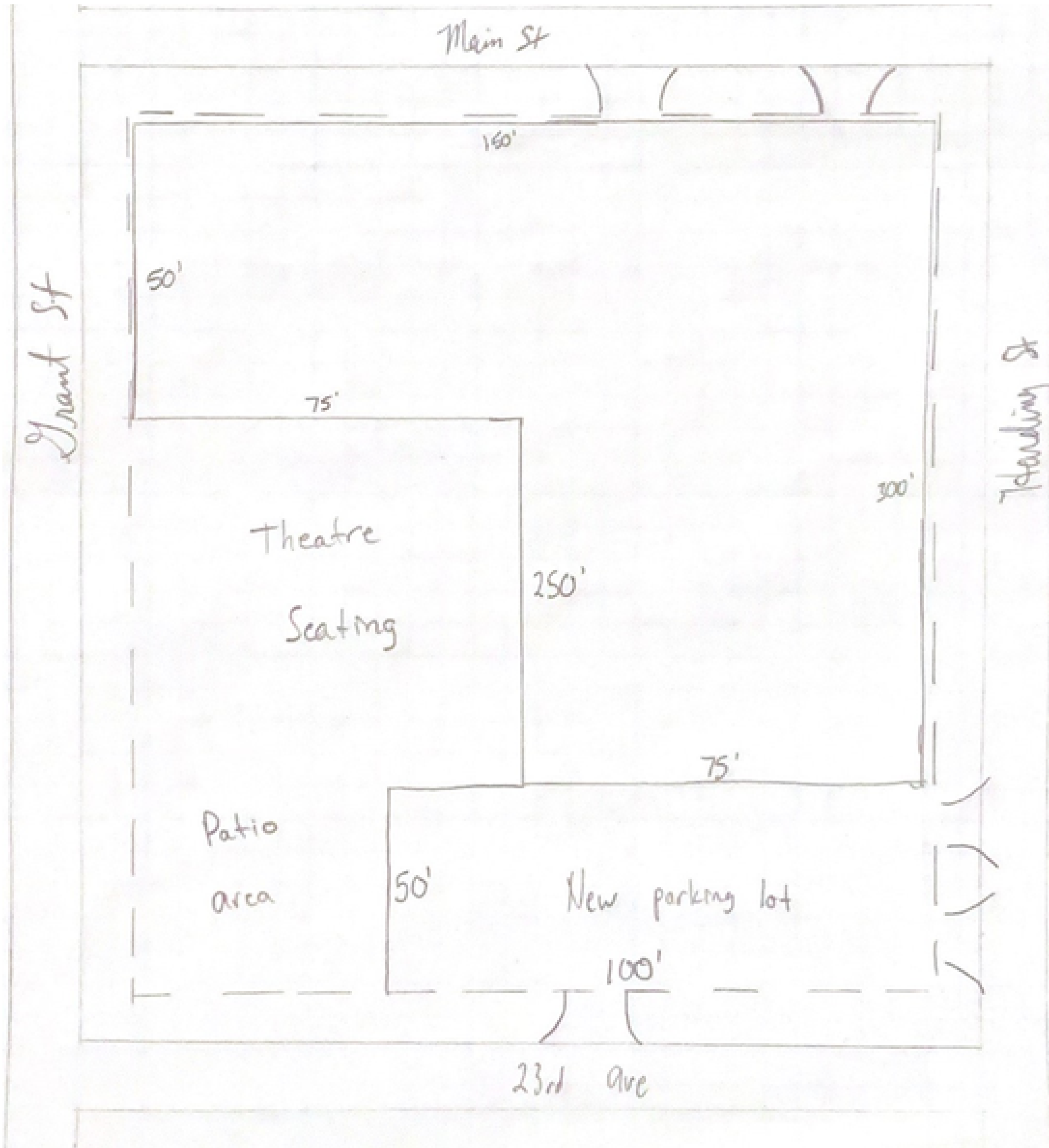
TASK	ASSIGNED TO	PROGRESS	START	END
Preliminary Building Design and Project Proposal				
Project Proposal Report	Everyone	100%	2/9/21	2/12/21
Initial Proposal Presentation Slides	Everyone	100%	2/9/21	2/12/21
Proposal Presentation	Everyone	100%	2/19/21	2/19/21
Final Proposal Presentation Slides	Everyone	100%	2/19/21	2/19/21
Site Analysis and Land Development				
Contact City Engineer	Libby	100%	2/18/21	2/20/21
Site Visit	Everyone	100%	2/24/21	2/24/21
Select Site Design Alternative	Everyone	100%	2/24/21	3/4/21
Locate Utility Hookups	Libby	100%	2/24/21	3/4/21
Runoff Analysis	Eric	100%	3/4/21	4/2/21
Site Drawings	Eric	100%	4/2/21	4/9/21
Complete Site Design		100%	4/2/21	4/9/21
Superstructure and Substructure Design				
Finalize Building Layout	Cade and Eric	100%	2/24/21	3/4/21
Create Grid and Framing Plan	Libby and Jack	100%	3/4/21	3/11/21
Calculate Design Loads	Libby and Cade	100%	2/24/21	3/18/21
Determine Framing Member Sizing	Libby and Cade	100%	3/18/21	3/25/21
Foundation Design	Libby and Cade	100%	3/18/21	4/2/21
Determine Connections	Libby and Cade	50%	3/18/21	4/2/21
Building Design and Computer Model Drawing	Libby and Cade	100%	3/18/21	4/2/21
Complete Building Design		100%	4/2/21	4/9/21
Parking Lot Design				
Preliminary Parking Lot Design	Jack	100%	3/4/21	3/11/21
Determine Cut and Fill Requirements	Jack	100%	3/11/21	3/18/21
Parking Lot Assemblies and Material Selection	Jack	100%	3/18/21	4/2/21
Parking Lot Drawings	Jack	100%	4/2/21	4/9/21
Complete Parking Lot Design		100%	4/9/21	4/9/21
Design Report and Presentation				
Final Report Draft	Everyone	100%	3/11/21	4/9/21
Final Presenation Draft		100%	3/11/21	4/9/21
Final Project Drawing Set Draft		100%	3/11/21	4/9/21
Final Poster Draft		100%	3/11/21	4/9/21
Final Report		0%	5/7/21	5/7/21
Final Presenation		0%	5/7/21	5/7/21
Final Project Drawing Set		0%	5/7/21	5/7/21
Final Poster		0%	5/7/21	5/7/21



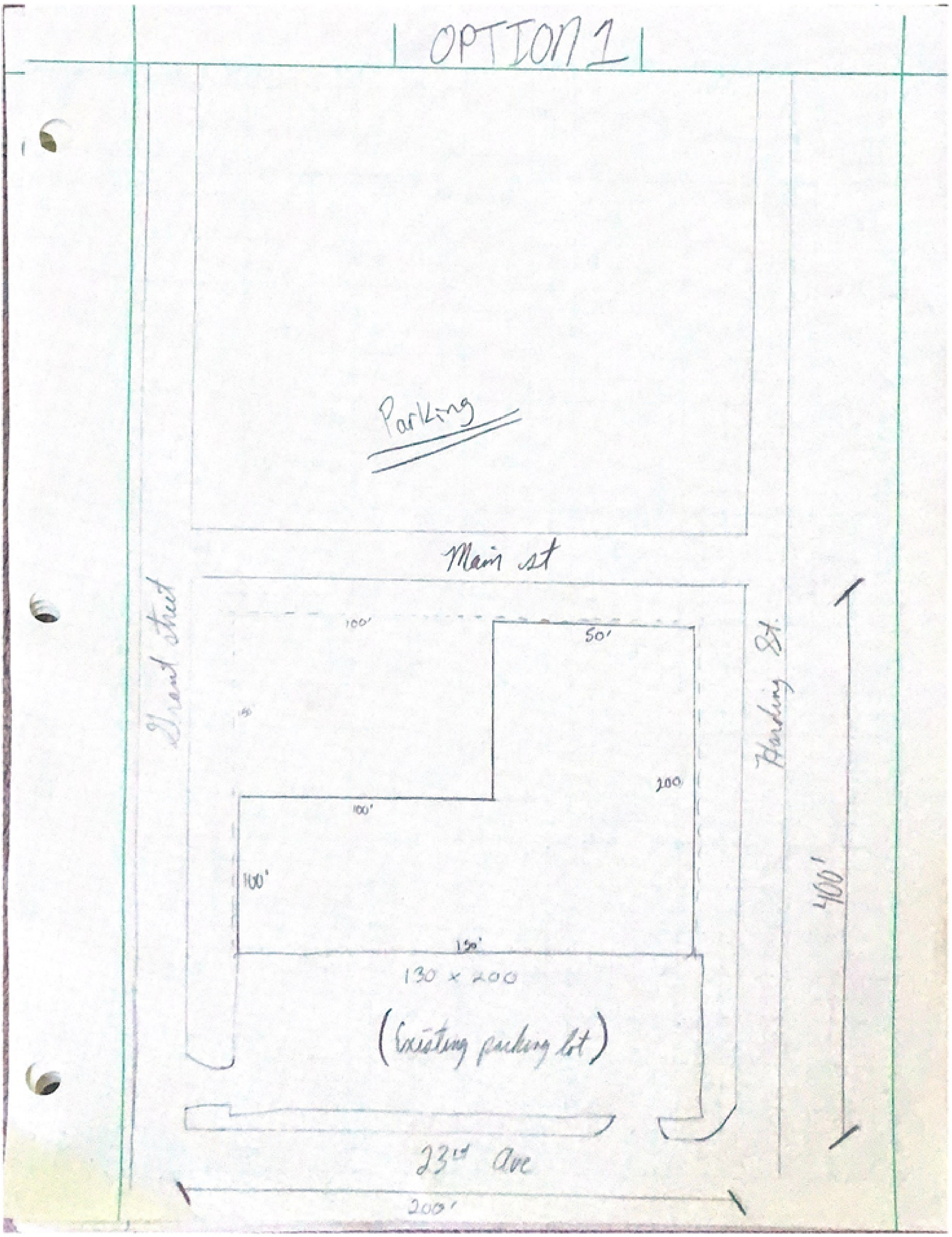
Appendix G - Preliminary Designs

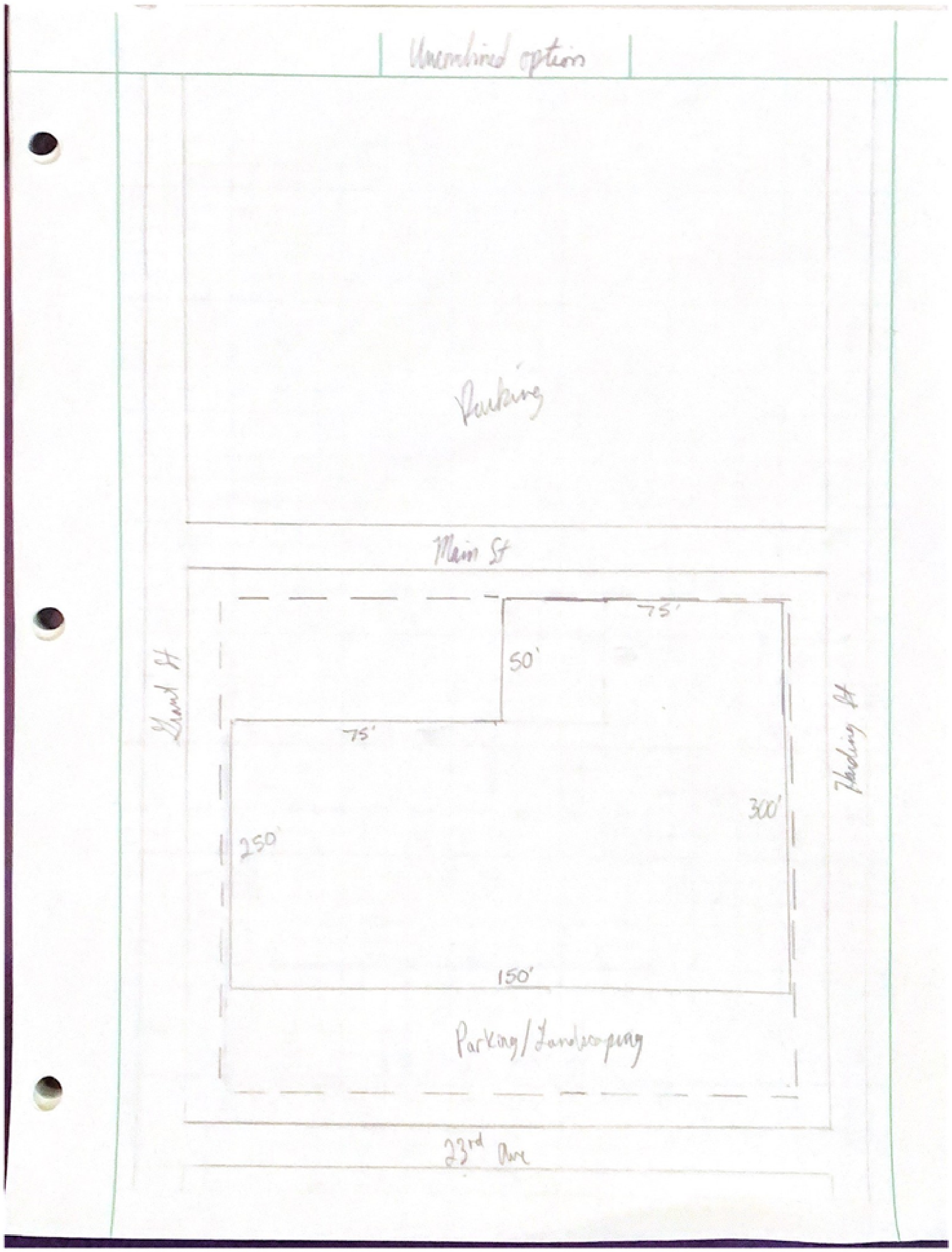


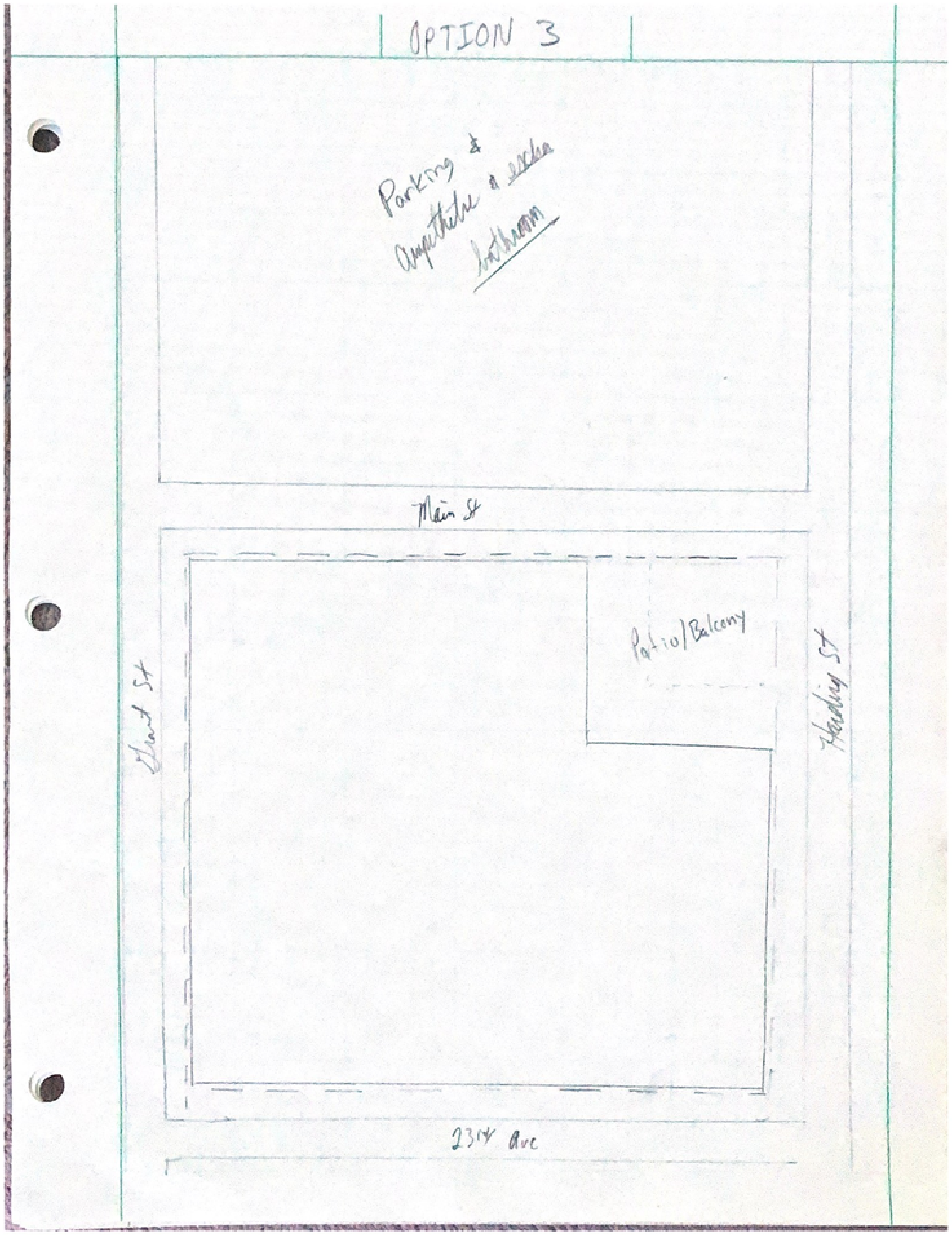

20,000 ft² space
Scale 245' / 10"(1'/12") = 295.2
(98.4')(73.8') + (98.4')(147.6') = 21,785.76 ft²
7261.92 ft²
14,523.84 ft²
Lot = 245' x 196.8' = 48,216 ft²
½ lot = 24,108 ft²
Here
8"
196.8'
9.225'
255 ft²
Office
27.675'
Stairwell
elevator 3500lb
4"
98.4'
6"
147.6'
3"
73.8'
10"
245' (corner of sidewalk to dirt parking lot)
Ball Room
4"
98.4'

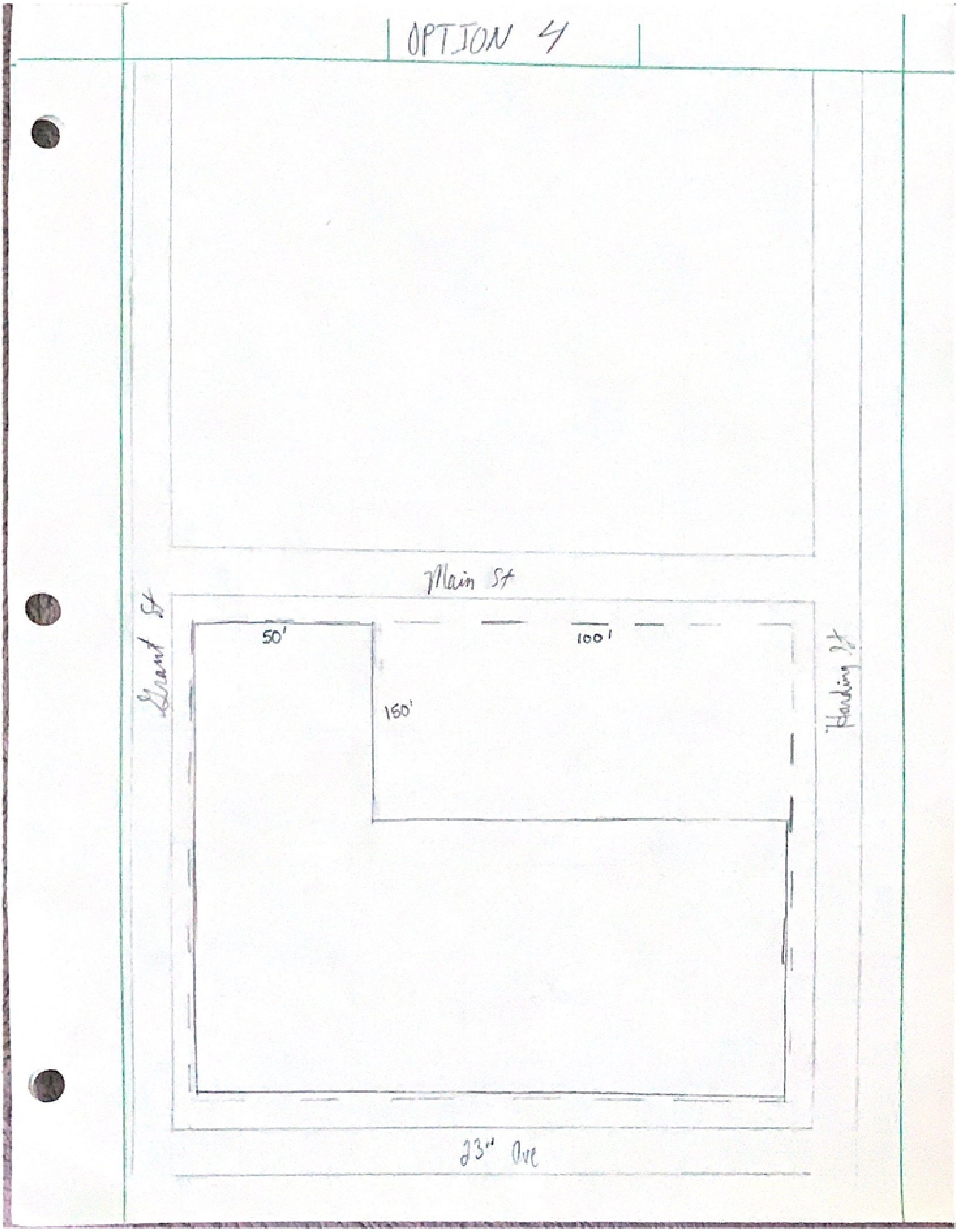


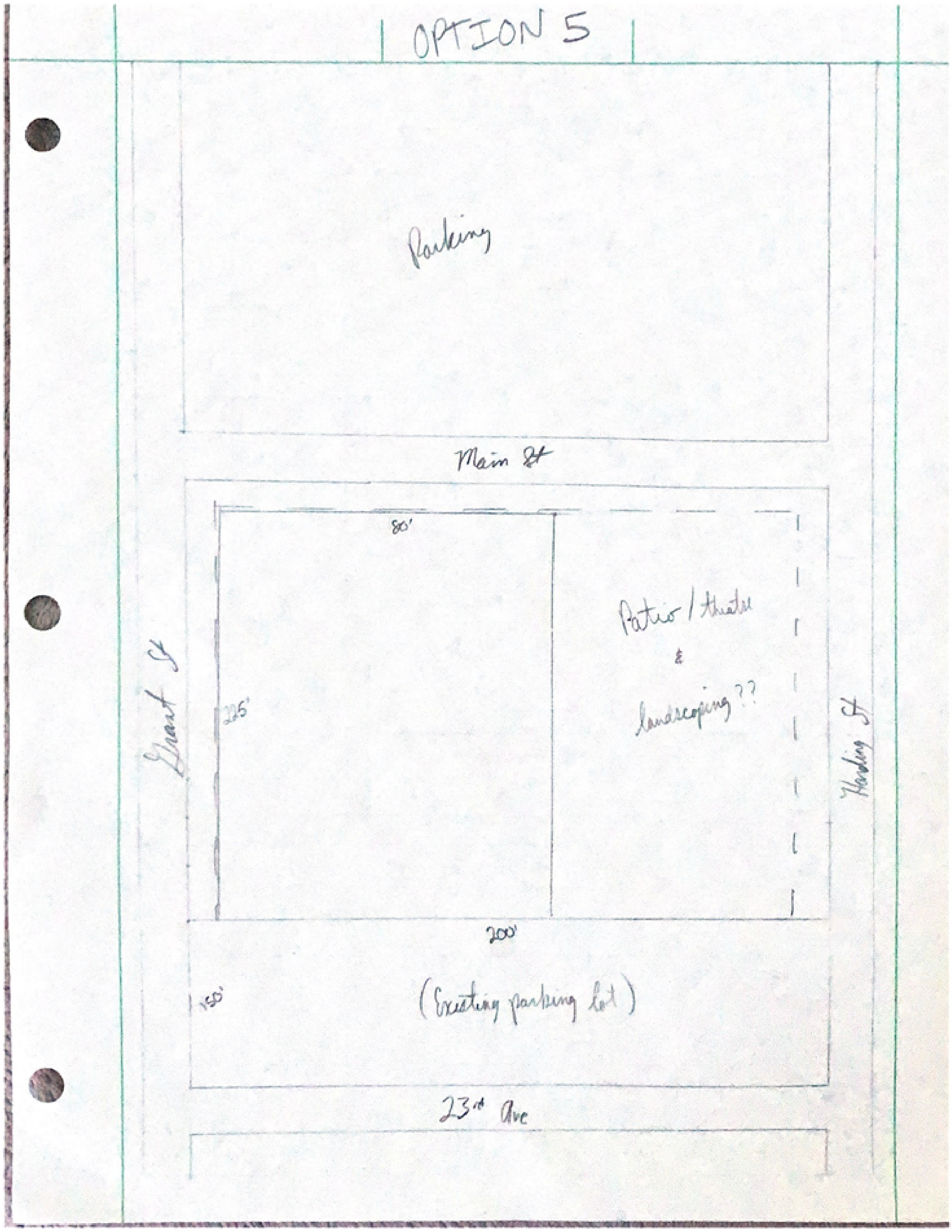
Main St
150'
50'
Grant St
75'
Harding St
300'
Theatre
Seating
250'
75'
Patio
area
50'
New parking lot
100'
23rd ave


OPTION 1
Parking
Main st
Grant street
Harding St.
100'
50'
150'
200
100'
100'
150'
130 x 200
(Existing parking lot)
23rd ave
200'
400'


Uncombined option
Parking
Main St
75'
50'
75'
Grant St
Harding St
300'
250'
150'
Parking/Landscaping
23rd Ave


OPTION 3
Parking &
Ampitheatre & extra
bathroom
Main St
Patio/Balcony
Grant St
Harding St
23rd Ave


OPTION 4
Main St
Grant St
50'
100'
150'
Harding St
23rd Ave


OPTION 5
Parking
Main St
80'
Patio / theatre
&
landscaping??
Grant St
225'
Harding St
200'
150'
(Existing parking lot)
23rd Ave

Appendix H - Notes
Meeting: February 3, 2020 @ 9:00am
General Notes From Meeting with Client

Motivation:
- Dream to develop more tourist attention
- Spur the development of the river road and bridge
- Build out the quad with tourist attractions
- Ideally becomes a trade space long term

Design:
- Make the steel fabrication building look prettier
- Possibly via signs/stonework
- Structure can be same as original
- Second floor tall enough to see over the levee

Current Museum setup:
- All-purpose approach
- No hotels near for large events aside from Eagle Point lodge
- 20,000 ft^2 for entire building

Would like included:
- Open dividable area
- Capability to have both meetings and traveling exhibits at simultaneously
- 5000 – 6000 ft^2 needed for traveling exhibit (Or 14,000 ft^2)?
- Second story to be the event center
- Looks over the river
- Is connected to the anticipated River Road
- Dedicated Lobby on first and mini Second floor lobby
- Lots of storage throughout
- Offices on the second floor or creative space/artist office
- A patio connected directly to the bike path and river levee

Estimated Numbers:
- Never hosted huge events
- 300 people for big events
- 60,000 people/YEAR for a $10 million museum
- 20,000 ft^2 needed

Need:
- Entrance lobby with ticket office
- Bathrooms
- Storage
    - Bride and groom rooms
- Large overhead doors (for RV shows)
- Temporary walls (sliding walls possibly)

- Giftshop
- Office
- Elevator with mini lobby on Second floor for sound reduction
- Kitchen/Catering service capability
- Senior friendly design is key

Architectural Style:
- Main Avenue design is the Italianate
- Not a major constraint

Parking lot:
- Vacate streets for possible street side parking
- Connect to Grant and Main (possible road connections)

Known constraints of client:
- River road
- Railroad
    - Noise issues along tracks
- No major known setbacks given by client
- Water table very high
- Flooding should not be an issue?

Budget:
- High potential for successful funding
- "The cost is what it is"?
    - Our opinion needed for best cost option
- 4,000 ft^2 costs approximately $400,000 (Engineers were able lower cost by $250,000?)

Site Visit:
Wednesday, February 17, 2021 @9:00am

Appendix I - Final Site Design

Cut/Fill Report

Generated: 2021-04-08 21:12:50

By user: jmarchiori

Drawing: \\iowa.uiowa.edu\shared\engineering\home\jmarchiori\windowsdata\Desktop\project senior\\\iowa.uiowa.edu\shared\engineering\home\jmarchiori\windowsdata\Desktop\project senior\cut fill corrected final surfaces.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
lot 1 west (2)	full	1.000	1.000	9570.00	2045.25	0.00	2045.25<Cut>
lot 3 (4)	full	1.000	1.000	5451.59	567.10	0.00	567.10<Cut>
lot 1 east (2)	full	1.000	1.000	41800.00	9676.57	0.00	9676.57<Cut>
lot 2 (3)	full	1.000	1.000	8820.00	1127.33	0.00	1127.33<Cut>
Building NW (1)	full	1.000	1.000	9789.75	0.00	274.20	274.20<Fill>
Building SW (1)	full	1.000	1.000	2708.18	0.00	175.92	175.92<Fill>
Building East	full	1.000	1.000	29608.32	0.00	1649.13	1649.13<Fill>
Sidewalk south parking lot	full	1.000	1.000	745.27	4.87	1.65	3.22<Cut>
Sidewalk North parking lot	full	1.000	1.000	1429.26	0.36	79.70	79.35<Fill>
Sidewalk north building	full	1.000	1.000	831.75	1.49	7.77	6.29<Fill>

Sidewalk west parking lot	full	1.000	1.000	552.00	3.36	0.31	3.06<Cut>
Sidewalk South building	full	1.000	1.000	2891.26	8.28	87.33	79.04<Fill>
Sidewalk west building	full	1.000	1.000	16632.02	188.93	552.78	363.86<Fill>

Totals

	2d Area (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Total	130829.41	13623.53	2828.78	10794.75<Cut>

* Value adjusted by cut or fill factor other than 1.0

Name	Cut Factor	Fill Factor	2d Area(Sq. Ft.)	Cut(adjusted)(Cu. ...	Fill(adjusted)(Cu. ...	Net(adjusted)(Cu. ...	Net Graph
Sidewalk north building	1.000	1.000	831.75	1.49	7.77	6.29<Fill>	
lot 3 (4)	1.000	1.000	5451.59	567.10	0.00	567.10<Cut>	
Building East	1.000	1.000	29608.32	0.00	1649.13	1649.13<Fill>	
Sidewalk west parking lot	1.000	1.000	552.00	3.36	0.31	3.06<Cut>	
lot 1 east (2)	1.000	1.000	41800.00	9676.57	0.00	9676.57<Cut>	
Sidewalk south parking lot	1.000	1.000	745.27	4.87	1.65	3.22<Cut>	
lot 2 (3)	1.000	1.000	8820.00	1127.33	0.00	1127.33<Cut>	
Building NW (1)	1.000	1.000	9789.75	0.00	274.20	274.20<Fill>	
Sidewalk South building	1.000	1.000	2891.26	8.28	87.33	79.04<Fill>	
lot 1 west (2)	1.000	1.000	9570.00	2045.25	0.00	2045.25<Cut>	
Sidewalk North parking lot	1.000	1.000	1429.26	0.36	79.70	79.35<Fill>	
Building SW (1)	1.000	1.000	2708.18	0.00	175.92	175.92<Fill>	
Sidewalk west building	1.000	1.000	16632.02	188.93	552.78	363.86<Fill>	

Data Source: ISWMM CH3

Runoff Coeff.
C

Cover Type	Soil Group B 5 yr	B 10 yr	B 100 yr	C 5 yr	C 10 yr	C 100 yr
Parking lots, roofs, etc	0.95	0.95	0.98	0.95	0.95	0.98
ommercial and Business (85% impervious)	-	-	-	0.85	0.85	0.90
Open Space	0.25	0.30	0.50	0.45	0.55	0.65

Parking Lot Option (POST)	Combined Runoff Coeff. 5 yr	10 yr	100 yr	5 yr	10 yr	100 yr
1	0.83	0.84	0.90	0.83	0.85	0.90
2	0.84	0.85	0.90	0.83	0.85	0.90
3	0.86	0.87	0.92	0.84	0.85	0.90

Parking Lot Option (PRE)	Combined Runoff Coeff. 5 yr	10 yr	100 yr	5 yr	10 yr	100 yr
1	0.62	0.64	0.75	0.71	0.76	0.82
2	0.58	0.61	0.73	0.69	0.74	0.81
3	0.51	0.54	0.68	0.64	0.70	0.77

Rainfall Intensity (in/hr)

Duration (hr.)	Return Period 5 yr	10 yr	100 yr	2 yr
0.25	3.88	4.53	6.94	3.14
24	0.15	0.18	0.3	0.12

	Even Center	Parking Lot 1	2	3	Open Space	
Area of Cove Types (acres)	0.90	0.52	0.69	1.20	0.30	Total Area about 3

POST-DEVELOPMENT
$Q_T = C\, i_T\, A$

est. peak rate of runoff (cfs), Q

Rainfall Duration (hr)		Soil Group B 5 yr	10 yr	100 yr	Soil Group C 5 yr	10 yr	100 yr
0.25	Option 1	5.52512	6.51867	10.698704	5.55616	6.62286	10.7223
	Option 2	6.15174	7.250265	11.854908	6.11682	7.277445	11.7841
	Option 3	8.0316	9.44505	15.32352	7.7988	9.2412	14.9696
24	Option 1	0.2136	0.25902	0.46248	0.2148	0.26316	0.4635
	Option 2	0.237825	0.28809	0.51246	0.236475	0.28917	0.5094
	Option 3	0.3105	0.3753	0.6624	0.3015	0.3672	0.6471

PRE-DEVELOPMENT
$Q_T = C\, i_T\, A$

est. peak rate of runoff (cfs), Q

Rainfall Duration (hr)		Soil Group B 5 yr	10 yr	100 yr	Soil Group C 5 yr	10 yr	100 yr
0.25	Option 1	4.1128	4.98753	8.96648	4.74912	5.91618	9.8201
	Option 2	4.2777	5.21856	9.55638	5.04594	6.339735	10.587
	Option 3	4.7724	5.91165	8.117024	5.9364	7.6104	12.8876
24	Option 1	0.159	0.19818	0.3876	0.1836	0.23508	0.4245
	Option 2	0.165375	0.20736	0.4131	0.195075	0.25191	0.45765
	Option 3	0.1845	0.2349	0.4896	0.2295	0.3024	0.5571

Table 2B-2.07: Section 6 - East Central Iowa
Rainfall Depth and Intensity for Various Return Periods

Duration	1 year D	1 year I	2 year D	2 year I	5 year D	5 year I	10 year D	10 year I	25 year D	25 year I	50 year D	50 year I	100 year D	100 year I	500 year D	500 year I
5 min	0.38	4.56	0.44	5.30	0.54	6.56	0.63	7.65	0.76	9.18	0.86	10.3	0.97	11.6	1.23	14.8
10 min	0.55	3.33	0.64	3.87	0.8	4.8	0.93	5.58	1.11	6.70	1.26	7.60	1.42	8.54	1.80	10.8
15 min	0.67	2.70	0.78	3.14	0.97	3.88	1.13	4.53	1.36	5.45	1.54	6.18	1.73	6.94	2.20	8.81
30 min	0.95	1.90	1.11	2.22	1.38	2.76	1.61	3.22	1.94	3.88	2.20	4.40	2.47	4.95	3.14	6.29
1 hr	1.23	1.23	1.44	1.44	1.80	1.80	2.11	2.11	2.58	2.58	2.96	2.96	3.36	3.36	4.37	4.37
2 hr	1.51	0.75	1.77	0.88	2.22	1.11	2.62	1.31	3.22	1.61	3.71	1.85	4.24	2.12	5.60	2.80
3 hr	1.68	0.56	1.96	0.65	2.47	0.82	2.93	0.97	3.63	1.21	4.22	1.40	4.85	1.61	6.50	2.16
6 hr	1.97	0.32	2.30	0.38	2.89	0.48	3.45	0.57	4.3	0.71	5.02	0.83	5.8	0.96	7.87	1.31
12 hr	2.28	0.19	2.65	0.22	3.31	0.27	3.93	0.32	4.88	0.40	5.68	0.47	6.56	0.54	8.87	0.73
24 hr	2.60	0.10	3.01	0.12	3.75	0.15	4.42	0.18	5.44	0.22	6.29	0.26	7.22	0.30	9.64	0.40
48 hr	2.98	0.06	3.43	0.07	4.22	0.08	4.93	0.10	6.01	0.12	6.90	0.14	7.86	0.16	10.3	0.21
3 day	3.28	0.04	3.72	0.05	4.51	0.06	5.24	0.07	6.32	0.08	7.22	0.10	8.19	0.11	10.7	0.14
4 day	3.53	0.03	3.98	0.04	4.78	0.04	5.50	0.05	6.58	0.06	7.49	0.07	8.46	0.08	10.9	0.11
7 day	4.17	0.02	4.67	0.02	5.53	0.03	6.29	0.03	7.39	0.04	8.30	0.04	9.25	0.05	11.6	0.06
10 day	4.75	0.01	5.30	0.02	6.24	0.02	7.04	0.02	8.20	0.03	9.12	0.03	10.0	0.04	12.4	0.05

D = Total depth of rainfall for given storm duration (inches)
I = Rainfall intensity for given storm duration (inches/hour)

Hydrologic Soil Group	A			B			C			D		
Recurrence Interval	5	10	100	5	10	100	5	10	100	5	10	100
Land Use Or Surface Characteristics Business:												
A. Commercial Area	.75	.80	.95	.80	.85	.95	.80	.85	.95	.85	.90	.95
B. Neighborhood Area	.50	.55	.65	.55	.60	.70	.60	.65	.75	.65	.70	.80
Residential:												
A. Single Family	.25	.25	.30	.30	.35	.40	.40	.45	.50	.45	.50	.55
B. Multi-Unit (Detached)	.35	.40	.45	.40	.45	.50	.45	.50	.55	.50	.55	.65
C. Multi-Unit (Attached)	.45	.50	.55	.50	.55	.65	.55	.60	.70	.60	.65	.75
D. ½ Lot Or Larger	.20	.20	.25	.25	.25	.30	.35	.40	.45	.40	.45	.50
E. Apartments	.50	.55	.60	.55	.60	.70	.60	.65	.75	.65	.70	.80
Industrial												
A. Light Areas	.55	.60	.70	.60	.65	.75	.65	.70	.80	.70	.75	.90
B. Heavy Areas	.75	.80	.95	.80	.85	.95	.80	.85	.95	.80	.85	.95
Parks, Cemeteries Playgrounds	.10	.10	.15	.20	.20	.25	.30	.35	.40	.35	.40	.45
Schools	.30	.35	.40	.40	.45	.50	.45	.50	.55	.50	.55	.65
Railroad Yard Areas	.20	.20	.25	.30	.35	.40	.40	.45	.45	.45	.50	.55
Streets												
A. Paved	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
B. Gravel	.25	.25	.30	.35	.40	.45	.40	.45	.50	.40	.45	.50
Drives, Walks, & Roofs	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
Lawns												
A. 50%-75% Grass (Fair Condition)	.10	.10	.15	.20	.20	.25	.30	.35	.40	.30	.35	.40
B. 75% Or More Grass (Good Condition)	.05	.05	.10	.15	.15	.20	.25	.25	.30	.30	.35	.40
Undeveloped Surface[1] (By Slope)[2]												
A. Flat (0-1%)	0.04-0.09			0.07-0.12			0.11-0.16			0.15-0.20		
B. Average (2-6%)	0.09-0.14			0.12-0.17			0.16-0.21			0.20-0.25		
C. Steep	0.13-0.18			0.18-0.24			0.23-0.31			0.28-0.38		

[1]Undeveloped Surface Definition: Forest and agricultural land, open space.
[2]Source: Storm Drainage Design Manual, Erie and Niagara Counties Regional Planning Board.

Table 2B-1.01: Applications of Hydrologic Methods

Method	Rational Method	NRCS Peak Flow	Modified Rational	NRCS TR-55
Channel protection volume (CPv)				✓
Overbank flood protection (Qp_5)				✓
Extreme flood protection (Qf)				✓
Storage facilities			✓	✓
Outlet structures				✓
Gutter flow and inlets	✓	✓		
Storm sewer piping	✓	✓		✓
Culverts	✓	✓		✓
Small ditches	✓	✓		✓
Open channels	✓	✓		✓
Energy dissipation				✓

Small storm hydrology and low impact development (LID) methods (utilized for water quality based design) as well as water balance calculations (utilized for permanent pond / wet detention design) are discussed in the Iowa Stormwater Management Manual (ISMM).

Table 2B-1.02: Limitations of Hydrologic Methods

Method	Size Limitations	Comments
Rational	40 acres	Method can be used for drainage areas with similar land uses for estimating peak flows and for the design of small site or subdivision storm sewer systems. *Should not be used for storage design.*
NRCS Peak Flow	0 to 2,000 acres	Method can be used for estimating peak flows for storm sewer or channel design. *Should not be used for storage design.*
Modified Rational	0 to 5 acres	Method can be used for estimating peak flows and developing simple hydrographs from small drainage areas with significantly different runoff coefficients.
NRCS TR-55	0 to 2,000 acres	Method can be used for estimating peak flows and developing hydrographs for all design applications. Can be used for low-impact development hydrologic analysis.

$16.4*(0.31/166) = 0.0306 = V_{s,\,pre}$

$20.9*(0.31/362) = 0.0179 = V_{s,\,post}$

Input requirements and procedures

Use figure 6-1 estimate storage volume (V_s) required or peak outflow discharge (q_o). The most frequent application is to estimate V_s, for which the required inputs are runoff volume (V_r), q_o, and peak inflow discharge (q_i). To estimate q_o, the required inputs are V_r, V_s, and q_i.

$q_o = 0.31$ cfs $V_r = 16.4$ acre-ft. $q_i = 166$ cfs

20.9

$\frac{q_o}{q_i}$?

Estimating V_s

Use worksheet 6a to estimate V_s, storage volume required, by the following procedure.

1. Determine q_o. Many factors may dictate the selection of peak outflow discharge. The most common is to limit downstream discharges to a desired level, such as predevelopment discharge. Another factor may be that the outflow device has already been selected.
2. Estimate q_i by procedures in chapters 4 or 5. Do not use peak discharges developed by other procedure. When using the Tabular Hydrograph method to estimate q_i for a subarea, only use peak discharge associated with $T_t = 0$.

Figure 6-1 Approximate detention basin routing for rainfall types I, IA, II, and III

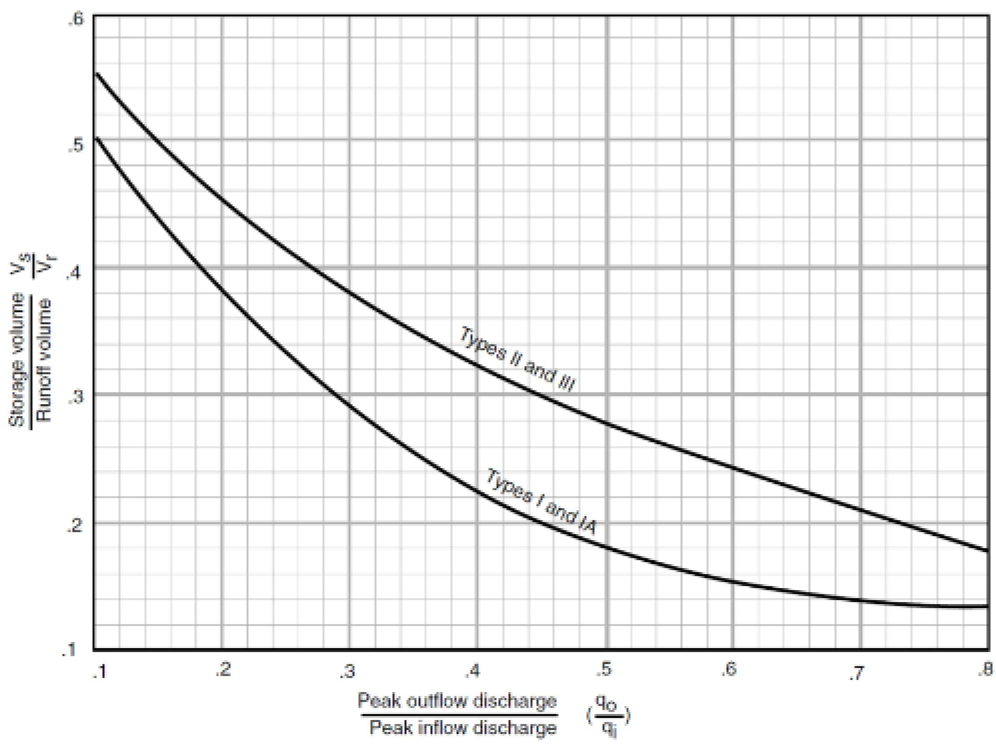
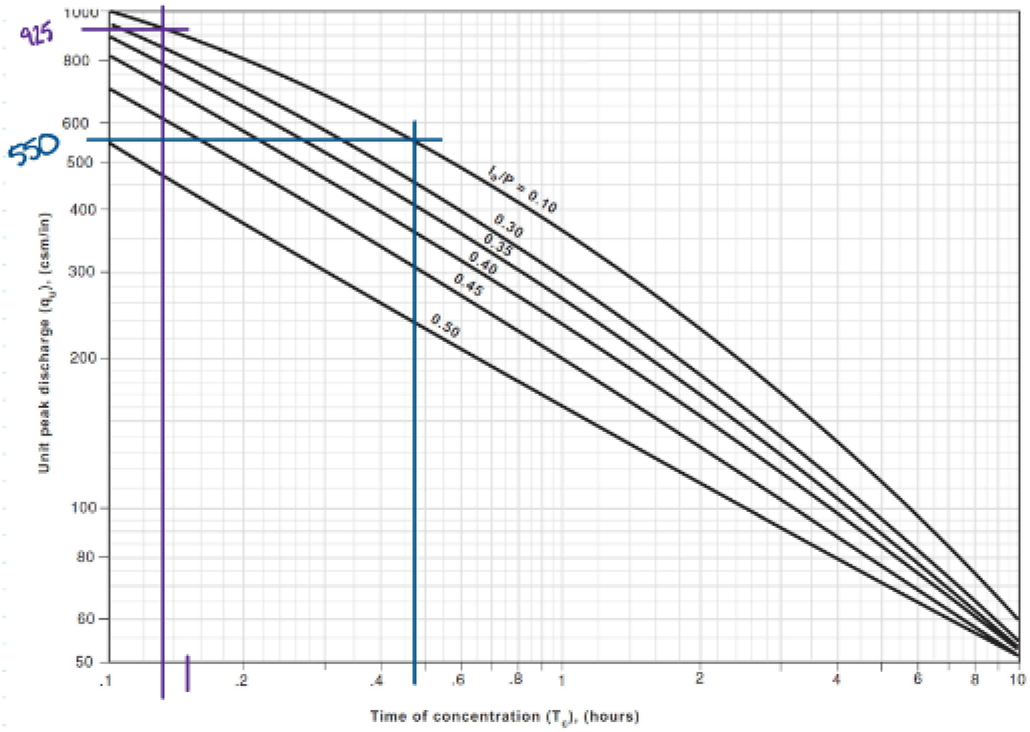


Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



= Pre-Dev $\frac{0.381}{3.75} = 0.1$

= Post-Dev $\frac{0.198}{3.75} = 0.05 \approx 0.1$

Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \quad \text{[eq. 4-1]}$$

$(540)(0.14)(2.2)(1) = 166$ cfs

$(925)(0.14)(2.8)(1) = 362$ cfs

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi²)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi²), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a / P is then computed.

