The University of Iowa
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FINAL DELIVERABLE

Title	Clinton - Downtown Commercial Building Rehabilitation (241-247 5th Ave South)
Completed By	Alecxander LaBelle, Mason White, Yunlong Li
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UI Department	Department of Civil & Environmental Engineering
Course Name	CEE:4850:0001 Project Design & Management
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Community Partners	Downtown Clinton Alliance

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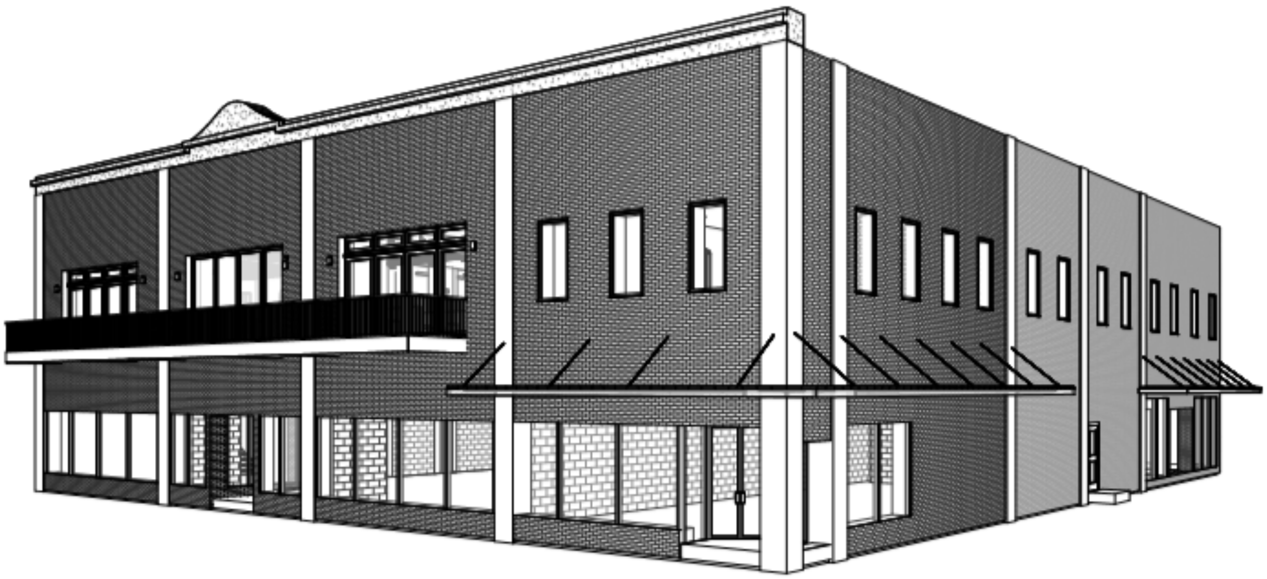
COMMERCIAL BUILDING REHABILITATION I FINAL DESIGN REPORT

SUBMITTAL DATE: 12/13/2019



Project Location: 241-247 5 Ave. South, Clinton, IA 52732

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UNIVERSITY OF IOWA

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Project Design & Management | CEE:4850:0001

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SECTION I: EXECUTIVE SUMMARY

This design report is submitted on behalf of YAM Engineering as part of our contracted services for the Commercial Building Rehabilitation I project at 241-247 5 Ave S, Clinton, IA. Design services started on September 13, 2019 and finished on December 13, 2019.

Design Services:

The design services provided by our team included delivery of fully functionable designs with Architectural, Structural and MEP-FP elements that will bring the building and its existing elevator system in accordance with today's legal standards to achieve commercial occupancy. The designs included third-floor renovations, passenger elevator replacement, building façade restoration and foundation repair. Alternate approaches were considered during the conceptual design phase and reviewed with the Clients on Friday, October 4, 2019 and Tuesday, October 15, 2019. Across all disciplines, alternative materials, building systems, and equipment were considered throughout design development to provide the most cost economical designs.

A contract drawing set has been prepared to a Level of Development (LOD) 200 per the U.S. GSA. Also included as part of our deliverables are the following: a construction cost estimate, a project poster (ANSI D size), a project presentation to the Client, a listing of entities/agencies permits that control design and/or construction of the project, and 3D renderings produced in Revit of the exterior and third floor designs.

Project Schedule: After award of RFP-#04a, the original work plan and Gantt Chart submitted with our proposal was expanded upon to include team project milestones set in place for performance review, and to track design work activities at a more detailed scale. The activity dates of the original Gantt Chart were still valid. Attached in Appendix D is our modified Gantt Chart to account for critical components of MEP-FP systems, structural systems and a conceptual design project phase so that during, alternatives could be adequately explored with the Client.

Constraints, Challenges and Societal Impacts:

Design Constraints: Constraints set on the project's design included: 1. Reciprocation of the building's historical 1900's design for the exterior; 2. Limited structural designs due to in adequate existing conditions found; 3. No modifications to the existing roof truss system; and 4. Reuse of the existing elevator shaft.

Design Challenges: Challenges encountered by our team during the project included: reducing blind spots in the retail area due to all existing interior walls being load-bearing; coordination; 2. Coordination of exposed ductwork with 27" mains and fire protection piping, designing MEP systems to be compatible for expansion; inclusion; 3. Inclusion of energy efficient design elements due to the building's exterior walls and lack daylight exposure from the North and West; a; and 4. cost economical balcony floor framing design that accounts for moisture protection.

Societal Impacts on the Community from the Project: For the City of Clinton and downtown business commerce, the project will pose economic benefits by supporting the recent growth of newly established businesses in the downtown area. The façade repair requires removing the billboard and reconstruction of 19-century fashion, the outside of the building will restore a consistent fashion with surrounding buildings. This will help promote the historic aspect of 5th Avenue South overall, which was the intention of our Clients. For the community body, the renovation will offer social improvements by offering an enjoyable place of gathering for multiple purposes with the combination of a mercantile store and coffee shop.

Final Design Details:

Café Area & Workroom | Sheets A1.1-A1.3, A2.0, A3.1

The care area is located at the Northeastern portion of the third floor with a total square footage of 1694 SF with a design occupancy of 50 people per day.

The café workroom is located at the Southeast side of the third floor, with immediate access to the café counter area through double flush doors. The kitchen includes all access and equipment.

Bathrooms | Sheets A1.1-A1.3, A2.1

Two single-person bathrooms are located at the Southeast corner of the third floor. The design includes all fixtures and bathroom accessories to follow local plumbing codes and specified at ADA compliant mounting elevations.

Structural | Sheets S-1, S-2, S-2.1, S-2.2, S-3, S-4, S-5, S-6

The proposed interior third floor framing was designed for live loads of 150 PSF at the kitchen, 100 PSF in the café, and 75 PSF in all retail areas, per ASCE 7-16. The areas that this affects included the area of floor framing that is expressing severe deflection, as well as the kitchen and café. These member types were chosen to be 16" spaced Laminated Veneer Lumber.

The balcony framing was designed for the same live load as the café (100 PSF), based on a typical restaurant/cafe from ASCE 7-16. This balcony was designed as a typical cantilever balcony with the interior balcony framing spanning twice the length of the exterior span (6'). The spacing for balcony floor framing is also designed at 16" O.C. The engineered lumber types chosen were Laminated Veneer Lumber and Parallel-Strand Lumber. Dimensional lumber members are also included for short spans. Exterior spans of the balcony floor framing are Laminated Veneer Lumber and are to be encased in aluminum for thermal/moisture protection.

Based on the increased loads from balcony framing on the north exterior wall, the existing lintel above the storefront windows will need to be field verified to be HSS9x9x5/8 or stronger. This will need to be resting on a 12"x6"x1/2" bearing plate to resist reaction forces at the columns.

The existing roof trusses were analyzed in order to find their structural capacity based on existing loads and new loads being applied from mechanical units and lowered ceilings. The existing roof trusses pass all bending, tension, and compression requirements.

Mechanical | Sheets M0.1, M0.3, M1.0-M1.2, M2.0, M3.1

There are two HVAC systems for the third floor: an air-cooled air conditioning unit with a combination evaporator coil and gas heat furnace located in the utility room, and a makeup air unit serving the workroom independently. Exhaust systems are designed in the workroom and restrooms. All exposed ductwork is to be double-lined and galvanized with 1" mineral wool lining. All concealed ductwork above false ceilings are permitted to be standard duct with 1" duct wrap insulation.

Electrical | Sheets E0.1, E1.0-E1.3, E2.0, E3.0-E3.1, E4.0

In the retail area, the existing light fixture housings are designed to be reused with LED retrofit kits. All lighting is controlled by occupancy sensors with timers and can be overridden by key-light switches. In the bathrooms, the occupancy sensors also control the exhaust fans serving the bathroom through means of a 120V one-line relay. There are three panelboards serving the third floor: lighting panelboard, equipment panelboard and power panelboard. All panels are 3-phase 208V power fed. The total added electrical demand from the third-floor is (75) kVA.

The fire alarm notification system design includes a conventional fire alarm panel with 4 zones (1 spare zone). Duct detectors are designed in the supply and return mains of the ACCU-1/FU-1 system per 2018 IMC.

A 24 VDC self-amplifying speaker communication system is designed. The speakers supply as much current as they draw, and have a calculated power demand of (19) W. A (24) W power supply head-end unit shall be supplied.

Plumbing | Sheets P0.1, P1.0-P1.1, P2.0, P3.0

Two individual use bathrooms (one male, one female) were designed with each having a single lavatory and wall-mounted water closet with (1.6) gpf flushometer valves. The workroom includes a dishwasher and stainless-steel double bay sink that is connected to a grease trap downstream of the sink. A single-bay sink designed at the café counter work space. Floor drains are located near all sink locations. All domestic plumbing pipe is to be Copper Type L. The hot water system is served by a tankless hot water heater, and has a hot water return loop which is regulated by a recirculation pump. The return loop and pump were sized for a temperature differential of (20) degrees Fahrenheit. The water will leave the tankless water heater at (140) degrees Fahrenheit. The recirculation pump performance parameters were found to be (6) GPM of flow and (20) feet of pressure head. All sanitary waste and vent piping is to be Schedule-40 PVC. Total waste loading from third floor to existing system is (37) WFU's, which will require a 4" Schedule 40 PVC waste pipe for the third floor main and connection to existing waste main on the first floor.

Fire Protection | Sheets F0.1, F1.0, F2.0

A wet-pipe sprinkler system was designed to serve the third-floor by expanding from the first floor. The approximate flow required for the entire third-floor is (1410) gpm. All sprinkler heads are designed to be industry standard type ½" orifice NPT (nominal K-Factor of 5.6 GPM/psi$^{1/2}$), and all piping shall be black steel pipe. This is to be most cost economical. The critical sprinkler head shall have a pressure of (20) psi, giving (40) psi available for pressure losses.

Traction Elevator System | Sheets M0.2, M3.0, E3.1

The traction elevator system design calls for an AC gearless machine room-less elevator system. The system will continue to serve the basement, 1st and 3rd floors through the existing elevator shaft. The elevator control panel will be located inside the hoistway at the third-floor level along with all other components being contained inside the hoistway. The replacement elevator design matches the existing system's 208V 3-Phase power supply requirement and 2000 lbs rated capacity. The elevator shall have a rated speed of (150) fpm, which is industry standard.

Engineer's Cost Estimate:

The estimated construction cost is $1,129,900. This includes hard construction costs of $943,900, soft costs of $74,500 and contingencies of $111,500. An overall (5%) contingency for all hard costs was included as a safety net. During our team's site visits, black mastic tile flooring underlayment was noticed that could potentially contain asbestos. A contingency was included for abatement of the entire third-floor flooring. A contingency was included for the exterior masonry work being performed during the winter season, in case the work causes significant impacts to neighboring businesses during prime shopping seasons by blocking access to sidewalks and street parking. All project costs have been categorized into hard or soft construction costs in accordance with the American Institute of Architects (AIA).

SECTION II: ORGANIZATIONAL QUALIFICATIONS AND EXPERIENCE

Section II-1: Name of Organization

YAM Engineering, Engineering Design Firm

Section II-2: Organization Location and Contact Information

Location:

4105 Seamans Center for the Engineering Arts and Sciences
Iowa City, Iowa, 52242

Contact Information:

Project Manager:	Alecxander LaBelle
Tel:	(815) 670-2996
E-mail:	alecxander-labelle@uiowa.edu

Section II-3: Organization and Design Team Description

YAM Engineering is a construction organization dedicated to improving the resiliency and sustainability of communities in the Midwest, while holding the safety and health of the public as priority. Our team skill set includes the use engineering design services, engineering software and project management processes in the field to ensure a quality design is delivered. The project team was led by project manager Alecxander LaBelle. The project team also included Mason White, technology support, and Yunlong Li, graphic designer and report editor.

The project's design was overseen by the Project Manager. A complete list of how design activities were split between team members can be found in Appendix D. In summary, the project's architectural design was led by Yunlong Li, structural design was led by Mason White, and the MEP-FP was led by Alecxander LaBelle.

The team members have mastered sufficient skills in dealing with engineering design software including: FormIt, Revit, Robot, Insight 360 (Building Energy Analysis), SketchUp, Microsoft Excel, MatchCAD.

Section II-4: Description of Experience with Similar Projects

Our team at YAM Engineering leaned on our past construction experiences to complete this project with maximum levels of competence. Renovation experience of the team includes renovating a residential home to a commercial building, addition of an elevator to an existing building, as well as renovation of HVAC, plumbing, electrical, and fire protection systems. New construction experience of the team includes that of commercial buildings, retail buildings, K-12 schools, healthcare buildings, and criminal justice buildings. Members of YAM Engineering have also obtained on-site construction management positions with various companies.

Alecxander LaBelle Project Experience:

1. University of Iowa Children's Hospital, Iowa City, IA
2. Dekalb County Jail Expansion, DeKalb, IL

3. A.E. Stevenson H.S. 2018 Summer Renovations, Transition House and Port Clinton Rd. Lincolnshire, IL
4. Highland Park SD#112 Renovations, Highland Park, IL
5. CCSD #21 HVAC & Secure-Entry Renovations, Wheeling, IL

Mason White Project Experience:

1. Denver Water OC Redevelopment, Denver, CO
2. Xtream Arena, Coralville, IA

Yunlong Li Project Experience

1. Kum & Go, Iowa City, IA (in class project)

Section III-1: Project Scope

This section summarizes the design services performed for this project. The design services start with a list of general requirements that were met, followed by specific design services categorized in the same way as the work plan and Gantt Chart also discussed in this section of the report.

Section III-1.1: Project Goals

Third Floor Renovations Design Scope

1. A complete design of the third-floor space has been provided to achieve commercial occupancy in accordance with City of Clinton Building Code, which adopts the 2018-International Building Code. This includes heating and air ventilation, life safety, fire protection notification system and fire sprinkler system, and public restrooms.
2. The design of the third-floor space embodies the Client's intent to rehabilitate the building back to its historic condition. All existing window openings on the North and West walls are incorporated into the new design. The drywall blocking the window bay openings are designed to remove and new French windows and panoramic windows are designed to be installed at the openings. The Demolition Plan on Sheet A1.0 accounts for these existing openings by calling out rehabilitation of the window rough openings (brick/CMU), demolition of drywall that covers existing openings, and patching the drywall that returns to the new windows to be installed.
3. The design also includes a medium-sized coffee shop with an open seating area and a commercial kitchen for the café. Electrical accommodations have also been made for future tenants of building's retail space (antique booths).

Passenger Elevator Replacement Design Scope

1. A replacement elevator design is included in the design documents for replacement of existing Traction Elevator System in the building that serves the Basement, 1st and 3rd floors. This design includes demolition of existing elevator system, and installation of a new elevator system that meets current ASME 17.1 and 2018-IBC standards. The design also includes fire alarm controls required for the elevator system. This design is in accordance with NEC 70 and NFPA 72.
2. The priority of the elevator replacement design was to reuse as many existing building features as possible. This included starting design work with investigating the plausibility of retrofitting the existing system. This was confirmed to not be a plausible solution, and so a new elevator design was produced. The new elevator system designed has the same power (208V/230) and motor requirements for successful retrofit in the existing building (gearless machine-less).

Building Façade Restoration Design Scope

Exterior design work consisted of two main components: restoration of the building's façade on the North and West elevations and added building features to restore the historical look of the building.

1. As part of the façade's restoration, the design incorporates demolition of the existing metal wood-framed false façade on the building's North and West elevations. A dormer was designed for the North elevation, to restore the historical dormer in the 1900's.

2. A walk-out balcony that cantilevers 6'-0" beyond the building's North wall was designed to be used as outdoor seating and event space for the café area. An aluminum canopy concept was explored during the conceptual design phase, which later was approved to become part of this scope.

Section III-1.2: Design Objectives

General Scope Requirements:

1. The design services provided by our team included delivery of fully functioning designs of the third-floor level with Architectural, Structural and MEP-FP elements that will bring the building and its existing elevator system in accordance with today's legal standards to achieve commercial occupancy.
2. Alternate approaches to design and construction of the project's ongoing design were considered during the conceptual design phase in September and October. Meetings were held to review conceptual designs on Friday, October 4, 2019 and Tuesday, October 15, 2019. The conceptual designs reviewed during these meetings included the following:

   Café Workroom: Commercial kitchen space to be used by Café employees for light to medium duty cooking and food prep activities.

   Skydeck: Extension of elevator shaft and addition of Skydeck at roof level for commercial occupancy.

   Lowered Ceiling: A lowered decorative ceiling was added to the café design after the second conceptual design meeting. The intent of the lowered ceiling set by the Owner was to provide a design that carried the same theme as the Skydeck pergola canopy design. The lowered ceiling design is included in the contract drawings on Sheets A1.2. MEP specification requirements have been included on the associated MEP drawing sheets for elements installed in the lowered ceiling (e.g. UL ratings of light housings and ductwork spacing requirements).

   Walk-Out Balcony: Extension of floor framing a total of 6' outside of the three existing bay windows, providing an outside gathering area that would be used by the café space. The idea of placing a canopy over the balcony in order to improve the scope of balcony design. This was turned down with the reasoning that this would limit the option of space heaters during the colder Fall and Spring seasons.

3. In addition to considering alternative approaches to the initial design intent of the Owner, alternative materials, building systems, and equipment were considered. All selections considered the Client's program and schedule. No budget was given for the project, though consideration was taken throughout design development to provide the most cost economical designs across all disciplines.
4. Applicable laws, codes, and regulations were reviewed to ensure the design documents incorporated in the requirements of governmental authorities having jurisdiction (AHJ).
5. A contract drawing set has been prepared as part of this scope. The contract drawings have been prepared to a Level of Development (LOD) 200 Approximate Geometry detail level per the U.S. General Services Administration (GSA). This level of design detail includes: approximate quantities, size, location and systematic relationships of all components that will eventually be installed.

Additional Work (Scope Changes)

Changes to the design services scope of work are listed here for record. Added scope items may be also referenced in the design scope sections above.

1. *Scope Change #001:* Foundation Wall Repair

It is visually apparent that the basement foundation walls need rehabilitation. It is our professional recommendation that the foundation walls be repaired in accordance with the design details in the drawing set.

2. *Scope Change #002:* Café Workroom (Commercial Kitchen)

A workroom was added off of the café area during the conceptual design phase. The objective was to design a commercial kitchen for light to medium-duty cooking and food prep activities.

3. *Scope Change #003:* Lowered Architectural Ceiling

Since a parogala skydeck design was forgone after conceptual design, the Client requested this was attempted to be included in the café design. A 1'x1' wood grid ceiling was designed for this.

4. *Scope Change #004:* Exterior Canopy Storefront

Section III-1.3: Deliverables

The following deliverables have been prepared and submitted as part of this contract:

- 4.1. Contract Drawings
- 4.2. Construction Cost Estimate based on Contract Drawings
- 4.3. A Project Poster (ANSI D size)
- 4.4. A project presentation has been prepared. The presentation will be held in Clinton, IA on Tuesday, December 17, 2019.
- 4.5. A list of entities/agencies permits that control design and/or construction of the project.
- 4.6. This design report is included in design deliverables.
- 4.7. 3D Renderings produced in Revit

Section III-2: Work Plan

The Work Plan and Gantt Chart submitted as part of our team's proposal for the project was the primary structure taken by our team for each of our team members roles, design elements and disciplines designed. After award of RFP-#04a, this work plan was expanded upon to include team project milestones set in place for performance review, and to track design work activities at a more detailed scale. Below is our summarized work plan that details work plan activities down to sub-sections of divisions. Attached in Appendix D is our modified work plan to account for critical components of MEP-FP systems, structural systems and a conceptual design project phase so that during, alternatives could be adequately explored with the Client. Ultimately, the detailed work plan narrowed our team's focus to critical components that ensured the team delivered a quality design by the schedule date committed to.

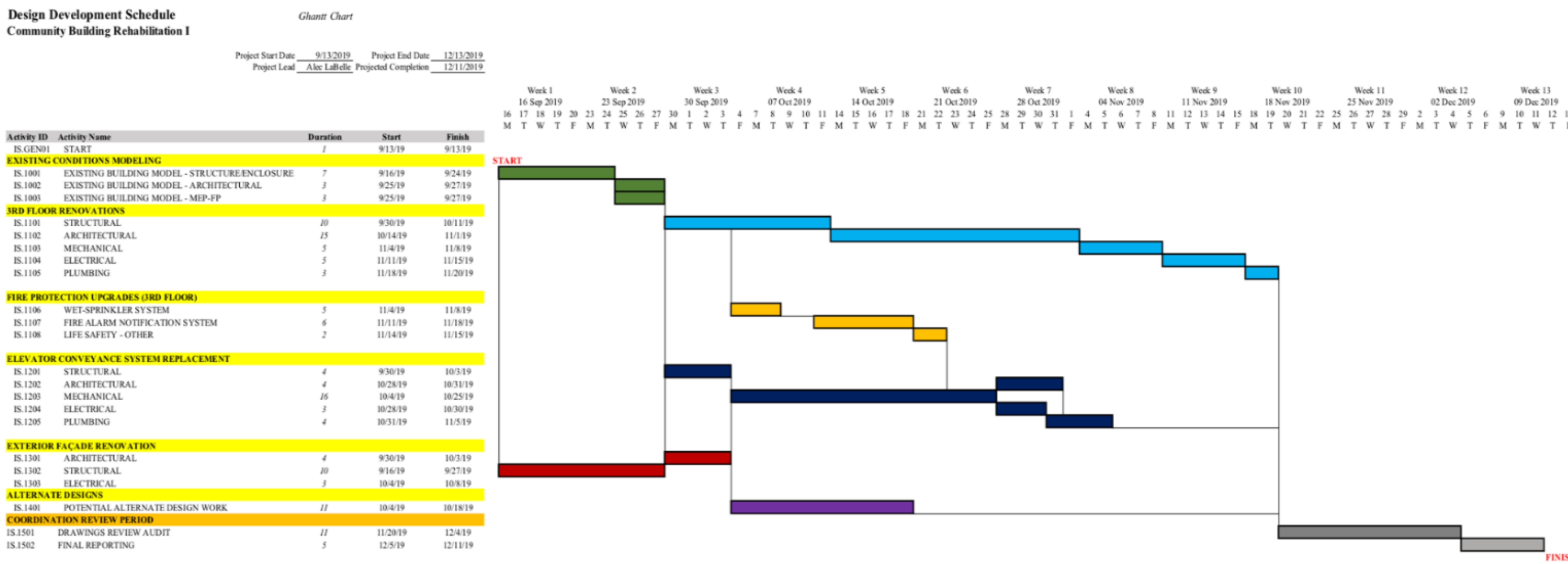

Figure 1: Design Development Gantt Chart submitted with proposal. Schedule dates were still valid throughout design development. Activates are categorized by construction discipline.

SECTION IV: CONSTRAINTS, CHALLENGES AND SOCIETAL IMPACTS

Section IV-1: Constraints

Constraint #1: Exterior Design had to restore the Historical 1900's Design

The exterior designs had to restore the historical look of the building in the original 1900's design of the building. This includes a crown-dormer at North elevation, and reuse of window openings on the front and side elevations of the building. The work detailed in the contract documents for these openings is limited to rehabilitation to preserve the openings, there are no modifications to be made to the existing openings. Likewise, the crown dormer has identical features to the historical dormer shown in historical pictures on record by the Clinton Historic Committee.

Constraint #2: Existing Structural Conditions Discovered

Findings of existing structural conditions (inadequate sized members/wood framing) confirmed limited modifications to structural components such as bearing walls could occur. Additionally, structural designs were constrained to methods functional with building's existing structural system type. We had to work with the type of system that was existing, since it would not be cost economical to change.

At the time of submitting our proposal, our understanding was that most of the structural scope would be for new construction work. After a second site visit and calculations, we gained a much greater understanding of the various structural components we would be dealing with. The majority of structural construction costs will be for replacement of existing building members. The only new construction/addition onto the building is the proposed cantilever balcony, which is made up of assemblies mostly contained within the interior of the building.

Constraint #3: No Modifications to Existing Roof Truss System

No modifications to the existing roof truss system was a constraint identified by the Owner during the first conceptual design meeting on October 4, 2019. The reasoning for this constraint was that the roof truss system is currently in good condition and was recently constructed a few years ago.

This resulted in no changes being able to be made regarding the 11'-0" ceiling elevation, or the drywall mounted on truss ceiling style. This limited the designs that could be considered for the Skydeck alternative, discussed further in Section V. Conceptual design discussions regarding the Skydeck were constrained to methods for the Skydeck's structural connections that avoided any modification to the existing truss system.

Constraint #4: Elevator System Constraints

The elevator system upgrade in conformance with today's standards was a necessity per code, since the third floor is accessible. The replacement traction elevator design was constrained to reincorporate existing conditions to ensure a cost economical design. The existing elevator shaft is re-used in the new design. A systemic result that could occur would be unenjoyable experience for people with disabilities that are only visiting the building for the café area. The elevator location is code compliant, however. This microscopic societal impact is discussed further in Section IV-3.

Section IV-2: Challenges

Challenge #1: Reducing Blind Spots in the Retail Area

The Owner's intent was to demolish all existing interior walls that were non-bearing to reduce blind spots on the third floor, mitigating shoplifting occurrences. During our initial site visit, it was believed that two interior walls were non-bearing and could be demolished. After being awarded the RFP and another site visit, it was determined that all interior walls that were existing on the third floor are bearing.

This posed a challenge, since the existing 2x6 wood stud interior wall running North to South greatly blocked visibility of the Northwest corner of the retail area.

Challenge #2: Exposed Ductwork and Fire Protection Piping

With over 6,000 CFM's of design airflow serving the third floor, ductwork mains are required to be 26" to 27" in diameter. Even with the retail spacing having a ceiling elevation of 11'-0", this results in the ductwork mains being hung at an elevation of approximately 8'-6" at bottom of duct. Fire protection piping is also designed to be exposed, as was identified as the Owner's original intent during the first conceptual design meeting. Many considerations were taken into the MEP coordination due to tight-space issues such as this one with exposed MEP components.

Challenge #3: MEP System Design Compatibility for Future Expansions

The 3rd floor presented the opportunity to renovate completely without being constrained to expanding from existing MEP systems. This presented a different challenge though, since the 1st floor MEP system is existing and functional. The team believed it was likely that the same MEP system types would like to be expanded to the first floor in a future renovation. This factor was considered throughout design development. The challenge was selecting systems that will best meet the needs of the third-floor space, but could be expanded upon in the future, without increasing costs of the systems now (e.g. buying over-sized systems, which is not cost economical or energy efficient).

Challenge #4: Inclusion of Energy Efficiency in the Design Process

The exterior walls of the building are not efficient in holding the temperature gradient due to the CMU and brick veneer construction of the walls. This will impact the extent of energy efficiency that can be achieved with the new HVAC system design.

Challenge #5: Balcony Floor Framing Moisture Protection

To design a safe and economical balcony, laminated veneer lumber was chosen for the floor framing. Laminated veneer lumber is known to be very resistive to high flexural stresses and is generally less expensive than glulam beams. However, one issue with using laminated veneer lumber for a balcony, is that laminated veneer lumber cannot be pressure treated. This would mean the lumber would have no protection to moisture, rotting, and insects, resulting in a non-resilient design. For these reasons, the decision was ultimately made to wrap the underside of the balcony in powder coated aluminum. This will provide protection from moisture, insects, and thermal damages.

Section IV-3: Societal Impacts within the Community

Project's Overall Impact on the Community:

The team's assessment on the project's societal impacts within the Community found overall that the project has a positive impact on the Community. For the City of Clinton and downtown business commerce, the renovation project will pose economic benefits by supporting the recent growth of newly established businesses in the downtown area. For the community body, the renovation will offer social improvements by offering an enjoyable place of gathering for multiple purposes. The project offers a coffee shop, sized to hold an adequate assembly gathering of people.

Although there are several cafés in the City of Clinton greater area, most of them concentrate at 2nd street. The owners take aim at the scenery along the Mississippi River. With there currently being a lack of access to a café at the center of the city, this provides an opportunity for the project. A café at the center of the city will provide people a good place for recreation and relaxation at a new location that will likely be closer to many customers that currently frequent the cafe shops near 2nd street.

Project's Design Impact on the Community:

Looking closer at the project's design itself having an impact at the community level, the team identified two positive impacts and one negative impact.

Positive Impact: Currently, the building outside is covered by a billboard, while neighboring buildings on 5 Avenue and 3rd Street have maintained the century fashion. Restoring the building's façade to its 19-century fashion will allow the building to maintain a consistent theme with surrounding buildings. This will help promote the historic aspect to 5 Ave South overall which was the intention of our Clients.

SECTION V: ALTERNATIVE DESIGNS

Section V-1: Alternative Concepts Considered

1. *West Elevation Plaster Area:*

Previously, plaster was chosen in order to cover up the face-brick on the west face of the building. Currently, there is a small, faded mural covering up part of this plaster area. The owner was interested in exposing as much face-brick as possible. However, this plaster has likely ruined the aesthetic purpose of any face-brick underneath it. For this reason, it was proposed that the plaster wall be cleaned and prepared to receive a new, larger mural.

With this option, it is possible that the mural could be vandalized. However, public art is often more respected by vandals than a typical, plain wall. This alternative will contract a local artist and give them a chance to showcase their talents, providing a sentimental, positive societal impact to the areas surrounding. This mural will also promote the values of both the owner, and the Downtown Clinton Alliance due to their partnership in restoring the exterior façade of the building.

2. *Dormer Location:*

The Owner's goal of the exterior façade redevelopment was to bring back the look of the building from a century ago. One feature of the building prior to its current renovation was a dormer, highlighting the top of the building. This was one of the Owner's main desires in the aesthetic of the façade design. The old crown was located towards the west end of the north face of the building, near the single hung windows.

During the first step of conceptual design, the idea was to turn this idea into a dormer with a window and a vaulted ceiling. This would require some existing roof framing to be removed and restructured. However, it would provide natural light and a great interior aesthetic. With further thought and conceptual design, it was determined that an uneconomical amount of restructuring would need to be done in order to make this design work. This restructuring would include masonry rework above the existing 16'x9' bay window openings. A vaulted ceiling would also cause there to be more work in restructuring the roofing system; restructuring the rather capable existing roof trusses would be a waste. After denying the previous dormer option, the Owner informed us that he would opt for a more historical aesthetic for the proposed crown.

The final design features a crown that replicates the crown from the building before it was renovated to its existing state. It will be located over the middle 16'-0" x 9'-0" window. The crown will offer a great aesthetic with minimal restructuring to the existing building design. It will simply need to be braced against the existing roof framing for wind resistance. With no real disadvantages to the project, this design alternative was granted approval and will be incorporated.

3. Canopy Over Sidewalk:

The current set up of the building already includes a canopy on the west building face. It was requested that new canopies replace the old and be expanded to cover larger areas. The conceptual design phase offered a few different options.

The first option was a 5'-0" cantilever canopy that would attach to the existing CMU beneath the exterior face-brick with anchor bolts. This design would showcase an exterior resilient hardwood such as cedar or tigerwood. It was proposed to wrap the entirety of the building. This would offer a unique design but, would increase construction costs. The same design was proposed to be over the balcony, giving shade and coverage to those who wish to sit outside amidst the elements. The owner identified that a canopy should not be designed over the balcony, since no heating units could be located on the balcony during the Fall or Spring seasons.

The second option was the same type; a 5'-0" cantilever canopy. However, this would use less expensive materials, and span only around the west end and the north end up to the balcony. Still, this was deemed too expensive, and not quite what the owner imagined in the ideal design.

The final option, a 5'-0" canopy attached to the CMU at two points with masonry anchor bolts. It is proposed to be simple, only black, powder coated aluminum casing; which only cover the northwest corner of the building and the south-most entrance on the west elevation. This design will require less material cost than the previous option, and offer a larger, uninterrupted area for the mural on the west face of the building.

4. *Café Seating Area Orientation:*

Three different seating area options were considered. These options were to use: all of the north-most section of the building (Option 1), only the east two-thirds of the north section (Option 2), or only the west two-thirds of the north section (Option 3). See the figures below for a visual:

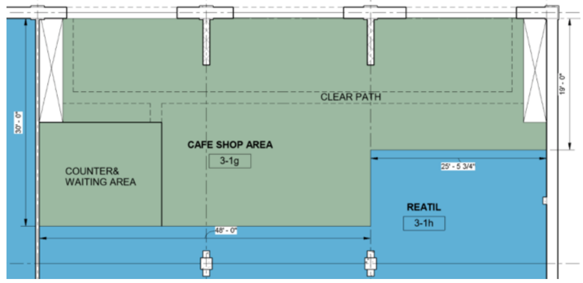

Figure G-1. Café area option 1

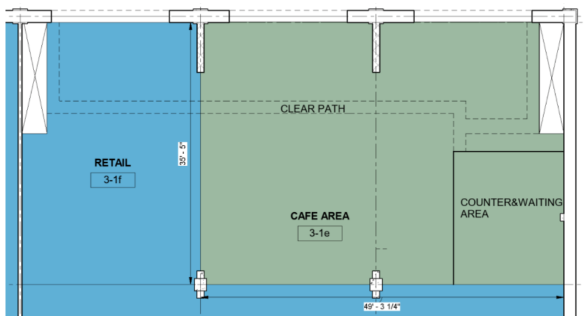

Figure G-2. Café area option 2

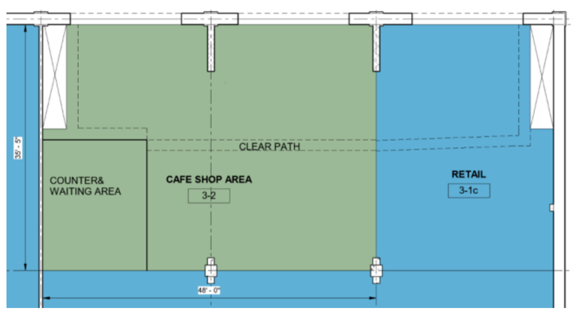

Figure G-3. Café area option 3

No matter which option was chosen, the entire north section of the building was structurally designed to withstand the live loads of a typical restaurant or café, so that in the future, seating sections could be rearranged to the owner's liking.

Option two became the final design option. Option three would require a kitchen to be place near the center of the building because of its location. The Owner liked the location of the counter waiting area in options one and two. However, he did not believe that the café needed to be as large as option one. Therefore, the design of option two was chosen. It will grant the café a total area of approximately 1,700 square feet. Along with the café seating area, a kitchen was added adjacent to the counter and waiting area.

5. *Low-Voltage Lighting with Daylight Photocells and Motion Sensors*:

An energy analysis study in Autodesk Insight360 revealed greatest daylight exposure was from the southeast. The analysis also showed that daylighting controls had no effect on energy usage, therefore daylight controls would be a cost increase to the project's design. Occupancy sensors resulted in a decrease of -0.02 USD/SF/yr on average. This does not include the fact that most spaces will not be occupied for durations at a time during the day. This will increase energy savings more with occupancy sensors/timer.

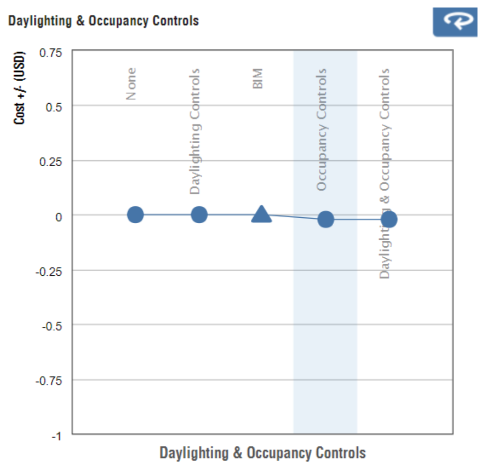

Figure E-14. Daylight

6. *Exposed Brick Veneer Interior Wall Finish*:

As stated before, the Owner expressed interest in exposing as much existing face-brick as possible. Using the exposed brick as a finish increases the aesthetic appeal of the building, which could become a potential attraction factor to customers. Exposed face-brick also absorbs large amounts of humidity and provides a lesser need for repetitive maintenance.

Interior face-brick was covered over with drywall in past renovations. Exposing the face-brick could have unexpected costs depending on the shape and integrity of the existing system. It is unclear what type of furring detail was used in past renovations to connect the existing drywall to the interior face-brick. There may also be extensive damages to the interior side from anchor bolts that were used to connect the existing false façade system to the exterior wall. If the brick is deteriorated, tuckpointing and re-grouting would be required in order restore the structural integrity of the wall.

Even if this alternative was not chosen, much of the existing drywall would need to be torn down due to its condition. Gypsum board sheathing, furring, and painting are only a few of the items that would be included in labor and material costs if it were decided to cover up the face-brick. All in all, exposing the face-brick behind the drywall will be the cheaper option and will offer a much more aesthetically pleasing looks. Not to mention the old age appeal it would give.

SECTION VI: FINAL DESIGN DETAILS

Section VI-1: Architectural

1. Café Area

The proposed café area is located at the Northeastern portion of the 3rd floor. The total square footage of café area is 1694 square-feet. The café area is designed to serve 50 people per day estimated by the traffic flow method.

In order to serve the estimated number of customers, the café area needs to be big enough to support the function. An easy rule of thumb is used to determine the total square footage of the café area: the café area is divided into dining area and work area including café counter and waiting area, which count 70% and 30% of total, respectively. The dining area is designed to allow for 23.7 square-feet per customer. This adds up to a total café square footage of approximately 1,694 square-feet.

Within the café area, the space is divided into three parts; the bar table located at the south side of the café area, the 3 and 4-seater tables located at the North side of the café area close to the two 16’-0’’ X 9’-0’’ windows, and the middle filled with 2-seater tables. The intent is to different sizes of groups. Within the café area, the wood plank tile is used as the flooring material to provide a consistent aesthetic with the façade design. Meanwhile, a 2’-0’’ X 2’-0’’ wood grid lowered ceiling system was designed to install into the café seating area to provide an aesthetic decoration to the café area. Within the café area, 4-foot knee walls were designed to divide the spaces. The knee wall under the bar table was designed as a base for the bar table to rest on. Not only were the knee walls designed to divide the space but, they were also designed to incorporate outlets for convenient electronic charging access. All designs were provided with the intent of allowing for a friendly environment to all types of customers. The café interior design rendering is shown in Appendix G Figure G-6.

Figure G-5: 3rd floor layout rendering

In order to serve people with disabilities, all designs within the café area were designed to comply with the 2010 ADA Standards for Accessible Design. Based on the International Building Code, a clear path is preserved between the tables to allow for acceptable means of egress of 3'-0''. At two stairways located at the West and East sides of the café area, railings were designed to be installed to provide a safe environment for all customers.

Café Workroom: congestion in space between café counter and kitchen. The opening of kitchen is directly facing the café counter, the space between café counter and kitchen is limited due to the existing condition. Meanwhile, in order to bring food materials into kitchen, workers have to use the same opening which is prepared for staff.

Retail Area: To eliminate the blind spot behind the South bearing wall, two arched openings are called to be cut into the interior 2'-0''X6'-0'' wall. The openings will have a height of 9'-0" at the top of the arch to match the elevation of the 16'-0'' X9'-0'' window bays on the North wall. The openings will be 8'-0" in width and spanned 10'-0" apart from each other.

With the proposed design layout of the 3rd floor, the advantages and disadvantages includes:

<u>Negative Impact:</u> The distance between the elevator and the café area is quite long due to the location of the existing elevator shaft that will be reused. This can be an unfriendly experience for people with disabilities. This is a result of reusing the existing elevator shaft to provide a cost economical design, as previously discussed in Section IV-1. Considering that the area that has to be crossed to access the café from the elevator is retail, this may pose an additional negative impact for disabled occupants that only wish to access the café area.

For a disabled occupant that only wishes to access the café area, the location of the bathrooms in Southeast corner could be an unenjoyable experience as well. To access the bathrooms from the café, retail space must be crossed again.

<u>Positive Impact:</u> Distinctive design features provided by the team can minimize the influence of location. The balcony design enables customers to enjoy the sunshine and natural wind, which could become a distinguishing feature to customers. At the same time, the effect is not limited to inside the commercial building

2. *Exterior Elevation*

The dormer is located at the middle of the North side of the building to bring back the 1900's historical view of the building. The picture of the historical view of the building coming from the Clients is shown in Figure G-7. The crown is designed to be braced against the existing roof framing for wind resistance. The existing false façade will be demolished, and the brick veneer will be exposed to bring back the historical view. At the North elevation of the building, a walk-out balcony is designed to boost the appeal to the building. A railing is designed to be installed on the balcony to protect the safety of the public. A panoramic sliding window will be installed at the middle of the 3 16'-0''X9'-0'' window bay openings to provide an access to the balcony. French windows will be used for the other two window bay openings. At the Northeast corner of the building, an aluminum canopy is installed just above the display window at the 1st floor.

Figure G-7: Historical view (left) exterior elevation rendering (right)

3. Bathroom & Kitchen

The single person bathroom is located at the Southeast of the 3rd floor, including single men and women bathroom. The bathroom accessories include water closet, sink, mirror, grab bars, paper towel dispenser, and strip lighting above mirror. All dimensions of the bathroom accessories and interior dimension of the bathroom were designed to comply with ADA regulations to make sure the accessibility for people with disabilities. The flooring material in the bathroom is porcelain tile to provide a water and slipping resistance surface. The porcelain tile extends 4 feet above the finish floor to provide a water resistance surface on the wall. The ceiling material in the bathroom is gypsum board.

The kitchen is located at the Southeastern side of the café area, with the two-flush door facing the café counter. The kitchen accessories include double oven, range top, commercial size 72 cubic-feet refrigerator, cabinet, sink, dishwasher, and work countertop. All dimensions of the kitchen accessories and interior dimensions of the kitchen were designed to comply with the ADA regulations to make sure the accessibility for people with disabilities. The porcelain tile was designed as the flooring material. The porcelain tile can provide a water resistance surface with easy clearing. The 2’-0’’ X 2’-0’’ acoustical ceiling tile was designed to be the ceiling material in the kitchen.

Section VI-2: Structural

1. Balcony Floor Framing

The proposed balcony framing was designed for a live load of 100 psf, based on a typical restaurant/cafe from ASCE 7-16. This is a conservative load based on the expected occupancy. This balcony was designed as a typical cantilever balcony with the interior balcony framing spanning twice the length of the exterior span. The beams span on the exterior side of the exterior wall for 6’ and on the interior side for 16.5’. Edge members of the framing system were designed to line up with that of the stairwells, offering an efficient solution for this relationship. The cantilevered framing runs North to South and rests on larger beams in which run East to West. The spacing for balcony floor framing is designed at 16” O.C. This will make for easier construction while applying floor sheathing.

Due to the larger than typical spans for wood framing, the decision was made to use engineered lumber in order to resist the large moment and deflection values that come with larger loads and larger spans. The specific types of engineered lumber chosen were Laminated Veneer Lumber and Parallel-Strand Lumber manufactured by Weyerhaeuser. These types of are made for high moment resistance and allowed for very good DCR values for a very economical design.

Laminated Veneer Lumber is not made to be pressure treated. For this reason, exterior spans of the balcony floor framing will be encased in aluminum for thermal/moisture protection, as well as aesthetic purposes. This aluminum is to be powder coated in order to match the color of the canopy system.

See Appendix S for calculations. All design loadings and tolerances of different balcony members are explained below:

<u>Balc-1</u>: There are a total of 33 of these members, all chosen to be 1.75”x9.25” laminated veneer lumber. This comes out to a total of about 734 lineal feet of board. After applying adjustment factors, this specific size and grade of laminated veneer lumber (manufactured by Weyerheauser) has an allowable moment of 5600 lbf-ft and an allowable shear of 3075 lbf. At the design length of 22.5’, it reaches a maximum moment of 3345.6 lbf-ft and a maximum shear force of 979.6 lbf due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.319 and 0.597 for shear and bending, respectively. It is important to note: 2x12 dimensional lumber would have provided a better design economically. However, 2x12’s did not pass bending and deflection checks. These members types will use WP1.81 H=9.5 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 3,635 lbf.

<u>Balc-2</u>: There are a total of 43 of these members, all chosen to be 2x6 dimensional southern pine. This comes out to a total of about 169 lineal feet of board. After applying adjustment factors, this specific type of dimensional lumber has a bending design value of 1012 psi and a shear design value of 140 psi. At the design length of 5.146’, it reaches a maximum shear stress of 46.354 psi and a maximum bending stress of 780.901 psi due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.331 and 0.772 for shear and bending, respectively. These members types will use LUS26 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 935 lbf.

<u>Balc-3</u>: There are a total of 11 of these members, all chosen to be 2x10 dimensional southern pine. This comes out to a total of about 120 lineal feet of board. After applying adjustment factors, this specific type of dimensional lumber has a bending design value of 1012 psi and a shear design value of 140 psi. At the design length of 9.063’, it reaches a maximum shear stress of 48.961 psi and a maximum bending stress of 863.763 psi due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.35 and 0.854 for shear and bending, respectively. These members types will use SS LUS28 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. Since Balc-3 members will be used on the exterior of the building, the appropriate hangers

have been chosen to be stainless steel. This hanger type allows for an end-reaction of 1,195 lbf.

Balc-4: There are a total of 6 of these members, all chosen to be 1.75"x14" laminated veneer lumber. This comes out to a total of about 134 lineal feet of board. After applying adjustment factors, this specific type of laminated veneer lumber (manufactured by Weyerheauser) has allowable moment of 13949.5 lbf-ft and an allowable shear of 5353 lbf. At the design length of 22.5', it reaches a maximum moment of 12987.35 lbf-ft and a maximum shear force of 1923.11 lbf due to dead, live, and snow loads. This design yields demand-to-capacity ratios of 0.359 and 0.931 for shear and bending, respectively. These members types will use WP1.81 H=14 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 3,635 lbf.

Balc-5: There are a total of 4 these members, all chosen to be 5.25"x18" parallel-strand lumber. This comes out to a total of about 95 lineal feet of board. After applying adjustment factors, this specific type of laminated veneer lumber (manufactured by Weyerheauser) has an allowable moment of 75319.25 lbf-ft and an allowable shear of 21010.5 lbf. At the design length of 25.5', it reaches a maximum moment of 67283.05 lbf-ft and a maximum shear force of 9218 lbf due to dead, live, and snow loads. This design yields demand-to-capacity ratios of 0.434 and 0.893 for shear and bending, respectively. These members types will use EGQ5.37-SDS H=18 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 19,800 lbf.

