THE UNIVERSITY OF IOWA
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

Condominium Design & Engineering in Mason City

Completed by: Duncan Winoski, Noah Kalter, Jake Knudtson, Hanjie Liang
May 2018

Class led by: Paul Hanley
Course Name: Project Design & Management
Department of Civil & Environmental Engineering

In partnership with
The City of Mason City

City of MASON CITY IOWA

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Mason City Condominium Development

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DHNJ Engineers

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Jake Knudtson	Technical Support
Hanjie Liang	Graphic Production

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I. Executive Summary

The main tasks to be fulfilled by DHNJ Engineers includes site design, access road design, parking lot design, and structural design. For each task in this design, 3D renderings will be produced, as well as elevation and plan views all assembled into a final plan set. The design of the site and condominium structure was undertaken per the request of Mason City for a local landowner trying to attract investment to a condominium project on her property. This condominium project has been in the works for almost 10 years, with now being an ideal time to generate additional ideas to make use of the land and to provide alternate ideas to generate interest from possible investors. The site has previously had a geotechnical investigation performed by Terracon, which was provided to use to aid in our design. We were also provided with previous early-stage condominium designs for the same site. The client requested at least 40 units for the site, which resulted in a large design relative to the single-family homes that make up the neighborhood. All tasks fulfilled by DHNJ Engineers for the site followed the appropriate codes specified by the city of Mason City.

Since there are multiple materials available for the design of the condominium, DHNJ determined the most economically efficient materials based on what we expect the size of the building to be. We selected the wood framing would be the cheapest option since the condominium will likely be no more than four stories. Using wood and steel over concrete members also allows for a quicker construction timetable. Both wood and steel have optimum strength upon installation, whereas the concrete takes time to reach its 28-day strength. Steel is used for the first-floor podium to provide maximum window space and keep an open floor plan. The only part of the structure that will be concrete is the foundation. Asphalt pavement is used for the access road and parking lot. The parking lot has been laid out to run in one-direction, having a specific entrance and exit. Following the proper Mason City codes, the parking lot provides a sufficient number of parking stalls for a condominium of this size. The pavement is sloped to drain into a retention pond at the front of the site, which ties into an existing storm water utility line under the street. The retention pond has been designed to keep the post-development storm runoff less than the storm development before our development has taken place.

A major constraint in the design of the site and structure was the limestone directly under 2 to 4 feet of soil over the whole site. The boring logs taken by Terracon showed the depth of this limestone. Structurally, it was decided to use the limestone to our advantage due to its very large bearing pressure. This allowed the foundations to be smaller than for a comparable structure on natural soil. If desired for underground parking, the limestone could be blasted and removed in a very expensive and obtrusive process that would very likely be fought against by others living in the vicinity of the project, which is why we opted to not remove any limestone, except for attaching utility lines. Permeable pavement was not an option for the parking lot due the limestone stopping the water from infiltrating any further. The depth of the limestone also controlled the design of the retention pond, causing the design to take up more land square footage instead of expanding deeper. The changes in grade at the back of the site also caused an issue. We needed to grade the site so that all rainfall was directed towards the retention pond at the front of the site. This resulted in a large elevation change from the back of our site to the back of the neighboring property. The most cost-effective option we decided on is to acquire this plot of land or obtain an easement that will allow us to gradually lower the grade on the neighboring property so this drop off doesn't occur. If this grading is not a feasible option, a retaining wall would need to be placed at this drop-off.

II. Organization Qualifications and Experience

Organizations

The University of Iowa

DHNJ Engineers

Organization Location and Contact Information

Duncan Winoski (Project Manager)

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Location: 3100 Seamans Center, Iowa City, IA 52242

Organization and Design Team Description

DHNJ Engineers is a group of engineering students currently enrolled at the University of Iowa where we are participating in the school's capstone design class. The members of our team are specialized in structural and architectural design. Duncan Winoski is the acting project manager and contributed to the hydraulics and structural/architectural design of the condominium. Jake Knudtson provided technical support for the group and contributed to the structural modeling and design. Noah Kalter was the editor for any written reports. He provided insight on the design of the transportation and structure aspects of the project. Our final member, Hanjie Liang, was responsible for the graphics used in all the reports and presentations. Hanjie also contributed to the sidewalk design as well as site grading.