If the computed I_a / P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a / P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a / P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a / P for P and CN

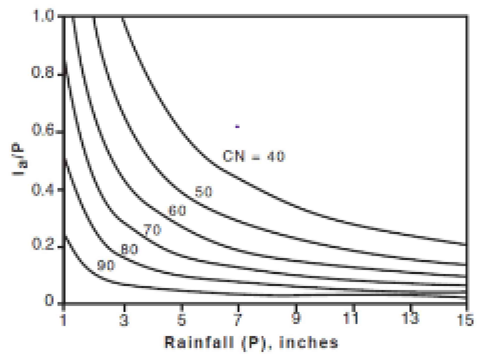


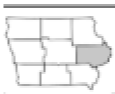
Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Table 4-2 Adjustment factor (F_p) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

Table 2B-2.07: Section 6 - East Central Iowa
Rainfall Depth and Intensity for Various Return Periods



	Return Period															
	1 year		***2 year***		***5 year***		***10 year***		***25 year***		***50 year***		***100 year***		***500 year***	
Duration	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***
5 min	0.38	4.56	0.44	5.30	0.54	6.56	0.63	7.65	0.76	9.18	0.86	10.3	0.97	11.6	1.23	14.8
10 min	0.55	3.33	0.64	3.87	0.8	4.8	0.93	5.58	1.11	6.70	1.26	7.60	1.42	8.54	1.80	10.8
15 min	0.67	2.70	0.78	3.14	0.97	3.88	1.13	4.53	1.36	5.45	1.54	6.18	1.73	6.94	2.20	8.81
30 min	0.95	1.90	1.11	2.22	1.38	2.76	1.61	3.22	1.94	3.88	2.20	4.40	2.47	4.95	3.14	6.29
1 hr	1.23	1.23	1.44	1.44	1.80	1.80	2.11	2.11	2.58	2.58	2.96	2.96	3.36	3.36	4.37	4.37
2 hr	1.51	0.75	1.77	0.88	2.22	1.11	2.62	1.31	3.22	1.61	3.71	1.85	4.24	2.12	5.60	2.80
3 hr	1.68	0.56	1.96	0.65	2.47	0.82	2.93	0.97	3.63	1.21	4.22	1.40	4.85	1.61	6.50	2.16
6 hr	1.97	0.32	2.30	0.38	2.89	0.48	3.45	0.57	4.3	0.71	5.02	0.83	5.8	0.96	7.87	1.31
12 hr	2.28	0.19	2.65	0.22	3.31	0.27	3.93	0.32	4.88	0.40	5.68	0.47	6.56	0.54	8.87	0.73
24 hr	2.60	0.10	3.01	0.12	3.75	0.15	4.42	0.18	5.44	0.22	6.29	0.26	7.22	0.30	9.64	0.40
48 hr	2.98	0.06	3.43	0.07	4.22	0.08	4.93	0.10	6.01	0.12	6.90	0.14	7.86	0.16	10.3	0.21
3 day	3.28	0.04	3.72	0.05	4.51	0.06	5.24	0.07	6.32	0.08	7.22	0.10	8.19	0.11	10.7	0.14
4 day	3.53	0.03	3.98	0.04	4.78	0.04	5.50	0.05	6.58	0.06	7.49	0.07	8.46	0.08	10.9	0.11
7 day	4.17	0.02	4.67	0.02	5.53	0.03	6.29	0.03	7.39	0.04	8.30	0.04	9.25	0.05	11.6	0.06
10 day	4.75	0.01	5.30	0.02	6.24	0.02	7.04	0.02	8.20	0.03	9.12	0.03	10.0	0.04	12.4	0.05

D = Total depth of rainfall for given storm duration (inches)
I = Rainfall intensity for given storm duration (inches/hour)

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

2.2

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \quad \text{[eq. 2-1]}$$

2.1

where

- Q = runoff (in)
- P = rainfall (in)
- S = potential maximum retention after runoff begins (in) and
- I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \quad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

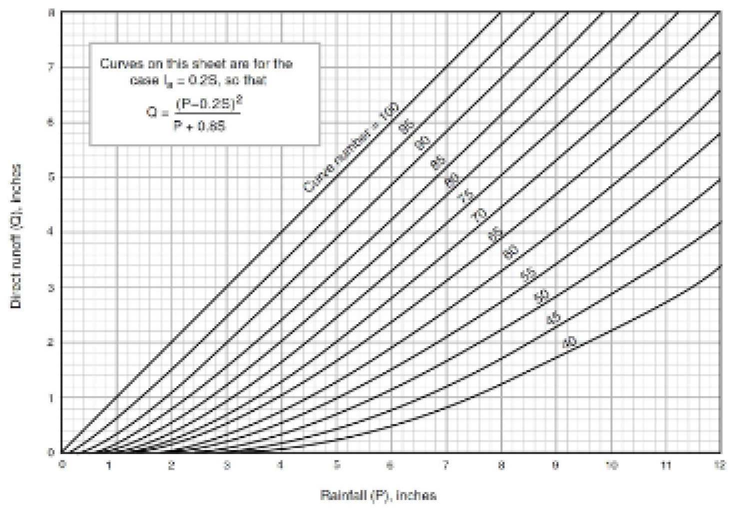
$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \quad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \quad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Figure 2-1 Solution of runoff equation.



5 yr, 24 hr → 3.75"

3. Compute q_o/q_i and determine V_s/V_r from figure 6-1.
4. Q (in inches) was determined when computing q_i in step 2, but now it must be converted to the units in which V_s is to be expressed—most likely, acre-feet or cubic feet. The most common conversion of Q to V_r is expressed in acre-feet:

$$V_r = 53.33Q(A_m) \qquad \text{[eq. 6-1]}$$

where
V_r = runoff volume (acre-ft)
Q = runoff (in)
A_m = drainage area (mi^2), and
53.33 = conversion factor from in-mi^2 to acre-ft.

5. Use the results of steps 3 to 4 to compute V_s:

$$V_s = V_r\left(\frac{V_s}{V_r}\right) \qquad \text{[eq. 6-2]}$$

where
V_s = storage volume required (acre-ft).

6. The stage in the detention basin corresponding to V_s must be equal to the stage used to generate q_o. In most situations a minor modification of the outflow device can be made. If the device has been preselected. repeat the calculations with a modified q_o value.

Estimating q_o

Use worksheet 6b to estimate q_o, required peak outflow discharge, by the following procedure.

1. Determine V_s. If the maximum stage in the detention basin is constrained, set V_s by the maximum permissible stage.
2. Compute Q (in inches) by the procedures in chapter 2, and convert it to the same units as V_s (see step 4 in "estimating V_s").
3. Compute V_s/V_r and determine q_o/q_i from figure 6-1.
4. Estimate q_i by the procedures in chapters 4 or 5. Do not use discharges developed by any other method. When using Tabular method to estimate q_i for a subarea, use only the peak discharge associated with $T_t = 0$.
5. From steps 3 to 4, compute q_o:

$$q_o = q_i\left(\frac{q_o}{q_i}\right) \qquad \text{[eq. 6-3]}$$

6. Proportion the outflow device so that the stage at q_o is equal to the stage corresponding to V_s. If q_o cannot be calibrated except in discrete steps (i.e., pipe sizes), repeat the procedure until the stages for q_o and V_s are approximately equal.

Limitations

- This routing method is less accurate as the q_o/q_i ratio approaches the limits shown in figure 6-1. The curves in figure 6-1 depend on the relationship between available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When storage volume (V_s) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when V_s is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge (q_o) approaches the peak flow discharge (q_i) parameters that affect the rate of rise of a hydrograph, such as rainfall volume, curve number, and time of concentration, become especially significant.
- The procedure should not be used to perform final design if an error in storage of 25 percent cannot be tolerated. Figure 6-1 is biased to prevent undersizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and routing will often pay for itself through reduced construction costs.

$V_r = 53.33(2.2)(0.14)$
$= 16.4$ acre-ft.

$V_r = 53.33(2.8)(0.14)$
$= 20.9$ acre-ft.

0.31/166=0.0019

0.18/166=0.0011

Assuming 0.6 from graph; 0.6 = V_s / V_r

Storage Volume, V_s = 0.6 * 11.3 = 6.78 acre-ft.

6.78 acre-ft*(43560 ft^3/1 acre-ft) = 295336.8 ~ **300000 ft^3**

Parking Lot 1: Area, A_1 = 59450 ~ 60000 ft^2
Parking Lot 2: Area, A_2 = 7977 ~ 8000 ft^2

Lot2 + Rain Garden = 8000 + 2000 = 10000 ft^2
2000/10000 = 0.2

Detention Basin for Lot 1 Area, A_{d1} = 30 ft * 390 ft = 11,700 ft^2

(60000/(60000+10000)) = 0.8571
(10000/(60000+10000)) = 0.1429

300000 * 0.8571 = 257130 ft^3
300000 * 0.1429 = 42870 ft^3

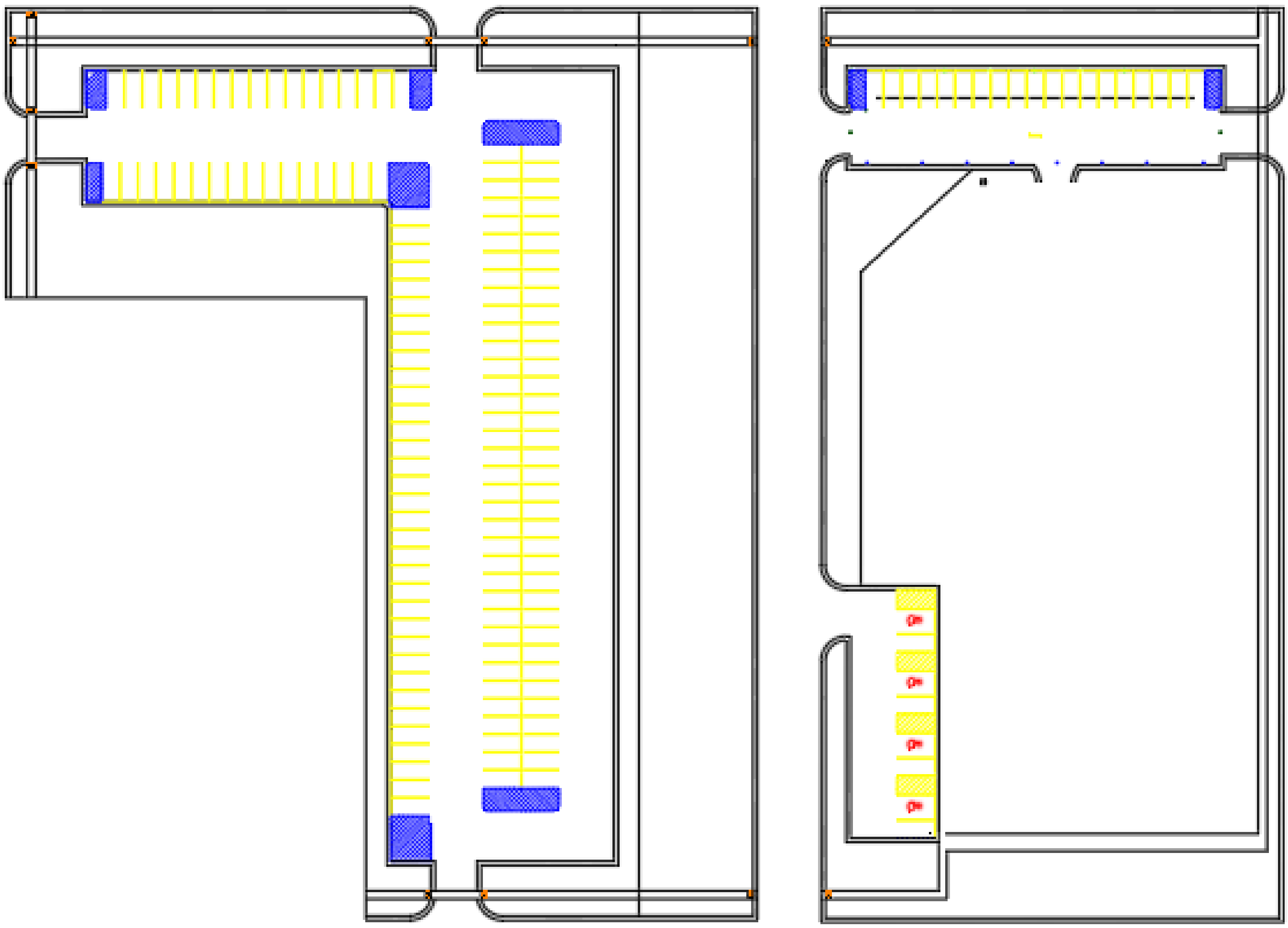
257130 / 60000 = ***4.2855 ft***
42870 /10000 = 4.287 ft

42870 /8000 = 5.3588

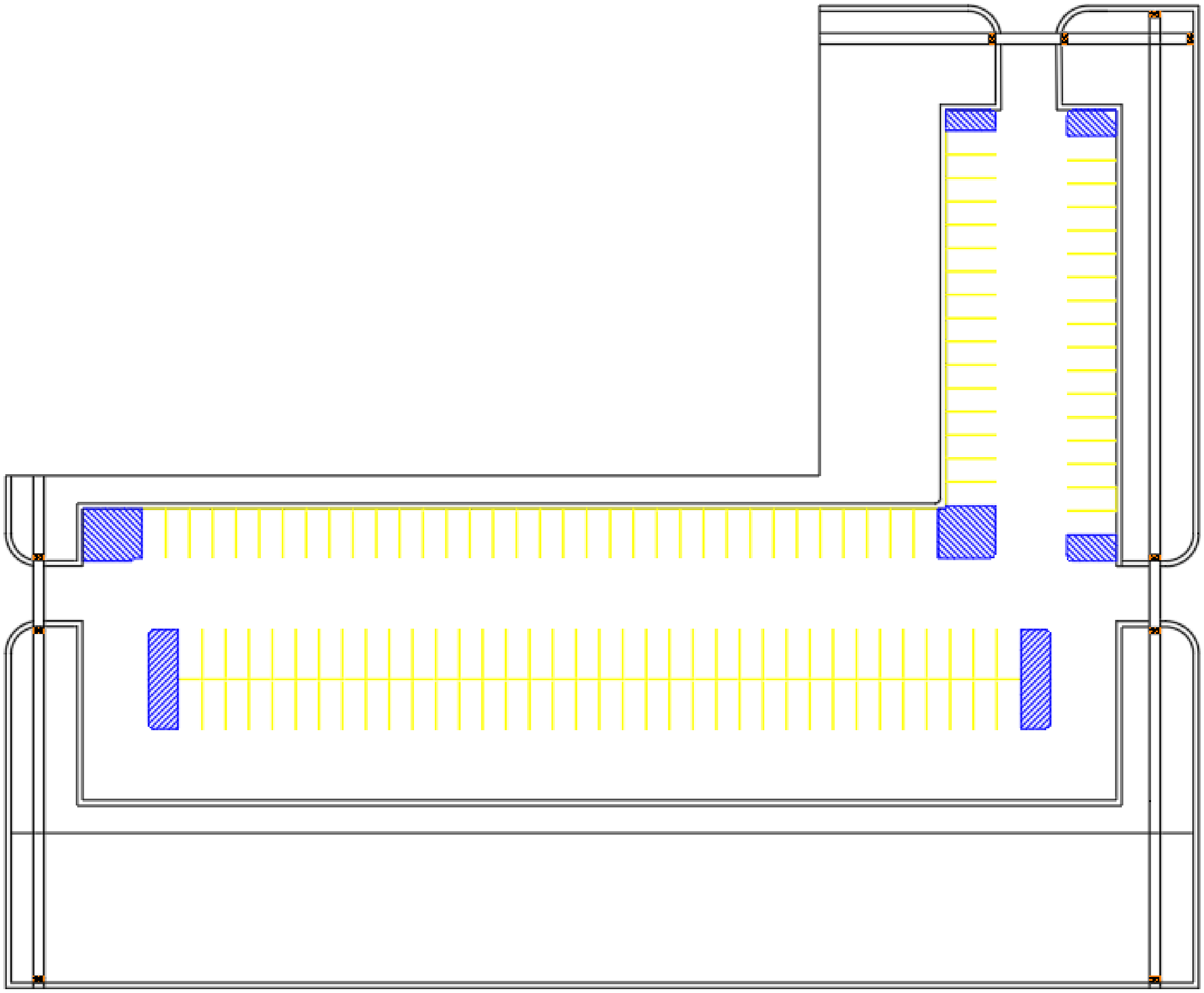
967 + 1022 = 1989 ft^2

2000/10000=0.2
.2*4.287=**0.8574 ft**
4.287 - 0.8574 = **3.4296 ft** ; 3.4/2=**1.7 ft**

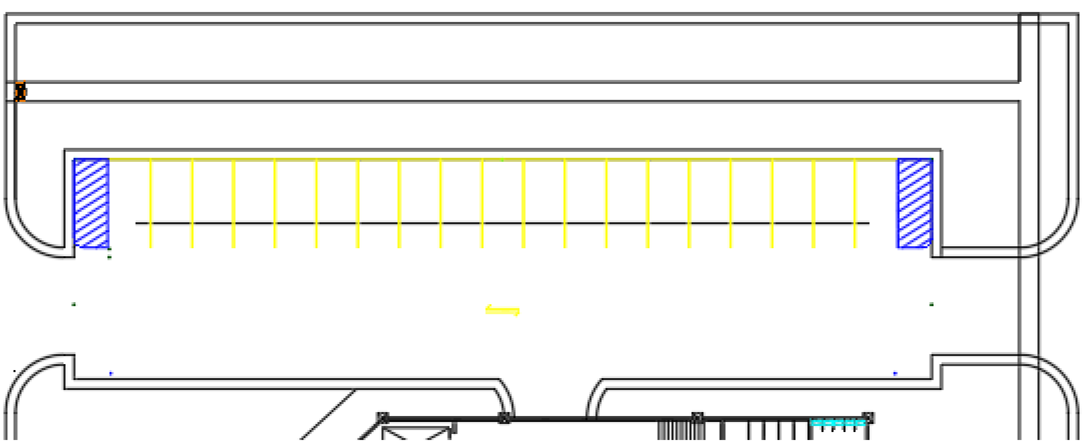
Appendix J - Final Parking Design
Overall Layout



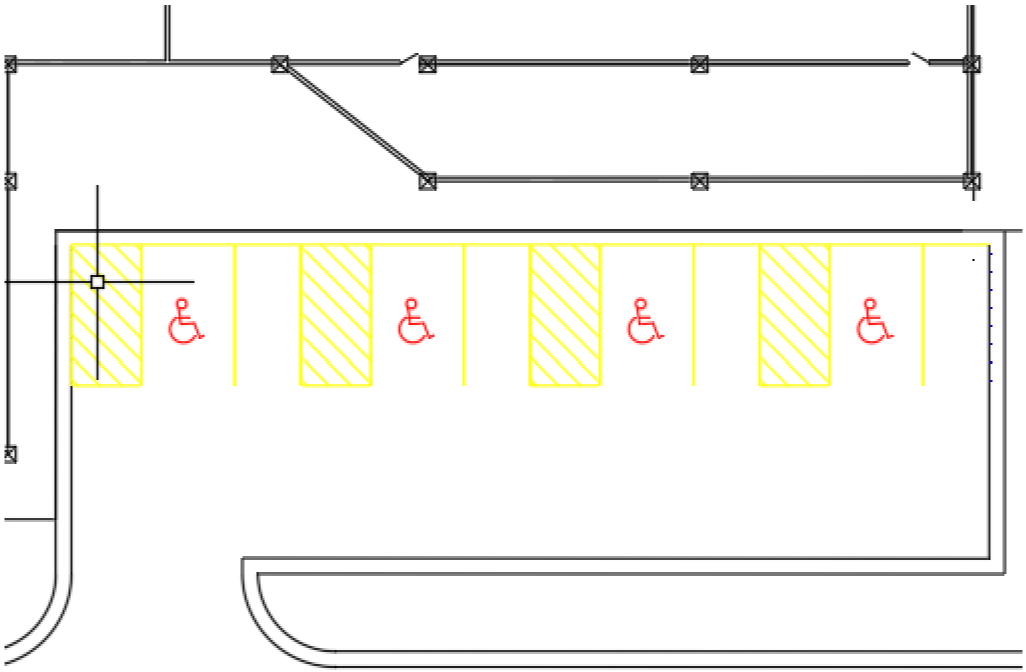
Lot 1 (west of train tracks)



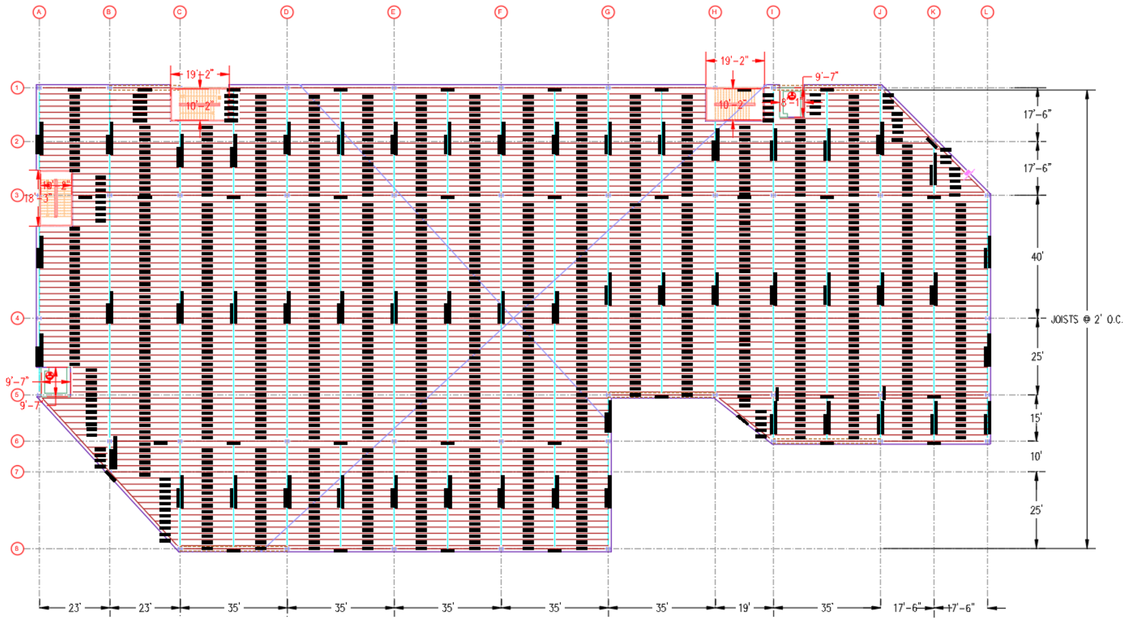
Lot 2 (north of building)

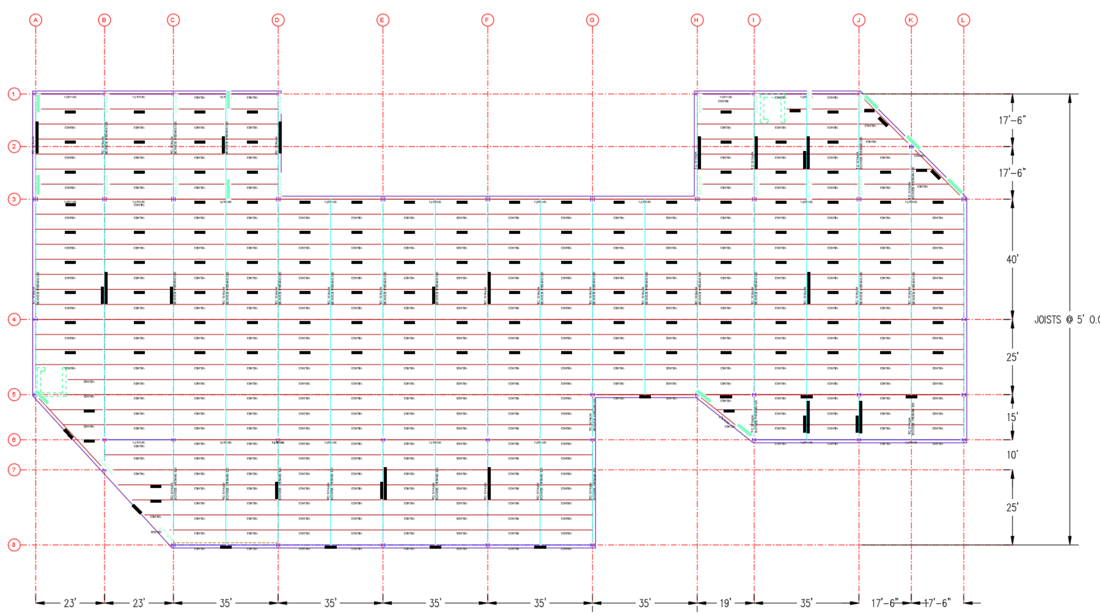


Lot 3 (south west of building)

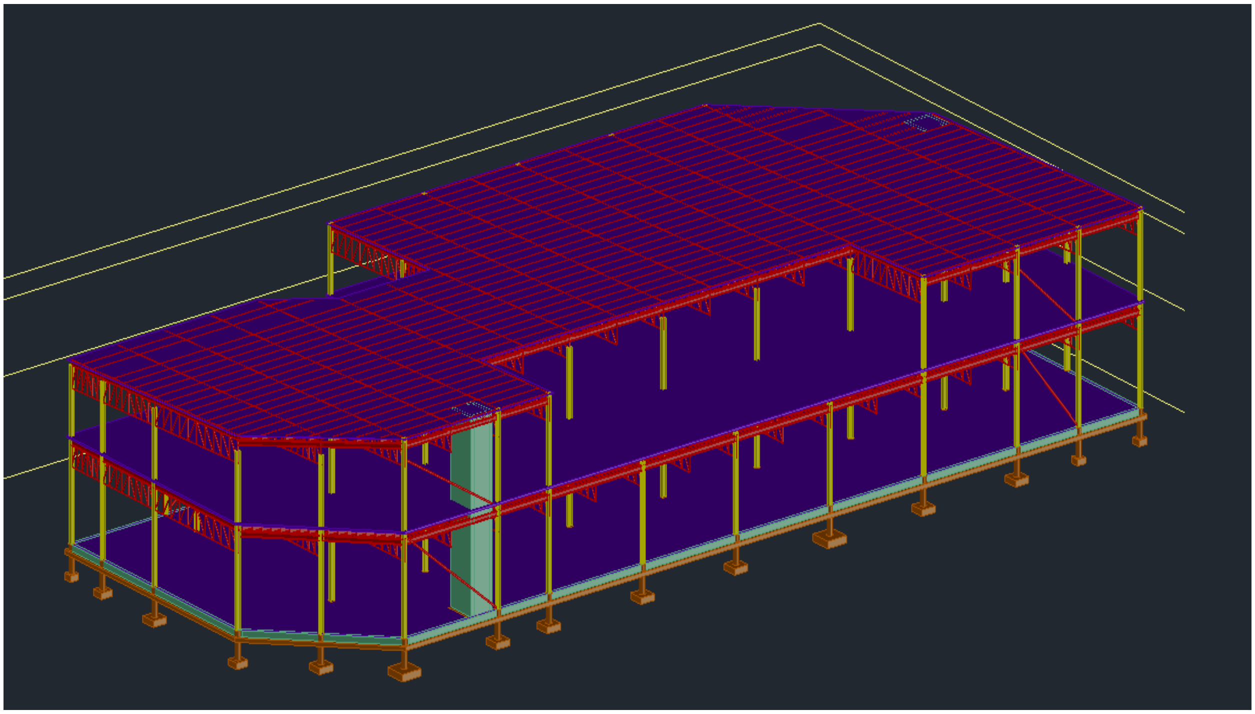


Appendix K - Final Building Design

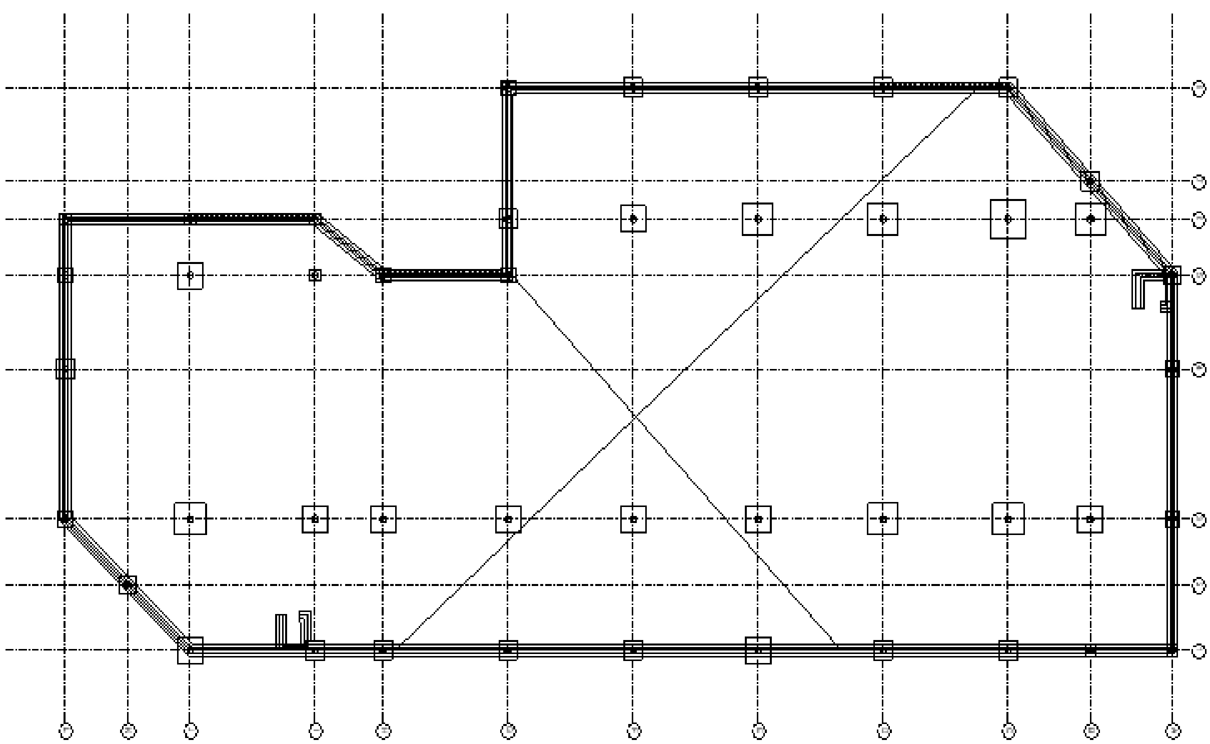




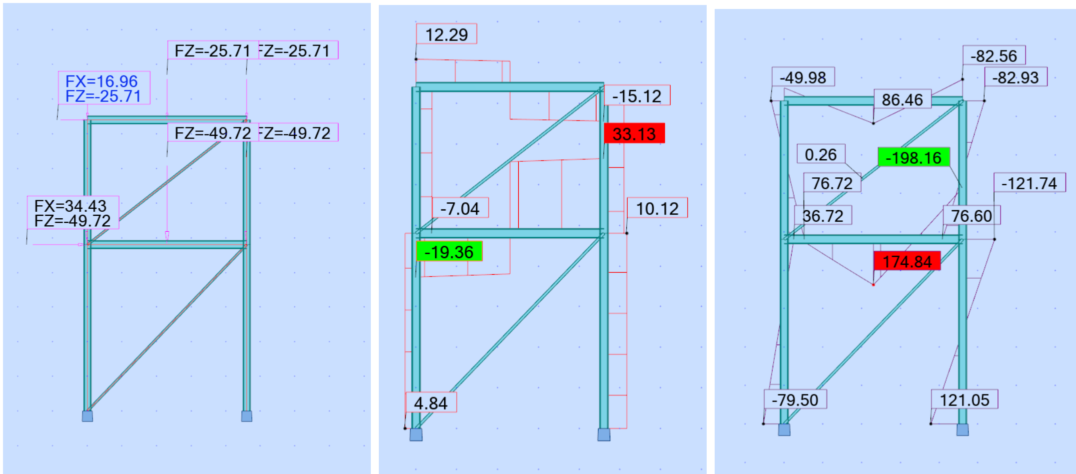
Isometric drawing of final structure:



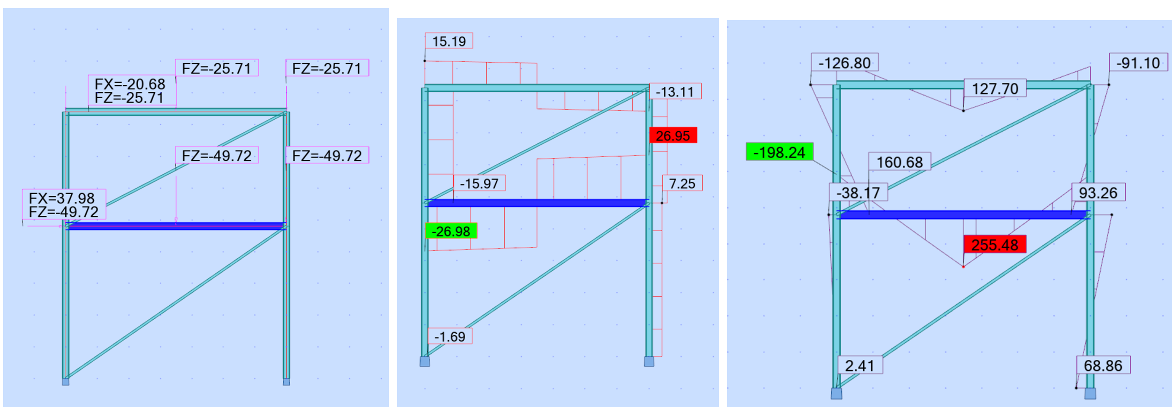
Foundation plan view and schedule:



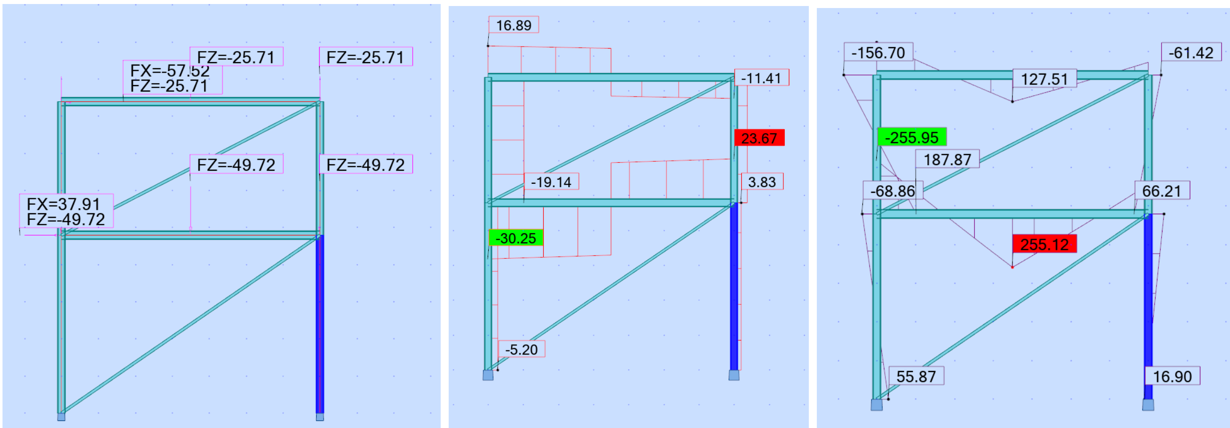
Lateral Force Resisting System Robot File Outputs



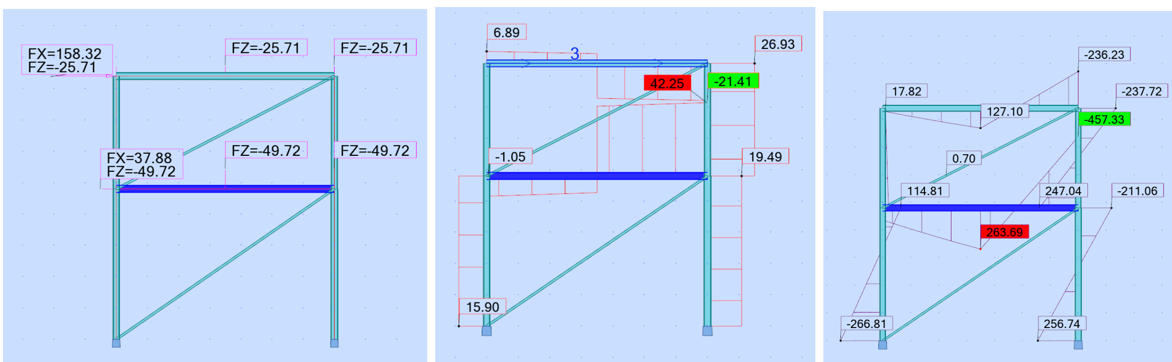
Braced Frame 1 - loading, shear, moment diagrams



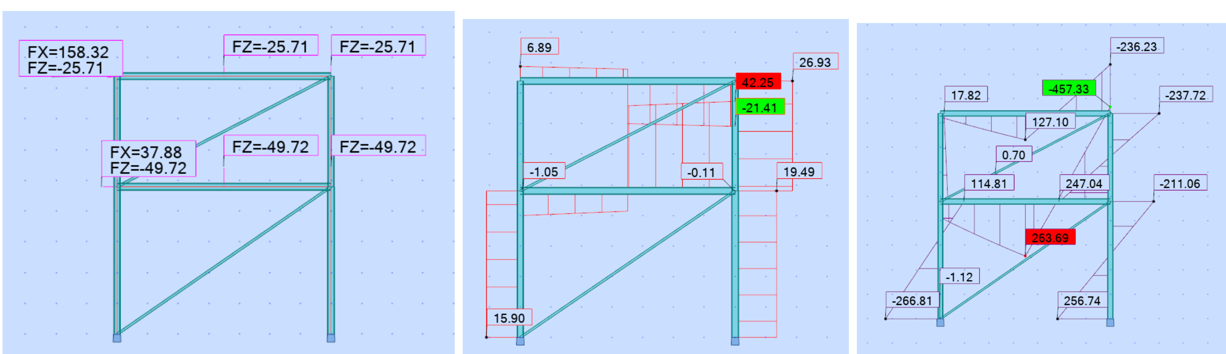
Braced Frame 2 - loading, shear, moment diagrams



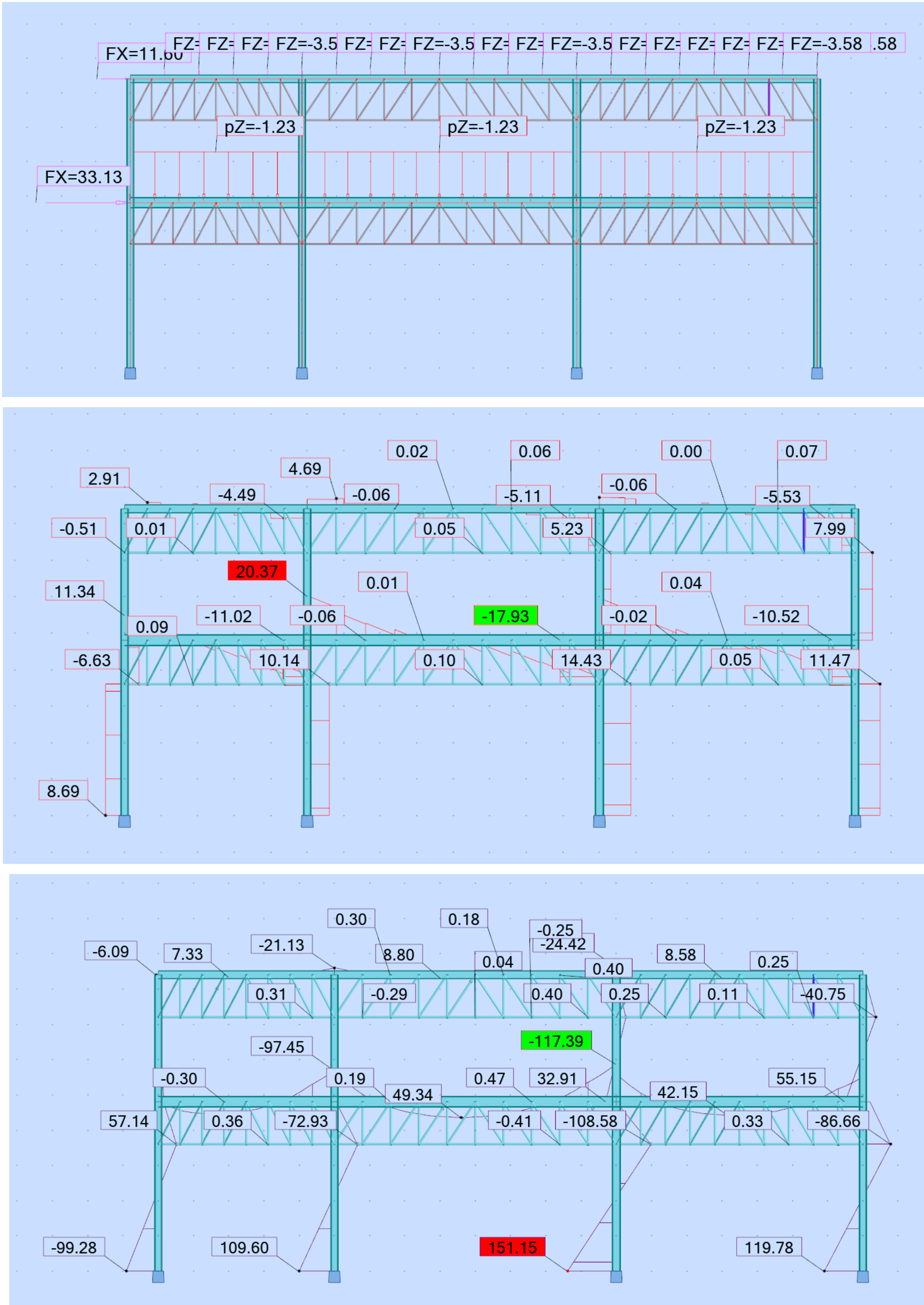
Braced Frame 3 - loading, shear, moment diagrams



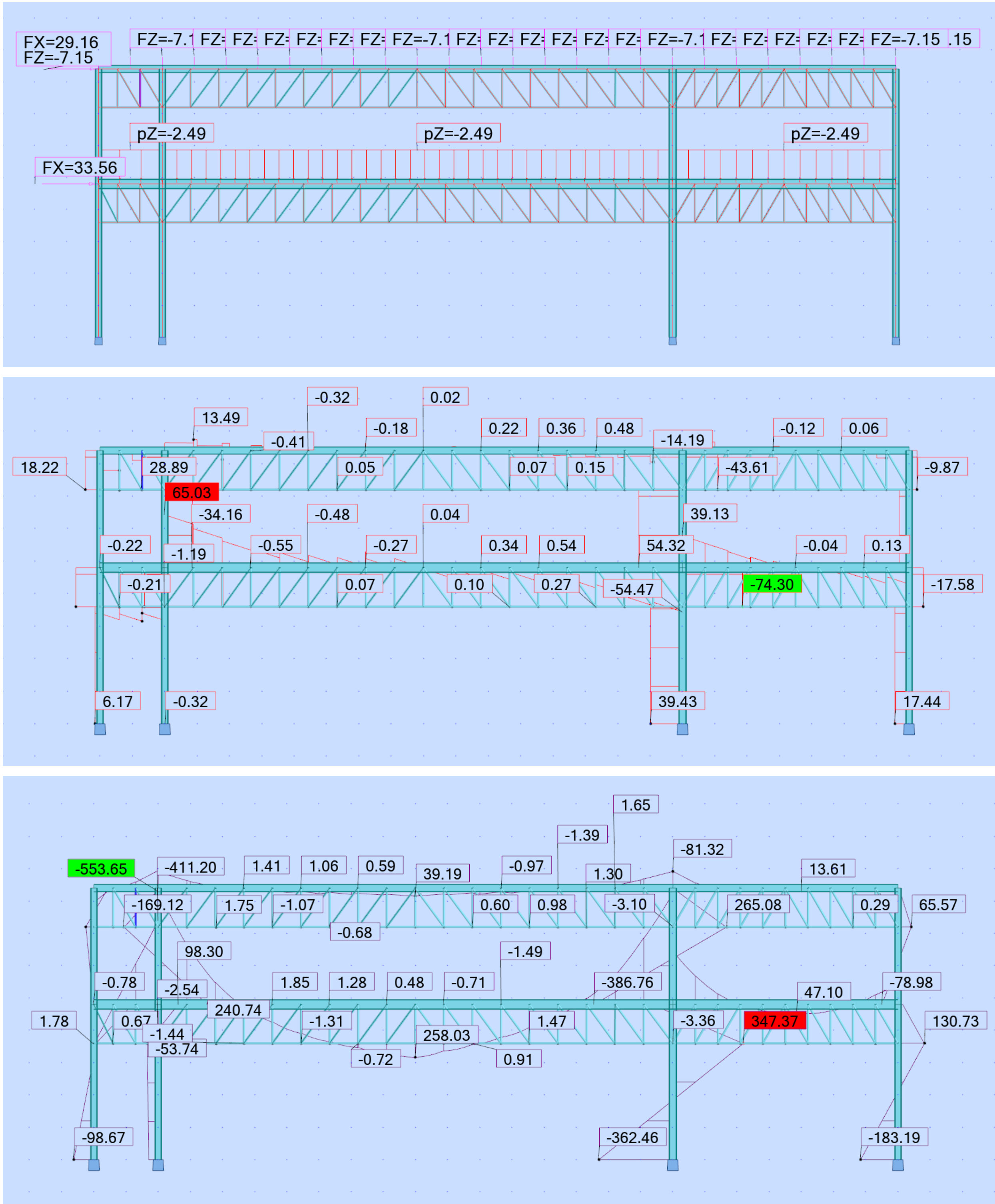
Braced Frame 4 - loading, shear, moment diagrams