2. *Balcony Railing:*

The proposed balcony railing was designed to be an aluminum, cable (or perforated metal) railing system. It will consist of 3"x3" aluminum posts and 3"x1.5" horizontal rails at the top and bottom. The infill between the top and bottom horizontal rails has been chosen to be either cable or perforated aluminum panels (both viable options).

The spacing of the railing posts was designed based on a concentrated loading of 200 lbf at any point and a uniform load of 50 plf at any point in any direction (per IBC and ASCE 7-16). After further calculations, it was found that the maximum allowable spacing was to be 5.4 ft. The design spacing will be shortened to 4' O.C. in order to offer a conservative design as well as make for easier constructability. The connection design is to be provided by the manufacturer. Blocking guidance for the railing post-floor connection can be found in the structural drawing sheets.

3. *General Floor Framing:*

The proposed interior floor framing was designed for live loads of 150 PSF at the kitchen and 75 PSF in all retail areas, per ASCE 7-16. The areas that this affects included the area of floor framing that is expressing severe deflection, as well as the kitchen area in which will experience high live loads. In order to keep the overall structure consistent, these areas of floor framing were also designed for spacings at 16" O.C. Member types were also chosen to be Laminated Veneer Lumber like that of the balcony floor framing.

See Appendix S for calculations. All design loadings and tolerances of different balcony members are explained below:

J1: There are a total of 14 these members, all chosen to be 1.75”x18” laminated veneer lumber. This comes out to a total of about 345 lineal feet of board. After applying adjustment factors, this specific type of laminated veneer lumber (manufactured by Weyerheauser) has an allowable moment of 19375 lbf-ft and an allowable shear of 5985 lbf. At the design length of 25.5’, it reaches a maximum moment of 18058.244 lbf-ft and a maximum shear force of 2834.982 lbf due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.474 and 0.932 for shear and bending, respectively. This member type will not require hangers as it will be bearing onto adjacent CMU walls. See the structural drawing sheets for this bearing detail.

J2: There are a total of 30 these members, all chosen to be 1.75”x14” laminated veneer lumber. This comes out to a total of about 719 lineal feet of board. After applying adjustment factors, this specific type of laminated veneer lumber (manufactured by Weyerheauser) has an allowable moment of 12130 lbf-ft and an allowable shear force of 4655 lbf. At the design length of 25.5’, it reaches a maximum moment of 12477.933 lbf-ft and a maximum shear force of 1958.923 lbf due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.421 and 1.029 for shear and bending, respectively. These members types will use WP1.81 H=14 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 3,635 lbf.

J3: There are a total of 29 these members, all chosen to be 1.75”x11.25” laminated veneer lumber. This comes out to a total of about 700 lineal feet of board. After applying adjustment factors, this specific type of laminated veneer lumber (manufactured by Weyerheauser) has an allowable moment of 8070 lbf-ft and an allowable shear force of 3740 lbf. At the design length of 25.5’, it reaches a maximum moment of 7360.168 lbf-ft and a maximum shear force of 1155.48 lbf due to dead, live, and snow loads. At 16” spacing this design yields demand-to-capacity ratios of 0.309 and 0.912 for shear and bending, respectively. These members types will use WP1.81 H=11.25 hangers (by Simpson Strong-Tie) in order to connect to adjacent framing members. This hanger type allows for an end-reaction of 3,635 lbf.

B1: There are a total of 2 these members, all chosen to be double up 5.25”x18” parallel-strand lumber. This comes out to a total of about 85.68 lineal feet of board. After applying adjustment factors, this specific type of member doubled up (manufactured by Weyerheauser) has an allowable moment of 150638.5 lbf-ft and an allowable shear force of 36540 lbf. At the design length of 20.5’, it reaches a maximum moment of 154014.09 lbf-ft and a maximum shear force of 24577.83 lbf due to dead, live, and snow loads. This design yields demand-to-capacity ratios of 0.673 and 1.022 for shear and bending, respectively.

4. *Roof Structure Capacity Analysis:*

The existing roof trusses were analyzed in order to find their structural capacity based on existing loads and new loads being applied. Per ASCE 7-16, existing design loads included the self-weight of the structure and roofing system, a roof live load of 20 psf, and a converted sloped-roof snow load of 25.2 psf. New loading conditions included the self-weight of new mechanical units on the roof, as well as the dead weight of a newly incorporated lowered ceiling in the café area (40 lbs. per hanger). The largest existing truss, a flat Howe-K truss with a height of 5’ and a length 50’, was analyzed assuming 4' spacing between trusses. See the following for loading, axial force, moment, and deflection diagrams (respectively) at a load combination of D+0.75L+0.75S :

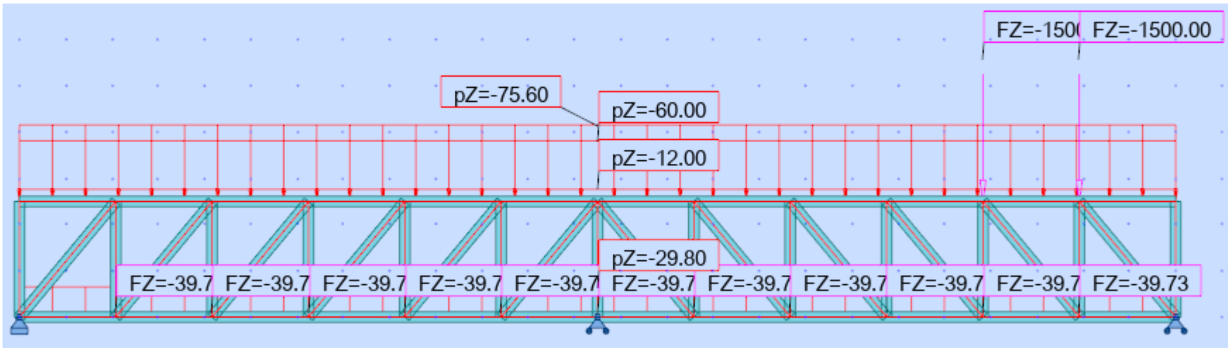

Figure H-1. Loading on roofing system

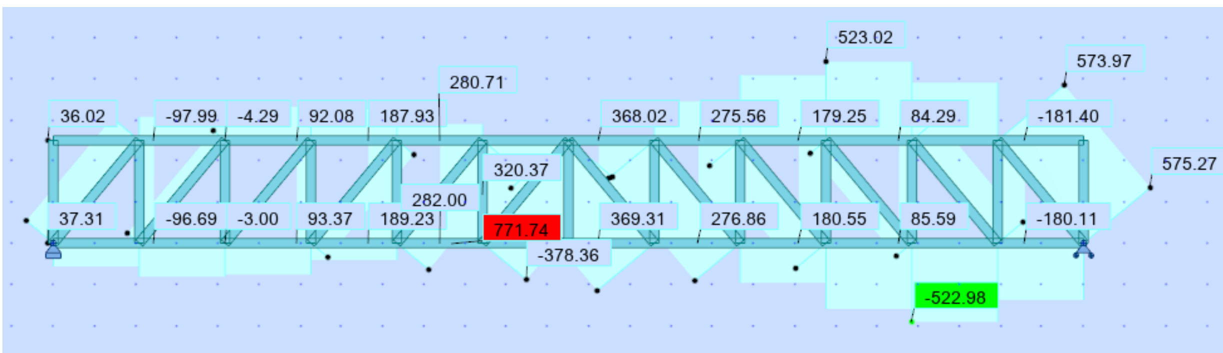

Figure H-2. Axial force on roofing system

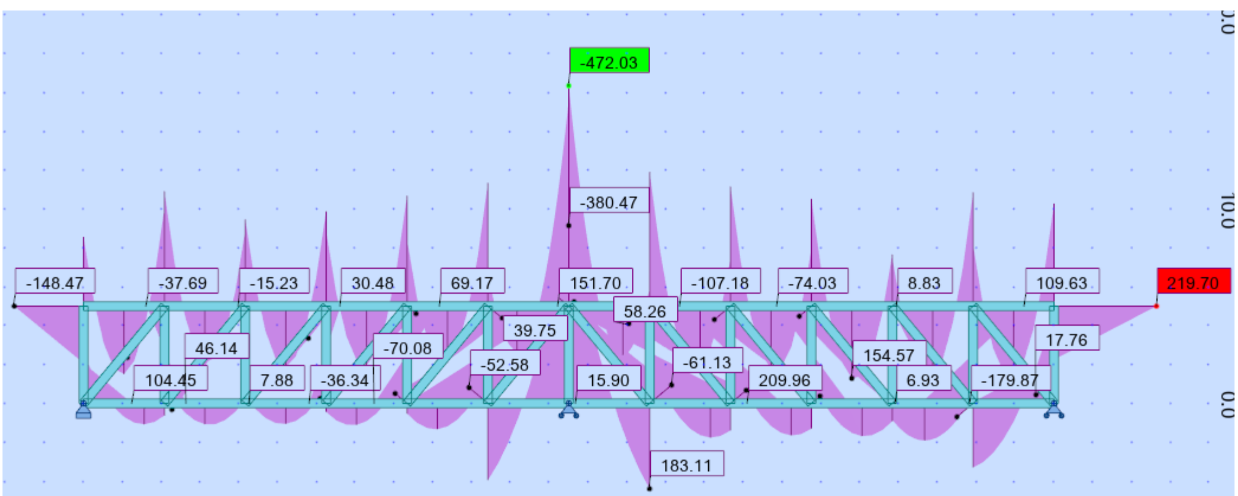

Figure H-3. Moment on roofing system

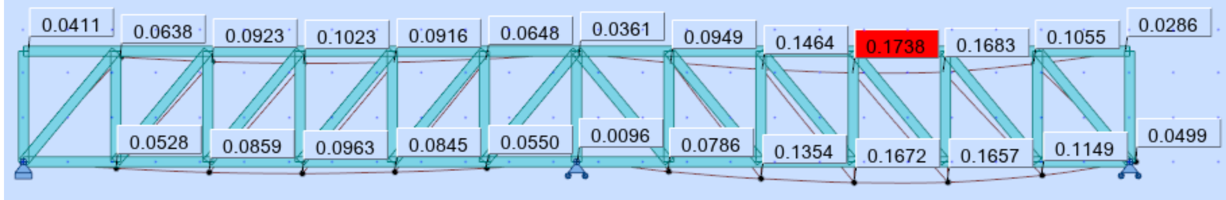

Figure H-4. Deflection of roofing system

The ASD approach was used to check the following design values: a maximum bending stress of 749.206 psi, a maximum tension stress of 522.98 psi, a maximum compression stress of 771.74 psi, and a maximum deflection of 0.1738. It was determined that the structural capacities of the current trusses are far adequate in withstanding the new loading. There are no improvement that need to be made to the structural roofing system.

5. <u>Storefront Lintel Verification</u>:

With the increased loads to the north exterior wall due to the balcony framing, the lintels above the storefront windows needed to be verified for sizing. The total load on these lintels was made up of the dead, live and snow loads on the balcony framing, as well as the existing façade. The newly applied, design uniform load on the lintels was found to be approximately 2000 plf. This uniform load yielded a maximum moment of 145 kip-ft with a design length of 26.25 ft. AISC 15 member tables were used against the maximum moment to find the design member size to be A500 Grade C HSS9x9x5/8. Hollow structural steel was chosen for the preliminary design because of its known resistance to lateral torsional buckling (LTB). The chosen member was checked for LTB; flange local buckling and web local buckling were ignored due to the compactness of the components. Based on calculations HSS9x9x5/8 sections are adequate for the applied loading. The contractor is to field verify that the existing lintels are of same, if not greater structural capacity than HSS9x9x5/8 sections or the lintels will need to be redesigned.

Bearing calculations were also completed using AISC 15 for guidance. Acceptable bearing plates are to have dimensions greater than or equal to the following: Length=12 in, Width=6 in, Thickness=0.5 in.

6. <u>Crown/Dormer Addition</u>:

The Owner has expressed wishes in bringing back a "look-alike" crown from before the structure was renovated in the mid-1900's. This crown went through a conceptual design process and endured a few different designs. It was finally decided to use a very similar design to that of the old crown. The only difference is that the "hill" of the crown will now be located at above the middle 16'x9' bay window.

Structurally, the design of the actual crown itself will be by others. The Owner expressed that he employs a carpenter in which obtains the skills to replicate the old design. No matter the end-product, 2x4 diagonal bracing is to be provided and attached to a 12" 2x4 plate located directly above each vertical or the northern-most Howe-K truss.

7. *Overhead Canopy*:

The overhead canopy was chosen to wrap around the northwest corner of the building and span over the south entrance at the west elevation. It will extend off of the building 5' and have two connection points. The first connection will be between the interior edge of the canopy and the exterior wall using masonry anchor bolts. The second connection will be a tension rod that spans between the exterior edge of the canopy (4.5" from the edge) and the exterior wall (4' above the top of the canopy).

The design span between supports was chosen to be 8'. Per ASCE 7-16, the design loading for the canopy will be 243.499 plf, which includes a flat snow load along with a maximum snow drift load. After further calculations, the tension rods are to hold a minimum of 2,435 lbs each. The contractor must submit a product under CSI division 10 73 16, to be approved by both the architect and structural engineer.

Section VI-3: Mechanical

1. *Supply Air*:

There are two HVAC systems for the third floor: an air-cooled air conditioning unit with gas heat furnace and a makeup air unit serving the workroom independently. An air-cooled condensing unit with a combination evaporator coil and gas-fired furnace was selected, since this system is the most energy efficient for the Midwest Climate Zone 2. The makeup air unit serves the workroom independently, so that an additional (450) CFM can be provided by the rooftop unit when the commercial kitchen hood is in use. (450) CFM was found to be the required discharge rate for the kitchen hood per 2018-IMC Section 403.2.

The design contains the largest ductwork at the South end of the third-floor. This is important to prevent any fire protection piping from having to cross underneath the ductwork mains. Piping crossing underneath the ductwork mains would result in too low of a clear overhead from the floor per 2018 IBC. Ductwork sizes reduce to 11" through 17" at the branches, which allow fire protection piping to divert underneath the ductwork. For the most cost economical design overall, fire protection piping should always divert around ductwork, and not vice versa. Ductwork diverting around fire protection piping would also most likely result in too low of a clear overhead. Greater coordination will be required in the field between the mechanical contractor and fire protection contractor. The mechanical contractor should be scheduled to install all ductwork, prior to the install of sprinkler piping. It should also be specified (or purchased in the contracts) for a coordination layout meeting with the mechanical and fire protection contractors, prior to the start of all work.

1.1. Diffusers, Registers and Grilles

All supply diffusers are designed to be 4-way throw (four directions) to ensure optimal coverage. For the retail area, diffusers are placed 12'-0" on center. Diffuser velocities were based on ASHRAE 2005, Chapter 33 Ventilation Rates Table, and in correlation with demand cooling load in a room (Btu/h*ft^2), Max ADPI, and the temperature at the given cooling load density. Heating and cooling loads were calculated using analytical spaces in Revit with Outdoor Air per Person, Area per Person and other constant parameters in accordance with ASHRAE Standard 62.1-2004.

The greater of the heating and cooling loads was selected for the design load. The design cooling load was found to be (246,500) btu/h, (6,818) CFM. A detailed heating and cooling loads report with all calculations has been attached in Appendix M.

SUPPLY AIR	Total Cooling Airflow	Qty. Diffusers	Airflow per Diffuser
Supply - Retail:	4967	24	**207 CFM**
Supply - Café Seating:	1350	9	**150 CFM**
Supply - Workroom:	232	1	**232 CFM**
Supply - North Bathroom:	84	1	**84 CFM**
Supply - South Bathroom:	82	1	**82 CFM**

Figure M-2. Supply air

1.2. Supply ductwork

All supply ductwork that is exposed is designed to be galvanized, double-lined sheet metal. For cost purposes, all ductwork that becomes concealed above a false-ceiling (e.g. workroom, bathrooms) is not called to be galvanized. This ductwork can be insulated with duct wrap around the exterior.

Ductwork was sized using the Equal-Friction Method in accordance with ASHRAE ductwork sizing standards for standard commercial buildings. An equal friction value of 0.08 in. wg-100 ft was held constant for all calculations.

Each duct segment was sized based on the required airflow in the duct (dictated by the supply/return/exhaust diffusers the ductwork serves). Design ductwork sizes chosen were based off the calculated equivalent diameter, and the quantity of other ducts that were also calculated to be roughly the same size. Some ductwork segments were designed to be smaller than their equivalent diameter due to this being the most cost economical solution. The optimal solution per the calculations would require more ductwork sizes and fittings, which will increase costs. The minimal added static pressure loading added to the furnace fan will still be better than a variety of ductwork sizes.

Ductwork hydraulic diameters were calculated using the McQuary Ductaculator Tool (McQuay International - McQuay Air Conditioning, 2003). The velocity was verified for each design ductwork size to ensure maximum recommended duct velocities were not exceeded per ASHRAE 2003, Chapter 42. The selected noise criteria (NC) for the third-floor was (35) NC. The third floor has both a café (restaurant, NC=40-45) and retail area (public area, NC=30-35); the smallest NC was chosen to govern the system, since the restaurant criteria could cause an unenjoyable experience for occupants in the retail area. The maximum NC that will be reached was found to be (20).

2. <u>Return Air:</u>

The return air diffusers and ductwork are designed based on the supply airflow. That way, a balance of positive (supply) air and negative (return) air is achieved. The location placement of the return grilles was selected to divide the building into thirds, and to mitigate airflow leakage to the exterior North and West walls. This is done by pulling airflow away from windows, back towards South and East ends of the building (where the building retains energy greatest). The return ductwork branch runs parallel to the East wall of the space, opposite from the exterior walls.

Ductwork was sized using the same method as described above in Supply Air.

RETURN AIR	Total Cooling Airflow	Qty. Diffusers	Airflow per Diffuser
Return - Retail (North)	2106 CFM	1	**2106 CFM**
Return - Retail (East)	2106 CFM	1	**2106 CFM**
Return - Retail (South)	2106 CFM	1	**2106 CFM**
Return - Workroom	232 CFM	1	**232 CFM**
Return - North Bathroom	84	1	**84 CFM**
Return - South Bathroom	82	1	**82 CFM**

Figure M-3: Design airflow per return grille type – return airflow equals supply airflow.

3. *Exhaust Air:*

The ventilation rate requirements for the retail and café area were taken into account with the heating and cooling loads calculation, since these areas do not have a separate exhaust system. These values were taken from ASHRAE Standard 62.1-2004 Table 6-2 for a retail store.

Exhaust ventilation rates for the bathrooms, workroom, utility room and elevator shaft were determined from 2018-IMC Table 403.3.1.1. Exhaust ventilation requirements have been summarized in the table below.

EXHAUST AIR	Total Exhaust Airflow	Qty. Diffusers	Airflow per Diffuser**
Exhaust - North Bathroom	70 CFM	1	**70 CFM**
Exhaust - South Bathroom	70 CFM	1	**70 CFM**
Exhaust - Utility Room	5 CFM	1	**5 CFM**
Exhaust - Workroom (kitchen hood)	450 CFM	1	**450 CFM**
Exhaust - Elev. Shaft (Pressure Relief Damper)	786	1	**786 CFM**

Figure M-4: Exhaust air grilles and louvers design airflow. All exhaust airflow values are in accordance with 2018 International Mechanical Code.

The utility room and elevator shaft are designed with natural ventilation. The utility room is served by a wind-turbine on the roof with a gravity backdraft pressure damper inside the ductwork near roof level to seal the room from outside air. A typical detail of the gravity ventilator is shown on sheet 2/M3.1 (detail 2). Likewise, the elevator shaft hoist way ventilation is regulated by a backdraft pressure relief damper, but the air is discharged through an aluminum storm-resistant louver in the elevator shaft East CMU wall.

The workroom exhaust hood is designed in combination with a centrifugal rooftop upblast exhaust fan. This fan also has a gravity backdraft damper in the ductwork near roof level to seal the room from outside air. The kitchen hood discharges 450 CFM from the Workroom, the rooftop fan discharges this 450 CFM to the atmosphere, per 2018-IMC. The total demand cooling load in the workroom is 232 CFM. An independent Makeup Air Unit is designed to serve the room, per 2018-IMC. The supply airflow on the unit is 682 CFM. The return airflow on the unit is 232 CFM to match the positive airflow from the workroom's supply diffuser, which is based on the demand cooling load.

4. *Mechanical Fans:*

The design static pressure for all mechanical fans was determined by summing the pressure drops in the duct systems that have to be overcome by the mechanical fan. The sum of these pressure drops is calculated to be the external static pressure (ESP) required to be overcome by the exhaust fan. The duct pressure losses in duct fittings and dampers were defined using ASHRAE coefficients. A fan's design airflow is based on the required exhaust rate (in CFM's). These values are listed in the table below.

Table M-3: Calculated static pressure for exhaust fan systems on third floor serving the bathrooms (EF-1 and EF-2) and Workroom (H-x/EF-3).

TAG	ROOM SERVED	CFM	SP "(WG)
EF-1	NORTH BATHROOM	70	0.72
EF-2	SOUTH BATHROOM	70	0.32
H-x	CAFÉ WORKROOM	450	0.28

TAG	TYPE	SYSTEM	FAN CHARACTERISTICS				
			NOM. CFM	MOTOR HP (hp)	ESP (W.C.)	FLA	V / PH / HZ
MAU-1	SPLIT-SYSTEM, DIRECT-FIRED GAS, VARIABLE SPEED	ACCU-1	682	0.11	0.95	0.32	208 / 3 / 60

TAG	TYPE	SYSTEM	FAN CHARACTERISTICS				
			NOM. CFM	MOTOR HP (hp)	ESP (W.C.)	FLA	V / PH / HZ
FU1	SPLIT SYSTEM, GAS, VARIABLE SPEED	ACCU-1	6715	5.39	4.59	15.5	208 / 3 / 60

5. *Refrigerant Piping:*

The air-cooled condensing unit on the roof is connected to the evaporator coil inside the Utility Room by refrigerant line piping specified to be Copper Type K pipe. The suction line and liquid line total lengths were calculated to be (80) feet and (71) feet, respectively. This required the long line set method to be used for sizing the refrigerant lines. R-410A was selected as the design refrigerant type, since this is the industry standard and therefore most cost economical. A Carrier Design Guide and associated tables were used to determine the pipe sizes based on the cooling capacity (20 tons) and maximum total equivalent length (rounded up to 100 feet).

Table M-2: Long Line Set sizing chart used from Carrier design guide for sizing of refrigerant lines.

TABLE 5: R-410A LIQUID LINE, MAXIMUM RISE CHART

Tons	Line Size	Maximum Total Equivalent Length								Velocity FPM
		75	100	125	150	175	200	225	250	
1.5	5/16	75	90	85	85	80	75	75	70	223
	3/8	75	100	95	95	95	95	90	90	138
2.0	5/16	75	80	75	70	65	60	55	50	297
	3/8	75	95	90	90	85	85	85	80	184
2.5	3/8	75	90	85	85	80	80	75	70	230
	1/2	75	100	100	100	100	95	95	95	123
3.0	3/8	75	85	85	80	75	70	65	60	276
	1/2	75	100	100	95	95	95	90	90	148
3.5	3/8	75	80	75	70	65	60	55	50	322
	1/2	75	95	95	95	95	90	90	90	173
4.0	3/8	75	75	70	60	55	45	40	35	368
	1/2	75	95	95	95	90	90	90	85	198
5.0	3/8	70	60	50	40	30	20	10	0	*460
	1/2	75	95	90	90	85	85	80	80	247
7.5	1/2	75	80	80	75	70	65	60	55	370
	5/8	75	95	95	95	90	90	90	85	231
10	5/8	75	90	90	85	85	80	80	75	307
	3/4	75	100	95	95	95	95	90	90	210
12.5	5/8	75	85	85	80	75	70	65	65	384
	3/4	75	95	95	90	90	90	90	85	262
15	3/4	75	95	90	90	85	85	85	80	315
	7/8	75	100	95	95	95	95	95	90	222
20	3/4	75	85	85	80	75	70	70	65	419
	7/8	75	95	95	90	90	90	85	85	296
25	7/8	75	95	90	90	85	85	80	75	371
	1-1/8	75	100	100	100	95	95	95	95	217

***Note**: Exceeds recommended maximum velocity of 400 fpm, consider noise when selecting this pipe size.

The suction line shall be ¾" diameter, and the liquid line shall be ½" in diameter. All refrigerant piping is to be Copper Type K piping.

6. *Natural Gas Piping:*

All Natural Gas piping was selected based on the Longest Length Method per 2018 UPC Section 1215.1 and 2018-UPC Table 1215.2(1) [NFPA 54: Table 6.2(B)]. A conversion factor of (1,062) Btu/CF was used per U.S. Energy Information Administration data on heat content of natural consumed for the state of Iowa. Average delivery pressures of Natural Gas from MidAmerican Energy (Natural Gas provider) is standard above 7" w.c. per MidAmerican Energy's specifications. This confirms no pump is required for the natural gas line.

All gas piping shall be 2" in diameter. However, it should be noted all takeoffs to single units off of the main branch lines should be sized based on manufacturer's recommendations and requirements for the furnished equipment.

Section VI-4: Electrical

1. *Electrical Lighting*

Lighting calculations were based on the required illuminance per 2018 International Building Code Section 1204.3 Artificial Light, which requires an average illumination of 10 footcandles (107 lux) over the area of the room at a height of 30" above floor level. The total estimated lighting load demand is (4,000) VA or (4,000) Watts.

1.1. Lighting Controls:

Lighting controls details are included on Sheet E3.0, details 1 and 2. Detail 1 shows power connections for combination occupancy sensors connected to one lighting load. This situation occurs in the café area and near the bathrooms. This is due to one occupancy sensor not being able to capture all areas where motion should be detected due to the orientation of new interior walls. Detail 2 shows the wiring details for power wiring of the occupancy sensor and a 120V relay connected to an exhaust fan. This detail applies to the switch systems in the bathrooms at the Southeast end of the third floor. The design calls for the occupancy sensors to tie into the exhaust fan serving the bathroom through means of a 120V one-line relay. This is so that the exhaust fan only runs while the lights are on, which means the exhaust fan will exhaust the space until the bathroom has been occupied long enough for the timer to shut off. The timer shall shut off after 5 minutes.

Lighting controls are included in the design for the exterior lighting at the balcony. Wall sconce lights are specified with up and down light ray directions. The light fixtures are to be wall-mounted on the brick veneer between the 16’x9’ window bays. These wall lights should be controlled by a daylight photo sensor with a programmable and adjustable timer. Photocell switch system shall turn the lights on when no natural light is detected (at dusk). The timer connected to the photocell shall be programmed to shut off the lights after 7:00PM.

1.2. Retail Lighting:

All areas of the third-floor retail space meet the required 10 footcandle illuminance with existing light fixtures. This will allow the existing 8’-0” light fixture housings (and locations) to be re-used. Only (1) light fixture will need to be added in the retail area at the Southeast corner. This is due to the new orientation of the space from the addition of the workroom and bathrooms, cutting off light from the area to a larger degree.

1.3. Café Lighting:

Café lighting was designed with a far greater illuminance than the retail area due to the vibrance of the café space. The average illuminance across the café area is approximately 40 fc. The increased illuminance will promote an optimal environment for focused work, and subtly set the café space apart from the rest of the retail area, highlighting the café’s features.

1.4. Workroom Lighting:

Workroom lighting was designed with increased illuminance than required per code for optimal lighting during cooking operations. The average illuminance in the Workroom is 49 fc. This will be most suitable for employees that will utilize the space. Lighting has also been specified to be equipped in the commercial exhaust hood. This lighting will be provided by the manufacturer of the hood, and power will need to be brought to the hood the by the Electrical Contractor.

2. <u>Electrical Power:</u>

Electrical power design includes reuse of existing boxes and conduit raceways where possible on the exterior walls, as well as additional receptacles being added on new locations at columns and new interior walls. All electrical calculations were performed in accordance with 2020 National Electric Code and can be referenced in the attached Appendix E.

2.1. Electrical Distribution Panels

There are three electrical distribution panels called to be installed in the third-floor utility room:

LPB-1	Lighting Panelboard
PPB-1	Power Panelboard
EPB-1	Equipment Panelboard

All panels are 3-phase power fed from 208V MDB. PPB-1 has the most loading connected, which is why 225 A mains are specified. LPB-1 and EPB-1 are specified with 100 Amp mains. All electrical circuit wire sizing and voltage drop calculations were performed in Revit in accordance with 2020 NEC 70E.

The total added electrical loading from the third-floor design was calculated to be 64 kVA. The existing building's power usage and transformer were unable to verified unfortunately, but in the case the transformer is found to be inadequate for the added loading in the field, 75 kVA minimum transformer capacity should be included for the third floor.

TRANSFORMER SIZING			
	Volts (3-phase)	208	
	Current Draw (A)	177	
	kVA	*64 kVA*	$kVA = \frac{(V * I * 1.732)}{1000}$
Added Transformer Power Required:		**75 kVA**	

Figure E-1: Added transformer loading from third floor design.

3. *Fire Alarm Notification System:*

3.1. Identification Device Circuits:

Zone 1 is the third-floor IDC loop. This includes a manual pull station located near the café, combination smoke and carbon monoxide detectors near gas appliances, and all smoke and heat detectors in the third-floor space.

Zone 2 is a Style B (Class B) Waterflow/Supervisory circuit for the third-floor wet sprinkler system. This identification device circuit includes a UL Listed Supervision Relay connected to a 4-Wire Smoke Detector. The supervision relay shall be of type "Tamper". The 4-wire smoke detector ties the alarm flow switch on the fire protection riser to the fire alarm control panel. If flow or a pressure drop in the main directly off the riser is detected, the alarm flow switch will signal the supervision relay switch in the 4-wire smoke detector. This supervision relay will signal an alarm to the fire alarm control panel for Zone 2.

Zone 3 is the elevator hoistway fire alarm identification devices and elevator fire alarm controls. An elevator Fire Alarm Controls Wiring Diagram has been included in the contract drawings on Sheet E3.1. This zone includes a smoke and heat detector at both the top and bottom of the elevator shaft, a smoke detector in each elevator lobby, addressable relay modules for fire fighter indication controls in elevator car, a shunt trip breaker, 30 A Fusible disconnect switch and 15 A fusible disconnect switch. Since the FA system is conventional, a dummy panel will be required to act as the addressable panel for the relay modules to signal the elevator shunt trip breaker.

Zone 4 is a spare zone, reserved for future use. All unused circuits should be dummy loaded with a 4.7k, ½ W resistor. It should be noted a fire alarm panel with more than 4 zones would be compatible for this design if a contractor proposes such a panel. Increasing zones on a fire alarm panel increases the cost of the panel however, which is why only one spare zone was included in the design.

3.2. Notification Appliance Circuit:

Ceiling horn strobes were designed with (75) candela strobes, which will require a spacing of 45' on-center, with rows 45'-0" apart.

Voltage drop was computed with a derated voltage of 20.4 VDC (85%). The design wire size selected for the NAC circuit is 14 AWG Solid (VD % = 7.2887). See attached calculations for details.

3.3. Duct Detectors:

Duct Detectors are required in supply and return mains with airflow greater than or equal to (3000) CFM per 2018 International Mechanical Code. Duct detectors are required in the ACCU-1/FU-1 HVAC system, but not the makeup air unit system (MAU-1). These duct detectors are shown on the mechanical drawing. The scope is referenced in the electrical drawings as well, and should be included in the electrical contractor's scope.

3.4. Fire Alarm Control Panel (FACP):

The fire alarm control panel design calls for a fire alarm panel with 4 zones. The fire alarm panel to be furnished should include the following components:

i. Power Supervision Relay with: resettable power output 24 VDC filtered, power-limited to smoke/heat detectors (Initiating Device Circuits), and a non-resettable power 24 VDC filtered, power-limited to NAC circuits.
ii. The Notification Appliance Circuit serving the third floor shall be Style Y (Class B) 2.5 amps max. per circuit. The total current draw calculated for the NAC circuit is 2.1 Amps.
iii. The Identification Device Circuits shall be Style B (Class B). Alarm and Supervision Circuits shall be Form-C Contacts: CLOSED-NORMALLY CLOSED-NORMALLY OPEN; Resistive Contact Rating: 2.0 Amps @ 30 VAC
iv. The Trouble circuit shall be Form-C Contacts: CLOSED-TROUBLE-NORMAL; Resistive Contact Rating: 2.0 Amps @ 30 VAC

The design calls for 120 VAC single phase power input to the panel. The panel requires a battery backup. The battery size required was calculated in accordance with NEC 70 (NFPA 70E) and found to be (6.6) Amp-Hours. The supplied battery size/capacity should be 10 Amp-Hours (next battery size up), which adds an actual factor of safety of (45)%.

4. <u>Speaker Communication System:</u>

The speaker communication system design calls for 24 VDC self-amplifying speakers. The reasoning for selecting this system, include: (1.) it's ease of future expansion during future renovations, and (2.) it's ability to work in smaller zones making it the cheaper solution for a speaker system on the third floor. Each speaker has an individual, built-in miniature amplifier that drives the speaker directly. Each speaker requires 4 wires. Two wires to supply the raw 24 VDC voltage to power the speaker's internal amplifier, and another two wires to supply the low-level audio paging signal to the amplifier's input. All amplified speakers contain volume controls to adjust output level.

A power supply head-end unit is included in the design to provide the raw 24 VDC voltage that will power the built-in amplifiers in each self-amplified speaker. The power supply required was calculated to be (19) W, therefore a 24W power supply should be supplied. The total resistance experienced is (0.48) kOhms. This power supply could be located in several different areas of the building at the Owner's discretion. Two suggestions proposed for its location are the Utility Room and Workroom. The workroom is proposed as a contract drawing Alternative, since this will greatly reduce the homerun wire length required for the speaker system.

Section VI-5: Plumbing

1. Plumbing Fixtures:

1.1. Bathrooms:

Two individual use bathrooms (one male, one female) were designed in accordance with 2018 IBC Chapter 10 Table 1004.5. These bathrooms are located in the South East corner of the building. Per 2018 IBC Section 2902.2, separate male and female facilities are required since the maximum occupant load is greater than (100) people. Each bathroom includes a lavatory and wall-mounted water closet with a 1.6 gallons-per-foot (gpf) flushometer valve. A wall-mounted urinal was not included in the male bathroom since it is not required per 2018 IBC. The male and female bathrooms are designed with identical plumbing fixture types and specifications specified in the contract drawings for the most cost economical design.

1.2. Café Workroom:

The workroom includes a stainless-steel double bay sink connected to a grease trap downstream of the sink. A dishwasher and floor drain are also served in the workroom. See the grease trap final details subsection for more information.

1.3. Utility Room:

A mop sink is designed in the Utility Room. The sink is called to be floor-mounted for easy use during housekeeping tasks, such as mopping. The mop sink has both hot and cold-water fixtures, since it was assumed hot water would be necessary for some cleaning solutions.

1.4. Miscellaneous Details:

Since no manufacturer's or models are specified at the design development phase, the plumbing fixture schedule on Sheet P0.1 shows the design waste fixture units (WFU), hot water fixture units (HWFU), and cold water fixture units (CWFU). This is so that the awarded contractor for the project can verify the furnished plumbing fixtures do not greatly vary from standard fixture unit values, which could impact fixture unit demand downstream of the plumbing fixture and effect pipe sizing. All piping near connection points to plumbing fixtures (+/- 3') should be sized per the manufacturer's requirements of the furnished fixture.

Table P-3. Plumbing fixture schedule

PLUMBING FIXTURE SCHEDULE					
Tag	Type and Description	Elevation	WFU	HWFU	CWFU
L1	Lavatory - Wall Mounted: 19"x14" - Private	2' - 9"	1	0.5	0.5
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
WC	Water Closet - Flush Valve - Wall Mounted: Public - Flushing 1.6 gpf Flushometer	0' - 0"	6	0	5
L1	Lavatory - Wall Mounted: 19"x14" - Private	2' - 9"	1	0.5	0.5
WC	Water Closet - Flush Valve - Wall Mounted: Public - Flushing 1.6 gpf Flushometer	0' - 0"	6	0	5
S2	Sink - Kitchen - Double: 42"x21" - Private	0' - 0"	2	1	1
FD	Floor Drain - Round: 5" Strainer - 4" Drain	0' - 0"	4	0	0
FD	Floor Drain - Round: 5" Strainer - 4" Drain	0' - 0"	4	0	0
S1	Sink - Island - Single: 18"x18" - Public ***	0' - 0"	2	3	3
S3	Sink - Work: 20"x18"	0' - 0"	2	2.25	2.25
DW	Dishwasher - Commercial 36" wide**	0'-0"	2	1.5	1.5
RF-1	Refrigerator ^			0	0.5

*** Dishwasher waste and domestic demand final determination is based on dishwasher manufacturer's requirements. WFU's, HWFU's and CWFU's were selected based on 2018 UPC Table A 103.1 (Appendix A) Dishwasher, domestic FU's. A safety factor was added in case a commercial grade dishwasher should be selected that would result in higher water demand. (2018 UPC FU's 1.5, Safety Factor 1.0)*

^ No identified FU's per 2018 UPC.

**** Café counter sink is slightly oversized for anticipation of more connections to water line in future, and to account for peak demand times of café traffic.*

General Note: *Floor and wall Cleanouts have been specified in design, but are not included in schedule due to no impact of FU values.*

2. *Domestic Water:*

The 2018 Uniform Plumbing Code Appendix A Design Standards were used for sizing of water supply plumbing system. Detailed tabulations for domestic pipe sizing can be referenced in Appendix P. All outlets to fixtures connected to the plumbing system were selected based on applicable code regulations listed under the 'Applicable Codes' section of this Technical Report.

The supply demand for the third floor main, principle branches and risers of the system were sized using 2018 UPC Chapter 6 Table 610.3.

The highest group of fixtures contains flushometer valves. This group of fixtures determined the minimum residual pressure required for the group, which should be not less than (15) psi. The pressure available for friction loss in supply pipes for the entire building was found to be (36) psi. The third-floor piping's average permissible friction loss per 100-ft. of pipe was found to be (13.10) psi/100-ft of pipe.

2.1. Hot Water Return Loop:

The hot water return loop connects to the tankless hot water with a recirculation pump, backflow preventer and pressure relief valve at the end of the loop (near the water heater). Check valves (one-way flow valves) are specified at the beginning and end of the HWR line to ensure a hydraulic separation between the return and supply hot water lines.

The Hot Water Return Loop (HWR) is sized as half the size of the building supply main for the third floor in order to allow a more efficient recirculation pump curve on the Hot Water Return Loop. The return loop and pump were sized for a temperature differential of (20) degrees Fahrenheit for the full loop. The water will leave the tankless water heater at (140) degrees Fahrenheit. Therefore, at the farthest point of the DHW/beginning of the HWR loop, the temperature will be approximately (130) degrees Fahrenheit due to heat loss.

Slightly oversizing the supply piping will allow a more efficient water heater process (less temperature difference to increase), and a smaller (more efficient) pump can be chosen. It is important to note, the third-floor principle branches were sized based on the same method as the building supply (2018 UPC Chapter 6 Table 610.3), instead of the method used for sub-branch lines (2018 UPC Appendix A Chart A 103.1(2).) This resulted in a more cost economical hot water return pump by sizing the supply lines larger due to a better flow and pressure head pump performance curve resulting.

2.2. HWR Recirculation Pump

The recirculation pump is sized per ASPE Plumbing Engineering Design Handbook based on a 20-degree temperature differential from the water heater out to the farthest fixture and back to the circulator near the water heater. If the system has 140-degree water in the water heater, then the sizing method maintains 130-deghree hot water at the end of the system and then back at the cold-water inlet to the water heater, the temperature would be approximately 120 degrees. The calculation is based on heat loss in the hot water piping circuit. It lists the British thermal unit loss per hour (BTU/h) losses for insulated and bare piping based on a 70-degree ambient temperature.

The recirculation pump performance parameters were found to be (6) GPM of flow and (20) feet of pressure head.

2.3. Tankless Hot Water Heater System:

The design GPM demanded for the tankless HW Heater is equal to the hot water demand by plumbing fixtures plus the flow required for the HWR loop. The tankless HW Heater design minimum output is (13) gpm. Detailed calculations have been attached in Appendix P.

TWH-1 FLOW DEMAND	
HW FIXTURES FU DEMAND:	8.75 FU
HW FIXTURES GPM DEMAND:	7.00 gpm
HWR LOOP GPM DEMAND:	5.43 gpm
DESIGN GPM DEMANDED	**12.43 gpm**
Tankless HW Heater Minimum Output:	**13 gpm**

Figure P-1: Tankless hot water heat design flow in gallons per minute (GPM).

The supply exhaust piping is permitted to be Schedule 40 PVC per 2018 UPC. Supply exhaust pipe sizing shall be based on manufacturer's requirements. This is because the supply pipe is only ran up vertically 3' feet with a 90 elbow at top end.

The exhaust piping for the water heater is permitted to be Schedule 40 PVC. Exhaust piping was designed to ensure maximum horizontal segments were not exceeded in accordance with 2018 UPC Chapter 5 Table 510.2.1.

The tankless hot water system can be upgraded for increased capacity by adding a storage tank, air separator, and an additional recirculation pump. This is optimal for the store, since peak demand fluctuations can be fast changing and at irregular intervals. Therefore, a storage tank system will balance the demand on the tankless hot water heater so that it can operate below capacity. The energy efficiency of a tankless hot water system with a storage tank is still more efficient than a standard hot water heater since the storage tank required is only 20-30 gallons.

3. *Sanitary Waste and Vent:*

Sanitary waste and vent piping were based on connected waste fixture unit (WFU) loading from plumbing fixtures. Waste fixture unit values used were in accordance with the specified drainage fixture unit values per 2018 UPC Chapter 7 Table 702.1. The drainage branch lines and main were then sized using UPC Chapter 7 Table 703.2. Detailed calculations have been attached in Appendix P, including a coordination drawing that call out the branch and main lines. Total waste loading from third floor to existing system is (37) WFU's. This will require a 4" Schedule 40 PVC waste pipe for the third floor main and connection to existing waste main on the first floor.

3.1. Plumbing Fixture Connections:

At the design development level of detail, plumbing fixtures are approximately located, the types of systems to be installed are specified in detail, and performance requirements are specified. However, manufacturers and models are not specified at this stage, and so, plumbing pipe within connection points to plumbing fixtures (+/3') should be sized based on the manufacturer's requirements of the furnished fixtures. Contractors should verify plumbing fixtures are in accordance with 2018 UPC plumbing fixture specifications. Design details that largely impact water/drainage fixture unit values have been specified in the contract drawings (e.g. wall-mounted commercial water closets with 1.6 gpf flushometer valves).

To ensure installed waste connections to plumbing fixtures meet the 2018 UPC drainage trap and trap arm requirements, 2018 UPC Table 702.2(1) has been included on Sheet P0.1 Plumbing General Notes. All connection piping to domestic water fixtures shall be based on manufacturer's requirements per 2018 UPC.

4. *Grease Interceptor (Workroom):*

All sinks in commercial kitchens require a grease interceptor to divert grease in waste flow from the building sewer. The grease interceptor was sized based on incoming flow rate of waste water. The waste fixture units (WFU) of the workroom commercial sink is (2) WFU. This equates to approximately (14) GPM of waste flow. The rated capacity of the grease interceptor (in pounds) is listed as twice the rated flow rate of the sink trap. Therefore, a 20 lb. grease interceptor is required for the workroom sink.

It also important to note, the design includes a secondary vent pipe directly upstream of the grease interceptor. This additional vent pipe is required as an air intake for the grease interceptor. The design shows this air intake sized the same as the kitchen sink vent pipe, which is in accordance with 2018 UPC. However, if the manufacturer of the furnished unit requires a differently sized air intake, the manufacturer's requirements should be followed.

5. *Miscellaneous Details:*

5.1. Fire-Resistant Construction:

All new interior walls are 1-hour fire-rated partitions. Included in the design are requirements for the piping penetrations through rated walls, shaft enclosures, and roofs/ceilings assemblies to be protected in accordance with the requirements of the local building code (2018-IBC) and 2018 UPC Chapter 14 "Firestop Protection", per 2018 UPC Section 312.7 Fire-Resistant Construction.

Section VI-6: Fire Protection

1. *Sprinkler System Coverage Area:*

The design coverage areas specified in Table F-1 below are within the maximum allowable coverage areas per NFPA 13 Table 8.6.2.2.1(b).

Table F-1: Selected design parameters for third floor sprinkler system. These parameters are specified on Sheet F0.1.

DESIGN GENERAL REQUIREMENTS:			
Maximum Spacing per NFPA:			
Light Hazard, Non-Combustible, Unobstructed			220 SF
Ordinary I Hazard			130 SF
Design Sprinkler Spacing:	15' x 12'	180 SF	
15' x 12' Optimal spacing in relation to new ductwork			

The total flow required for light coverage and Ordinary I hazard areas equaled (851 gpm) and (41) gpm, respectively. The approximate flow (total demand) for third floor was calculated using an Overflow Rate of (1.3), a Hose Allowance of (250.0) gpm, and the required flow based on coverage area. This resulted in approximate flow required of (1410) gpm for the entire third-floor sprinkler system.

2. *Sprinkler Heads*:

All sprinkler heads are designed to be industry standard type ½" orifice NPT with a nominal K-Factor of 5.6 GPM/psi$^{1/2}$. This a laboratory tested value that sprinkler head vendors and NFPA use to standardize different sprinkler head types. The design K-Factor is in accordance with NFPA 13 Table 6.2.3.1 Sprinkler Discharge Characteristics Identification. These are the most common sprinkler head type, and therefore, the lowest cost. The design flow rate at the critical sprinkler – farthest sprinkler head from street service – was calculated to be (20) gpm.

Table F-2: Sprinkler discharge characteristics per NFPA 13 Table 6.2.3.1.

Nominal K-Factor [gpm/(psi)$^{1/2}$]	Nominal K-Factor [L/min/(bar)$^{1/2}$]	K-Factor Range [gpm/(psi)$^{1/2}$]	K-Factor Range [L/min/(bar)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	20	1.3–1.5	19–22	25	1⁄2 in. NPT
1.9	28	1.8–2.0	26–29	33.3	1⁄2 in. NPT
2.8	40	2.6-2.9	38–42	50	1⁄2 in. NPT
4.2	61	4.0-4.4	57-63	75	1⁄2 in. NPT
5.6	81	5.3-5.8	76-84	100	1⁄2 in. NPT

Table F-3: Minimum required sprinkler heads per NFPA 72 and design quantity of sprinkler heads per room.

SPRINKLER ROOM SCHEDULE			
Room	**Hazard Classification**	**Min. Required Sprinkler Heads**	**Design Sprinkler Heads**
Cafe Seating	Light	8	9
Retail	Light	30	37
Bathrooms	Light	1	1
Workroom	Ordinary I	2	2
Utility Room	Ordinary I	1	1

3. *Fire Protection Piping*:

The design pipe material for the wet-pipe sprinkler system shall be Black Steel Pipe. A Hazen-Williams coefficient of 120 was used per NFPA 13 Section 23 Table 23.4.4.7.1 Hazen-Williams C Values. Pressure losses in piping fittings was determined by the equivalent length method and using NFPA 13 Table 23.4.3.1.1.