III. Proposed Services

Project Scope

- Site Design
    - Set up the construction boundaries for the site
        - Determined a location for the parking lot, access roads, and structure
        - Ensured the setbacks followed Mason City Ordinances
    - Verified where the current utilities are and relocated them if needed.
        - Ensured the utilities are of adequate size for both sanitary and water supply
    - Determined the grading required for the site and calculated the required cut and fill
    - The use of retaining walls was determined based on the finalized grading of the site. Retaining walls would potentially be implemented where steep slopes are present
    - Post and pre-development storm water runoff was calculated
- Access Road
    - Horizontal and vertical alignment, as well as a proper pavement cross section, was determined using Mason City ordinances and Iowa DOT specifications
    - A swept path analysis was used to show the ability of design vehicles to utilize the access roads
    - Pavement type and thickness was selected based on Mason City ordinances and Iowa DOT specifications
    - Access road grades were established to allow for adequate storm water drainage
- Parking Lot
    - Location and size of the parking lot was determined
    - Required size, location, number of stalls, and curb islands was determined by using Mason City ordinances
    - Swept path analysis was used to show design vehicles could maneuver through the lot
    - Grading was determined to efficiently move storm water runoff off the parking lot
- Sidewalk
    - 5ft. By 5ft. Concrete slab was designed
    - Detectable warning was applied on each crosswalk intersection.
- Residential Building
    - Designed a new foundation, foundation wall, floor slab, floor framing, and roof framing
    - Locations and sizes of any door or window were determined

- ○ Lintels and headers were designed over openings in walls
  - ○ Stairs and an elevator shaft were designed
  - ○ Insulation was included
  - ○ Utility connections for water supply, wastewater, natural gas and electrical supply were included

- Plan Drawings
  - All major tasks outlined above were shown in plan and cross section views as well as being rendered in 3D

Work Plan

The building design began by determining the exterior dimensions of the structure and then laying out the interior walls for the units. Next, Jake laid out the framing plan by determining which walls will be bearing walls and which walls will be shear walls. The truss spacing was then designed accordingly. Due to all floors being identical, this framing layout was used for floors 2 through 5. Jake also sized shear walls, bearing walls, corridor joists, headers, and multi-ply wood beams used in odd situations. The wood sizes were then modeled in Revit and put on plan. A few key details were also created. In total, the wood framing took two weeks to complete.