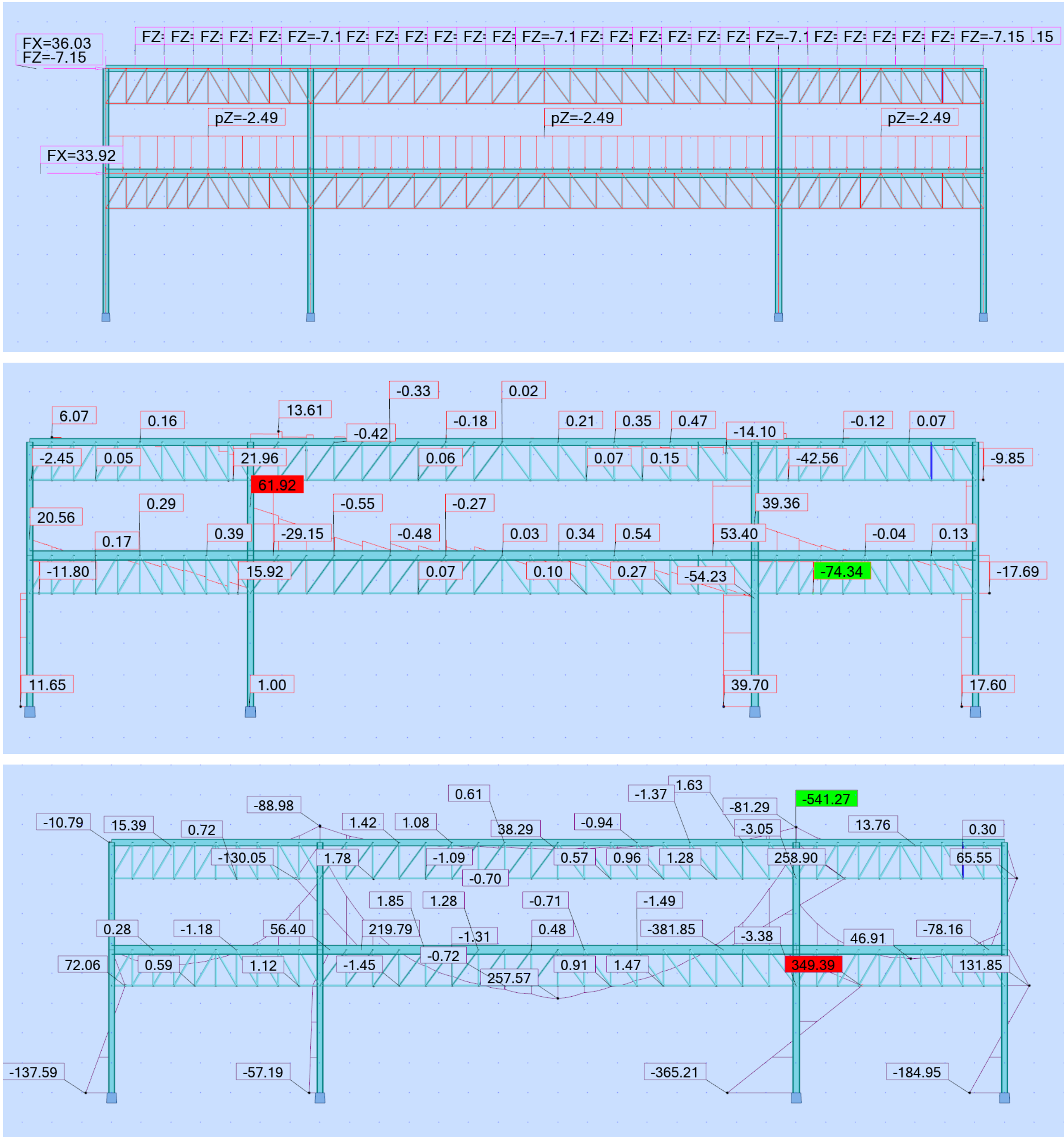
Braced Frame 5 - loading, shear, moment diagrams



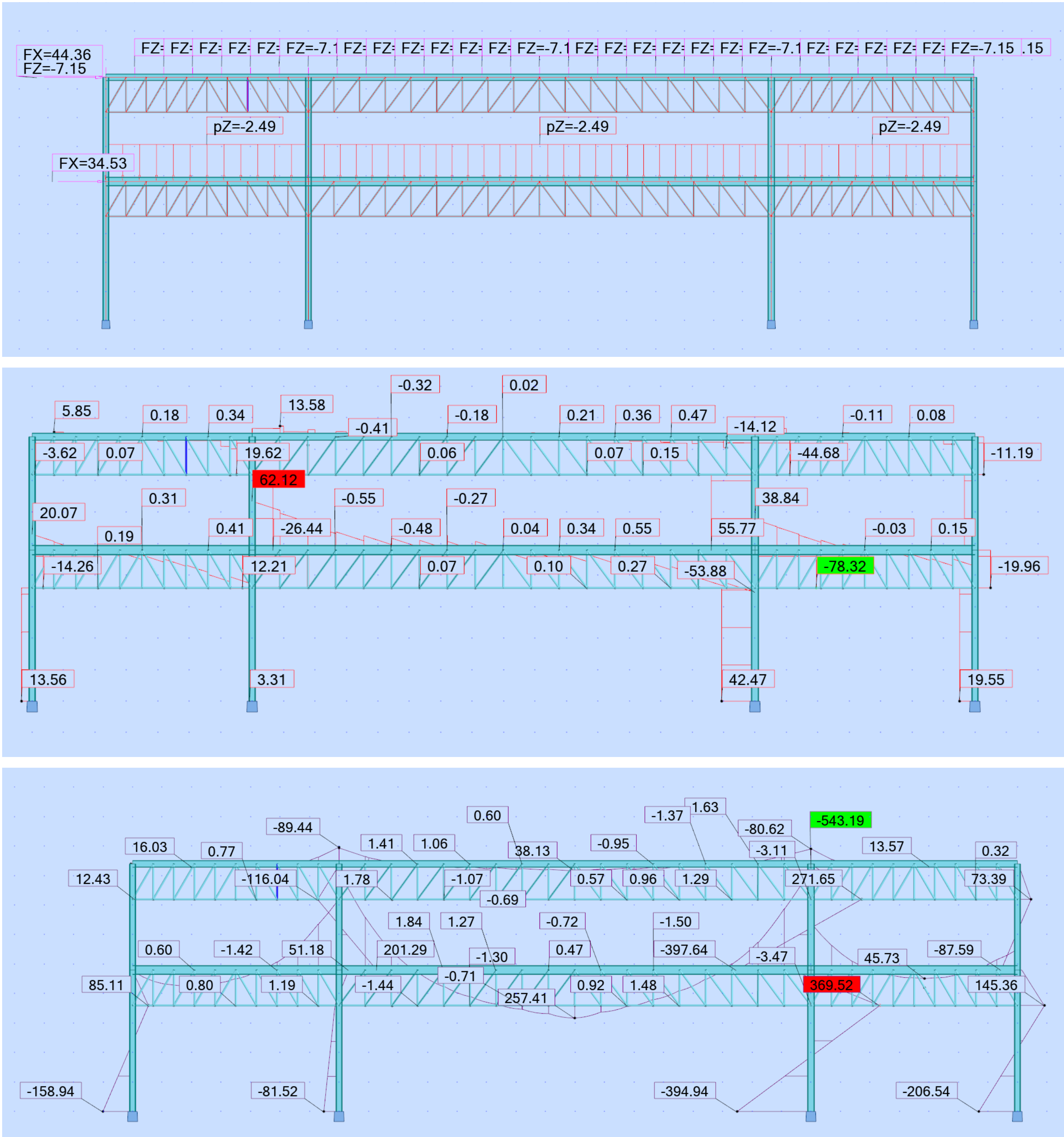
Moment Frame A - loading, shear, moment diagrams



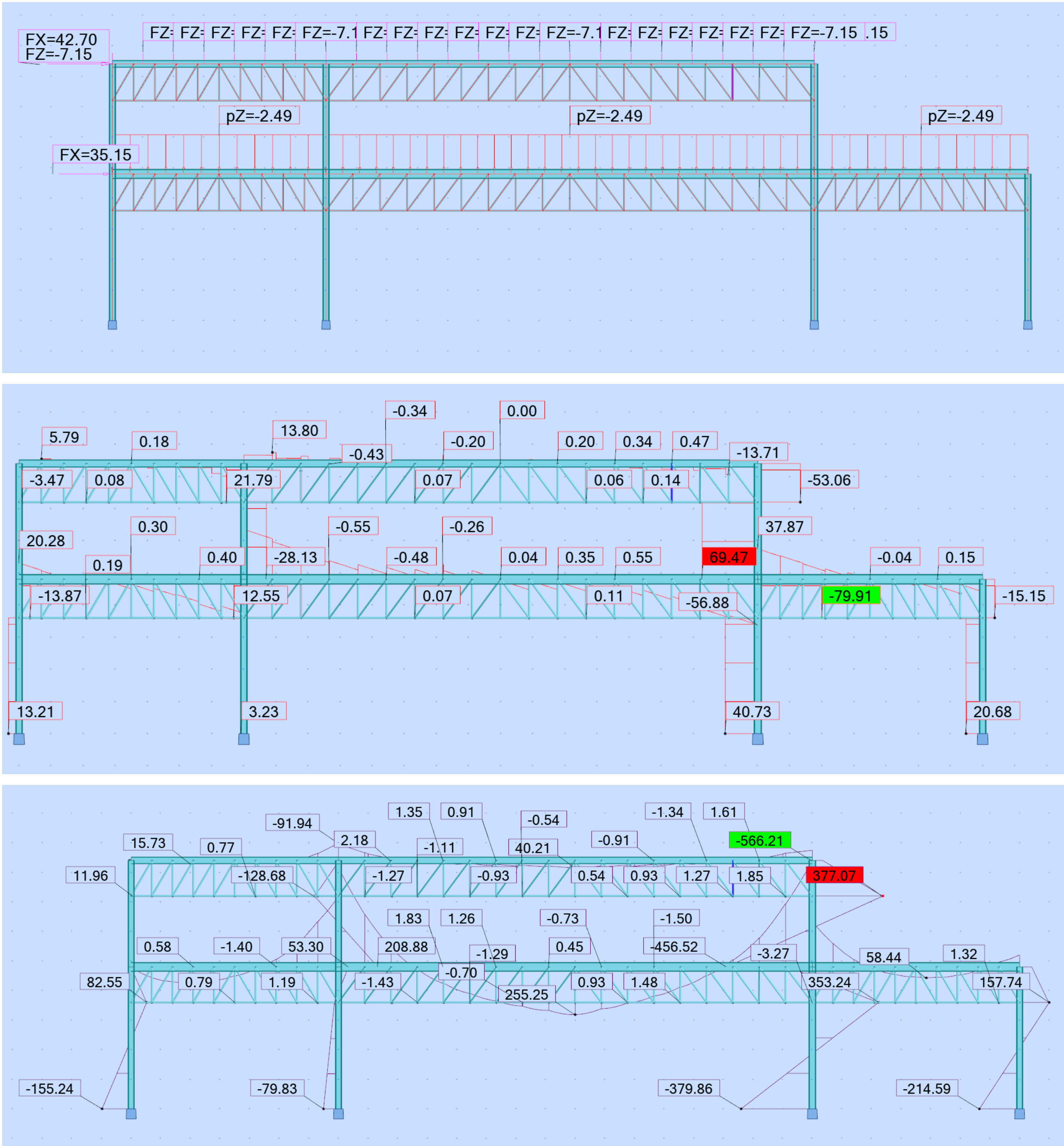
Moment Frame K - loading, shear, moment diagrams



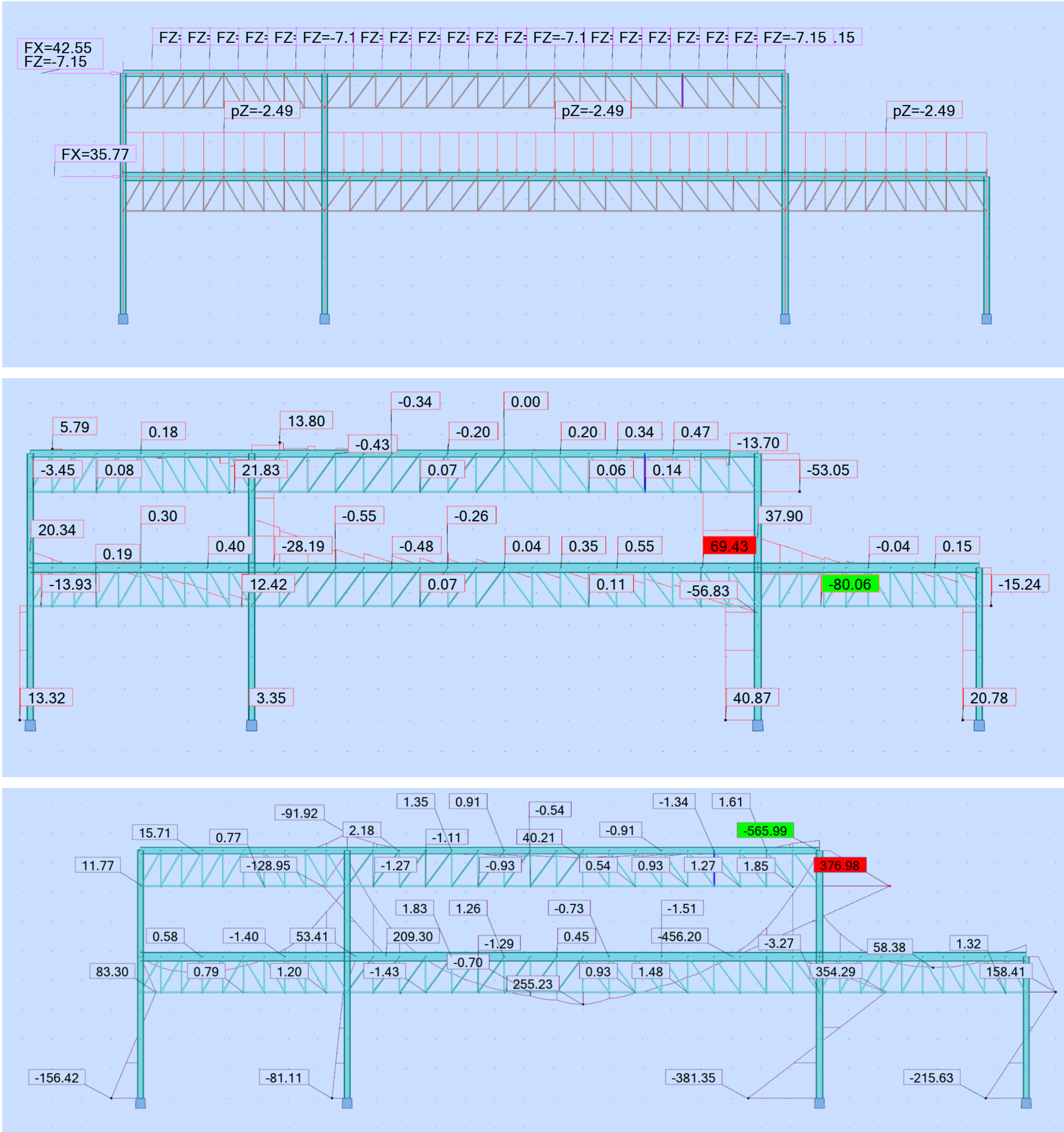
Moment Frame B - loading, shear, moment diagrams



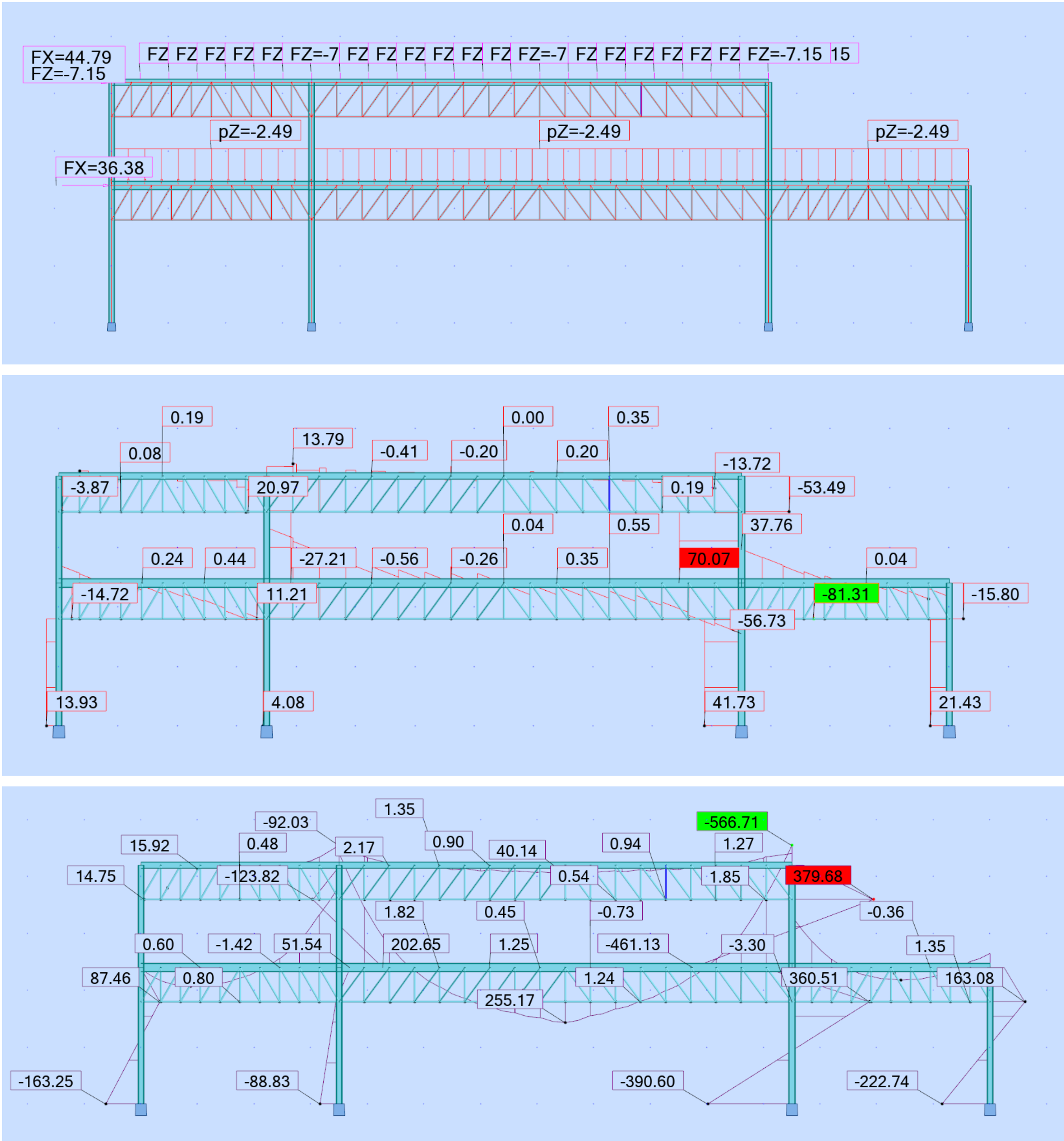
Moment Frame C - loading, shear, moment diagrams



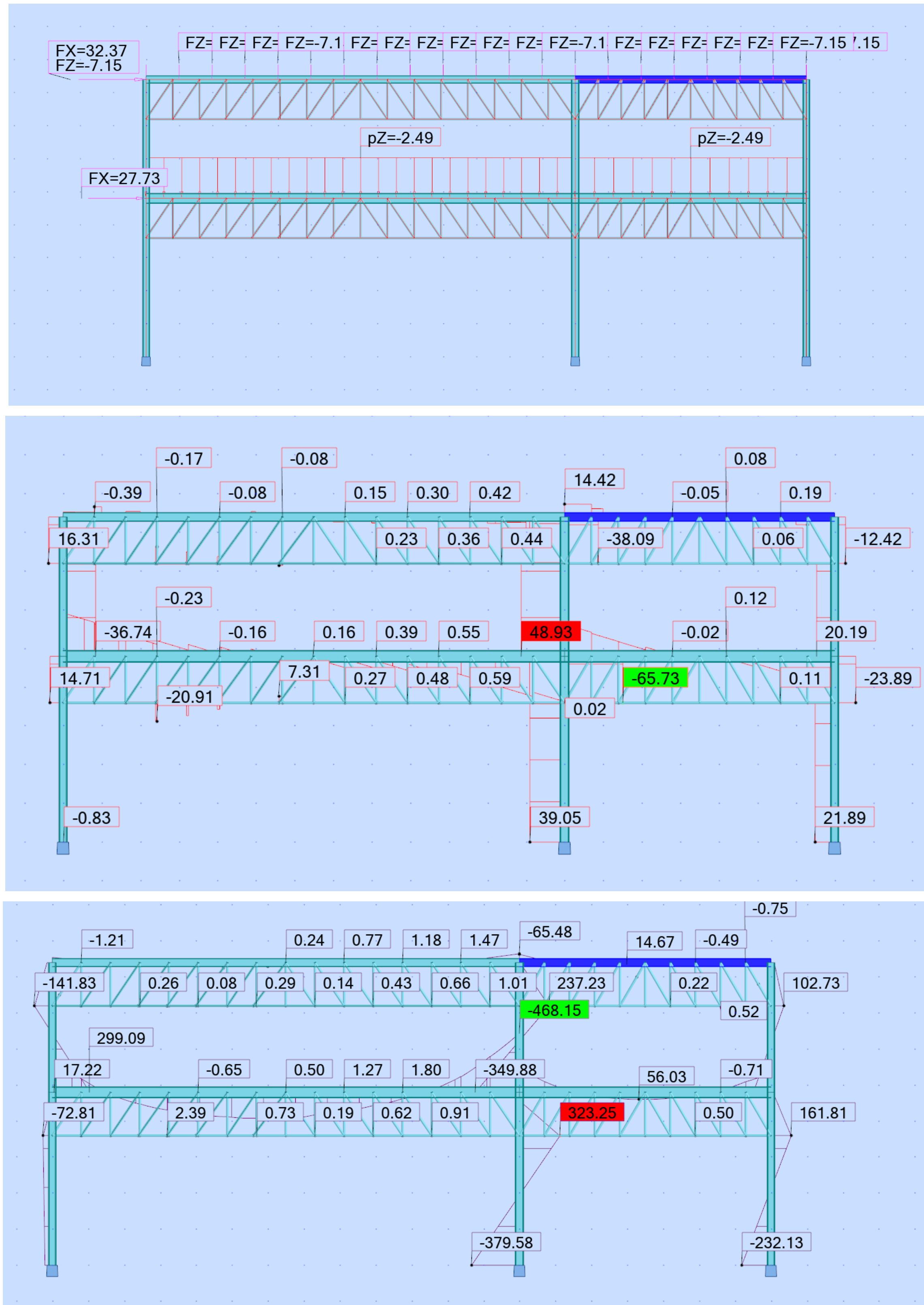
Moment Frame D - loading, shear, moment diagrams



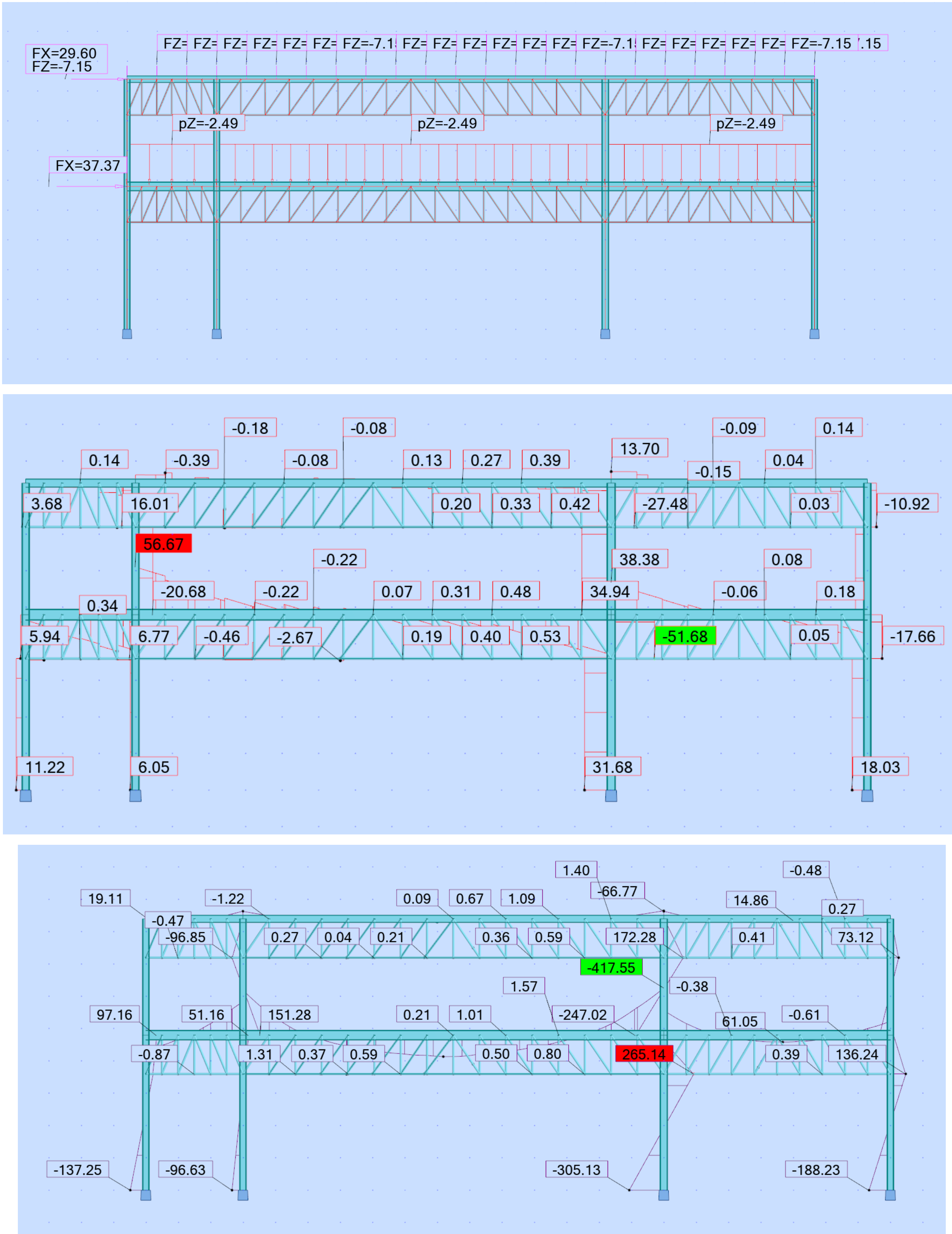
Moment Frame E - loading, shear, moment diagrams



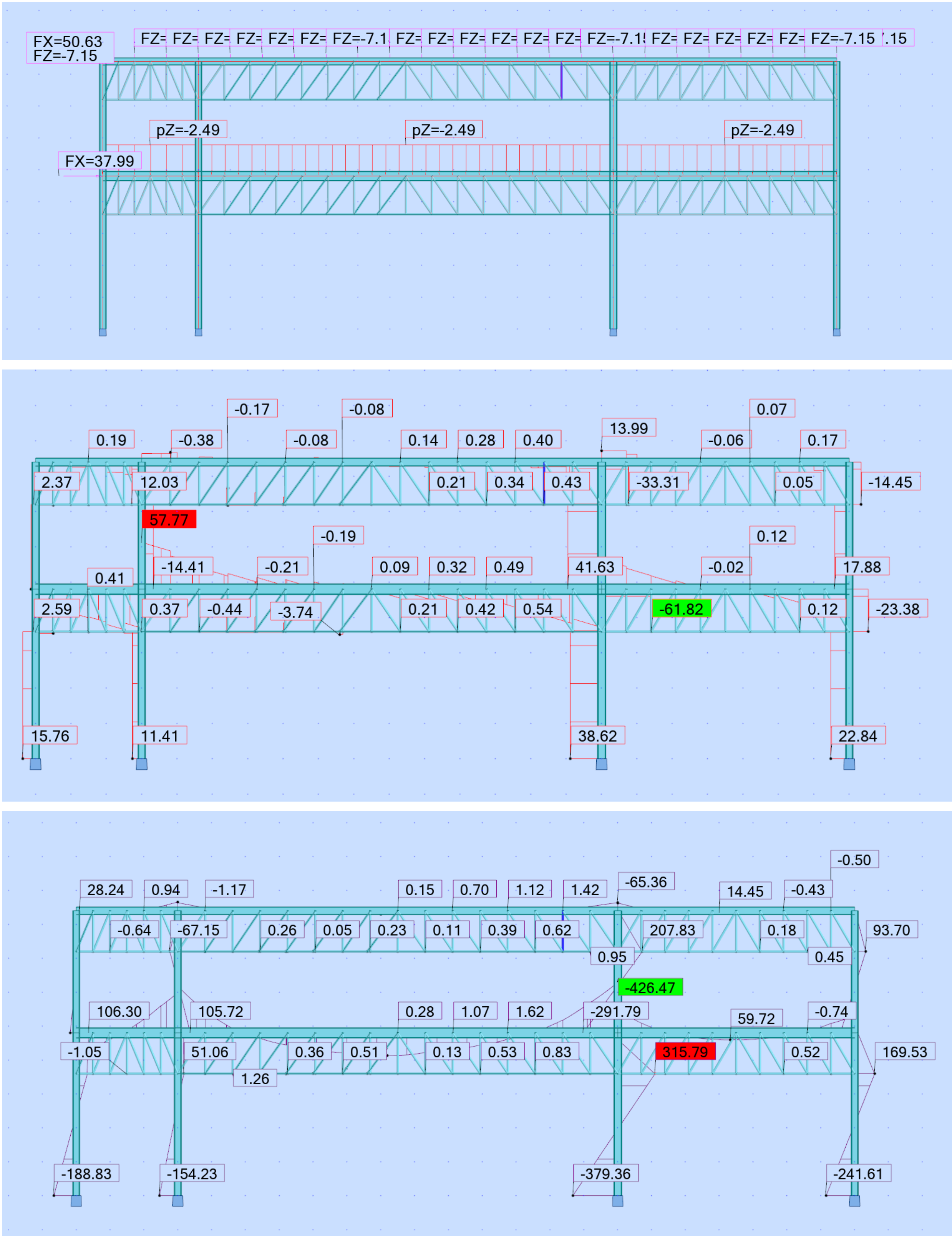
Moment Frame F - loading, shear, moment diagrams



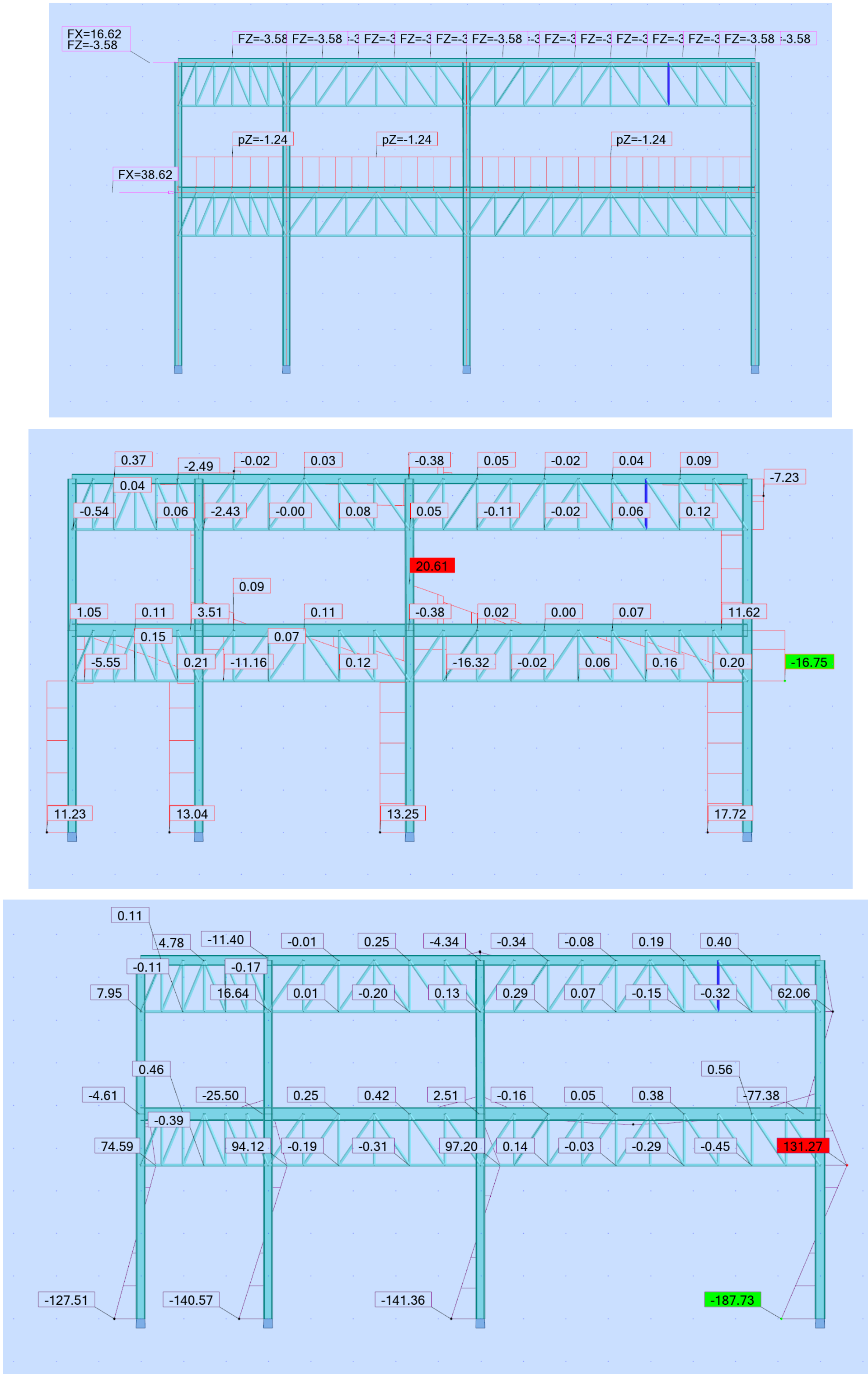
Moment Frame G - loading, shear, moment diagram



Moment Frame H - loading, shear, moment diagram



Moment Frame I - loading, shear, moment diagram



Moment Frame J - loading, shear, moment diagram

Name	Cut Factor	Fill Factor	2d Area(Sq. Ft.)	Cut(adjusted)(Cu. ...	Fill(adjusted)(Cu. ...	Net(adjusted)(Cu. ...	Net Graph
Sidewalk north building	1.000	1.000	831.75	1.49	7.77	6.29<Fill>	
lot 3 (4)	1.000	1.000	5451.59	567.10	0.00	567.10<Cut>	
Building East	1.000	1.000	29608.32	0.00	1649.13	1649.13<Fill>	
Sidewalk west parking lot	1.000	1.000	552.00	3.36	0.31	3.06<Cut>	
lot 1 east (2)	1.000	1.000	41800.00	9676.57	0.00	9676.57<Cut>	
Sidewalk south parking lot	1.000	1.000	745.27	4.87	1.65	3.22<Cut>	
lot 2 (3)	1.000	1.000	8820.00	1127.33	0.00	1127.33<Cut>	
Building NW (1)	1.000	1.000	9789.75	0.00	274.20	274.20<Fill>	
Sidewalk South building	1.000	1.000	2891.26	8.28	87.33	79.04<Fill>	
lot 1 west (2)	1.000	1.000	9570.00	2045.25	0.00	2045.25<Cut>	
Sidewalk North parking lot	1.000	1.000	1429.26	0.36	79.70	79.35<Fill>	
Building SW (1)	1.000	1.000	2708.18	0.00	175.92	175.92<Fill>	
Sidewalk west building	1.000	1.000	16632.02	188.93	552.78	363.86<Fill>	

Cut/Fill report for building site

Clinton Event Center loading:

Snow load:

Risk category III
Exposure factor C

page 106

$Ce := .9$

$Ct := 1.0$

$Is := 1.10$

$pg := 35$

$Iw := 1.0$

$pf := .7 \cdot Ce \cdot Ct \cdot Is \cdot pg = 24.255$ psf

$Cs := 1.0$

$ps := Cs \cdot pf = 24.255$ psf

N-S Wind load:

$z15 := 15$
$z24 := 24$
$z42 := 42$
$zh := h = 40.5$
$zp := 47$

$B := 150$
$L := 310$
$Iw = 1$
$Kd := .85$
$V := 115$

$Kzt := 1.0$
$Ke := 1.0$
$GCpi := .18$
$zg := 900$
$\alpha := 9.5$
$Gf := .85$

$hpeak := 20 + 18 + 5 = 43$
$he := 20 + 18 = 38$
$Cpwindward := .8$
$Cpleeward := -.3$
$GCpwindward := 1.5$
$GCleeward := -1.0$

$h := 0.5 \cdot (hpeak + he) = 40.5$

$\frac{L}{B} = 2.0667$

$theta := \operatorname{atan}\left(\frac{5}{115}\right) = 2.4896\,°$

$K15 := 2.01 \cdot \left(\frac{z15}{zg}\right)^{\frac{2}{\alpha}} = 0.8489$

$q15 := .00256 \cdot K15 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 24.4288$

$K24 := 2.01 \cdot \left(\frac{z24}{zg}\right)^{\frac{2}{\alpha}} = 0.9372$

$q20 := .00256 \cdot K24 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 26.9697$

$K42 := 2.01 \cdot \left(\frac{z42}{zg}\right)^{\frac{2}{\alpha}} = 1.0544$

$q38 := .00256 \cdot K42 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.3418$

$Kh := 2.01 \cdot \left(\frac{zh}{zg}\right)^{\frac{2}{\alpha}} = 1.0463$

$qh := .00256 \cdot Kh \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.1104$

$Kp := 2.01 \cdot \left(\frac{zp}{zg}\right)^{\frac{2}{\alpha}} = 1.0796$

$qp := .00256 \cdot Kh \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.1104$

Positive pressure:

$p15pos := q15 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 11.1917$
$p20pos := q20 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 12.9195$
$p38pos := q38 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 15.2126$
$pleepos := qh \cdot Gf \cdot Cpleeward - qh \cdot GCpi = -13.098$

psf

$p15netpos := p15pos - pleepos = 24.2898$
$p20netpos := p20pos - pleepos = 26.0175$
$p38netpos := p38pos - pleepos = 28.3106$

psf

Negative internal:

$p15neg := q15 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 22.0315$
$p20neg := q20 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 23.7592$
$p38neg := q38 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 26.0523$
$pleeneg := qh \cdot Gf \cdot Cpleeward - qh \cdot (-GCpi) = -2.2583$

psf

$p15netneg := p15neg - pleeneg = 24.2898$
$p20netneg := p20neg - pleeneg = 26.0175$
$p38netneg := p38neg - pleeneg = 28.3106$

psf

Roof Pressures: analyze as a parapet

$pp\_pos := qp \cdot 1.5 = 45.1656$

$pp\_neg := qp \cdot (-1.0) = -30.1104$

$pp := pp\_pos - pp\_neg = 75.276$

E-W Wind load:

$z15 := 15$
$z24 := 24$
$z42 := 42$
$zh := h = 40.5$
$zp := 47$

$B := 310$
$L := 150$
$Iw = 1$
$Kd := .85$
$V := 115$

$Kzt := 1.0$
$Ke := 1.0$
$GCpi := .18$
$zg := 900$
$\alpha := 9.5$
$Gf := .85$

$hpeak := 20 + 18 + 5 = 43$
$he := 20 + 18 = 38$
$Cpwindward := .8$
$Cpleeward := -.5$
$GCpwindward := 1.5$
$GCleeward := -1.0$

$h := 0.5 \cdot (hpeak + he) = 40.5$

$\frac{L}{B} = 0.4839$

$theta := \mathrm{atan}\left(\frac{5}{115}\right) = 2.4896\,°$

$K15 := 2.01 \cdot \left(\frac{z15}{zg}\right)^{\frac{2}{\alpha}} = 0.8489$ $\qquad q15 := .00256 \cdot K15 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 24.4288$

$K24 := 2.01 \cdot \left(\frac{z24}{zg}\right)^{\frac{2}{\alpha}} = 0.9372$ $\qquad q20 := .00256 \cdot K24 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 26.9697$

$K42 := 2.01 \cdot \left(\frac{z42}{zg}\right)^{\frac{2}{\alpha}} = 1.0544$ $\qquad q38 := .00256 \cdot K42 \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.3418$

$Kh := 2.01 \cdot \left(\frac{zh}{zg}\right)^{\frac{2}{\alpha}} = 1.0463$ $\qquad qh := .00256 \cdot Kh \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.1104$

$Kp := 2.01 \cdot \left(\frac{zp}{zg}\right)^{\frac{2}{\alpha}} = 1.0796$ $\qquad qp := .00256 \cdot Kh \cdot Kzt \cdot Kd \cdot Ke \cdot V^2 = 30.1104$

Positive pressure:

$p15pos := q15 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 11.1917$
$p20pos := q20 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 12.9195$
$p38pos := q38 \cdot Gf \cdot Cpwindward - qh \cdot GCpi = 15.2126$
$pleepos := qh \cdot Gf \cdot Cpleeward - qh \cdot GCpi = -18.2168$ $\qquad psf$

$p15netpos := p15pos - pleepos = 29.4085$
$p20netpos := p20pos - pleepos = 31.1363$
$p38netpos := p38pos - pleepos = 33.4293$ $\qquad psf$

Negative internal:

$p15neg := q15 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 22.0315$
$p20neg := q20 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 23.7592$
$p38neg := q38 \cdot Gf \cdot Cpwindward - qh \cdot (-GCpi) = 26.0523$
$pleeneg := qh \cdot Gf \cdot Cpleeward - qh \cdot (-GCpi) = -7.377$ $\qquad psf$

$p15netneg := p15neg - pleeneg = 29.4085$
$p20netneg := p20neg - pleeneg = 31.1363$
$p38netneg := p38neg - pleeneg = 33.4293$ $\qquad psf$

Roof Pressures: analyze as a parapet

$$pp\_pos := qp \cdot 1.5 = 45.1656$$

$$pp\_neg := qp \cdot (-1.0) = -30.1104$$

$$pp := pp\_pos - pp\_neg = 75.276$$

Design Loading - Museum Event Center

Live Loads *(ASCE 7-16: Ch4 and C4)*

Office Spaces - $LL_{office} := 50\ psf$

Lobby Spaces - $LL_{lobby} := 100\ psf$

any special requirements for RV's??