The total pressure losses relative to the critical sprinkler head was found to be (20) psi. The pressure at the water main service is (60) psi, which gives the available pressure loss in pipes and fittings to be (40) psi. This confirmed a fire pump is not needed for added pressure. Total demand flow rate at fire protection service main is approximately (2819) gpm. Detailed calculations of all hydraulic calculations have been attached in Appendix F.

Section VI-7: Traction Elevator System

1. *Traction Gearless Machine-room less Elevator System*:

Two possible elevator manufacturers have been identified to work for this project:

1. Kone, Inc.
2. Schindler Group

The traction elevator system design calls for an AC gearless machine room-less elevator system. The elevator machine shall be located at the top of elevator hoistway, and shall be AC gearless, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway. The variable voltage variable frequency AC drive system will develop high starting torque with low starting current, resulting in less power consumption. The controller location shall be located on the front wall integrated with the top landing entrance frame, machine side of the elevator. A separate control space should not be required. The machine location shall be located inside the hoistway mounted on the car guide rail.

The replacement elevator design, includes:

i. 208V 3-Phase Main Power Supply
ii. 2000 lbs rated capacity
iii. Rated speed of 150 fpm
iv. Regenerative drive (optional) for redistribution of energy back into building electrical distribution system.

The elevator will serve the basement, first floor and third floor, with all three elevator door openings being front openings. The entrance height shall be 7'-0" so that no modification will need to be made to the existing opening. The door shall open from the right side (to accommodate orientation of basement lobby better), and shall be a width of 3'0".

Car Lantern and Chime: A lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound. The chime will sound once for up and twice for down.

The design calls for a simplex collective operation by means of a microprocessor- based controller, in which the operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.

The design calls for an emergency battery power supply. When the main line power is lost for longer than 5 seconds the emergency battery power supply provides power automatically to the elevator controller. The elevator will rise or lower to the first available landing, open the doors, and shut down. The elevator will return to service upon the return of normal main line power. An auxiliary contact on the main line disconnect and shunt trip breaker will be provided by electrical contractor.

An elevator fire alarm controls wiring diagram is included in the contractor drawings on Sheet E3.1 and should be included in the electrical contractor's scope.

There is no special elevator for transporting goods or food materials from the ground level to 3rd floor. Elevator design does not include "Overriding Service" feature, since it is not a necessary item considering building use. As a result, employees and antique mall tenants will have to share the passenger elevator with customers. If the elevator system experiences daily usage from loading dock traffic for an extended duration of time, this could become somewhat of a challenge for employees and an enjoyable experience for customers. The overriding service is estimated to add $6,000 (selective car operation) if this was included in the design. While this is relatively not a high cost in comparison to the cost of the elevator system, this is one example of upgraded controls that would be ideal, but not necessary to add. These upgraded controls were excluded overall from the elevator specifications.

2. *Structural Components:*

The hoist beam for the elevator system and all connection details are to be designed by the elevator manufacturer. Design loads for the new elevator system's connection points were provided by the manufacturer. Please refer to the following figures for indication:

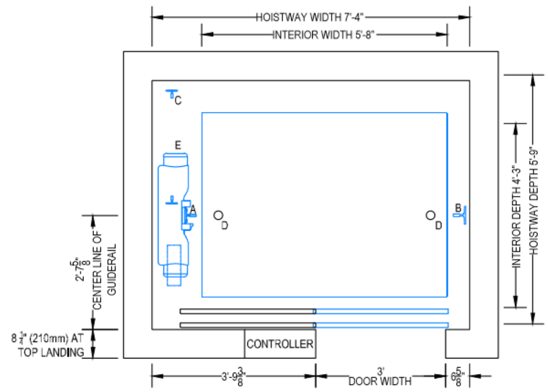

Figure I-1. Hostway plan view

Table I-1. Hoist beam and life line vertical forces

HOISTBEAM & LIFE LINE VERTICAL FORCES (lbf)				
REACTION LOCATION	A	B	C	D
Z DIRECTION	4800	4700	5000	5000

The existing CMU was analyzed at a compressive strength of 1000 psi which is the lowest possible strength of un-grouted CMU according to the Portland Cement Association. An allowable compression reduction factor of 0.45 was used in order to be conservative as possible with a potentially weak structure. All theoretical loadings are acceptable based on calculations.

Due to the age of the building, pre-construction calculations will not be enough to guarantee the strength of the elevator shaft. Once the current elevator is removed, a material-testing consultant will be hired to complete structural testing on the existing elevator shaft. The shaft walls would then be re-analyzed and reinforced as necessary.

Section VI-8: Contract Drawing Set Alternatives

1. <u>Skydeck</u>:

To give the new commercial building design a "wow" appeal, a new skydeck was proposed. This design would include a raised deck off the roof with two fireplaces, a walk-up bar, a vast amount of seating options, an overhead canopy, and a glass vestibule entrance. See below for visual references:

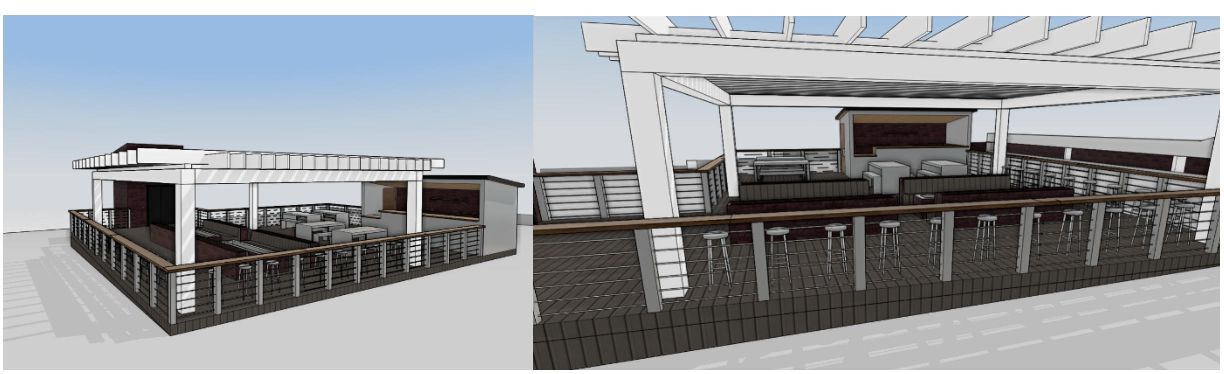

Figure G-4. Skydeck design

This alternate design was not chosen due the potential restructuring of a new and existing roof. The dead and live loads that would have been acting on the roof if this idea was chosen would have been too much for the existing members to handle. Other disadvantages include the high costs of exterior-resilient finishes and the increased elevator cost of making the roof ADA accessible.

Information regarding this design was still provided to the Owner in the drawing set with the intent that the Owner can use this information at a future point in time, either on the current building or a different building. The structural, architectural, and MEP scopes are defined and are accessible through the roof drawings on the architectural drawing set.

2. *Tankless Hot Water Heater Storage Tank Add:*

The tankless hot water was sized to have a minimum output of (13) gpm. This is sufficient to serve the bathrooms and café area on the third floor. However, if the Owner would wish to expand the tankless hot water system to the first floor as well, a storage tank in combination with the tankless system will be required. The storage tank with a tankless system will still be more efficient than a standard water heater, since the storage tank required is only roughly (20) gallons, to accommodate for peak demand intervals that the tankless system cannot keep up on its own. The added storage tank evens out these fluctuations in demand, so that the tankless system can operate at a continual rate. When there is low demand on the water heater and the storage tank is at capacity, the water heater will use the storage tank hot water to mix with the cold water at the inlet, reducing the required temperature differential to be achieved by the water heater. The storage tank also serves the domestic hot water line directly. This keeps the energy efficiency trait of the system, while still being capable of handling greater peak demand loads.

Included in the design is an additional recirculation pump for the tank, an expansion tank and air separator.

3. *Low Voltage Panel Relocation to Workroom:*

In the drawings a low voltage controls panelboard (CPB-1) is shown for reference in the third-floor Utility Room that could be used for HVAC controls and/or communications controls. A low voltage panel may not be required for HVAC controls since the mechanical equipment manufacturer's controls are specified to be used as the temperature controls system.

For a communication system head-end unit, locating the head-end in the Workroom would be a cheaper alternative for the communication system. Overall, less homerun wire will be required back to the panel.

SECTION VII: ENGINEER'S COST ESTIMATE

The cost estimate for our preliminary design was estimated using 2018 RSMeans Building Construction Costs Handbook. A detailed Schedule of Values (SOV) sheet has been attached for backup in Appendix J. The SOV quantifies project costs and materials with units, such as: linear feet (LF), lump sum (ls), each (ea), ton, and cubic feet (CF). The schedule of values breaks down costs by Construction Specification Institute (CSI) Division number. All cost items include overhead and profit of 25%. Industry standard is 10% for overhead and 5% profit, but a 25% markup is a conservative choice given by RSMeans.

The SOV also serves as a List of Materials.

All project costs have been categorized into hard or soft construction costs in accordance with the American Institute of Architects (AIA).

The estimated construction cost is $1,129,900. This includes hard construction costs of $943,900, soft costs of $74,500 and contingencies of $111,500. A +5% markup has been included for expected subcontracted work under another contractor. Therefore, this estimate is less conservative. Due to the limited quantity of certain work, it is not feasible to bid the work separately to a contractor, since the work is not worthwhile. In these cases, there will either be issues finding a contractor to bid the work, or you will receive an extremely high bid for the work. To avoid these scenarios, it is best to lump work together. For example, casework is often lumped with general trades, since there is not enough casework to have its own bid package for the project.

Table J-1: Total project costs by division. Costs do not include additional +5% markups. All values in Overhead & Profit markup of (25%).

COSTS BY DIVISION

Division 1	GENERAL REQUIREMENTS	$4,825
Division 2	EXISTING CONDITIONS	$5,147
Division 3	CONCRETE	$0
Division 4	MASONRY	$42,695
Division 5	METAL	$11,262.67
Division 6	WOODS, PLASTICS & COMPOSITES	$66,721
Division 7	THERMAL & MOISTURE PROTECTION	$5,743
Division 8	OPENINGS	$31,407
Division 9	FINISHES	$84,762
Division 10	SPECIALTIES	$24,700
Division 11	EQUIPMENT	$32,400
Division 12	FURNISHINGS	$31,500
Division 13	SPECIAL CONSTRUCTION	$0
Division 14	CONVEYING SYSTEMS	$230,145
Division 21	FIRE SUPPRESION	$51,455
Division 22	PLUMBING	$90,268
Division 23	HEATING, VENTILATING & AIR CONDITIONING	$101,965
Division 26	ELECTRICAL	$68.863
Division 27	TELECOMMUNICATIONS	$6,808
Division 28	ELECTRONIC SAFETY & SECURITY	$20,310
Division 31	EARTHWORK	$0
Division 32	EXTERIOR IMPROVEMENTS	$0
Division 33	UTILITIES	$0
ALLOWANCES		$54,713
CONTINGENCY		$111,514

1. *Allowances:*

Allowances included in the cost estimate are for foreseeable extra work that may be required due to the nature of the project being renovation work. These allowances include: unforeseen electrical work, additional masonry allowance, and a general trades allowance for miscellaneous work and demolition.

Allowances are purchased from the contractors as part of their contract. If any on the allowance remains at the end of the project, the Owner receives this money back when closing out the contractor's contract. Allowances are great for unforeseen work that is very likely to happen, since it alleviates the need for an official change order. Contractors markup a profit on allowances at base bid, so any work performed on allowance should not be charged with the overhead & profit on it. Note however, that the contractors still retain this overhead and profit at the end of the project, even if they return their allowance money that was not spent.

2. *Contingencies:*

Four contingencies in total have been included in the cost estimate based on our team's suggestion. These contingencies, include:

1. Asbestos Abatement
2. Lead Paint Remediation
3. Exterior Work Contingency
4. Overall Project Contingency

Testing of asbestos and lead paint has been included in the project's cost estimate as a soft cost because this work needs to be performed to identify if any materials are 'hot' with asbestos or lead. Whether or not remediation work will be required is an unknown at this time, which is why the remediation work (worst-case scenario) has been estimated by square footage and included in the estimate as a contingency.

The exterior work contingency is included in the case a major delay occurs in the project schedule due to an unknown, such as asbestos/lead remediation or having to require multiple mobilizations from contractors to work with the schedules of neighboring stores that will be open during the construction. The exterior work has been estimated as the cost for scaffolding and tarpaulin cover hung over the scaffolding, which is the cost required to complete the work in the winter.

3. *Hard Construction Costs:*

The hard construction costs include all costs that directly relate to material, labor and equipment to construct the project's design. All hard construction costs are directly attributable to trade contractors.

4. *Soft Costs:*

The project's soft costs include: necessary inspections, permit fees, furniture, general contractor overhead and profit, administration fees, builder's risk insurance, and asbestos/lead paint preliminary testing. All soft costs will be incurred by the project's design but are not directly relatable to a trade contractor.

SECTION VIII: APPENDICES

Appendix A: Methods and Design Guides

The following are methods and design guides used in combination to deliver drawings in accordance with the City of Clinton adopted building codes. The preliminary starting point for all codes was the 2018 International Building Code (IBC). The IBC classifies the building category type, and details specific requirements based on the building's occupancy and category type. These requirements are general in nature, and ensure all baseline requirements were followed, such as:

General Codes and Standards:

International Code Council. (2018). International Existing Building Code. Country Club Hill, IL.
International Code Council. (2018). International Building Code. Country Club Hills, IL.

Structural Codes and Standards:

American Society of Civil Engineers. (2016). *ASCE Minimum Design Loads and Associated Criteria for Building and Other Structures.*

American Wood Council. *National Design Standard for Wood Construction.* Leesburg, VA.

Amrhein, J. (2000). *Reinforced Masonry Engineering Handbook Clay and Concrete Masonry.* Los Angeles: Masonry Institute of America.

American Institute of Steel Construction, *Manual of Steel Construction, 15th Edition*.

Mechanical Codes and Standards:

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (2017). ASHRAE *Handbook- Fundamentals.*

Plumbing Codes and Standards:

International Association of Plumbing and Mechanical Officials. (2018). *Uniform Plumbing Code*. Ontario, CA: the International Association of Plumbing and Mechanical Officials.
American Society of Plumbing Engineers (ASPE)

Fire Protection Codes and Standards:

International Code Council, INC. (2018). *International Fire Code*. Country Club Hills, IL.
National Fire Protection Association. (2017). *National Fire Code*. Bostion, MA.

National Fire Protection Association. (2020). *National Electrical Code*. Quincy, MA.

Electrical Codes and Standards:

International Code Council, INC. (2018). *International Energy Conservation Code*. Country Club Hills, IL. National Fire Protection Association. (2017). *National Fire Code*. Bostion, MA.

Elevator Codes and Standards:

American Society of Mechanical Engineers. (2017). *Safety Code for Elevators and Escalators*. New York. International Code Council, INC. (2018). *International Mechanical Code*. Country Club Hills, IL.

Appendix B: Permits and Government Approvals

Electrical Building Permit Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA
EASY-APP FOR BUILDING PERMIT ELECTRICAL
ELECTRIC

REQUIRED INFORMATION

Permit Address	241-247 5 Ave S, Clinton, IA
Contractor Name	
State License #	
Phone #	
Contractor Address	
City, St, Zip	
E-mail	
Owner Name	Bill Twyford
Owner Address	
City, St, Zip	
Phone #	
E-mail	billtwyford@aol.com

CITY USE ONLY
PIN:
PERMIT #
INSPECTIONS REQ'D
Temp Electric
Svc/Panel Energize
Rough/Cover
Final
Hard-wired Smokes
____
Fee: $

Type of Occupancy — Residential — Commercial — Industrial

Service Voltage: 208V

Service size: ________ — Single phase / Three phase

Type of release: Temporary / Permanent / Rewire / Rehook

Estimate of construction project cost: $ 1,129,900

Additional work to be performed:
New Lighting
Fire Alarm Notification System

I agree to perform all work in accordance with the adopted codes of the City of Clinton, Iowa.

2018 International Building Code
2018 International Residential Code
2017 National Electric Code

Owner/Agent Signature ____________________ Date ____________

Certificate of Occupancy #3 Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA

EASY-APP FOR BUILDING PERMIT AND CERTIFICATE OF OCCUPANCY - #3

RESIDENTIAL (1 & 2 Family) | **COMMERCIAL (Multi-res, 3 + units & Commercial)** | **INDUSTRIAL**

BUILDING DATA

Building Address: 241-247 5 Ave S, Clinton, IA

Expected Start date:

Expected Occupancy date:

Use & Occupancy: Mercantile

Flood Plain (Elevation):

Zoning:

Code Edition: 2012 2018

TYPE OF WORK

New

Remodel

Addition

Accessory Bldg

Attached

Detached

RESIDENTIAL BASEMENT

Unfinished (No occupancy)

Finished w/Egress windows

Bedroom (#)

Bath (#)

Family Room (#)

Finished basement requires 1 hr rated mech room

OWNER

Name: Bill Twyford

Address:

City, St, Zip:

Phone:

E-mail: billtwyford@aol.com

SIGN

TYPE:	Pole	Monument	Fascia	Roof
SIZE:	Total Height		Copy Area	
VALUATION:	$		Fee: $	

ARCH/ENGINEER

Name:

Address:

City, St, Zip:

Phone:

E-mail:

GENERAL CONTRACTOR

Name:

Address:

City, St, Zip:

Phone:

E-mail:

State Reg #

FOR CITY USE ONLY

PERMIT #

Zoning:

Use & Occupancy:

Sprinkler Required? YES NO

Code section allowing non-sprinklered building:

Size of Bldg: X = sq ft

Height: # Floors:

Legal:

VALUATION

No review will be performed without an estimated cost of construction:

Estimated Cost of Construction: $ 1,129,900

Fee to be determined by the City $

NOTES

2018 International Building Code, Residential Code, Mechanical Code, Zoning Code, Fuel Oil/Gas.

2018 Uniform Plumbing Code, 2017 National Electrical Code

APPROPRIATE DOCUMENTS

No review will be performed without all required construction documents :

For new construction on a vacant lot, stamped survey attached

Site Plan attached (Topo for SWPP)

Contractor Information Worksheet attached w/license info

Building Plans stamped and attached (One stamped full set, one pdf)

SIGNATURES

I certify that I am the owner of the property, or, the gerneral contractor/agent for the owner for this project.

DBA Name:

OWNER SIGNATURE **Date** **CONTRACTOR SIGNATURE** **Date**

Deck Building Permit Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA

EASY-APP FOR BUILDING PERMIT DECK

Permit Address	**241-247 5 Ave S, Clinton, IA**
Contractor Name	
State License #	
Phone #	
Contractor Address	
City, St, Zip	
E-mail	
Owner Name	Bill Twyford
Owner Address	
City, St, Zip	
Phone #	
E-mail	billtwyford@aol.com

CITY USE ONLY
PIN:
PERMIT #
INSPECTIONS REQ'D
Zoning
Post depth
Framing/Final
☐ Cost of Deck $
Is this a corner lot? Yes
Property lines known/marked? Yes
Utilities located? TBD
Will deck be in front yard? (May extend up to 15' into front yard setback)
Height from grade to top of deck floor? Aproximately 14ft
Depth , size, spacing of posts? (42" min/min 4X4/suggest 6')
Size of piers? (12" min suggested)
Size & no of support beams? (Depends upon size of deck) Cantilever
Size, spacing of joists? (Depends upon size of deck) 1.75x11.75 @16"
Thickness of deck flr?
Deck ledgered to house? (Suggested)
Stair rise & tread? (Min 7 3/4 & 11)
Height of guard/hand rail? Spindle width? (Min 34"/4" or less) 34"

Sketch of property with dimensions to lot lines and other buildings

N

W E

S

I agree to perform all work in accordance with the adopted codes of the City of Clinton, Iowa.

2018 International Residential Code

2018 International Zoning Code

Chapter 159 Zoning Ordinance

Owner/Agent Signature ____________________ Date ____________

Water Heater Building Permit Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA
EASY-APP FOR BUILDING PERMIT PLUMBING
WATER HEATER / PLUMBING

Permit Address	**241-247 5 Ave S, Clinton, IA**
Contractor Name	
State License #	
Phone #	
Contractor Address	
City, St, Zip	
E-mail	
Owner Name	Bill Twyford
Owner Address	
City, St, Zip	
Phone #	
E-mail	billtwyford@aol.com

CITY USE ONLY
PIN:
PERMIT #
INSPECTIONS REQ'D
Undergrd Plumb
Rough/Cover
Rough/Cover
Final
Grease Interceptor
Water Heater
____

Type of occupancy — **Residential** — **Commercial** — **Industrial**

Plumbing:

	Additional notes:
Water Heater, Gas	
Water Heater, Electric	
Water Heater, Tankless	Yes
Piping, install or conversion	Install
Geothermal	
Grease Interceptor	Yes
Other ________	

CITY USE ONLY

SERIAL # ____________

MODEL # ____________

BRAND ____________

GALLONS: ______

FUEL TYPE: GAS | ELECTRIC

VENT TYPE: DRAFT / POWER | Disconnect req'd and in place

Estimate of construction project cost: $ **1,129,900**

I agree to perform all work in accordance with the adopted codes of the City of Clinton, Iowa. (2012 accepted until October 1, 2019)

2018 International Building Code — 2018 Uniform Plumbing Code

2018 International Residential Code — 2018 International Mechanical Code

Owner/Agent Signature ____________ Date ____________

THE UNIVERSITY OF IOWA

Y | A | M

Mechanical Building Permit Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA

EASY-APP FOR BUILDING PERMIT MECHANICAL

HVAC

Permit Address	**241-247 5 Ave S, Clinton, IA**
Contractor Name	
State License #	
Phone #	
Contractor Address	
City, St, Zip	
E-mail	
Owner Name	Bill Twyford
Owner Address	
City, St, Zip	
Phone #	
E-mail	billtwyford@aol.com

CITY USE ONLY
PIN:
PERMIT #
INSPECTIONS REQ'D
Undergrd Plumb
Rough/Cover
Rough/Cover
Final
Furnace
Air Conditioner
Fee: $

Type of occupancy **Residential** **Commercial** **Industrial**

HVAC:

- Furnace, Gas
- Furnace, Electric
- Boiler
- Baseboard, Electric
- A/C Install
- Gas piping, install
- Gas piping, conversion
- Geothermal
- Supplemental unit install
- Othe ________

Additional notes:

CITY USE ONLY

SERIAL # ________

MODEL # ________

BRAND ________

FUEL TYPE: GAS | ELECTRIC

VENT TYPE: DRAFT POWER | Disconnect req'd and in place

Estimate of construction project cost: **$ 1,129,900**

I agree to perform all work in accordance with the adopted codes of the City of Clinton, Iowa. (2012 Codes accepted until October 1, 2019)

2018 International Building Code   2018 Uniform Plumbing Code

2018 International Residential Code   2018 International Mechanical Code

Owner/Agent Signature ________   Date ________

The University of Iowa

Y | A | M

Roof Building Permit Application:

BUILDING & NEIGHBORHOOD SERVICES - CITY OF CLINTON, IOWA

EASY-APP FOR BUILDING PERMIT

ROOF

Permit Address	**241-247 5 Ave S, Clinton, IA**

Contractor Name	
State License #	
Phone #	
Contractor Address	
City, St, Zip	
E-mail	

Owner Name	Bill Twyford
Owner Address	
City, St, Zip	
Phone #	
E-mail	billtwyford@aol.com

CITY USE ONLY
PIN:
PERMIT #
INSPECTIONS REQ'D
Pre-shingle or Final
Fee
$

Type of occupancy **Residential** **Commercial / Industrial**

Estimate of construction project cost:

$ 1,129,900

When will work start: TBD

Notes

CITY USE ONLY

Ice & Water Barrier Applied

Venting appropriate

Chimney compliant

Final Approved

Date of Inspection Time

Verbally made aware of Ice and Water Inspection [ ]

I agree to perform all work in accordance with the adopted codes of the City of Clinton, Iowa.

2018 International Building Code, 2018 International Residential Code

Owner/Agent Signature

Date

Appendix C: Schedule of Value and Suggested Manufacturer
Schedule of Values

Description		Quantity	Units	LUMP-SUM TOTAL (INCLDG. OH&P) Unit Price	Amount	Cost Type Hard	Soft	SALES TAX Amount
DIVISION 4: MASONRY								
04 01 20	Maintenance of Masonry	**3725**	SF	**$6.75**	$25,143.75	X		**$0.0**
04 01 30	Unit Masonry Cleaning	**3725**	SF	**$1.16**	$4,321.00	X		**$0.00**
04 05 13	Masonry Mortaring	**1400**	CF	**$8.75**	$12,250.00	X		**$980.00**
04.20.00	Unit Masonry	**0**	ls	**$0.00**	$0.00			**$0.00**
04.99.01	Other - Explain	**0**	ls	**$0.00**	$0.00			**$0.00**
04.99.02	Other - Explain	**0**	ls	**$0.00**	$0.00			**$0.00**
DIVISION 5: METALS								
05.12.00	Structural Steel Framing	**0**	ls	**$0.00**	$0.00			**$0.00**
05.41.00	Metal Stud Framing	**0**	ls	**$0.00**	$0.00			**$0.00**
05.52.00	Metal Railings	**77**	LF	**$146.27**	$11,262.67	X		**$0.00**
05.99.01	Undercounter Steel	**0**	ls	**$0.00**	$0.00			**$0.00**
DIVISION 6: WOODS, PLASTICS & COMPOSITES								
06.10.00	Rough Carpentry	**1**	MBF	**$3,650.00**	$3,650.00	X		**$292.00**
06 05 05.10	Selective Demolition Wood Framing	**2700**	SF	**$1.62**	$4,374.00	X		**$349.92**
06 05 05.10	Selective Demolition Wood Framing	**4000**	LF	**$1.77**	$7,080.00	X		**$566.40**
06 05 05.10	Selective Demolition Wood Framing	**4000**	SF	**$0.81**	$3,240.00	X		**$259.20**

06 05 23.60	Timber Connectors	**35.8**	Lb.	**$1.27**	$45.47	X		**$3.64**
06 05 23.60	Timber Connectors	**0.9**	Lb.	**$2.41**	$2.22	X		**$0.18**
06 05 23.60	Timber Connectors	**40.0**	Ea.	**$0.76**	$30.40	X		**$2.43**
06 05 23.60	Timber Connectors	**1.0**	Ca	**$25.00**	$25.00	X		**$2.00**
06 05 23.60	Timber Connectors	**1.0**	Ca	**$55.00**	$55.00	X		**$4.40**
06 05 23.60	Timber Connectors	**84**	Ea.	**$5.15**	$432.60	X		**$34.61**
06 05 23.60	Timber Connectors	**22**	Ea.	**$5.15**	$113.30	X		**$9.06**
06 05 23.60	Timber Connectors	**33**	Ea.	**$32.21**	$1,062.93	X		**$85.03**
06 05 23.60	Timber Connectors	**9**	Ea.	**$34.03**	$306.27	X		**$24.50**
06 05 23.60	Timber Connectors	**33**	Ea.	**$35.85**	$1,183.05	X		**$94.64**
06 05 23.60	Timber Connectors	**4**	Ea.	**$388.00**	$1,552.00	X		**$124.16**
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	**0.169**	MBF	**$1,700.00**	$287.11	X		**$22.97**
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	**0.200**	MBF	**$1,750.00**	$350.29	X		**$28.02**
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	**0.152**	MBF	**$1,775.00**	$270.58	X		**$21.65**

06 16 26	Underlayment	**4000**	SF	**$2.21**	$8,840.00	X		**$707.20**
06 18 13.20	Laminated Framing	**734**	LF	**$7.25**	$5,320.92	X		**$425.67**
06 18 13.20	Laminated Framing	**699**	LF	**$8.65**	$6,047.04	X		**$483.76**
06 18 13.20	Laminated Framing	**852**	LF	**$10.85**	$9,248.54	X		**$739.88**
06 18 13.20	Laminated Framing	**347**	LF	**$14.05**	$4,871.84	X		**$389.75**
06 18 13.20	Laminated Framing	**181**	LF	**$0.00**	$0.00	X		**$0.00**
06.22.00	Millwork	**0**	ls	**$0.00**	$0.00	X		**$0.00**
06.41.00	Cabinetry & Shelving	**0**	ls	**$0.00**	$0.00	X		**$0.00**
06.41.00	Kitchen & Breakroom Cabinetry	**0**	ls	**$0.00**	$0.00	X		**$0.00**
06.41.00	Teller Lines	**0**	ls	**$0.00**	$0.00	X		**$0.00**
06.41.00	Display Cases	**0**	ls	**$0.00**	$0.00	X		**$0.00**
06.43.16	Wood Railing	**51**	l.f.	**$67.00**	$3,390.20	X		**$271.22**
DIVISION 7: THERMAL & MOISTURE PROTECTION								
07 05 05	Selective Demo., Thermal and Moisture Protection	**2700**	SF	**$1.21**	$3,267.00	X		**$261.36**
07 10 00	Dampproofing and Waterproofing	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 21 00	Thermal Insulation	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 27 26	Fluid Applied Membrane Air Barrier	**2100**	SF	**$0.39**	$819.00	X		**$65.52**

07 31 00	Shingles and Shakes	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 32 00	Roof Tiles	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 41 00	Roof Panels	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 50 00	Membrane Roofing	**0**	ls	**$0.00**	$0.00	X		**$0.00**
07 65 19.10	Plastic Sheet Flashing and Counter Flashing	**360**	LF	**$3.42**	$1,231.20	X		**$98.50**
07 84 13	Firestopping	**0**	Ea	**$23.00**	$0.00	X		**$0.00**
07 84 13	Firestopping	**0**	Ea	**$45.50**	$0.00	X		**$0.00**
DIVISION 8: OPENINGS								
08.10.00	Doors & Frames	**0**	ls	**$0.00**	$0.00			**$0.00**
08.12.13	Metal Frames	**4**	Ea	**$330.00**	$1,320.00	X		**$105.60**
08.14.16	Wood Door	**4**	Ea	**$605.00**	$2,420.00	X		**$193.60**
08.12.13	Metal Frames	**1**	Ea	**$340.00**	$340.00	X		**$27.20**
	Wood Door	**2**	Ea	**$293.00**	$586.00	X		**$46.88**
08.30.00	Specialty Doors & Frames (Dorma Door)	**0**	ls	**$0.00**	$0.00	X		**$0.00**
08.40.00	Entrances, Storefronts, and Curtain Walls	**0**	ls	**$0.00**	$0.00	X		**$0.00**
08.34.59	Vault Doors	**0**	ls	**$0.00**	$0.00	X		**$0.00**
08.51.13	Aluminum Window	**15**	Ea	**$530.00**	$7,950.00	X		**$636.00**
08.52.10	Picture Window	**2**	Ea	**$5,688.00**	$11,376.00	X		**$910.08**

08.52.10	Sliding Window	**1**	Ea	**$4,536.00**	$4,536.00	X		**$362.88**
08.70.00	Hardware	**2**	Ea.	**$0.00**	$0.00	X		**$0.00**
08.80.00	Glazing	**0**	ls	**$0.00**	$0.00	X		**$0.00**
08.70.00	Hardware	**5**	Ea.	**$24.50**	$122.50	X		**$9.80**
08.70.00	Hardware	**5**	Ea.	**$86.00**	$430.00	X		**$34.40**
DIVISION 9: FINISHES								
09.20.00	Gypsum Board	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.29.10	Gypsum Board, ceilings	**181**	sf	**$1.09**	$197.29	X		**$15.78**
09.20.10	Gypsum Board, Wall, Fireproof	**737**	sf	**$1.03**	$759.11	X		**$60.73**
09.20.10	Gypsum Board, Wall	**787**	sf	**$1.01**	$794.87	X		**$63.59**
09.30.00	Tiling	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.51.23	Acoustical Tile Ceilings	**293**	sf	**$1.86**	$544.98	X		**$43.60**
09.64.29	Wood Strip and Plank Flooring	**1694**	sf	**$6.00**	$10,164.00	X		**$813.12**
09.65.19	Vinyl Tile Flooring	**6617**	sf	**$6.80**	$44,995.60	X		**$3,599.65**
09.66.16	Terrazzo	**302**	sf	**$4.24**	$1,280.48	X		**$102.44**
09.68.00	Carpeting	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.69.00	Access Flooring	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.70.00	Wall Finishes	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.91.13	Painting - Exterior	**0**	ls	**$0.00**	$0.00	X		**$0.00**
09.91.23	Painting - Interior	**1400**	SF	**$1.81**	$2,534.00	X		**$202.72**
09 91 13	Painting	**5**	ea	**$118.00**	$590.00	X		**$47.20**
09 91 13	Painting	**16000**	SF	**$0.96**	$15,360.00	X		**$1,228.80**
09 91 13	Painting - FP Pipe	**820**	LF	**$1.54**	$1,262.80	X		**$101.02**
DIVISION 10: SPECIALTIES								
10.14.00	Signage - Interior Sign Band	**0**	ls	**$0.00**	$0.00	X		**$0.00**

10.13.00	Directory Boards	0	ls	$0.00	$0.00	X		$0.00
10.15.00	ATM Signage	0	ls	$0.00	$0.00	X		$0.00
10.28.00	Toilet, Bath & Laundry Accessories	0	ls	$0.00	$0.00	X		$0.00
10.28.13	Towel Dispenser and Waste Receptacle	2	Ea	$425.00	$850.00	X		$68.00
10.28.13	Grab Bar	4		$69.50	$278.00	X		$22.24
10.28.13	Hand Dryer	2		$695.00	$1,390.00	X		$111.20
10.28.13	Mirror	2		$176.00	$352.00	X		$28.16
10.44.00	Fire Extinguishers & Cabinets	0	ls	$0.00	$0.00	X		$0.00
10.73.16	Metal Canopies	4	Ea.	$5,000.00	$20,000.00	X		$1,600.00
10.51.00	Wood and Metal Lockers	0	ls	$0.00	$0.00	X		$0.00
10.11.00	Visual Display Surfaces - Chalkboards & Tackboards	0	ls	$0.00	$0.00	X		$0.00
10.99.01	Other - Explain	0	ls	$0.00	$0.00	X		$0.00
10.99.02	Other - Explain	0	ls	$0.00	$0.00	X		$0.00
DIVISION 11: EQUIPMENT								
11.21.13	Checkout Counter	1	Ea	$3,850.00	$3,850.00	X		$308.00
11.41.13	Refrigerator	1	Ea	$4,275.00	$4,275.00	X		$342.00
11 44 00	Cooking	1	Ea	$10,600.00	$10,600.00	X		$848.00
11 44 00	Cooking	1	Ea	$3,575.00	$3,575.00	X		$286.00
11 46 00	Ice Machines	1	Ea	$2,000.00	$2,000.00	X		$160.00
11.48	Dishwasher	1	Ea	$5,700.00	$5,700.00	X		$456.00

DIVISION 12: FURNISHINGS								
12.01.00	Furniture	**0**	ls	**$0.00**	$0.00			**$0.00**
12.11.00	Artwork	**0**	ls	**$0.00**	$0.00			**$0.00**
12.20.00	Window Treatments - Blinds / Shades	**0**	ls	**$0.00**	$0.00			**$0.00**
12.35.80	Kitchen casewook, Base Cabinets	**3**	ea	**$240.00**	$720.00	X		**$57.60**
12.35.80	Kitchen casewook, Wall Cabinets	**1**	ea	**$225.00**	$225.00	X		**$18.00**
12.36.00	Wood countertop	**32.0**	lf	**$119.00**	$3,808.00	X		**$304.64**
12.36.16	Stainless Countertop	**17.5**	lf	**$445.00**	$7,787.50	X		**$623.00**
12.37.00	Workstations (Cubicles)	**0**	ls	**$0.00**	$0.00			**$0.00**
12.38.00	Moveable Wall Partitions (Fabric Panels)	**0**	ls	**$0.00**	$0.00			**$0.00**
12.50.00	Kiosk Systems	**0**	ls	**$0.00**	$0.00			**$0.00**
12.54.16	Tables	**15**	ea	**$200.00**	$3,000.00		X	**$240.00**
12.54.16	Bar Table	**21**	l.f.	**$450.00**	$9,450.00		X	**$756.00**
12.54.16	Chair	**36**	ea	**$116.00**	$4,176.00		X	**$334.08**
DIVISION 13: SPECIAL CONSTRUCTION								
DIVISION 14: CONVEYING SYSTEMS								
14 21 23.10	Electric Traction Passenger Elevator	**1**	ea	**$154,500.00**	$154,500.00	X		**$12,360.00**
14 27 13	Custom Elevator Cab Finishes	**1**	ea	**$670.00**	$670.00	X		**$53.60**

14 27 13	Elevator Pit Ladder	**1**	ls	**$200.00**	$200.00	X			**$16.00**
14 28 10.10	Elevator Controls and Doors	**1**	ea	**$1,275.00**	$637.50	X			**$51.00**
14 28 10.10	Elevator Controls and Doors	**1**	ea	**$51,500.00**	$51,500.00	X			**$4,120.00**
14 28 10.10	Elevator Controls and Doors	**1**	ea	**$4,125.00**	$4,125.00	X			**$330.00**
14 28 10.10	Elevator Controls and Doors	**1**	ea	**$845.00**	$845.00	X			**$67.60**
14 28 10.10	Elevator Controls and Doors	**1**	ea	**$620.00**	$620.00	X			**$49.60**
14.99.02	Phone Jack & Data Service - Elevator	**0**	ls	**$0.00**	$0.00	X			**$0.00**
DIVISION 21: FIRE SUPPRESSION									
21 05 23.50	Check, swing, C.I. body, brass fittings, auto, ball drip	**2**	ea	**$850.00**	$1,700.00	X			**$136.00**
21 05 23.50	Check, wafer, butterfly type, C.I. body, bronze fittings	**1**	ea	**$1,725.00**	$1,725.00	X			**$138.00**
21 12 23	Fire-Suppression Hose Valves	**1**	ea	**$330.00**	$330.00	X			**$26.40**
21 12 23	FHV Markup	**1**	ls	**$165.00**	$165.00	X			**$13.20**
21 13 13.50	Wet-Pipe Sprinkler System Components	**51**	ea	**$56.50**	$2,881.50	X			**$230.52**
21 13 13.50	Wet-Pipe Sprinkler System Components	**10**	ea	**$89.00**	$890.00	X			**$71.20**
21 22 16	Clean-Agent Fire Extinguisher System	**2**	ea	**$254.00**	$508.00	X			**$40.64**

21 13 13	Welded, Sch. 40 Black Steel Pipe	**194**	LF	**$106.00**	$20,564.00	X		**$1,645.1**
21 13 13	Welded, Sch. 40 Black Steel Pipe	**25**	LF	**$54.50**	$1,362.50	X		**$109.00**
21 13 13	Welded, Sch. 40 Black Steel Pipe	**336**	LF	**$35.50**	$11,928.00	X		**$954.24**
21 13 13	Welded, Sch. 40 Black Steel Pipe	**253**	LF	**$19.50**	$4,933.50	X		**$394.68**
21 13 13	Welded, Sch. 40 Black Steel Pipe	**12**	LF	**$16.15**	$193.80	X		**$15.50**
10 44 16.13	Portable Fire Extinguishers	**1**	ea	**$152.00**	$152.00	X		**$12.16**
10 44 13	Fire Protection Cabinet	**1**	ea	**$310.00**	$310.00	X		**$24.80**
DIVISION 22: PLUMBING								
22 01 02.20	Labor Adjustment Factors	**0**	ls	**$0.00**	$0.00	X		**$0.00**
22 05 05.10	Plumbing Demolition	**1**	ea	**$107.00**	$107.00	X		**$8.56**
22 05 05.10	Plumbing Demolition	**20**	LF	**$15.00**	$300.00	X		**$24.00**
22 05 05.10	Plumbing Demolition	**2**	Ton	**($200.00)**	($388.60)	X		**($31.09)**
22 05 23.10	Valves, Brass	**3**	ea	**$74.00**	$222.00	X		**$17.76**
22 05 23.20	Valves, Bronze		ea	**$159.00**	$0.00	X		**$0.00**
22 05 23.20	Valves, Bronze		ea	**$50.00**	$0.00	X		**$0.00**
22 05 23.20	Valves, Bronze	**1**	ls	**$302.00**	$302.00	X		**$24.16**
22 05 23.20	Valves, Bronze	**2**	ea	**$795.00**	$1,590.00	X		**$127.20**

22 05 23.20	Valves, Bronze	**1**	ls	**$354.00**	$354.00	X		**$28.32**
22 11 19.42	Backflow Preventers	**1**	ea	**$585.00**	$585.00	X		**$46.80**
22 11 19.54	Water Hammer Arresters/Shock Absorbers	**1**	ea	**$93.50**	$93.50	X		**$7.48**
22 13 23.10	Interceptors	**1**	ea	**$2,550.00**	$2,550.00	X		**$204.00**
22 05 53	Identification for Plumbing Piping and Equipment	**0**	ls	**$0.00**	$0.00	X		**$0.00**
22 07 00	Plumbing Insulation	**0**	ls	**$0.00**	$0.00	X		**$0.00**
22 09 00	Instrumentation and Control for Plumbing	**0**	ls	**$0.00**	$0.00	X		**$0.00**
22 10 00	Plumbing Piping	**0**	LF	**$22.50**	$0.00	X		**$0.00**
22 10 00	Plumbing Piping	**0**	LF	**$34.00**	$0.00	X		**$0.00**
22 10 00	Plumbing Piping	**51**	LF	**$39.50**	$2,014.50	X		**$161.16**
22 10 00	Plumbing Piping	**117**	LF	**$49.00**	$5,733.00	X		**$458.64**
22 10 00	Plumbing Piping	**15**	LF	**$54.00**	$810.00	X		**$64.80**
22 10 00	Plumbing Piping	**1**	ls	**$2,567.25**	$2,567.25	X		**$205.38**
22 10 00	Plumbing Piping	**0**	LF	**$11.40**	$0.00	X		**$0.00**
22 10 00	Plumbing Piping	**241**	LF	**$12.95**	$3,114.48	X		**$249.16**
22 10 00	Plumbing Piping	**123**	LF	**$14.80**	$1,820.40	X		**$145.63**
22 10 00	Plumbing Piping	**190**	LF	**$18.60**	$3,534.00	X		**$282.72**

22 10 00	Plumbing Piping	**41**	LF	**$26.00**	$1,066.00	X		**$85.28**
22 10 00	Plumbing Piping	**48**	LF	**$37.50**	$1,800.00	X		**$144.00**
22 10 00	Plumbing Piping	**1**	ls	**$3,400.46**	$3,400.46	X		**$272.04**
22 07 00	Plumbing Insulation	**3**	LF	**$6.20**	$20.77	X		**$1.66**
22 07 00	Plumbing Insulation	**241**	LF	**$6.20**	$1,494.20	X		**$119.54**
22 07 00	Plumbing Insulation	**123**	LF	**$6.20**	$762.60	X		**$61.01**
22 07 00	Plumbing Insulation	**190**	LF	**$3.20**	$608.00	X		**$48.64**
22 07 00	Plumbing Insulation	**41**	LF	**$6.50**	$266.50	X		**$21.32**
22 07 00	Plumbing Insulation	**48**	LF	**$8.00**	$384.00	X		**$30.72**
22 11 23.26	Close-Coupled, Horizontally Mounted, In-Line Centrifugal Domestic-Water Pumps	**1**	ea	**$1,250.00**	$1,250.00	X		**$100.00**
22 13 16.60	Traps	**11**	ea	**$247.00**	$2,717.00	X		**$217.36**
22 13 16.80	Vent Flashing and Caps	**2**	ea	**$50.00**	$100.00	X		**$8.00**
22 13 19.13	Sanitary Drains	**5**	ea	**$395.00**	$1,975.00	X		**$158.00**
22 05 76.10	Cleanouts	**3**	ea	**$278.00**	$834.00	X		**$66.72**
22 05 76.20	Cleanout Tees	**1**	ea	**$60.00**	$60.00	X		**$4.80**
22 30 00	Plumbing Equipment	**0**	ls	**$0.00**	$0.00	X		**$0.00**

22 33 33	Light-Commercial Electric Domestic Water Heaters	**1**	ls	**$6,175.00**	$6,175.00	X		**$494.00**
22 42 13.13	Water Closets - Commercial	**2**	ea	**$1,300.00**	$2,600.00	X		**$208.00**
22 42 13.13	Water Closets - Commercial	**2**	ea	**$1,828.00**	$3,656.00	X		**$292.48**
22 41 16.13	Lavatories	**2**	ea	**$660.00**	$1,320.00	X		**$105.60**
22 41 16.13	Lavatories	**2**	ea	**$1,325.00**	$2,650.00	X		**$212.00**
22 41 16.16	Sinks	**1**	ea	**$575.00**	$575.00	X		**$46.00**
22 41 16.16	Sinks	**1**	ea	**$935.00**	$935.00	X		**$74.80**
22 42 00	Sinks	**1**	ea	**$1,000.00**	$1,000.00	X		**$80.00**
22 42 16	Sinks	**1**	ea	**$1,025.00**	$1,025.00	X		**$82.00**
22 42 16.40	Service Sinks	**1**	ea	**$1,425.00**	$1,425.00	X		**$114.00**
22 42 16.40	Service Sinks	**1**	ea	**$1,875.00**	$1,875.00	X		**$150.00**
22 42 39.30	Carriers and Supports	**2**	ea	**$450.00**	$900.00	X		**$72.00**
22 42 39.30	Carriers and Supports	**1**	ea	**$1,725.00**	$1,725.00	X		**$138.00**
22 42 39.30	Carriers and Supports	**1**	ea	**$730.00**	$730.00	X		**$58.40**
22 42 39.10	Faucets and Fttings	**2**	ea	**$239.00**	$478.00	X		**$38.24**
22 42 39.10	Faucets and Fttings	**3**	ea	**$137.00**	$411.00	X		**$32.88**
22 42 39.10	Faucets and Fttings	**2**	ea	**$615.00**	$1,230.00	X		**$98.40**
22 11 13.44	Pipe, Steel	**297**	LF	**$34.00**	$10,098.00	X		**$807.84**