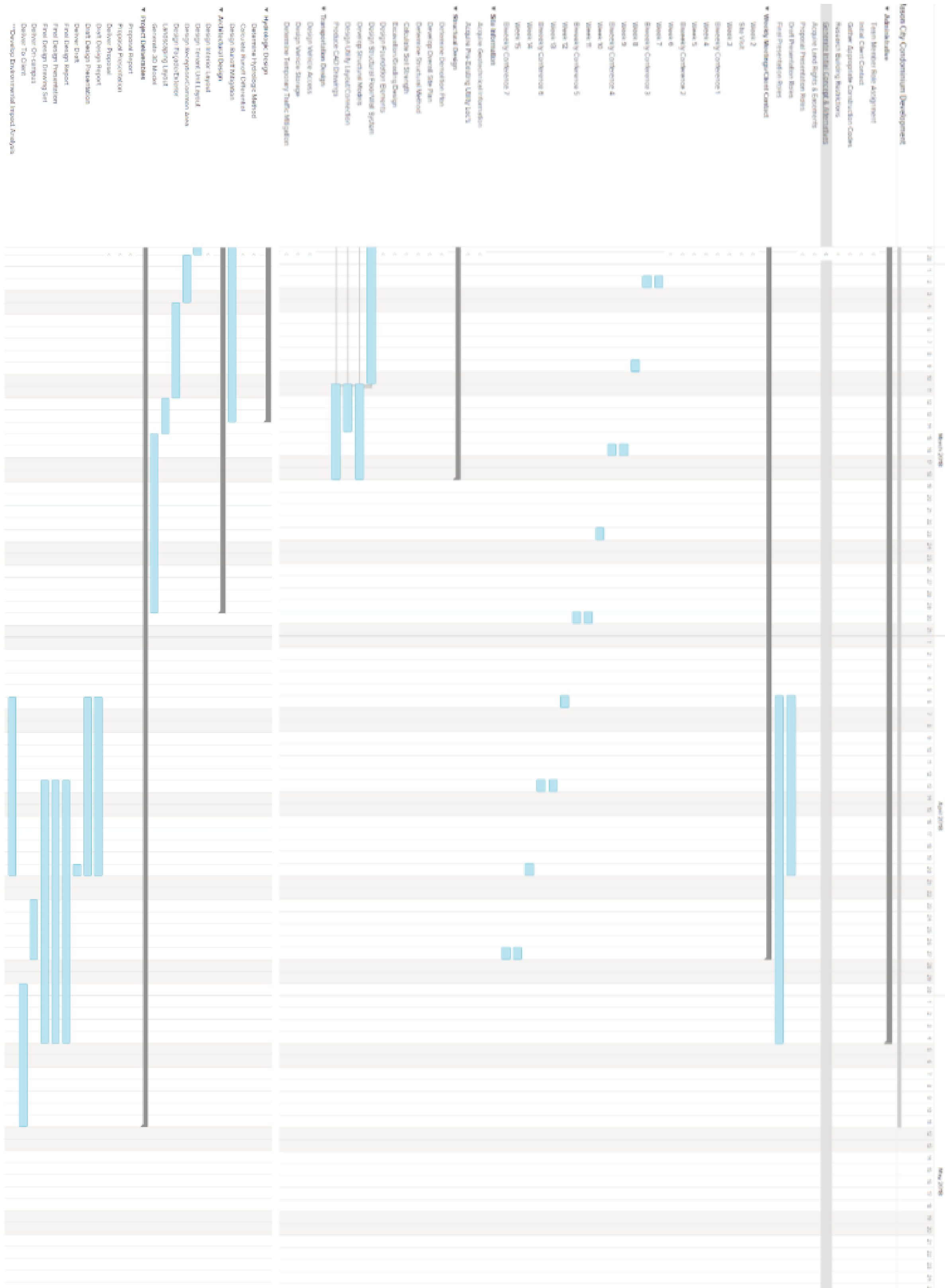
After the wood framing was laid out, the steel framing was laid out to properly support the wood framing. Jake determined the steel framing beam and column placement, as well as designating certain spaces for lateral reinforcement. A finite-element analysis software was used to speed up this process. The steel framing was then modeled in Revit and put in a plan view with all sizes called out. The steel framing took two weeks to complete.

The final step of the building design was for the foundations. Limestone was researched and the foundations were sized accordingly. The foundations designed were then modeled in Revit and put into a plan view, where proper elevations and sizes were called out. The foundation design took one-week total to complete. In total, the building design took 5 weeks.

As the building was being designed, the site layout was also being worked on. Duncan and Noah took on the role of ensuring that all the design aspects would be able to fit on the site while still following various design standards and regulations. The site layout took us roughly a week to complete.

After the site was laid out, the necessary grading was completed. Noah designed the grading of the parking lot first to get the water from the top of the parking lot down to a retention pond. The grading of the parking lot took a week due to various challenges encountered during the design. The access road grading was also designed by Noah. The grading needed to flow with the parking lot and the same challenges were encountered during the design of the parking lot. The design of the access road also included the need to determine a horizontal and vertical alignment, which was used to generate an accurate assembly of the road. The alignments and corridor of the access road took two weeks to complete.

Once every design task was completed, a 3D rendering was completed. Duncan and Noah spent two weeks working on modeling the site in Autodesk Infraworks to produce a realistic representation of the Condominium.



IV. Constraints, Challenges and Impacts

Constraints

There are several constraints in this project to consider. The location and the aesthetic to the natural view around the condominium will play a major role in our design. For example, since the condominium will be located near the Winnebago River, the minimum distance from the condo to the river is limited by the Mason City ordinances. Also, the height of the condo may be limited or impacted by the city recreation propose such as a scenic overlook that would be obstructed if the building were a certain height. There are also various setbacks required for all sides of the buildings that are needed for fire safety reasons. The first-floor elevation of the building was also constrained by the requirement of meeting the existing grade along 4th street.