Showroom (1st floor) - $LL_{showroom} := 100\ psf$

Bathrooms - $LL_{bathrooms} := 60\ psf$

Event Space/Ballroom (2nd floor)/Balcony - $LL_{ballroom} := 100\ psf$

Elevator (by 2inx2in area) - $LL_{elevator} := 300\ lbf$

Elevator Machine Room - $LL_{elevator\_m} := 150\ psf$

Machine Space (AC, etc) - $LL_{machine} := 200\ psf$

Boiler Room - $LL_{boiler} := 300\ psf$

Kitchen - $LL_{kitchen} := 150\ psf$

Vegatative Roof (No Occupancy) - $LL_{roof} := 20\ psf$ veg and non veg

Stairs - $LL_{stairs} := 100\ psf$

Storage - $LL_{storage\_light} := 125\ psf$

$LL_{storage\_heavy} := 250\ psf$

Snow Load - $LL_{snow} := 24.55\ psf$

Dead Loads *(ASCE 7-16: Ch3 and C3)*

--Materials--

Roof Covering Material - $DL_{roof\_covering} := 1.5\ psf$

rubber applied membrane
(for lighter load)

Roof Underlayment - $DL_{underlayment} := 0.7\ psf$

Waterproofing Membrane, Single-Ply Felt

Design Loading - Museum Event Center

Roof Sheathing/Decking -

B24 Deck - $DL_{deck} := 1.36\ psf$

Conservative Estimate - $DL_{upper\_roof} := DL_{roof\_covering} + DL_{underlayment} + DL_{deck}$

Roof Insulation - $DL_{insulation} := 1.5\ pcf \cdot 0.75\ in = 0.094\ psf$

Foam Board (rigid - general)

Mechanical and Electrical Allowance - $DL_{MEP} := 4\ psf$

Roof Steel Framing Elements - $DL_{framing} := 10\ psf$

TOTAL ROOF DEAD LOAD AND LIVE LOAD:

$$DL_{roof} := DL_{upper\_roof} + DL_{insulation} + DL_{MEP} + DL_{framing} = 17.654\ psf$$

$LL_{roof} := 20\ psf$ $LL_{snow} := 24.55\ psf$ $LL_{wind} := 28.5\ psf$

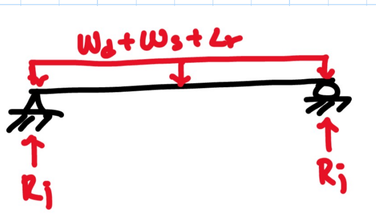
Roof Framing Component Anaylsis

ROOF DECK SPECS:

- Number of Spans => 2
- Deck Type => B24
- Max SDI Resultant Span => 5'-10"
- Span => 5'
- Total Factored => 124 psf
- Load Causing Deflection => 153 psf
- Thickness => 1.5 in

$$\left(LL_{snow} + LL_{roof}\right) \cdot 17.5\ ft = 0.78\ \frac{kip}{ft}$$

--Joists--



$w_{joist} := DL_{roof} + LL_{snow} + LL_{roof} = 62.204\ psf$

Longest Joist Length - $L_{joist} := 23\ ft$

Joist Spacing Options:

2 feet $R_{j\_2} := \dfrac{w_{joist} \cdot 2\ ft \cdot L_{joist}}{2} = 1.431\ kip$ $M_{j\_2} := \dfrac{w_{joist} \cdot 2\ ft \cdot L_{joist}^{2}}{8} = 8.226\ kip \cdot ft$

Design Loading - Museum Event Center

4 feet $R_{j\_4} := \dfrac{w_{joist} \cdot 4\ ft \cdot L_{joist}}{2} = 2.861\ kip$ $M_{j\_4} := \dfrac{w_{joist} \cdot 4\ ft \cdot L_{joist}^{\ 2}}{8} = 16.453\ kip \cdot ft$

5 feet $R_{j\_5} := \dfrac{w_{joist} \cdot 5\ ft \cdot L_{joist}}{2} = 3.577\ kip$ $M_{j\_5} := \dfrac{w_{joist} \cdot 5\ ft \cdot L_{joist}^{\ 2}}{8} = 20.566\ kip \cdot ft$

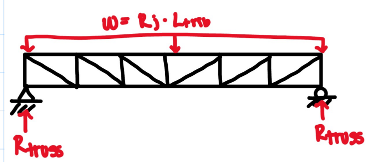
6 feet $R_{j\_6} := \dfrac{w_{joist} \cdot 6\ ft \cdot L_{joist}}{2} = 4.292\ kip$ $M_{j\_6} := \dfrac{w_{joist} \cdot 6\ ft \cdot L_{joist}^{\ 2}}{8} = 24.679\ kip \cdot ft$

ROOF JOIST SPECS:

- 18LH03
- 11plf
- 18 in deep
- Safe Load Between => 13300
- Total Factored => 781 plf
- Unfactored => 348 plf

Joists are subjected to bending

--Trusses--



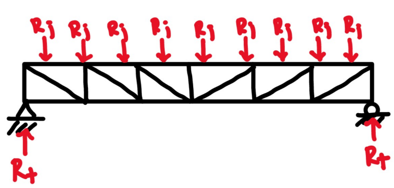
Longest Truss Length - $L_{truss} := 80\ ft$

Largest Tributary Width - $w_{t\_trib} := 23\ ft$

At 2 ft Joist Spacing - $n_2 := 40$

2 foot Joist Spacing:

$$R_{t\_2} := \dfrac{\dfrac{n_2 \cdot R_{j\_2}}{L_{truss}} \cdot L_{truss}}{2} = 28.614\ kip$$



At 4 ft Joist Spacing - $n_4 := 20$

At 5 ft Joist Spacing - $n_5 := 16$

At 6 ft Joist Spacing - $n_6 := 13$

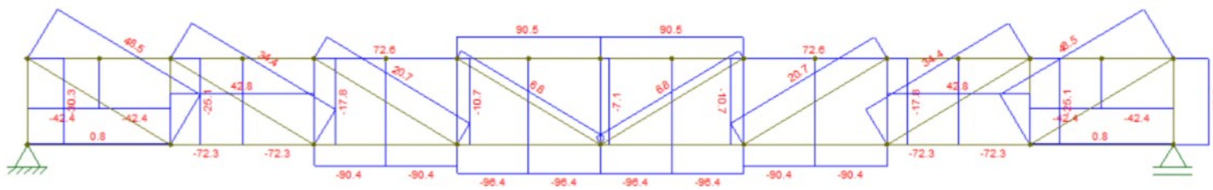
4 foot Joist Spacing: $R_{t\_4} := \dfrac{R_{j\_4} \cdot (824\ ft)}{80\ ft} = 29.472\ kip$

5 foot Joist Spacing: $R_{t\_5} := \dfrac{R_{j\_5} \cdot (575\ ft)}{80\ ft} = 25.708\ kip$

6 foot Joist Spacing: $R_{t\_6} := \dfrac{R_{j\_6} \cdot (546\ ft)}{80\ ft} = 29.293\ kip$

Design Loading - Museum Event Center

Axial - 5ft spacing

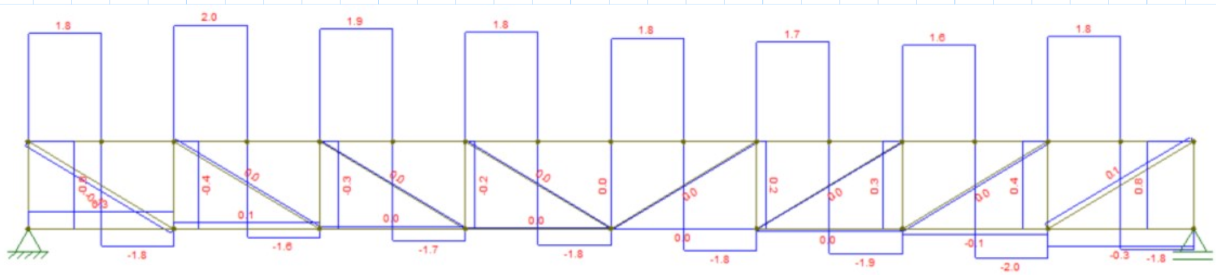


$P_{c\_TC} := 96.4\ kip$

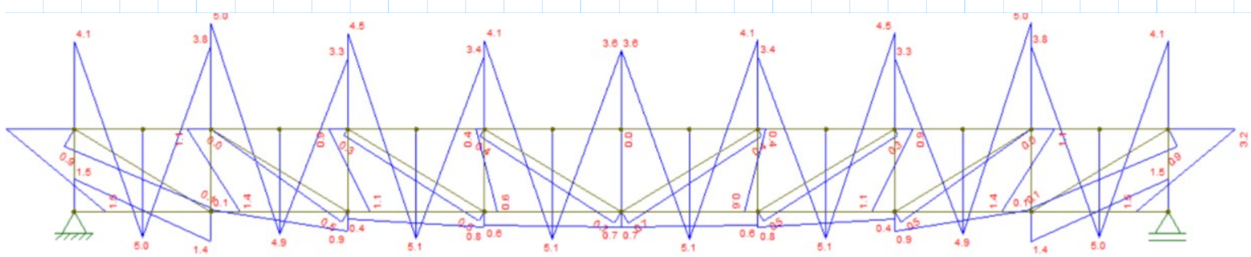
$P_{c\_WEB} := 30.3\ kip$

$P_{t\_BC\_WEB} := 90.5\ kip$

Shear - 5ft spacing



Moment - 5ft spacing



$M_{max\_TC} := 5.1\ kip \cdot ft$

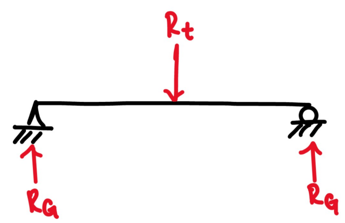
ROOF TRUSS SPECS:

- 5' Joist Spacing
- Top Chord =>W14x61
- Bottom Chord/Web =>HSS 4x0.313

Design Loading - Museum Event Center

Trusses are subjected to:
bending and compression in top chord
tension and compression in web memebers
tension in bottom chord

--Girder--



Greatest Loaded Girder Length - $L_{girder} := 35\ ft$

$$R_{g\_2} := \frac{R_{t\_2}}{2} = 14.307\ kip$$

2 foot Joist Spacing:

$$M_{g\_2} := \frac{R_{t\_2} \cdot L_{girder}}{4} = 250.37\ kip \cdot ft$$

4 foot Joist Spacing:

$$R_{g\_4} := \frac{R_{t\_4}}{2} = 14.736\ kip$$

$$M_{g\_4} := \frac{R_{t\_4} \cdot L_{girder}}{4} = 257.881\ kip \cdot ft$$

5 foot Joist Spacing:

$$R_{g\_5} := \frac{R_{t\_5}}{2} = 12.854\ kip$$

$2 \cdot R_{g\_5} = 25.708\ kip$

$$M_{g\_5} := \frac{R_{t\_5} \cdot L_{girder}}{4} = 224.942\ kip \cdot ft$$

6 foot Joist Spacing:

$$R_{g\_6} := \frac{R_{t\_6}}{2} = 14.647\ kip$$

$$M_{g\_6} := \frac{R_{t\_6} \cdot L_{girder}}{4} = 256.316\ kip \cdot ft$$

ROOF GIRDER SPECS:

- 5' Joist Spacing
- W14x61

Girders are subjected to bending

Design Loading - Museum Event Center

--Column--

$LL_{wind} := 27.8804\ psf$

$TA_{panel} := 35\ ft$

$w_{column} := LL_{wind} \cdot TA_{panel} = 0.976\ \frac{kip}{ft}$

Look at end for frame analysis

Columns are subjected to compression and bending

Design Loading - Museum Event Center

Second Floor Loading

$LL_{machine} \cdot 2\ ft = 400\ plf$ $\qquad LL_{machine} \cdot 5\ ft = 1000\ plf$

$LL_{machine} \cdot 4\ ft = 800\ plf$ $\qquad LL_{machine} \cdot 6\ ft = 1200\ plf$

$LL_{lobby} \cdot 2\ ft = 200\ plf$ $\qquad LL_{lobby} \cdot 5\ ft = 500\ plf$

$LL_{lobby} \cdot 4\ ft = 400\ plf$ $\qquad LL_{lobby} \cdot 6\ ft = 600\ plf$

$LL_{kitchen} \cdot 2\ ft = 300\ plf$ $\qquad LL_{kitchen} \cdot 5\ ft = 750\ plf$

$LL_{kitchen} \cdot 4\ ft = 600\ plf$ $\qquad LL_{kitchen} \cdot 6\ ft = 900\ plf$

TOTAL SECOND FLOOR DEAD LOAD AND LIVE LOAD:

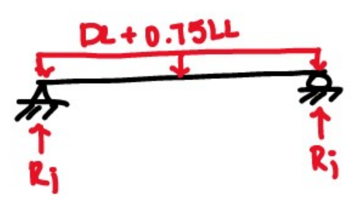
SECOND FLOOR DECK SPECS:

- 2 spans
- Deck Type => 1.0c24
- Span => 5'
- Fb => 36000 => 98
- L/240 => 73
- L/180 => 98
- Thickness => 1 in
- Light Weight Concrete => 5 in
- Reinforcement => 6x6-W2.9xW2.9

Conservative Deck Load - $DL_{deck} := 19\ psf$

$$DL_{2\_floor} := DL_{deck} + DL_{insulation} + DL_{MEP} + DL_{framing} = 33.094\ psf$$

$LL_{2\_floor\_design} := 100\ psf$ $\qquad LL_{2\_floor\_design} \cdot 17.5\ ft = 1.75\ \dfrac{kip}{ft}$



$$w_{joist} := DL_{2\_floor} + 0.75 \cdot LL_{2\_floor\_design} = 108.094\ psf$$

Longest Joist Length - $L_{joist} := 23\ ft$

Joist Spacing Options:

2 feet $\quad R_{j\_2} := \dfrac{w_{joist} \cdot 2\ ft \cdot L_{joist}}{2} = 2.486\ kip$ $\qquad M_{j\_2} := \dfrac{w_{joist} \cdot 2\ ft \cdot L_{joist}^{\ 2}}{8} = 14.295\ kip \cdot ft$

Design Loading - Museum Event Center

4 feet $R_{j\_4} := \dfrac{w_{joist} \cdot 4\ ft \cdot L_{joist}}{2} = 4.972\ kip$ $M_{j\_4} := \dfrac{w_{joist} \cdot 4\ ft \cdot {L_{joist}}^2}{8} = 28.591\ kip \cdot ft$

5 feet $R_{j\_5} := \dfrac{w_{joist} \cdot 5\ ft \cdot L_{joist}}{2} = 6.215\ kip$ $M_{j\_5} := \dfrac{w_{joist} \cdot 5\ ft \cdot {L_{joist}}^2}{8} = 35.738\ kip \cdot ft$

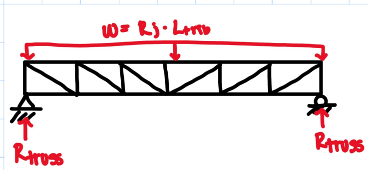
6 feet $R_{j\_6} := \dfrac{w_{joist} \cdot 6\ ft \cdot L_{joist}}{2} = 7.458\ kip$ $M_{j\_6} := \dfrac{w_{joist} \cdot 6\ ft \cdot {L_{joist}}^2}{8} = 42.886\ kip \cdot ft$

SECOND FLOOR JOIST SPECS:

- 20LH10
- 23plf
- 20 in deep
- Safe Load Between => 27400
- Total Factored => 1602 plf
- Unfactored => 348 plf

Joists are subjected to bending

--Trusses--



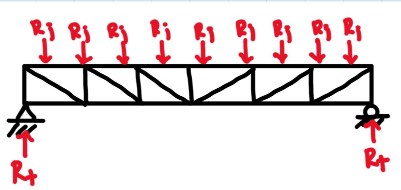
Longest Truss Length - $L_{truss} := 80\ ft$

Largest Tributary Width - $w_{t\_trib} := 23\ ft$

At 2 ft Joist Spacing - $n_2 := 40$

2 foot Joist Spacing:

$$R_{t\_2} := \dfrac{\dfrac{n_2 \cdot R_{j\_2}}{L_{truss}} \cdot L_{truss}}{2} = 49.723\ kip$$



At 4 ft Joist Spacing - $n_4 := 20$

At 5 ft Joist Spacing - $n_5 := 16$

At 6 ft Joist Spacing - $n_6 := 13$

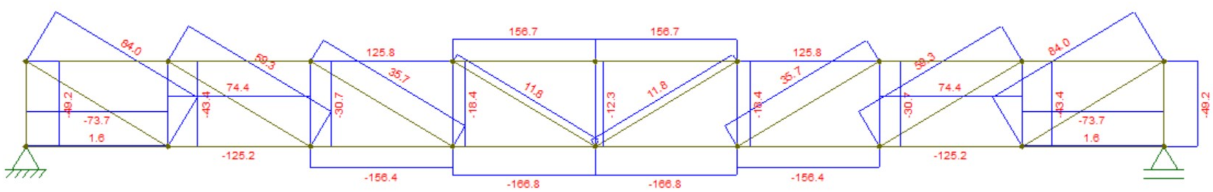
4 foot Joist Spacing: $R_{t\_4} := \dfrac{R_{j\_4} \cdot (824\ ft)}{80\ ft} = 51.215\ kip$

5 foot Joist Spacing: $R_{t\_5} := \dfrac{R_{j\_5} \cdot (575\ ft)}{80\ ft} = 44.673\ kip$

Design Loading - Museum Event Center

6 foot Joist Spacing: $R_{t\_6} := \dfrac{R_{j\_6} \cdot (546\ ft)}{80\ ft} = 50.904\ kip$

Axial - 2 ft spacing

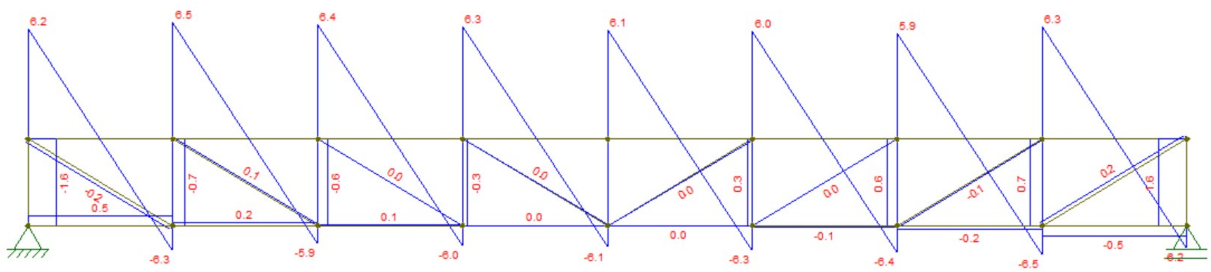


$P_{c\_TC} := 156.7\ kip$

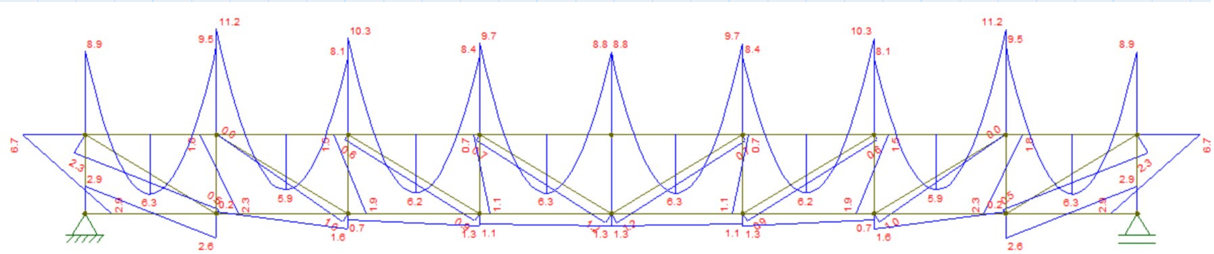
$P_{c\_WEB} := 49.2\ kip$

$P_{t\_BC\_WEB} := 156.7\ kip$

Shear - 2 ft spacing



Moment - 2 ft spacing



$M_{max\_TC} := 11.2\ kip \cdot ft$

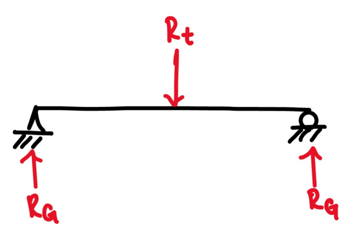
Design Loading - Museum Event Center

SECOND FLOOR TRUSS SPECS:

- 2' Joist Spacing
- Top Chord => W16x57
- Bottom Chord/Web => HSS 5x0.5

Trusses are subjected to:
bending and compression in top chord
tension and conpression in web memebers
tension in bottom chord

--Girder--



Greatest Loaded Girder Length - $L_{girder} := 35\ ft$

2 foot Joist Spacing:

$$R_{g\_2} := \frac{R_{t\_2}}{2} = 24.862\ kip$$

$$M_{g\_2} := \frac{R_{t\_2} \cdot L_{girder}}{4} = 435.077\ kip \cdot ft$$

4 foot Joist Spacing:

$$R_{g\_4} := \frac{R_{t\_4}}{2} = 25.607\ kip$$

$$M_{g\_4} := \frac{R_{t\_4} \cdot L_{girder}}{4} = 448.13\ kip \cdot ft$$

5 foot Joist Spacing:

$$R_{g\_5} := \frac{R_{t\_5}}{2} = 22.337\ kip$$

$$M_{g\_5} := \frac{R_{t\_5} \cdot L_{girder}}{4} = 390.89\ kip \cdot ft$$

$$2 \cdot R_{g\_5} = 44.673\ kip$$

6 foot Joist Spacing:

$$R_{g\_6} := \frac{R_{t\_6}}{2} = 25.452\ kip$$

$$M_{g\_6} := \frac{R_{t\_6} \cdot L_{girder}}{4} = 445.41\ kip \cdot ft$$

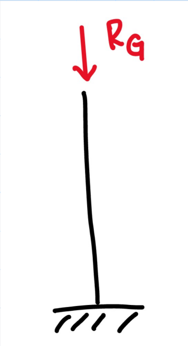
SECOND FLOOR GIRDER SPECS:

- 5' Joist Spacing
- W16x89

Design Loading - Museum Event Center

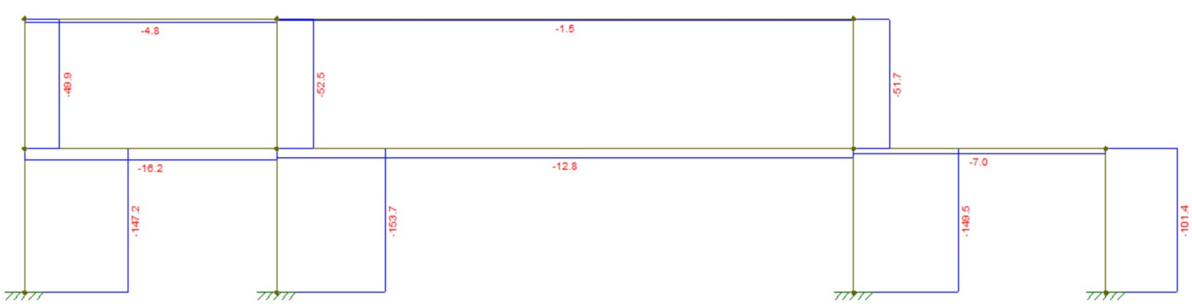
Girders are subjected to bending

--Column--



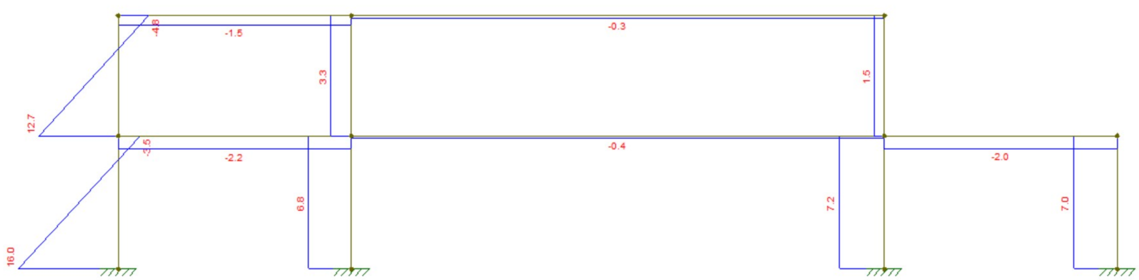
Columns are subjected to compression and bending

Axial



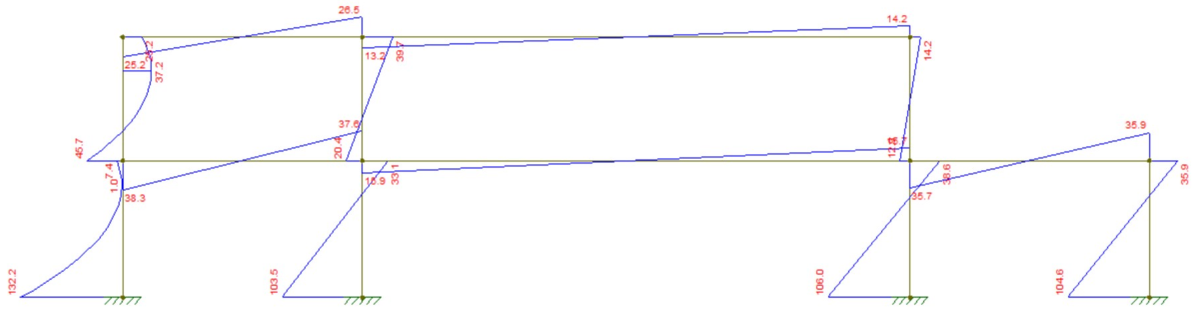
$L_e := 0.5 \cdot 20\ ft = 10\ ft$

Shear



Design Loading - Museum Event Center

Bending



COLUMN SPECS:

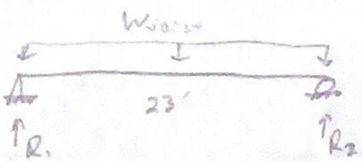
- All Columns W8x67

Joists roof

Roof

$W_{joist} = 62.744$

$L_{joist} = 23$



TC = W14 x 257

BC = HSS 3.5 x .188 50

Web = HSS 3.5 x .188

$\Sigma M = -(62.744 \cdot 23 \cdot \frac{23}{2}) + R_2 \cdot 23$

$R_2 = R_1 = 721.56$

Joist designation => 18LH03

- 11 plf
- 18" deep
- Safe load between 21-24 => 13300
- Total factored = 781 plf
- Unfactored = 348 plf

Trusses

5' joist spacing,

Joist designation => 18LH09

- 21 plf
- 18" deep
- 24000 safe load between
- 1404 total factored
- 616 unfactored

TC = W14 x 61

BC = HSS 4 x .313

Web = HSS 3 x .125

Deck roof

\# of spans = 2

Deck type => B24

Max SDI constant span => 5'10

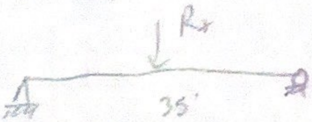
Span => 5'

Total factored = 124 psf

Load causing deflection = 153 psf

Girders

5' joist spacing



$M_{34'} = 260.12$ k-ft 35

TC = W14 x 61

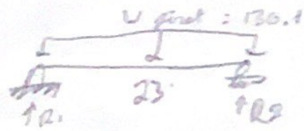
BC = HSS 5.563 x .134

Web = HSS 5.563 x .136

Joist designation => 24LH05

- 13 plf
- 24" deep
- Load between = 22650

Joists floor



$\Sigma M = -(130.1 \cdot 23 \cdot 23/2) + (R_2 \cdot 23)$

$R_2 = 1496.15 = R_1$

Joist designation => 20LH10
- 23 plf
- 20" deep
- 27700 safe load between 20-24
- Total factored = 1602 plf
- Unfactored = 786 plf
- 5' joist spacing

Trusses

5' joist spacing

$\frac{7.48 \cdot 575}{4} = 1075.25$

TC = ~~W16~~ x 45
BC = HSS 4 x .313
Web = HSS 3 x .134

Joist designation => 18LH06
- 15 plf
- 18" deep
- 20700 safe load between
- 1213 total factored
- 526 unfactored

TC = W16 x 57
BC = HSS 5 x .5
Web = HSS 3 x .25

1st floor deck

Span = 5'

Deck type = 1.0C24
- Fb = 76000 => 98
- L/240 => 73
- L/180 = 98

Girders

$M_{g4} = 539.34$

TC = W16 x 89
BC = HSS 7.5 x .5
Web = HSS 4.5 x .375

4' spacing for joists

Joist designation => 24LH11 => factored = 1312 unfactored = 555
- 25 plf
- 24" deep
- safe load between = 46800

Design Loading - Museum Event Center

ROOF FRAMING

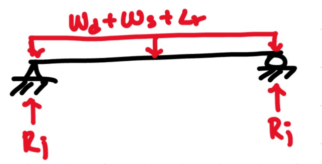
Roof Dead Load - $DL_{roof} := 17.654\ psf$

Roof Live Load - $LL_{roof} := 20\ psf$

$LL_{snow} := 24.55\ psf$

Roof Deck - Deck Type: B24
Thickness: 1.5 in

Roof Joists - $w_{joist} := DL_{roof} + LL_{snow} + LL_{roof} = 62.204\ psf$



Longest Joist Length - $L_{joist} := 23\ ft$

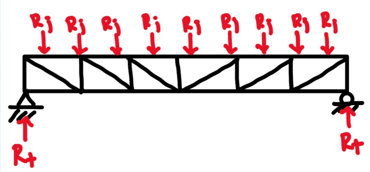
5 feet

$$R_{j\_5} := \frac{w_{joist} \cdot 5\ ft \cdot L_{joist}}{2} = 3.577\ kip$$

$$M_{j\_5} := \frac{w_{joist} \cdot 5\ ft \cdot L_{joist}^{\ 2}}{8} = 20.566\ kip \cdot ft$$

Joist Type: 18LH03 $R_{j\_5} \cdot 2 = 7.153\ kip$

Roof Trusses - Longest Truss Length - $L_{truss} := 80\ ft$

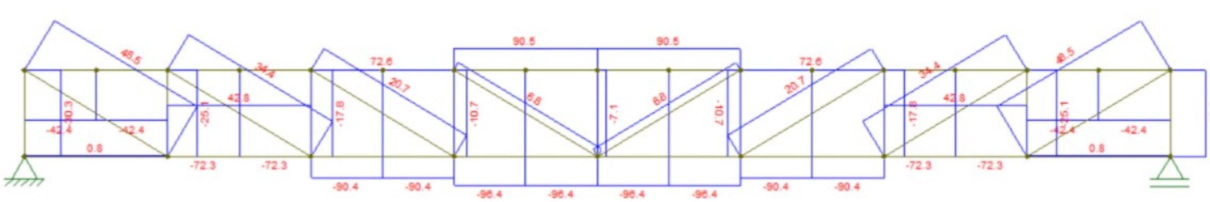


Largest Tributary Width - $w_{t\_trib} := 23\ ft$

At 5 ft Joist Spacing - $n_5 := 16$

$$R_{t\_5} := \frac{R_{j\_5} \cdot (575\ ft)}{80\ ft} = 25.708\ kip$$

Axial - 5ft spacing



$P_{c\_TC} := 96.4\ kip$ $P_{c\_WEB} := 30.3\ kip$ $P_{t\_BC\_WEB} := 90.5\ kip$

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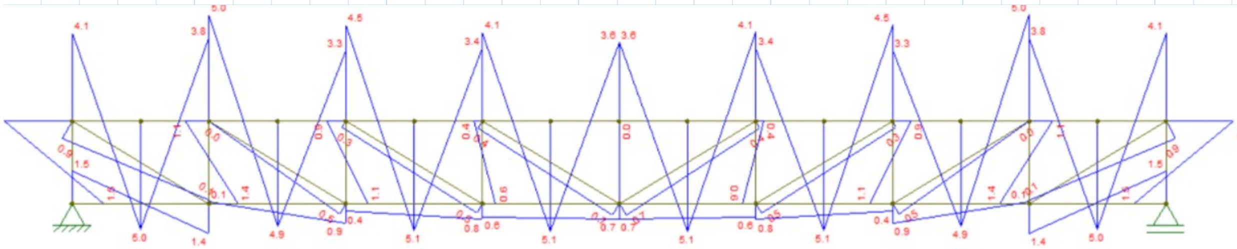
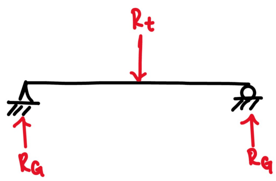
Moment - 5ft spacing



$M_{max\_TC} := 5.1\ kip \cdot ft$

Truss Top Chord: W14x61
Truss Bottom Chord/Web: HSS 4x0.313

Roof Girder -



Greatest Loaded Girder Length - $L_{girder} := 35\ ft$

5 foot Joist Spacing:

$$R_{g\_5} := \frac{R_{t\_5}}{2} = 12.854\ kip$$

$$M_{g\_5} := \frac{R_{t\_5} \cdot L_{girder}}{4} = 224.943\ kip \cdot ft$$

$$2 \cdot R_{g\_5} + R_{t\_5} = 51.415\ kip$$

Grider: W14x61

SECOND FLOOR FRAMING

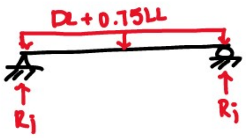
Second Floor Dead Load - $DL_{2\_floor} := 33.094\ psf$

Second Flood Live Load - $LL_{2\_floor} := 100\ psf$

Second Floor Deck -

Deck Type: 1.0C24
Thickness: 1 in
Lightweight concrete: 5 in
Reinforcement: 6x6-W2.9xW2.9

Second Floor Joist -



$$w_{joist} := DL_{2\_floor} + 0.75 \cdot LL_{2\_floor} = 108.094\ psf$$

Longest Joist Length - $L_{joist} := 23\ ft$

Joist Spacing at 2 feet

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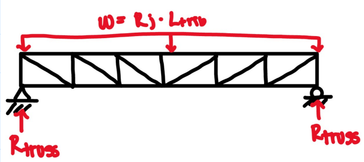
$$R_{j\_2} := \frac{w_{joist} \cdot 2\ ft \cdot L_{joist}}{2} = 2.486\ kip$$

$$M_{j\_2} := \frac{w_{joist} \cdot 2\ ft \cdot L_{joist}^{2}}{8} = 14.295\ kip \cdot ft$$

Joist Type: 20LH10

Second Floor Truss -



$$\frac{n_2 \cdot R_{j\_2}}{L_{truss}} = 1.243\ \frac{kip}{ft}$$

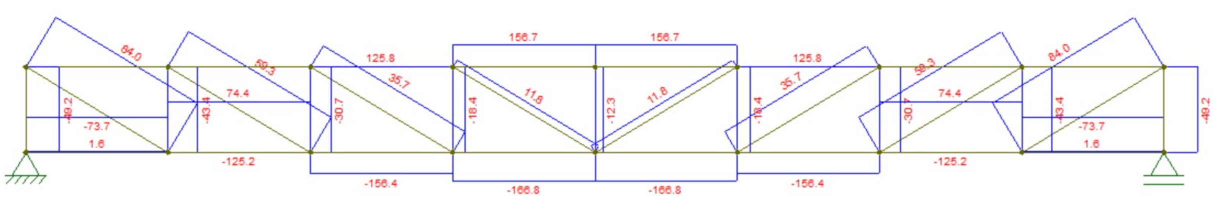
Longest Truss Length - $L_{truss} := 80\ ft$

Largest Tributary Width - $w_{t\_trib} := 23\ ft$

At 2 ft Joist Spacing - $n_2 := 40$

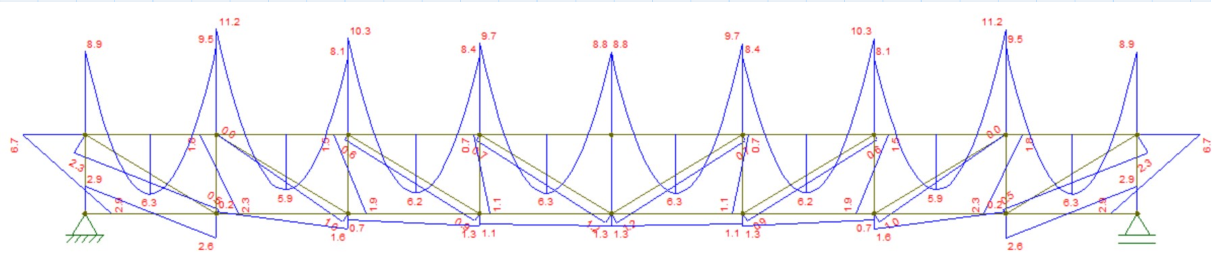
$$R_{t\_2} := \frac{\frac{n_2 \cdot R_{j\_2}}{L_{truss}} \cdot L_{truss}}{2} = 49.723\ kip$$

Axial - 2 ft spacing



$P_{c\_TC} := 156.7\ kip$ $P_{c\_WEB} := 49.2\ kip$ $P_{t\_BC\_WEB} := 156.7\ kip$

Moment - 2 ft spacing



$M_{max\_TC} := 11.2\ kip \cdot ft$

Truss Top Chord: W16x57
Truss Bottom Chord/Web: HSS 5x0.5

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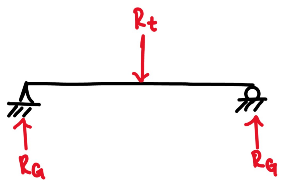
Second Floor Girder -



Greatest Loaded Girder Length -

$L_{girder} := 35\ ft$

$$R_{g\_2} := \frac{R_{t\_2}}{2} = 24.862\ kip$$

$$2 \cdot R_{g\_2} + R_{t\_2} = 99.446\ kip$$

$$M_{g\_2} := \frac{R_{t\_2} \cdot L_{girder}}{4} = 435.078\ kip \cdot ft$$

Girder: W16x89

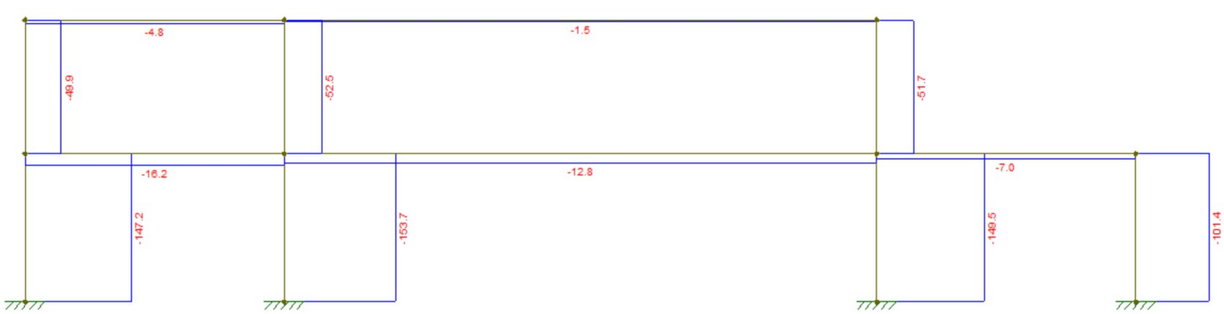
Second Floor and Roof Columns -

$$LL_{wind} := 27.8804\ psf$$

$$TA_{panel} := 35\ ft$$

$$w_{column} := LL_{wind} \cdot TA_{panel} = 0.976\ \frac{kip}{ft}$$

Axial



$$L_e := 0.5 \cdot 20\ ft = 10\ ft$$

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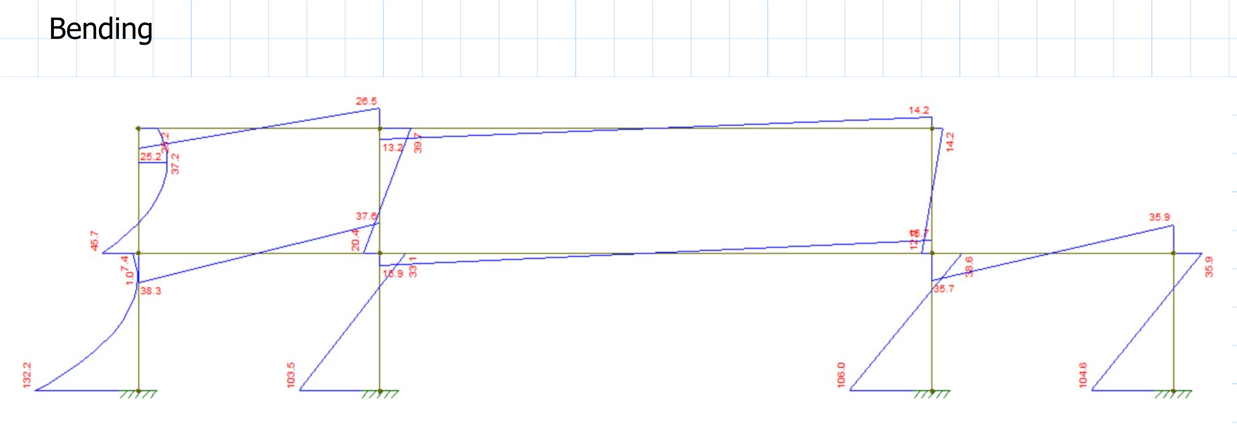
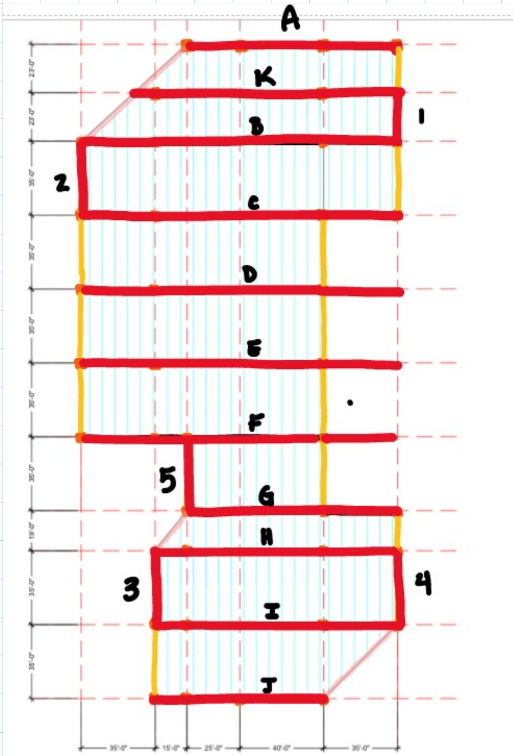


All Columns W8x67



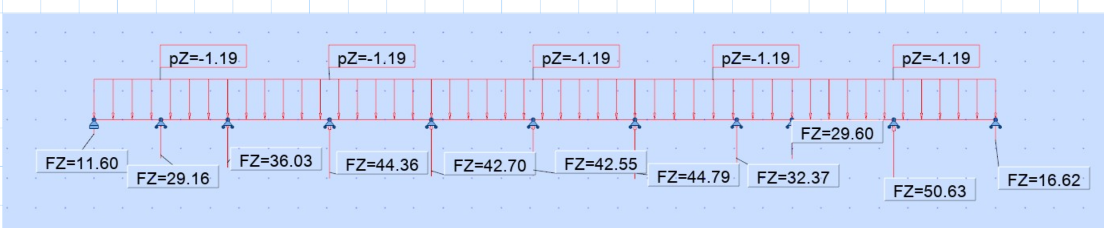
Diaphragm Loading (E-W Wind Loading) -

Roof Flexible Diaphragm Load:

$w_1 := 29.4085\ psf$ $w_2 := 31.1363\ psf$ $w_3 := 33.4293\ psf$ $w_p := 75.276\ psf$

$h_1 := 3\ ft$ $h_2 := 9\ ft$ $h_3 := 18\ ft$ $h_p := 5\ ft$

$$w_{roof} := \frac{w_p \cdot h_p \cdot \left(\frac{h_3}{2} + h_p\right) + w_3 \cdot \frac{h_3^{\ 2}}{2}}{\frac{h_3}{2}} = 1.187\ \frac{kip}{ft}$$



$R_{swA} := 11.60\ kip$ $R_{swF} := 44.79\ kip$

$R_{swK} := 29.16$ ***kip***

$R_{swB} := 36.03$ ***kip***

$R_{swC} := 44.36$ ***kip***

$R_{swD} := 42.70$ ***kip***

$R_{swE} := 42.55$ ***kip***

$R_{swG} := 32.37$ ***kip***

$R_{swH} := 29.60$ ***kip***

$R_{swI} := 50.63$ ***kip***

$R_{swJ} := 16.62$ ***kip***

$V_{swA} := R_{swA} = 11.6$ ***kip***

$V_{swK} := R_{swK} = 29.16$ ***kip***

$V_{swB} := R_{swB} = 36.03$ ***kip***

$V_{swC} := R_{swC} = 44.36$ ***kip***

$V_{swD} := R_{swD} = 42.7$ ***kip***

$V_{swE} := R_{swE} = 42.55$ ***kip***

$V_{swF} := R_{swF} = 44.79$ ***kip***

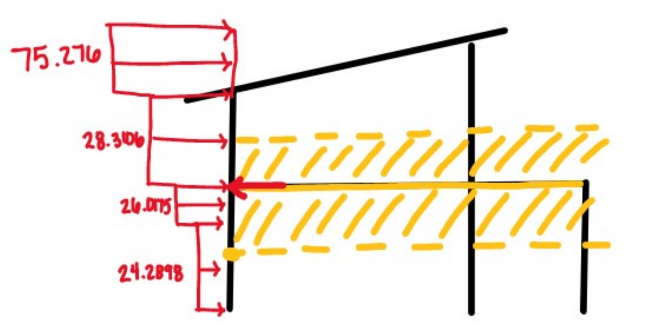
$V_{swG} := R_{swG} = 32.37$ ***kip***

$V_{swH} := R_{swH} = 29.6$ ***kip***

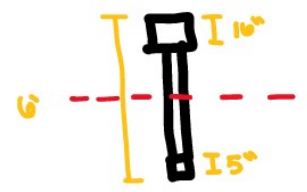
$V_{swI} := R_{swI} = 50.63$ ***kip***

$V_{swJ} := R_{swJ} = 16.62$ ***kip***

Second Floor Rigid Diaphragm Load:



finding moment of interia for second floor truss



$d := 13.9\ in$ $\qquad b_f := 10\ in$

$r := 4\ in$ $\qquad h_t := 6\ ft$

$$y := \frac{r^2 \cdot \frac{r}{2} + r \cdot (h_t - r - d) \cdot \frac{h_t}{2} + d \cdot b_f \cdot \left(h_t - \frac{d}{2}\right)}{r^2 + r \cdot (h_t - r - d) + d \cdot b_f} = 3.784\ ft$$

$$I_{t\_roof} := \frac{r \cdot r^3}{12} + r^2 \cdot \left(y - \frac{r}{2}\right)^2 + \frac{r \cdot (h_t - r - d)^3}{12} + r \cdot (h_t - r - d) \cdot \left(y - \frac{h_t}{2}\right)^2 + \frac{b_f \cdot d^3}{12} + d \cdot b_f \cdot \left(y - \left(h_t - \frac{d}{2}\right)\right)^2 = \left(1.58 \cdot 10^5\right)\ in^4$$

$d := 16.3\ in$ $\qquad b_f := 7.07\ in$

$r := 4\ in$ $\qquad h_t := 6\ ft$

$$y := \frac{r^2 \cdot \frac{r}{2} + r \cdot (h_t - r - d) \cdot \frac{h_t}{2} + d \cdot b_f \cdot \left(h_t - \frac{d}{2}\right)}{r^2 + r \cdot (h_t - r - d) + d \cdot b_f} = 3.657\ ft$$

$$I_{t\_2floor} := \frac{r \cdot r^3}{12} + r^2 \cdot \left(y - \frac{r}{2}\right)^2 + \frac{r \cdot (h_t - r - d)^3}{12} + r \cdot (h_t - r - d) \cdot \left(y - \frac{h_t}{2}\right)^2 + \frac{b_f \cdot d^3}{12} + d \cdot b_f \cdot \left(y - \left(h_t - \frac{d}{2}\right)\right)^2 = \left(1.355 \cdot 10^5\right)\ in^4$$

$E := 29000\ ksi$ $\qquad h := 18\ ft$

$I_{g\_roof} := 640\ in^4$ $\qquad I_c := 272\ in^4$

$I_{g\_2floor} := 1300\ in^4$

Moment Frame Components

$$K_{swA} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{25\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{40\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.856\ \frac{kip}{ft}$$

$$K_{swK} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{10\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 450.189\ \frac{kip}{ft}$$

$$K_{swB} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.516\ \frac{kip}{ft}$$

$$K_{swC} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.516\ \frac{kip}{ft}$$

$$K_{swD} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.516\ \frac{kip}{ft}$$

$$K_{swE} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.516\ \frac{kip}{ft}$$

$$K_{swF} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{80\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 449.516\ \frac{kip}{ft}$$

$$K_{swG} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{65\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(3 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 336.95\ \frac{kip}{ft}$$

$$K_{swH} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{15\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{65\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 450.008\ \frac{kip}{ft}$$

$$K_{swI} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{15\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{65\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{35\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 450.008\ \frac{kip}{ft}$$

$$K_{swJ} := \left(\frac{h^2}{12 \cdot E \cdot \left(\frac{I_{t\_roof} + I_{t\_2floor}}{15\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{25\ ft} + \frac{I_{t\_roof} + I_{t\_2floor}}{40\ ft} \right)} + \frac{h^2}{12 \cdot E \cdot \left(4 \cdot \frac{I_c}{h} \right)} \right)^{-1} = 450.142\ \frac{kip}{ft}$$

Braced Frame Components (4.5x4.5x1/8)

$h := 24\ ft$

$A_d := 2.00\ in^2$

$A_{g\_roof} := 20.0\ in^2$

$A_{g\_2floor} := 26.2\ in^2$

$L_1 := 23\ ft$

$L_2 := 35\ ft$

$L_3 := 35\ ft$

$L_4 := 35\ ft$

$L_5 := 35\ ft$

$d_1 := \sqrt[2]{h^2 + {L_1}^2} = 33.242\ ft$

$d_2 := \sqrt[2]{h^2 + {L_2}^2} = 42.438\ ft$

$d_3 := \sqrt[2]{h^2 + {L_3}^2} = 42.438\ ft$

$d_4 := \sqrt[2]{h^2 + {L_4}^2} = 42.438\ ft$

$d_5 := \sqrt[2]{h^2 + {L_5}^2} = 42.438\ ft$

$$K_{sw1} := \left(\frac{{d_1}^3}{E \cdot {L_1}^2 \cdot A_d} + \frac{L_1}{E \cdot A_{g\_2floor}} \right)^{-1} = 814.696\ \frac{kip}{ft}$$

$$K_{sw2} := \left(\frac{{d_2}^3}{E \cdot {L_2}^2 \cdot A_d} + \frac{L_2}{E \cdot A_{g\_2floor}} \right)^{-1} = 891.422\ \frac{kip}{ft}$$

$$K_{sw3} := \left(\frac{{d_3}^3}{E \cdot {L_3}^2 \cdot A_d} + \frac{L_3}{E \cdot A_{g\_2floor}} \right)^{-1} = 891.422\ \frac{kip}{ft}$$

$$K_{sw4} := \left(\frac{{d_4}^3}{E \cdot {L_4}^2 \cdot A_d} + \frac{L_4}{E \cdot A_{g\_2floor}} \right)^{-1} = 891.422\ \frac{kip}{ft}$$

$$K_{sw5} := \left(\frac{{d_5}^3}{E \cdot {L_5}^2 \cdot A_d} + \frac{L_4}{E \cdot A_{g\_2floor}} \right)^{-1} = 891.422\ \frac{kip}{ft}$$

$$Ky := K_{swA} + K_{swB} + K_{swC} + K_{swD} + K_{swE} + K_{swF} + K_{swG} + K_{swH} + K_{swI} + K_{swJ} + K_{swK} = \left(4.835 \cdot 10^3\right)\ \frac{kip}{ft}$$

$$Kx := K_{sw1} + K_{sw2} + K_{sw3} + K_{sw4} + K_{sw5} = \left(4.38 \cdot 10^3\right)\ \frac{kip}{ft}$$