22 11 13.44	Pipe, Steel	**1**	ls	**$2,726.00**	$2,726.00	X			**$218.08**
DIVISION 23: HEATING, VENTILATING & AIR CONDITIONING (HVAC)									
23 21 20.78	Strainer, y-Type	**1**	ls	**$53.00**	$53.00	X			**$4.24**
23 21 20.88	Venturi Flow Device	**1**	ls	**$350.00**	$350.00	X			**$28.00**
23 05 93	T.A.B. for HVAC - Air	**1**	ls	**$6,888.00**	$6,888.00	X			**$551.04**
23 07 13	Duct Insulation	**2078**	sf	**$4.46**	$9,267.88	X			**$741.43**
23.30.00	HVAC - Air Distribution (Ducts etc)	**2500**	lbs.	**$8.05**	$20,125.00	X			**$1,610.00**
23.30.00	For 40% Fittings, Added 34%	**1**	ls	**$18.02**	$18.02	X			**$1.44**
23 33 46.10	Flexible Air Ducts (Flex Ducts)	**33**	LF	**$8.45**	$278.85	X			**$22.31**
	Natural Gas Piping	**297**	LF	**$0.00**	$0.00	X			**$0.00**
23 33 13.13	Volume-Control Dampers	**16**	ea	**$148.00**	$2,368.00	X			**$189.44**
23 33 13.16	Fire Dampers	**5**	ea	**$156.00**	$780.00	X			**$62.40**
23 33 33	Duct Access Doors	**4**	ls	**$106.00**	$424.00	X			**$33.92**
23 55 33	Gas-Fired Furnace	**1**	ea	**$2,200.00**	$2,200.00	X			**$176.00**
23 63 13	Air-Cooled Condensing Unit	**1**	ea	**$14,400.00**	$14,400.00	X			**$1,152.00**
23 81 19	Self-Contained Air Conditions	**1**	ls	**$17,000.00**	$17,000.00	X			**$1,360.00**
23 74 33.10	Makeup Air Unit	**1**	ls	**$5,025.00**	$5,025.00	X			**$402.00**
22 11 13.23	Refrigerant Piping System	**71**	LF	**$13.02**	$924.42	X			**$73.95**
22 11 13.23	Refrigerant Piping System	**80**	LF	**$15.37**	$1,229.60	X			**$98.37**

			ls		$0.00	X		**$0.00**
23 34 16	Centrifugal HVAC Fans	**1**	ls	**$3,875.00**	$3,875.00	X		**$310.00**
23 37 13	Diffusers, Registers, and Grilles	**47**	ea	**$75.00**	$3,525.00	X		**$282.00**
23.99.01	Louvers	**2**	ls	**$200.00**	$400.00	X		**$32.00**
23 38 13	Commercial Kitchen Hoods	**1**	ls	**$5,075.00**	$5,075.00	X		**$406.00**
23.99.02	HVAC Gravity Ventilators	**1**	ls	**$205.00**	$205.00	X		**$16.40**
DIVISION 26: ELECTRICAL								
26 01 02.20	Labor Adjustment Factors			**10%**				
26 01 02.20	Labor Adjustment Factors			**25%**				
				30%				
				35%				
				40%				
26 05 05.10	**Electrical Demolition**							
26 05 05.10	**Electrical Demolition**							
26.00.00	Electrical	**0**	ls	**$0.00**	$0.00			**$0.00**
26 05 05	Electrical Demolition	**0**	ls	**$0.00**	$0.00	X		**$0.00**
26 05 19.90	Wire	**3.30**	CLF	**$1,350.00**	$4,455.00	X		**$356.40**
26 05 19.90	Wire	**0.97**	CLF	**$801.00**	$775.37	X		**$62.03**
26 05 19.90	Wire	**3.07**	CLF	**$465.00**	$1,425.23	X		**$114.02**

26 05 19.90	Wire	**4.17**	CLF	**$375.00**	$1,563.75	X			**$125.10**
26 05 19.90	Wire	**23.50**	CLF	**$261.00**	$6,133.50	X			**$490.68**
26 05 19.90	Wire	**0.32**	CLF	**$222.00**	$71.04	X			**$5.68**
26 05 19.90	Wire	**0.91**	CLF	**$505.05**	$461.11	X			**$36.89**
26 05 19.90	Wire	**1.71**	CLF	**$263.25**	$448.84	X			**$35.91**
26 05 19.90	Wire	**2.11**	CLF	**$1,449.50**	$3,057.00	X			**$244.56**
26 05 19.90	Wire	**1.13**	CLF	**$631.32**	$712.13	X			**$56.97**
26 05 19.90	Wire	**4.94**	CLF	**$329.07**	$1,623.96	X			**$129.92**
26 05 33.13	Conduit	**300**	LF	**$8.85**	$2,655.00	X			**$212.40**
26 05 33.13	Conduit	**300**	LF	**$0.47**	$139.80	X			**$11.18**
26 06 33.16	Boxes for Electrical Systems	**84**	ea	**$41.00**	$3,444.00	X			**$275.52**
26 27 26.20	Wiring Device Elements	**96**	ea	**$36.00**	$3,456.00	X			**$276.48**
26 05 80.10	Motor Connections	**8**	ea	**$110.00**	$880.00	X			**$70.40**
26 28 16.20	Safety Switches (Disconnect Switch)	**2**	ea	**$315.00**	$630.00	X			**$50.40**
26 09 23	Lighting Control Devices		ea	**$244.00**	$0.00	X			**$0.00**
26 09 23	Lighting Control Devices	**1**	ea	**$112.00**	$112.00	X			**$8.96**
26 27 26.10	Low Voltage Switching	**4**	ea	**$103.00**	$412.00	X			**$32.96**
26 27 26.20	Wiring Device Elements	**2**	ea	**$17.95**	$35.90	X			**$2.87**
26 27 26.20	Wiring Device Elements	**8**	ea	**$32.00**	$256.00	X			**$20.48**

26 24 16.30	Panelboards Commercial Applications **EPB-1**	**1**	ea	**$3,125.00**	$3,125.00	X		**$250.00**
26 24 16.30	Panelboards Commercial Applications **LPB-1**	**1**	ea	**$1,800.00**	$1,800.00	X		**$144.00**
26 24 16.30	Panelboards Commercial Applications **PPB-1**	**1**	ea	**$3,575.00**	$3,575.00	X		**$286.00**
26.51.00	Interior Lighting	**2**	ea	**$455.00**	$910.00	X		**$72.80**
26.51.00	Interior Lighting	**4**	ea	**$365.00**	$1,460.00	X		**$116.80**
26.51.00	Interior Lighting	**11**	ea	**$126.00**	$1,386.00	X		**$110.88**
26.51.00	Interior Lighting	**32**	ea	**$175.00**	$5,600.00	X		**$448.00**
26.51.00	Interior Lighting	**3**	ea	**$370.00**	$1,110.00	X		**$88.80**
26.51.00	Interior Lighting	**3**	ea	**$370.00**	$1,110.00	X		**$88.80**
26.51.00	Interior Lighting	**2**	ea	**$111.00**	$222.00	X		**$17.76**
26.51.00	Interior Lighting	**56**	ea	**$111.00**	$6,216.00	X		**$497.28**
26 52 13	EM LIGHT FIXTURES	**8**	ea	**$330.00**	$2,640.00	X		**$211.20**
26.56.36	Exterior Building Lighting	**6**	ea	**$310.00**	$1,860.00	X		**$148.80**
DIVISON 27: TELECOMMUNCATIONS								
27 51 19.10	Sound System	**1**	ea	**$279.00**	$279.00	X		**$22.32**
27 51 19.10	Sound System	**1**	ea	**$2,025.00**	$2,025.00	X		**$162.00**
26 05 23.10	Control Cable	**1**	CLF	**$119.00**	$159.46	X		**$12.76**
27 51 19.10	Sound System	**16**	ea	**$240.00**	$3,840.00	X		**$307.20**
DIVISION 28: ELECTRONIC SAFETY & SECURITY								
28 46 11.21	Carbon-Monoxide Detection Sensors	**2**	ea	**$88.50**	$177.00	X		**$14.16**

28 46 11.27	Smoke Detector, ceiling type	**17**	ea	**$244.00**	$4,148.00	X		**$331.84**
28 46 11.27	Smoke Detector, Duct type	**2**	ea	**$585.00**	$1,170.00	X		**$93.60**
28 46 11.50	Heat Detectors	**10**	ea	**$144.00**	$1,440.00	X		**$115.20**
28 46 21	Fire Alarm Panel	**1**	ea	**$1,100.00**	$1,100.00	X		**$88.00**
28 46 21	FA Panel - Battery and rack	**1**	ea	**$630.00**	$630.00	X		**$50.40**
28 46 21.50	Fire Alarm Actuating Device	**3**	ea	**$406.00**	$1,218.00	X		**$97.44**
28 46 00	Alarm Flow Switch	**1**	ea	**$350.00**	$350.00	X		**$28.00**
28 46 21.50	Strobe and Horn (ADA-type)	**17**	ea	**$300.00**	$5,100.00	X		**$408.00**
28 46 21.50	Manual Pull Station	**1**	ea	**$180.00**	$180.00	X		**$14.40**
28 46 21.50	Remote duct detector key switch test station	**1**	ea	**$203.00**	$203.00	X		**$16.24**
26 05 19.90	FA Wire	**1.53**	CLF	**$60.00**	$91.80	X		**$7.34**
26 05 19.90	FA LV Cable (free-air hung)	**1.53**	CLF	**$60.00**	$91.80	X		**$7.34**
26 05 19.90	FA LV Cable	**1.54**	CLF	**$60.00**	$92.40	X		**$7.39**
26 05 19.90	FA LV Cable	**0.44**	CLF	**$60.00**	$26.40	X		**$2.11**
26 05 19.90	Electrical Wire	**1.18**	CLF	**$261.00**	$307.98	X		**$24.64**
26 05 33.13	Conduit	**118**	LF	**$8.85**	$1,044.30	X		**$83.54**
26 05 33.13	Conduit	**118**	LF	**$0.47**	$54.99	X		**$4.40**
28 46 21.50	Actuating Devices	**3**	ea	**$460.00**	$1,380.00	X		**$110.40**
DIVISION 31: EARTHWORK								
DIVISION 32: EXTERIOR IMPROVEMENTS								
DIVISION 33: UTILITIES								
GC ALLOWANCES and/or OTHER SPECIALTIES								
01.21.00	Allowance #00				$0.00	X		**$0.00**

01.21.01	Allowance #01 Ext. Brick Repairs	**0**	ls	**$0.00**	$0.00	X		**$0.00**
01.21.02	Allowance #02 Transformer Upgrades	**1**	ls	**$10,000.00**	$10,000.00	X		**$800.00**
01.21.03	Allowance #03 Building Fire Protection Upgrades	**1**	ls	**$10,000.00**	$10,000.00	X		**$800.00**
01.21.04	Allowance #04	**0**	ls	**$0.00**	$0.00	X		**$0.00**
01.21.05	Allowance #05 General Trades	**1**	ls	**$10,000.00**	$10,000.00	X		**$800.00**
01.21.06	Allowance #06 Electrical	**1**	ls	**$20,660.00**	$20,660.00	X		**$1,652.80**
CONTINGENCY								
01.22.00	Exterior Work Contingency	**160**	Ea	**$109.93**	$17,588.80			**$0.00**
01.22.01	Overall Project Contingency	**1**	ls	**$40,000.00**	$40,000.00			**$3,200.00**
01.22.02	Asbestos Abatement	**8500**	SF	**$4.82**	$40,970.00			**$3,277.60**
01.22.03	Lead Paint Remediation		SF	**$2.35**	$0.00			**$0.00**

Recommended Manufacturers

Description		High Level Description	SUGGESTED MANUFACTURERS AND/OR VENDORS
DIVISION 4: MASONRY			
04 01 30	Unit Masonry Cleaning	Acid cleanser, smooth brick surface	Prosoco, Diedrich
04 05 13	Masonry Mortaring	Type O, 1:3 Mix for Foundation Repair	Spec Mix, Arcat, Cemex
DIVISION 5: METALS			

05.52.00	Metal Railings		Viewrail, Feeney, Atlantis Rail
DIVISION 6: WOODS, PLASTICS & COMPOSITES			
06.10.00	Rough Carpentry	2" x 8" Blocking	*Local*
06 05 23.60	Timber Connectors	Common Nails	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	Galvanized Nails	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	3.5" SDS Screw	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	1/2" Anchor Bolt	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	Galvanized #10 x 1.5" Screw	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	2" x 6" Hangers	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	2" x 10" Hangers	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	1.75" x 9.25" LVL Hangers	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	1.75" x 11.25" LVL Hangers	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	1.75" x 14" LVL Hangers	SIMPSON Strong-Tie
06 05 23.60	Timber Connectors	5.25" x 18" PSL Hangers	SIMPSON Strong-Tie
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	2" x 6"	*Local*
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	2" x 10"	*Local*
06 11 10.18	Framing with Dimensional, Engineered or Composite Lumber	2" x 14"	*Local*
06 16 26	Underlayment	5/8" Thick Pneumatic nailed	*Local*
06 18 13.20	Laminated Veneer Lumber		Weyerhaeuser, Boise Cascade, Louisiana-Pacific

06 18 13.20	Parallel Strand Lumber		Weyerhaeuser, Boise Cascade, Louisiana-Pacific
06.41.00	Display Cases		
06.43.16	Wood Railing		
DIVISION 7: THERMAL & MOISTURE PROTECTION			
07 05 05	Selective Demo., Thermal and Moisture Protection	DEMOLITION of Siding, Metal, Vertical	
07 10 00	Dampproofing and Waterproofing		
07 21 00	Thermal Insulation		
07 27 26	Fluid Applied Membrane Air Barrier	Only applied for the exterior limestone foundation walls	Dupont, WR Meadows, Carlisle
07 31 00	Shingles and Shakes		
07 32 00	Roof Tiles		
07 41 00	Roof Panels		
07 50 00	Membrane Roofing		
07 65 19.10	Plastic Sheet Flashing and Counter Flashing	White, 60 mil	
07 84 13	Firestopping	Metallic Piping, Insulated, Through Floors, 2" diameter	
07 84 13	Firestopping	Metallic Piping, Insulated, Through Walls, 2" diameter	
07 99 02	Other - Explain		
DIVISION 8: OPENINGS			
08.12.13	Metal Frames		
08.14.16	Wood Door	1-hr Fire Rated Wood Door	

08.12.13	Metal Frames		
	Wood Door		
08.51.13	Aluminum Window	36''x72'' (3'x4')	
08.52.10	Picture Window	16'X9'	
08.52.10	Sliding Window	16'X9'	
08.70.00	Hardware	Pull Handle and Pushbar Aluminum	
08.70.00	Hardware	ADA Compliant Thresholds, 3' long saddles, Alum.	
08.70.00	Hardware	Kick Plates S.S. .050", 16ga, 8" x 28", US32	
DIVISION 9: FINISHES			
09.20.00	Gypsum Board		
09.29.10	Gypsum Board, ceilings		
09.20.10	Gypsum Board, Wall, Fireproof		
09.20.10	Gypsum Board, Wall		
09.30.00	Tiling		
09.51.23	Acoustical Tile Ceilings		
09.64.29	Wood Strip and Plank Flooring	café area	
09.65.19	Vinyl Tile Flooring	Retail Area	
09.66.16	Terrazzo	Bathroom, Kitchen, Utility room	
09.91.13	Painting - Exterior	MURAL EXCLUDED FROM COSTS	

09.91.23	Painting - Interior	Spray, Primer & 2 coats, latex	
09 91 13	Painting	Doors & Windows, epoxy paint (hollow-metal)	
09 91 13	Painting	Lowered Ceiling - trusses/wood frames, Stain, brushwork, wipe off	
09 91 13	Painting - FP Pipe	1-4" diameter brushwork, Paint 2 Coats	
DIVISION 10: SPECIALTIES			
10.28.13	Towel Dispenser and Waste Receptacle	Bathroom	Lavex Janitorial
10.28.13	Grab Bar	Two grab bars in each room	Lavex Janitorial
10.28.13	Hand Dryer	one in each room	Lavex Janitorial
10.28.13	Mirror	one in each room, currently have two in one. Delete	Bobrick
10.44.00	Fire Extinguishers & Cabinets	*Cost item tracked under Division 21*	Cato
10.73.16	Metal Canopies	Approximately (4) 20' sections of 6' wide wall hung canopies	Architectural Fabrications (Titan Canopy)
10.51.00	Wood and Metal Lockers		Winholt
10.11.00	Visual Display Surfaces - Chalkboards & Tackboards		Araco
10.99.01	Other - Explain		
10.99.02	Other - Explain		
DIVISION 11: EQUIPMENT			
11.41.13	Refrigerator		Avantco Refrigeration
11 44 00	Cooking	oven	Cooking Performance Group
11 44 00	Cooking	range	Cooking Performance Group
11 46 00	Ice Machines		Scotsman
11.48	Dishwasher		Noble Warewashing
DIVISION 12: FURNISHINGS			

12.35.80	Kitchen casewook, Base Cabinets		Avantco
12.35.80	Kitchen casewook, Wall Cabinets		Avantco
12.36.00	Wood countertop		Advance Tabco
12.36.16	Stainless Countertop		Regency Tables & Sinks
12.54.16	Tables	Cafe area table, 2 seater, 3 Seater, 4 Seater	Lancaster Table & Seating
12.54.16	Bar Table	*SOFT COST*	Lancaster Table & Seating
12.54.16	Chair	*SOFT COST*	Lancaster Table & Seating
DIVISION 13: SPECIAL CONSTRUCTION			
DIVISION 14: CONVEYING SYSTEMS			
14 21 23.10	Electric Traction Passenger Elevator	2,000lb capacity, 200fpm, 4 stop, std. fin.	Kone Elevators, Schindler Group
14 27 13	Custom Elevator Cab Finishes	Textured Rubber Flooring	Kone Elevators, Schindler Group
14 27 13	Elevator Pit Ladder	Provided by Elev. Contractor, installed by others	Kone Elevators, Schindler Group
14 28 10.10	Elevator Controls and Doors	Intercom Service	Kone Elevators, Schindler Group
14 28 10.10	Elevator Controls and Doors	Variable Voltage, O.H. gearless machine, min.	Kone Elevators, Schindler Group
14 28 10.10	Elevator Controls and Doors	12 month maintenance contract	Kone Elevators, Schindler Group
14 28 10.10	Elevator Controls and Doors	Signal Devices, hall lanterns	Kone Elevators, Schindler Group
14 28 10.10	Elevator Controls and Doors	Position Indicicators (up to 3)	Kone Elevators, Schindler Group
DIVISION 21: FIRE SUPPRESSION			
21 13 13	Welded, Sch. 40 Black Steel Pipe	6" Diameter (Welded)	Charlotte Pipe and Foundry Co.
21 13 13	Welded, Sch. 40 Black Steel Pipe	3" Diameter (Threaded)	Charlotte Pipe and Foundry Co.
21 13 13	Welded, Sch. 40 Black Steel Pipe	2" Diameter (Threaded)	Charlotte Pipe and Foundry Co.

21 13 13	Welded, Sch. 40 Black Steel Pipe	1" Diameter (Threaded)	Charlotte Pipe and Foundry Co.
21 13 13	Welded, Sch. 40 Black Steel Pipe	1/2" Diameter (Threaded)	Charlotte Pipe and Foundry Co.
DIVISION 22: PLUMBING			
22 05 23.10	Valves, Brass	Gas cocks, threaded, 1" diam.	Legend Valve, Hammond Valve,
22 11 19.42	Backflow Preventers	1" pipe size	Watts Regulator, Zurn
22 11 19.54	Water Hammer Arresters/Shock Absorbers	3/4" male IPS For 1 to 11 fixtures	
22 13 23.10	Interceptors	Grease, 10 GPM, 20 lb. fat capacity	Jay R. Smith
22 10 00	Plumbing Piping	PVC Schedule 40 DWV	Charlotte Pipe and Foundry Co.
22 10 00	Plumbing Piping	COP TYP "L" Domestic Water	Cerro Copper, Mueller
22 07 00	Plumbing Insulation	3/4" & 1" wall COP Pipe	
22 11 23.26	Close-Coupled, Horizontally Mounted, In-Line Centrifugal Domestic-Water Pumps	3/4" to 1-1/2: size, 1/3 HP	Bell & Gossett, Taco
22 13 16.60	Traps	Standard 2" without vent (cost included in vent piping and fittings)	Jay R. Smith
22 13 16.80	Vent Flashing and Caps	Vent Caps Aluminum with lead ring 3" pipe (average)	Jay R. Smith
22 13 19.13	Sanitary Drains	Floor, medium duty, deep flange, 7" diam top 2-3" pipe diam.	Jay R. Smith

22 05 76.10	Cleanouts	Floor type, 2" pipe size	Jay R. Smith
22 05 76.20	Cleanout Tees	Access cover, wall cleanout, 2" pipe size	Jay R. Smith
22 33 33	TANKLESS Light-Commercial Electric Domestic Water Heaters	all assembly components (not incldg. Backflow preventer, recirc pump)	Eemax, Chronomite, Rheem
22 42 13.13	Water Closets - Commercial	Wall hung, 1.6 gpf flush valve, seat	Moen
22 41 16.13	Lavatories	Lavatories, wall mounted 20" x20" color: WHITE - same as residential (22 41 16)	Moen,
22 41 16.16	Sinks	Sink - Kitchen, ctop style, PE on CI 24"x21" single bowl (cafe barista workstation)	Advance Tabco, Aero Manufacturing, Elkay
22 42 00	Sinks	Commercial Sink - Double Bay Stainless Steel	Advance Tabco, Aero Manufacturing, Elkay
22 42 16.40	Service Sinks	Mop sink, floor mounted	Advance Tabco, Aero Manufacturing, Elkay
22 42 39.30	Carriers and Supports	Mounting Brackets, Carriers, hangers and supports	Holdright
22 42 39.10	Faucets and Fttings	Faucets and associated accessories	American Standard, Aero Manufacturing, Sloan, Chicago Faucets, Charlotte Pipe and Foundry
22 42 39.10	Faucets and Fttings	Automatic flush sensor and operator w.c. ADA compliant	Sloan
22 11 13.44	Pipe, Steel	Natural Gas Piping 2"	Charlotte Pipe and Foundry Co.
DIVISION 23: HEATING, VENTILATING & AIR CONDITIONING (HVAC)			

23 63 13	Air-Cooled Condensing Unit	20 ton	Carrier, Daiken
23 74 33.10	Makeup Air Unit	Rooftop unit, 3 ton cooling	Modine, Carrier, Daiken
DIVISION 26: ELECTRICAL			
26 28 16.20	Safety Switches (Disconnect Switch)	30A Heavy Duty used	Square D , MARS
26 09 23	Lighting Control Devices	Occupany Sensors, Dual-tech, ceiling mounted	System Sensors, Simplex
26 27 26.10	Low Voltage Switching	Relays, 120 V or 277 V Standard	System Sensors, Simplex
26.51.00	Interior Lighting	EL2	GE, Phillips
26.51.00	Interior Lighting	EL4	GE, Phillips
26.51.00	Interior Lighting	CL1	GE, Phillips
26.51.00	Interior Lighting	L8 **LED RETROFIT REPLACEMENT PACKAGE housing E.T.R.	GE, Phillips
26.51.00	Interior Lighting	L4	GE, Phillips
26.51.00	Interior Lighting	L3	GE, Phillips
26.51.00	Interior Lighting	PL1	GE, Phillips
26.51.00	Interior Lighting	PL2	GE, Phillips

26 52 13	EM LIGHT FIXTURES		
26.56.36	Exterior Building Lighting	Wall mounted, indoor/outdoor, 12 watt LED	
DIVISON 27: TELECOMMUNCATIONS			
27 51 19.10	Sound System	Microphone	Simplex, Johnson Controls
27 51 19.10	Sound System	Amplifier	Simplex, Johnson Controls
26 05 23.10	Control Cable	Copper, #14 THWN wire with PVC jacket, 2 wires	Simplex, Johnson Controls
27 51 19.10	Sound System	Speakers, Ceiling or Wall	Simplex, Johnson Controls
DIVISION 28: ELECTRONIC SAFETY & SECURITY			
28 46 11.21	Carbon-Monoxide Detection Sensors	Smoke and Carbon	Simplex, System Sensors
28 46 11.27	Smoke Detector, ceiling type		Simplex, System Sensors
28 46 11.27	Smoke Detector, Duct type		Simplex, System Sensors
28 46 11.50	Heat Detectors	Rate of rise	Simplex, System Sensors
28 46 21	Fire Alarm Panel	4 zone, conventional not including wires and conduits	Simplex-Grinnell, Firelite
28 46 21.50	Strobe and Horn (ADA-type)		Simplex, System Sensors
28 46 21.50	Manual Pull Station		Simplex, System Sensors
28 46 21.50	Remote duct detector key switch test station		Simplex, System Sensors

Appendix D: Gantt Chart and Work Plan

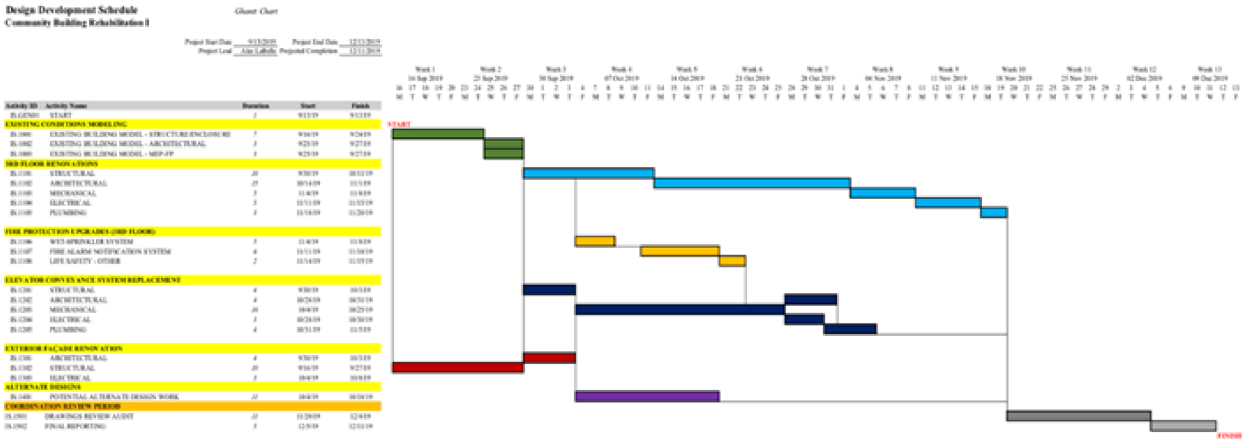

Figure 1: Design Development Gantt Chart submitted with proposal, and still valid through design development. Activities are categorized by construction discipline.

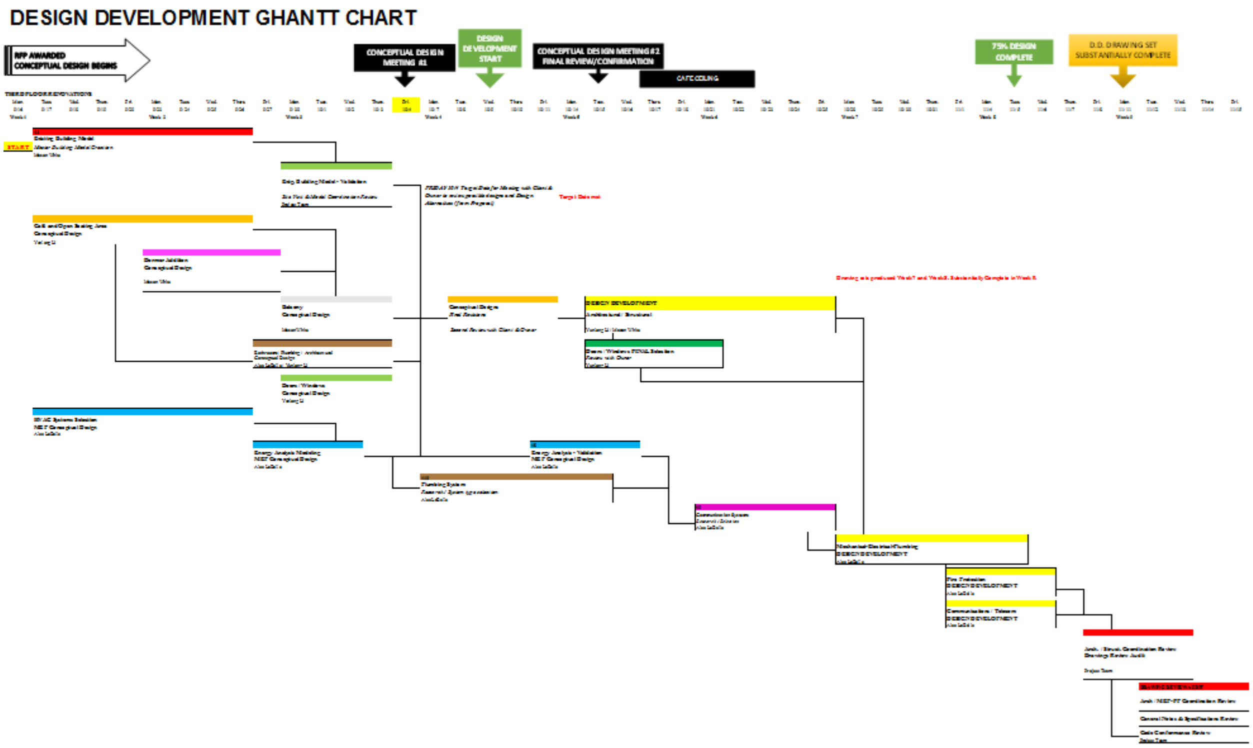

Figure 1 (cont):

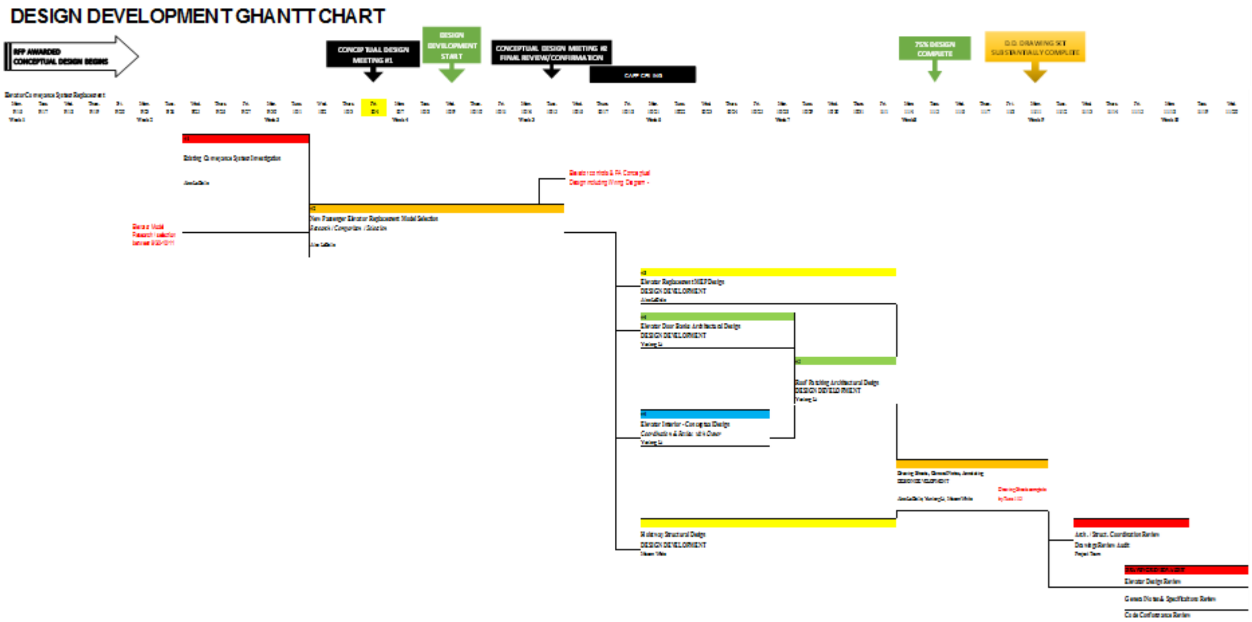

Figure 1 (cont):

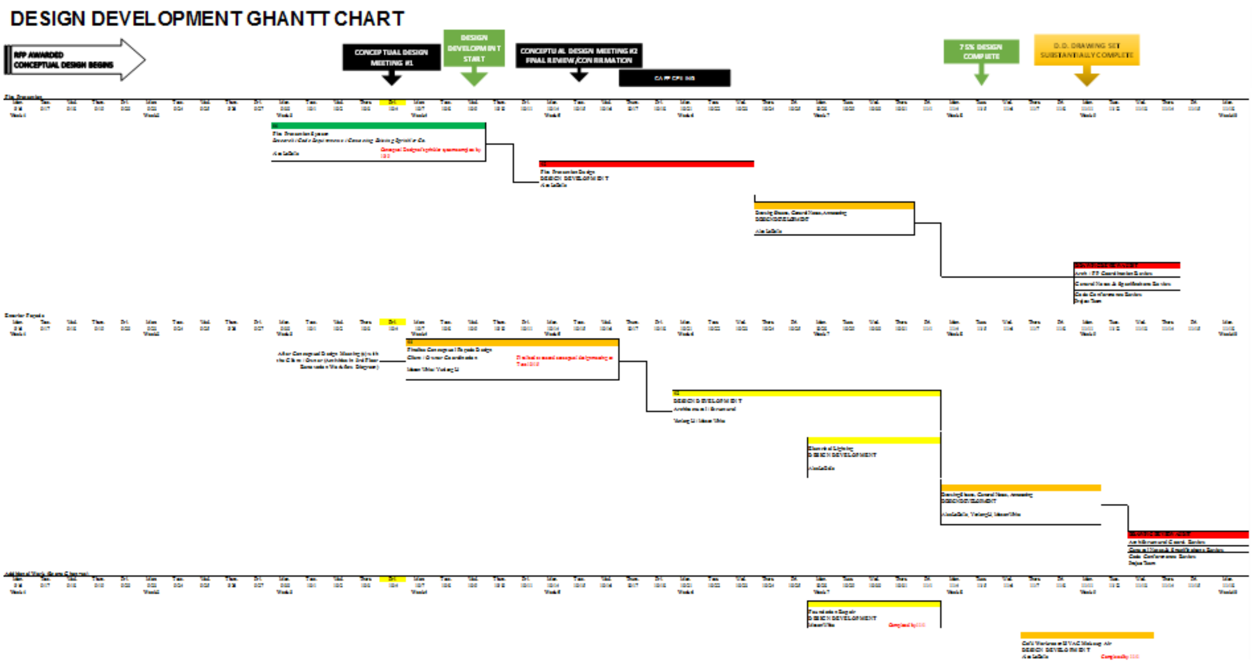

Figure 1 (cont):

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Design Development Schedule
Community Building Rehabilitation I

Project Start Date 9/13/2019 Project End Date 12/13/2019

Projected Completion 12/11/2019

Work Plan

GENERAL NOTES

1. All activities include coordination with codes and design standards. This work will be performed ongoing with time. Approximate time required for code and design standards coordination is: 1 hour : 5 hours of design

2. Work to produce General Notes drawing sheets has been included as separate schedule activities since all project specifications will be included within the design drawings.

Summary

10 days	EXISTING CONDITIONS MODELING
38 days	3RD FLOOR RENOVATIONS
11 days	FIRE PROTECTION UPGRADES - 3RD
27 days	ELEVATOR CONVEYANCE SYSTEM
17 days	EXTERIOR FAÇADE RENOVATION
11 days	ALTERNATE DESIGNS
16 days	COORDINATION REVIEW PERIOD

Activity ID	Activity Name	Duration	Start	Finish	Responsible Team Member
IS.GEN01	START	1 days	9/13/2019	9/13/2019	
EXISTING CONDITIONS MODELING					
IS.1001	**EXISTING BUILDING MODEL - STRUCTURE / ENCLOSURE**	**7 days**	**9/16/2019**	**9/24/2019**	*Mason White*
IS.1001.1	SUBSTRUCTURE				
IS.1001.2	SUPERSTRUCTURE				
IS.1001.3	BUILDING ENVELOPE				
IS.1002	**EXISTING BUILDING MODEL - ARCHITECTURAL**	**3 days**	**9/25/2019**	**9/27/2019**	*Yunlong Li*
IS.1002.1	OPENINGS (DOORS, WINDOWS AND PASS-THROUGH)				
IS.1002.2	INTERIOR WALLS				
IS.1002.3	CEILINGS				
IS.1002.4	CASEWORK				
IS.1002.5	FINISHES				
IS.1002.6	STAIRCASES				
IS.1003	**EXISTING BUILDING MODEL - MEP-FP**	**3 days**	**9/25/2019**	**9/27/2019**	*Alecxander LaBelle*
IS.1003.1	HVAC SYSTEMS				
IS.1003.2	WET-SPRINKLER SYSTEM				
IS.1003.3	ELECTRICAL POWER AND LIGHTING SYSTEMS				
IS.1003.4	PLUMBING SYSTEMS				
3RD FLOOR RENOVATIONS					
IS.1101	**STRUCTURAL**	**10 days**	**9/30/2019**	**10/11/2019**	*Mason White*
IS.1101.1	FLOOR DECK				
IS.1101.2	BEARING WALLS				
IS.1101.3	STRUCTURAL COLUMNS				
IS.1101.4	GENERAL NOTES				
IS.1102	**ARCHITECTURAL**	**15 days**	**10/14/2019**	**11/1/2019**	*Yunlong Li*
IS.1102.1	OPENINGS (DOORS, WINDOWS AND PASS-THROUGH)				
IS.1102.2	INTERIOR WALLS (BEARING / NON-BEARING) *				
IS.1102.3	CEILINGS				
IS.1102.4	ARCHITECTURAL FINISHES				
IS.1102.5	CASEWORK				
IS.1102.6	TYPICAL DETAILS				
IS.1102.7	ARCHITECTURAL SCHEDULES				
IS.1102.8	GENERAL NOTES				
IS.1102.9					
IS.1103	**MECHANICAL**	**5 days**	**11/4/2019**	**11/8/2019**	*Alecxander LaBelle*
IS.1103.1	MECHANICAL EQUIPMENT				
IS.1103.2	AIR TERMINALS				
IS.1103.3	DUCTWORK				
IS.1103.4	ACCESS PANELS, DAMPERS AND FIRE DAMPERS				
IS.1103.5	MECHANICAL PIPING				
IS.1103.6	MECHANICAL VALVES				
IS.1103.7	ENERGY CONSERVATION				
IS.1103.8	TEMPERATURE CONTROLS				
IS.1103.9	MECHANICAL SCHEDULES & DIAGRAMS				
IS.1103.10	TYPICAL DETAILS				
IS.1103.11	GENERAL NOTES				
IS.1104	**ELECTRICAL**	**5 days**	**11/11/2019**	**11/15/2019**	*Alecxander LaBelle*
IS.1104.1	ELECTRICAL SERVICE				
IS.1104.2	ELECTRICAL POWER				
IS.1104.3	LIGHTING				
IS.1104.4	ELECTRICAL PANELS				
IS.1104.5	COMMUNICATIONS / TELECOM				
IS.1104.6	FIRE ALARM **				
IS.1104.7	LIFE SAFETY **				
IS.1104.8	GENERAL NOTES				
IS.1105	**PLUMBING**	**3 days**	**11/18/2019**	**11/20/2019**	*Alecxander LaBelle*
IS.1105.1	PLUMBING EQUIPMENT				
IS.1105.2	PLUMBING FIXTURES				
IS.1105.3	DOMESTIC PIPING				
IS.1105.4	WASTE PIPING				
IS.1105.5	STORM PIPING				
IS.1105.6	PLUMBING VALVES AND SPECIALTIES				
IS.1105.7	PLUMBING SCHEDULES				
IS.1105.8	GENERAL NOTES				

FIRE PROTECTION UPGRADES - 3RD FLOOR RENOVATIONS					
IS.1106	**WET-SPRINKLER SYSTEM**	*5 days*	11/4/2019	11/8/2019	*Alecxander LaBelle*
IS.1106.1	SPRINKLER EQUIPMENT AND CONTROL ROOM				
IS.1106.2	SPRINKLER SYSTEM ZONING				
IS.1106.3	STANDPIPES AND MAINS				
IS.1106.4	BRANCH PIPING				
IS.1106.5	GENERAL NOTES				
IS.1107	**FIRE ALARM NOTIFICATION SYSTEM**	*6 days*	11/11/2019	11/18/2019	*Alecxander LaBelle*
IS.1107.1	SMOKE, HEAT AND DUCT DETECTORS				
IS.1107.2	STROBE RELAYS				
IS.1107.3	PULL STATIONS				
IS.1107.4	FIRE ALARM CONTROL PANEL				
IS.1107.5	NAC PANEL				
IS.1107.6	GENERAL NOTES				
IS.1108	**LIFE SAFETY - OTHER**	*2 days*	11/14/2019	11/15/2019	*Alecxander LaBelle*
IS.1108.1	EXIT SIGNS (ACCESS / EGRESS)				
IS.1108.2	AREA OF RESCUE				
IS.1108.3	GENERAL NOTES				
ELEVATOR CONVEYANCE SYSTEM REPLACEMENT					
IS.1201	**STRUCTURAL**	*4 days*	9/30/2019	10/3/2019	*Mason White*
IS.1201.1	ELEVATOR SHAFT				
IS.1201.2	FOUNDATION				
IS.1201.3	GENERAL NOTES				
IS.1201.4					
IS.1202	**ARCHITECTURAL**	*4 days*	10/28/2019	10/31/2019	*Yunlong Li*
IS.1202.1	ELEVATOR BANK FRONTS				
IS.1202.2	PENTHOUSE ROOFING				
IS.1203	**MECHANICAL**	*16 days*	10/4/2019	10/25/2019	*Alecxander LaBelle*
IS.1203.1	HYDRAULIC/NON-HYDRAULIC CONVEYANCE SYSTEM				
IS.1203.2	ELEVATOR CONTROL PANEL / CONTROL ROOM				
IS.1203.3	ACCESS AND MAINTENANCE				
IS.1203.4	GENERAL NOTES				
IS.1204	**ELECTRICAL**	*3 days*	10/28/2019	10/30/2019	*Alecxander LaBelle*
IS.1204.1	ELEVATOR POWER AND DISCONNECT SWITCH				
IS.1204.2	SUMP-PUMP POWER (IF HYDRAULIC)				
IS.1204.3	ELEVATOR BANK CALL-BUTTONS				
IS.1204.4	ELEVATOR COMMUNICATIONS				
IS.1205	**PLUMBING**	*4 days*	10/31/2019	11/5/2019	*Alecxander LaBelle*
IS.1205.1	SUMP PUMP (IF HYDRAULIC), FLOOR DRAIN (NON-HYDRAULIC)				
IS.1205.2	STORM SEWER PIPING				
EXTERIOR FAÇADE RENOVATION					
IS.1301	**ARCHITECTURAL**	*4 days*	9/30/2019	10/3/2019	*Yunlong Li*
IS.1301.1	DEMOLITION DESIGN OF EXISTING CURTAIN WALL SYSTEM				
IS.1301.2	BRICK PATCHING/REPAIR DESIGN				
IS.1301.3	ROOF PATCHING, ROOF SOFFITS, FASCIAS AND GUTTERS				
IS.1301.4	SIGNAGE *				
IS.1301.5	BALCONY FINISHES				
IS.1301.6	GENERAL NOTES				
IS.1302	**STRUCTURAL**	*10 days*	9/16/2019	9/27/2019	*Mason White*
IS.1302.1	DORMER DESIGN WITH REQ'D ROOF REINFORCEMENT				
IS.1302.2	BALCONY STRUCTURAL DESIGN				
IS.1302.3	MASONRY MODIFICATIONS				
IS.1303	**ELECTRICAL**	*3 days*	10/4/2019	10/8/2019	*Alecxander LaBelle*
IS.1303.1	EXTERIOR BUILDING LIGHTING				
IS.1303.2	BALCONY LIGHTING				
ALTERNATE DESIGNS					
IS.1401	**POTENTIAL ALTERNATE DESIGN WORK**	*11 days*	10/4/2019	10/18/2019	*Project Team*
IS.1401.1	ALTERNATE #1, #2, #3				
IS.1401.2	GENERAL NOTES				
COORDINATION REVIEW PERIOD					
IS.1501	**DRAWINGS REVIEW AUDIT**	*11 days*	11/20/19	12/4/2019	*Project Team*
IS.1501.1	ARCHITECTURAL / MEP-FP DRAWINGS COORDINATION REVIEW				
IS.1501.2	ARCHITECTURAL / STRUCTURAL COORDINATION REVIEW				
IS.1501.3	GENERAL NOTES AND SPECIFICATIONS REVIEW				
IS.1501.4	CODE CONFORMANCE REVIEW				
IS.1502	**FINAL REPORTING**	*5 days*	12/5/19	12/11/2019	*Project Team*
IS.1502.1	FINAL REPORTING				

* IN COORDINATION WITH STRUCTURAL DESIGN
** IN COORDINATION WITH FIRE PROTECTION FIRE ALARM AND LIFE SAFETY DESIGN

Appendix E: Electrical Calculation

VOLTAGE DROP CALCULATIONS – REVIT:

CIRCUIT WIRE SCHEDULE						
CIRCUIT NO.	PANEL	WIRE SIZE	VOLTAGE DROP	POWER FACTOR	POWER FACTOR STATE	BALANCED LOAD
19	PPB-1	1-#8, 1-#8, 1-#8	2 V	1	Lagging	No
8	PPB-1	1-#6, 1-#6, 1-#6	2 V	1	Lagging	No
2	MDB	3-#10, 1-#10, 1-#10	3 V	0.93363	Lagging	No
9	PPB-1	1-#8, 1-#8, 1-#8	2 V	1	Lagging	No
7	PPB-1	1-#10, 1-#10, 1-#10	2 V	1	Lagging	No
1	XREM-1	3-#1, 1-#1, 1-#1	6 V	0.991834	Lagging	No
1	MDB	3-#10, 1-#10, 1-#10	1 V	0.995918	Lagging	No
5	MDB	3-#1, 1-#1, 1-#1	5 V	1	Lagging	No
1	ECP	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
16,18,20	EPB-1	3-#10, 1-#10, 1-#10	0 V	0.8	Lagging	Yes
9	LPB-1	1-#10, 1-#10, 1-#10	2 V	0.95	Lagging	No
4	MDB	3-#6, 1-#6, 1-#6	4 V	0.972771	Lagging	No
10,12,14	EPB-1	3-#10, 1-#10, 1-#10	0 V	1	Lagging	Yes
5	LPB-1	1-#10, 1-#10, 1-#10	0 V	0.95	Lagging	No
3	LPB-1	1-#10, 1-#10, 1-#10	0 V	0.95	Lagging	No
11	LPB-1	1-#10, 1-#10, 1-#10	2 V	0.95	Lagging	No
2	LPB-1	1-#10, 1-#10, 1-#10	2 V	0.95	Lagging	No
7	LPB-1	1-#10, 1-#10, 1-#10	2 V	0.887244	Lagging	No
6	LPB-1	1-#10, 1-#10, 1-#10	0 V	0.95	Lagging	No
1	PPB-1	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
7	EPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
8	EPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
3,5	EPB-1	2-#6, 1-#6, 1-#6	4 V	1	Lagging	Yes
1	EPB-1	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
2	ECP	1-#12, 1-#12, 1-#12	0 V	0.95	Lagging	No
3	ECP	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
4	ECP	1-#12, 1-#12, 1-#12	0 V	1	Lagging	No
5	ECP	1-#12, 1-#12, 1-#12	0 V	1	Lagging	No
6	ECP	1-#12, 1-#12, 1-#12	0 V	1	Lagging	No
2	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
13	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
16	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
14	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
4	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
4	LPB-1	1-#10, 1-#10, 1-#10	0 V	0.95	Lagging	No
2	EPB-1	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
13,15	EPB-1	2-#10, 1-#10, 1-#10	0 V	1	Lagging	Yes
3	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
6	PPB-1	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
7	ECP	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
17,19,21	EPB-1	3-#10, 1-#10, 1-#10	0 V	0.8	Lagging	Yes
20	PPB-1	1-#1/0, 1-#1/0, 1-#1/0	2 V	1	Lagging	No
17	PPB-1	1-#1/0, 1-#1/0, 1-#1/0	2 V	1	Lagging	No
21	PPB-1	1-#8, 1-#8, 1-#8	2 V	1	Lagging	No
11	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
5	PPB-1	1-#2, 1-#2, 1-#2	2 V	1	Lagging	No
15	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
22	PPB-1	1-#1/0, 1-#1/0, 1-#1/0	2 V	1	Lagging	No
22,24,26	EPB-1	3-#10, 1-#10, 1-#10	0 V	0.8	Lagging	Yes
10	PPB-1	1-#6, 1-#6, 1-#6	2 V	1	Lagging	No
12	PPB-1	1-#10, 1-#10, 1-#10	2 V	1	Lagging	No
Feed Through Lugs	PPB-1	3-#10, 1-#10, 1-#10	0 V	1	Lagging	Yes
8,10	LPB-1	2-#10, 1-#10, 1-#10	0 V	1	Lagging	Yes
1	LPB-1	1-#10, 1-#10, 1-#10	0 V	1	Lagging	No
18	PPB-1	1-#10, 1-#10, 1-#10	1 V	1	Lagging	No
23	PPB-1	1-#10, 1-#10, 1-#10	2 V	1	Lagging	No

TRANSFORMER SIZING

Volts (3-phase)	208	
Current Draw (A)	177	
kVA	*64 kVA*	$kVA = \frac{(V * I * 1.732)}{1000}$
Added Transformer Power Required:	**75 kVA**	

Figure E-1: Added power demand on the building's transformer from new design.

Project Lighting Summary

Project: COMMERCIAL BUILDING REHABILITATION I

Engineer: Alecxander LaBelle
Date: 10/28/2019

REQUIRED ILLUMINANCE

Room / Area	Maint. (fc)	Width	Length	Fixtures Required	Watts per SqFt
Retail-1	10	48	55.5	12	0.6
Retail-2	10	20	72	6	0.5
Retail-3	10	18	90.5	7	0.6
Retail-4	10	20	25	3	0.8
Retail-5	10	19	33	3	0.6
Café Seating-1	10	23	49.25	7	0.9
Café Seating-2	10	12.25	49.25	16	1.6
Café Workroom	10	19	16.25	1	0.5
North Bathroom	10	15	6.66	1	0.8
South Bathroom	10	14.5	6.66	1	0.8
Utility Room	10	9	15	2	0.5

Project Average Watts / Sq.Ft. 0.7

DESIGN ILLUMINANCE

Room / Area	Maint. (fc)	Width	Length	Luminares Specified	Watts per SqFt
Retail-1	11			12	0.6
Retail-2	10			6	0.5
Retail-3	12			8	0.6
Retail-4	15			3	0.8
Retail-5	12			3	0.6
Café Seating-1	39			56	1.2
Café Seating-2	39			18	1.8
Café Workroom	49			4	2.1
North Bathroom	15			1	0.8
South Bathroom	16			1	0.8
Utility Room	11			2	0.5

Project Average Watts / Sq.Ft. 0.9

Figure E-2: Comparison of required illuminance per 2018-IBC and design illuminance.

Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	48	Lamp Lumen Depreciation	0.8
Room Length	55.5	Luminaire Dirt Depreciation	0.8
Luminaire Height	10.75	Ballast Factor	0.95
Lumens per Lamp	3205	Work Plane (ft)	2.5
Watts Per Lamp	64		
Coefficient of Utilization	0.6		

Calculated	
Room Cavity Ratio	1.6

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	12	Desired Illuminance (fc)	10
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	**11**	**Fixtures Required**	**12**
Watts per Sq.Ft.	0.6	Watts per Sq.Ft.	0.6

Figure E-3: Retail-1 Lighting backup calculations.

Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	20	Lamp Lumen Depreciation	0.8
Room Length	72	Luminaire Dirt Depreciation	0.8
Luminaire Height	10.75	Ballast Factor	0.95
Lumens per Lamp	3205	Work Plane (ft)	2.5
Watts Per Lamp	64		
Coefficient of Utilization	0.63		

Calculated	
Room Cavity Ratio	2.6

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	6	Desired Illuminance (fc)	10
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	**10**	**Fixtures Required**	**6**
Watts per Sq.Ft.	0.5	Watts per Sq.Ft.	0.5

Figure E-4: Retail-2 Lighting backup calculations.

Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	18	Lamp Lumen Depreciation	0.8
Room Length	90.5	Luminaire Dirt Depreciation	0.8
Luminaire Height	10.75	Ballast Factor	0.95
Lumens per Lamp	3205	Work Plane (ft)	2.5
Watts Per Lamp	64		
Coefficient of Utilization	0.63		

Calculated	
Room Cavity Ratio	2.7

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	8	Desired Illuminance (fc)	10
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	12	Fixtures Required	7
Watts per Sq.Ft.	0.6	Watts per Sq.Ft.	0.6

Figure E-5: Retail-3 Lighting backup calculations.

Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	20	Lamp Lumen Depreciation	0.8
Room Length	25	Luminaire Dirt Depreciation	0.8
Luminaire Height	10.75	Ballast Factor	0.95
Lumens per Lamp	3205	Work Plane (ft)	2.5
Watts Per Lamp	64		
Coefficient of Utilization	0.63		

Calculated	
Room Cavity Ratio	3.7

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	3	Desired Illuminance (fc)	10
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	15	Fixtures Required	3
Watts per Sq.Ft.	0.8	Watts per Sq.Ft.	0.8

Figure E-6: Retail-4 Lighting backup calculations

Quick Lighting Calculator

Variables

Room Width (ft)	19
Room Length	33
Luminaire Height	10.75
Lumens per Lamp	3205
Watts Per Lamp	64
Coefficient of Utilization	0.63

Constants

Lamp Lumen Depreciation	0.8
Luminaire Dirt Depreciation	0.8
Ballast Factor	0.95
Work Plane (ft)	2.5

Calculated

Room Cavity Ratio	3.4

Maintained Illuminance (fc)

Number of Luminaires	3
Lamps per Luminaire	2
Maintained Illuminance (fc)	12
Watts per Sq.Ft.	0.6

Luminaires Required

Desired Illuminance (fc)	10
Lamps per Luminaire	2
Fixtures Required	3
Watts per Sq.Ft.	0.6

Figure E-7: Retail-5 Lighting backup calculations.

Quick Lighting Calculator

Variables

Room Width (ft)	23
Room Length	49.25
Luminaire Height	9.25
Lumens per Lamp	2400
Watts Per Lamp	24
Coefficient of Utilization	0.89

Constants

Lamp Lumen Depreciation	1
Luminaire Dirt Depreciation	0.8
Ballast Factor	0.95
Work Plane (ft)	2.5

Calculated

Room Cavity Ratio	2.2

Maintained Illuminance (fc)

Number of Luminaires	28
Lamps per Luminaire	1
Maintained Illuminance (fc)	40
Watts per Sq.Ft.	0.6

Luminaires Required

Desired Illuminance (fc)	10
Lamps per Luminaire	1
Fixtures Required	7
Watts per Sq.Ft.	0.1

Figure E-8: Café Seating-1 Lighting backup calculations.

Quick Lighting Calculator

Variables	
Room Width (ft)	12.25
Room Length	49.25
Luminaire Height	11
Lumens per Lamp	1800
Watts Per Lamp	60
Coefficient of Utilization	0.61

Constants	
Lamp Lumen Depreciation	1
Luminaire Dirt Depreciation	0.8
Ballast Factor	0.95
Work Plane (ft)	2.5

Calculated	
Room Cavity Ratio	4.3

Maintained Illuminance (fc)	
Number of Luminaires	28
Lamps per Luminaire	1
Maintained Illuminance (fc)	39
Watts per Sq.Ft.	2.8

Luminaires Required	
Desired Illuminance (fc)	10
Lamps per Luminaire	1
Fixtures Required	8
Watts per Sq.Ft.	0.8

Figure E-9: Café Seating-2 Lighting backup calculations.

Quick Lighting Calculator

Variables	
Room Width (ft)	19
Room Length	16.25
Luminaire Height	9
Lumens per Lamp	5200
Watts Per Lamp	80
Coefficient of Utilization	0.48

Constants	
Lamp Lumen Depreciation	1
Luminaire Dirt Depreciation	0.8
Ballast Factor	0.95
Work Plane (ft)	2.5

Calculated	
Room Cavity Ratio	3.7

Maintained Illuminance (fc)	
Number of Luminaires	4
Lamps per Luminaire	2
Maintained Illuminance (fc)	49
Watts per Sq.Ft.	2.1

Luminaires Required	
Desired Illuminance (fc)	10
Lamps per Luminaire	2
Fixtures Required	1
Watts per Sq.Ft.	0.5

Figure E-10: Café Workroom lighting backup calculations.

Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	15	Lamp Lumen Depreciation	0.8
Room Length	6.66	Luminaire Dirt Depreciation	0.8
Luminaire Height	9	Ballast Factor	0.95
Lumens per Lamp	2600	Work Plane (ft)	2.5
Watts Per Lamp	40		
Coefficient of Utilization	0.48		

Calculated

Room Cavity Ratio	7.0

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	1	Desired Illuminance (fc)	12
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	15	Fixtures Required	1
Watts per Sq.Ft.	0.8	Watts per Sq.Ft.	0.8

Figure E-11: North bathroom lighting backup calculations.

Quick Lighting Calculator

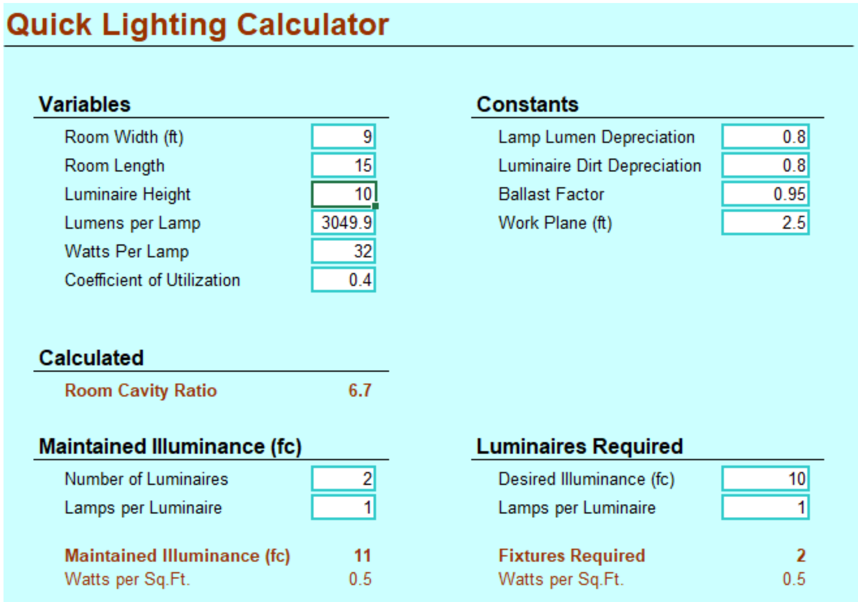
Variables		Constants	
Room Width (ft)	14.5	Lamp Lumen Depreciation	0.8
Room Length	6.66	Luminaire Dirt Depreciation	0.8
Luminaire Height	9	Ballast Factor	0.95
Lumens per Lamp	2600	Work Plane (ft)	2.5
Watts Per Lamp	40		
Coefficient of Utilization	0.48		

Calculated

Room Cavity Ratio	7.1

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	1	Desired Illuminance (fc)	12
Lamps per Luminaire	2	Lamps per Luminaire	2
Maintained Illuminance (fc)	16	Fixtures Required	1
Watts per Sq.Ft.	0.8	Watts per Sq.Ft.	0.8

Figure E-12: South Bathroom Lighting backup calculations



Quick Lighting Calculator

Variables		Constants	
Room Width (ft)	9	Lamp Lumen Depreciation	0.8
Room Length	15	Luminaire Dirt Depreciation	0.8
Luminaire Height	10	Ballast Factor	0.95
Lumens per Lamp	3049.9	Work Plane (ft)	2.5
Watts Per Lamp	32		
Coefficient of Utilization	0.4		

Calculated

Room Cavity Ratio	6.7

Maintained Illuminance (fc)		Luminaires Required	
Number of Luminaires	2	Desired Illuminance (fc)	10
Lamps per Luminaire	1	Lamps per Luminaire	1
Maintained Illuminance (fc)	11	Fixtures Required	2
Watts per Sq.Ft.	0.5	Watts per Sq.Ft.	0.5

Figure E-13: Utility room lighting backup calculations.

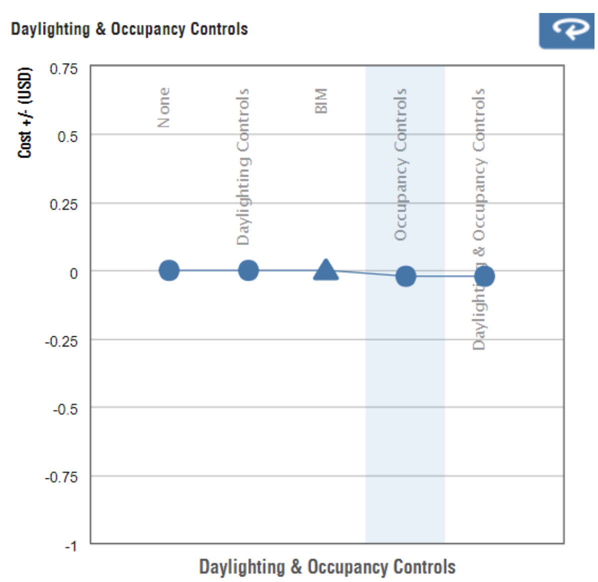


Figure E-14. Daylight

Appendix F: Fire Protection Calculations

Table F-1: Selected design parameters for third floor sprinkler system. These parameters are specified on Sheet F0.1.

DESIGN GENERAL REQUIREMENTS:			
Maximum Spacing per NFPA:			
Light Hazard, Non-Combustible, Unobstructed			220 SF
Ordinary I Hazard			130 SF
Design Sprinkler Spacing:	15' x 12'	180 SF	
15' x 12' Optimal spacing in relation to new ductwork			

Table F-2: Third floor rooms categorized by hazard type with comparison of minimum sprinkler heads to design sprinkler heads.

Sprinkler Hazard Zones per NFPA 13:					
Room	**Hazard Classification**	**Farthest Hydraulic Design Area of Operation**	**Design Area**	**Min. Required Sprinkler Heads**	**Design Sprinkler Heads**
Cafe Seating	Light	1500 SF	1695 SF	8	9
Retail	Light	1500 SF	6629 SF	30	37
Bathrooms	Light	1500 SF	182 SF	1	1
Workroom	Ordinary I	2000 SF	222 SF	2	2
Utility Room	Ordinary I	2000 SF	121 SF	1	1

Table F-3: Third floor room coverage area breakdown.

Space Schedule			
Name	**Area**	**Level**	**Volume**
Retail	805 SF	Level 3	8853.36 CF
Retail	853 SF	Level 3	9379.45 CF
Café Seating	806 SF	Level 3	8860.99 CF
Café Seating	889 SF	Level 3	9775.72 CF
Retail	450 SF	Level 3	4953.88 CF
Retail	455 SF	Level 3	5007.22 CF
Retail	422 SF	Level 3	4641.03 CF
Retail	434 SF	Level 3	4778.95 CF
Retail	479 SF	Level 3	5272.24 CF
Retail	390 SF	Level 3	4285.26 CF
Retail	414 SF	Level 3	4555.32 CF
Retail	371 SF	Level 3	4083.31 CF
Retail	463 SF	Level 3	5092.66 CF
Retail	451 SF	Level 3	4961.31 CF
Retail	243 SF	Level 3	2672.43 CF
Retail	312 SF	Level 3	3432.60 CF
Utility Room	121 SF	Level 3	1328.80 CF
Retail	87 SF	Level 3	952.20 CF
North Bathroom	92 SF	Level 3	1016.85 CF
South Bathroom	90 SF	Level 3	987.81 CF
Workroom	222 SF	Level 3	2447.23 CF

Table F-4: Water demand based on NFPA 13 Coverage Area method and using

NFPA 13 Density/Area Curve:			
Light	Area of Sprinkler Operati	8506 SF	
	Density (gpm/SF)	0.1	
	GPM Demanded:		**850.6 gpm**
Ordinary I	Area of Sprinkler Operati	343 SF	
	Density (gpm/SF)	0.12	
	GPM Demanded:		**41.2 gpm**
THIRD FLOOR TOTAL DEMAND:			
Approximate Flow = Density x Area x Overflow Rate + Hose Allowance			
Overflow Rate:	1.3		
Hose Allowance	250.0 gpm		
		Approximate Flow:	**1409.3 gpm**
FIRST FLOOR TOTAL DEMAND:			
Assuming equal demand and hazard classification areas			**1409.3 gpm**
TOTAL BUILDING DEMAND			
			2819 gpm

Table F-5: NFPA 13 Density/Area Curve for Coverage Area sprinkler operation.

Nominal K-Factor [gpm/(psi)$^{1/2}$]	Nominal K-Factor [L/min/(bar)$^{1/2}$]	K-Factor Range [gpm/(psi)$^{1/2}$]	K-Factor Range [L/min/(bar)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	20	1.3–1.5	19–22	25	1⁄2 in. NPT
1.9	28	1.8–2.0	26–29	33.3	1⁄2 in. NPT
2.8	40	2.6-2.9	38–42	50	1⁄2 in. NPT
4.2	61	4.0-4.4	57-63	75	1⁄2 in. NPT
5.6	81	5.3-5.8	76-84	100	1⁄2 in. NPT

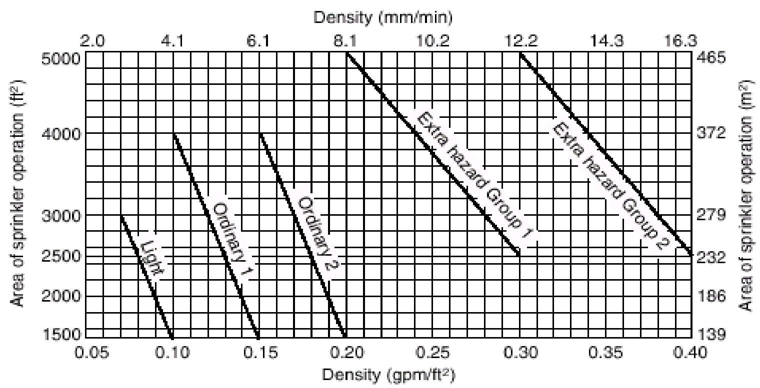


Figure F-1: Sprinkler discharge characteristics per NFPA 13 Table 6.2.3.1.

Table F-6: Minimum required sprinkler heads per NFPA 72 and design quantity of sprinkler heads per room.

SPRINKLER ROOM SCHEDULE			
Room	**Hazard Classification**	**Min. Required Sprinkler Heads**	**Design Sprinkler Heads**
Cafe Seating	Light	8	9
Retail	Light	30	37
Bathrooms	Light	1	1
Workroom	Ordinary I	2	2
Utility Room	Ordinary I	1	1

Table F-7: Critical sprinkler head characteristics.

Critical Path Sprinkler Head	
K	5.6
Q	20 gpm
P	12.76 psi

Table F-8: Pressure loss calculations for critical path sprinkler head (farthest sprinkler head from service main; must main 20 gpm).

Path	Q (gpm)	D (in.)	Length of Straight Pipe (ft.) (a)	Fitting and Devices	Qty.	Equivalent Length (fittings) (b)	Total Equivalent Lengths (a+b)	Friction Loss (psi/ft)	Pressure Friction (psi)	P (psi)	Notes	
1-2	20	1	9.5	Tee or Cross	1	5	23	0.1643	3.6961	12.7551	P2 =	12.76 psi
				90 Elbow	4	2					K =	K = 5.6
											Q2 =	20
2-3	40	2	19	90 Elbow	1	5	34	0.0203	0.6885	12.7551		
				Tee or Cross	1	10						
											Q3 =	40
3-4	137.44	6	12.256	TEE OR CROSS	3	30	102	0.0009	0.0964	13.4436		
											Q4 =	60
4-5	197.44	6	12	TEE OR CROSS	2	30	72	0.0018	0.1327	13.5401		
											Q5 =	60
5-6	257.44	6	12	TEE OR CROSS	1	30	42	0.0030	0.1265	13.6728		
											Q6 =	40
6A	297.44	6	84	TEE OR CROSS	5	30	234	0.0039	0.9206	13.7993		
											QRISER ^ =	1112
RISER	1409.44	6	40	CHECK VALVE	1	32	248	0.0700	17.3478	14.7199		
				GLOBE VALVE	2	1						
				90 Elbow	6	14					QBASEMENT * =	1410
				Tee or Cross	3	30						
BASEMENT**	2819.44	6	32	90 Elbow	2	14	128	0.2523	32.2900	32.0677		
				Tee or Cross	1	30						
				Alarm Check Valve	1	32						
				Double Gate Valve	1	6						
									PRESSURE LOSSES	**19.31 psi**		

* Assumption: Total first floor demand same as third floor demand (equivalent areas of protection, equivalent hazard types, etc.). No documentation could be found on the existing sprinkler system.
**Additional alarm check valve in basement (seriving first floor) assumed to remain for economical purposes. Therefore, the first floor alarm check valve impacts the critical path on the third floor.
^ Overflow Rate and Hose Allowance added at Riser to account for friction losses at peak demand

$$p = \frac{4.52Q^{185}}{C^{1.85}d^{4.87}} \qquad Q = K \times P^{1/2}$$

Appendix G: Architectural Designs

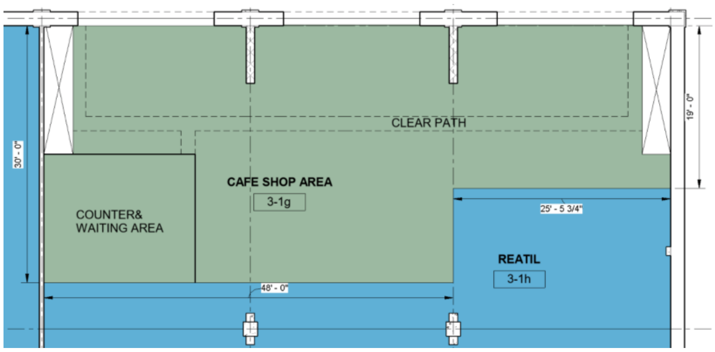


Figure G-1: Café area option 1

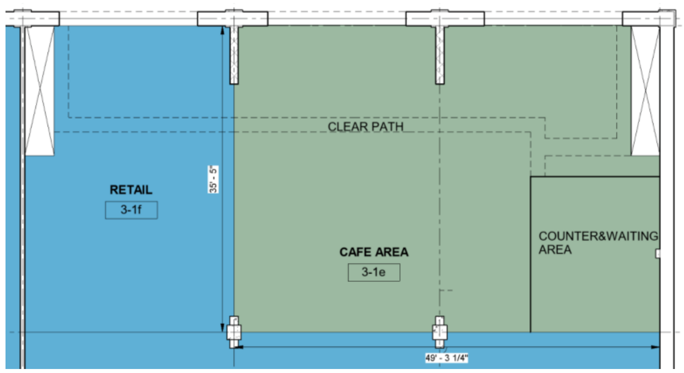


Figure G-2: Café area option 2

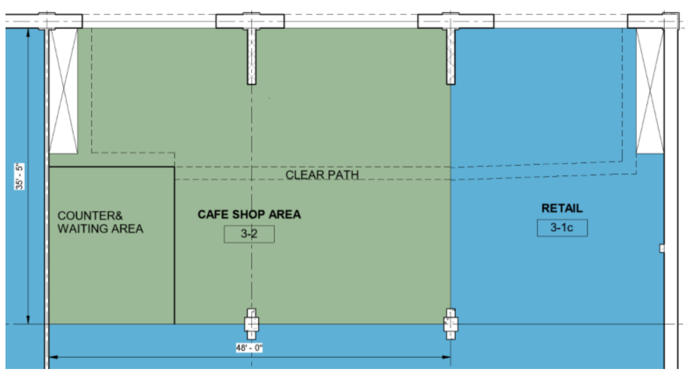


Figure G-3: Café area option 3

Figure G-4: Skydeck design

Appendix H: Elevator System

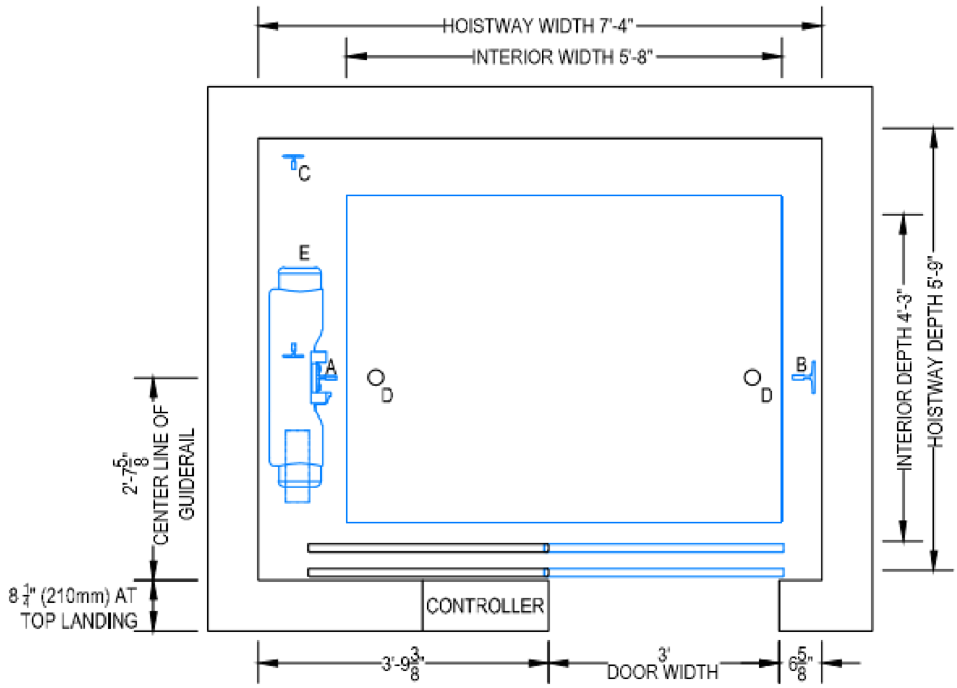


Figure H-1. Hostway plan view

Table H-1. Hoist beam and life line vertical forces

HOISTBEAM & LIFE LINE VERTICAL FORCES (lbf)				
REACTION LOCATION	A	B	C	D
Z DIRECTION	4800	4700	5000	5000

Appendix M: Mechanical Calculation

HEATING & COOLING LOADS CALCULATION

EXHAUST VENTILATION

	Area (SF)	Volume (CF)	Airflow Rate (Air Changes/hr)	Exhaust Airflow Rate (CFM/SF)	Ventilation Airflow (CFM)	
North Bathroom:	92 SF	1016.85 CF			**70 CFM**	*PER 2018 IMC CHAPTER 4 TABLE 403.3.1.1 MINIMUM VENTILATION RATES (70 CFM PER W.C./URINAL - ONLY OPERATIONAL WHEN ROOM OCCUPIED)*
South Bathroom:	90 SF	987.81 CF			**70 CFM**	*PER 2018 IMC CHAPTER 4 TABLE 403.3.1.1 MINIMUM VENTILATION RATES (70 CFM PER W.C./URINAL - ONLY OPERATIONAL WHEN ROOM OCCUPIED)*
Workroom (Exhaust Hood)	293 SF	3217.81 CF		0.7	**450 CFM**	*STANDARD SUGGESTED PRACTICE FOR COMMERCIAL KITCHEN EXHAUST HOODS: 150 CFM/LN FT OF STOVETOP. HOOD ASSUMED TO BE WALL MOUNTED WITH EDGE PANELS.*
Utility Room (Wind Turbine EF)	121 SF	1328.80 CF		0.04	**5 CFM**	*PER 2018 IMC CHAPTER 4 VENTILATION SECTION 403.2 MINIMUM VENTILATION REQUIREMENT*
Elevator Shaft Hoistway	76 SF	3929.19 CF	12		**786 CFM**	*PER 2012 IBC - AIR CHANGES PER HOUR IN ELEVATOR SHAFTS SHALL BE A MINIMUM OF 12 AIR CHANGES PER AN HOUR*

$$\text{Air Changes / h} = \frac{\text{CFM} \times 60 \text{ min}}{\text{Volume of Room}}$$

Elevator Shaft Parameters:

Height (Bot. of Pit to T.O. Shaft)		51.44	ft
Area:		76.384	SF
Width:	8.8		
Depth:	8.68		
Volume:		3929.19	CF

Figure M-1. Ventilation loads

AIR TERMINALS

SUPPLY AIR	Total Cooling Airflow	Qty. Diffusers	Airflow per Diffuser
Supply - Retail:	4967	24	**207 CFM**
Supply - Café Seating:	1350	9	**150 CFM**
Supply - Workroom:	232	1	**232 CFM**
Supply - North Bathroom:	84	1	**84 CFM**
Supply - South Bathroom:	82	1	**82 CFM**

Figure M-2. Supply air

RETURN AIR	Total Cooling Airflow	Qty. Diffusers	Airflow per Diffuser
Return - Retail (North)	2106 CFM	1	**2106 CFM**
Return - Retail (East)	2106 CFM	1	**2106 CFM**
Return - Retail (South)	2106 CFM	1	**2106 CFM**
Return - Workroom	232 CFM	1	**232 CFM**
Return - North Bathroom	84	1	**84 CFM**
Return - South Bathroom	82	1	**82 CFM**

Figure M-3. Design airflow per return grille type – return airflow equals supply airflow.

EXHAUST AIR	Total Exhaust Airflow	Qty. Diffusers	Airflow per Diffuser**
Exhaust - North Bathroom	70 CFM	1	**70 CFM**
Exhaust - South Bathroom	70 CFM	1	**70 CFM**
Exhaust - Utility Room	5 CFM	1	**5 CFM**
Exhaust - Workroom (kitchen hood)	450 CFM	1	**450 CFM**
Exhaust - Elev. Shaft (Pressure Relief Damper)	786	1	**786 CFM**

Figure M-4. Exhaust air grilles and louvers design airflow. All exhaust airflow values are in accordance with 2018 International Mechanical Code

DUCTWORK SIZING

SUPPLY AIRFLOW

Duct	Airflow (CFM)	in. wg-100ft	Velocity (FPM)	Equivalent Diameter (in.)	Design Diameter (in.)	Rectangular Size (in. x in.)
B1-A	1449	0.08	951.3	16.7	17	
B1-B	828	0.08	828.5	13.5	14	
B2-A	1449	0.08	951.3	16.7	17	
B2-B	828	0.08	828.5	13.5	14	
B3-A	1537	0.08	965.2	17.1	17	
B3-B	828	0.08	828.5	13.5	14	
B3-C	450	0.08	711.8	10.8	11	
B4-A	1744	0.08	995.6	17.9	18	
B4-B	957	0.08	858.8	14.3	14	
B4-D	166	0.08	553.3	7.4	8	
B4-D TAKEOFFS	84	0.08	464.7	5.8	6	
B4-E	450	0.08	711.8	10.8	11	
M3	1449	0.08	951.3	16.7	17	
M2	2898	0.08	1127.1	21.7	22	
M1	4435	0.08	1249.9	25.5	26	
SUPP-MAIN	6261	0.08	1358.5	29.1	29	30 x 24
MAU-1 SUPP-DROP	682	0.08	789.6	12.6	12	20 x 7
MAU-1 RETURN-DROP	232	0.08	602.4	8.4		6 x 10

Figure M-5. Ductwork size

RETURN AIRFLOW

Duct	Airflow (CFM)	in. wg-100ft	Velocity (FPM)	Equivalent Diameter (in.)	Design Diameter (in.)	Rectangular Size (in. x in.)
RB-1	2338	0.08	1069.6	20	20	20
RB-1 TAKEOFF	232	0.08	602.4	8.4	8	
RB-1	2338	0.08	1069.6	20	20	
RM-2	4528	0.08	1256.2	25.7	26	
RM-2 TAKEOFF	84	0.08	464.7	5.8	6	
RM-1	4528	0.08	1256.2	25.7	26	
RB3-A	2106	0.08	1042.6	19.2	20	20 x 15
RB3-B TAKEOFF	82	0.08	461.8	5.7	6	
RB3-B	2188	0.08	1052.4	19.5	20	
RETURN-MAIN	6716	0.08	1381.7	29.9	30	23 x 33

Figure M-6. Return air

EXHAUST AIRFLOW

Duct	Airflow (CFM)	in. wg-100ft	Velocity (FPM)	Equivalent Diameter (in.)	Design Rect. Size (in. x in.)	Rectangular Size (in. x in.)
EB-1	70	0.08	443.3	5.4	5 x 5	5 x 5
EB-2	70	0.08	443.3	5.4	5 x 5	5 x 5
EB-3	140	0.08	529.8	7	8 x 5	8 x 5
EK-1	450	0.08	711.8	10.8	10 x 10	10 x 10
EK-2	5	0.08	219.06	2		

Figure M-7. Exhaust airflow

Table M-1. Refrigerant piping schedule

Refrigerant Piping Schedule

Comments	System Name	Schedule/Type	Diameter	Length	Top Elevation
LIQUID-LINE	Refrigerant Piping	K	1"	5.986	-0' - 11 5/8
LIQUID-LINE	Refrigerant Piping	K	1"	0.213	4' - 8 3/4"
LIQUID-LINE	Refrigerant Piping	K	1"	5.47	4' - 6 3/8"
SUCTION LINE	Refrigerant Piping	K	1"	13.273	1' - 1 3/4"
SUCTION LINE	Refrigerant Piping	K	2"	5.337	4' - 9 3/4"
SUCTION LINE	Refrigerant Piping	K	1"	0.377	4' - 9 1/2"
SUCTION LINE	Refrigerant Piping	K	2"	3.236	4' - 7 1/2"
LIQUID-LINE	Refrigerant Piping	K	1"	13.305	13' - 0 5/8"
LIQUID-LINE	Refrigerant Piping	K	1"	1.692	0' - 9"
SUCTION LINE	Refrigerant Piping	K	1"	14.418	1' - 1 3/8"
LIQUID-LINE	Refrigerant Piping	K	1"	22.203	1' - 0 1/2"
SUCTION LINE	Refrigerant Piping	K	1"	22.505	13' - 1 3/8"
SUCTION LINE	Refrigerant Piping	K	1"	0.216	3' - 6 3/4"
SUCTION LINE	Refrigerant Piping	K	1"	8.367	11' - 11 3/8
SUCTION LINE	Refrigerant Piping	K	1"	0.587	12' - 0 3/8"
SUCTION LINE	Refrigerant Piping	K	1"	10.4	12' - 0 7/8"
SUCTION LINE	Refrigerant Piping	K	1"	0.832	12' - 11 1/8
LIQUID-LINE	Refrigerant Piping	K	1"	10.735	12' - 0 7/8"
LIQUID-LINE	Refrigerant Piping	K	1"	0.763	12' - 10 1/4
LIQUID-LINE	Refrigerant Piping	K	1"	0.224	3' - 2 5/8"
LIQUID-LINE	Refrigerant Piping	K	1"	0.235	3' - 2 1/2"
LIQUID-LINE	Refrigerant Piping	K	1"	1.044	3' - 2 3/8"
LIQUID-LINE	Refrigerant Piping	K	1"	8.732	11' - 11 1/2

SUCTION-LINE TOTAL LENGTH **79.548** ft.

LIQUID-LINE TOTAL LENGTH: **70.602** ft.

NOTE: MAXIMUM EQUIVALENT PIPE LENGTH FOR STANDARD SIZING METHOD IS 75'-0". ACCU PIPING EXCEEDS THIS CONSTRAINT.

LONG LINE SET APPLICATIONS WILL BE USED FOR SIZING THE REFRIGERANT PIPING.

Table M-2. Long Line Set sizing chart used from Carrier design guide for sizing of refrigerant lines.

TABLE 5: R-410A LIQUID LINE, MAXIMUM RISE CHART

Tons	Line Size	Maximum Total Equivalent Length								Velocity FPM
		75	100	125	150	175	200	225	250	
1.5	5/16	75	90	85	85	80	75	75	70	223
	3/8	75	100	95	95	95	95	90	90	138
2.0	5/16	75	80	75	70	65	60	55	50	297
	3/8	75	95	90	90	85	85	85	80	184
2.5	3/8	75	90	85	85	80	80	75	70	230
	1/2	75	100	100	100	100	95	95	95	123
3.0	3/8	75	85	85	80	75	70	65	60	276
	1/2	75	100	100	95	95	95	90	90	148
3.5	3/8	75	80	75	70	65	60	55	50	322
	1/2	75	95	95	95	95	90	90	90	173
4.0	3/8	75	75	70	60	55	45	40	35	368
	1/2	75	95	95	95	90	90	90	85	198
5.0	3/8	70	60	50	40	30	20	10	0	*460
	1/2	75	95	90	90	85	85	80	80	247
7.5	1/2	75	80	80	75	70	65	60	55	370
	5/8	75	95	95	95	90	90	90	85	231
10	5/8	75	90	90	85	85	80	80	75	307
	3/4	75	100	95	95	95	95	90	90	210
12.5	5/8	75	85	85	80	75	70	65	65	384
	3/4	75	95	95	90	90	90	90	85	262
15	3/4	75	95	90	90	85	85	85	80	315
	7/8	75	100	95	95	95	95	95	90	222
20	3/4	75	85	85	80	75	70	70	65	419
	7/8	75	95	95	90	90	90	85	85	296
25	7/8	75	95	90	90	85	85	80	75	371
	1-1/8	75	100	100	100	95	95	95	95	217

*__Note__: Exceeds recommended maximum velocity of 400 fpm, consider noise when selecting this pipe size.

SELECTED REFRIGERANT PIPE SIZES:		
	SUCTION LINE	3/4"
	LIQUID LINE	1/2"

NATURAL GAS PIPE SIZING

Table M-3. Calculated static pressure for exhaust fan systems on third floor serving the bathrooms (EF-1 and EF-2) and Workroom (H-x/EF-3).

GENERAL INFORMATION:

Sizing Method:	Longest Length Method (2018 UPC Chapter 12 Section 1215.1 and Tables 1215.2(1) through Table 1215.2(36)
Assumption:	Standard Delivery pressure above 0.7 w.c. (0.25 psig) (per MidAmerican Energy), therefore 2018 UPC Table A1215.2(1) will be used for pipe sizing schedule
Assumption:	Nat Gas stovetop (GST) will not require demand of industry standard commercial cooktop

PATH	PIPE LENGTH	
TO GST	238 ft.	
TO TWH-1	201 ft.	
TO FU-1	197 ft.	
TO MAU-1	224 ft.	> FARTHEST PIPE ROUTE
3RD FLOOR SUPPLY FROM GAS METER **(NOTE 3RD FLOOR SUPPLY ADDED TO ALL LISTED PATHS ABOVE)	192 ft.	

TAG	NAME	OUTPUT CAPACITY / DEMAND	Conversion Factor	Demand (CF/h)	
FU-1	COMMERCIAL FURNACE	222000 btu/h	1062	209 CF/h	
GST	GAS STOVETOP	18000 btu/h	1062	17 CF/h	*PEAK DEMAND (ALL BURNERS ON)*
TWH-1	TANKLESS WATER HEATER	428400 btu/h	1062	403 CF/h	
MAU-1	MAKEUP AIR UNIT	5500 btu/h	1062	5 CF/h	
			TOTAL DEMAND (CF/h)	635 CF/h	

Pipe Sizing:

Path:	Demand Load (CF/h)	Length:	Selected Size
Gas Meter to 3rd Floor (FU-1 branch o	635 CF/h	191.63	**2"**
3rd Floor to TWH-1 Branch off	420 CF/h	9 ft.	**2"**
TWH-1 Branch off to GST	17 CF/h	47 ft.	**2"**
MAU-1 Branch	5 CF/h	33 ft.	**2"**

NOTE : ALL TAKEOFFS TO SINGLE UNITS OFF MAIN BRANCH LINES SHALL BE SIZED BASED ON MANUFACTURER'S RECOMMENDATIONS AND REQUIREMENTS FOR FURNISHED EQUIPMENT.

Length (ft):	238 ft.
Total Demand (CF/h):	635 CF/h

2" SCHED 40 METALLIC PIPE SELECTED BASED ON 2018-UPC TABLE 1215.2(1) [NFPA 54: TABLE 6.2(B)]

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Table M-4. MAU-1 STATIC HEAD CALCULATION

PROJECT: COMMERCIAL BUILDING REHABILITATION I **BUILDING :** 241-247 5 AVE S. Date : 12/5/2019

UNIT.NO. : MAU-1 **FLOOR:** 3RD FLOOR Revision : 0

NOTE: MAKE-UP AIR SUPPLY AND RETURN ONLY HAS ONE DUCT FOR EACH MAIN. FLEX DUCT TAKEOFFS TO DIFFUSERS ARE SIZED FOR DIFFUSER INLET. THEREFORE, DIFFUSER SIZE AND INLET SIZE WERE SELECTED BASED ON EQUIVALENT DIAMETER

***INCLUDE REFRIGERANT LINE SIZE SCHEDULE IN DWG'S FOR IN FIELD ADJUSTMENTS

GENERAL DATA

Design Airflow:	75deg Air at 50% RH and 1 atm		DUCT MATERIAL	:	G. I. Sheet			
Fluid Density	0.0731	lb/ft^3	ROUGHNESS COEF.	:	0.93			32.1740 lb = 1 slug
Fluid viscosity	0.0441	lb/ft-h	ALTITUDE	:	179	Meters	588 feet	
Specific Heat	0.24	Btu/lb-degF	ALTITUDE COEF.	:	0.000			
Energy Factor	1.05	Btu/h-degF-cfm	AIR DENSITY	:	0.00227	slugs/CF		

DUCTS PRESSURE LOSSES BOARD

		POSITIVE AIR																NEGATIVE AIR											
SECTION		SUPP-DROP																RETURN-DROP											TOTAL
FLOW	CFM	682																232											
LENGTH	ft	5.00																9.00											**5.0 ft.**
DIAM.	in	12.60																8.40											
DIAM. EQUIV.	in.	12.60																8.40											
WIDTH	in	20																6											
HEIGHT	in	7																10											
AREA	sq in	124.69																55.42											
VELOCITY	FPM	787.62																602.84											
PD per ft. duct	in w.g.-100 ft	**0.08**																**0.08**											
PD x LENGTH	in w.g.	**0.40**																**0.70**											**1.10 Pa**

	Co	SUPP-MAIN																RETURN-DROP											TOTAL
ELBOW 30°	0.07																												
ELBOW 45° ROUNDED (d < 1')	0.2																												
ELBOW 45° ROUNDED (d > 1')	0.05																												
ELBOW 45°, SHARP	0.5																												
ELBOW 90°, SHARP	1.3	4																											
ELBOW 90° ROUNDED (d < 1)	0.5																	3											
ELBOW 90° ROUNDED (d > 1)	0.25	2																											
TEE 45° (FLOW TO BRANCH)	0.3																												
TEE 90°	1																												
END TEE	1.5																												
BRANCH TEE	0.05																												
TRANSITION	0.22	4																1											
CONTRACTION	0.05	1																1											
WIRE MESH	0.04																	1											
TOTAL	Co	6.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	**8.44**
DUCTS PD	psf (lb/SF)	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	**1.58 Pa**
PRESSURE DROP	Pa	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	**2.67 Pa**

SPECIAL FITTING PRESSURE DROPS

DESIGNATION	PD (PA)	QTY	TOTAL
FIRE DAMPER	10	0	0
VOLUME DAMPER	10	2	20
SUPPLY GRILLE	15	1	15
RETURN GRILLE	10	1	10
FRESH AIR LOUVER	20		0
VAV BOX	100		0
ALUMINUM FILTER	80	2	160
BAG FILTER	150		0
PLENUM BOX	50		0
DUCT HEATER	5		0
DISC EXHAUST VALVE	70		0
FLEXIBLE DUCT CONNECTION	15	2	30
SOUND ATTENUATOR	75	1	
TOTAL			**235 Pa**

	0.95 W.g
STATIC PRESSURE AT **100%**	**238 Pa**
FLOW AT 100%	**682 CFM**
* DUCTS PRESSURE DROP :	3 Pa
* FITTING PRESSURE DROP :	235 Pa

Table M-5. FU-1 STATIC HEAD CALCULATION

PROJECT: COMMERCIAL BUILDING REHABILITATION I | **BUILDING :** 241-247 5 AVE S. | Date : 12/5/2019
UNIT.NO. : FU-1 | **FLOOR:** 3RD FLOOR | Revision : 0

GENERAL DATA

***INCLUDE REFRIGERANT LINE SIZE SCHEDULE IN DWG'S FOR IN FIELD ADJUSTMENTS

Design Airflow:	75deg Air at 50% RH and 1 atm		DUCT MATERIAL	:	G. I. Sheet			
Fluid Density	0.0731	lb/ft^3	ROUGHNESS COEF.	:	0.93			
Fluid viscosity	0.0441	lb/ft-h	ALTITUDE	:	179	Meters	588	feet
Specific Heat	0.24	Btu/lb-degF	ALTITUDE COEF.	:	0.000			
Energy Factor	1.05	Btu/h-degF-cfm	AIR DENSITY	:	0.00234	slugs/CF		

DUCTS PRESSURE LOSSES BOARD

POSITIVE AIR

SECTION		SUPP-MAIN	M1	B4-A	B4-D	B4-C	B4-B	B4-E	B3-A	B3-B	B3-C	M2	B2-A	B2-B	M3	B1-A	B1-B
FLOW	CFM	6715	4435	1826.0	166	232	1039	450	1537	657	450	2898	1449	828	1449	1449	828
LENGTH	ft	9.91	22.50	39.02	23.24	13.60	21.81	19.11	37.73	21.81	20.50	27.55	39.02	38.00	18.10	39.04	38.00
DIAM.	in	24.00	22.00	18.00	8.00	8.00	14.00	11.00	17.00	14.00	11.00	22.00	17.00	14.00	17.00	17.00	14.00
DIAM. EQUIV.	in.	24.00	22.00	18.00	8.00	8.00	14.00	11.00	17.00	14.00	11.00	22.00	17.00	14.00	17.00	17.00	14.00
WIDTH	in																
HEIGHT	in																
AREA	sq in	452.39	380.13	254.47	50.27	50.27	153.94	95.03	226.98	153.94	95.03	380.13	226.98	153.94	226.98	226.98	153.94
VELOCITY	FPM	2137.45	1680.04	1033.30	475.55	664.63	971.92	681.87	975.10	614.58	681.87	1097.81	919.27	774.55	919.27	919.27	774.55
PD per ft. duct	in w.g.-100 ft	**0.24**	**0.17**	**0.09**	**0.05**	**0.10**	**0.10**	**0.07**	**0.08**	**0.04**	**0.07**	**0.08**	**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
PD x LENGTH	in w.g.	**2.38**	**3.81**	**3.35**	**1.23**	**1.36**	**2.26**	**1.36**	**3.11**	**0.95**	**1.46**	**2.08**	**2.87**	**2.56**	**1.33**	**2.88**	**2.56**