$x_{swA} := 0\ ft$ $Kx_{swA} := K_{swA} \cdot x_{swA} = 0\ kip$

$x_{swK} := 23\ ft$ $Kx_{swK} := K_{swK} \cdot x_{swK} = \left(1.035 \cdot 10^{4}\right)\ kip$

$x_{swB} := 46\ ft$ $Kx_{swB} := K_{swB} \cdot x_{swB} = \left(2.068 \cdot 10^{4}\right)\ kip$

$x_{swC} := 81\ ft$ $Kx_{swC} := K_{swC} \cdot x_{swC} = \left(3.641 \cdot 10^{4}\right)\ kip$

$x_{swD} := 116\ ft$ $Kx_{swD} := K_{swD} \cdot x_{swD} = \left(5.214 \cdot 10^{4}\right)\ kip$

$x_{swE} := 151\ ft$ $Kx_{swE} := K_{swE} \cdot x_{swE} = \left(6.788 \cdot 10^{4}\right)\ kip$

$x_{swF} := 186\ ft$ $Kx_{swF} := K_{swF} \cdot x_{swF} = \left(8.361 \cdot 10^{4}\right)\ kip$

$x_{swG} := 221\ ft$ $Kx_{swG} := K_{swG} \cdot x_{swG} = \left(7.447 \cdot 10^{4}\right)\ kip$

$x_{swH} := 240\ ft$ $Kx_{swH} := K_{swH} \cdot x_{swH} = \left(1.08 \cdot 10^{5}\right)\ kip$

$x_{swI} := 275\ ft$ $Kx_{swI} := K_{swI} \cdot x_{swI} = \left(1.238 \cdot 10^{5}\right)\ kip$

$x_{swJ} := 310\ ft$ $Kx_{swJ} := K_{swJ} \cdot x_{swJ} = \left(1.395 \cdot 10^{5}\right)\ kip$

$y_{sw1} := 150\ ft$ $Ky_{sw1} := K_{sw1} \cdot y_{sw1} = \left(1.222 \cdot 10^{5}\right)\ kip$

$y_{sw2} := 0\ ft$ $Ky_{sw2} := K_{sw2} \cdot y_{sw2} = 0\ kip$

$y_{sw3} := 35\ ft$ $Ky_{sw3} := K_{sw3} \cdot y_{sw3} = \left(3.12 \cdot 10^{4}\right)\ kip$

$y_{sw4} := 150\ ft$ $Ky_{sw4} := K_{sw4} \cdot y_{sw4} = \left(1.337 \cdot 10^{5}\right)\ kip$

$y_{sw5} := 50\ ft$ $Ky_{sw5} := K_{sw5} \cdot y_{sw5} = \left(4.457 \cdot 10^{4}\right)\ kip$

$$Kyx := Kx_{swA} + Kx_{swB} + Kx_{swC} + Kx_{swD} + Kx_{swE} + Kx_{swF} + Kx_{swG} + Kx_{swH} + Kx_{swI} + Kx_{swJ} + Kx_{swK} = \left(7.168 \cdot 10^{5}\right)\ kip$$

$$Kxy := Ky_{sw1} + Ky_{sw2} + Ky_{sw3} + Ky_{sw4} + Ky_{sw5} = \left(3.317 \cdot 10^{5}\right)\ kip$$

$x_{cr} := \dfrac{Kyx}{Ky} = 148.268\ ft$ $y_{cr} := \dfrac{Kxy}{Kx} = 75.721\ ft$

$x_{swA\_cr} := x_{swA} - x_{cr} = -148.268\ ft$ $Kx_{swA\_cr} := K_{swA} \cdot {x_{swA\_cr}}^{2} = \left(9.889 \cdot 10^{6}\right)\ kip \cdot ft$

$x_{swK\_cr} := x_{swK} - x_{cr} = -125.268\ ft$ $Kx_{swK\_cr} := K_{swK} \cdot {x_{swK\_cr}}^{2} = \left(7.064 \cdot 10^{6}\right)\ kip \cdot ft$

$x_{swB\_cr} := x_{swB} - x_{cr} = -102.268\ ft$ $Kx_{swB\_cr} := K_{swB} \cdot {x_{swB\_cr}}^{2} = \left(4.701 \cdot 10^{6}\right)\ kip \cdot ft$

$x_{swC\_cr} := x_{swC} - x_{cr} = -67.268\ ft$ $\qquad Kx_{swC\_cr} := K_{swC} \cdot x_{swC\_cr}{}^2 = \left(2.034 \cdot 10^6\right)\ kip \cdot ft$

$x_{swD\_cr} := x_{swD} - x_{cr} = -32.268\ ft$ $\qquad Kx_{swD\_cr} := K_{swD} \cdot x_{swD\_cr}{}^2 = \left(4.681 \cdot 10^5\right)\ kip \cdot ft$

$x_{swE\_cr} := x_{swE} - x_{cr} = 2.732\ ft$ $\qquad Kx_{swE\_cr} := K_{swE} \cdot x_{swE\_cr}{}^2 = \left(3.354 \cdot 10^3\right)\ kip \cdot ft$

$x_{swF\_cr} := x_{swF} - x_{cr} = 37.732\ ft$ $\qquad Kx_{swF\_cr} := K_{swF} \cdot x_{swF\_cr}{}^2 = \left(6.4 \cdot 10^5\right)\ kip \cdot ft$

$x_{swG\_cr} := x_{swG} - x_{cr} = 72.732\ ft$ $\qquad Kx_{swG\_cr} := K_{swG} \cdot x_{swG\_cr}{}^2 = \left(1.782 \cdot 10^6\right)\ kip \cdot ft$

$x_{swH\_cr} := x_{swH} - x_{cr} = 91.732\ ft$ $\qquad Kx_{swH\_cr} := K_{swH} \cdot x_{swH\_cr}{}^2 = \left(3.787 \cdot 10^6\right)\ kip \cdot ft$

$x_{swI\_cr} := x_{swI} - x_{cr} = 126.732\ ft$ $\qquad Kx_{swI\_cr} := K_{swI} \cdot x_{swI\_cr}{}^2 = \left(7.228 \cdot 10^6\right)\ kip \cdot ft$

$x_{swJ\_cr} := x_{swJ} - x_{cr} = 161.732\ ft$ $\qquad Kx_{swJ\_cr} := K_{swJ} \cdot x_{swJ\_cr}{}^2 = \left(1.177 \cdot 10^7\right)\ kip \cdot ft$

$y_{sw1\_cr} := y_{sw1} - y_{cr} = 74.279\ ft$ $\qquad Ky_{sw1\_cr} := K_{sw1} \cdot y_{sw1\_cr}{}^2 = \left(4.495 \cdot 10^6\right)\ kip \cdot ft$

$y_{sw2\_cr} := y_{sw2} - y_{cr} = -75.721\ ft$ $\qquad Ky_{sw2\_cr} := K_{sw2} \cdot y_{sw2\_cr}{}^2 = \left(5.111 \cdot 10^6\right)\ kip \cdot ft$

$y_{sw3\_cr} := y_{sw3} - y_{cr} = -40.721\ ft$ $\qquad Ky_{sw3\_cr} := K_{sw3} \cdot y_{sw3\_cr}{}^2 = \left(1.478 \cdot 10^6\right)\ kip \cdot ft$

$y_{sw4\_cr} := y_{sw4} - y_{cr} = 74.279\ ft$ $\qquad Ky_{sw4\_cr} := K_{sw4} \cdot y_{sw4\_cr}{}^2 = \left(4.918 \cdot 10^6\right)\ kip \cdot ft$

$y_{sw5\_cr} := y_{sw5} - y_{cr} = -25.721\ ft$ $\qquad Ky_{sw5\_cr} := K_{sw5} \cdot y_{sw5\_cr}{}^2 = \left(5.898 \cdot 10^5\right)\ kip \cdot ft$

$$Kyx_{cr} := Kx_{swA\_cr} + Kx_{swB\_cr} + Kx_{swC\_cr} + Kx_{swD\_cr} + Kx_{swE\_cr} + Kx_{swF\_cr} + Kx_{swG\_cr} + Kx_{swH\_cr} + Kx_{swI\_cr} + Kx_{swJ\_cr} + Kx_{swK\_cr} = \left(4.937 \cdot 10^7\right)\ kip \cdot ft$$

$$Kxy_{cr} := Ky_{sw1\_cr} + Ky_{sw2\_cr} + Ky_{sw3\_cr} + Ky_{sw4\_cr} + Ky_{sw5\_cr} = \left(1.659 \cdot 10^7\right)\ kip \cdot ft$$

$$J := Kyx_{cr} + Kxy_{cr} = \left(6.596 \cdot 10^7\right) \frac{kip \cdot ft^2}{ft}$$

$w_1 := 29.4085\ psf$ $\qquad w_2 := 31.1363\ psf$ $\qquad w_3 := 33.4293\ psf$ $\qquad w_p := 75.276\ psf$

$h_1 := 3\ ft$ $\qquad h_2 := 9\ ft$ $\qquad h_3 := 18\ ft$ $\qquad h_p := 5\ ft$

$$w_{2floor} := \frac{w_1 \cdot \dfrac{h_1{}^2}{2} + w_2 \cdot h_2 \cdot \left(h_1 + \dfrac{h_2}{2}\right) + w_3 \cdot \left(h_3\right) \cdot \left(h_1 + h_2 + \dfrac{h_3}{2}\right)}{h_1 + h_2} = 1.047\ \frac{kip}{ft}$$

$$V_g := w_{2floor} \cdot 310\ ft = 324.645\ kip$$

$x_{bar} := \frac{310\ ft}{2} = 155\ ft$

$y_{bar} := \frac{150\ ft}{2} = 75\ ft$

$e_x := x_{bar} - x_{cr} = 6.732\ ft$

$e_y := y_{bar} - y_{cr} = -0.721\ ft$

SW/A:

$V_{AT} := V_g \cdot \frac{K_{swA}}{Ky} = 35.744\ kip$

$V_{AR} := V_g \cdot e_x \cdot \frac{K_{swA} \cdot x_{swA\_cr}}{J} = -2.615\ kip$

$V_A := V_{AT} + V_{AR} = 33.129\ kip$

SW/B:

$V_{BT} := V_g \cdot \frac{K_{swB}}{Ky} = 35.717\ kip$

$V_{BR} := V_g \cdot e_x \cdot \frac{K_{swB} \cdot x_{swB\_cr}}{J} = -1.802\ kip$

$V_B := V_{BT} + V_{BR} = 33.915\ kip$

SW/C:

$V_{CT} := V_g \cdot \frac{K_{swC}}{Ky} = 35.717\ kip$

$V_{CR} := V_g \cdot e_x \cdot \frac{K_{swC} \cdot x_{swC\_cr}}{J} = -1.185\ kip$

$V_C := V_{CT} + V_{CR} = 34.531\ kip$

SW/D:

$V_{DT} := V_g \cdot \frac{K_{swD}}{Ky} = 35.717\ kip$

$V_{DR} := V_g \cdot e_x \cdot \frac{K_{swD} \cdot x_{swD\_cr}}{J} = -0.569\ kip$

$V_D := V_{DT} + V_{DR} = 35.148\ kip$

SW/E:

$V_{ET} := V_g \cdot \frac{K_{swE}}{Ky} = 35.717\ kip$

$V_{ER} := V_g \cdot e_x \cdot \frac{K_{swE} \cdot x_{swE\_cr}}{J} = 0.048\ kip$

$V_E := V_{ET} + V_{ER} = 35.765\ kip$

SW/F:

$V_{FT} := V_g \cdot \frac{K_{swF}}{Ky} = 35.717\ kip$

$V_{FR} := V_g \cdot e_x \cdot \frac{K_{swF} \cdot x_{swF\_cr}}{J} = 0.665\ kip$

$V_F := V_{FT} + V_{FR} = 36.382\ kip$

SW/G:

$$V_{GT} := V_g \cdot \frac{K_{swG}}{Ky} = 26.773\ kip$$

$$V_{GR} := V_g \cdot e_x \cdot \frac{K_{swG} \cdot x_{swG\_cr}}{J} = 0.961\ kip$$

$$V_G := V_{GT} + V_{GR} = 27.734\ kip$$

SW/H:

$$V_{HT} := V_g \cdot \frac{K_{swH}}{Ky} = 35.756\ kip$$

$$V_{HR} := V_g \cdot e_x \cdot \frac{K_{swH} \cdot x_{swH\_cr}}{J} = 1.618\ kip$$

$$V_H := V_{HT} + V_{HR} = 37.374\ kip$$

SW/I:

$$V_{IT} := V_g \cdot \frac{K_{swI}}{Ky} = 35.756\ kip$$

$$V_{IR} := V_g \cdot e_x \cdot \frac{K_{swI} \cdot x_{swI\_cr}}{J} = 2.236\ kip$$

$$V_I := V_{IT} + V_{IR} = 37.992\ kip$$

SW/J:

$$V_{JT} := V_g \cdot \frac{K_{swJ}}{Ky} = 35.767\ kip$$

$$V_{JR} := V_g \cdot e_x \cdot \frac{K_{swJ} \cdot x_{swJ\_cr}}{J} = 2.854\ kip$$

$$V_J := V_{JT} + V_{JR} = 38.621\ kip$$

SW/K:

$$V_{KT} := V_g \cdot \frac{K_{swK}}{Ky} = 35.77\ kip$$

$$V_{KR} := V_g \cdot e_x \cdot \frac{K_{swK} \cdot x_{swK\_cr}}{J} = -2.211\ kip$$

$$V_K := V_{KT} + V_{KR} = 33.559\ kip$$

SW/1:

$$V_{1T} := V_g \cdot \frac{0\ klf}{Ky} = 0\ kip$$

$$V_{1R} := V_g \cdot e_x \cdot \frac{K_{sw1} \cdot y_{sw1\_cr}}{J} = 2.372\ kip$$

$$V_1 := V_{1T} + V_{1R} = 2.372\ kip$$

SW/2:

$$V_{2T} := V_g \cdot \frac{0\ klf}{Ky} = 0\ kip$$

$$V_{2R} := V_g \cdot e_x \cdot \frac{K_{sw2} \cdot y_{sw2\_cr}}{J} = -2.646\ kip$$

$$V_2 := V_{2T} + V_{2R} = -2.646\ kip$$

SW/3:

$$V_{3T} := V_g \cdot \frac{0\ klf}{Ky} = 0\ kip$$

$$V_{3R} := V_g \cdot e_x \cdot \frac{K_{sw3} \cdot y_{sw3\_cr}}{J} = -1.423\ kip$$

$$V_3 := V_{3T} + V_{3R} = -1.423\ kip$$

SW/4:

$$V_{4T} := V_g \cdot \frac{0\ klf}{Ky} = 0\ kip$$

$$V_{4R} := V_g \cdot e_x \cdot \frac{K_{sw4} \cdot y_{sw4\_cr}}{J} = 2.596\ kip$$

$$V_4 := V_{4T} + V_{4R} = 2.596\ kip$$

SW/5:

$$V_{5T} := V_g \cdot \frac{0\ klf}{Ky} = 0\ kip$$

$$V_{5R} := V_g \cdot e_x \cdot \frac{K_{sw5} \cdot y_{sw5\_cr}}{J} = -0.899\ kip$$

$$V_5 := V_{5T} + V_{5R} = -0.899\ kip$$

sum in x:

$$V_1 + V_2 + V_3 + V_4 + V_5 = 0\ kip$$

sum in y:

$$V_A + V_B + V_C + V_D + V_E + V_F + V_G + V_H + V_I + V_J + V_K - V_g = 0\ kip$$

Summary of Shears (E-W Wind Loading):

Roof Shears -

$V_{swA} = 11.6\ kip$ $V_{swF} = 44.79\ kip$ $V_{swK} = 29.16\ kip$

$V_{swB} = 36.03\ kip$ $V_{swG} = 32.37\ kip$

$V_{swC} = 44.36\ kip$ $V_{swH} = 29.6\ kip$

$V_{swD} = 42.7\ kip$ $V_{swI} = 50.63\ kip$

$V_{swE} = 42.55\ kip$ $V_{swJ} = 16.62\ kip$

Second Floor Shears -

$V_A = 33.129\ kip$ $V_1 = 2.372\ kip$

$V_B = 33.915\ kip$

$V_C = 34.531\ kip$

$V_D = 35.148\ kip$

$V_E = 35.765\ kip$

$V_F = 36.382\ kip$

$V_G = 27.734\ kip$

$V_H = 37.374\ kip$

$V_I = 37.992\ kip$

$V_J = 38.621\ kip$

$V_K = 33.559\ kip$

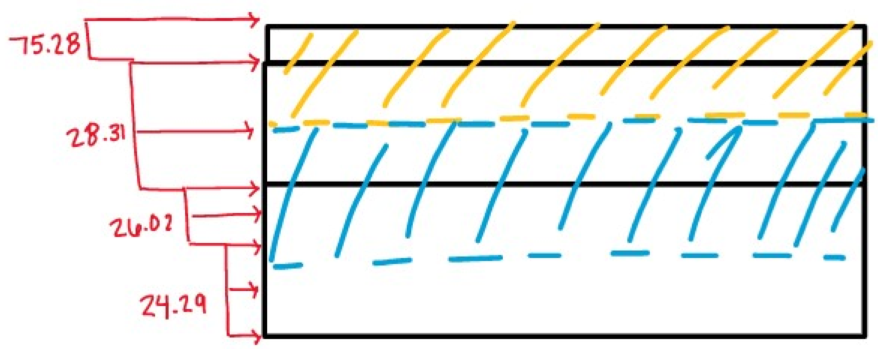
$V_2 = -2.646\ kip$

$V_3 = -1.423\ kip$

$V_4 = 2.596\ kip$

$V_5 = -0.899\ kip$

Diaphragm Loading (N-S Wind Loading) -

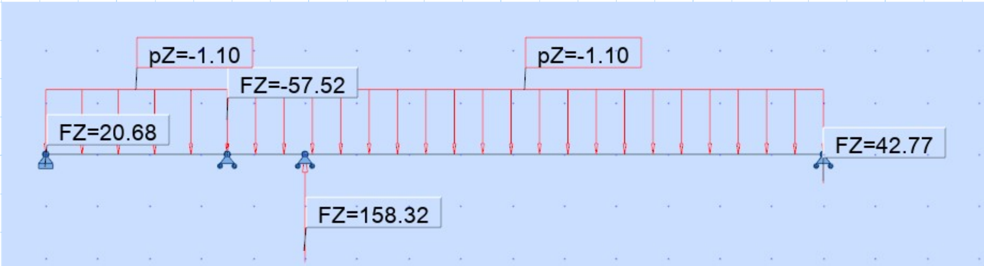


Roof Flexible Diaphragm Load:

$w_1 := 24.2898\ psf$ $\quad w_2 := 26.0175\ psf$ $\quad w_3 := 28.3106\ psf$ $\quad w_p := 75.276\ psf$

$h_1 := 3\ ft$ $\quad h_2 := 9\ ft$ $\quad h_3 := 18\ ft$ $\quad h_p := 5\ ft$

$$w_{roof} := \frac{w_p \cdot h_p \cdot \left(\frac{h_3}{2} + h_p\right) + w_3 \cdot \frac{h_3^{\ 2}}{2}}{\frac{h_3}{2}} = 1.095\ \frac{kip}{ft}$$



$R_{sw1} := 16.9605\ kip$ $\quad R_{sw3} := -57.52\ kip$ $\quad R_{sw5} := 158.32\ kip$

$R_{sw2} := -20.68\ kip$ $\quad R_{sw4} := 25.809\ kip$

$V_{sw1} := R_{sw1} = 16.961\ kip$ $\quad V_{sw3} := R_{sw3} = -57.52\ kip$ $\quad V_{sw5} := R_{sw5} = 158.32\ kip$

$V_{sw2} := R_{sw2} = -20.68\ kip$ $\quad V_{sw4} := R_{sw4} = 25.809\ kip$

Second Floor Rigid Diaphragm Load:

$w_1 := 24.2898\ psf$ $\quad w_2 := 26.0175\ psf$ $\quad w_3 := 28.3106\ psf$ $\quad w_p := 75.276\ psf$

$h_1 := 3\ ft$ $\quad h_2 := 9\ ft$ $\quad h_3 := 18\ ft$ $\quad h_p := 5\ ft$

$$w_{2floor} := \frac{w_1 \cdot \frac{{h_1}^2}{2} + w_2 \cdot h_2 \cdot \left(h_1 + \frac{h_2}{2}\right) + w_3 \cdot (h_3) \cdot \left(h_1 + h_2 + \frac{h_3}{2}\right)}{h_1 + h_2} = 1.239\ \frac{kip}{ft}$$

$V_g := w_{2floor} \cdot 150\ ft = 185.879\ kip$

$x_{bar} := \frac{310\ ft}{2} = 155\ ft$ $\quad y_{bar} := \frac{150\ ft}{2} = 75\ ft$

$e_x := x_{bar} - x_{cr} = 6.732\ ft$ $\quad e_y := y_{bar} - y_{cr} = -0.721\ ft$

SW/A:

$V_{AT} := V_g \cdot \frac{0\ klf}{Kx} = 0\ kip$

$V_{AR} := V_g \cdot e_y \cdot \frac{K_{swA} \cdot x_{swA\_cr}}{J} = 0.136\ kip$

$V_A := V_{AT} + V_{AR} = 0.136\ kip$

SW/B:

$V_{BT} := V_g \cdot \frac{0\ klf}{Kx} = 0\ kip$

$V_{BR} := V_g \cdot e_y \cdot \frac{K_{swB} \cdot x_{swB\_cr}}{J} = 0.093\ kip$

$V_B := V_{BT} + V_{BR} = 0.093\ \mathbf{kip}$

SW/C:

$V_{CT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{CR} := V_g \cdot e_y \cdot \dfrac{K_{swC} \cdot x_{swC\_cr}}{J} = 0.061\ \mathbf{kip}$

$V_C := V_{CT} + V_{CR} = 0.061\ \mathbf{kip}$

SW/D:

$V_{DT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{DR} := V_g \cdot e_y \cdot \dfrac{K_{swD} \cdot x_{swD\_cr}}{J} = 0.029\ \mathbf{kip}$

$V_D := V_{DT} + V_{DR} = 0.029\ \mathbf{kip}$

SW/E:

$V_{ET} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{ER} := V_g \cdot e_y \cdot \dfrac{K_{swE} \cdot x_{swE\_cr}}{J} = -0.002\ \mathbf{kip}$

$V_E := V_{ET} + V_{ER} = -0.002\ \mathbf{kip}$

SW/F:

$V_{FT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{FR} := V_g \cdot e_y \cdot \dfrac{K_{swF} \cdot x_{swF\_cr}}{J} = -0.034\ \mathbf{kip}$

$V_F := V_{FT} + V_{FR} = -0.034\ \mathbf{kip}$

SW/G:

$V_{GT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{GR} := V_g \cdot e_y \cdot \dfrac{K_{swG} \cdot x_{swG\_cr}}{J} = -0.05\ \mathbf{kip}$

$V_G := V_{GT} + V_{GR} = -0.05\ \mathbf{kip}$

SW/H:

$V_{HT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{HR} := V_g \cdot e_y \cdot \dfrac{K_{swH} \cdot x_{swH\_cr}}{J} = -0.084\ \mathbf{kip}$

$V_H := V_{HT} + V_{HR} = -0.084\ \mathbf{kip}$

SW/I:

$V_{IT} := V_g \cdot \dfrac{0\ \mathbf{klf}}{Kx} = 0\ \mathbf{kip}$

$V_{IR} := V_g \cdot e_y \cdot \dfrac{K_{swI} \cdot x_{swI\_cr}}{J} = -0.116\ \mathbf{kip}$

$V_I := V_{IT} + V_{IR} = -0.116\ \mathbf{kip}$

SW/J:

$$V_{JT} := V_g \cdot \frac{0\ klf}{Kx} = 0\ kip$$

$$V_{JR} := V_g \cdot e_y \cdot \frac{K_{swJ} \cdot x_{swJ\_cr}}{J} = -0.148\ kip$$

$$V_J := V_{JT} + V_{JR} = -0.148\ kip$$

SW/K:

$$V_{KT} := V_g \cdot \frac{0\ klf}{Kx} = 0\ kip$$

$$V_{KR} := V_g \cdot e_y \cdot \frac{K_{swK} \cdot x_{swK\_cr}}{J} = 0.115\ kip$$

$$V_K := V_{KT} + V_{KR} = 0.115\ kip$$

SW/1:

$$V_{1T} := V_g \cdot \frac{K_{sw1}}{Kx} = 34.571\ kip$$

$$V_{1R} := V_g \cdot e_y \cdot \frac{K_{sw1} \cdot y_{sw1\_cr}}{J} = -0.123\ kip$$

$$V_1 := V_{1T} + V_{1R} = 34.448\ kip$$

SW/2:

$$V_{2T} := V_g \cdot \frac{K_{sw2}}{Kx} = 37.827\ kip$$

$$V_{2R} := V_g \cdot e_y \cdot \frac{K_{sw2} \cdot y_{sw2\_cr}}{J} = 0.137\ kip$$

$$V_2 := V_{2T} + V_{2R} = 37.964\ kip$$

SW/3:

$$V_{3T} := V_g \cdot \frac{K_{sw3}}{Kx} = 37.827\ kip$$

$$V_{3R} := V_g \cdot e_y \cdot \frac{K_{sw3} \cdot y_{sw3\_cr}}{J} = 0.074\ kip$$

$$V_3 := V_{3T} + V_{3R} = 37.901\ kip$$

SW/4:

$$V_{4T} := V_g \cdot \frac{K_{sw4}}{Kx} = 37.827\ kip$$

$$V_{4R} := V_g \cdot e_y \cdot \frac{K_{sw4} \cdot y_{sw4\_cr}}{J} = -0.135\ kip$$

$$V_4 := V_{4T} + V_{4R} = 37.692\ kip$$

SW/5:

$$V_{5T} := V_g \cdot \frac{K_{sw5}}{Kx} = 37.827\ kip$$

$$V_{5R} := V_g \cdot e_y \cdot \frac{K_{sw5} \cdot y_{sw5\_cr}}{J} = 0.047\ kip$$

$$V_5 := V_{5T} + V_{5R} = 37.874\ kip$$

sum in x:

$$V_1+V_2+V_3+V_4+V_5-V_g=0\ kip$$

sum in y:

$$V_A+V_B+V_C+V_D+V_E+V_F+V_G+V_H+V_I+V_J+V_K=0\ kip$$

Summary of Shears (N-S Wind Loading):

Roof Shears -

$V_{sw1}=16.961\ kip$

$V_{sw2}=-20.68\ kip$

$V_{sw3}=-57.52\ kip$

$V_{sw4}=25.809\ kip$

$V_{sw5}=158.32\ kip$

Second Floor Shears -

$V_A=0.136\ kip$

$V_B=0.093\ kip$

$V_C=0.061\ kip$

$V_D=0.029\ kip$

$V_E=-0.002\ kip$

$V_F=-0.034\ kip$

$V_G=-0.05\ kip$

$V_H=-0.084\ kip$

$V_I=-0.116\ kip$

$V_J=-0.148\ kip$

$V_K=0.115\ kip$

$V_1=34.448\ kip$

$V_2=37.964\ kip$

$V_3=37.901\ kip$

$V_4=37.692\ kip$

$V_5=37.874\ kip$

- FAILURE TESTING-

TABLE 1604.3 DEFLECTION LIMITS[a, b, c, h, i]

CONSTRUCTION	L or L_r	S or W[f]	D + L[d, g]
Roof members:[e]			
Supporting plaster or stucco ceiling	l/360	l/360	l/240
Supporting nonplaster ceiling	l/240	l/240	l/180
Not supporting ceiling	l/180	l/180	l/120
Floor members	l/360	—	l/240
Exterior walls:			
With plaster or stucco finishes	—	l/360	—
With other brittle finishes	—	l/240	—
With flexible finishes	—	l/120	—
Interior partitions:[b]			
With plaster or stucco finishes	l/360	—	—
With other brittle finishes	l/240	—	—
With flexible finishes	l/120	—	—
Farm buildings	—	—	l/180
Greenhouses	—	—	l/120

$E := 29000\ ksi$

Girder Steel - A992 $\quad F_{y\_girder} := 50\ ksi \quad F_{u\_girder} := 65\ ksi$

Column Steel - A992 $\quad F_{y\_col} := 50\ ksi \quad F_{u\_col} := 65\ ksi$

Bracing Steel - A500 Gr C $\quad F_{y\_brace} := 50\ ksi \quad F_{u\_brace} := 62\ ksi$

Truss Web and BC - A500 Gr C $\quad F_{y\_BC} := 46\ ksi \quad F_{u\_BC} := 62\ ksi$

- Available Strengths -

Roof Truss:

$L_e := 5\ ft \quad K := 0.65 \quad L_e \cdot K = 3.25\ ft$

Top Chord - W14x34

Web/Bottom Chord - HSS 4x0.125

$$P_{RTC} := \frac{4.02}{10^3} \frac{1}{kip} \qquad B_{RTC} := \frac{6.67}{10^3} \frac{1}{kip \cdot ft}$$

$$P_{RBC\_T} := 31.0\ kip \qquad P_{RBC\_C} := 30.1\ kip$$

$A_g := 3.39\ in^2 \quad A_e := 2.54\ in^2 \quad \Omega_t := 2.00 \quad L_e := 6\ ft$

Roof Girder - W14x74 $\quad B_{RG} := 239\ kip \cdot ft$

$L_e := 23\ ft$ $K := 1.0$ $L_e \cdot K = 23\ ft$

$A_g := 17.9\ in^4$ $A_e := 13.4\ in^2$

Second Floor Truss:

$L_e := 5\ ft$ $K := 0.65$ $L_e \cdot K = 3.25\ ft$

Top Chord - W18x106

Web/Bottom Chord - HSS 4x0.125

$P_{2TC} := \frac{1.13}{10^3}\ \frac{1}{kip}$ $B_{2TC} := \frac{1.55}{10^3}\ \frac{1}{kip \cdot ft}$

$P_{2BC\_T} := 31.0\ kip$ $P_{2BC\_C} := 30.1\ kip$

$A_g := 6.62\ in^2$ $A_e := 4.97\ in^2$ $\Omega_t := 2.00$

Second Floor Girder - W14x120

$B_{2G5} := 480\ kip \cdot ft$

$L_e := 23\ ft$ $K := 1.0$ $L_e \cdot K = 23\ ft$

$A_g := 17.9\ in^4$ $A_e := 13.4\ in^2$

Columns - W12x120
(changed from W8x67)

$P_C := \frac{1.46}{10^3}\ \frac{1}{kip}$ $B_C := \frac{2.07}{10^3}\ \frac{1}{kip \cdot ft}$

$L_e := 24\ ft$ $K := 0.8$ $L_e \cdot K = 19.2\ ft$

Columns - W14x120 - interior
(changed from W8x67)

$P_{CI} := \frac{1.28}{10^3}\ \frac{1}{kip}$ $B_{CI} := \frac{1.80}{10^3}\ \frac{1}{kip \cdot ft}$

$L_e := 24\ ft$ $K := 0.8$ $L_e \cdot K = 19.2\ ft$

Braces - HSS 4.5x4.5x0.125

$P_{b\_T} := 43.5\ kip$ $P_{b\_C} := 9.07\ kip$

$L_e := \sqrt[2]{24^2 + 35^2} \cdot ft = 42.438\ ft$ $K := 0.65$ $L_e \cdot K = 27.585\ ft$

$A_g := 2.00\ in^2$ $A_e := 1.50\ in^2$

Braced Frame 1:

Deflection - $L := 23\ ft$ $\Delta_{max\_R} := 0.1805\ in$

$\frac{L}{240} = 1.15\ in$ $\Delta_{max\_2floor} := 0.2261\ in$ checks!

Members in Bending -

- Girders -

Max Allowed		**Max Required**
$B_{RG} = 239\ kip \cdot ft$	checks!	$B := 85.56\ kip \cdot ft$
$B_{2G5} = 480\ kip \cdot ft$		$B := 198.16\ kip \cdot ft$

Members in Compression and Tension -

- Braces -

Max Allowed		**Max Required**
$P_{b\_T} = 43.5\ kip$	checks! (lowest value)	$T := 0.08\ kip$
$P_{b\_C} = 9.07\ kip$		$C := 0.08\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C = 0.001\ \frac{1}{kip}$	$P := 10.12\ kip$
$B_C = 0.002\ \frac{1}{kip \cdot ft}$	$B := 121.74\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.291$ $P \cdot P_C = 0.015$

When $pP_r \geq 0.2$:

$$pP_r + b_x M_{rx} + b_y M_{ry} \leq 1.0$$

When $pP_r < 0.2$:

$$\tfrac{1}{2} pP_r + \tfrac{9}{8}\left(b_x M_{rx} + b_y M_{ry}\right) \leq 1.0$$

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Braced Frame 2:

Deflection - $L := 35\ ft$ $\quad \Delta_{max\_R} := 0.5833\ in$

$\dfrac{L}{240} = 1.75\ in$ $\quad \Delta_{max\_2floor} := 0.7100\ in$ checks!

Members in Bending -

- Girders -

Max Allowed **Max Required**

$B_{RG} = 239\ kip \cdot ft$ $\quad B := 126.80\ kip \cdot ft$

checks!

$B_{2G5} = 480\ kip \cdot ft$ $\quad B := 255.48\ kip \cdot ft$

Members in Compression and Tension -

- Braces -

Max Allowed **Max Required**

$P_{b\_T} = 43.5\ kip$ $\quad T := 0.13\ kip$

$P_{b\_C} = 9.07\ kip$ checks! (lowest value) $\quad C := 0.12\ kip$

Members in Combined Loading -

- Column -

Max Allowed **Max Required**

$P_C = 0.001\ \dfrac{1}{kip}$ $\quad P := 15.97\ kip$

$B_C = 0.002\ \dfrac{1}{kip \cdot ft}$ $\quad B := 160.68\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.386$

$P \cdot P_C = 0.023$

Braced Frame 3:

Deflection - $L := 35\ ft$ $\Delta_{max\_R} := 0.5867\ in$

$\frac{L}{240} = 1.75\ in$ $\Delta_{max\_2floor} := 0.7099\ in$ checks!

Members in Bending -

- Girders -

Max Allowed		**Max Required**
$B_{RG} = 239\ kip \cdot ft$	checks!	$B := 156.70\ kip \cdot ft$
$B_{2G5} = 480\ kip \cdot ft$		$B := 255.95\ kip \cdot ft$

Members in Compression and Tension -

- Braces -

Max Allowed		**Max Required**
$P_{b\_T} = 43.5\ kip$	checks! (lowest value)	$T := 0.13\ kip$
$P_{b\_C} = 9.07\ kip$		$C := 0.13\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C = 0.001\ \frac{1}{kip}$	$P := 19.14\ kip$
$B_C = 0.002\ \frac{1}{kip \cdot ft}$	$B := 187.87\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.451$

$P \cdot P_C = 0.028$

Braced Frame 4:

Deflection - $L := 35\ ft$ $\Delta_{max\_R} := 0.5862\ in$

$\frac{L}{240} = 1.75\ in$ $\Delta_{max\_2floor} := 0.7168\ in$ checks!

Members in Bending -

- Girders -

Max Allowed **Max Required**

$B_{RG} = 239\ kip \cdot ft$ $B := 127.94\ kip \cdot ft$

checks!

$B_{2G5} = 480\ kip \cdot ft$ $B := 269.34\ kip \cdot ft$

Members in Compression and Tension -

- Braces -

Max Allowed **Max Required**

$P_{b\_T} = 43.5\ kip$ checks! (lowest value) $T := 0.13\ kip$

$P_{b\_C} = 9.07\ kip$ $C := 0.13\ kip$

Members in Combined Loading -

- Column -

Max Allowed **Max Required**

$P_C = 0.001\ \frac{1}{kip}$ $P := 14.23\ kip$

$B_C = 0.002\ \frac{1}{kip \cdot ft}$ $B := 142.40\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.342$ $P \cdot P_C = 0.021$

Braced Frame 5:

Deflection - $L := 35\ ft$ $\Delta_{max\_R} := 0.6183\ in$

$\frac{L}{240} = 1.75\ in$ $\Delta_{max\_2floor} := 0.8155\ in$ checks!

Members in Bending -

- Girders -

Max Allowed **Max Required**

$B_{RG} = 239\ kip \cdot ft$ checks! $B := 236.23\ kip \cdot ft$

$B_{2G5} = 480\ kip \cdot ft$ $B := 457.33\ kip \cdot ft$

Members in Compression and Tension -

- Braces -

Max Allowed **Max Required**

$P_{b\_T} = 43.5\ kip$ checks! (lowest value) $T := 0.12\ kip$

$P_{b\_C} = 9.07\ kip$ $C := 0.16\ kip$

Members in Combined Loading -

- Column -

Max Allowed **Max Required**

$P_C = 0.001\ \frac{1}{kip}$ $P := 26.93\ kip$

$B_C = 0.002\ \frac{1}{kip \cdot ft}$ $B := 266.81\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.641$ $P \cdot P_C = 0.039$

Moment Frame A -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		Max Required
$P_{RBC\_T}=31\ kip$		$T:=0.13\ kip$
$P_{RBC\_C}=30.1\ kip$	checks! (lowest value)	$C:=0.29\ kip$
$P_{2BC\_T}=31\ kip$		$T:=0.17\ kip$
$P_{2BC\_C}=30.1\ kip$		$C:=0.68\ kip$

Members in Combined Loading -

- Column -

Max Allowed	Max Required
$P_C=0.001\ \frac{1}{kip}$	$P:=11.47\ kip$
$B_C=0.002\ \frac{1}{kip \cdot ft}$	$B:=119.78\ kip \cdot ft$
$0.5 \cdot P_C \cdot P+\frac{9}{8} \cdot B_C \cdot B=0.287$	$P \cdot P_C=0.017$
$P_{CI}=0.001\ \frac{1}{kip}$	$P:=17.93\ kip$
$B_{CI}=0.002\ \frac{1}{kip \cdot ft}$	$B:=151.15\ kip \cdot ft$
$0.5 \cdot P_{CI} \cdot P+\frac{9}{8} \cdot B_{CI} \cdot B=0.318$	$P \cdot P_{CI}=0.023$

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.195$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$0.5 \cdot P_{2TC} \cdot P + \frac{9}{8} \cdot B_{2TC} \cdot B = 0.216$

Max Required

$B := 24.53 \ kip \cdot ft$

$P := 5.50 \ kip$

$P \cdot P_{RTC} = 0.022$

$B := 117.39 \ kip \cdot ft$

$P := 20.37 \ kip$

$P \cdot P_{2TC} = 0.023$

Moment Frame K -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed | **Max Required**

$P_{RBC\_T} = 31\ kip$ | $T := 1.65\ kip$

$P_{RBC\_C} = 30.1\ kip$ | $C := 1.04\ kip$

checks!
(lowest value)

$P_{2BC\_T} = 31\ kip$ | $T := 0.65\ kip$

$P_{2BC\_C} = 30.1\ kip$ | $C := 1.19\ kip$

Members in Combined Loading -

- Column -

Max Allowed | **Max Required**

$P_C = 0.001\ \frac{1}{kip}$ | $P := 34.16\ kip$

$B_C = 0.002\ \frac{1}{kip \cdot ft}$ | $B := 240.74\ kip \cdot ft$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.586$ | $P \cdot P_C = 0.05$

$P_{CI} = 0.001\ \frac{1}{kip}$ | $P := 74.30\ kip$

$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$ | $B := 386.76\ kip \cdot ft$

$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.831$ | $P \cdot P_{CI} = 0.095$

Max Allowed | **Max Required**

$B_{RTC} = 0.007\ \frac{1}{kip \cdot ft}$ | $B := 85.95\ kip \cdot ft$

$P_{RTC} = 0.004\ \frac{1}{kip}$ | $P := 24.59\ kip$

$$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.694$$

$$P \cdot P_{RTC} = 0.099$$

$$B_{2TC} = 0.002 \; \frac{1}{kip \cdot ft}$$

$$B := 543.65 \; kip \cdot ft$$

$$P_{2TC} = 0.001 \; \frac{1}{kip}$$

$$P := 65.85 \; kip$$

$$0.5 \cdot P_{2TC} \cdot P + \frac{9}{8} \cdot B_{2TC} \cdot B = 0.985$$

$$P \cdot P_{2TC} = 0.074$$

Moment Frame B -

Deflection - $L:=80\ ft$ $\Delta_{max\_R}:=2.7830\ in$

$\frac{L}{240}=4\ in$ $\Delta_{max\_2floor}:=3.894\ in$ checks!

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		Max Required
$P_{RBC\_T}=31\ kip$		$T:=0.51\ kip$
$P_{RBC\_C}=30.1\ kip$	checks! (lowest value)	$C:=1.02\ kip$
$P_{2BC\_T}=31\ kip$		$T:=0.65\ kip$
$P_{2BC\_C}=30.1\ kip$		$C:=1.12\ kip$

Members in Combined Loading -

- Column -

Max Allowed	Max Required
$P_C=0.001\ \frac{1}{kip}$	$P:=29.15\ kip$
$B_C=0.002\ \frac{1}{kip\cdot ft}$	$B:=219.79\ kip\cdot ft$
$0.5\cdot P_C\cdot P+\frac{9}{8}\cdot B_C\cdot B=0.533$	$P\cdot P_C=0.043$
$P_{CI}=0.001\ \frac{1}{kip}$	$P:=74.34\ kip$
$B_{CI}=0.002\ \frac{1}{kip\cdot ft}$	$B:=365.21\ kip\cdot ft$
$0.5\cdot P_{CI}\cdot P+\frac{9}{8}\cdot B_{CI}\cdot B=0.787$	$P\cdot P_{CI}=0.095$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.7$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.909$

Max Required

$B := 88.98 \ kip \cdot ft$

$P := 16.30 \ kip$

$P \cdot P_{2TC} = 0.018$

$B := 541.27 \ kip \cdot ft$

$P := 61.92 \ kip$

$P \cdot P_{RTC} = 0.249$

Moment Frame C -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		**Max Required**
$P_{RBC\_T}=31\ kip$		$T:=0.51\ kip$
$P_{RBC\_C}=30.1\ kip$	checks! (lowest value)	$C:=1.04\ kip$
$P_{2BC\_T}=31\ kip$		$T:=0.65\ kip$
$P_{2BC\_C}=30.1\ kip$		$C:=1.15\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C=0.001\ \frac{1}{kip}$	$P:=26.44\ kip$
$B_C=0.002\ \frac{1}{kip\cdot ft}$	$B:=206.54\ kip\cdot ft$
$0.5\cdot P_C\cdot P+\frac{9}{8}\cdot B_C\cdot B=0.5$	$P\cdot P_C=0.039$
$P_{CI}=0.001\ \frac{1}{kip}$	$P:=78.32\ kip$
$B_{CI}=0.002\ \frac{1}{kip\cdot ft}$	$B:=397.64\ kip\cdot ft$
$0.5\cdot P_{CI}\cdot P+\frac{9}{8}\cdot B_{CI}\cdot B=0.855$	$P\cdot P_{CI}=0.1$

<u>- Trusses (TC) -</u>

Max Allowed

$B_{RTC} = 0.007 \; \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \; \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.704$

$B_{2TC} = 0.002 \; \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \; \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.912$

Max Required

$B := 89.44 \; kip \cdot ft$

$P := 16.39 \; kip$

$P \cdot P_{2TC} = 0.019$

$B := 543.19 \; kip \cdot ft$

$P := 62.12 \; kip$

$P \cdot P_{RTC} = 0.25$

Moment Frame D -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed

$P_{RBC\_T} = 31\ kip$

$P_{RBC\_C} = 30.1\ kip$

checks!
(lowest value)

$P_{2BC\_T} = 31\ kip$

$P_{2BC\_C} = 30.1\ kip$

Max Required

$T := 0.54\ kip$

$C := 1.22\ kip$

$T := 0.65\ kip$

$C := 1.08\ kip$

Members in Combined Loading -

- Column -

Max Allowed

$P_C = 0.001\ \frac{1}{kip}$

$B_C = 0.002\ \frac{1}{kip \cdot ft}$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.52$

$P_{CI} = 0.001\ \frac{1}{kip}$

$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$

$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.976$

Max Required

$P := 28.13\ kip$

$B := 214.59\ kip \cdot ft$

$P \cdot P_C = 0.041$

$P := 79.91\ kip$

$B := 456.52\ kip \cdot ft$

$P \cdot P_{CI} = 0.102$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \dfrac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \dfrac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \dfrac{9}{8} \cdot B_{RTC} \cdot B = 0.722$

$B_{2TC} = 0.002 \dfrac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \dfrac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.948$

Max Required

$B := 91.94\ kip \cdot ft$

$P := 15.90\ kip$

$P \cdot P_{2TC} = 0.018$

$B := 566.21\ kip \cdot ft$

$P := 62.15\ kip$

$P \cdot P_{RTC} = 0.25$

Moment Frame E -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed

$P_{RBC\_T} = 31\ kip$

$P_{RBC\_C} = 30.1\ kip$

$P_{2BC\_T} = 31\ kip$

$P_{2BC\_C} = 30.1\ kip$

checks!
(lowest value)

Max Required

$T := 0.54\ kip$

$C := 1.22\ kip$

$T := 0.65\ kip$

$C := 1.08\ kip$

Members in Combined Loading -

- Column -

Max Allowed

$P_C = 0.001\ \dfrac{1}{kip}$

$B_C = 0.002\ \dfrac{1}{kip \cdot ft}$

$0.5 \cdot P_C \cdot P + \dfrac{9}{8} \cdot B_C \cdot B = 0.523$

$P_{CI} = 0.001\ \dfrac{1}{kip}$

$B_{CI} = 0.002\ \dfrac{1}{kip \cdot ft}$

$0.5 \cdot P_{CI} \cdot P + \dfrac{9}{8} \cdot B_{CI} \cdot B = 0.975$

Max Required

$P := 28.19\ kip$

$B := 215.63\ kip \cdot ft$

$P \cdot P_C = 0.041$

$P := 80.06\ kip$

$B := 456.20\ kip \cdot ft$

$P \cdot P_{CI} = 0.102$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.722$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.948$

Max Required

$B := 91.92 \ kip \cdot ft$

$P := 15.91 \ kip$

$P \cdot P_{2TC} = 0.018$

$B := 565.99 \ kip \cdot ft$

$P := 62.20 \ kip$

$P \cdot P_{RTC} = 0.25$

Moment Frame F -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed

$P_{RBC\_T} = 31\ kip$

$P_{RBC\_C} = 30.1\ kip$

$P_{2BC\_T} = 31\ kip$

$P_{2BC\_C} = 30.1\ kip$

checks!
(lowest value)

Max Required

$T := 0.41\ kip$

$C := 1.23\ kip$

$T := 0.65\ kip$

$C := 1.11\ kip$

Members in Combined Loading -

- Column -

Max Allowed

$P_C = 0.001\ \frac{1}{kip}$

$B_C = 0.002\ \frac{1}{kip \cdot ft}$

$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.539$

Max Required

$P := 27.21\ kip$

$B := 222.74\ kip \cdot ft$

$P \cdot P_C = 0.04$

$P_{CI} = 0.001\ \frac{1}{kip}$

$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$

$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.986$

$P := 81.31\ kip$

$B := 461.13\ kip \cdot ft$

$P \cdot P_{CI} = 0.104$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.722$

$B_{2TC} = 0.002 \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.949$

Max Required

$B := 92.03\ kip \cdot ft$

$P := 15.83\ kip$

$P \cdot P_{2TC} = 0.018$

$B := 566.71\ kip \cdot ft$

$P := 62.23\ kip$

$P \cdot P_{RTC} = 0.25$

Moment Frame G -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		**Max Required**
$P_{RBC\_T} = 31\ kip$		$T := 0.18\ kip$
$P_{RBC\_C} = 30.1\ kip$	checks! (lowest value)	$C := 1.01\ kip$
$P_{2BC\_T} = 31\ kip$		$T := 0.87\ kip$
$P_{2BC\_C} = 30.1\ kip$		$C := 6.18\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C = 0.001\ \frac{1}{kip}$	$P := 36.74\ kip$
$B_C = 0.002\ \frac{1}{kip \cdot ft}$	$B := 299.09\ kip \cdot ft$
$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.723$	$P \cdot P_C = 0.054$
$P_{CI} = 0.001\ \frac{1}{kip}$	$P := 65.73\ kip$
$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$	$B := 379.58\ kip \cdot ft$
$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.811$	$P \cdot P_{CI} = 0.084$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.553$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.783$

Max Required

$B := 69.84 \ kip \cdot ft$

$P := 14.42 \ kip$

$P \cdot P_{2TC} = 0.016$

$B := 468.15 \ kip \cdot ft$

$P := 50.95 \ kip$

$P \cdot P_{RTC} = 0.205$

Moment Frame H -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		**Max Required**
$P_{RBC\_T} = 31\ kip$		$T := 0.44\ kip$
$P_{RBC\_C} = 30.1\ kip$	checks! (lowest value)	$C := 1.18\ kip$
$P_{2BC\_T} = 31\ kip$		$T := 0.53\ kip$
$P_{2BC\_C} = 30.1\ kip$		$C := 1.88\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C = 0.001\ \frac{1}{kip}$	$P := 20.68\ kip$
$B_C = 0.002\ \frac{1}{kip \cdot ft}$	$B := 188.23\ kip \cdot ft$
$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.453$	$P \cdot P_C = 0.03$
$P_{CI} = 0.001\ \frac{1}{kip}$	$P := 51.68\ kip$
$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$	$B := 305.13\ kip \cdot ft$
$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.651$	$P \cdot P_{CI} = 0.066$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \dfrac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \dfrac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \dfrac{9}{8} \cdot B_{RTC} \cdot B = 0.562$

$B_{2TC} = 0.002 \dfrac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \dfrac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.711$

Max Required

$B := 71.00\ kip \cdot ft$

$P := 14.50\ kip$

$P \cdot P_{2TC} = 0.016$

$B := 417.55\ kip \cdot ft$

$P := 56.67\ kip$

$P \cdot P_{RTC} = 0.228$

Moment Frame I -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		**Max Required**
$P_{RBC\_T}=31\ kip$		$T:=0.43\ kip$
$P_{RBC\_C}=30.1\ kip$	checks! (lowest value)	$C:=1.12\ kip$
$P_{2BC\_T}=31\ kip$		$T:=0.54\ kip$
$P_{2BC\_C}=30.1\ kip$		$C:=2.33\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C=0.001\ \frac{1}{kip}$	$P:=23.38\ kip$
$B_C=0.002\ \frac{1}{kip\cdot ft}$	$B:=241.61\ kip\cdot ft$
$0.5\cdot P_C\cdot P+\frac{9}{8}\cdot B_C\cdot B=0.58$	$P\cdot P_C=0.034$
$P_{CI}=0.001\ \frac{1}{kip}$	$P:=61.82\ kip$
$B_{CI}=0.002\ \frac{1}{kip\cdot ft}$	$B:=379.36\ kip\cdot ft$
$0.5\cdot P_{CI}\cdot P+\frac{9}{8}\cdot B_{CI}\cdot B=0.808$	$P\cdot P_{CI}=0.079$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.587$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$P_{2TC} \cdot P + B_{2TC} \cdot B = 0.726$

Max Required

$B := 74.17 \ kip \cdot ft$

$P := 15.18 \ kip$

$P \cdot P_{2TC} = 0.017$

$B := 426.47 \ kip \cdot ft$

$P := 57.77 \ kip$

$P \cdot P_{RTC} = 0.232$

Moment Frame J -

Members in Compression and Tension -

- Trusses (BC/Web) -

Max Allowed		**Max Required**
$P_{RBC\_T} = 31\ kip$		$T := 0.15\ kip$
$P_{RBC\_C} = 30.1\ kip$	checks! (lowest value)	$C := 0.37\ kip$
$P_{2BC\_T} = 31\ kip$		$T := 0.20\ kip$
$P_{2BC\_C} = 30.1\ kip$		$C := 1.26\ kip$

Members in Combined Loading -

- Column -

Max Allowed	**Max Required**
$P_C = 0.001\ \frac{1}{kip}$	$P := 16.32\ kip$
$B_C = 0.002\ \frac{1}{kip \cdot ft}$	$B := 141.36\ kip \cdot ft$
$0.5 \cdot P_C \cdot P + \frac{9}{8} \cdot B_C \cdot B = 0.341$	$P \cdot P_C = 0.024$
$P_{CI} = 0.001\ \frac{1}{kip}$	$P := 17.72\ kip$
$B_{CI} = 0.002\ \frac{1}{kip \cdot ft}$	$B := 187.73\ kip \cdot ft$
$0.5 \cdot P_{CI} \cdot P + \frac{9}{8} \cdot B_{CI} \cdot B = 0.391$	$P \cdot P_{CI} = 0.023$

- Trusses (TC) -

Max Allowed

$B_{RTC} = 0.007 \ \frac{1}{kip \cdot ft}$

$P_{RTC} = 0.004 \ \frac{1}{kip}$

$0.5 \cdot P_{RTC} \cdot P + \frac{9}{8} \cdot B_{RTC} \cdot B = 0.349$

$B_{2TC} = 0.002 \ \frac{1}{kip \cdot ft}$

$P_{2TC} = 0.001 \ \frac{1}{kip}$

$0.5 \cdot P_{2TC} \cdot P + \frac{9}{8} \cdot B_{2TC} \cdot B = 0.197$

Max Required

$B := 43.35 \ kip \cdot ft$

$P := 11.84 \ kip$

$P \cdot P_{2TC} = 0.013$

$B := 106.40 \ kip \cdot ft$

$P := 20.61 \ kip$

$P \cdot P_{RTC} = 0.083$

Sizing foundation footings:

$P := 28 \quad kip$

$LLwind := 28 \quad psf$

Assume soil is capable of supporting 3000 psf

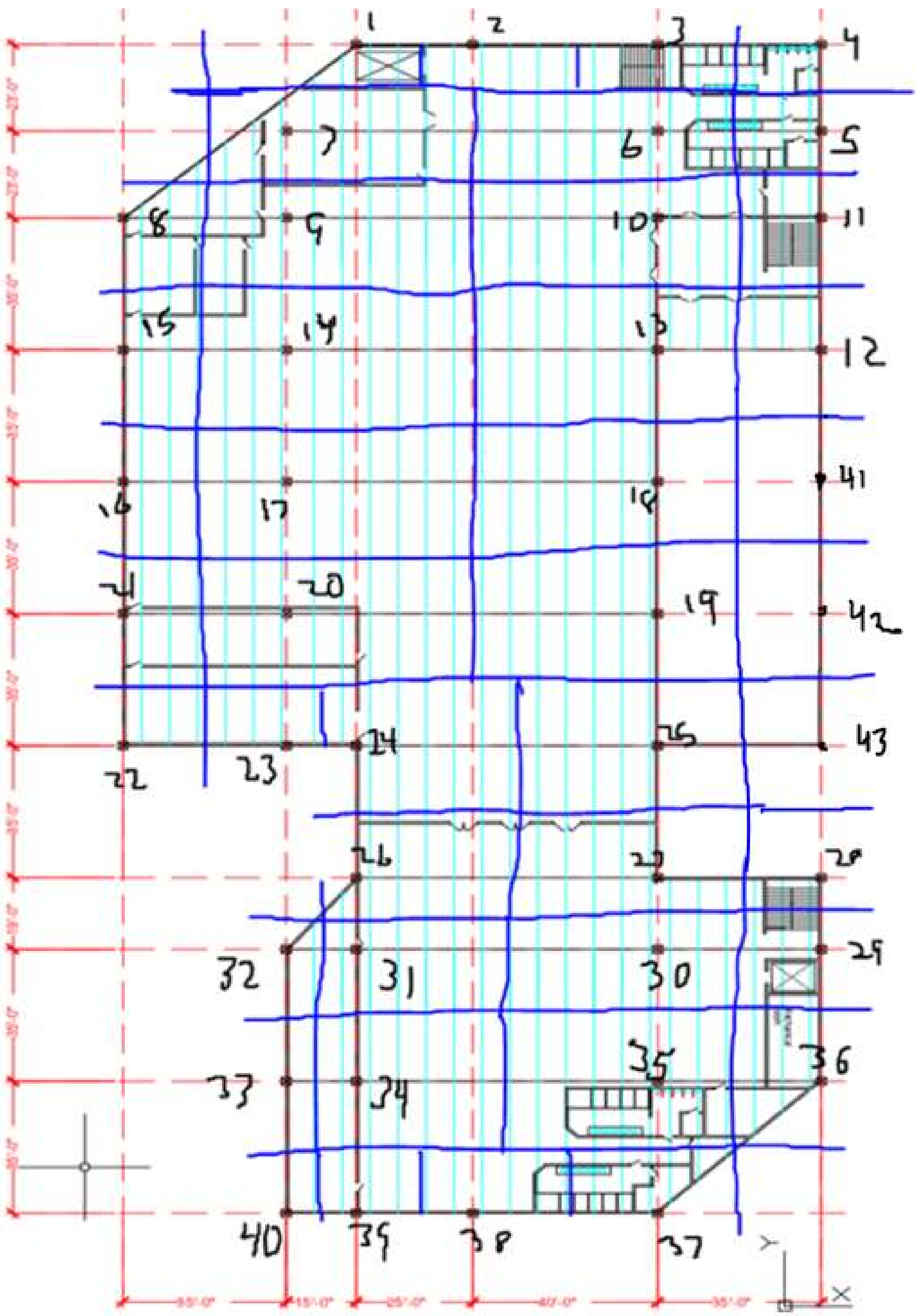


Figure A crudely shows the tributary area for each column. This will be used to determine footing sizes

Tributary area of each column:

$$A1 := ((12.5 \cdot 11.5)) + \left(.5 \cdot 15 \cdot \frac{23}{2}\right) = 230$$

$$A2 := \frac{23}{2} \cdot (32.5) = 373.75$$

$$A3 := 37.5 \cdot \frac{23}{2} = 431.25$$

$$A4 := \frac{35}{2} \cdot \frac{23}{2} = 201.25$$

$$A5 := 23 \cdot \frac{35}{2} = 402.5$$

$$A6 := 57.5 \cdot 23 = 1322.5$$

$$A7 := 57.5 \cdot 23 = 1322.5$$

$$A8 := 29 \cdot \frac{35}{2} = 507.5$$

$$A9 := 57.5 \cdot 29 = 1667.5$$

$$A10 := 57.5 \cdot 29 = 1667.5$$

$$A11 := \frac{35}{2} \cdot 29 = 507.5$$

$$A12 := 35 \cdot \frac{35}{2} = 612.5$$

$$A13 := 35 \cdot 57.5 = 2012.5$$

$$A14 := 57.5 \cdot 35 = 2012.5$$

$$A15 := \frac{35}{2} \cdot 35 = 612.5$$

$$A16 := 35 \cdot \frac{35}{2} = 612.5$$

$$A17 := 57.5 \cdot 35 = 2012.5$$

$$A18 := 40 \cdot 35 = 1400$$

$$A19 := 35 \cdot 40 = 1400$$

$$A20 := 57.5 \cdot 35 = 2012.5$$

Equation for finding sizes of footings:

Solving for A of footing

P = Ai * psf of room

Stress = P/A

$$A21 := 35 \cdot \frac{35}{2} = 612.5$$

$$A22 := \frac{35}{2} \cdot \frac{35}{2} = 306.25$$

$$A23 := \left(\frac{35}{2} + \frac{15}{2}\right) \cdot \frac{35}{2} = 437.5$$

$$A24 := 7.5 \cdot \frac{35}{2} + \left(\frac{65}{2} \cdot 35\right) = 1268.75$$

$$A25 := 35 \cdot 32.5 = 1137.5$$

$$A26 := \left(\left(\frac{35}{2} + \frac{19}{2}\right) \cdot \frac{65}{2}\right) + .5 \cdot 7.5 \cdot \frac{19}{2} = 913.125$$

$$A27 := \left(\frac{65}{2} \cdot \left(\frac{35}{2} + \frac{19}{2}\right)\right) + \frac{35}{2} \cdot \frac{19}{2} = 1043.75$$

$$A28 := \frac{19}{2} \cdot \frac{35}{2} = 166.25$$

$$A29 := \left(\frac{19}{2} + \frac{35}{2}\right) \cdot \frac{35}{2} = 472.5$$

$$A30 := 27 \cdot \left(\frac{65}{2} + \frac{35}{2}\right) = 1350$$

$$A31 := \left(\frac{65}{2} + \frac{15}{2} \cdot \left(\frac{19}{2} + \frac{35}{2}\right)\right) = 235$$

$$A32 := \frac{15}{2} \cdot \frac{35}{2} + 7.5 \cdot .5 \cdot \frac{19}{2} = 166.875$$

$$A33 := 35 \cdot \frac{15}{2} = 262.5$$

$$A34 := 40 \cdot 35 = 1400$$

$$A35 := 50 \cdot 35 = 1750$$

$$A36 := 35 \cdot \frac{35}{2} + \left(\frac{35}{2} \cdot .5 \cdot \frac{35}{2}\right) = 765.625$$

$$A37 := 20 \cdot \frac{35}{2} + .5 \cdot \frac{35}{2} \cdot \frac{35}{2} = 503.125$$

$$A38 := \frac{35}{2} \cdot 32.5 = 568.75$$

$$A39 := (7.5 + 12.5) \cdot \frac{35}{2} = 350$$

$$A40 := 7.5 \cdot \frac{35}{2} = 131.25$$

$$A41 := \frac{35}{2} \cdot 35 = 612.5$$

$$A42 := 612.5$$

$$A43 := 612.5$$

Area of footings in sq ft:

$$Af1 := \frac{300 \cdot A1}{3000} = 23$$
$$Af2 := \frac{100 \cdot A2}{3000} = 12.4583$$
$$Af3 := \frac{100 \cdot A3}{3000} = 14.375$$
$$Af4 := \frac{60 \cdot A4}{3000} = 4.025$$
$$Af5 := \frac{60 \cdot A5}{3000} = 8.05$$
$$Af6 := \frac{100 \cdot A6}{3000} = 44.0833$$
$$Af7 := \frac{150 \cdot A7}{3000} = 66.125$$
$$Af8 := \frac{150 \cdot A8}{3000} = 25.375$$
$$Af9 := \frac{150 \cdot A9}{3000} = 83.375$$
$$Af10 := \frac{100 \cdot A10}{3000} = 55.5833$$

$$Af11 := \frac{100 \cdot A11}{3000} = 16.9167$$
$$Af12 := \frac{100 \cdot A12}{3000} = 20.4167$$
$$Af13 := \frac{100 \cdot A13}{3000} = 67.0833$$
$$Af14 := \frac{100 \cdot A14}{3000} = 67.0833$$
$$Af15 := \frac{100 \cdot A15}{3000} = 20.4167$$
$$Af16 := \frac{100 \cdot A16}{3000} = 20.4167$$
$$Af17 := \frac{100 \cdot A17}{3000} = 67.0833$$
$$Af18 := \frac{100 \cdot A18}{3000} = 46.6667$$
$$Af19 := \frac{100 \cdot A19}{3000} = 46.6667$$
$$Af20 := \frac{100 \cdot A20}{3000} = 67.0833$$

$$Af21 := \frac{100 \cdot A21}{3000} = 20.4167$$
$$Af22 := \frac{100 \cdot A22}{3000} = 10.2083$$
$$Af23 := \frac{100 \cdot A23}{3000} = 14.5833$$
$$Af24 := \frac{100 \cdot A24}{3000} = 42.2917$$
$$Af25 := \frac{100 \cdot A25}{3000} = 37.9167$$
$$Af26 := \frac{50 \cdot A26}{3000} = 15.2188$$
$$Af27 := \frac{100 \cdot A27}{3000} = 34.7917$$
$$Af28 := \frac{100 \cdot A28}{3000} = 5.5417$$
$$Af29 := \frac{300 \cdot A29}{3000} = 47.25$$
$$Af30 := \frac{100 \cdot A30}{3000} = 45$$

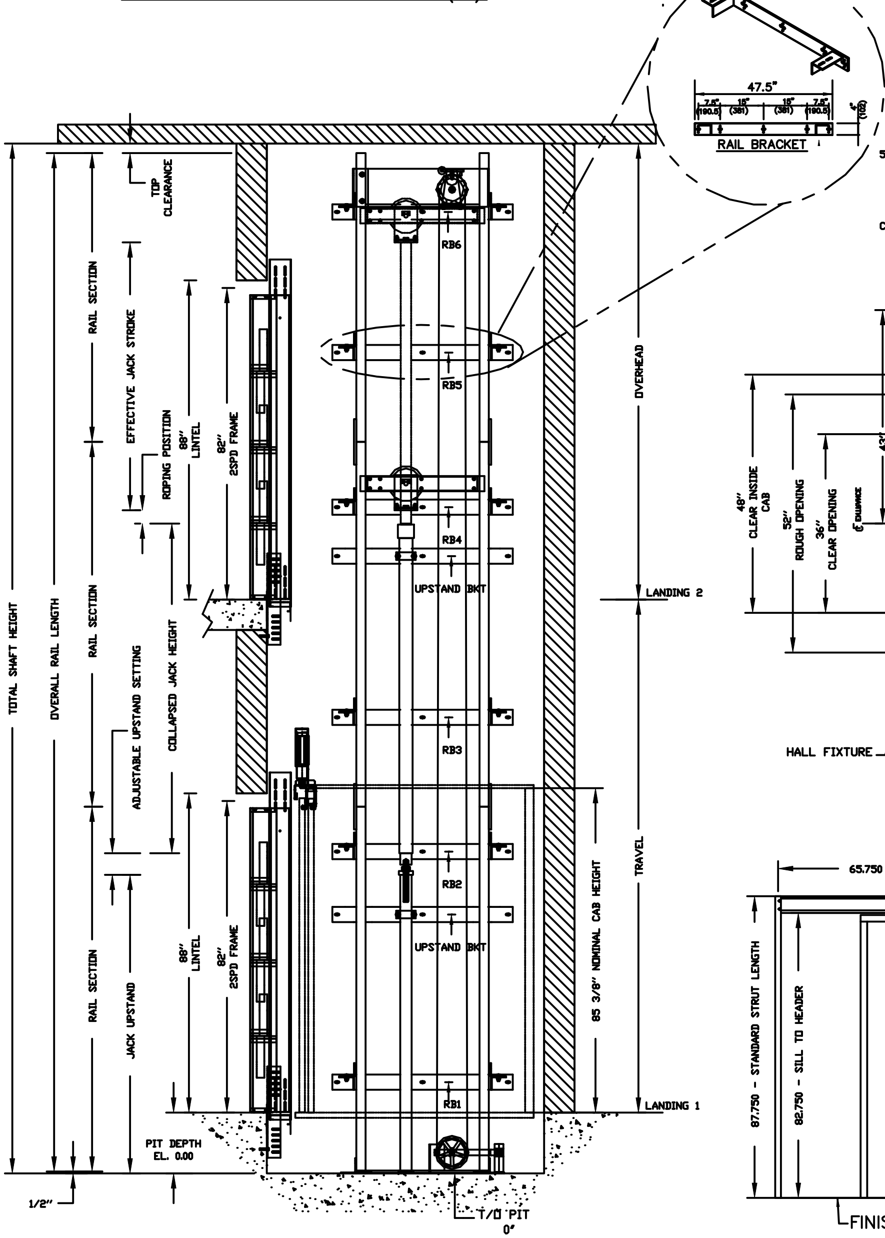
$$Af31 := \frac{100 \cdot A31}{3000} = 7.8333$$
$$Af32 := \frac{100 \cdot A32}{3000} = 5.5625$$
$$Af33 := \frac{100 \cdot A33}{3000} = 8.75$$
$$Af34 := \frac{100 \cdot A34}{3000} = 46.6667$$
$$Af35 := \frac{100 \cdot A35}{3000} = 58.3333$$
$$Af36 := \frac{150 \cdot A36}{3000} = 38.2812$$
$$Af37 := \frac{60 \cdot A37}{3000} = 10.0625$$
$$Af38 := \frac{100 \cdot A38}{3000} = 18.9583$$
$$Af39 := \frac{100 \cdot A39}{3000} = 11.6667$$
$$Af40 := \frac{100 \cdot A40}{3000} = 4.375$$

$$Af41 := \frac{100 \cdot A41}{3000} = 20.4167$$
$$Af42 := \frac{100 \cdot A42}{3000} = 20.4167$$
$$Af43 := \frac{100 \cdot A43}{3000} = 20.4167$$

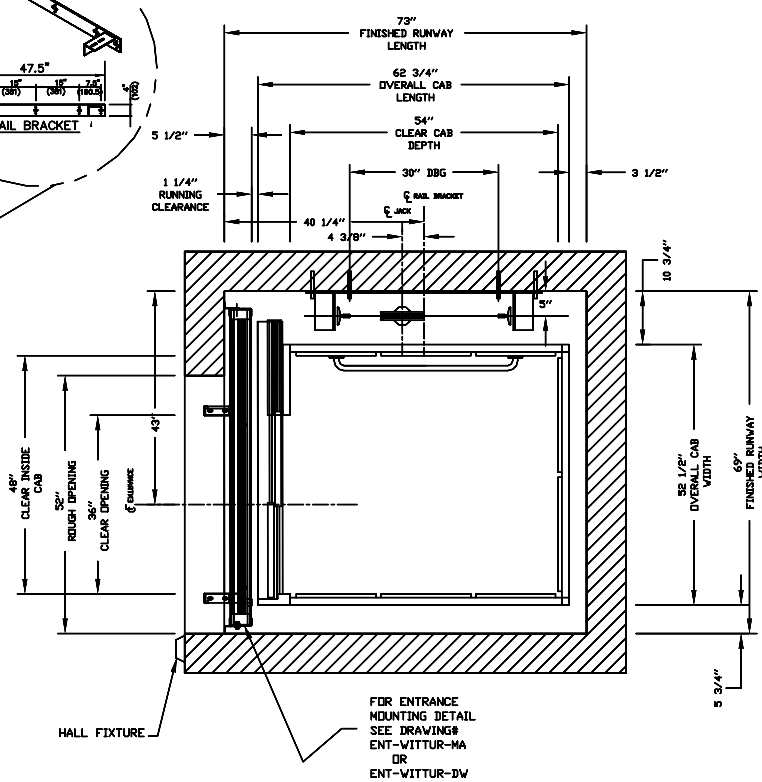
Chosen footing:

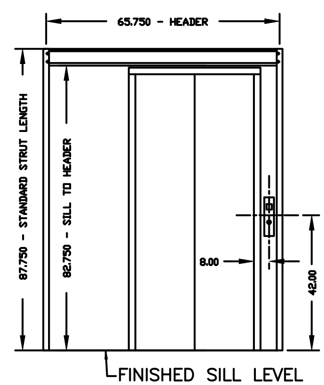
$\sqrt{Af1}=4.7958$	5 x 5 x1'6
$\sqrt{Af2}=3.5296$	4 x 4 x 1'6
$\sqrt{Af3}=3.7914$	4 x 4 x 1'6
$\sqrt{Af4}=2.0062$	2 x 2 x 1'6
$\sqrt{Af5}=2.8373$	3 x 3 x 1'6
$\sqrt{Af6}=6.6395$	7 x 7 x 1'6
$\sqrt{Af7}=8.1317$	8.5 x 8.5 x 1'9"
$\sqrt{Af8}=5.0374$	5 x 5 x1'6
$\sqrt{Af9}=9.131$	10 x 10 x 2'
$\sqrt{Af10}=7.4554$	8.5 x 8.5 x 1'9
$\sqrt{Af11}=4.113$	5 x 5 x1'6
$\sqrt{Af12}=4.5185$	5 x 5 x1'6
$\sqrt{Af13}=8.1904$	8.5 x 8.5 x 1'9"
$\sqrt{Af14}=8.1904$	8.5 x 8.5 x 1'9"
$\sqrt{Af15}=4.5185$	5 x 5 x1'6
$\sqrt{Af16}=4.5185$	5 x 5 x1'6
$\sqrt{Af17}=8.1904$	8.5 x 8.5 x 1'9"
$\sqrt{Af18}=6.8313$	7 x 7 x 1'6
$\sqrt{Af19}=6.8313$	7 x 7 x 1'6
$\sqrt{Af20}=8.1904$	8.5 x 8.5 x 1'9"
$\sqrt{Af21}=4.5185$	5 x 5 x1'6
$\sqrt{Af22}=3.195$	4 x 4 x 1'6
$\sqrt{Af23}=3.8188$	4 x 4 x 1'6
$\sqrt{Af24}=6.5032$	7 x 7 x 1'6
$\sqrt{Af25}=6.1577$	7 x 7 x 1'6
$\sqrt{Af26}=3.9011$	4 x 4 x 1'6
$\sqrt{Af27}=5.8984$	7 x 7 x 1'6
$\sqrt{Af28}=2.3541$	4 x 4 x 1'6
$\sqrt{Af29}=6.8739$	7 x 7 x 1'6
$\sqrt{Af30}=6.7082$	7 x 7 x 1'6
$\sqrt{Af31}=2.7988$	3 x 3 x 1'6
$\sqrt{Af32}=2.3585$	3 x 3 x 1'6
$\sqrt{Af33}=2.958$	3 x 3 x 1'6
$\sqrt{Af34}=6.8313$	7 x 7 x 1'6
$\sqrt{Af35}=7.6376$	8.5 x 8.5 x 1'9"
$\sqrt{Af36}=6.1872$	7 x 7 x 1'6
$\sqrt{Af37}=3.1721$	4 x 4 x 1'6
$\sqrt{Af38}=4.3541$	5 x 5 x1'6
$\sqrt{Af39}=3.4157$	4 x 4 x 1'6
$\sqrt{Af40}=2.0917$	3 x 3 x 1'6
$\sqrt{Af41}=4.5185$	5 x 5 x1'6
$\sqrt{Af42}=4.5185$	5 x 5 x1'6
$\sqrt{Af43}=4.5185$	5 x 5 x1'6

SECTIONAL VIEW - ORION-4854 (1L)



PLAN VIEW - ORION-4854 (1L) 2 SPEED WITTUR DOORS





HALL FIXTURE LOCATION

RAIL FORCES	
✱ R1	✱ R2
729 lbf/3.2KN	260 lbf/1.16KN
RAIL WEIGHT : 8.0 lbs / ft	

R3 NOTE:
PIT FLOOR TO SUPPORT LOAD OF:
10 kips/44.48KN ✱ (INCLUDES IMPACT)

FOR TOTAL PULL-OUT FORCE ON RAIL BRACKET, R1 MUST BE DOUBLED eg. 1440LBS

NOTE A
WHERE SMOKE DETECTORS ARE REQUIRED, WIRING FROM A NORMALLY CLOSED CONTACT AT BOTH THE DESIGNATED RETURN LANDING, SMOKE DETECTORS AND ALTERNATE RETURN LANDING SMOKE DETECTOR SHALL BE PROVIDED TO THE CONTROLLER. A NORMALLY CLOSED CONTACT REPRESENTING ALL OTHER SMOKE DETECTORS MUST BE PROVIDED TO THE CONTROLLER.

NOTE B
ALL INFORMATION IS SUBJECT TO CHANGE.
PLEASE REFERENCE OUR ON-LINE DRAWINGS AT www.concordelevator.com FOR THE MOST RECENT UPDATES

PIT / OVERHEAD REQUIREMENTS

MAX. SPEED (ft/min)	PIT	TOTAL TRAVEL	OVERHEAD	
			NEW BLDG	EXISTING BLDG
30	14" ***		131"(3327)	120"(3048)

*** NOTE: Additional pit equipment required when over 36" deep , consult your local dealer for details

PROVISIONS BY OTHERS

✱GENERAL

HOISTWAY - THE HOISTWAY MUST BE IN ACCORDANCE WITH SAFETY CODE FOR ELEVATORS (ASME A17.1 OR B44-2000) AND ALL STATE/PROVINCIAL AND LOCAL CODES.

PLUMB HOISTWAY- DUE TO CLOSE RUNNING CLEARANCES OWNER/AGENT MUST ENSURE THAT HOISTWAY AND PIT (WHERE PROVIDED) ARE LEVEL, PLUMB AND SQUARE AND ARE IN ACCORDANCE WITH THE DIMENSIONS ON THESE DRAWINGS.

MINIMUM OVERHEAD CLEARANCE- OWNER/AGENT MUST ENSURE MINIMUM OVERHEAD CLEARANCE IS IN COMPLIANCE WITH CODES.

CONSTRUCTION SITE- OWNER/AGENT TO PROVIDE ALL MASONRY, CARPENTRY AND DRYWALL WORK AS REQUIRED AND SHALL PATCH AND MAKE GOOD (INCLUDING FINISH PAINTING) ALL AREAS WHERE WALLS/FLOORS MAY REQUIRE TO BE CUT, DRILLED OR ALTERED IN ANY WAY TO PERMIT THE PROPER INSTALLATION OF THE LIFT.

DIMENSIONS
CONTRACTOR/CUSTOMER TO VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES TO OUR OFFICE IMMEDIATELY.

✱STRUCTURAL

FLOOR/SUPPORT WALL LOADS- STRUCTURAL ENGINEER TO ASSURE THAT BUILDING AND SHAFT WILL SAFELY SUPPORT ALL LOADS IMPOSED BY THE LIFT EQUIPMENT. REFER TO THE TABLES ON THIS DRAWING FOR LOADS IMPOSED BY THE EQUIPMENT.

DOORS- SUITABLE LINTELS MUST BE PROVIDED BY OWNER/AGENT. DOOR FRAMES ARE NOT DESIGNED TO SUPPORT OVERHEAD WALL LOADS.

✱MACHINE ROOM

LOCATION / ACCESS- MACHINE ROOM LOCATED AT THE LOWEST LEVEL ADJACENT TO HOISTWAY, UNLESS SHOWN OTHERWISE ON THE LAYOUT DRAWINGS. FIELD ADJUSTMENT BY INSTALLER MAY BE NECESSARY TO MEET JOB SITE CONDITIONS OR REGULATIONS. ACCESS TO MACHINE ROOM TO BE THROUGH A SELF CLOSING AND SELF LOCKING DOOR.

SLEEVES FOR OIL & ELECTRIC LINES- PROVIDED BY OTHERS, FROM MACHINE ROOM TO HOISTWAY. (POSITION PER INSTALLERS INSTRUCTIONS).

	INPUT VOLTAGE (V/PH/CYCLE)	DISCONNECT SIZE (AMPS)	TIME DELAY FUSE (AMPS)	FULL LOAD CURRENT (AMPS)
MOTOR INFO	208/3PH/60HTZ	30	30	15.6
	230/1PH/60HTZ	60	50	21
CAB LIGHTS	115/1PH		15	

✱ELECTRICAL

POWER SUPPLY- (SEE SPECIFICATIONS) LOCKABLE FUSED DISCONNECT WITH AUXILIARY CONTACT TO BRAKE THE BATTERY FEED, OR CIRCUIT BREAKERS WITH A 3-POLE BREAKER FOR BATTERY FEED REQUIRED, IN COMPLIANCE WITH ELECTRICAL CODE, AS FOLLOWS:
(LOCATED ON WALL ON LOCK JAMB SIDE OF MACHINE ROOM DOOR)

PERMANENT POWER- BEFORE INSTALLATION CAN BEGIN, PERMANENT POWER MUST BE SUPPLIED.

LIGHTING- OWNER/AGENT TO ENSURE AT LEAST 5 FTC OR 54 LUX AMBIENT LIGHTING OVER ELEVATOR AREA.

✱ENTRANCES

FASCIA PANEL BELOW UPPER LEVEL ENTRANCE- WHERE REQUIRED, FASCIA PANEL MUST BE FASTENED TO A SOLID WALL AND BE PERPENDICULAR TO THE FLOOR AND WALLS. HOISTWAY FASCIA IS NOT SELF-SUPPORTING FOR LONG, CONTINUOUS RUNS VOID OF ENTRANCES. ADEQUATE SUPPORT AND THE FASCIA MUST BE PROVIDED BY OTHERS.

ENTRANCE ASSEMBLIES- ENTRANCE ASSEMBLIES MUST BE ADJUSTED TO ALIGN WITH PLATFORM AND INTERLOCK EQUIPMENT. OTHERS TO ALLOW AN ADEQUATE ROUGH OPENING.

RETURN WALLS- RETURN WALLS AT ENTRANCES MUST BE BUILT-IN BY OTHERS AFTER ENTRANCE ASSEMBLIES ARE IN PLACE. ENTRANCE ASSEMBLY MUST BE SECURELY FASTENED TO WALLS BY ELEVATOR CONTRACTOR.

REV-000

savaria

LU/LA
ORION MODEL 4854 (1L)

Cover Type	Runoff Coeff. C	
		B
	5 yr	10 yr
Parking lots, roofs, etc	0.95	0.95
Commercial and Business (85% impervious)	-	-
Open Space	0.25	0.30

Parking Lot Option	Combined Runoff Coeff.	
1	0.83	0.84
2	0.84	0.85
3	0.86	0.87

Rainfall Intensity (in/hr)

Duration (hr.)	Return Period 5 yr	10 yr
0.25	3.88	4.53
24	0.15	0.18

	Even Center	1
Area of Cove Types (acres)	0.90	0.52

est. peak rate of runoff (cfs)

$Q_T = C\, i_T\, A$

Rainfall Duration (hr)		Soil Group B 5 yr	10 yr
0.25	Option 1	5.52512	6.51867
	Option 2	6.15174	7.250265
	Option 3	8.0316	9.44505
24	Option 1	0.2136	0.25902
	Option 2	0.237825	0.28809
	Option 3	8.0316	9.44505

Soil Group			
		C	
100 yr	5 yr	10 yr	100 yr
0.98	0.95	0.95	0.98
-	0.85	0.85	0.90
0.50	0.45	0.55	0.65

0.90	0.83	0.85	0.90
0.90	0.83	0.85	0.90
0.92	0.84	0.85	0.90

100 yr
6.94
0.3

Parking Lot 2	3	Open Space
0.69	1.20	0.30

, Q

		Soil Group C	
100 yr	5 yr	10 yr	100 yr
10.698704	5.55616	6.62286	10.7223
11.854908	6.11682	7.277445	11.78412
15.32352	7.7988	9.2412	14.96958
0.46248	0.2148	0.26316	0.4635
0.51246	0.236475	0.28917	0.5094
15.32352	0.3015	0.3672	0.6471

§ 53.08 SEDIMENTATION AND EROSION CONTROL.
No building permit will be issued or subdivision plat approved unless adequate measures are taken to reduce, control or eliminate erosion during development, as well as improvements reasonably required to prevent erosion after completion of the development.

(A) Permit required. Development sites that result in a total disturbed area of one or more acres shall obtain an erosion control permit prior to any land disturbing activities.

(B) Erosion control permits. All erosion control permits shall be issued by the City Engineering Department upon approval of a completed erosion control permit application. The application shall be signed by the title holder of the site, together with the applicant, if different from the title holder. Any site required to obtain an erosion control permit is also required to obtain the Iowa DNR NPDES General Permit Number 2.

(C) Application. A major erosion control permit application shall include the following:

(1) A completed application for erosion control permit on a form provided by the city.

(2) A stormwater pollution prevention plan (SWPPP) conforming to:

(a) The requirements of this chapter, and the requirements of General Permit No. 2.

(b) If a SWPPP for the site has previously been submitted to the city and has not been modified, the applicant shall submit a signed and dated statement that the SWPPP has not been modified, in which case the SWPPP need not be resubmitted.

(c) Payment of the permit fee, which is scheduled at $100. Erosion control permits are good for one year from date of issuance.

(D) All SWPPPs shall comply with all current minimum mandatory requirements for SWPPPs promulgated by the Iowa DNR in connection with the General Permit No. 2, including those published as summary guidance for General Permit No. 2 by the Iowa DNR. All SWPPPs shall be signed and dated by a qualified professional certified in preparation of a SWPPP in the State of Iowa or a licensed engineer in the State of Iowa.

(E) The City Engineer or designee may inspect all sites in response to reports from third parties or at any other time, at the City Engineer's discretion. The City Engineer or designee may issue a notice to comply to the responsible party or parties, describing any problems and specifying a compliance date. Failure to achieve a specified compliance date is a violation of this section. The City Engineer may issue a notice of violation in writing which may order the discontinuance of work and ordering action to correct it. Failure to respond and comply after the notice of violation within a four- day period will result in enforcement by civil action including action of injunctive relief, withholding of occupancy permits, and a municipal infraction.

(Ord. 2390, passed 10-28-2008; Ord. 2543, passed 9-27-2016) Penalty, see § 53.99

§ 53.09 STORMWATER MANAGEMENT PLAN.
When necessary the Public Works Director may require the owner or developer of a property to submit a stormwater management plan. The plan shall be required when it is determined that the existing natural or manmade drainage ways are
not adequate to carry stormwater flow from a proposed development. Plans and specifications shall be prepared and certified by a professional engineer registered in the state.
(A) Design criteria. The design of stormwater runoff systems, structures and facilities shall be based on the following
minimum standards which do not preclude the use of higher design standards.
(B) Applicability. The provisions of divisions (C) through (G) below shall apply to the following areas under development:
(1) All residential development of two acres or more and all commercial and industrial developments in excess of onehalf
acres;
(2) Any development where the percentage of the impervious area of the lot is 50% or greater; and
(3) Any development which, in the opinion of the City Engineer, lacks an adequate internal or external excess stormwater passageway.
(C) Runoff calculation.
(1) Design flows shall normally be calculated using the procedures outlined in the Soil Conservation Services, Technical Release No. 55 Urban Hydrology for Small Watersheds and the Iowa Users Guide and Supplement for the Technical Release No. 55. For drainage basins of 20 acres or less, the rational method may be used.
(2) In all cases, all areas are to be considered fully developed, in accordance with the city's current comprehensive plan.
(D) Storm sewers. Storm sewers and intakes shall be designed for a five-year frequency storm in a manner that the flooded street width shall not exceed ten feet on each side from the face of the curb.
(E) Excess stormwater passageway. An excess stormwater passageway shall be provided for all developments. The passage shall have the capacity to convey through the proposed development the excess stormwater from the tributary
watershed. The capacity of the excess stormwater passage shall be constructed in a manner as to transport the peak rate of
runoff from a 100-year return frequency storm.
(F) Open channels. The size and shape of open channels shall be designed to meet the requirements of runoff, depth, side slopes, gradient and velocity limitations in accordance with the site conditions. Runoff shall be based on 100-year storm
frequency. Manning's formula as cited in most civil engineering handbooks, shall be used in hydraulic design of open
channels. Channel banks shall be protected by use of low vegetation, rip-rap, turf reinforcement matting, or paving as design
velocity dictates subject to the approval of the City Engineer.
(G) Easements.
(1) Drainage easements shall be provided for all conduits and those bypass channels where the 100-year runoff exceeds one cubic foot per second.
(2) Whenever any stream or water course is located in an area that is being subdivided, the subdivider shall dedicate a
public right-of-way or drainage easement conforming substantially with the lines of the stream or water course and shall
include the additional area adjoining both edges of the stream or water course that has been affected by damaging flood

waters and/or inundated by the 100-year flood waters, as determined by the city engineer. Maintenance of the stream and
banks shall be the responsibility of the landowners upon which the stream is located. This maintenance responsibility shall
be clearly defined in a recorded document. The subdivider shall also provide reasonable public easements for access.
(3) It shall be noted on the final plat, “Owners of lots on which a drainage easement has been established as a stormwater passageway shall maintain the easement as a lawn, planted in grass and free of structures, fences, fill, bushes,
trees, shrubs or other landscaping that would impede the flow of water.” In the event that the area established as a drainage
easement is reshaped or otherwise restricted for use as a drainage easement, the city will cause the restrictions to be removed at the expense of the parties causing the restrictions.
(Ord. 2390, passed 10-28-2008; Ord. 2543, passed 9-27-2016) Penalty, see § 53.99

§ 53.10 STORMWATER DETENTION REGULATIONS.
(A) Purpose. The purpose of these regulations is to diminish threats to public health, safety and welfare caused by runoff
of excessive stormwater from new development and redevelopment. This excessive stormwater could result in flooding of
damageable properties. The cause of increase in stormwater runoff quantity is the development and improvement of land
and, as such, this section regulates these activities to reduce adverse impacts.
(B) Applicability. No building permit shall be issued for the construction, reconstruction or structural alteration of a building and/or its parking area nor shall a certificate of occupancy be granted for a use nor shall a preliminary plat, final plat
or site plan be approved without conformity with the provisions of the stormwater detention regulations.
(C) Stormwater detention criteria.
(1) All stormwater storage areas must be designed to contain and safely pass stormwater runoff. When platting, the land extending to the centerline of any adjacent right-of-way shall be considered part of the development for purposes of
determining the runoff rate. Adequate spillway provisions shall be provided to transport peak runoff from a 100-year storm
assuming the outlet to be plugged. All stormwater facilities shall be designed in accordance with the design standards
established by the city engineer.
(2) For the release for drainage, the combined capacity of these storage areas shall be sufficient to contain the stormwater runoff from a 100-year storm from the development with a peak release rate less than or equal to the predevelopment release of five-year storm having a runoff co- efficient “c” of 0.15, when using the rational method for areas
under 20 acres or a curve number of 60 when using the S.C.S. TR-55.
(3) For the release for drainage, the combined capacity of these storage areas shall be sufficient to contain the stormwater runoff from a two-year storm from the development with a peak release rate less than or equal to the predevelopment release of two-year storm having a runoff co- efficient “c” of 0.15, when using the rational method for areas
under 20 acres or a curve number of 60 when using the S.C.S. TR-55.
(4) For the release for drainage, the combined capacity of these storage areas shall be sufficient to contain the stormwater runoff from a one-year storm from the development with a peak release rate less than or equal to the predevelopment release of one-year storm having a runoff co- efficient “c” of 0.15, when using the rational method for areas

under 20 acres or a curve number of 60 when using the S.C.S. TR-55.
(D) Exemptions. The following shall be exempt from these regulations.
(1) Any final plat approved within three years of October 28, 2008, and based upon a preliminary plat which was approved prior to the October 28, 2008, subject to the development not being required to provide detention facilities by any
other ordinances of the city.
(a) Any preliminary or final plat of a single-family or two-family development consisting of no more than two acres in
total area;
(b) A preliminary or final plat of single-family development consisting of lots, all of which are one acre or larger; and
(c) Any developed lot zoned commercial, industrial or multi-family which existed on October 28, 2008, where the sum
of modifications or additions:
1. Does not increase the stormwater runoff more than 20% for any storm, as determined, using the rational formula; and
2. Does not increase the impervious area more than 5,000 square feet.
(2) (a) Any developed lot zoned commercial, industrial or multi-family which existed on October 28, 2008, which does
not qualify for these exemptions shall provide stormwater detention sufficient to store the increased runoff resulting from the
alterations and additions; and
(b) Any single-family and two-family developed and undeveloped lots which existed on October 28, 2008.
(E) Stormwater detention plan review. Stormwater detention plans shall be submitted to the City Engineer for review.
(1) For new or expanding commercial, industrial and multi-family developments, a stormwater detention plan shall be
submitted as part of the site plan review.
(2) For new single-family and two-family residential developments, a stormwater detention plan shall be submitted as
part of the plat review.
(3) If no plat or site plan review is required, a stormwater detention plan must be approved by the City Engineer before
a building permit is issued.
(F) Stormwater detention plan requirements. Each applicant shall submit all calculations and other information as deemed necessary to demonstrate to the City Engineer the stormwater runoff rate and capacity of stormwater storage facilities. Required information may vary according to the size of development but shall include, but not be limited to, the
following:
(1) Map of the property and immediate vicinity showing elevation or contours (based on city datum);
(2) Mapping and description of existing and proposed drainage system features of the property and immediate vicinity;
(3) Physical features of the property and immediate vicinity; and
(4) If the development is to be staged, a plan of how the stormwater detention requirement will be met for each stage.
(G) Common detention facilities. The city may, in lieu of on-site detention facilities, accept the furnishing of off-site facilities which, when added to on-site detention facilities shall provide sufficient storage capacity to provide the stormwater
detention required to meet this regulation. Until the time as the permanent off-site stormwater detention facilities are

available, temporary on-site detention shall be provided. An acceptable legal contract between the developer and the off-site
land owner shall be approved by the City Council.

(H) Completion of facilities. The stormwater detention facilities shall be constructed and in use according to the following
criteria.

(1) For commercial, industrial and multi-family developments, the facilities shall be constructed concurrent with site grading. A certificate of completion shall be furnished by the developer's engineer certifying that they have been constructed
according to the approved plans before an occupancy permit is issued by the city.

(2) For single-family and two-family residential buildings, the developer's engineer shall certify that the structural improvements have been substantially complete and the detention facility rough graded before a building permit is issued. A
certificate of completion shall be furnished by the engineer certifying that the facilities into which the lot(s) drain have been
constructed according to the approved plans before an occupancy permit is issued by the city. These requirements may be
delayed for six months when the developer provides to the city a performance bond, by cash or certified check, guaranteeing construction of the detention facility in an amount equal to 150% of the estimated cost. The city shall assume
its maintenance responsibilities upon the receipt of the engineer's certificate of completion.

(I) Responsibilities.

(1) Industrial, commercial, condominiums and multi-family developments and single-family or two-family lots or development with individual detention facilities or single-family or two-family lots or development when the developer elects
that the maintenance of the stormwater detention facility shall be the responsibility of parties other than the city.