NEGATIVE AIR

SECTION		RB-1	RB-1 TAKEOFF	RM-2	RM-2 TAKEOFF	RB3-A	RB3-B TAKEOFF	RB3-B	RETURN-MAIN				TOTAL
FLOW	CFM	2338	232	4528	84	1656	82	2188	6261				
LENGTH	ft	14.10	15.10	16.10	17.10	19.10	20.10	21.10	22.10				**333.8 ft.**
DIAM.	in	16.00	8.00	26.00	6.00	19.00	6.00	20.00	26.00				
DIAM. EQUIV.	in.	16.00	8.00	26.00	6.00	19.00	6.00	20.00	26.00				
WIDTH	in												
HEIGHT	in												
AREA	sq in	201.06	50.27	530.93	28.27	283.53	28.27	314.16	530.93				
VELOCITY	FPM	1674.47	664.63	1228.10	427.81	841.06	417.62	1002.91	1698.12				
PD per ft. duct	in w.g.-100 ft	**0.25**	**0.10**	**0.08**	**0.06**	**0.05**	**0.06**	**0.07**	**0.14**				
PD x LENGTH	in w.g.	**3.49**	**1.51**	**1.22**	**1.05**	**1.04**	**1.18**	**1.50**	**3.11**				**49.63 Pa**

	Co	SUPP-MAIN	M1	B4-A	B4-D	B4-C	B4-B	B4-E	B3-A	B3-B	B3-C	M2	B2-A	B2-B	M3	B1-A	B1-B
ELBOW 30°	0.07				1												
ELBOW 45° ROUNDED (d < 1')	0.2																
ELBOW 45° ROUNDED (d > 1')	0.05																
ELBOW 45°, SHARP	0.5																
ELBOW 90°, SHARP	1.3	4															
ELBOW 90° ROUNDED (d < 1)	0.5					2		2			2						
ELBOW 90° ROUNDED (d > 1)	0.25	2			3										1		
TEE 45° (FLOW TO BRANCH)	0.3		1									2					
TEE 90°	1																
END TEE	1.5							1			1			1			1
BRANCH TEE	0.05				1		1	3			3						
TRANSITION	0.22	4															
CONTRACTION	0.05	1		1	1	1	1		1	1			1			1	
WIRE MESH	0.04					1											
TOTAL	Co	6.63	0.30	0.05	0.92	1.09	0.10	2.65	0.05	0.05	2.65	0.60	0.05	1.50	0.25	0.05	1.50
DUCTS PD	psf (lb/SF)	3.54	0.13	0.01	0.11	0.18	0.02	0.45	0.01	0.01	0.45	0.16	0.01	0.29	0.06	0.01	0.29
PRESSURE DROP	Pa	5.92	3.93	3.36	1.34	1.54	2.29	1.81	3.12	0.95	1.91	2.24	2.89	2.85	1.39	2.89	2.85

	Co	RB-1	RB-1 TAKEOFF	RM-2	RM-2 TAKEOFF	RB3-A	RB3-B TAKEOFF	RB3-B	RETURN-MAIN				TOTAL
ELBOW 30°	0.07		1										
ELBOW 45° ROUNDED (d < 1')	0.2												
ELBOW 45° ROUNDED (d > 1')	0.05					2							
ELBOW 45°, SHARP	0.5												
ELBOW 90°, SHARP	1.3					1			1				
ELBOW 90° ROUNDED (d < 1)	0.5		1		1				2				
ELBOW 90° ROUNDED (d > 1)	0.25	2				1		1					
TEE 45° (FLOW TO BRANCH)	0.3												
TEE 90°	1												
END TEE	1.5												
BRANCH TEE	0.05	1		1				1	1				
TRANSITION	0.22		1		1		1		1				
CONTRACTION	0.05			1					1				
WIRE MESH	0.04												
TOTAL	Co	0.55	0.79	0.10	0.72	1.65	0.22	0.30	2.62			0.00	**25.39**
DUCTS PD	psf (lb/SF)	0.23	0.13	0.03	0.08	0.35	0.02	0.08	1.11			0.00	**7.76 Pa**
PRESSURE DROP	Pa	3.72	1.64	1.25	1.13	1.38	1.20	1.58	4.22			0.00	**57.39 Pa**

SPECIAL FITTING PRESSURE DROPS

DESIGNATION	PD (PA)	QTY	TOTAL
FIRE DAMPER	10	4	40
VOLUME DAMPER	10	19	190
SUPPLY GRILLE	15	35	525
RETURN GRILLE	10	6	60
FRESH AIR LOUVER	20		0
VAV BOX	100		0
ALUMINUM FILTER	80		0
BAG FILTER	150		0
PLENUM BOX	50	1	50
DUCT HEATER	5		0
DISC EXHAUST VALVE	70	1	70
FLEXIBLE DUCT CONNECTION	15	10	150
SOUND ATTENUATOR	75		
TOTAL			**1085 Pa**

	4.59 W.g
STATIC PRESSURE AT **100%**	**1142 Pa**
FLOW AT 100%	**6715 CFM**
* DUCTS PRESSURE DROP :	57 Pa
* FITTING PRESSURE DROP :	1085 Pa

Table M-6. EF-1 STATIC HEAD CALCULATION

PROJECT: COMMERCIAL BUILDING REHABILITATION I **SITE :** 241-247 5 AVE S. Date : 12/5/2019
UNIT.NO. : EF-1 **FLOOR:** 3RD FLOOR Revision : 0

GENERAL DATA

***INCLUDE REFRIGERANT LINE SIZE SCHEDULE IN DWG'S FOR IN FIELD ADJUSTMENTS

DUCT MATERIAL	:	G. I. Sheet			
ROUGHNESS COEF.	:	0.93			
ALTITUDE	:	179	Meters	588	feet
ALTITUDE COEF.	:	0.000			
AIR DENSITY	:	0.00234	slugs/CF		

DUCTS PRESSURE LOSSES BOARD

SECTION		EB-1	EB-3	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL
FLOW	CFM	70	70													
LENGTH	ft	10.50	18.79													**29.3 ft.**
DIAM.	in	14.21	14.21													
DIAM. EQUIV.		14.21	14.21													
WIDTH	in	13	13													
HEIGHT	in	13	13													
AREA	sq in	158.62	158.62													
VELOCITY	FPM	63.55	63.55													
PD per ft. duct	in w.g.-100 ft	**0.00**	**0.00**													
PD x LENGTH	in w.g.	**0.01**	**0.01**													**0.02 Pa**

	Co	EB-1	EB-3	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL
ELBOW 30°	0.07															
ELBOW 45° ROUNDED (d < 1')	0.2															
ELBOW 45° ROUNDED (d > 1'), SHARP	0.05															
ELBOW 45°, SHARP	0.5															
ELBOW 90°, SHARP	1.3	2														
ELBOW 90° ROUNDED (d < 1)	0.5															
ELBOW 90° ROUNDED (d > 1)	0.25															
TEE 45° (FLOW TO BRANCH)	0.3		1													
TEE 90°	1															
END TEE	1.5															
BRANCH TEE	0.05															
TRANSITION	0.22	1	1													
CONTRACTION	0.05															
WIRE MESH	0.04															
TOTAL	Co	2.82	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.34**
DUCTS PD	psf (lb/SF)	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.05 Pa**
PRESSURE DROP	Pa	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.07 Pa**

SPECIAL FITTING PRESSURE DROPS

DESIGNATION	PD (PA)	QTY	TOTAL
FIRE DAMPER	10	1	10
VOLUME DAMPER	10	0	0
SUPPLY GRILLE	15		0
RETURN GRILLE	10		0
FRESH AIR LOUVER	20		0
VAV BOX	100	1	100
ALUMINUM FILTER	80		0
BAG FILTER	150		0
PLENUM BOX	50	0	0
DUCT HEATER	5		0
DISC EXHAUST VALVE	70	1	70
FLEXIBLE DUCT CONNECTION	15	0	0
SOUND ATTENUATOR	75		
TOTAL			**180 Pa**

	0.72 W.g
STATIC PRESSURE AT **100%**	**180 Pa**
FLOW AT 100%	**70 CFM**
* DUCTS PRESSURE DROP :	0.07 Pa
* FITTING PRESSURE DROP :	180 Pa

Table M-7. EF-2 STATIC HEAD CALCULATION

PROJECT: **COMMERCIAL BUILDING REHABILITATION I** **SITE :** **241-247 5 AVE S.** Date : 12/5/2019
UNIT.NO. : **EF-2** **FLOOR:** **3RD FLOOR** Revision : 0

GENERAL DATA

***INCLUDE REFRIGERANT LINE SIZE SCHEDULE IN DWG'S FOR IN FIELD ADJUSTMENTS

DUCT MATERIAL	:	G. I. Sheet		
ROUGHNESS COEF.	:	0.93		
ALTITUDE	:	179	Meters	588 feet
ALTITUDE COEF.	:	0.000		
AIR DENSITY	:	0.00234	slugs/CF	

DUCTS PRESSURE LOSSES BOARD

SECTION		EB-2	EB-3	3	3	3	3	3	3	3	3	3	3	3	3	TOTAL
FLOW	CFM	70	70													
LENGTH	ft	0.33	18.79													**19.1 ft.**
DIAM.	in	14.21	14.21													
DIAM. EQUIV.		14.21	14.21													
WIDTH	in	13	13													
HEIGHT	in	13	13													
AREA	sq in	158.62	158.62													
VELOCITY	FPM	63.55	63.55													
PD per ft. duct	in w.g.-100 ft	**0.00**	**0.00**													
PD x LENGTH	in w.g.	**0.00**	**0.01**													**0.01 Pa**

	Co	1	2	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL
ELBOW 30°	0.07	1														
ELBOW 45° ROUNDED (d < 1')	0.2															
ELBOW 45° ROUNDED (d > 1'), SHARP	0.05															
ELBOW 45°, SHARP	0.5															
ELBOW 90°, SHARP	1.3	1	1													
ELBOW 90° ROUNDED (d < 1)	0.5															
ELBOW 90° ROUNDED (d > 1)	0.25															
TEE 45° (FLOW TO BRANCH)	0.3		1													
TEE 90°	1															
END TEE	1.5															
BRANCH TEE	0.05															
TRANSITION	0.22	1	1													
CONTRACTION	0.05															
WIRE MESH	0.04															
TOTAL	Co	1.59	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.41**
DUCTS PD	psf (lb/SF)	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.05 Pa**
PRESSURE DROP	Pa	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.07 Pa**

SPECIAL FITTING PRESSURE DROPS

DESIGNATION	PD (PA)	QTY	TOTAL
FIRE DAMPER	10	1	10
VOLUME DAMPER	10		0
SUPPLY GRILLE	15		0
RETURN GRILLE	10		0
FRESH AIR LOUVER	20		0
VAV BOX	100		0
ALUMINUM FILTER	80		0
BAG FILTER	150		0
PLENUM BOX	50		0
DUCT HEATER	5		0
DISC EXHAUST VALVE	70	1	70
FLEXIBLE DUCT CONNECTION	15		0
SOUND ATTENUATOR	75		
TOTAL			**80 Pa**

	0.32 W.g
STATIC PRESSURE AT **100%**	**80 Pa**
FLOW AT 100%	**70 CFM**
* DUCTS PRESSURE DROP :	0.07 Pa
* FITTING PRESSURE DROP :	80 Pa

Table M-8. EF-3/H-x STATIC HEAD CALCULATION

PROJECT: **COMMERCIAL BUILDING REHABILITATION I** **SITE :** **241-247 5 AVE S.** Date : 12/5/2019
UNIT.NO. : **EF-3** **FLOOR:** **3RD FLOOR** Revision : 0

GENERAL DATA

DUCT MATERIAL	:	G. I. Sheet
ROUGHNESS COEF.	:	0.93
ALTITUDE	:	179 Meters 588 feet
ALTITUDE COEF.	:	0.000
AIR DENSITY	:	0.00234 slugs/CF

DUCTS PRESSURE LOSSES BOARD

SECTION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL
FLOW	CFM	450														
LENGTH	ft	3.00														3.0 ft.
DIAM.	in	14.16														
DIAM. EQUIV.		14.16														
WIDTH	in	12														
HEIGHT	in	14														
AREA	sq in	157.44														
VELOCITY	FPM	411.57														
PD per ft. duct	in w.g.-100 ft	**0.02**														
PD x LENGTH	in w.g.	**0.06**														**0.06 Pa**

	Co	1	2	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL
ELBOW 30°	0.07															
ELBOW 45° ROUNDED (d < 1')	0.2															
ELBOW 45° ROUNDED (d > 1'), SHARP	0.05	1														
ELBOW 45°, SHARP	0.5	1														
ELBOW 90°, SHARP	1.3															
ELBOW 90° ROUNDED (d < 1)	0.5															
ELBOW 90° ROUNDED (d > 1)	0.25	1														
TEE 45° (FLOW TO BRANCH)	0.3															
TEE 90°	1															
END TEE	1.5															
BRANCH TEE	0.05															
TRANSITION	0.22	1														
CONTRACTION	0.05	1														
WIRE MESH	0.04	1														
TOTAL	Co	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.11**
DUCTS PD	psf (lb/SF)	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.11 Pa**
PRESSURE DROP	Pa	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.17 Pa**

SPECIAL FITTING PRESSURE DROPS

DESIGNATION	PD (PA)	QTY	TOTAL
FIRE DAMPER	10		0
VOLUME DAMPER	10		0
SUPPLY GRILLE	15		0
RETURN GRILLE	10		0
FRESH AIR LOUVER	20		0
VAV BOX	100		0
ALUMINUM FILTER	80		0
BAG FILTER	150		0
PLENUM BOX	50		0
DUCT HEATER	5		0
DISC EXHAUST VALVE	70	1	70
FLEXIBLE DUCT CONNECTION	15		0
SOUND ATTENUATOR	75		
TOTAL			**70 Pa**

	0.28 W.g
STATIC PRESSURE AT **100%**	**70 Pa**
FLOW AT 100%	**450 CFM**
* DUCTS PRESSURE DROP :	0.17 Pa
* FITTING PRESSURE DROP :	70 Pa

Appendix P: Plumbing Calculations

Tankless HW Heater Sizing

Design GPM Demanded = HW Demanded by Fixtures + GPM required HWR Loop

TWH-1 FLOW DEMAND	
HW FIXTURES FU DEMAND:	8.75 FU
HW FIXTURES GPM DEMAND:	7.00 gpm
HWR LOOP GPM DEMAND:	5.43 gpm
DESIGN GPM DEMANDED	**12.43 gpm**
Tankless HW Heater Minimum Output:	**13 gpm**

RECIRCULATION PUMP PERFORMANCE PARAMETERS:	
6 GPM	FLOW
20 ft.	PRESSURE HEAD

Figure P-1. Tankless hot water heat design flow in gallons per minute (GPM).

DOMESTIC SUPPLY PIPING

A 102.0 PRELIMINARY INFORMATION

A 102.1 Daily Service Pressure.

*Minimum Daily Service Pressure in the Area:	**60 psi**

*Based on buildings location

A 102.2 Water Meter.

^ Friction Loss in Meter Relevative to the Rate of Flow of Meter:

^ Friciton-loss data is capable of being obtained from most manufacturers of water meters. Friciton losses for disk type meters shall be permitted to be obtained from Chart A 102.2.

A 103.0 DEMAND LOAD

A 103.1 Supply Demand.

ADDED DEMAND TO BUILDING SUPPLY

FIXTURE UNITS AND ESTIMATED DEMANDS							
BUILDING SUPPLY DEMAND					BRANCH TO HOT WATER SYSTEM		
KIND OF FIXTURES	NUMBER OF FIXTURES	FIXTURE UNIT DEMAND	TOTAL UNITS	BUILDING SUPPLY DEMAND (gpm)	NUMBER OF FIXTURES	FIXTURE UNIT DEMAND CALCULATION	DEMAND (gpm)
Water Closets - 1.6 gpf Flushometer Valve	2	5.0	10	-	*Included in Building Supply Demand*		
Urinals - 1.0 gpf Flushometer Valve	1	4.0	4	-	*Included in Building Supply Demand*		
Lavatories	2	1.0	2	-	*Included in Building Supply Demand*		
Service Sinks	1	3.0	3	-	*Included in Building Supply Demand*		
Kitchen Sinks	1	2.0	2	-	*Included in Building Supply Demand*		
Tankless Hot Water Heater 9 GPM					1	N/A	9
Subtotals	-	-	21	26			9
TOTAL							**35**

a. Note, Building supply demand (gpm) for fixture units determined by 2018 UPC Appendix A Chart A 103.1(1). Tankless hot water heater demand added on afterwards since this gpm value was determined by manufacturer.

3rd Floor Branch

Total Developed Length:	135.633
Pressure Available for Friciton Loss (psi):	35.54
Avg. Permissible Friction Loss per 100 ft. Length of Pipe:	26.20299828
ADDED ALLOWANCE FOR FIRST FLOOR EXISTING:	135.633
TOTAL DEVELOPED LENGTH:	**271.267**
Avg. Permissible Friction Loss per 100 ft. Length of Pipe:	**13.10 psi per 100-ft length**

Figure P-2. Domestic supply piping

A 104.0 PERMISSIBLE FRICTION LOSS

A 104.1 Residual Pressure.

Minimum residual pressure: 15 psi *PRESSURE REQUIRED FOR FLUSHOMETER VALVES PER 2018 UPC APPENDIX A 104.1 RESIDUAL PRESSURE.*

A 104.2 Elevation.

Criteria	Elevation	Elevation Difference	Loss of Static Pressure (psi) ^
Elevation of highest fixture or fixture group:	16 ft.	22 ft.	9 psi
Elevation of Water main from Basement Slab:	2 ft.		
Distance Basement Slab to Level 1	-8 ft.		

^ Elevation difference multiplied by 0.43 per 2018 Uniform Plumbing Code Appendix A, Section A 104.2 Elevation.

A 104.3 Available Pressure.

Pressure Available for Friction Loss in Supply Pipes where no water meter is used = Average Minimum Daily Service Pressure - (Static Pressure +Residual Pressure)

Pressure Available for Friction Loss in Supply Pipes: 36 psi *THIS VALUE APPLIES FOR ENTIRE BUILDING.*

A 104.4 Developed Length.

Supply Riser 11.25 ft.
Supply Main Allowance for routing off of existing 61.00 ft. ASSUMPTION: WORST-CASE SCENARIO, ROUTE LINES FROM LEVEL 1 BATHROOM NEAR ELEV SHAFT

3rd Floor Main

Domestic Water Supply Critical Path - Pipe Schedule

System Name	Schedule/Type	Length	Invert Elevation	Size	Comments	DEVELOPED LENGTH
Domestic Cold Water 2	K	15' - 4 1/2"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	25.375
Domestic Cold Water 2	K	9' - 5 1/4"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	3.438
Domestic Cold Water 2	K	2' - 9 3/8"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.281
Domestic Cold Water 2	K	16' - 10 1/4"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	16.854
Domestic Cold Water 2	K	1' - 10 7/8"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	1.906
Domestic Cold Water 2	K	1' - 1 1/4"	13' - 11 1/2"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	1.104
Domestic Cold Water 2	K	4' - 5 5/8"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	4.469
Domestic Cold Water 2	K	22' - 10 1/8"	25' - 9 3/4"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	22.844
Domestic Cold Water 2	K	1' - 4 7/8"	17' - 5 1/2"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	1.406
Domestic Cold Water 2	K	0' - 11 3/4"	25' - 10"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	0.979
Domestic Cold Water 2	K	8' - 3 1/4"	17' - 6 3/8"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	8.271
Domestic Cold Water 2	K	4' - 4 7/8"	25' - 10"	1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	4.406
					LINEAR PIPE DEVELOPED LENGTH:	**93.333**

Domestic Water Supply Critical Path - Fitting Schedule

System Name	Family and Type	Elevation from Le	Size	Comments	EQUIVALENT DEVELOPED LENGTH	
Domestic Cold Water 2	Tee - Welded - Generic: Standard	11' - 3"	1"ø-1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	5.3	*FROM 2018 UPC APPENDIX A TABLE A 104.4(2) "90 DEGREE STANDARD TEE"*
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	11' - 3"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Elbow - Generic: Standard	11' - 3"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Tee - Welded - Generic: Standard	11' - 3"	1"ø-1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	5.3	
Domestic Cold Water 2	Tee - Welded - Generic: Standard	11' - 3"	1"ø-1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	5.3	
Domestic Cold Water 2	Tee - Welded - Generic: Standard	25' - 10 1/4"	1"ø-1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	5.3	
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	14' - 0"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	14' - 0"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	2' - 10 1/2"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	11' - 3"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	
Domestic Cold Water 2	Elbow - Welded - Generic: Standard	11' - 3"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	2.6	*FROM 2018 UPC APPENDIX A TABLE A 104.4(2) "90 DEGREE ELBOW"*
Domestic Cold Water 2	Transition - Welded - Generic: Standard	11' - 3"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PATCH	1.7	*FROM 2018 UPC APPENDIX A TABLE A 104.4(2) "COUPLING OR STRAIGHT RUN OF TEE"*
				TOTAL EQUIVALENT DEVELOPED LENGTH:	**41.1**	

Domestic Water Supply Critical Path - Accessory Schedule

System Name	Type	Size	Comments	Elevation from Level	EQUIVALENT DEVELOPED LENGTH	
Domestic Cold Water 2	1"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PA'	11' - 3"	0.6	*FROM 2018 UPC APPENDIX A TABLE A 104.4(1)*
Domestic Cold Water 2	1/2"	1"ø-1"ø	DOMESTIC SUPPLY - CRITICAL PA'	11' - 3"	0.6	
				TOTAL EQUIVALENT DEVELOPED LENGTH:	**1.2**	

GRAND TOTAL: **135.63 ft.**

Figure P-3. Friction losses

A 105.0 SIZE OF BUILDING SUPPLY

A 105.1 Diameter.

Obtained from Chart A 105.1(1), Chart A 105.1(2), Chart A 105.1(3), Chart A 105.1(4), Chart A 105.1(5), Chart A 105.1(6), or Chart A 105.1(7), whichever is applicable.
Assumption: Building demand for first floor is identical to third floor. This is an over approximation.

Total Building Demand: 69 gpm

PIPE TYPE	REFERENCED CHART	OBTAINED VALUE
Copper Type L	2018 UPC Chart A 105.1(1)	**1.5 in.** (Diameter)
Ferrous Pipe Fairly Smooth	2018 UPC Chart A 105.1(2)	**1.5 in.** (Diameter)
Sched. 40 IPS Plastic Pipe Very Smooth C=150	2018 UPC Chart A 105.1(6)	**1 in.** (Diameter)

Figure P-4. Size of building supply

A 106.0 SIZE OF PRINCIPAL BRANCHES AND RISERS

A 106.1 Size.

The required size of branches and risers shall be permitted to be obtained in the same manner as the building supply, by obtaining the demand load on each branch or riser and using the permissible friction loss computed in Section A 104.0

DHW AND DCW PIPE SIZES WERE FOUND IN 2018 UPC APPENDIX A CHART A 105.1(1)

PIPE SIZING						SELECTION BASED OFF MIN 5 GPM CHART VALUE		MODIFICATIONS TO LINES WITH LESS THAN 5 GPM *	
ID	**PIPING LINE**	**HWFU**	**CWFU**	**HW GPM**	**CW GPM**	**DHW PIPE SIZE**	**DCW PIPE SIZE**	**DHW PIPE SIZE**	**DCW PIPE SIZE**
1	DHW MAIN	8.75		7.00		3/4" TYPE M		3/4" TYPE M	
	DCW MAIN		17.00		12.00		3/4" TYPE M		3/4" TYPE M
2	DHW UTILITY/BATHROOM BRANCH	3.25		5.00		1/2" TYPE M		1/2" Type K	
	DCW UTILITY/BATHROOM BRANCH		13.25		13.00		3/4" TYPE M		3/4" TYPE M
	DHW BRANCH TO WORK SINK LINE	2.25		5.00		1/2" TYPE M		3/8" Type K	
	DCW BRANCH TO WORK SINK LINE		2.25		5.00		1/2" TYPE M		3/8" Type K
3	DHW BATHROOM BRANCH	1.00		5.00		1/2" TYPE M		3/8" Type K	
	DCW BATHROOM		11.00		9.00		3/4" TYPE K		3/4" TYPE K
	DHW BRANCH TO LAVATORY LINE DROP	1.00		5.00		1/2" TYPE M		3/8" Type K	
	DCW BRANCH TO LAVATORY LINE DROP		1.00		5.00		1/2" TYPE M	3/8" Type K	
	DHW LINE DROP TO LAVATORY	0.50		5.00		1/2" TYPE M		3/8" Type K	
	DCW LINE DROP TO LAVATORY		0.50		5.00		1/2" TYPE M		3/8" Type K
	DCW BRANCH TO WC. DCW BRANCH		10.00		10.00		3/4" TYPE K		3/4" TYPE K
	WC DCW BRANCH TO WATER CLOSET LINE	5.00		5.00		1/2" TYPE M		1/2" TYPE M	
4	DHW REDUCED MAIN 1	5.50		5.00		1/2" TYPE M		1/2" TYPE M	
	DCW REDUCED MAIN 1		6.00		5.25		1/2" TYPE M		1/2" TYPE M
	DHW BRANCH TO DISHWASHER	1.50		5.00		1/2" TYPE M		3/8" Type K	
	DCW BRANCH TO DISHWASHER		1.50		5.00		1/2" TYPE M		3/8" Type K
5	DHW REDUCED MAIN 2	4.00		5.00		1/2" TYPE M		1/2" TYPE M	
	DCW REDUCED MAIN 2		4.50		5.00		1/2" TYPE M		1/2" TYPE M
	DHW BRANCH TO KITCHEN SINK	1.00		5.00		1/2" TYPE M		3/8" Type K	
	DCW BRANCH TO KITCHEN		1.00		5.00		1/2" TYPE M		3/8" Type K
6	DHW REDUCED MAIN 3	3.00		5.00		1/2" TYPE M		1/2" Type K	
	DCW REDUCED MAIN 3		3.50		5.00		1/2" TYPE M		1/2" Type K
	DCW BRANCH TO REFRIGERATOR		0.50		5.00		1/2" TYPE M		3/8" Type K
7	DHW REDUCED MAIN 4 (SAME AS 3)	3.00		5.00		1/2" TYPE M		1/2" Type K	
	DCW REDUCED MAIN 4		3.00		5.00		1/2" TYPE M		1/2" Type K
	DHW BRANCH TO CAFE SINK	3.00		5.00		1/2" TYPE M		1/2" Type K	
	DCW BRANCH TO CAFÉ SINK		3.00		5.00		1/2" TYPE M		1/2" Type K

* Note, for pipe loads of 5 Fixture Units or less, the demand is rather linear (no values are specified on Chart A 103.1 for demands less than 5 gpm). Assumption: fixture units = demand (in gpm) for pipes with less than 5 FU's

Figure P-5. Size of principal branches and risers

Table P-1. Sanitary waste and vent piping schedule

DRAINAGE FIXTURE UNITS AND ESTIMATED DEMANDS				
BUILDING DRAINAGE DEMAND				
KIND OF FIXTURES	**MINIMUM SIZE TRAP AND TRAP ARM (inches)**	**NUMBER OF FIXTURES**	**FIXTURE UNIT DEMAND**	**TOTAL UNITS**
Food Waste Disposer, commercial	2	0	3.0	0
Floor Drain	2	4	3.0	12
Lavatory	1 1/4	2	1.0	2
Water Closets - 1.6 gpf Flushometer Val	3	2	4.0	8
Urinal, integral trap 1.0 GPF^2	2	1	2.0	2
Receptor, indirect waste *	2	1	1.0	1
Service Sinks	2	1	3.0	3
Kitchen Sinks	1 1/2	1	2.0	2
Standard Sink (Special Purpose)	2	1	3.0	3
Total		-	-	33

DRAINAGE BRANCH PIPING								
DRAINAGE BRANCH DEMAND					MAXIMUM DRAINAGE BRANCH LOADING AND LENGTH			
BRANCH NUMBER	**BRANCH LOCATION**	**FIXTURES ON BRANCH**	**FIXTURE UNIT DEMAND**	**TOTAL FIXTURE UNIT DEMAND**	**SIZE OF PIPE ***	**MAXIMUM UNITS (Vert / Horiz)**	**MAXIMUM LENGTH (VERTICAL) ***	**MAXIMUM LENGTH (HORIZONTAL) ***
01	Cafe Counter	Standard Sink	3.0	6.0	**3.0 in.**	48 / 35	212.0	Unlimited
		Floor Drain	3.0					
02	Cafe Workroom	Food waste Disposer, Commercial	3.0	11.0	**3.0 in.**	48 / 35	212.0	Unlimited
		Kitchen Sink	2.0					
		Floor Drain	3.0					
		Dishwasher	3.0					
03	Utility Room	Mop Sink	3.0	4.0	**2.0 in.**	16 / 8	85.0	Unlimited
		W.H. Condensate Drain (Continuous Flow) ^	1.0					
04	Utility Room	Floor Drain	3.0	4.0	**2.0 in.**	16 / 8	85.0	Unlimited
		E.C. Condensate Drain (Continuous Flow) ^	1.0					
05	Restrooms	Water Closet - 1.6 GPF Flushometer Valve	4.0	8.0	**3.0 in.**	48 / 35	212.0	Unlimited
		Water Closet - 1.6 GPF Flushometer Valve	4.0					
06	North Restroom	Lavatory	1.0	4.0	**2.0 in.**	16 / 8	85.0	Unlimited
		Floor Drain	3.0					
07	South Restroom	Lavatory	1.0	4.0	**2.0 in.**	16 / 8	85.0	Unlimited
		Floor Drain	3.0					

* Per 2018 Uniform Plumbing Code Section 700 Sanitary Drainage, Table 703.2 Maximum unit Loading and Maximum Length of Drainage and Vent Piping

^ 2018 Uniform Plumbing Code Section 702.3 allows condensate drains to be tied into drainage systems downstream of traps. Condensate drain has 2 parts: primary condensate line with trap installed (to stop airflow from being sucked in, but water to be pushed out), line from p trap connects to emergency drain pan. Emergency drain pan discharge has a trap connected. The remaining drain line ties into drainage system downstream of trap a sufficient distance by wye vent fitting. Preferably connected in a line typically used as a vent.

DRAIN SUB-MAIN PIPING							
DRAINAGE BRANCH DEMAND					MAXIMUM DRAINAGE BRANCH LOADING AND LENGTH		
SUB-MAIN NUMBER	**BRANCHES CONNECTED**	**CONNECTED BRANCHES LOADING**	**TOTAL FIXTURE UNIT DEMAND**	**SIZE OF PIPE ***	**MAXIMUM UNITS (Vert / Horiz)**	**MAXIMUM LENGTH (VERTICAL) ***	**MAXIMUM LENGTH (HORIZONTAL) ***
01	BRANCH 01 /BRANCH 02	17.0	17.0	**3.0 in.**	48 / 35	212.0	Unlimited
02	BRANCH 04 / BRANCH 05 / BRANCH 06 / BRANCH 07	16.0	16.0	**3.0 in.**	48 / 35	212.0	Unlimited
03	SUB-MAIN 02 / BRANCH 03	20.0	20.0	**3.0 in.**			
04	SUB-MAIN 01 / SUB-MAIN 03	37.0	37.0	**4.0 in.**	256 / 216	300.0	Unlimited

* Per 2018 Uniform Plumbing Code Section 700 Sanitary Drainage, Table 703.2 Maximum unit Loading and Maximum Length of Drainage and Vent Piping

Table P-2. Sanitary vent piping schedule

VENT PIPE SIZING							
DRAINAGE BRANCH DEMAND					MAXIMUM UNIT LOADING AND LENGTH OF VENT PIPING		
BRANCH NUMBER	BRANCH LOCATION	FIXTURES ON BRANCH	FIXTURE UNIT DEMAND	TOTAL FIXTURE UNIT DEMAND	SIZE OF PIPE *	MAXIMUM UNITS	MAXIMUM LENGTH (HORIZONTAL & VERTICAL) *
		Floor Drain	1				
01	Café Counter	Floor Drain	1.0	5.0	2 in.	8.0 FU	60.0 ft.
		Special Purpose Sink	3.00				
02	Café Workroom	Kitchen Sink	2.0	5.0	1.5 in.	8.0 FU	60.0 ft.
		Food waste Disposer, Commercial	3.0				
03	Utility Room	Mop Sink	3.0	4.0	1.5 in.	8.0 FU	60.0 ft.
		W.H. Condensate Drain (Continuous Flow) ^	1.0				
04	Utility Room	Floor Drain	3.0	4.0	1.5 in.	8.0 FU	60.0 ft.
		E.C. Condensate Drain (Continuous Flow) ^	1.0				
05	Restrooms	Water Closet - 1.6 GPF Flushometer Valve	4.0	10.0	2.0 in.	24.0 FU	120.0 ft.
		Water Closet - 1.6 GPF Flushometer Valve	4.0				
		Urinal, integral trap 1.0 GPF	2.0				
06	North Restroom	Lavatory	1.0	4.0	1.5 in.	8.0 FU	60.0 ft.
		Floor Drain	3.0				
07	South Restroom	Lavatory	1.0	4.0	1.5 in.	8.0 FU	60.0 ft.
		Floor Drain	3.0				

* Per 2018 Uniform Plumbing Code Section 700 Sanitary Drainage, Table 703.2 Maximum unit Loading and Maximum Length of Drainage and Vent Piping

** Note, this sizing is for dry venting only. Wet venting is limited to vertical drainage pipiong receiving the discharge from the trap arm of one and two fixture unit fixtures that also serve as a vent not exceeding four fixtures. Wet-vented vfixtures shall be within the same story; provided, further, that fixtures with a continuous vent discharging into a wet vent shall be within the same story as the wet-vented

The vertical piping between two consecutive inlet levels shall be considered a wet-vented section. Each wet-vented section shall be not less than one pipe size exceeding the required minimum waste pipe size of the upper fixture or shall be one pipie size exceeding the required minimum pipe size for the sum of the fixture units served by such wet-vented section, whichever is larger, but in no case less than 2 inches.

VENT PIPE SIZING						
VENT SUB-MAIN DEMAND				MUM UNIT LOADING AND LENGTH OF VENT PI		
SUB-MAIN NUMBER	BRANCHES CONNECTED	CONNECTED BRANCHES LOADING	TOTAL FIXTURE UNIT DEMAND	SIZE OF PIPE *	MAXIMUM UNITS (Vert / Horiz)	MAXIMUM LENGTH (HORIZONTAL & VERTICAL) *
01	BRANCH 01 & BRANCH 02	10.0	10.0	2.0 in.	24.0 FU	120.0 ft.
02	BRANCH 05, 06 & 07	18.0	18.0	3.0 in.	84.0 FU	212.0 ft.
03	BRANCH 03 & 04	8.0	8.0	1.5 in.	8.0 FU	60.0 ft.

Table P-3. Plumbing fixture schedule

PLUMBING FIXTURE SCHEDULE					
Tag	**Type and Description**	**Elevation**	**WFU**	**HWFU**	**CWFU**
L1	Lavatory - Wall Mounted: 19"x14" - Private	2' - 9"	1	0.5	0.5
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
FD	Floor Drain - Round: 5" Strainer - 2" Drain	0' - 0"	2	0	0
WC	Water Closet - Flush Valve - Wall Mounted: Public - Flushing 1.6 gpf Flushometer	0' - 0"	6	0	5
L1	Lavatory - Wall Mounted: 19"x14" - Private	2' - 9"	1	0.5	0.5
WC	Water Closet - Flush Valve - Wall Mounted: Public - Flushing 1.6 gpf Flushometer	0' - 0"	6	0	5
S2	Sink - Kitchen - Double: 42"x21" - Private	0' - 0"	2	1	1
FD	Floor Drain - Round: 5" Strainer - 4" Drain	0' - 0"	4	0	0
FD	Floor Drain - Round: 5" Strainer - 4" Drain	0' - 0"	4	0	0
S1	Sink - Island - Single: 18"x18" - Public ***	0' - 0"	2	3	3
S3	Sink - Work: 20"x18"	0' - 0"	2	2.25	2.25
DW	Dishwasher - Commercial 36" wide**	0'-0"	2	1.5	1.5
RF-1	Refrigerator ^			0	0.5

*** Dishwasher waste and domestic demand final determination is based on dishwasher manufacturer's requirements. WFU's, HWFU's and CWFU's were selected based on 2018 UPC Table A 103.1 (Appendix A) Dishwasher, domestic FU's. A safety factor was added in case a commercial grade dishwasher should be selected that would result in higher water demand. (2018 UPC FU's 1.5, Safety Factor 1.0)*

^ No identified FU's per 2018 UPC.

**** Café counter sink is slightly oversized for anticipation of more connections to water line in future, and to account for peak demand times of café traffic.*

General Note: *Floor and wall Cleanouts have been specified in design, but are not included in schedule due to no impact of FU values.*

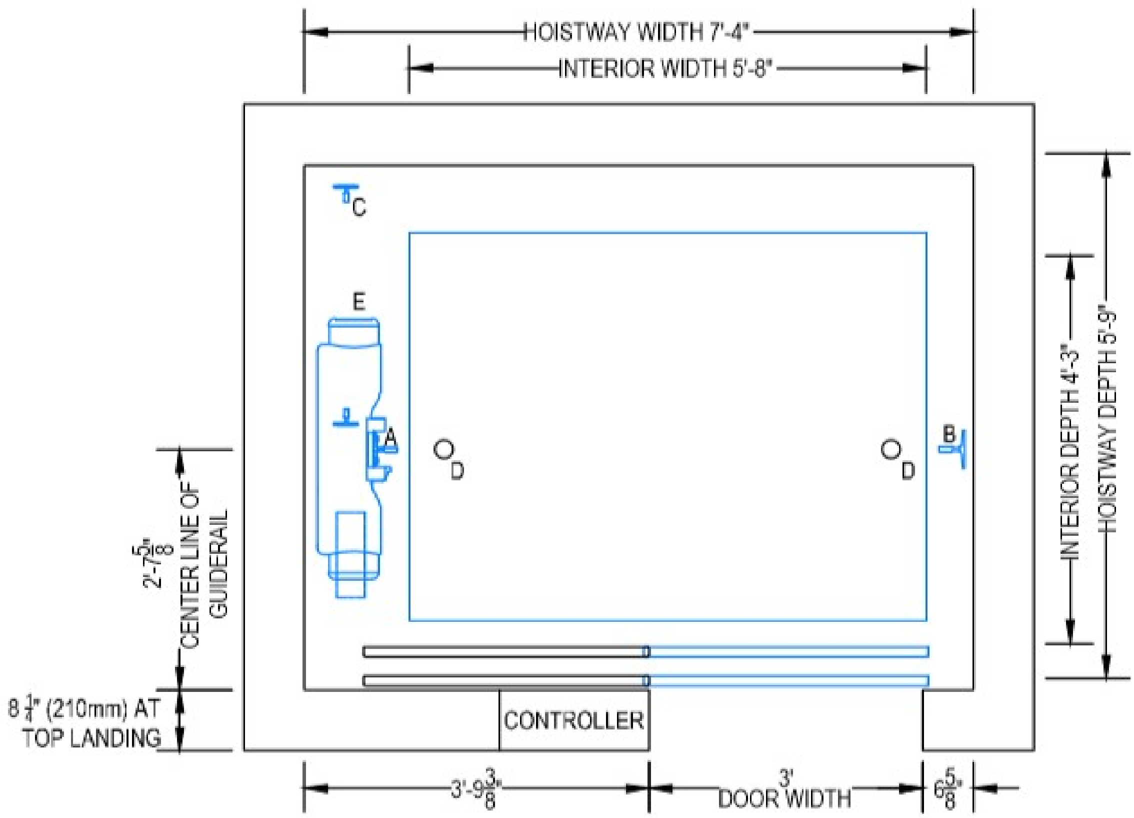
Applicable Structural Notes (Provided by Manufacturer):

2. PROVIDE ADEQUATE SUPPORT FOR GUIDE RAIL BRACKETS (INCLUDING DIVIDER BEAMS FOR MULTIPLE ELEVATORS IN A COMMON HOISTWAY) FROM PIT FLOOR TO THE TOP OF THE HOISTWAY AND NOT SPANNING FURTHER THAN ALLOWED BY THE GOVERNING CODE AUTHORITY. FIREPROOFING SHALL BE AFTER INSTALLATION OF BRACKETS.

7. PROVIDE A DRY PIT REINFORCED TO SUSTAIN VERTICAL FORCE FROM RAILS AND BUFFERS. REFERENCE THE REACTION LOAD TABLES FOR VERTICAL FORCES. SUMPS AND / OR PUMPS PUMPS (WHERE PERMITTED) LOCATED WIHTIN THE PIT MAY NOT INTRFERE WITH THE ELEVATOR EQUIPMENT.

11. AN I-BEAM, PROVIDED BY KONE, MUST BE INSTALLED IN THE ELEVATOR HOISTWAY OVERHEAD PER THE KONE FINAL LAYOUT DRAWINGS.

Loading Figures and Tables (Provided by Manufacturer):



HOISTWAY PLAN VIEW

BRKTS ABOVE TOPMOST LANDING - IMPACT LOADING REACTIONS (lbf)			
REACTION LOCATION	A	B	C
X DIRECTION	840	140	60
Y DIRECTION	360	970	110

BRKTS BELOW TOPMOST LANDING - RUNNING REACTIONS (lbf)			
X DIRECTION	190	140	60
Y DIRECTION	160	60	110
MAX DEFLECTION NOT TO EXCEED 0.125" (3mm) DUE TO APPLIED LOADS			

VERTICAL FORCES ONTO PIT FLOOR (lbf)					
REACTION LOCATION	A	B	C	D	E
Z DIRECTION	14600	7500	4100	9000	14200

**VERTICAL REACTIONS A, B & C OCCUR SIMULTANEOUSLY. VERTICAL REACTIONS D & E OCCUR INDIVIDUALLY AND SEPERATELY FROM A, B & C.

HOISTBEAM & LIFE LINE VERTICAL FORCES (lbf)				
REACTION LOCATION	A	B	C	D
Z DIRECTION	4800	4700	5000	5000

Designing for Compression:

(Reinforced Masonry Engineering Handbook; Chapter 5, Section 4)

Define Variables: Applied Loads: $P_A := 4800\ lbf$ $P_B := 4700\ lbf$ $P_C := 5000\ lbf$

Block Parameters: $I_{avg} := 334\ in^4$ A_{avg}

At Point A:

Define Variables:

Applied Load @ A:

Area of Bearing: $A_b := 64\ in^2$

Compressive Strength: $f'_m := 0.45 \cdot 1000\ psi = 450\ psi$

Check: $C_{max} := P_A \cdot A_b^{-1} = 75\ psi$ $C_{max} \le f'_m = 1$

At Point B:

Define Variables:

Applied Load @ B:

Area of Bearing: $A_b := 64\ in^2$

Compressive Strength: $f'_m := 0.45 \cdot 1000\ psi = 450\ psi$

Check: $C_{max} := P_B \cdot A_b^{-1} = 73.438\ psi$ $C_{max} \le f'_m = 1$

At Point C:

Define Variables:

Applied Load @ C:

Area of Bearing: $A_b := 64\ in^2$

Compressive Strength: $f'_m := 0.45 \cdot 1000\ psi = 450\ psi$

Check: $C_{max} := P_C \cdot A_b^{-1} = 78.125\ psi$ $C_{max} \le f'_m = 1$

Existing elevator shaft is structurally cable to handle the design loads for this elevator model.

General Notes and Assumptions:

- ASCE 7-16 and NDS 2018 govern the structural design.
- Flat roof section members are spaced at 2' O.C. ----> $w_t := 2\ ft$
- Assume members are Douglas Fir-Larch 2x20's -----> $t := 2\ in$ $\quad d := 20\ in$
  (Assuming undressed sizes for an old building) $A := t \cdot d \quad S_x := t \cdot d^2 \cdot 6^{-1} = 133.333\ in^3$
- Maximum span is 25'-5 3/4" ----------------------------> $Span := 25\ ft + 5.75\ in$
- Roof system components (Top to bottom)
  - Roof Covering - EPDM (smooth)
  - 5/8" OSB Sheathing
  - 3" Closed-Cell Spray Foam Insulation
- Assume Risk Category II (ASCE 7-16, Table 1.5-2)

Dead Load Calculations:

Upper Roof Dead Load: $Covering := 1\ psf \quad Sheathing := 2\ psf$

$D_{upper} := Covering + Sheathing = 3\ psf$

$w_{d.up} := D_{upper} \cdot w_t = 6\ plf$

Lower Roof Dead Load: $Insulation := 3 \cdot 0.15\ psf \quad Gypsum := 3\ psf \quad MEP := 4\ psf$

$D_{lower} := Insulation + Gypsum + MEP = 7.45\ psf$

$w_{d.low} := D_{lower} \cdot w_t = 14.9\ plf$

Self Weight of Members: $SG := 0.5 \quad Framing := \dfrac{A}{144\ in^2} \cdot 62.4\ psf \cdot SG \cdot \dfrac{12\ in}{w_t} = 4.333\ psf$

$w_{sw} := Framing \cdot w_t = 8.667\ plf$

Roof Live Load Calculations:

$L_r := 20\ psf$ (From ASCE 7-16 Live Load Tables)

$w_l := L_r \cdot w_t = 40\ plf$

Snow Load Calculations:

Location: **Clinton, IA**

Ground Snow Load: $p_g := 30\ psf$

Exposure Factor: $C_e := 1.0$

Thermal Factor: $C_t := 1.2$

Importance Factor: $I_s := 1.0$

Flat Snow Load: $p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\ psf$

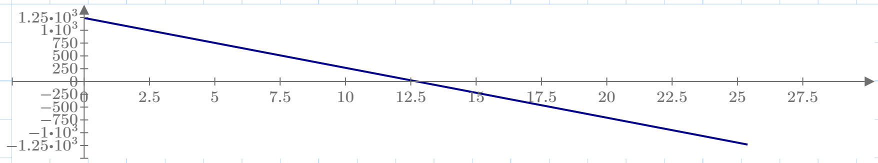
$w_s := p_f \cdot w_t = 50.4\ plf$

Total Loading:

$w := w_{d.up} + w_{d.low} + w_{sw} + 0.75 \cdot w_l + 0.75 \cdot w_s = 97.367\ plf$

Check Shear: $x := 0.0001\ ft, 0.2\ ft .. Span$ $\quad V(x) := w \cdot (0.5 \cdot Span - x)$

Free Body Diagram:



$V(x)\ (lbf)$

$x\ (ft)$

$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 1240.411\ lbf$

Shear Stress: $f_v := V_{max} \cdot A^{-1} = 31.01\ psi$

Reference Design Value: $F_v := 180\ psi$

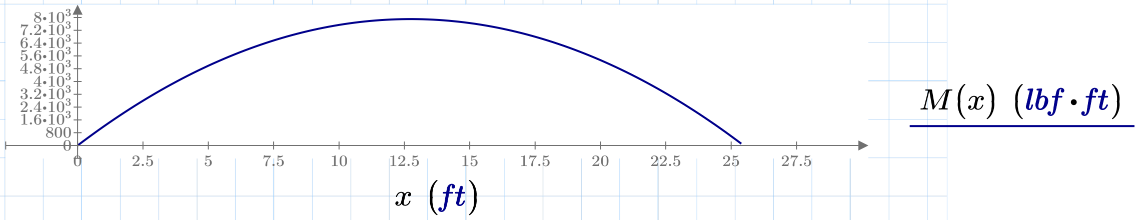
Adjustment Factors: $C_D := 1.15 \quad C_M := 1.0 \quad C_t := 1.0 \quad C_F := 1.0$

Adjusted Design Value: $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t = 207\ psi$

Check: if $f_v \le F'_v$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR SHEAR"

Check Bending: $x := 0.0001\ ft, 0.2\ ft .. Span$ $M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$

Free Body Diagram:



$M_{max} := \text{abs}\left(w \cdot Span^2 \cdot 8^{-1}\right) = 7901.158\ lbf \cdot ft$

Bending Stress: $f_b := M_{max} \cdot S_x^{-1} = 711.104\ psi$

Reference Design Value: $F_b := 900\ psi$

Adjustment Factors: $C_D := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_F := 1.0$

Adjusted Design Value: $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F = 1035\ psi$

Check: if $f_b \le F'_b$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Existing flat roof members are structurally capable to withstand all existing and new loadings.