(a) The developer shall be responsible for providing a plan of ownership of the detention facilities involving a single owner, an association or another plan of ownership approved by the city.

(b) The owner shall be responsible to ensure the continuing functioning of the facility as originally designed and intended.

(c) The owner(s) shall be responsible for the continued functioning and adequate maintenance and repairs of the detention facility.

(d) The developer shall dedicate an easement to the city reserving the land for use as a stormwater detention facility providing the city with the right to inspect the facility and the necessary easements for ingress and egress.

(e) The Public Works Director, or his or her designee, shall provide inspection of the detention facilities at the schedule established by Council resolution. If the Director finds any maintenance work is necessary, the Director shall serve
a written order to the owner of the facilities specifying therein the work necessary to be done and providing for a reasonable
time for its completion. Any property owner to whom an order is directed shall have the right, within three days from service
of the order, to appeal to the City Administrator who shall review the order within five working days and file his or her
decision. Unless the order is revoked or modified, it shall remain in full force and be obeyed by the owner as directed within
the time established by the Director's written order or the time as modified by the City Administrator's decision. When an
owner to whom an order has been issued fails to comply within the time specified, the Director shall remedy the condition, or

contract with others for the purpose, and charge all costs, including administration, to whom the order is directed. If the cost
of remedying a condition is not paid within 30 days after the mailing of a statement therefore from the Public Works Director,
the cost shall be assessed against the property for collection in the same manner as a property tax. In the event the association fails or is unable to pay the costs associated with detention facility maintenance, these costs shall be assessed
against those users of the facility based upon their percentage of use.
(2) Single-family and two-family development with common detention facilities where maintenance or the stormwater
detention facility shall be the responsibility of the city.
(a) Common detention facilities, for the purpose of this section, shall be defined as a facility which serves two or more
lots which has outlet pipes and structures in conformance with city design and construction standards.
(b) The developer shall dedicate an easement to the city reserving the land for use as a stormwater detention facility; the right to enter upon the lands to inspect, reconstruct, regrade, maintain and repair the facility including the levee and
detention structures and the necessary easements for ingress and egress.
(c) The owner of the land upon which the detention easement is located shall mow and maintain the grass, trees and other vegetation, but shall not plant or allow to grow trees, shrubs or bushes on or within ten feet of the detention levee or
berm. The owner may place nonfloatable benches or other nonfloatable amenities within the easement area but same shall
be maintained by the owner.
(d) The city shall be responsible for the continued functioning maintenance and repair or the detention levee or berms, storm sewer, inlet structures or similar appurtenances.
(J) Appeal. The City Council may, in the resolution approving the preliminary plat of any subdivision and upon appeal of
the developer or the recommendation of the Director of Community Development, waive or change the requirements of this
chapter for a particular development whenever the developer demonstrates either:
(1) Due to the location of the property, strict compliance would provide no discernible benefit for reduction of flooding
on any plat adjacent or downstream property;
(2) Due to the nature of the property, strict compliance would create unusual hardship out of proportion to any foreseeable benefit and that the requested change or reduction in requirements will not increase the risk of flooding of any
building or the buildable portion of any lot on any adjacent or downstream property; or
(3) The developer, in lieu of a detention facility, provides stormwater management sufficient to achieve the purpose of
this chapter by keeping stormwater runoff from the property in accordance with division (C) above.
(Ord. 2390, passed 10-28-2008; Ord. 2543, passed 9-27-2016) Penalty, see § 53.99

Iowa SUDAS Chapter 2

Figure 2B-2.01: Climatic Sectional Codes for Iowa

1 - Northwest
2 - North Central
3 - Northeast

4 - West Central
5 - Central
6 - East Central

7 - Southwest
8 - South Central
9 - Southeast

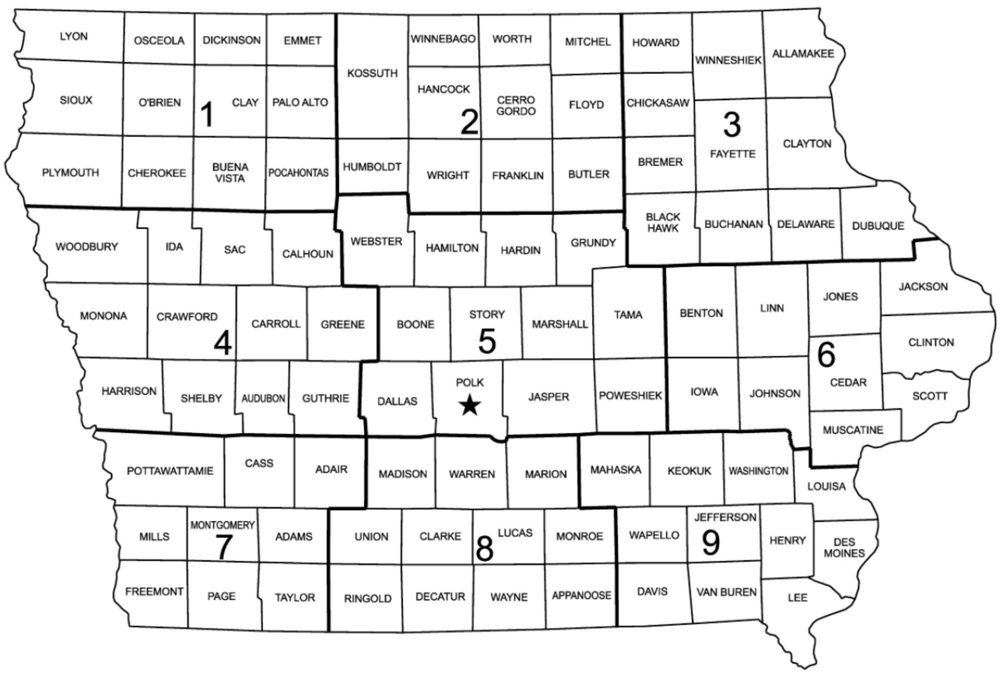
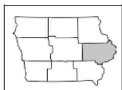


Table 2B-2.07: Section 6 - East Central Iowa

Rainfall Depth and Intensity for Various Return Periods

	Return Period															
	1 year		***2 year***		***5 year***		***10 year***		***25 year***		***50 year***		***100 year***		***500 year***	
Duration	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***
5 min	0.38	4.56	0.44	5.30	0.54	6.56	0.63	7.65	0.76	9.18	0.86	10.3	0.97	11.6	1.23	14.8
10 min	0.55	3.33	0.64	3.87	0.8	4.8	0.93	5.58	1.11	6.70	1.26	7.60	1.42	8.54	1.80	10.8
15 min	0.67	2.70	0.78	3.14	0.97	3.88	1.13	4.53	1.36	5.45	1.54	6.18	1.73	6.94	2.20	8.81
30 min	0.95	1.90	1.11	2.22	1.38	2.76	1.61	3.22	1.94	3.88	2.20	4.40	2.47	4.95	3.14	6.29
1 hr	1.23	1.23	1.44	1.44	1.80	1.80	2.11	2.11	2.58	2.58	2.96	2.96	3.36	3.36	4.37	4.37
2 hr	1.51	0.75	1.77	0.88	2.22	1.11	2.62	1.31	3.22	1.61	3.71	1.85	4.24	2.12	5.60	2.80
3 hr	1.68	0.56	1.96	0.65	2.47	0.82	2.93	0.97	3.63	1.21	4.22	1.40	4.85	1.61	6.50	2.16
6 hr	1.97	0.32	2.30	0.38	2.89	0.48	3.45	0.57	4.3	0.71	5.02	0.83	5.8	0.96	7.87	1.31
12 hr	2.28	0.19	2.65	0.22	3.31	0.27	3.93	0.32	4.88	0.40	5.68	0.47	6.56	0.54	8.87	0.73
24 hr	2.60	0.10	3.01	0.12	3.75	0.15	4.42	0.18	5.44	0.22	6.29	0.26	7.22	0.30	9.64	0.40
48 hr	2.98	0.06	3.43	0.07	4.22	0.08	4.93	0.10	6.01	0.12	6.90	0.14	7.86	0.16	10.3	0.21
3 day	3.28	0.04	3.72	0.05	4.51	0.06	5.24	0.07	6.32	0.08	7.22	0.10	8.19	0.11	10.7	0.14
4 day	3.53	0.03	3.98	0.04	4.78	0.04	5.50	0.05	6.58	0.06	7.49	0.07	8.46	0.08	10.9	0.11
7 day	4.17	0.02	4.67	0.02	5.53	0.03	6.29	0.03	7.39	0.04	8.30	0.04	9.25	0.05	11.6	0.06
10 day	4.75	0.01	5.30	0.02	6.24	0.02	7.04	0.02	8.20	0.03	9.12	0.03	10.0	0.04	12.4	0.05

D = Total depth of rainfall for given storm duration (inches)
I = Rainfall intensity for given storm duration (inches/hour)

Table 2B-4.01: Runoff Coefficients for the Rational Method

Cover Type and Hydrologic Condition		**Runoff Coefficients for Hydrologic Soil Group** *A*			*B*			*C*			*D*		
	Recurrence Interval	*5*	*10*	*100*	*5*	*10*	*100*	*5*	*10*	*100*	*5*	*10*	*100*
Open Space (lawns, parks, golf courses, cemeteries, etc.)													
Poor condition (grass cover < 50%)		.25	.30	.50	.45	.55	.65	.65	.70	.80	.70	.75	.85
Fair condition (grass cover 50% to 75%)		.10	.10	.15	.25	.30	.50	.45	.55	.65	.60	.65	.75
Good condition (grass cover >75%)		.05	.05	.10	.15	.20	.35	.35	.40	.55	.50	.55	.65
Impervious Areas													
Parking lots, roofs, driveways, etc. (excluding ROW)		.95	.95	.98	.95	.95	.98	.95	.95	.98	.95	.95	.98
Streets and roads:													
Paved; curbs & storm sewers (excluding ROW)		.95	.95	.98	.95	.95	.98	.95	.95	.98	.95	.95	.98
Paved; open ditches (including ROW)		---	---	---	.70	.75	.85	.80	.85	.90	.80	.85	.90
Gravel (including ROW)		---	---	---	.60	.65	.75	.70	.75	.85	.75	.80	.85
Dirt (including ROW)		---	---	---	.55	.60	.70	.65	.70	.80	.70	.75	.85
Urban Districts (excluding ROW)													
Commercial and business (85% impervious)		---	---	---	---	---	---	.85	.85	.90	.90	.90	.95
Industrial (72% impervious)		---	---	---	---	---	---	.80	.80	.85	.80	.85	.90
Residential Districts by Average Lot Size (excluding ROW)[1]													
1/8 acre (36% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/4 acre (36% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/3 acre (33% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/2 acre (20% impervious)		---	---	---	---	---	---	.45	.50	.65	.60	.65	.70
1 acre (11% impervious)		---	---	---	---	---	---	.40	.45	.60	.55	.60	.65
2 acres (11% impervious)		---	---	---	---	---	---	.40	.45	.60	.55	.60	.65
Newly Graded Areas (pervious areas only, no vegetation)													
Agricultural and Undeveloped													
Meadow - protected from grazing (pre-settlement)		.10	.10	.25	.10	.15	.30	.30	.35	.55	.45	.50	.65
Straight Row Crops													
Straight Row (SR)	*Poor Condition*	.33	.39	.55	.52	.58	.71	.70	.74	.84	.78	.81	.89
	Good Condition	.24	.30	.46	.45	.51	.66	.62	.67	.78	.73	.76	.86
SR + Crop Residue (CR)	*Poor Condition*	.31	.37	.54	.50	.56	.70	.67	.72	.82	.75	.79	.87
	Good Condition	.19	.25	.41	.38	.45	.61	.55	.60	.73	.62	.67	.78
Contoured (C)............................	*Poor Condition*	.29	.35	.52	.47	.53	.70	.60	.65	.77	.70	.74	.84
	Good Condition	.21	.26	.43	.38	.45	.61	.55	.60	.73	.65	.69	.80
C+CR...	*Poor Condition*	.27	.33	.50	.45	.51	.66	.57	.63	.75	.67	.72	.82
	Good Condition	.19	.25	.41	.36	.43	.59	.52	.58	.71	.62	.67	.78
Contoured & Terraced (C&T)	*Poor Condition*	.22	.28	.45	.36	.43	.59	.50	.56	.70	.55	.60	.73
	Good Condition	.16	.22	.38	.31	.37	.54	.45	.51	.66	.52	.58	.71
C&T + CR	*Poor Condition*	.13	.19	.35	.31	.37	.54	.45	.51	.66	.52	.58	.71
	Good Condition	.10	.16	.32	.27	.33	.50	.43	.49	.65	.50	.56	.70

[1] The average percent impervious area shown was used to develop composite coefficients.

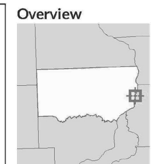
Note: Rational coefficients were derived from SCS CN method

SAWMILL EVENT CENTER

2232 Grant Street
Clinton, IA

Matt Parbs, Executive Director Sawmill Museum
director@thesawmillmuseum.org

Overview



Legend
- Railroad Centerlin
- Road Centerlines
- Road Right of Way
- Railroad Right of Way
- Creeks
- Rivers and Lakes
- Original River Bed

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
103 S CAPITOL ST
IOWA CITY, IOWA 52242
PHONE: 319.335.5647
FAX: 319.335.5660
EMAIL: civil-hawks@uiowa.edu

PROJECT:	CEE:4850:MEC
DATE :	4/9/2021
DRAWN BY:	EV
REVISION:	

EDUCATIONAL - NOT FOR CONSTRUCTION

SAWMILL EVENT CENTER

2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
COVER SHEET

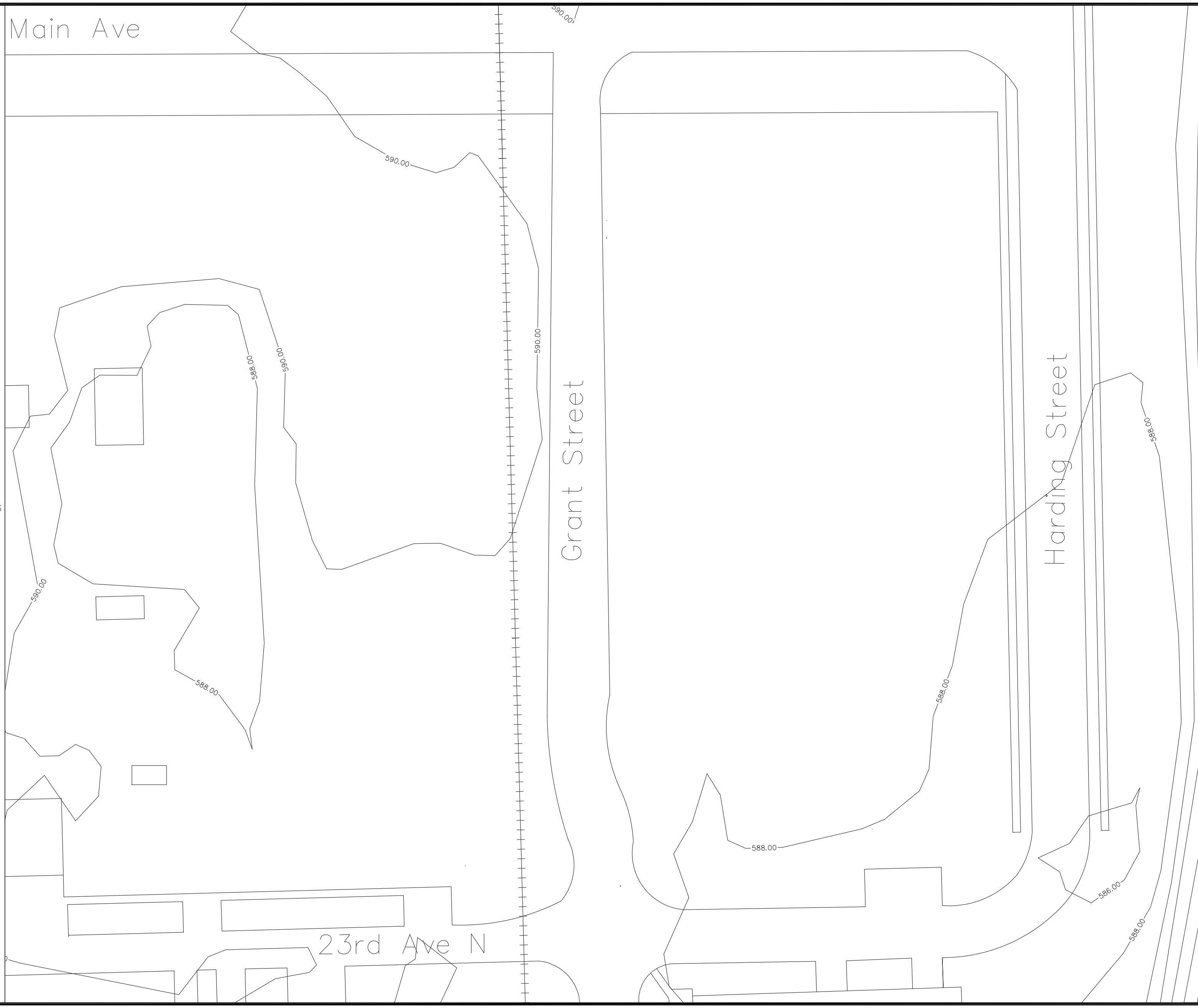
SHEET NO.
00.00

STORM SEWER

1. NO EXISTING STORM SEWERS EXIST ON SITE
2. THE SITE CONTRACTOR TO SETUP AGREEMENT WITH IAW FOR PLANS

SANITARY SEWER

1. NO EXISTING SANITARY SEWER EXISTS ON SITE
2. THE SITE CONTRACTOR TO SETUP AGREEMENT WITH IAW FOR PLANS



PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: JM
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
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IOWA CITY, IOWA 52242
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EMAIL: civil-hawks@uiowa.edu

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SAWMILL EVENT CENTER

2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
EXISTING SITE
1/28" = 1'-0"

SHEET NO.
G0.01

PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: JM
REVISION:

THE UNIVERSITY OF IOWA
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4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
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IOWA CIVIL & ENVIRONMENTAL ENGINEERING

EDUCATIONAL - NOT FOR CONSTRUCTION

SAWMILL EVENT CENTER

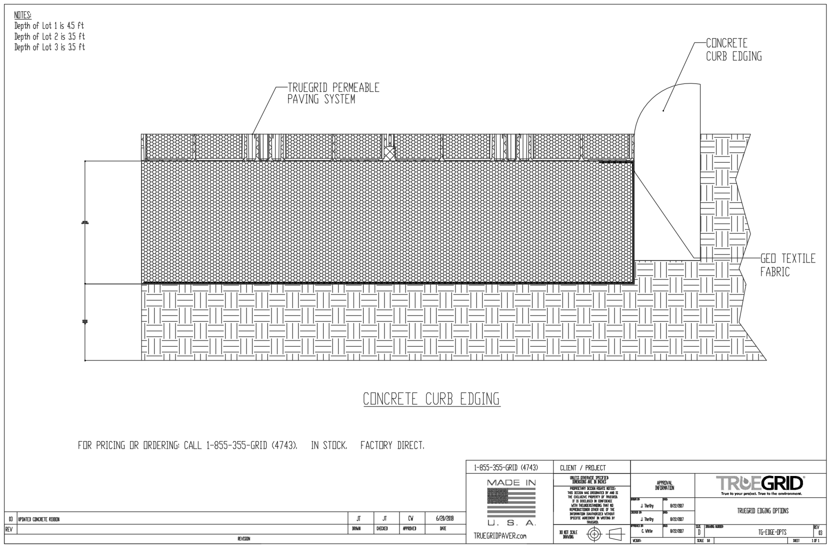
2232 GRANT STREET
CLINTON, IOWA 52732

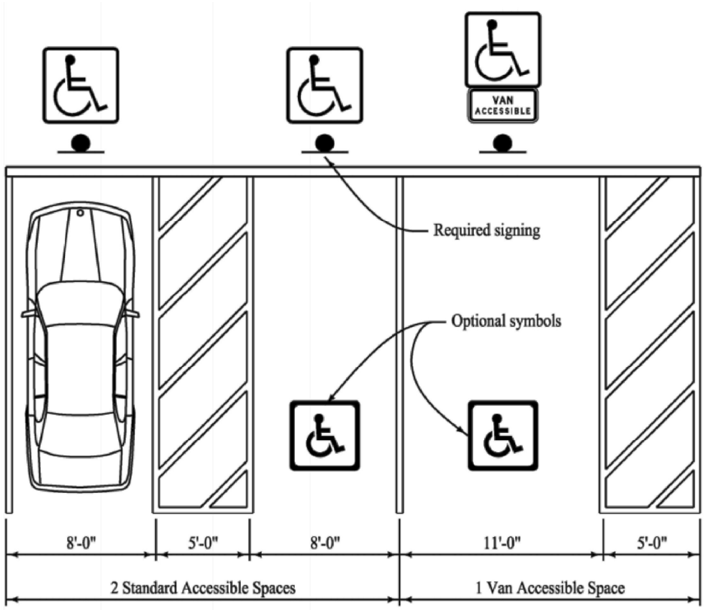
SHEET NAME

SITE PLAN
1" = 30'-0"

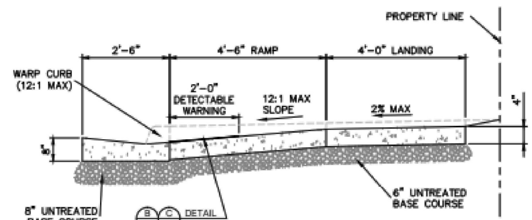
SHEET NO.

C0.01

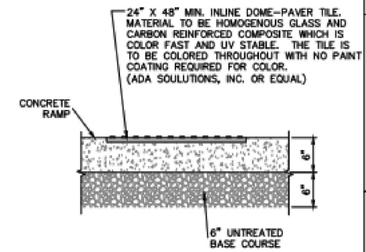




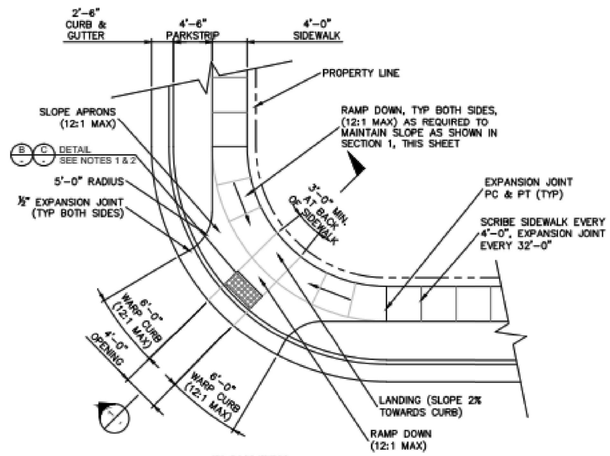
STANDARD ADA ACESSIBLE PARKING STALL



SECTION 1

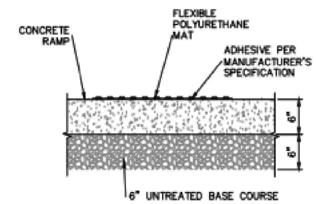


INLINE DOME-PAVER TILE



PLAN VIEW

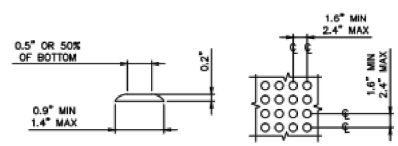
DETAIL A



FLEXIBLE POLYURETHANE MAT

(FOR RETROFIT OF EXISTING RAMPS ONLY)

DETECTABLE WARNING SYSTEM DETAIL C



RAISED TRUNCATED DOMES

DETAIL B

NOTES:
1. LOCATE RAISED TRUNCATED DOMES SO THAT THE EDGE NEAREST THE CURB LINE IS WITHIN 6 TO 8 INCHES FROM THE CURB LINE. PROVIDE 2-FOOT OF TRUNCATED DOME PATTERN AT THE LOWER END OF ALL CURB RAMPS EXTENDING THE FULL WIDTH OF THE CURB RAMP.
2. CHANGES IN ELEVATION GREATER THAN ¼" SHALL BE BEVELED WITH A SLOPE NO GREATER THAN 2:1
3. THE DETECTABLE WARNING SURFACE DOMES SHALL BE ORIENTED SUCH THAT THE ROWS ARE PARALLEL WITH THE DIRECTION OF PEDESTRIAN TRAVEL TO THE RAMP ON THE OPPOSITE SIDE OF THE STREET.
4. THE STANDARD COLOR FOR THE DETECTABLE WARNING SHALL BE RED BRICK. WHEN THE EXISTING SIDEWALK COLOR IS NOT STANDARD CONCRETE, THE COLOR OF THE DETECTABLE WARNING SURFACE SHALL BE DETERMINED BY CLINTON CITY.
5. WHEN A DETECTABLE WARNING SURFACE DOME IS CUT, THE REMAINING PORTION OF THE DOME SHALL BE BEVELED TO A MAXIMUM SLOPE OF 1:2.
6. INSTALLATION SHALL BE DONE IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATION.

CURB RAMP DETAIL

SCALE N.T.S.

PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: JM
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
103 S CAPITOL ST
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SAWMILL EVENT CENTER

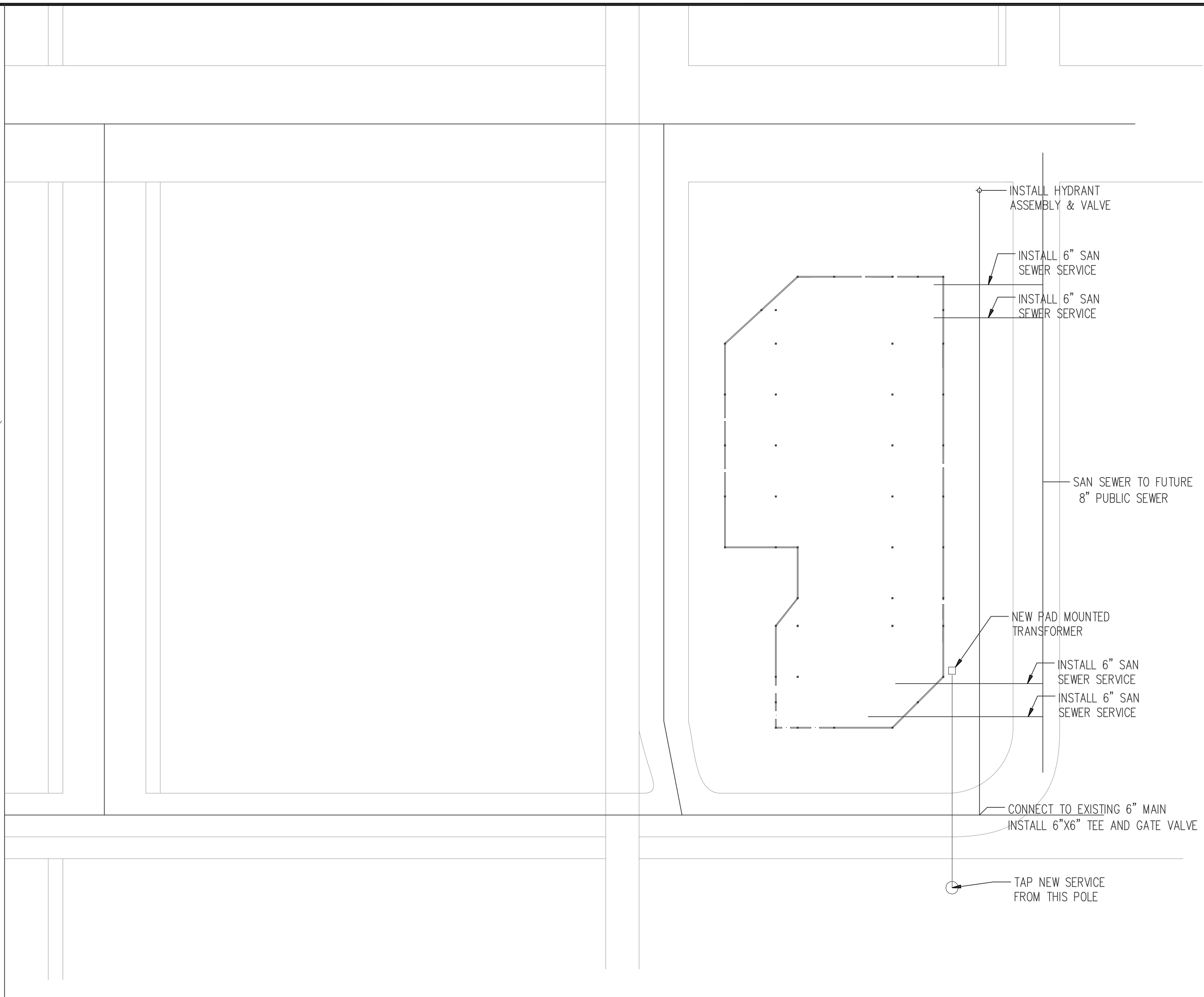
2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
PAVEMENT DETAILS

SHEET NO.
C0.02

WATER SERVICE

1. CONTRACTORS TO ARRANGE AND PAY FOR ANY REQUIRED TAP TO MAINS
2. CONTRACTOR SHALL COMPLY WITH ALL CITY CODES AND ORDINANCES
3. PLUMBING CONTRACTOR SHALL INSTALL REQUIRED FITTINGS AND VALVES FOR DOMESTIC SERVICE



PROJECT:	CEE:4850:MEC
DATE :	4/9/2021
DRAWN BY:	EV & LL
REVISION:	

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SAWMILL EVENT CENTER

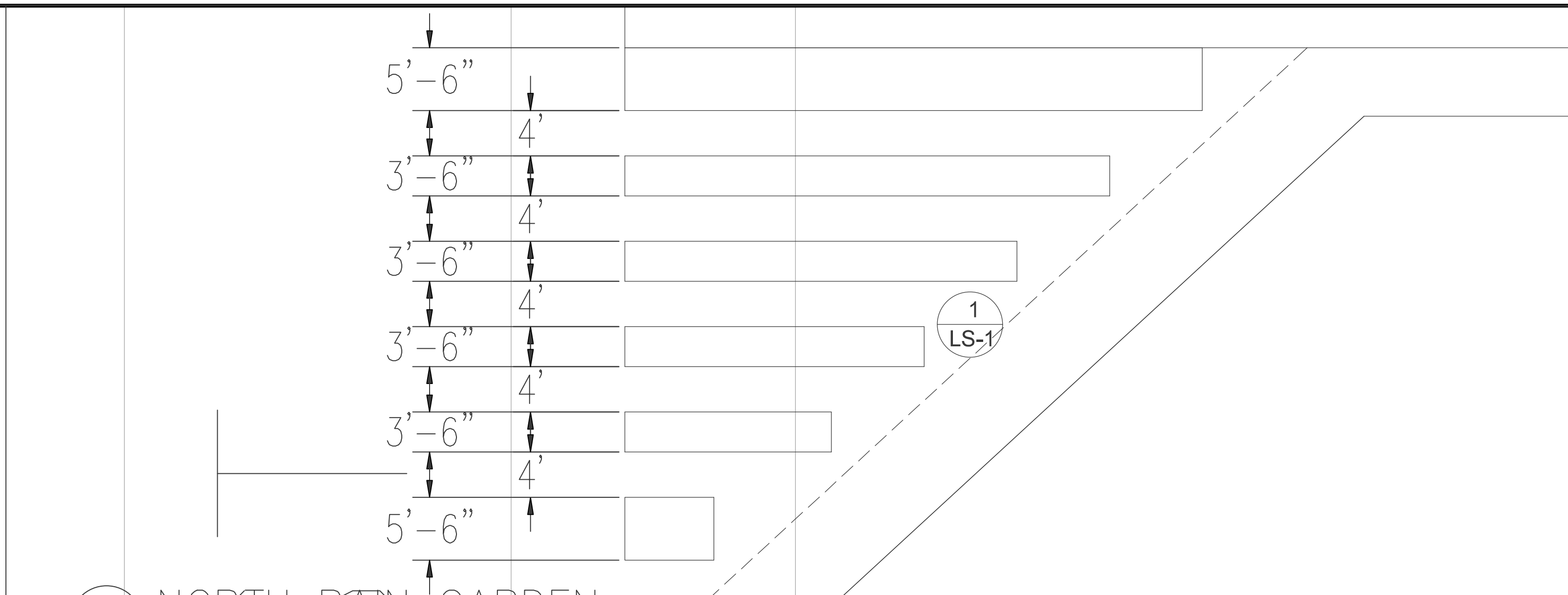
2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
UTILITY PLAN

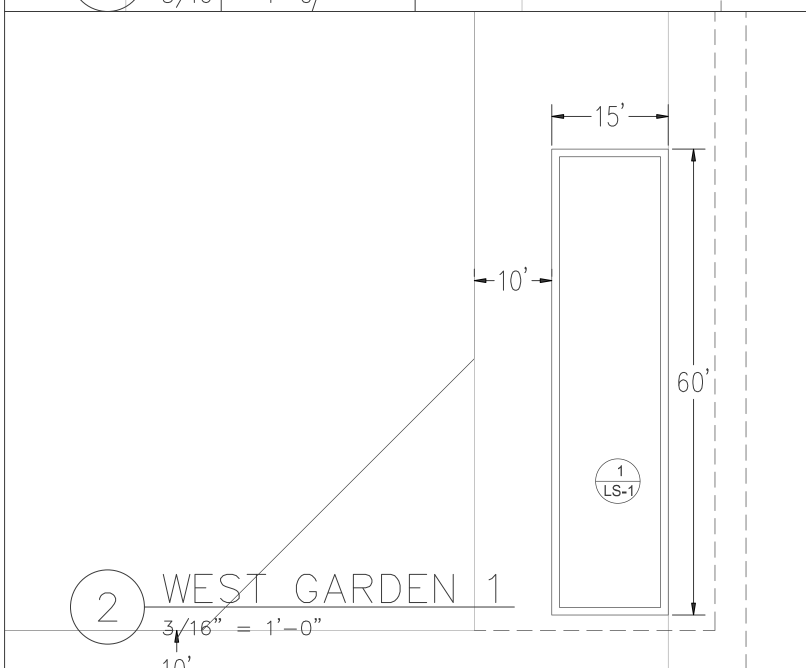
SHEET NO.
C0.03

LANDSCAPE NOTES

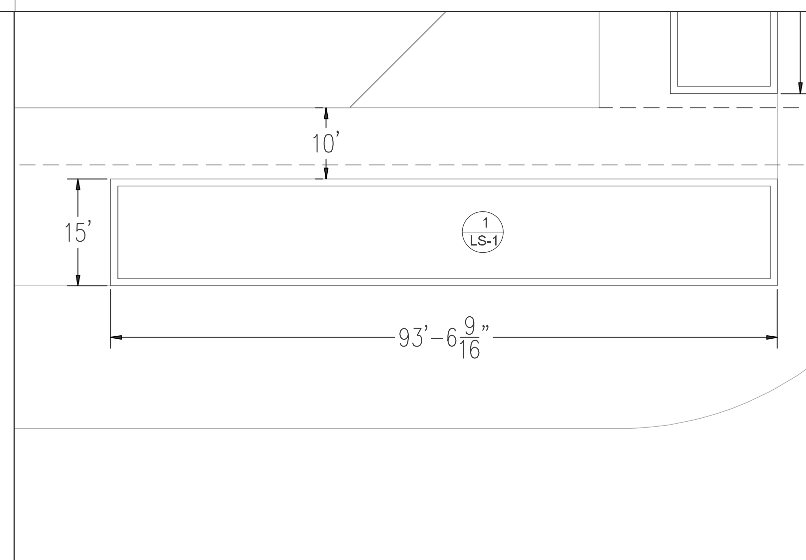
1. ALL PLANT MATERIAL INSTALLATION, INCLUDING SEED AND SOD TO BE COMPLETED PRIOR TO OPENING
2. THE CONTRACTOR SHALL VERIFY LOCATION AND PROTECT ALL UTILITIES AND STRUCTURES. DAMAGE TO UTILITIES AND STRUCTURES SHALL BE REPAIRED BY THE CONTRACTOR TO SATISFACTION OF THE OWNER
3. LOCATION AND CHOICE OF NATIVE PLANTS WITH GUIDANCE OF IOWA RAIN GARDEN DESIGN



1 NORTH RAIN GARDEN
3/16" = 1'–0"



2 WEST GARDEN 1
3/16" = 1'–0"



3 WEST GARDEN 2
3/16" = 1'–0"

PROJECT: CEE:4850:MEC
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DRAWN BY: EV
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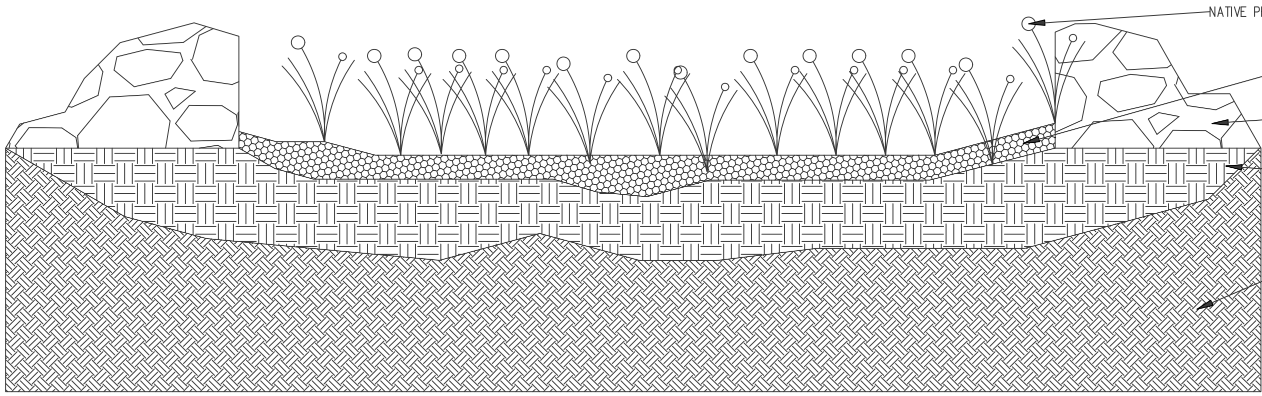
SHEET NAME
LANDSCAPE PLAN

SHEET NO.
C0.04



PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: EV
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SAWMILL EVENT CENTER

2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
LANDSCAPE DETAIL

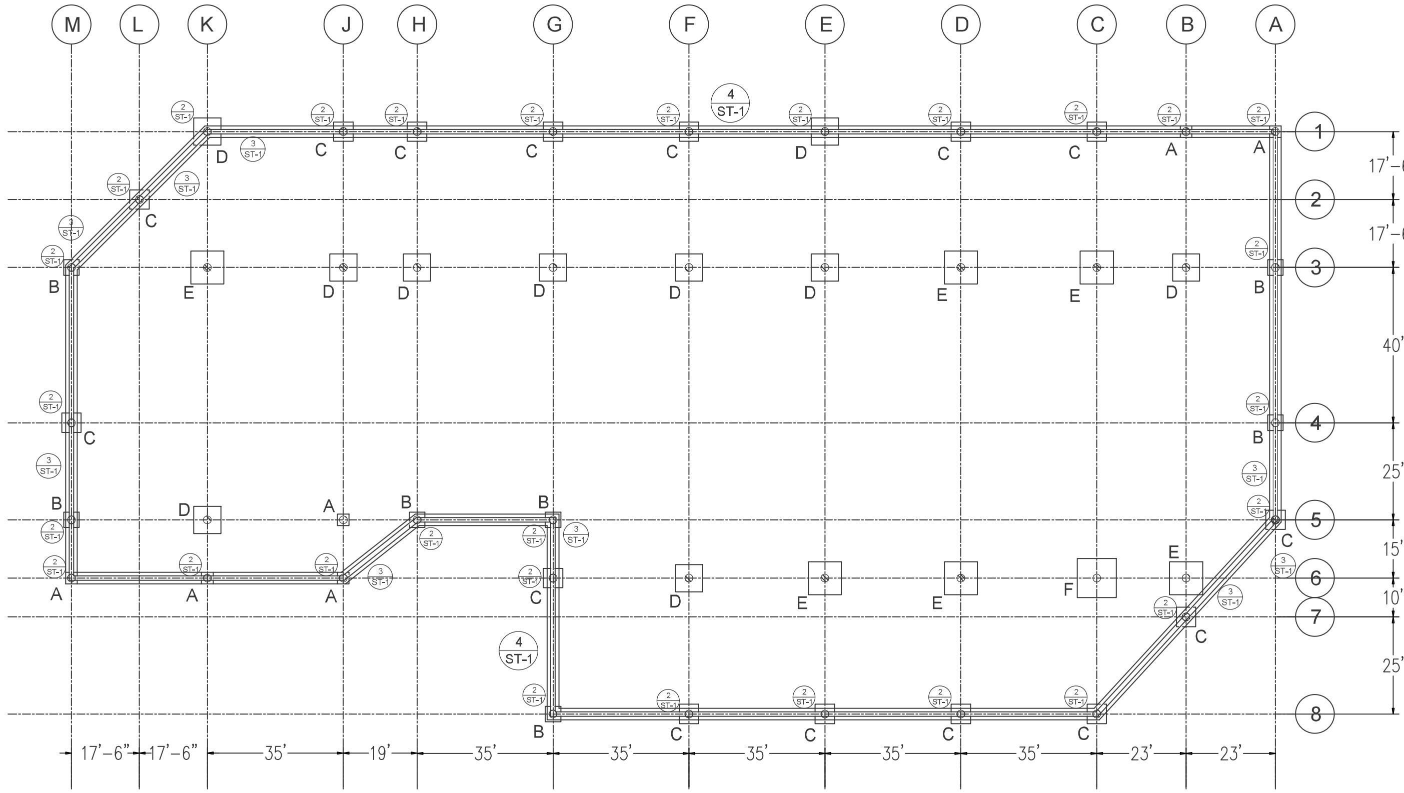
SHEET NO.
C0.05

Footing Schedule

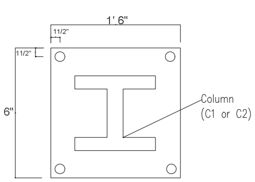
Size	Note	Count
3 x 3	A	6
4 x 4	B	7
5 x 5	C	15
7 x 7	D	10
8.5 x 8.5	E	6
10 x 10	F	1
24" diameter pier		45

Reinforcement

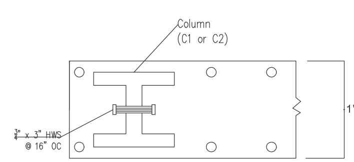
Note	Top	Bottom
A	#5 12" OC	#6 12" OC
B	#5 12" OC	#7 12" OC
C	#5 12" OC	#7 12" OC
D	#5 12" OC	#8 12" OC
E	#5 12" OC	#8 12" OC
F	#5 12" OC	#8 12" OC



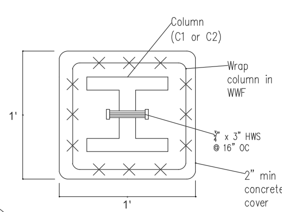
1 Foundation Layout Plan
Scale 1/16"-1'-0"



2 ST-1 Base Plate Detail



3 ST-1 Embedded Column Detail



4 ST-1 Concrete Cover Detail

PROJECT: CEE:4850:MEC
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SAWMILL EVENT CENTER
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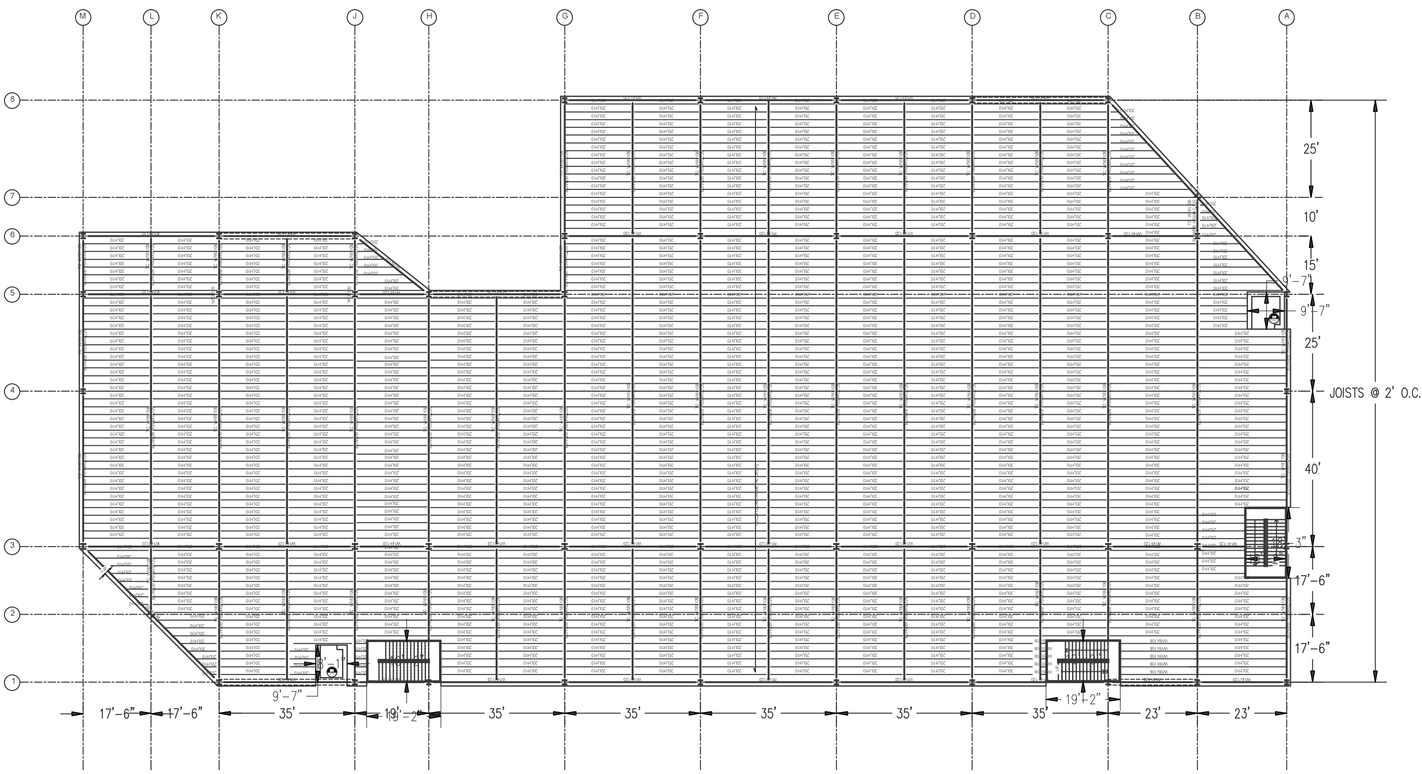
CLINTON, IOWA 52732

SHEET NAME
FOUNDATION PLAN

SHEET NO.
S0.01

FRAMING DETAIL NOTES:

1. W-SHAPES ARE A992 AND HAVE A YIELD STRENGTH OF 50 KSI
2. HSS-SHAPES ARE A500 GR. C AND HAVE A YIELD STRENGTH OF 46 KSI
3. TRUSS MEMBERS ARE CONNECTED WITH PIN CONNECTIONS
4. ELEVATOR AND STAIR SPECS. CAN BE FOUND ON DETAIL SHEET
5. JOISTS ARE CONNECTED DIRECTLY TO ELEVATOR SHAFT CONCRETE WALL



1 Second Floor Framing Plan

Scale 1/16"-1'-0"

N

PROJECT: CEE:4850:MEC

DATE : 4/9/2021

DRAWN BY: LL

REVISION:

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CIVIL AND ENVIRONMENTAL ENGINEERING

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SAWMILL EVENT CENTER

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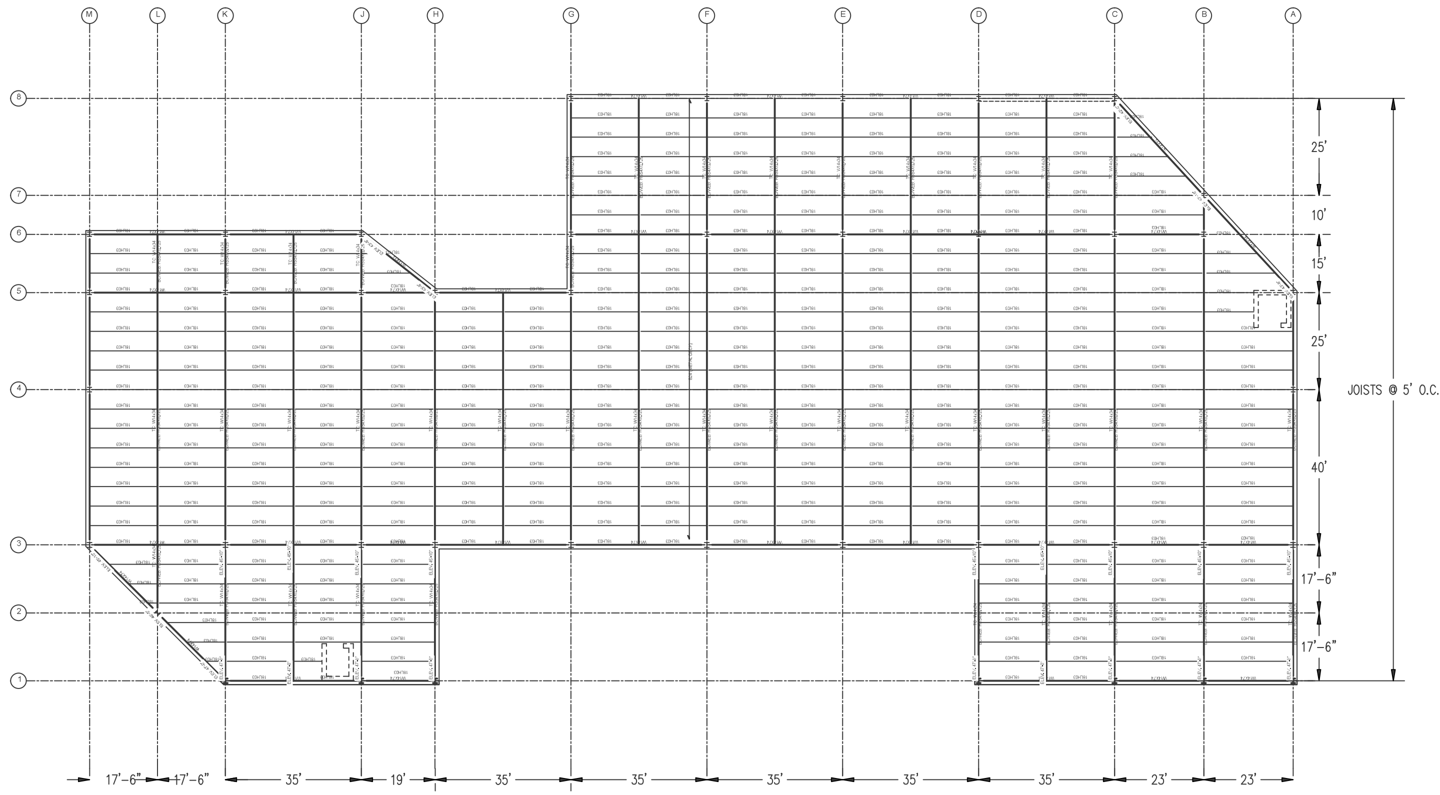
CLINTON, IOWA 52732

SHEET NAME

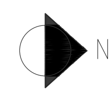
SECOND FLOOR FRAMING PLAN

SHEET NO.

S0.02



1 Roof Framing Plan
Scale 1/16"-1'-0"



PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: LL
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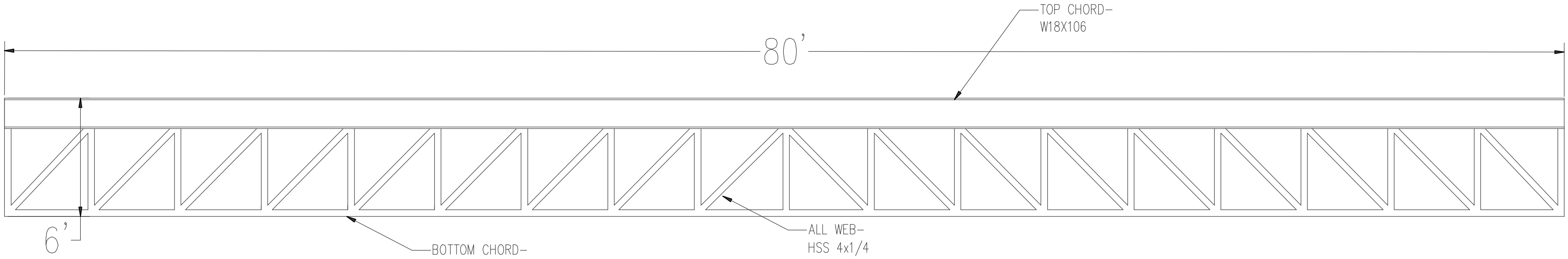
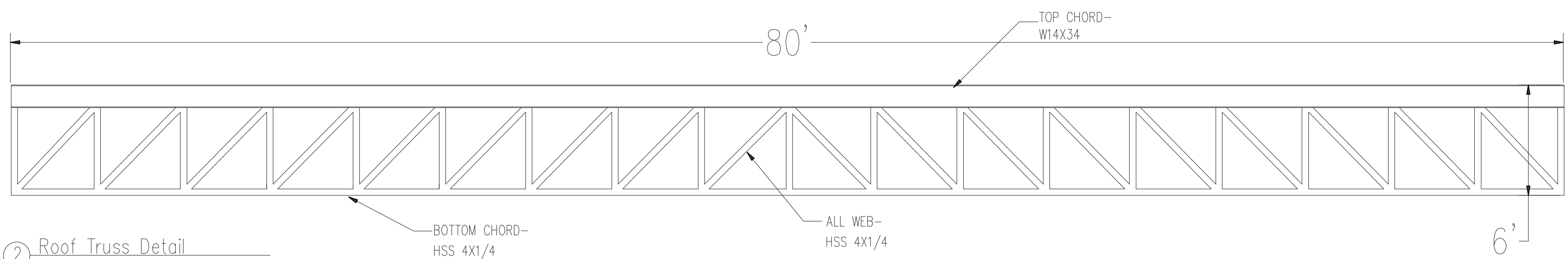
SHEET NAME
ROOF FRAMING PLAN

SHEET NO.
S0.03



1 Second Floor Truss Detail
Scale 3/8"-1'-0"



2 Roof Truss Detail
Scale 3/8"-1'-0"

Scale 3/8"-1'-0"

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DRAWN BY: LL
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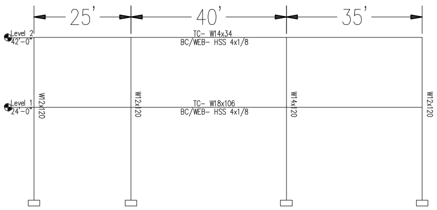
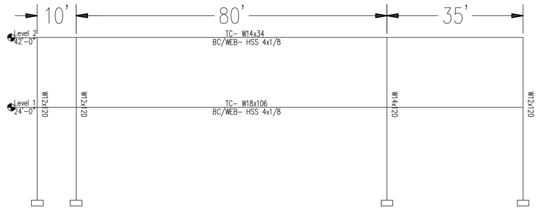
SHEET NAME
FRAMING DETAILS

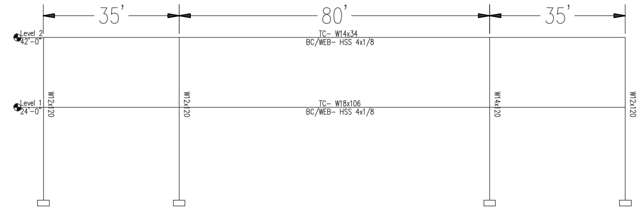
SHEET NO.
S0.04



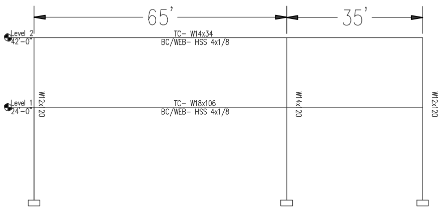
1 Moment Frame at Grid "A"
Scale 1/16"-1'-0"



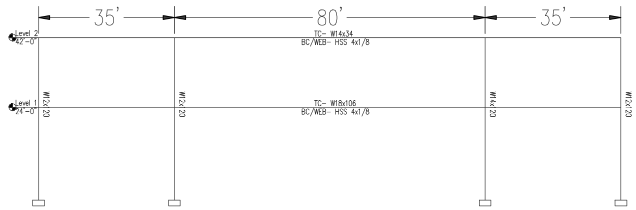
2 Moment Frame at Grid "B"
Scale 1/16"-1'-0"



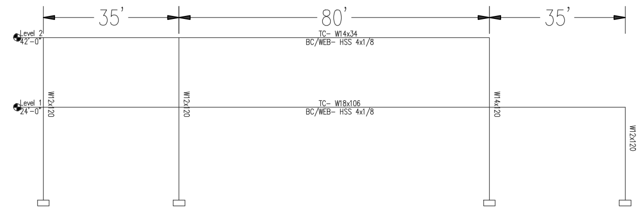
3 Moment Frame at Grid "C"
Scale 1/16"-1'-0"



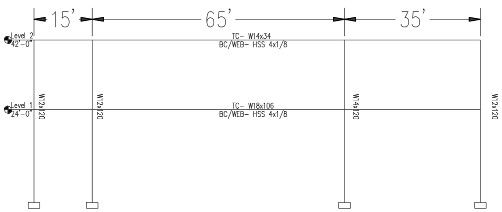
4 Moment Frame at Grid "H"
Scale 1/16"-1'-0"



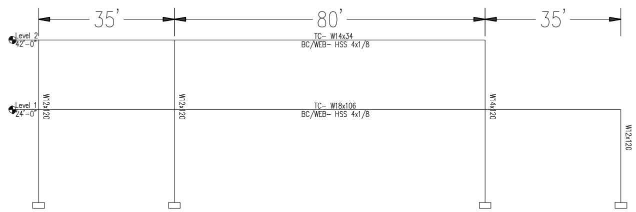
5 Moment Frame at Grid "D"
Scale 1/16"-1'-0"



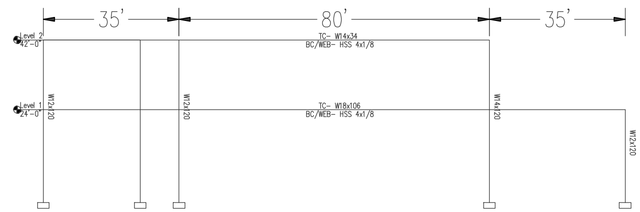
6 Moment Frame at Grid "E"
Scale 1/16"-1'-0"



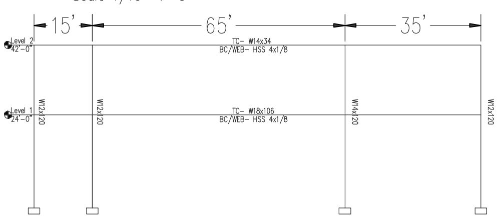
7 Moment Frame at Grid "I"
Scale 1/16"-1'-0"



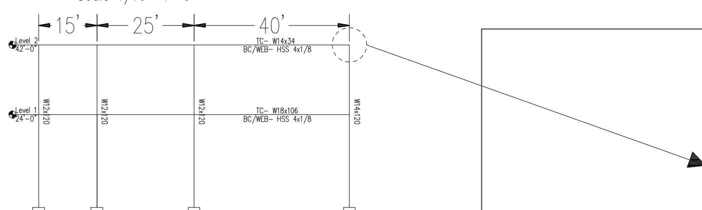
8 Moment Frame at Grid "F"
Scale 1/16"-1'-0"



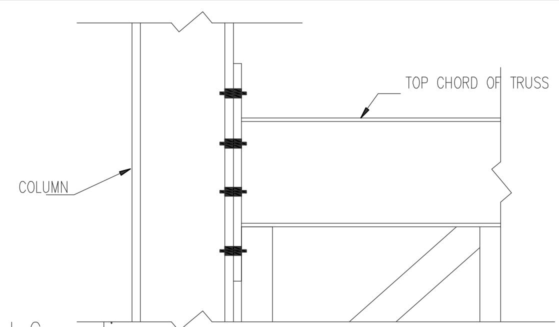
9 Moment Frame at Grid "G"
Scale 1/16"-1'-0"



10 Moment Frame at Grid "J"
Scale 1/16"-1'-0"



11 Moment Frame at Grid "K"
Scale 1/16"-1'-0"



12 Typical Moment Connection
Scale 1 1/2"-1'-0"

PROJECT: CEE: 4850: MEC
DATE : 4/9/2021
DRAWN BY: LL
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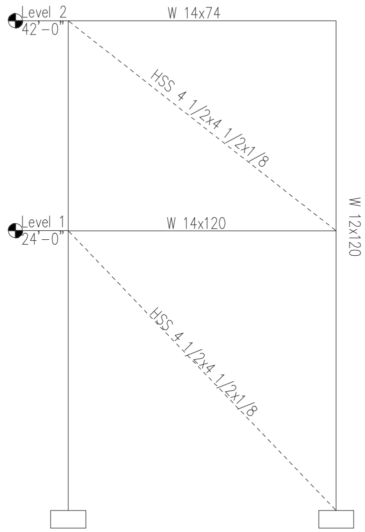
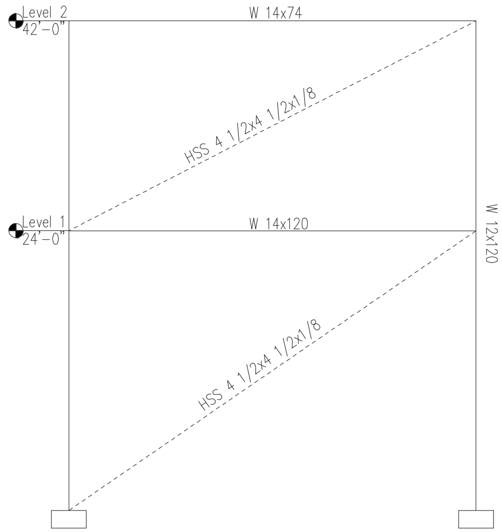
SHEET NAME
MOMENT FRAMING PLAN

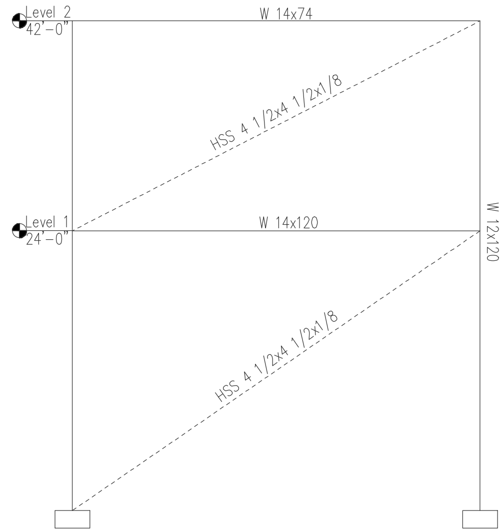
SHEET NO.
S0.05



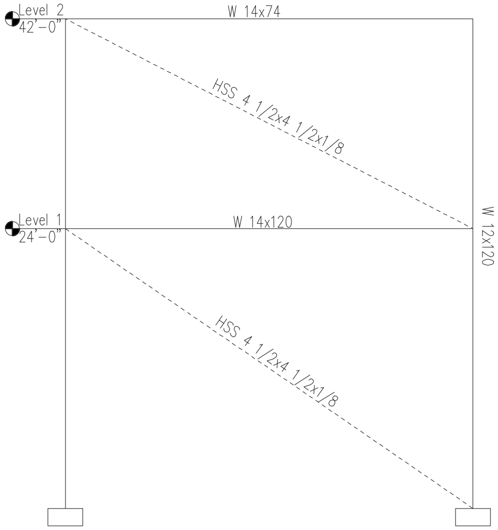
1 Diagonal Bracing at Bay "B-1"
Scale 3/16"-1'-0"



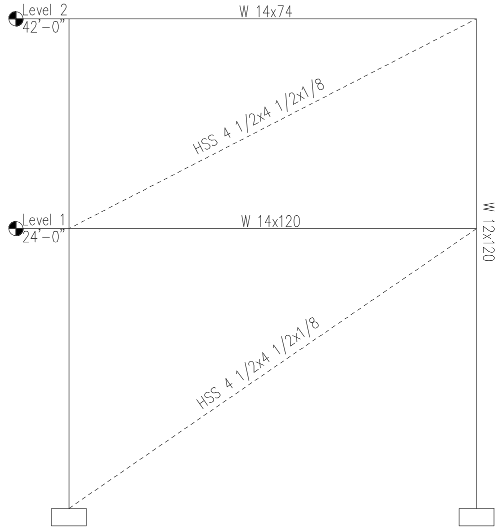
2 Diagonal Bracing at Bay "C-8"
Scale 3/16"-1'-0"



3 Diagonal Bracing at Bay "I-6"
Scale 3/16"-1'-0"



4 Diagonal Bracing at Bay "I-1"
Scale 3/16"-1'-0"



5 Diagonal Bracing at Bay "G-5"
Scale 3/16"-1'-0"

PROJECT: CEE:4850:MEC
DATE : 4/9/2021
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SAWMILL EVENT CENTER

2232 GRANT STREET
CLINTON, IOWA 52732

SHEET NAME
BRACING DETAILS

SHEET NO.
S0.06

COLUMN SCHEDULE

Roof	47' - 0"
Level 2	42' - 0"
Level 1	24' - 0"
Ground	0' - 0"

Column Locations	A-1	A-3	A-4	A-5	B-1	B-3	B-6	B-7	C-1	C-3	C-6	C-8
Size	W12X120	W14X120	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120

Column Locations	D-1	D-3	D-6	D-8	E-1	E-3	E-6	E-8	F-1	F-3	F-6
Size	W12X120	W14X120	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120	W12X120	W14X120	W12X120

COLUMN SCHEDULE (CONT'D)

Roof	47' - 0"
Level 2	42' - 0"
Level 1	24' - 0"
Ground	0' - 0"

Column Locations	F-8	G-1	G-3	G-5	G-6	G-8	H-1	H-3	H-5	I-1	I-3
Size	W12X120	W12X120	W14X120	W12X120	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120	W14X120

Column Locations	I-5	I-6	J-1	J-3	J-5	J-6	K-2	L-3	L-4	L-5	L-6
Size	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120	W12X120	W14X120	W12X120	W12X120	W12X120

PROJECT: CEE:4850:MEC
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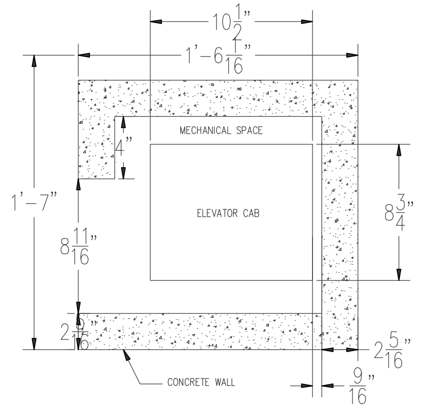
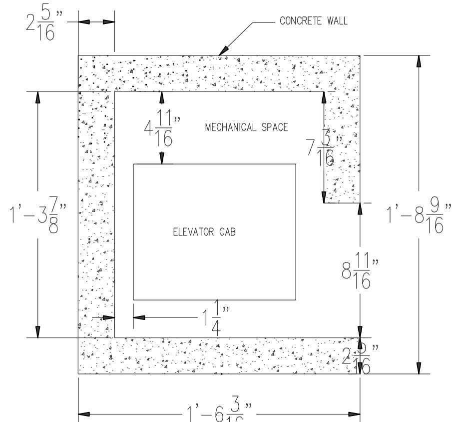
SHEET NAME
COLUMN SCHEDULE

SHEET NO.
S0.07



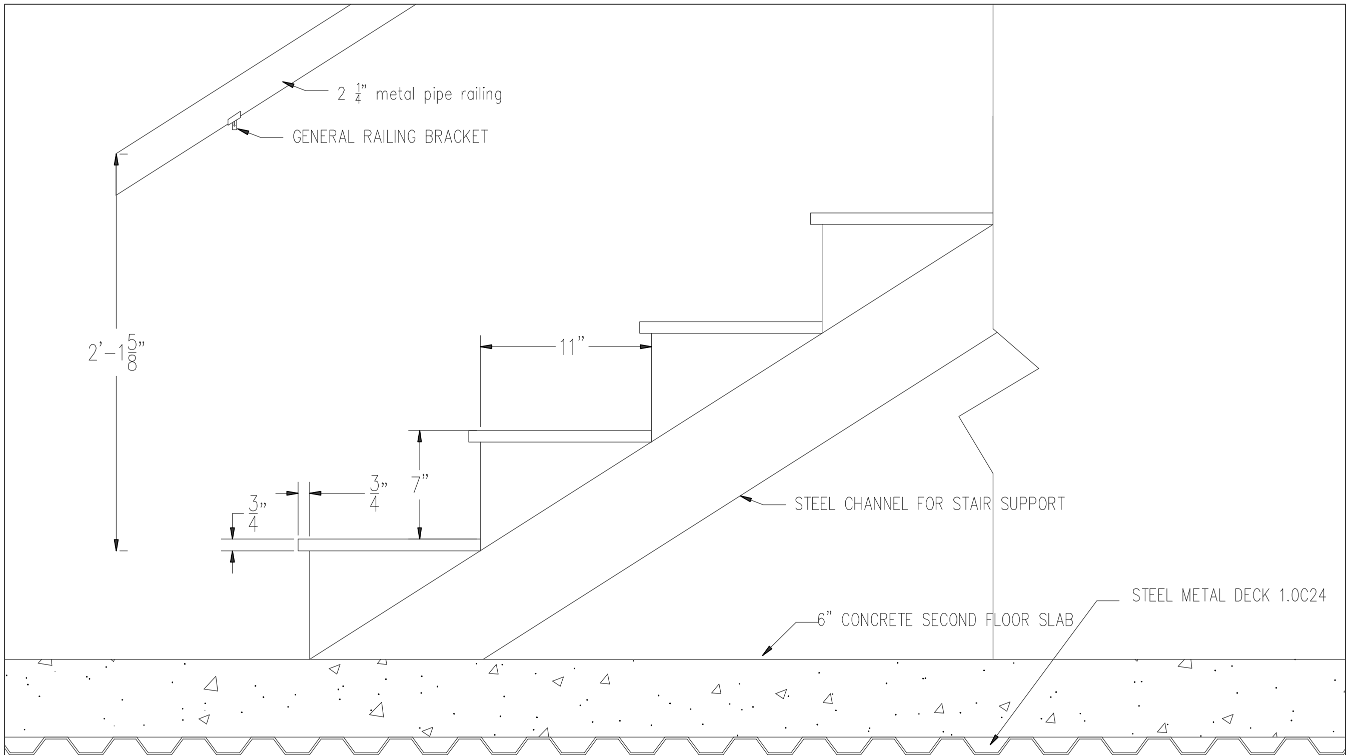
1 Elevator A Layout
Scale 1/2"-1'-0"



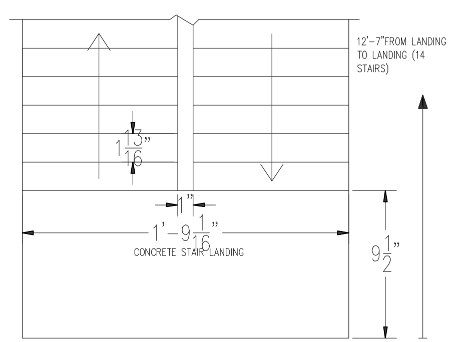
2 Elevator B Layout
Scale 1/2"-1'-0"

ELEVATOR NOTES:

1. ORION MODEL 4854 ELEVATOR SERVES TWO FLOORS, WITH OVERHEAD SPACE AND PIT ACCOUNTED FOR IN DESIGN
2. FOR FOUNDATION SPECS OF EACH ELEVATOR, SEE FOUNDATION DETAILS



3 Stair Side View
Scale 3"-1'-0"



4 Stairwell Top View
Scale 1/2"-1'-0"

STAIR NOTES:

1. STAIRS FOLLOW GUIDELINES IN ACCORDANCE TO THE INTERNATIONAL BUILDING CODE.
2. THREE STAIRWELLS PROVIDED FOR ADEQUATE FIRE SAFETY
3. EACH STAIRWELL HAS THREE FLIGHTS AND TWO LANDINGS TO SPAN 24' TO THE SECOND LEVEL, EACH FLIGHT HAS 13 STAIRS.

PROJECT:	CEE:4850:MEC
DATE :	4/9/2021
DRAWN BY:	LL
REVISION:	

THE UNIVERSITY OF IOWA
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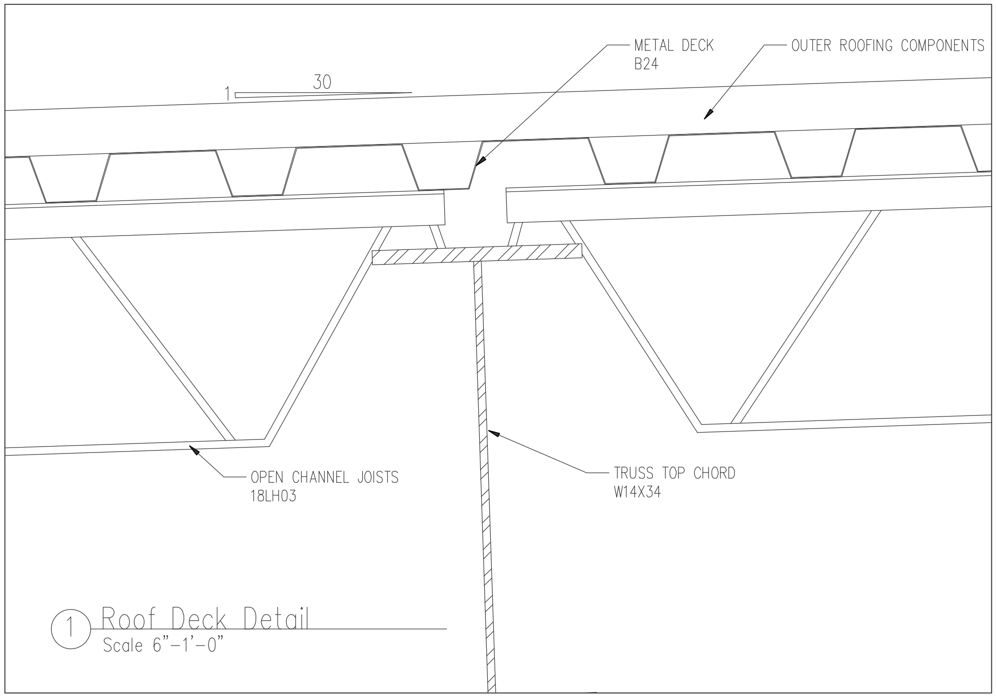
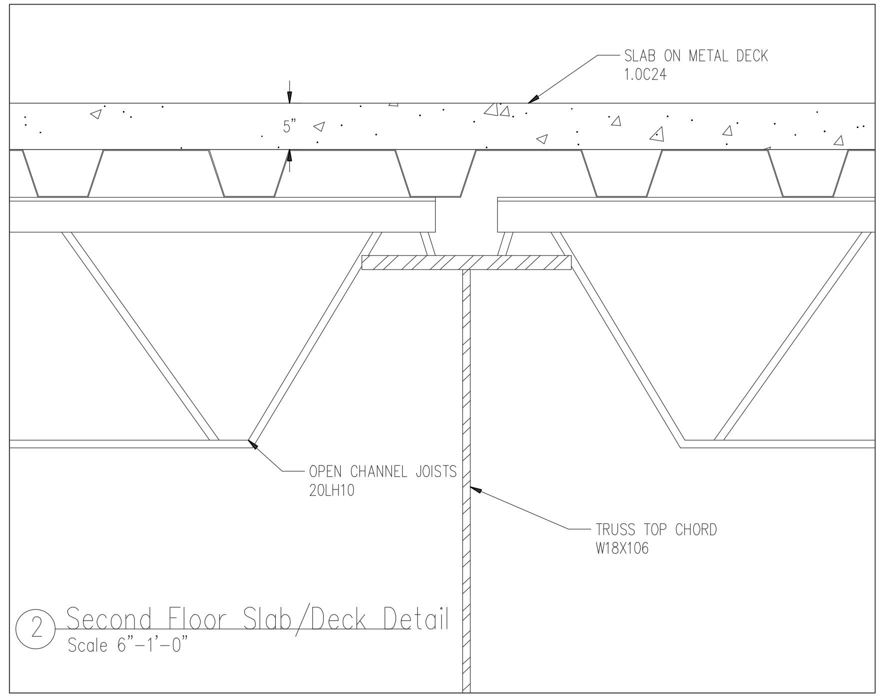
SHEET NAME
STAIR & ELEVATOR DETAILS

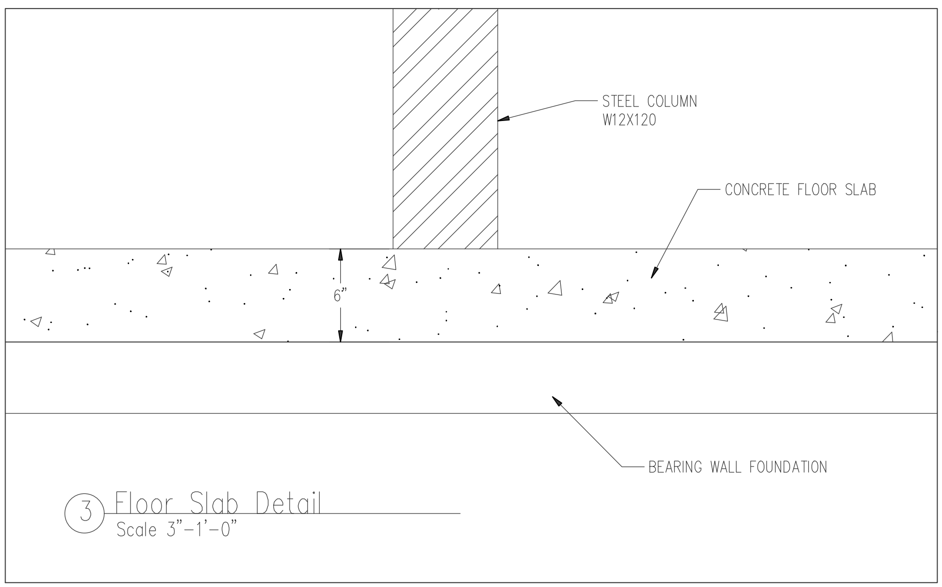
SHEET NO.
S0.08



1 Roof Deck Detail
Scale 6"-1'-0"



2 Second Floor Slab/Deck Detail
Scale 6"-1'-0"



3 Floor Slab Detail
Scale 3"-1'-0"

PROJECT:	CEE: 4850: MEC
DATE :	4/9/2021
DRAWN BY:	LL
REVISION:	

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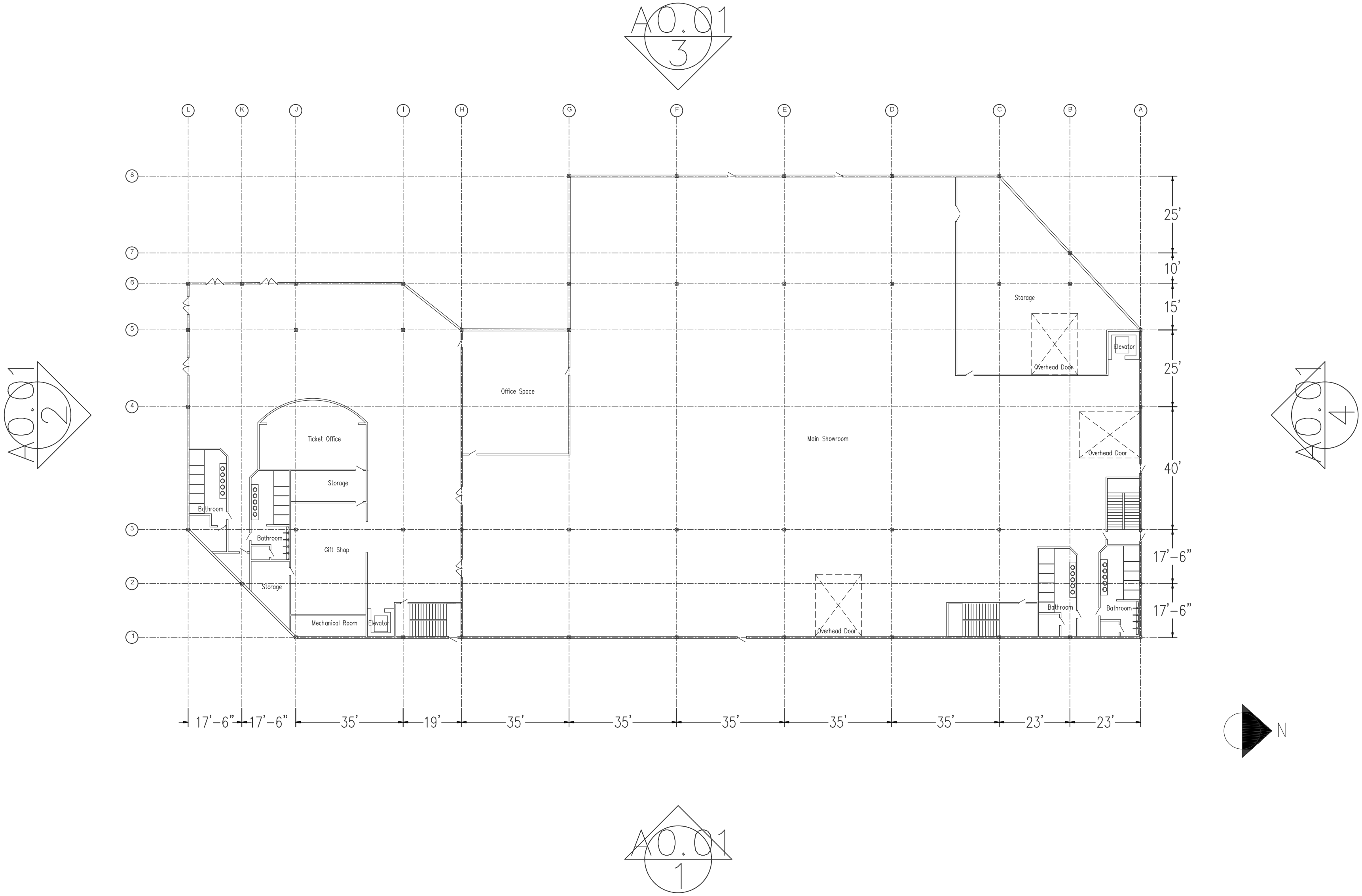
SHEET NAME
SLAB DETAIL

SHEET NO.
S0.09



PROJECT: CEE:4850:MEC

DATE : 4/9/2021

DRAWN BY: LL

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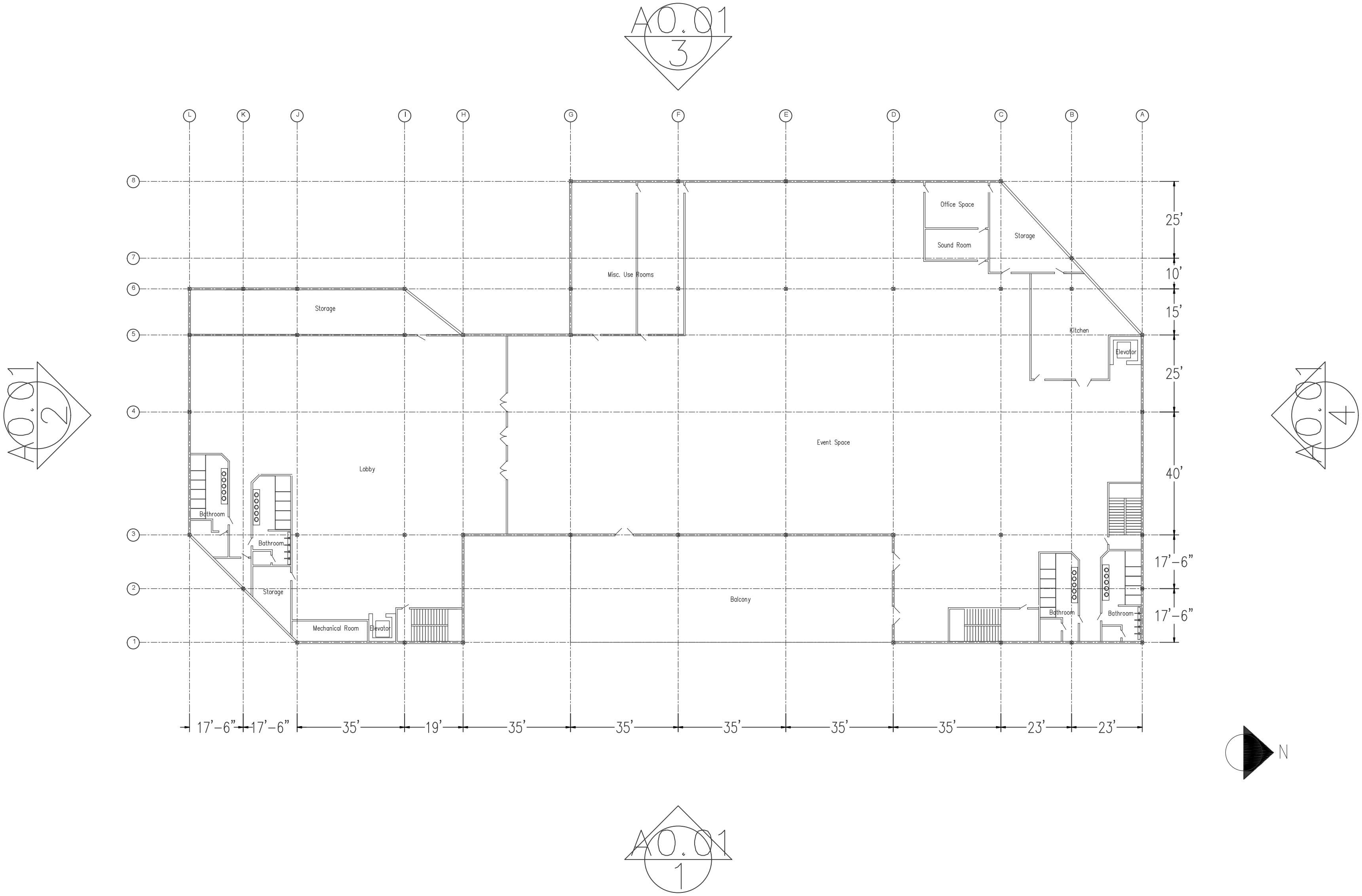
SHEET NAME

FIRST FLOOR PLAN

SHEET NO.

A0.01



PROJECT: CEE:4850:MEC
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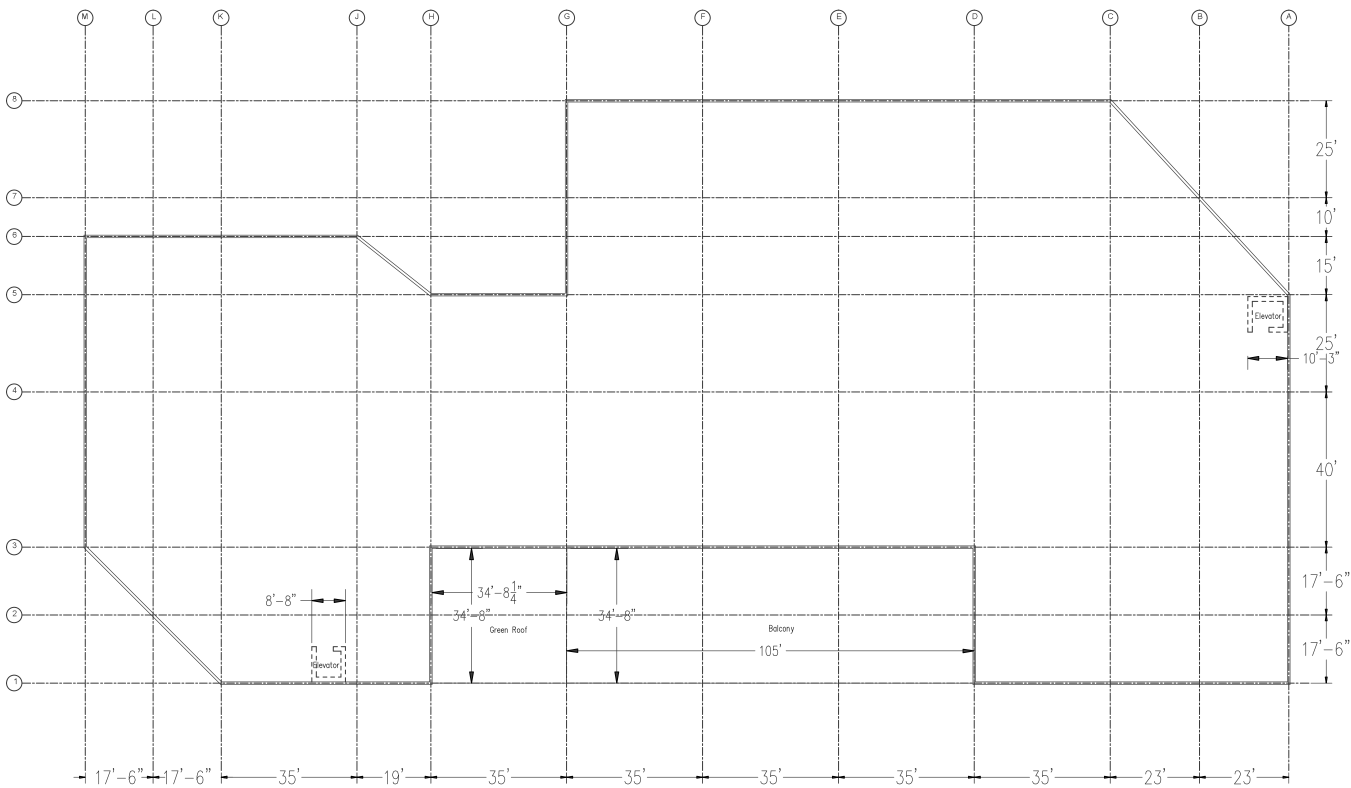
SHEET NAME

SECOND FLOOR PLAN

SHEET NO.

A0.02



1 Roof Plan
Scale 1/16"-1'-0"

N

PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: LL
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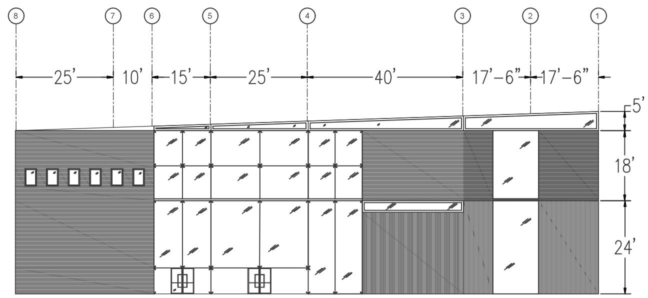
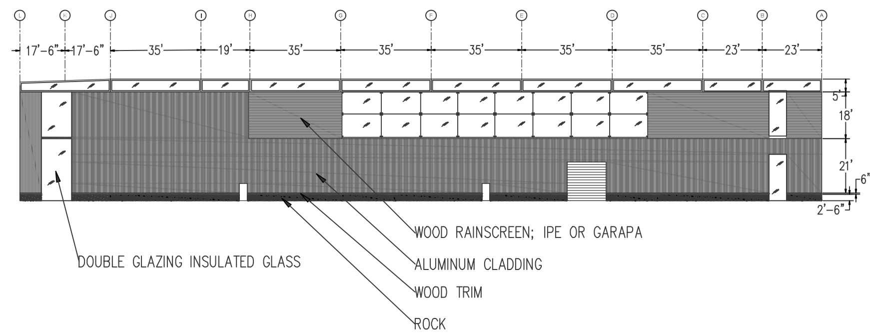
SHEET NAME
ROOF PLAN

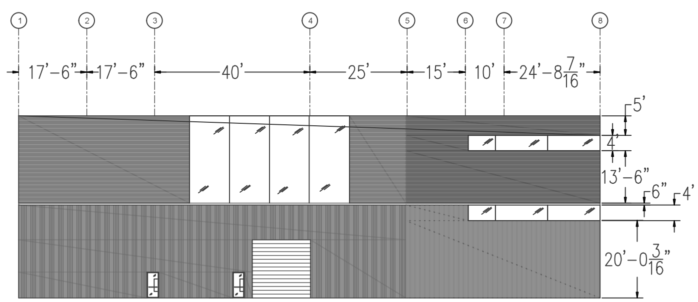
SHEET NO.
A0.03



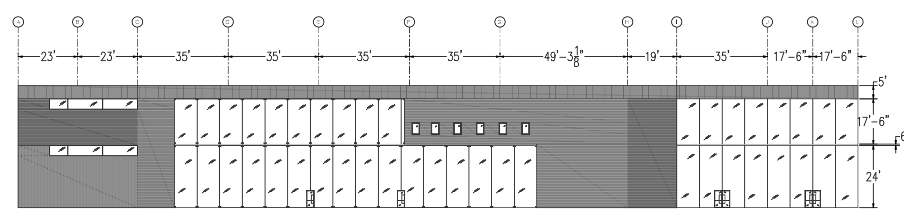
2 FRONT ELEVATION
1/16" = 1'-0"



1 EAST ELEVATION
3/32" = 1'-0"



4 REAR ELEVATION
1/16" = 1'-0"



3 WEST ELEVATION
3/32" = 1'-0"

PROJECT: CEE:4850:MEC
DATE : 4/9/2021
DRAWN BY: EV
REVISION:

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SHEET NAME
BUILDING ELEVATIONS

SHEET NO.
A0.04