General Notes and Assumptions:

- ASCE 7-16 and NDS 2018 govern the structural design.
- Roof trusses are spaced at 4' O.C. ----> $w_t := 4\ ft$
- Roof system components (Top to bottom)
  - Roof Covering - EPDM (smooth)
  - 5/8" OSB Sheathing
  - 3" Closed-Cell Spray Foam Insulation
- Assume Risk Category II (ASCE 7-16, Table 1.5-2)

Dead Load Calculations:

Upper Roof Dead Load: $Covering := 1\ psf$ $Sheathing := 2\ psf$

$D_{upper} := Covering + Sheathing = 3\ psf$

$$w_{d.up} := D_{upper} \cdot w_t = 12\ plf$$

Lower Roof Dead Load: $Insulation := 3 \cdot 0.15\ psf$ $Gypsum := 3\ psf$ $MEP := 4\ psf$

$D_{lower} := Insulation + Gypsum + MEP = 7.45\ psf$

$$w_{d.low} := D_{lower} \cdot w_t = 29.8\ plf$$

Roof Live Load Calculations:

$L_r := 20\ psf$ (From ASCE 7-16 Live Load Tables)

$$w_l := L_r \cdot w_t = 80\ plf$$

Snow Load Calculations:

Location: **Clinton, IA**

Ground Snow Load: $p_g := 30\ psf$

Exposure Factor: $C_e := 1.0$

Thermal Factor: $C_t := 1.2$

Importance Factor: $I_s := 1.0$

Flat Snow Load: $p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\ psf$

$$w_s := p_f \cdot w_t = 100.8\ plf$$

Lowered Ceiling Dead Load Calculations:

Weight of 1x4's @10 O.C. Each Way:

Define Variables:

Thickness: $b := 1\ in$

Depth: $d := 3.75\ in$

Area: $A_{member} := b \cdot d = 3.75\ in^2$

Specific Gravity: $SG := 0.5$

Spacing: $s := 10\ in$

Weight of Members: $W_{members} := 2 \cdot \frac{A_{member}}{144\ in^2} \cdot 62.4\ psf \cdot SG \cdot \frac{12\ in}{s} = 1.95\ psf$

Weight of Lighting:

Define Variables:

Weight of Light/Casing: $W_{light} := 6.2\ lbf$

Number of Lights in System: $N := 28$

Area of System: $A := 20\ ft \cdot 20\ ft$

Weight of Members: $W_{lights} := N \cdot W_{light} \cdot A^{-1} = 0.434\ psf$

Total Weight of System: $W_{system} := W_{members} + W_{lights} = 2.384\ psf$

Convert to Point Loads for Hangers:

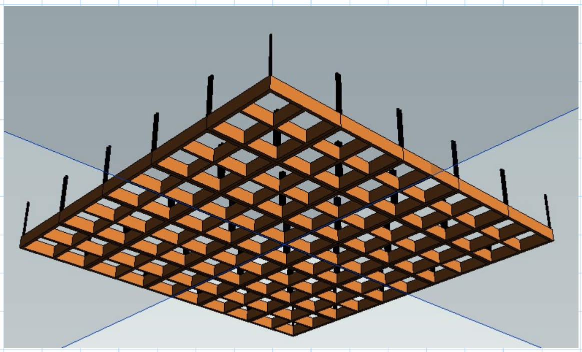
Define Variables:

Longitudinal Tributary Width: $w_{long} := 4\ ft$

Latitudinal Tributary Width: $w_{lat} := 4\ ft + 2\ in$

Total tributary Area: $A_t := w_{long} \cdot w_{lat} = 16.667\ ft^2$

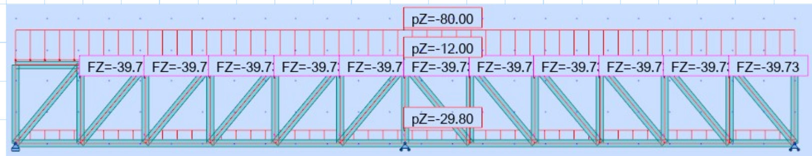
Hanger Load: $P_{hanger} := W_{system} \cdot A_t = 39.733\ lbf$



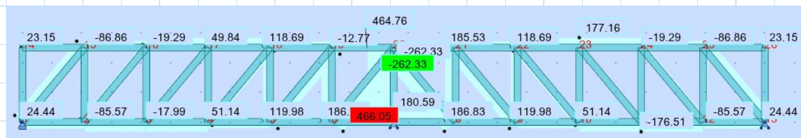
Structural Analysis (Robot):

Load Case 1 (Dead+Live):

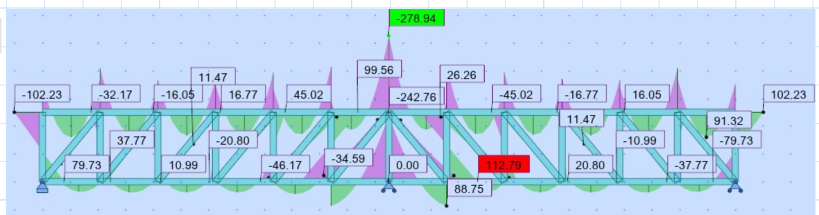
Load Diagram:



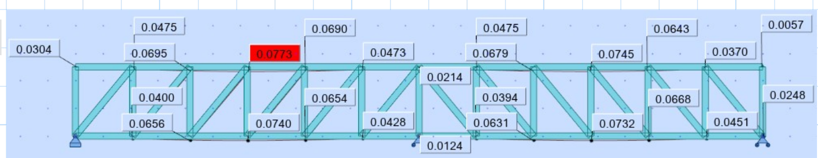
Axial Forces (psi):



Moment Results (lbf*ft):



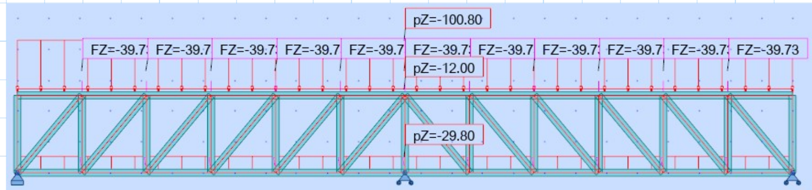
Deformation Results (in)



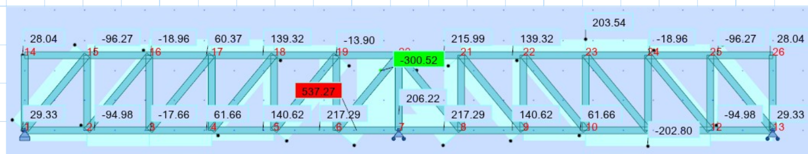
Structural Analysis (Robot):

Load Case 2 (Dead+Snow):

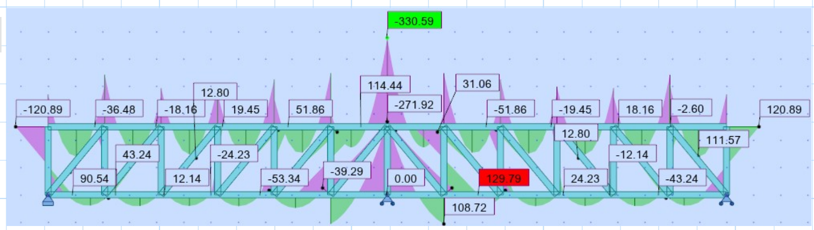
Load Diagram:



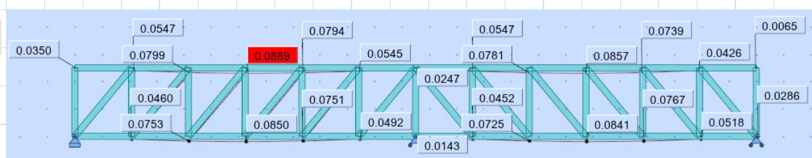
Axial Forces (psi):



Moment Results (lbf*ft):



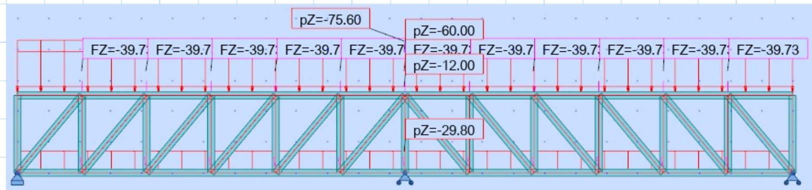
Deformation Results (in)



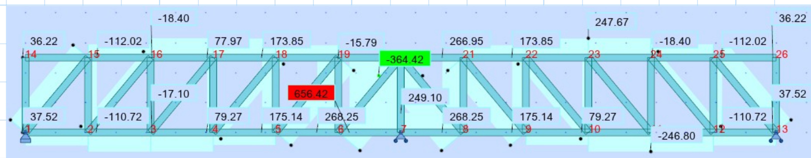
Structural Analysis (Robot): **GOVERNING CASE**

Load Case 3 (Dead+0.75*Live+0.75*Snow):

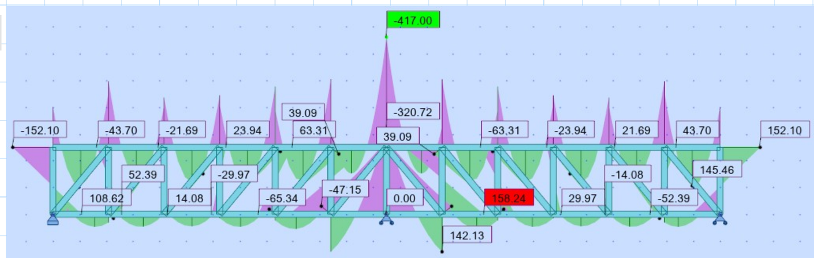
Load Diagram:



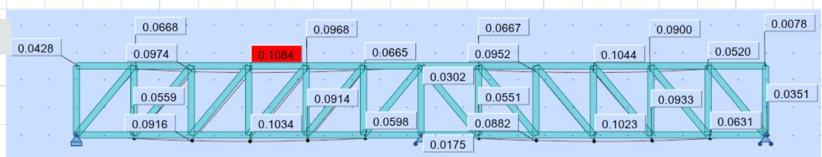
Axial Forces (psi):



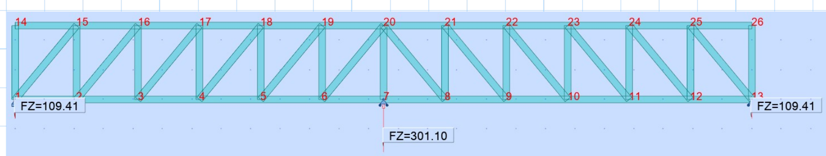
Moment Results (lbf*ft):



Deformation Results (in):



Reaction Results (lbf):



Checking Tension and Compression (Load Case 3):

Define Variables:

Area of Members: $A := 1.5\ in \cdot 5.5\ in$ (Assume No. 2 Douglas Fir-Larch)

Max Compression: $f_c := 656.42\ psi$

Max Tension: $f_t := 364.42\ psi$

Reference Design Values: $F_c := 1350\ psi$ $F_t := 575\ psi$ (Assume No. 2 Douglas Fir-Larch)

Adjustment Factors: $C_D := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_F := 1.0$

Adjusted Design Values: $F'_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_F = \left(1.553 \cdot 10^3\right)\ psi$

$F'_t := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_F = 661.25\ psi$

Check:

if $f_c \le F'_c$
"DESIGN IS OKAY FOR COMPRESSION"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR COMPRESSION"

if $f_t \le F'_t$
"DESIGN IS OKAY FOR TENSION"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR TENSION"

Checking Bending (Load Case 3):

$M_{max} := 417\ lbf \cdot ft$ $S_x := 7.56\ in^3$

Bending Stress: $f_b := M_{max} \cdot {S_x}^{-1} = 661.905\ psi$

Reference Design Value: $F_b := 900\ psi$ (Assume No. 2 Douglas Fir-Larch)

Adjustment Factors: $C_D := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_F := 1.0$

Adjusted Design Value: $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F = \left(1.035 \cdot 10^3\right)\ psi$

Check:

if $f_b \le F'_b$
"DESIGN IS OKAY FOR BENDING"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Analysis of Additional Weight of Air Handler Unit to the Roof:

Air Handler Unit Information: -Model -- 62X Air-Cooled DOAS Unit
-Weight -- About 3 Tons

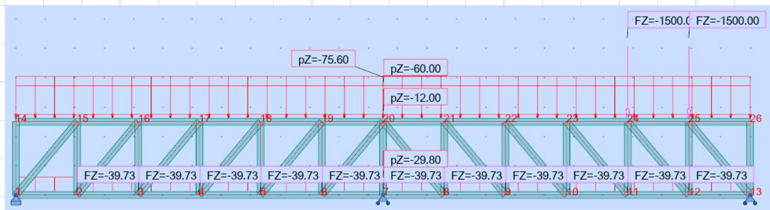
Assumptions: Weight of unit will be carried at each of the four corners for truss analysis.

$$P := 3\ tonf \cdot 4^{-1} = 1500\ lbf$$

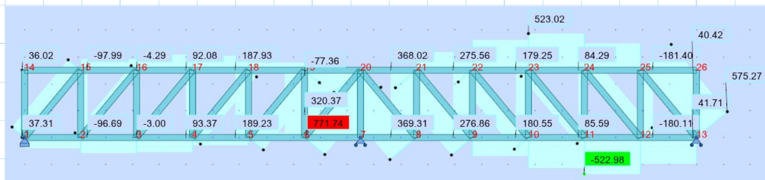
Structural Analysis (Robot):

Load Case 3 (Dead+0.75*Live+0.75*Snow):

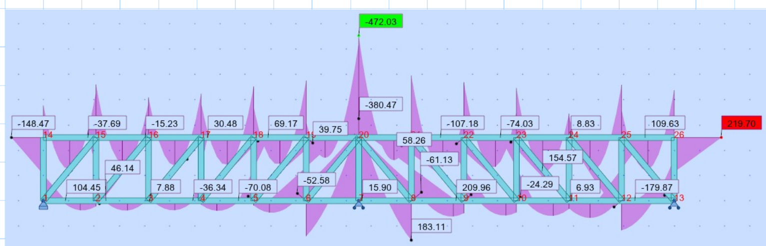
Load Diagram:



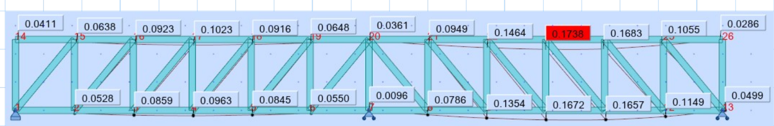
Axial Forces (psi):



Moment Results (lbf*ft):



Deformation Results (in)



Checking Tension and Compression (Load Case 3):

Define Variables:
Area of Members: $A := 1.5\ in \cdot 5.5\ in$ (Assume No. 2 Douglas Fir-Larch)
Max Compression: $f_c := 771.74\ psi$
Max Tension: $f_t := 522.98\ psi$

Reference Design Values: $F_c := 1350\ psi$ $F_t := 575\ psi$ (Assume No. 2 Douglas Fir-Larch)

Adjustment Factors: $C_D := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_F := 1.0$

Adjusted Design Values: $F'_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_F = (1.553 \cdot 10^3)\ psi$
$F'_t := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_F = 661.25\ psi$

Check:

if $f_c \le F'_c$
"DESIGN IS OKAY FOR COMPRESSION"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR COMPRESSION"

if $f_t \le F'_t$
"DESIGN IS OKAY FOR TENSION"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR TENSION"

Checking Bending (Load Case 3):

$M_{max} := 472\ lbf \cdot ft$ $S_x := 7.56\ in^3$

Bending Stress: $f_b := M_{max} \cdot S_x^{-1} = 749.206\ psi$

Reference Design Value: $F_b := 900\ psi$ (Assume No. 2 Douglas Fir-Larch)

Adjustment Factors: $C_D := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_F := 1.0$

Adjusted Design Value: $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F = (1.035 \cdot 10^3)\ psi$

Check:

if $f_b \le F'_b$
"DESIGN IS OKAY FOR BENDING"
else
"DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Checking Deflection (Load Case 3):

$\delta_{tot} := 0.1738\ in$ $L := 25\ ft$

Deflection Limits:

$\Delta_{st} := L \cdot 360^{-1} = 0.833\ in$ $\delta_{tot} \le \Delta_{st} = 1$

$\Delta_{lt} := L \cdot 240^{-1} = 1.25\ in$ $\delta_{tot} \le \Delta_{lt} = 1$

$\Delta_{tot} := L \cdot 240^{-1} = 1.25\ in$ $\delta_{tot} \le \Delta_{tot} = 1$

Existing roof trusses are structurally capable to handle all new loadings.

General Notes and Assumptions:

- ASCE 7-16 and NDS 2018 govern the structural design.
- Floor system components (Top to bottom)
  - Floor finish: 1" hardwood flooring, with 1" shoes
  - Subfloor: 3/4" OSB sheathing
  - Floor framing: TBD
  - Floor insulation: 6" fiberglass batt insulation
- Assume Risk Category II (ASCE 7-16, Table 1.5-2)

Live Load Assignments:

(From ASCE 7-16 Live Load Tables)

Kitchen Live Load: $Kitchen := 150\ psf$

Cafe Live Load: $Cafe := 100\ psf$

Retail Live Load: $Retail := 75\ psf$

Restroom Live Load: $Restroom := 60\ psf$

Snow Load Calculations:

Location: **Clinton, IA**

Ground Snow Load: $p_g := 30\ psf$

Exposure Factor: $C_e := 1.0$

Thermal Factor: $C_t := 1.2$

Importance Factor: $I_s := 1.0$

Flat Snow Load: $p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\ psf$

(J1) See sheet S-2.1 for indication:

Try 1.75" x 18" Microllam LVL Joist By Weyerhaeuser: $M_{allow} := 19375\ lbf \cdot ft$ $V_{allow} := 5985\ lbf$

Define Variables: Tributary Width: $w_t := 16\ in$

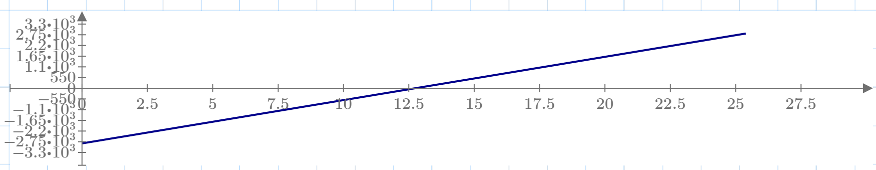
Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$
Self Weight: $w_{sw} := 9.2\ plf$
Dead Load: $Dead := Finish + Under + Sheathing + Insulation$
Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 22.533\ plf$

Joists Spanning From Grid 4 to Grid 5: $Span := 25\ ft + 5.75\ in$

Max Live Load in Span: $Live := Kitchen = 150\ psf$
Distributed Live Load: $w_l := Live \cdot w_t = 200\ plf$
Total Distributed Load: $w := -w_d - w_l = -222.533\ plf$

Design For Shear: $x := 0.0001\ ft, 0.2\ ft .. Span$ $V(x) := w \cdot (0.5 \cdot Span - x)$



$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 2834.982\ lbf$

Adjustment Factors: $C_D := 1.0$

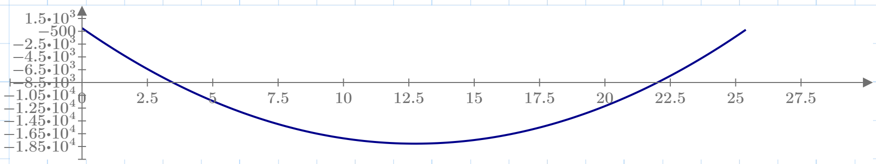
Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 5985\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.474$

if $V_{max} \le V_{allow}$
  "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending: $x := 0.0001\ ft, 0.2\ ft..Span$ $\quad M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$



$M(x)\ (lbf \cdot ft)$

$x\ (ft)$

$M_{max} := \text{abs}\left(w \cdot Span^2 \cdot 8^{-1}\right) = 18058.244\ lbf \cdot ft$

Adjustment Factors: $C_D := 1.0$

Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 19375\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 0.932$

if $M_{max} \le M_{allow}$
‖ "DESIGN IS OKAY FOR BENDING"
else if $0.95 \le DCR \le 1.05$
‖ "DESIGN IS OKAY FOR BENDING"
else
‖ "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I := 851\ in^4$ $\quad E := 2.0 \cdot 10^6\ psi$

Limits: $\Delta_{st} := Span \cdot 360^{-1} = 0.849\ in$ $\quad \Delta_{lt} := Span \cdot 240^{-1} = 1.274\ in$

Short Term: $\delta_{st} := \dfrac{5 \cdot 0.5 \cdot w_l \cdot Span^4}{384 \cdot E \cdot I} = 0.557\ in$ $\quad \delta_{st} \le \Delta_{st} = 1$

Long Term: $\delta_{lt} := \dfrac{5 \cdot \left(w_d + 0.5 \cdot w_l\right) \cdot Span^4}{384 \cdot E \cdot I} = 0.683\ in$ $\quad \delta_{lt} \le \Delta_{lt} = 1$

DESIGN SUMMARY: Use 18" Deep TJI 560 Joists by Weyerheauser @ 12" O.C. for floor joists tagged as 'J1'. See appendix for indication. DCR value is a bit low. Instead of using a 20" TJI 360, an 18" TJI 560 keeps a more consistent ceiling height. If contractor wishes to use another product, they must submit a substitution request.

(J2) See sheet S-2.1 for indication:

Try 1.75" x 14" Microllam LVL Joist By Weyerhaeuser: $M_{allow} := 12130\ lbf \cdot ft$ $V_{allow} := 4655\ lbf$

Define Variables: Tributary Width: $w_t := 16\ in$

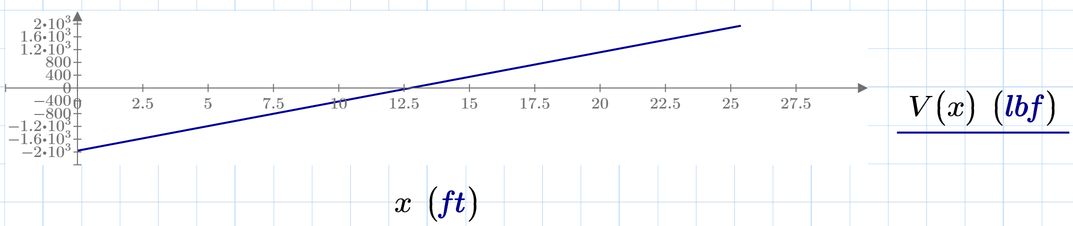
Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$
Self Weight: $w_{sw} := 7.1\ plf$
Dead Load: $Dead := Finish + Under + Sheathing + Insulation$
Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 20.433\ plf$

Joists Spanning From Grid 4 to Grid 5: $Span := 25\ ft + 5.75\ in$

Max Live Load in Span: $Live := Cafe = 100\ psf$
Distributed Live Load: $w_l := Live \cdot w_t = 133.333\ plf$
Total Distributed Load: $w := -w_d - w_l = -153.767\ plf$

Design For Shear: $x := 0.0001\ ft, 0.2\ ft .. Span$ $V(x) := w \cdot (0.5 \cdot Span - x)$



$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 1958.923\ lbf$ $P_{J2} := 1958.923\ lbf$

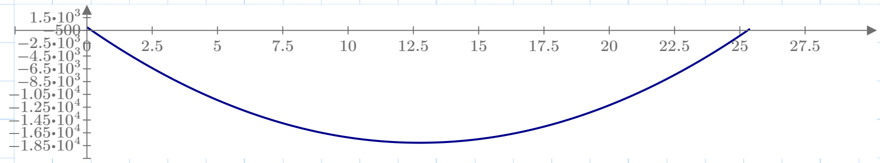
Adjustment Factors: $C_D := 1.0$
Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 4655\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.421$

if $V_{max} \le V_{allow}$
 "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
 "DESIGN IS OKAY FOR SHEAR"
else
 "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending: $x := 0.0001\ ft, 0.2\ ft .. Span$ $M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$



$M(x)\ (lbf \cdot ft)$

$x\ (ft)$

$M_{max} := \text{abs}\left(w \cdot Span^2 \cdot 8^{-1}\right) = 12477.933\ lbf \cdot ft$

Adjustment Factors: $C_D := 1.0$

Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 12130\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 1.029$

if $M_{max} \le M_{allow}$
  "DESIGN IS OKAY FOR BENDING"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $E := 2.0 \cdot 10^6\ psi$ $I := 400\ in^4$

Limits: $\Delta_{st} := Span \cdot 360^{-1} = 0.849\ in$ $\Delta_{lt} := Span \cdot 240^{-1} = 1.274\ in$

Short Term: $\delta_{st} := \dfrac{5 \cdot 0.5 \cdot w_l \cdot Span^4}{384 \cdot E \cdot I} = 0.79\ in$ $\delta_{st} \le \Delta_{st} = 1$

Long Term: $\delta_{lt} := \dfrac{5 \cdot (w_d + 0.5 \cdot w_l) \cdot Span^4}{384 \cdot E \cdot I} = 1.032\ in$ $\delta_{lt} \le \Delta_{lt} = 1$

DESIGN SUMMARY: Use 18" Deep TJI 360 Joists by Weyerheauser @ 12" O.C. for floor joists tagged as 'J2'. See appendix for indication. If contractor wishes to use another product, they must submit a substitution request.

(J3) See sheet S-2.1 for indication:

Try 11.25" Deep Microllam LVL By Weyerhaeuser: $M_{allow} := 8070\ lbf \cdot ft$ $V_{allow} := 3740\ lbf$

Define Variables: Tributary Width: $w_t := 12\ in$

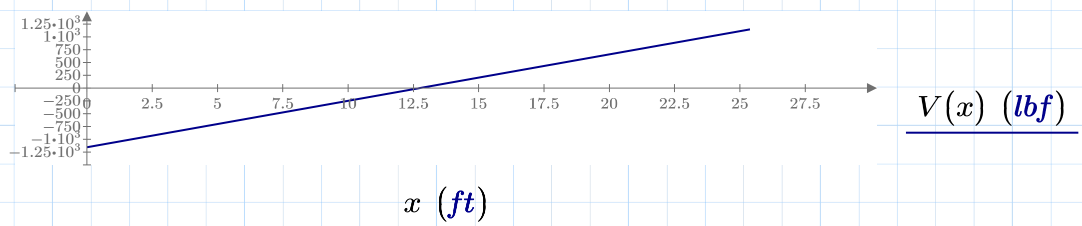
Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$
Self Weight: $w_{sw} := 5.7\ plf$
Dead Load: $Dead := Finish + Under + Sheathing + Insulation$
Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 15.7\ plf$

Joists Spanning From Grid 4 to Grid 5: $Span := 25\ ft + 5.75\ in$

Max Live Load in Span: $Live := Retail = 75\ psf$
Distributed Live Load: $w_l := Live \cdot w_t = 75\ plf$
Total Distributed Load: $w := -w_d - w_l = -90.7\ plf$

Design For Shear: $x := 0.0001\ ft, 0.2\ ft .. Span$ $V(x) := w \cdot (0.5 \cdot Span - x)$



$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 1155.48\ lbf$ $P_{J3} := V_{max}$

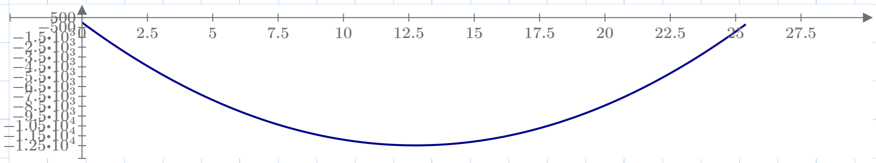
Adjustment Factors: $C_D := 1.0$
Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 3740\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.309$

if $V_{max} \le V_{allow}$
  "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending: $x := 0.0001\ ft, 0.2\ ft..Span$ $M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$



$M_{max} := \text{abs}(w \cdot Span^2 \cdot 8^{-1}) = 7360.168\ lbf \cdot ft$

Adjustment Factors: $C_D := 1.0$
Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 8070\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 0.912$

if $M_{max} \le M_{allow}$
  "DESIGN IS OKAY FOR BENDING"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I := 208\ in^4$ $E := 2.0 \cdot 10^6\ psi$

Limits: $\Delta_{st} := Span \cdot 360^{-1} = 0.849\ in$ $\Delta_{lt} := Span \cdot 240^{-1} = 1.274\ in$

Short Term: $\delta_{st} := \dfrac{5 \cdot 0.5 \cdot w_l \cdot Span^4}{384 \cdot E \cdot I} = 0.855\ in$ $\delta_{st} \le \Delta_{st} = 0$

Long Term: $\delta_{lt} := \dfrac{5 \cdot (w_d + 0.5 \cdot w_l) \cdot Span^4}{384 \cdot E \cdot I} = 1.213\ in$ $\delta_{lt} \le \Delta_{lt} = 1$

DESIGN SUMMARY: Use 11.25" Deep Grade 2.0E Microllam LVL's by Weyerheauser @ 12" O.C. for floor joists tagged as 'J3'. See appendix for indication. If contractor wishes to use another product, they must submit a substitution request.

(BALC 1) See sheet S-2.1 for indication:

Try 1.75" x 9.25" Microllam LVL's: $M_{allow} := 5600\ lbf \cdot ft \quad V_{allow} := 3075\ lbf$

Define Variables: Tributary Width: $w_t := 16\ in \quad \gamma_{snow} := 20\ pcf$

Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4"Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$

Self Weight: $w_{sw} := 4.7\ plf$

Dead Load: $Dead := Finish + Under + Sheathing + Insulation$

Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 18.033\ plf$

Calculate Linear Load: $Span := 22.5\ ft \quad Overhang := 6.75\ ft \quad Span_{int} := Span - Overhang$

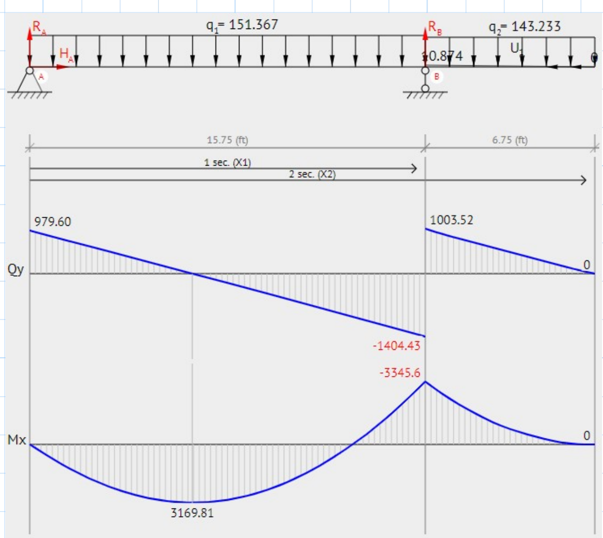
Max Live Load in Span: $Live := Cafe$
Distributed Live Load: $w_l := Live \cdot w_t = 133.333\ plf$
Flat Snow Load: $p_f = 25.2\ psf$ --> $w_f := p_f \cdot w_t = 33.6\ plf$
Windward Snow Drift Load: $l_u := Overhang \cdot ft^{-1} = 6.75 \quad p_g := p_g \cdot psf^{-1}$
$h_d := \left(0.43 \cdot \sqrt[3]{l_u} \cdot \sqrt[4]{p_g + 10} - 1.5\right) = 0.544 \quad h_d := h_d \cdot ft$

$w_{d.max} := 0.75 \cdot h_d \cdot \gamma_{snow} \cdot w_t = 10.874\ plf$

Interior Distributed Load: $w_{int} := -w_d - w_l = -151.367\ plf$

Exterior Distributed Load: $w_{ext} := -w_d - 0.75 \cdot w_l - 0.75 \cdot w_f = -143.233\ plf$

Free Body Diagram:



$V_{max} := 979.60\ lbf$

$P_1 := V_{max}$

$M_{max} := 3345.6\ lbf \cdot ft$

Design For Shear:

Adjustment Factors: $C_D := 1.0$

Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 3075\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.319$

if $V_{max} \le V_{allow}$
  "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending:

Adjustment Factors: $C_D := 1.0$

Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 5600\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 0.597$

if $M_{max} \le M_{allow}$
  "DESIGN IS OKAY FOR BENDING"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I := 115\ in^4$ $E := 2.0 \cdot 10^6\ psi$ $l := Span_{int}$ $x := 0.5 \cdot Span_{int}$ $a := Overhang$

Limits: $\Delta_{st} := Span_{int} \cdot 360^{-1} = 0.525\ in$ $\Delta_{lt} := Span_{int} \cdot 240^{-1} = 0.788\ in$

Short Term: $$\delta_{st} := \frac{w_l \cdot x}{24 \cdot E \cdot I \cdot l} \cdot \left(l^4 - 2 \cdot l^2 \cdot x^2 + l \cdot x^3 - 2 \cdot a^2 \cdot l^2 + 2 \cdot a^2 \cdot x^2\right) = 0.449\ in$$

$\delta_{st} \le \Delta_{st} = 1$

Long Term: $$\delta_{lt} := \frac{\left(w_d + 0.5 \cdot w_l\right) \cdot x}{24 \cdot E \cdot I \cdot l} \cdot \left(l^4 - 2 \cdot l^2 \cdot x^2 + l \cdot x^3 - 2 \cdot a^2 \cdot l^2 + 2 \cdot a^2 \cdot x^2\right) = 0.285\ in$$

$\delta_{lt} \le \Delta_{lt} = 1$

(BALC 2) See sheet S-2.1 for indication:

Try 2x6's @ 16" Spacing: $A := 8.25\ in^2$ $S_x := 7.56\ in^3$ $SG := 0.55$ (Southern Pine)

Define Variables: Tributary Width: $w_t := 16\ in$

Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$

Framing: $Framing := \frac{A}{144\ in^2} \cdot 62.4\ psf \cdot SG \cdot \frac{12\ in}{w_t} = 1.475\ psf$

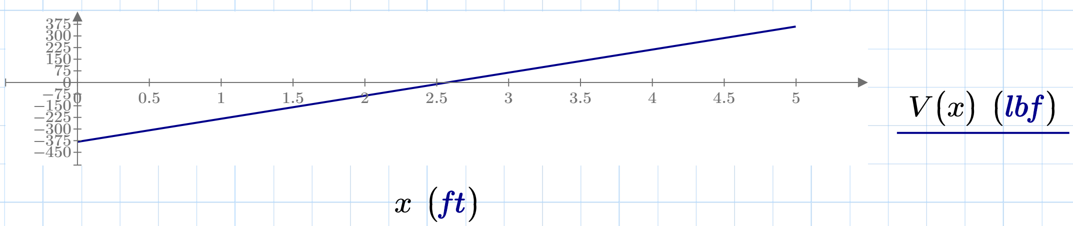
Dead Load: $Dead := Finish + Under + Sheathing + Insulation + Framing$

Distributed Dead Load: $w_d := Dead \cdot w_t = 15.3\ plf$

Calculate Linear Load: $Span := 5\ ft + 1.75\ in$

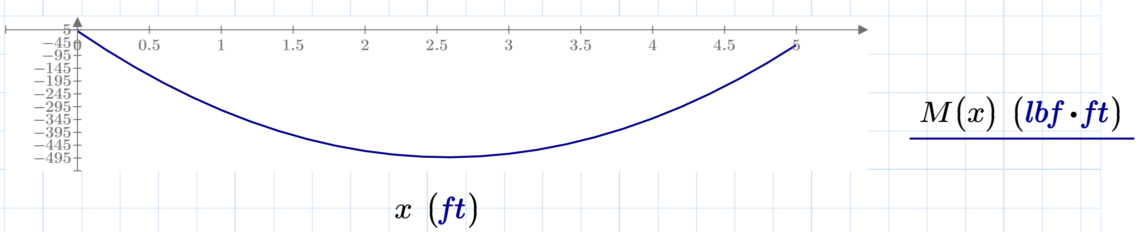
Max Live Load in Span: $Live := Cafe$
Distributed Live Load: $w_l := Live \cdot w_t = 133.333\ plf$
Total Distributed Load: $w := -w_d - w_l = -148.633\ plf$

Shear FBD: $x := 0.0001\ ft, 0.2\ ft .. Span$ $V(x) := w \cdot (0.5 \cdot Span - x)$



$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 382.42\ lbf$ $P_2 := V_{max}$

Bending FBD: $x := 0.0001\ ft, 0.2\ ft .. Span$ $M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$



$M_{max} := \text{abs}(w \cdot Span^2 \cdot 8^{-1}) = 491.968\ lbf \cdot ft$

Design For Shear:

Max Shear: $V_{max} = 382.42\ lbf$

Shear Stress: $f_v := V_{max} \cdot A^{-1} = 46.354\ psi$

Allowable Shear: $F_v := 175\ psi$

Adjustment Factors for Shear: (NDS Supplement, Part 4, Adjustment Factors)

$C_D := 1.0 \quad C_M := 1.0 \quad C_i := 0.80 \quad C_t := 1.0$

Adjusted Design Value: $F'_v := F_v \cdot C_D \cdot C_M \cdot C_i \cdot C_t = 140\ psi$

Check: $DCR := f_v \cdot {F'_v}^{-1} = 0.331$

if $f_v \le F'_v$
 "DESIGN IS OKAY FOR SHEAR"
else
 "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR SHEAR"

Design For Bending:

Max Shear: $M_{max} = 491.968\ ft \cdot lbf$

Shear Stress: $f_b := M_{max} \cdot S_x^{-1} = 780.901\ psi$

Allowable Shear: $F_b := 1100\ psi$ (Assume No. 2 Southern Pine)

Adjustment Factors for Bending: $C_D := 1.0 \quad C_t := 1.0 \quad C_r := 1.15$

(NDS and NDS Supplement) $C_M := 1.0 \quad C_i := 0.80 \quad C_F := 1.0$

Adjusted Design Value: $F'_b := F_b \cdot C_D \cdot C_F \cdot C_M \cdot C_t \cdot C_i \cdot C_t \cdot C_r = \left(1.012 \cdot 10^3\right)\ psi$

Check: $DCR := f_b \cdot {F'_b}^{-1} = 0.772$

if $f_b \le F'_b$
 "DESIGN IS OKAY FOR BENDING"
else
 "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I := 20.80\ in^4 \qquad E := 1400000\ psi$

Limits: $\Delta_{st} := Span \cdot 480^{-1} = 0.129\ in \qquad \Delta_{lt} := Span \cdot 360^{-1} = 0.172\ in$

Short Term: $\delta_{st} := \dfrac{5 \cdot 0.5 \cdot w_l \cdot Span^4}{384 \cdot E \cdot I} = 0.036\ in \qquad \delta_{st} \le \Delta_{st} = 1$

Long Term: $\delta_{lt} := \dfrac{5 \cdot \left(w_d + 0.5 \cdot w_l\right) \cdot Span^4}{384 \cdot E \cdot I} = 0.044\ in \qquad \delta_{lt} \le \Delta_{lt} = 1$

(BALC 3) See sheet S-2.1 for indication:

Try 2x10's @ 16" Spacing: $A := 13.88\ in^2$ $S_x := 21.39\ in^3$ $SG := 0.55$ (Southern Pine)

Define Variables: Tributary Width: $w_t := 16\ in$

Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$

Framing: $Framing := \frac{A}{144\ in^2} \cdot 62.4\ psf \cdot SG \cdot \frac{12\ in}{w_t} = 2.481\ psf$

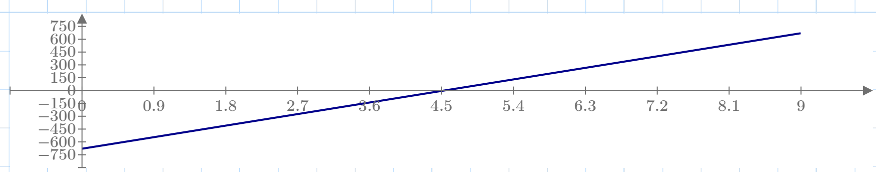
Dead Load: $Dead := Finish + Under + Sheathing + Insulation + Framing$

Distributed Dead Load: $w_d := Dead \cdot w_t = 16.641\ plf$

Calculate Linear Load: $Span := 9\ ft + 0.75\ in$

Max Live Load in Span: $Live := Cafe$
Distributed Live Load: $w_l := Live \cdot w_t = 133.333\ plf$
Total Distributed Load: $w := -w_d - w_l = -149.975\ plf$

Shear FBD: $x := 0.0001\ ft, 0.2\ ft..Span$ $V(x) := w \cdot (0.5 \cdot Span - x)$

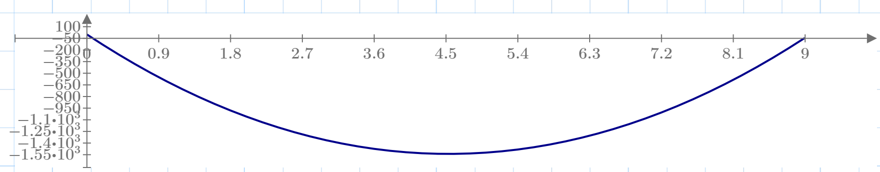


$V(x)\ (lbf)$

$x\ (ft)$

$V_{max} := \text{abs}(w \cdot Span \cdot 0.5) = 679.573\ lbf$ $P_3 := V_{max}$

Bending FBD: $x := 0.0001\ ft, 0.2\ ft..Span$ $M(x) := 0.5 \cdot w \cdot x \cdot (Span - x)$



$M(x)\ (lbf \cdot ft)$

$x\ (ft)$

$M_{max} := \text{abs}(w \cdot Span^2 \cdot 8^{-1}) = 1539.658\ lbf \cdot ft$

Design For Shear:

Max Shear: $V_{max}=679.573\ lbf$

Shear Stress: $f_v:=V_{max}\cdot A^{-1}=48.961\ psi$

Allowable Shear: $F_v:=175\ psi$ (Assume No. 2 Southern Pine)

Adjustment Factors for Shear: (NDS Supplement, Part 4, Adjustment Factors)

$C_D:=1.0$ $C_M:=1.0$ $C_i:=0.80$ $C_t:=1.0$

Adjusted Design Value: $F'_v:=F_v\cdot C_D\cdot C_M\cdot C_i\cdot C_t=140\ psi$

Check: $DCR:=f_v\cdot {F'_v}^{-1}=0.35$

if $f_v\le F'_v$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR SHEAR"

Design For Bending:

Max Shear: $M_{max}=\left(1.54\cdot 10^3\right)\ ft\cdot lbf$

Shear Stress: $f_b:=M_{max}\cdot S_x^{-1}=863.763\ psi$

Allowable Shear: $F_b:=1100\ psi$ (Assume No. 2 Southern Pine)

Adjustment Factors for Bending: $C_D:=1.0$ $C_t:=1.0$ $C_r:=1.15$

(NDS and NDS Supplement) $C_M:=1.0$ $C_i:=0.80$ $C_F:=1.0$

Adjusted Design Value: $F'_b:=F_b\cdot C_D\cdot C_F\cdot C_M\cdot C_t\cdot C_i\cdot C_t\cdot C_r=\left(1.012\cdot 10^3\right)\ psi$

Check: $DCR:=f_b\cdot {F'_b}^{-1}=0.854$

if $f_b\le F'_b$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I:=98.93\ in^4$ $E:=1400000\ psi$

Limits: $\Delta_{st}:=Span\cdot 480^{-1}=0.227\ in$ $\Delta_{lt}:=Span\cdot 360^{-1}=0.302\ in$

Short Term: $\delta_{st}:=\dfrac{5\cdot 0.5\cdot w_l\cdot Span^4}{384\cdot E\cdot I}=0.073\ in$ $\delta_{st}\le\Delta_{st}=1$

Long Term: $\delta_{lt}:=\dfrac{5\cdot\left(w_d+0.5\cdot w_l\right)\cdot Span^4}{384\cdot E\cdot I}=0.091\ in$ $\delta_{lt}\le\Delta_{lt}=1$

(BALC 4) See sheet S-2.1 for indication:

Try 1.75"x14" 2.0E Grade LVL By Weyerhaeuser:

$t:=1.75\ in$ $d:=14\ in$ $A:=t \cdot d$

$I:=t \cdot d^3 \cdot 12^{-1}=400.167\ in^4$ $S_x:=I \cdot t^{-1}=228.667\ in^3$

Define Variables: Tributary Width: $w_t:=6\ in$

Calculate Dead Load:

1" Finished Hardwood: $Finish:=4\ psf$

Wood Underlayment: $Under:=3\ psf$

3/4"Sheathing: $Sheathing:=2\ psf$

6" Batt Insulation: $Insulation:=1\ psf$

Self Weight: $w_{sw}:=7.1\ plf$

Dead Load: $Dead:=Finish+Under+Sheathing+Insulation$

Distributed Dead Load: $w_d:=Dead \cdot w_t+w_{sw}=12.1\ plf$

Calculate Linear Load: $Span:=22.5\ ft$ $Overhang:=6.75\ ft$ $Span_{int}:=Span-Overhang$

Max Live Load in Span: $Live:=Cafe$

Distributed Live Load: $w_l:=Live \cdot w_t=50\ plf$

Flat Snow Load: $p_f=25.2\ psf$ --> $w_f:=p_f \cdot w_t=12.6\ plf$

Windward Snow Drift Load: $l_u:=Overhang \cdot ft^{-1}=6.75$ $p_g=30$

$h_d:=\left(0.43 \cdot \sqrt[3]{l_u} \cdot \sqrt[4]{p_g+10}-1.5\right)=0.544$ $h_d:=h_d \cdot ft$

$w_{d.max}:=0.75 \cdot h_d \cdot \gamma_{snow} \cdot w_t=4.078\ plf$

Interior Distributed Load: $w_{int}:=-w_d-w_l=-62.1\ plf$

Exterior Distributed Load: $w_{ext}:=-w_d-0.75 \cdot w_l-0.75 \cdot w_f=-59.05\ plf$

Point Loads From 'Balc 2' Framing Members:

$P_2=382.42\ lbf$ (@ 20" Spacing)

$w_{P2}:=P_2 \cdot \left(Span_{int} \cdot (16\ in)^{-1}\right) \cdot Span_{int}^{-1}=286.815\ plf$

Point Loads From 'Balc 3' Framing Members:

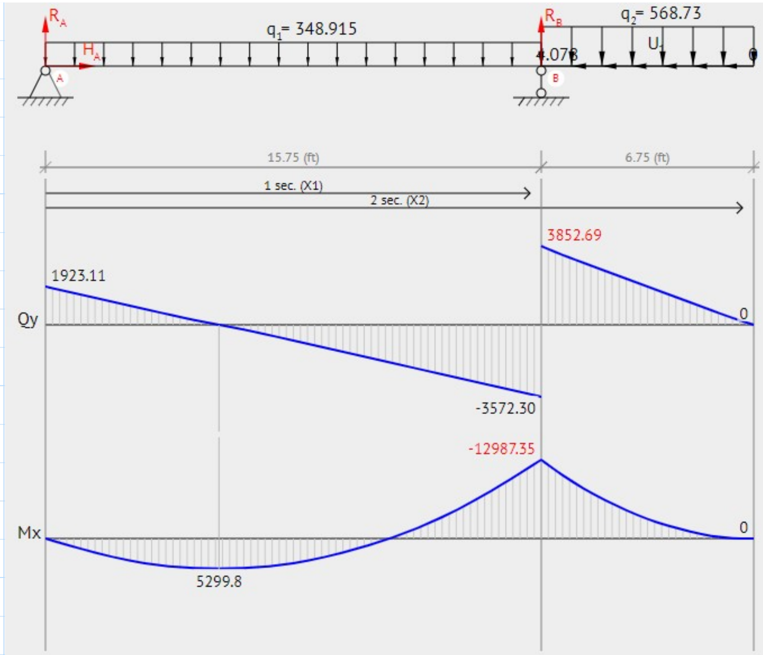
$P_3=679.573\ lbf$ (@ 18" Spacing)

$w_{P3}:=P_3 \cdot \left(Overhang \cdot (16\ in)^{-1}\right) \cdot Overhang^{-1}=509.68\ plf$

Total Interior Dist Load: $w_{int}:=w_{int}-w_{P2}=-348.915\ plf$

Total Exterior Dist Load: $w_{ext}:=w_{ext}-w_{P3}=-568.73\ plf$

Free Body Diagram:



$V_{max} := 1923.11\ lbf$

$P_4 := V_{max}$

$M_{max} := 12987.35\ lbf \cdot ft$

Design For Shear: (Design properties can be found in Table 2 of Appendix A)

Max Shear: $V_{max} = \left(1.923 \cdot 10^3\right)\ lbf$

Allowable Shear: $V_{allow} := 4655\ lbf$

Adjustment Factors for Shear: $C_D := 1.15$

Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = \left(5.353 \cdot 10^3\right)\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.359$

if $V_{max} \le V_{allow}$
 "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
 "DESIGN IS OKAY FOR SHEAR"
else
 "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending: (Design properties can be found in Table 2 of Appendix A)

Max Moment: $M_{max}=12987.35\ lbf\cdot ft$

Allowable Bending: $M_{allow}:=12130\ lbf\cdot ft$

Adjustment Factors for Bending: $C_D:=1.15$

Adjusted Design Value: $M_{allow}:=M_{allow}\cdot C_D=13949.5\ ft\cdot lbf$

Check: $DCR:=M_{max}\cdot M_{allow}^{-1}=0.931$

if $M_{max}\le M_{allow}$
  "DESIGN IS OKAY FOR BENDING"
else if $0.95\le DCR\le 1.05$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I=400.167\ in^4$ $E:=1016535\ psi$ $l:=Span_{int}$ $x:=0.5\cdot Span_{int}$ $a:=Overhang$

Limits: $\Delta_{st}:=Span_{int}\cdot 480^{-1}=0.394\ in$ $\Delta_{lt}:=Span_{int}\cdot 360^{-1}=0.525\ in$

Short Term: $$\delta_{st}:=\frac{w_l\cdot x}{24\cdot E\cdot I\cdot l}\cdot\left(l^4-2\cdot l^2\cdot x^2+l\cdot x^3-2\cdot a^2\cdot l^2+2\cdot a^2\cdot x^2\right)=0.095\ in$$

$\delta_{st}\le\Delta_{st}=1$

Long Term: $$\delta_{lt}:=\frac{\left(w_d+0.5\cdot w_l\right)\cdot x}{24\cdot E\cdot I\cdot l}\cdot\left(l^4-2\cdot l^2\cdot x^2+l\cdot x^3-2\cdot a^2\cdot l^2+2\cdot a^2\cdot x^2\right)=0.071\ in$$

$\delta_{lt}\le\Delta_{lt}=1$

(BALC 5) See sheet S-2.1 for indication:

Try 5.25"x18" 2.0E Grade PSL By Weyerhaeuser:

$t := 5.25\ in$ $\quad d := 18\ in$ $\quad A := t \cdot d$

$I := t \cdot d^3 \cdot 12^{-1} = \left(2.552 \cdot 10^3\right)\ in^4$ $\quad S_x := I \cdot t^{-1} = 486\ in^3$

Define Variables: Tributary Width: $w_t := 6\ in$

Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$
Wood Underlayment: $Under := 3\ psf$
3/4" Sheathing: $Sheathing := 2\ psf$
6" Batt Insulation: $Insulation := 1\ psf$
Self Weight: $w_{sw} := 29.5\ plf$
Dead Load: $Dead := Finish + Under + Sheathing + Insulation$
Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 34.5\ plf$

Calculate Linear Load: $Span := 25\ ft + 5.75\ in$ $\quad Span_{balc1} := 16\ ft$ $\quad Span_{end} := 5.15\ ft$

Point Loads From 'Balc 1' Framing Members: $P_1 = 979.6\ lbf$ $\quad s := 16\ in$ (@ 16" Spacing)

$$w_{P1} := P_1 \cdot \left(Span_{balc1} \cdot s^{-1}\right) \cdot Span_{balc1}^{\ -1} = 734.7\ plf$$

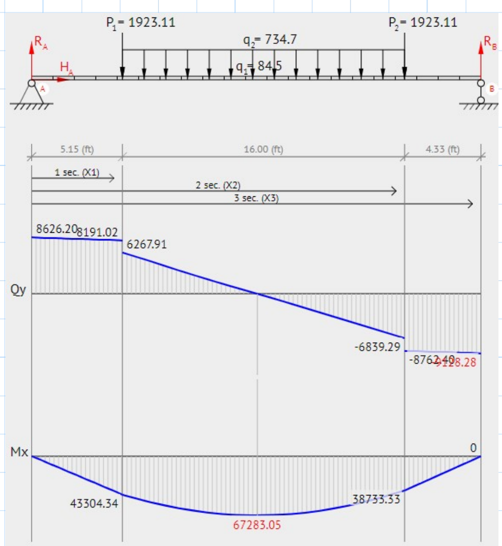
Point Loads From 'Balc 4' Framing Members: $P_4 = 1923.11\ lbf$

Max Live Load in Span: $Live := Cafe$
Distributed Live Load: $w_l := Live \cdot w_t = 50\ plf$

Total Middle Span Distributed Load: $w_{mid} := -w_d - w_l - w_{P1} = -819.2\ plf$

Total Regular Distributed Load: $w_{reg} := -w_d - w_l = -84.5\ plf$

Free Body Diagram:



$V_{max} := 9128.28\ lbf$
$P_5 := V_{max}$

$M_{max} := 67283.05\ lbf \cdot ft$

Design For Shear: (Design properties can be found in Table 2 of Appendix A)

Max Shear: $V_{max} = \left(9.128 \cdot 10^3\right)\ lbf$

Allowable Shear: $V_{allow} := 18270\ lbf$

Adjustment Factors for Shear: $C_D := 1.15$

Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 21010.5\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.434$

if $V_{max} \le V_{allow}$
  "DESIGN IS OKAY FOR SHEAR"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR SHEAR"

Design For Bending: (Design properties can be found in Table 2 of Appendix A)

Max Moment: $M_{max} = 67283.05\ lbf \cdot ft$

Allowable Bending: $M_{allow} := 65495\ lbf \cdot ft$

Adjustment Factors for Bending: $C_D := 1.15$

Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 75319.25\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 0.893$

if $M_{max} \le M_{allow}$
  "DESIGN IS OKAY FOR BENDING"
else if $0.95 \le DCR \le 1.05$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Check Deflection: $I=\left(2.552\cdot10^{3}\right)\ in^{4}$ $E:=2\cdot10^{6}\ psi$ $w_d:=-w_{mid}+w_l$

Loading Distribution: $Live:=70\%$ $Dead:=30\%$

Limits: $\Delta_{st}:=Span\cdot360^{-1}=0.849\ in$ $\Delta_{lt}:=Span\cdot240^{-1}=1.274\ in$

Short Term: $\delta_{st}:=\dfrac{5\cdot5\cdot w_l\cdot Span^{4}}{384\cdot E\cdot I}=0.465\ in$ $\delta_{st}\le\Delta_{st}=1$

Long Term: $\delta_{lt.1}:=\dfrac{P_4\cdot Span_{end}}{24\cdot E\cdot I}\cdot\left(3\cdot Span^{2}-4\cdot {Span_{end}}^{2}\right)=0.257\ in$

$$\delta_{lt.2}:=\frac{5\cdot\left(0.5\cdot w_d+0.5\cdot w_l\right)\cdot Span^{4}}{384\cdot E\cdot I}=0.854\ in$$

$\delta_{lt}:=\delta_{lt.1}+\delta_{lt.2}=1.111\ in$ $\delta_{lt}\le\Delta_{lt}=1$

(B1) See sheet S-2.1 for indication:

Try Doubled up 5.25"x18" 2.0E Grade PSL's By Weyerhaeuser:

$M_{allow} := 2 \cdot 65495\ lbf \cdot ft = 130990\ lbf \cdot ft$

$V_{allow} := 2 \cdot 18270\ lbf = 36540\ lbf$

Define Variables: Tributary Width: $w_t := 6\ in$

Calculate Dead Load:

1" Finished Hardwood: $Finish := 4\ psf$

Wood Underlayment: $Under := 3\ psf$

3/4" Sheathing: $Sheathing := 2\ psf$

6" Batt Insulation: $Insulation := 1\ psf$

Self Weight: $w_{sw} := 39.4\ plf$

Dead Load: $Dead := Finish + Under + Sheathing + Insulation$

Distributed Dead Load: $w_d := Dead \cdot w_t + w_{sw} = 44.4\ plf$

Calculate Linear Load: $Span := 20.5\ ft$ $Span_{balc2} := 8\ ft + 4.25\ in$ $Span_{J2} := 12\ ft + 1.5\ in$

Point Loads From 'Balc 2' Framing Members: $P_2 = 382.42\ lbf$ $s := 20\ in$ (@ 20" Spacing)

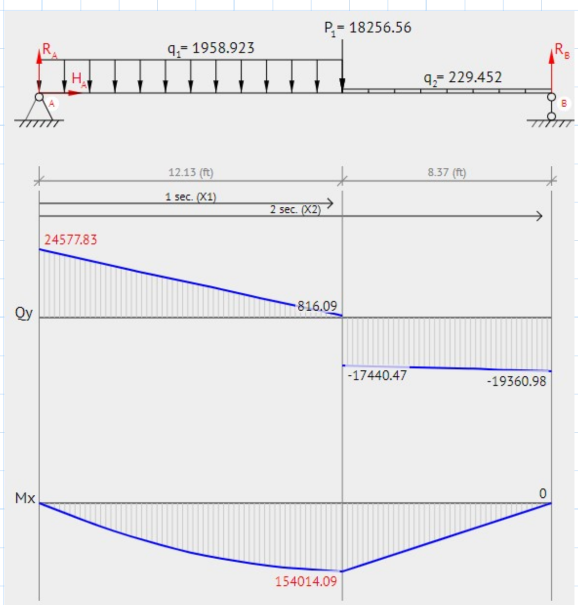
$w_{P2} := P_2 \cdot \left(Span_{balc2} \cdot s^{-1}\right) \cdot Span_{balc2}^{-1} = 229.452\ plf$

Point Loads From 'Balc 2' Framing Members: $P_{J2} = \left(1.959 \cdot 10^3\right)\ lbf$ $s := 12\ in$ (@ 12" Spacing)

$w_{PJ2} := P_{J2} \cdot \left(Span_{J2} \cdot s^{-1}\right) \cdot Span_{J2}^{-1} = 1958.923\ plf$

Point Loads From 'Balc 5' Framing Members: $P_5 := 2 \cdot P_5 = 18256.56\ lbf$

Free Body Diagram:



$V_{max} := 24577.83\ lbf$

$M_{max} := 154014.09\ lbf \cdot ft$

Design For Shear: (Design properties can be found in Table 2 of Appendix A)

Max Shear: $V_{max} = 24577.83\ lbf$

Allowable Shear: $V_{allow} = \left(3.654 \cdot 10^{4}\right)\ lbf$

Adjustment Factors for Shear: $C_D := 1.0$

Adjusted Design Value: $V_{allow} := V_{allow} \cdot C_D = 36540\ lbf$

Check: $DCR := V_{max} \cdot V_{allow}^{-1} = 0.673$

```
if V_max ≤ V_allow                      = "DESIGN IS OKAY FOR SHEAR"
  ‖ "DESIGN IS OKAY FOR SHEAR"
else if 0.95 ≤ DCR ≤ 1.05
  ‖ "DESIGN IS OKAY FOR SHEAR"
else
  ‖ "DESIGN IS UNACCEPTABLE"
```

Design For Bending: (Design properties can be found in Table 2 of Appendix A)

Max Moment: $M_{max} = 154014.09\ lbf \cdot ft$

Allowable Bending: $M_{allow} = \left(1.31 \cdot 10^{5}\right)\ lbf \cdot ft$

Adjustment Factors for Bending: $C_D := 1.15$

Adjusted Design Value: $M_{allow} := M_{allow} \cdot C_D = 150638.5\ ft \cdot lbf$

Check: $DCR := M_{max} \cdot M_{allow}^{-1} = 1.022$

```
if M_max ≤ M_allow                      = "DESIGN IS OKAY FOR BENDING"
  ‖ "DESIGN IS OKAY FOR BENDING"
else if 0.95 ≤ DCR ≤ 1.05
  ‖ "DESIGN IS OKAY FOR BENDING"
else
  ‖ "DESIGN IS UNACCEPTABLE"
```

APPENDIX A

Table 1: TJI Joist Design Properties

Depth	TJI®	Basic Properties: Joist Weight (lbs/ft)	Maximum Resistive Moment(1) (ft-lbs)	Joist Only EI x 10⁶ (in.²-lbs)	Maximum Vertical Shear (lbs)	Reaction Properties: 1¾" End Reaction (lbs)	3½" End Reaction (lbs)	3½" Intermediate Reaction (lbs): No Web Stiffeners	3½" Intermediate Reaction (lbs): With Web Stiffeners(2)	5¼" Intermediate Reaction (lbs): No Web Stiffeners	5¼" Intermediate Reaction (lbs): With Web Stiffeners(2)
9½"	110	2.3	2,500	157	1,220	910	1,220	1,935	N.A.	2,350	N.A.
	210	2.6	3,000	186	1,330	1,005	1,330	2,145	N.A.	2,565	N.A.
	230	2.7	3,330	206	1,330	1,060	1,330	2,410	N.A.	2,790	N.A.
11⅞"	110	2.5	3,160	267	1,560	910	1,375	1,935	2,295	2,350	2,705
	210	2.8	3,795	315	1,655	1,005	1,460	2,145	2,505	2,565	2,925
	230	3.0	4,215	347	1,655	1,060	1,485	2,410	2,765	2,790	3,150
	360	3.0	6,180	419	1,705	1,080	1,505	2,460	2,815	3,000	3,360
	560	4.0	9,500	636	2,050	1,265	1,725	3,000	3,475	3,455	3,930
14"	110	2.8	3,740	392	1,860	910	1,375	1,935	2,295	2,350	2,705
	210	3.1	4,490	462	1,945	1,005	1,460	2,145	2,505	2,565	2,925
	230	3.3	4,990	509	1,945	1,060	1,485	2,410	2,765	2,790	3,150
	360	3.3	7,335	612	1,955	1,080	1,505	2,460	2,815	3,000	3,360
	560	4.2	11,275	926	2,390	1,265	1,725	3,000	3,475	3,455	3,930
16"	110	3.0	4,280	535	2,145	910	1,375	1,935	2,295	2,350	2,705
	210	3.3	5,140	629	2,190	1,005	1,460	2,145	2,505	2,565	2,925
	230	3.5	5,710	691	2,190	1,060	1,485	2,410	2,765	2,790	3,150
	360	3.5	8,405	830	2,190	1,080	1,505	2,460	2,815	3,000	3,360
	560	4.5	12,925	1,252	2,710	1,265	1,725	3,000	3,475	3,455	3,930

Depth	TJI	Basic Properties: Joist Weight (lbs/ft)	Maximum Resistive Moment(1) (ft-lbs)	Joist Only EI x 10⁶ (lbs-in.²)	Maximum Vertical Shear (lbs)	Reaction Properties: 1¾" End Reaction (lbs): No Web Stiffeners	1¾" End Reaction (lbs): With Web Stiffeners(2)	3½" Intermediate Reaction (lbs): No Web Stiffeners	3½" Intermediate Reaction (lbs): With Web Stiffeners(2)	5¼" Intermediate Reaction (lbs): No Web Stiffeners	5¼" Intermediate Reaction (lbs): With Web Stiffeners(2)
18"	360	3.7	9,465	1,085	2,425	1,080	1,440	2,460	2,815	3,000	3,360
	560	4.8	14,550	1,631	3,030	1,265	1,740	3,000	3,475	3,455	3,930
	560D	5.0	14,785	1,661	3,080	1,400	2,030	3,350	3,980	3,965	4,600
20"	360	4.0	10,515	1,376	2,660	1,080	1,440	2,460	2,815	3,000	3,360
	560	5.1	16,165	2,064	3,345	1,265	1,740	3,000	3,475	3,455	3,930
	560D	5.3	16,435	2,105	3,345	1,400	2,190	3,350	4,140	3,965	4,755
22"	560D	5.6	18,075	2,606	3,615	NA(3)	2,345	NA(3)	5,090	NA(3)	5,705
24"	560D	5.8	19,700	3,165	3,400	NA(3)	2,345	NA(3)	5,405	NA(3)	6,020

Table 2: Microllam LVL Allowable Design Properties

Grade	Width	Design Property	Depth: 4⅜"	5½"	5½" Plank Orientation	7¼"	9¼"	9½"	11¼"	11⅞"	14"	16"	18"	20"
TimberStrand® LSL														
1.3E	3½"	Moment (ft-lbs)	1,735	2,685	1,780	4,550								
		Shear (lbs)	4,340	5,455	1,925	7,190								
		Moment of Inertia (in.⁴)	24	49	20	111								
		Weight (plf)	4.5	5.6	5.6	7.4								
1.55E	1¾"	Moment (ft-lbs)						5,210		7,975	10,920	14,090		
		Shear (lbs)						3,435		4,295	5,065	5,785		
		Moment of Inertia (in.⁴)						125		244	400	597		
		Weight (plf)						5.2		6.5	7.7	8.8		
	3½"	Moment (ft-lbs)						10,420		15,955	21,840	28,180		
		Shear (lbs)						6,870		8,590	10,125	11,575		
		Moment of Inertia (in.⁴)						250		488	800	1,195		
		Weight (plf)						10.4		13	15.3	17.5		
Microllam® LVL														
2.0E	1¾"	Moment (ft-lbs)		2,125		3,555	5,600	5,885	8,070	8,925	12,130	15,555	19,375	23,580
		Shear (lbs)		1,830		2,410	3,075	3,160	3,740	3,950	4,655	5,320	5,985	6,650
		Moment of Inertia (in.⁴)		24		56	115	125	208	244	400	597	851	1,167
		Weight (plf)		2.8		3.7	4.7	4.8	5.7	6.1	7.1	8.2	9.2	10.2
Parallam® PSL														
2.0E	3½"	Moment (ft-lbs)					12,415	13,055	17,970	19,900	27,160	34,955	43,665	
		Shear (lbs)					6,260	6,430	7,615	8,035	9,475	10,825	12,180	
		Moment of Inertia (in.⁴)					231	250	415	488	800	1,195	1,701	
		Weight (plf)					10.1	10.4	12.3	13.0	15.3	17.5	19.7	
	5¼"	Moment (ft-lbs)					18,625	19,585	26,955	29,855	40,740	52,430	65,495	
		Shear (lbs)					9,390	9,645	11,420	12,055	14,210	16,240	18,270	
		Moment of Inertia (in.⁴)					346	375	623	733	1,201	1,792	2,552	
		Weight (plf)					15.2	15.6	18.5	19.5	23.0	26.3	29.5	
	7"	Moment (ft-lbs)					24,830	26,115	35,940	39,805	54,325	69,905	87,325	
		Shear (lbs)					12,520	12,855	15,225	16,070	18,945	21,655	24,360	
		Moment of Inertia (in.⁴)					462	500	831	977	1,601	2,389	3,402	
		Weight (plf)					20.2	20.8	24.6	26.0	30.6	35.0	39.4	

Table 3: Microllam LVL Allowable Design Stresses

Grade	Orientation	G Shear Modulus of Elasticity (psi)	E Modulus of Elasticity[2] (psi)	E_{min} Adjusted Modulus of Elasticity[3] (psi)	F_b Flexural Stress[4] (psi)	F_t Tension Stress[5] (psi)	$F_{c\perp}$ Compression Perpendicular to Grain[6] (psi)	$F_{c\parallel}$ Compression Parallel to Grain (psi)	F_v Horizontal Shear Parallel to Grain (psi)	SG Equivalent Specific Gravity[7]
TimberStrand® LSL										
1.3E	Beam/Column	81,250	1.3×10^6	660,750	1,700	1,300	710	1,835	425	0.50[8]
	Plank	81,250	1.3×10^6	660,750	1,900[9]	1,300	670	1,835	150	0.50[8]
1.55E	Beam	96,875	1.55×10^6	787,815	2,325	1,290[10]	900	2,170	310[10]	0.50[8]
Microllam® LVL										
2.0E	Beam	125,000	2.0×10^6	1,016,535	2,600	1,895	750	2,510	285	0.50
Parallam® PSL										
1.8E	Column	112,500	1.8×10^6	914,880	2,400[11]	1,995	545[11]	2,500	190[11]	0.50
2.0E	Beam	125,000	2.0×10^6	1,016,535	2,900	2,300	625[12]	2,900[13]	290	0.50

Table 4: 2x6 Hanger Options (From Simpson Strong-Tie)

Joist Size	Model No.	Ga.	Dimensions (in.)			Min./Max.	Fasteners (in.)		DF/SP Allowable Loads				Installed Cost Index (ICI)
			W	H	B		Header	Joist	Uplift (160)	Floor (100)	Snow (115)	Roof (125)	
Sawn Lumber Sizes													
2X4	LU24	20	1 9/16	3 1/8	1 1/2	—	(4) 0.162 x 3 1/2	(2) 0.148 x 1 1/2	240	555	630	655	Lowest
	LUS24	18	1 9/16	3 1/8	1 3/4	—	(4) 0.148 x 3	(2) 0.148 x 3	435	670	765	820	3%
	U24	16	1 9/16	3 1/8	1 1/2	—	(4) 0.162 x 3 1/2	(2) 0.148 x 1 1/2	240	575	650	705	67%
	HU26	14	1 9/16	3 1/16	2 1/4	—	(4) 0.162 x 3 1/2	(2) 0.148 x 1 1/2	305	595	670	720	295%
DBL 2X4	LUS24-2	18	3 1/8	3 1/8	2	—	(4) 0.162 x 3 1/2	(2) 0.162 x 3 1/2	410	800	905	980	Lowest
	U24-2	16	3 1/8	3	2	—	(4) 0.162 x 3 1/2	(2) 0.148 x 3	240	575	650	705	33%
	HU24-2 / HUC24-2	14	3 1/8	3 1/16	2 1/2	—	(4) 0.162 x 3 1/2	(2) 0.148 x 3	380	595	670	720	240%
2x6	LUS26	18	1 9/16	4 3/4	1 3/4	—	(4) 0.148 x 3	(4) 0.148 x 3	1,165	865	990	1,060	Lowest
	LU26	20	1 9/16	4 3/4	1 1/2	—	(6) 0.162 x 3 1/2	(4) 0.148 x 1 1/2	540	835	950	1,030	6%
	U26	16	1 9/16	4 3/4	2	—	(6) 0.162 x 3 1/2	(4) 0.148 x 1 1/2	535	865	980	1,055	43%
	LUC26Z	18	1 9/16	4 3/4	1 3/4	—	(6) 0.162 x 3 1/2	(4) 0.148 x 1 1/2	730	845	965	1,040	160%
	HU26	14	1 9/16	3 1/16	2 1/4	—	(4) 0.162 x 3 1/2	(2) 0.148 x 1 1/2	305	595	670	720	179%
	HUS26	16	1 5/8	5 3/8	3	—	(14) 0.162 x 3 1/2	(6) 0.162 x 3 1/2	1,320	2,735	3,095	3,235	276%

Table 5: 2x10 AND 2X12 Hanger Options (From Simpson Strong-Tie)

Joist Size	Model No.	Ga.	Dimensions (in.)			Min./Max.	Fasteners (in.)		DF/SP Allowable Loads				Installed Cost Index (ICI)
			W	H	B		Header	Joist	Uplift (160)	Floor (100)	Snow (115)	Roof (125)	
Sawn Lumber Sizes													
2x10	LUS28	18	1 9/16	6 5/8	1 3/4	—	(6) 0.148 x 3	(4) 0.148 x 3	1,165	1,100	1,260	1,350	Lowest
2x10	LU28	20	1 9/16	6 3/16	1 1/2	—	(8) 0.162 x 3½	(6) 0.148 x 1½	850	1,110	1,180	1,180	13%
2x10	LUS210	18	1 9/16	7 13/16	1 3/4	—	(8) 0.148 x 3	(4) 0.148 x 3	1,165	1,335	1,530	1,640	15%
2x10	LU210	20	1 9/16	7 13/16	1 1/2	—	(10) 0.162 x 3½	(6) 0.148 x 1½	850	1,390	1,580	1,615	28%
2x10	U210	16	1 9/16	7 13/16	2	—	(10) 0.162 x 3½	(6) 0.148 x 1½	990	1,440	1,565	1,565	76%
2x10	LUC210Z	18	1 9/16	7 3/4	1 3/4	—	(10) 0.162 x 3½	(6) 0.148 x 1½	985	1,410	1,605	1,735	180%
2x10	HU210	14	1 9/16	7 1/8	2 1/4	—	(8) 0.162 x 3½	(4) 0.148 x 1½	605	1,190	1,345	1,440	225%
2x10	HUS210	16	1 5/8	9	3	—	(30) 0.162 x 3½	(10) 0.162 x 3½	2,635	5,450	5,795	5,830	450%
2x10	HGUS210	12	1 5/8	9 1/8	5	—	(46) 0.162 x 3½	(16) 0.162 x 3½	2,090	9,100	9,100	9,100	•
DBL 2X10	LUS28-2	18	3 1/8	7	2	—	(6) 0.162 x 3½	(4) 0.162 x 3½	1,060	1,315	1,490	1,610	Lowest
DBL 2X10	LUS210-2	18	3 1/8	9	2	—	(8) 0.162 x 3½	(6) 0.162 x 3½	1,445	1,830	2,075	2,245	34%
DBL 2X10	U210-2	16	3 1/8	8 1/2	2	—	(14) 0.162 x 3½	(6) 0.148 x 3	990	2,015	2,280	2,465	88%
DBL 2X10	HUS210-2	14	3 1/8	9 3/16	2	—	(8) 0.162 x 3½	(8) 0.162 x 3½	3,270	2,110	2,385	2,575	217%
DBL 2X10	HU210-2 / HUC210-2	14	3 1/8	8 19/32	2 1/2	Min.	(14) 0.162 x 3½	(6) 0.148 x 3	1,135	2,085	2,350	2,520	441%
DBL 2X10	HU210-2 / HUC210-2	14	3 1/8	8 19/32	2 1/2	Max.	(18) 0.162 x 3½	(10) 0.148 x 3	1,895	2,680	3,020	3,250	467%
DBL 2X10	HUCQ210-2-SDS	14	3 1/4	9	3	—	(12) ¼ x 2½ SDS	(6) ¼ x 2½ SDS	2,345	4,315	4,315	4,315	•
DBL 2X10	HHUS210-2	14	3 5/16	9 3/32	3	—	(30) 0.162 x 3½	(10) 0.162 x 3½	3,550	5,705	6,435	6,485	•
TPL 2X10	LUS28-3	18	4 5/8	6 1/4	2	—	(6) 0.162 x 3½	(4) 0.162 x 3½	1,060	1,315	1,490	1,610	•
TPL 2X10	LUS210-3	18	4 5/8	8 3/16	2	—	(8) 0.162 x 3½	(6) 0.162 x 3½	1,445	1,830	2,075	2,245	•
TPL 2X10	U210-3	16	4 5/8	7 3/4	2	—	(14) 0.162 x 3½	(6) 0.148 x 3	990	2,015	2,280	2,465	•
TPL 2X10	HU210-3 / HUC210-3	14	4 11/16	8 1/32	2 1/2	Min.	(14) 0.162 x 3½	(6) 0.148 x 3	1,135	2,085	2,350	2,520	•
TPL 2X10	HU210-3 / HUC210-3	14	4 11/16	8 1/32	2 1/2	Max.	(18) 0.162 x 3½	(10) 0.148 x 3	1,895	2,680	3,020	3,250	•
TPL 2X10	HHUS210-3	14	4 11/16	8 7/8	3	—	(30) 0.162 x 3½	(10) 0.162 x 3½	3,405	5,630	6,375	6,485	•
TPL 2X10	HGUS210-3	12	4 15/16	9 1/8	4	—	(46) 0.162 x 3½	(16) 0.162 x 3½	4,095	9,100	9,100	9,100	•
TPL 2X10	HUCQ210-3-SDS	14	4 5/8	9	3	—	(12) ¼ x 2½ SDS	(6) ¼ x 2½ SDS	2,345	4,315	4,315	4,315	•
QUAD 2x10	HU210-4 / HUC210-4	14	6 1/8	8 3/8	2 1/2	Min.	(14) 0.162 x 3½	(6) 0.162 x 3½	1,345	2,085	2,350	2,520	•
QUAD 2x10	HU210-4 / HUC210-4	14	6 1/8	8 3/8	2 1/2	Max.	(18) 0.162 x 3½	(8) 0.162 x 3½	1,795	2,680	3,020	3,250	•
QUAD 2x10	HHUS210-4	14	6 1/8	8 7/8	3	—	(30) 0.162 x 3½	(10) 0.162 x 3½	3,405	5,630	6,375	6,485	•
QUAD 2x10	HGUS210-4	12	6 9/16	9 1/8	4	—	(46) 0.162 x 3½	(16) 0.162 x 3½	4,095	9,100	9,100	9,100	•
2x12	LUS210	18	1 9/16	7 13/16	1 3/4	—	(8) 0.148 x 3	(4) 0.148 x 3	1,165	1,335	1,530	1,640	Lowest
2x12	LU210	20	1 9/16	7 13/16	1 1/2	—	(10) 0.162 x 3½	(6) 0.148 x 1½	850	1,390	1,580	1,615	11%
2x12	U210	16	1 9/16	7 13/16	2	—	(10) 0.162 x 3½	(6) 0.148 x 1½	990	1,440	1,565	1,565	53%
2x12	LUC210Z	18	1 9/16	7 3/4	1 3/4	—	(10) 0.162 x 3½	(6) 0.148 x 1½	985	1,410	1,605	1,735	180%
2x12	HU212	14	1 9/16	9	2 1/4	—	(10) 0.162 x 3½	(6) 0.148 x 1½	1,135	1,490	1,680	1,800	347%
2x12	HUS210	16	1 5/8	9	3	—	(30) 0.162 x 3½	(10) 0.162 x 3½	2,635	5,450	5,795	5,830	378%

General Notes and Assumptions:

- ASCE 7-16 and NDS 2018 govern the structural design.
- Assume Risk Category II (ASCE 7-16, Table 1.5-2)
- Factor of Safety of 2.0 --> $FS_T := 2.0$

Snow Load Calculations:

Location: **Clinton, IA**

Ground Snow Load: $p_g := 30\ psf$

Exposure Factor: $C_e := 1.0$

Thermal Factor: $C_t := 1.2$

Importance Factor: $I_s := 1.0$

Flat Snow Load: $p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\ psf$

Length of Cross Section: $L := 60\ in$

Unit Weight of Snow: $\gamma_{snow} := 20\ pcf$

Tributary Width of Supports: $w_t := 8\ ft$

Windward Snow Drift Load: $l_u := L \cdot ft^{-1} = 5$ $\quad p_g := p_g \cdot psf^{-1}$

$h_d := \left(0.43 \cdot \sqrt[3]{l_u} \cdot \sqrt[4]{p_g + 10} - 1.5\right) = 0.349 \quad h_d := h_d \cdot ft$

$w_{d.max} := 0.75 \cdot h_d \cdot \gamma_{snow} \cdot w_t = 41.899\ plf$

$w_s := p_f \cdot w_t = 201.6\ plf$

Maximum Snow Load: $w_s := \left(p_f \cdot w_t\right) + w_{d.max} = 243.499\ plf$

Total Load Per Support: $T_{support} := L \cdot w_s = \left(1.217 \cdot 10^3\right)\ lbf$

$T_{allow} := T_{support} \cdot FS_T = \left(2.435 \cdot 10^3\right)\ lbf$

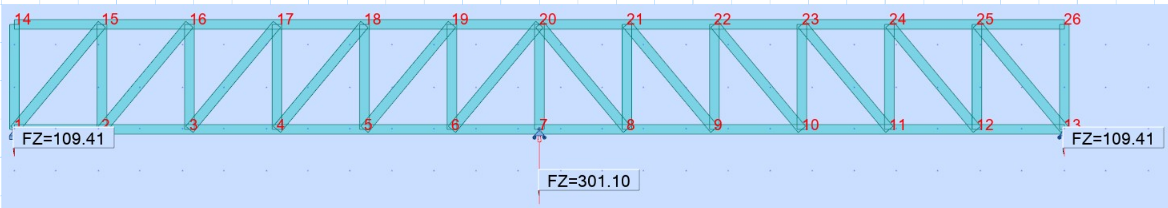
Contractor's submitted product must have tension supports with an allowable tension strength of 2,435 LBS.

General Notes and Assumptions:

- ASCE 7-16 and NDS 2018 govern the structural design.
- Roof system components (Top to bottom)
- Wall studs are 2x6 members spaced at 16" O.C.
- Vertical distributed load is based on the truss with the largest loading.
- Assume Risk Category II (ASCE 7-16, Table 1.5-2)

Load Calculations:

Diagram: $R := 301.1\ lbf$



Distributed Load:

Wall Length: $L := 75\ ft$

Truss Spacing: $s := 4\ ft$

Linear Load: $w := R \cdot \left(L \cdot s^{-1}\right) \cdot L^{-1} = 75.275\ plf$

Wall Stud Properties: $S := 7.56\ in^3$ $\quad I := 20.80\ in^4$ $\quad A := 8.25\ in^2$

Reference Design Values:

$F_b := 1000\ psi$ $\quad F_t := 675\ psi$ $\quad E_{min} := 620000\ psi$

$F_c := 1500\ psi$ $\quad F_v := 180\ psi$ $\quad E := 1700000\ psi$

$F_{c.parallel} := 625\ psi$

Individual Stud Loading: $spacing := 16\ in$ $\quad P := w \cdot spacing = 100.367\ lbf$

Designing Headers at Openings:

$L_{opening} := 9\ ft$

Try Standard DF-L 2x8: $S_x := 13.14\ in^3 \quad I := 47.63\ in^4 \quad A := 10.88\ in^2$

Design For Bending: $M_{max} := w \cdot L_{opening}^{\ 2} \cdot 8^{-1} = 762.159\ lbf \cdot ft$

$f_b := M_{max} \cdot S_x^{\ -1} \cdot 2^{-1} = 348.018\ psi$

Reference Design Value: $F_b := 575\ psi$
Adjustment Factors: $C_D := 1.15 \quad C_F := 1.1$
Adjusted Design Value: $F'_b := F_b \cdot C_D \cdot C_F = 727.375\ psi$

Check: $DCR := f_b \cdot F'^{\ -1}_b = 0.478$

if $f_b \le F'_b$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR BENDING"

Design For Shear: $V_{max} := \text{abs}(w \cdot L \cdot 0.5) = 2822.813\ lbf$

$f_v := V_{max} \cdot A^{-1} = 259.45\ psi$

Reference Design Value: $F_v := 375\ psi$
Adjustment Factors: $C_D := 1.15$
Adjusted Design Value: $F'_v := F_v \cdot C_D = 431.25\ psi$

Check: $DCR := f_v \cdot F'^{\ -1}_v = 0.602$

if $f_v \le F'_v$
  "DESIGN IS OKAY FOR SHEAR"
else
  "DESIGN IS UNACCEPTABLE"
= "DESIGN IS OKAY FOR SHEAR"

Design For Deflection: $E := 1400000\ psi$

Maximum Deflection: $\delta_{max} := 5 \cdot w \cdot L_{opening}^{\ 4} \cdot (384 \cdot E \cdot I)^{-1} = 0.167\ in$

Allowable Deflection: $\Delta_{all} := L_{opening} \cdot 360^{-1} = 0.3\ in$

Check: $\delta_{max} \le \Delta_{all} = 1$

Designing Studs at Header Edges:

Try DBL No. 3 Stud Southern Pine 2x6's: $A := 2 \cdot 8.25\ in^2 = 16.5\ in^2$

Design For Compression: $R := V_{max} = \left(2.823 \cdot 10^3\right)\ lbf$

$f_c := R \cdot A^{-1} = 171.08\ psi$

Reference Design Value: $F_c := 565\ psi$

Adjustment Factors: $C_D := 1.15$

Adjusted Design Value: $F'_c := F_c \cdot C_D = 649.75\ psi$

Check: $DCR := f_c \cdot {F'_c}^{-1} = 0.263$

if $f_c \le F'_c$
  "DESIGN IS OKAY FOR BENDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR BENDING"

Y | A | M

General Notes and Assumptions:

- Railings must be able to sustain a 200 lb point load per the International Building Code
- Railings msut be able to sustain a uniform load of 50 pounds per foot per the International Building Code
- Commercial railings are required to be 42" or higher per the International Building Code

SELECT RAILING SYSTEM DESIGN PARAMETERS:

Design Parameters:

$h := 4\ ft$ (Post Height)
$E_{alum} := 9990\ ksi$ (Young's Modulus of Elasticity)
$F_{u.alum} := 42\ ksi$ (Ultimate Strength of Aluminum)
$F_{y.alum} := 35\ ksi$ (Yield Strength of Aluminum)

$b := 3\ in$ (Post Width)
$l := 3\ in$ (Post Length)
$S := b \cdot l^2 \cdot 6^{-1} = 4.5\ in^3$ (Section Modulus of Post)
$M_{all.post} := S \cdot F_{y.alum}$ (Allowable Moment of Post)

$b := 3\ in$ (Horizontal Rail Width)
$d := 1\ in$ (Horizontal Rail Length)
$S := b \cdot d^2 \cdot 6^{-1} = 0.5\ in^3$ (Section Modulus of Horizontal Rail)
$M_{all.rail} := S \cdot F_{y.alum}$ (Allowable Moment of Horizontal Rail)

Maximum Parameters Based on All Loadings Conditions:

Concentrated Load on Horizontal Rail:

$P := 200\ lbf$ (Design Concentrated Load)

$L_{max.rail.p} := M_{all.rail} \cdot P^{-1} = 7.292\ ft$

Uniform Load on Horizontal Rail:

$w := 50\ plf$ (Design Uniform Load)
$K := 9.5$ (Live Load Coefficient)

$L_{max.rail.w} := \sqrt{M_{all.rail} \cdot w^{-1}} = 5.401\ ft$

Uniform Load on Interior Post:

$w := 50\ plf$ (Design Uniform Load)
$h = 4\ ft$ (Height of Railing Posts)

$L_{max.post.w} := M_{all.post} \cdot (w \cdot h)^{-1} = 65.625\ ft$

MAXIMUM LENGTH BETWEEN POSTS:

$L_{max} := min\left(L_{max.rail.p}, L_{max.rail.w}, L_{max.post.w}\right)$

$L_{max} = 5.401\ ft$ --> **USE 4' SPACING**

General Notes and Assumptions:

ASCE 7-16, NDS 2018, and NCMA Lintel Design Manual (2004), and AISC 15 govern the structural design.

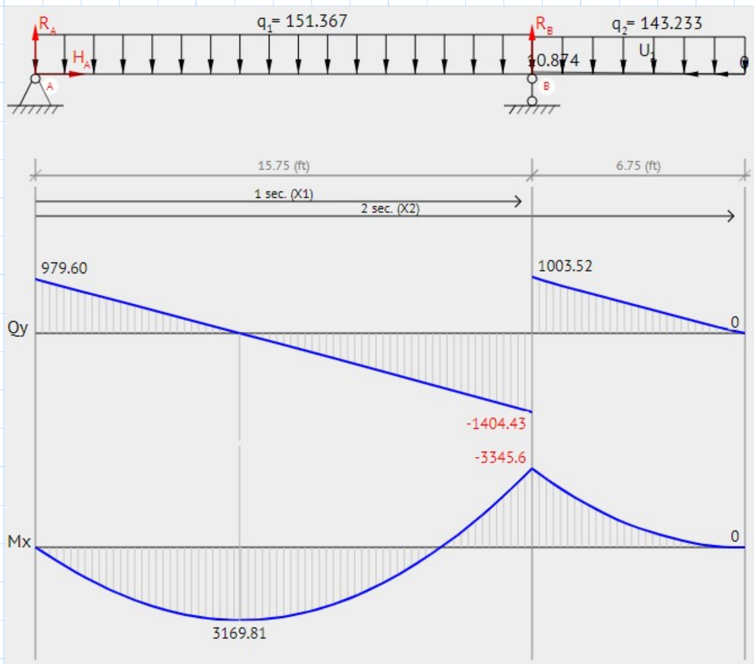
- Assume existing lintel is made of steel lumber
- Dead, live, and snow loads for the balcony already used the proper combinations
- Design lintel span will be over the windows on the East edge of North face of the building

---> $L := 26.25\ ft - 20\ in = 24.583\ ft$

Design Loads:

Balcony Framing:

FBD:



$V_{max} := 1404.43\ lbf$

$P := V_{max}$

Uniform Load From Balcony:

Height of Level to Lintel: $h_m := 6.5\ ft$

Balcony Framing Spacing: $S_L := 16\ in$

Check Dist Load is Acceptable: $h_m > 0.33 \cdot S_L = 1$

Uniformly Distributed Load: $span := 16\ ft$

$w_{balc} := P \cdot S_L^{-1} = \left(1.053 \cdot 10^{3}\right)\ plf$

Wall Loads:

Wall Weights: (From Boise Cascade and NCMA TEK)

8" CMU, Medium Weight, Grout @ 8", Full Mortar Bedding: $q_{CMU} := 81\ psf$ (NCMA TEK)

4" Clay Brick: $q_{brick} := 39\ psf$

MEP: $q_{MEP} := 1.5\ psf$

Spray Insulation: $q_{insulation} := 4 \cdot 0.15\ psf = 0.6\ psf$

1/2" Gypsum Board: $q_{gyp} := 2.2\ psf$

Total: $q_{tot} := q_{CMU} + q_{brick} + q_{MEP} + q_{insulation} + q_{gyp}$

$q_{tot} = 124.3\ psf$

Design Loads:

Total Uniform Load: $w_{tot} := w_{balc} + q_{tot} \cdot h_m = 1861.273\ plf$

Maximum Shear: $V_{max} := 0.5 \cdot w_{tot} \cdot L = 22.878\ kip$

Structural Design:

Check Flexure:

Choose Member Size: Try HSS9x9x5/8 --> $M_{all} := 149\ kip \cdot ft$ (From table 3-13 in AISC 15)

$w_{sw} := 67.82\ plf$

Maximum Moment: $M_{max} := \left(w_{tot} + w_{sw}\right) \cdot L^2 \cdot 8^{-1} = 145.729\ kip \cdot ft$

Check:

if $M_{max} \le M_{all}$
 "DESIGN IS OKAY FOR FLEXURE"
else
 "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR FLEXURE"

Check Lateral Torsional Buckling:

Define Variables:

Unbraced Length:	$L_b := L = 24.583\ ft$	
Moment Gradient Parameter:	$C_b := 1.14$	(From table 3-1 in AISC 15)
Yield Strength:	$F_y := 50\ ksi$	(ASTM A500 Grade C)
Modulus of Elasticity:	$E := 29000\ ksi$	
Thickness:	$t := 0.625\ in$	
Width:	$B := 9\ in$	$b := B - 3 \cdot t = 7.125\ in$
Depth:	$H := 9\ in$	$h := H - 3 \cdot t = 7.125\ in$
Area:	$A := 18.7\ in^2$	
Plastic Section Modulus:	$Z_x := 58.1\ in^3$	
Section Modulus:	$S_x := 47.9\ in^3$	
Moment of Inertia:	$I := 216\ in^4$	

Plastic Moment: $M_p := Z_x \cdot F_y = 242.083\ kip \cdot ft$

Web Local Buckling: $\lambda_{pw} := 2.42 \cdot \left(E \cdot F_y^{-1}\right)^{0.5} = 58.281$ $\quad \lambda_{rw} := 5.70 \cdot \left(E \cdot F_y^{-1}\right)^{0.5} = 137.274$

$\lambda_w := h \cdot t^{-1} = 11.4$

$\lambda_w \le \lambda_{pw} = 1$ -->Web is compact. No WLB.

Flange Local Buckling: $\lambda_{pf} := 1.12 \cdot \left(E \cdot F_y^{-1}\right)^{0.5} = 26.973$ $\quad \lambda_{rf} := 1.4 \cdot \left(E \cdot F_y^{-1}\right)^{0.5} = 33.716$

$\lambda_f := b \cdot t^{-1} = 11.4$

$\lambda_w \le \lambda_{pf} = 1$ -->Flange is compact. No FLB.

Allowable Moment: No WLB --> No FLB --> $M_{all} := M_{all} = 149\ kip \cdot ft$

Check:

if $M_{max} \le M_{all}$
  "DESIGN IS OKAY FOR FLEXURE"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR FLEXURE"

Check Yielding: $f_v := V_{max} \cdot A^{-1} = 1.223\ ksi$ $\quad V_{all} := 0.6 \cdot F_y = 30\ ksi$

Check:

if $f_v \le V_{all}$
  "DESIGN IS OKAY FOR YIELDING"
else
  "DESIGN IS UNACCEPTABLE"

= "DESIGN IS OKAY FOR YIELDING"

Bearing Plate Design:

Define Variables:

Beam End Reaction: $R_u := V_{max} = 22.878\ kip$

Bearing Compression Strength: $f'_c := 1000\ psi$ (Assume weak compressive strength to be conservative)

Bearing Plate Width: $N := 6\ in$

Bearing Plate Length: $B := 12\ in$

Bearing Plate Area: $A_1 := N \cdot B = 72\ in^2$

Distance to Support Edge: $e := 2\ in$

Bearing Plate Support Area: $A_2 := (N + 2 \cdot e) \cdot (B + 2 \cdot e) = 160\ in^2$

Thickness of Bearing Plate: $k_1 := 0.5 \cdot 9\ in - 0.625\ in = 3.875\ in$ $l := 0.5 \cdot B - k_1 = 2.125\ in$

$$t_p := \sqrt{\frac{2 \cdot R_u \cdot l^2}{0.9 \cdot B \cdot N \cdot F_y}} = 0.253\ in$$

--> Use 1/2" Thickness --> $t_p := 0.5\ in$

Check Reaction Pressure:

Reaction Pressure: $f_p := R_u \cdot (N \cdot B)^{-1} = 317.752\ psi$

Check: $f_p \le f'_c = 1$