Challenges

Project challenges include a limestone stratum that is located just under the soil surface where excavation may be needed depending on potential demand for a basement, underground parking, etc. The topography of the site also proved to be a challenge. The change in elevation from the northwest side of the project site to the 4th street is about ten feet. This proved to be a problem when ensuring runoff could drain off the parking surface and allow for the access road to match the existing road elevation. This resulted in a substantial need for fill to bring the building and parking lot to proper elevations. Limited space and poor soil infiltration also proved to be a challenge as roughly 4000 cubic feet of water need to be retained to match pre-development conditions.

Societal Impacts within the Community and/or State of Iowa

With the implementation of a new condominium, there will be the need to address the potential societal impacts both during and after construction. Mason City has the option to hire local construction companies to work on the project. Residents would benefit from local contractors being awarded this project bid. The increase in living space allows for more people to move into Mason City from either a different city in Iowa or a different state. The local government could benefit from an influx in population via increase tax collection. Mason City will also have new residents that can contribute to the community by working in the city, and purchasing goods from local retailers. The main population affected directly by the construction of the new condominium are the residents who live on or next to the site. The people living on the site will need to be relocated to allow for the construction. Property values of the nearby houses can expect an increase due to the addition of a condominium, which as designed will offer amenities for the community such as a gym or coffee shop. This in-turn could result in an increase in property taxes for homes in the neighborhood, which some could say is a reason for the development not to take place.

V. Proffer of Alternative Design Options

One important decision made in the design of the structure is which material to use. No matter which material was used, reinforced concrete was planned to be used for the foundation structures. For structures up to four floors, wood framing is the most economic option most of the time. When using wood framing, if more open space is desired on the first floor then incorporating steel framing in the 1st floor can create larger openings. The other primary materials that could be used are concrete or steel. Looking at the price for material and the scope of the project, wood would be the more economical option for most of the structure compared to concrete and steel. Steel and concrete would both provide more flexibility in the layout of the building, creating more open spaces and less need for bearing walls. When looking at construction time, steel and wood framing have the edge over concrete, as both materials can be easily assembled and put into place without the requirement to wait for the material to reach 28-day strength, which is the case with concrete. Environmentally speaking, steel and concrete result in large amounts of carbon emissions during production, while wood is beginning to be farmed more sustainably, making wood the more sustainable building material. While utilizing one material would be sufficient for the design of this project, incorporating multiple materials would result in a unique structural layout. A steel framed one-story podium was selected over a concrete podium due to construction time and the lack of concrete contractors in the area for that type of construction.

There are multiple alternatives for every portion of the structural layout. One major alternative that would greatly affect the foundation design is to provide underground parking under the site. This requires the blasting and removal of a large volume of rock, which provides complications for both cost reasons and affecting the surrounding structures. This option would also provide a larger area for green space to be used on-site. Another option to provide parking under the site would be to have a taller structure, and have the cars park on ground level. For the structure itself, using all steel framing instead of a combination of steel and wood would allow for more window space, but at a higher cost. It was determined to not provide underground parking due to additional costs. Instead, above ground parking was used which took away green space.

The pavement used on the project will play a role in the hydraulic and transportation design. One option would be to use a typical pavement surface such as concrete or asphalt. This would result in storm water intakes being placed on site for the runoff to flow off site. Another option would be to use a permeable pavement which would directly drain the storm water, resulting in no pipes needing to be placed on site and save money in groundwork costs. However, this permeable pavement would cost more than a typical pavement surface which would offset the savings in using intakes anyways. Permeable pavements also have had issues with salt and with clogging and becoming impermeable, which are issues typical pavements do not have. Since there is a limestone bed relatively close to the surface, permeable pavements wouldn't be as useful. The water would be soaked in, but then they would run down limestone rather than being soaked up by existing soil. The final design selected a traditional asphalt pavement. The asphalt pavement would be cheaper than the permeable counterpart. We also designed a retention pond at the end of the parking lot, which allowed us to grade the parking lot to drain towards the retention pond. This would omit the need for extra piping.

Lastly, there are multiple options on how to keep the post-development storm water runoff matching the pre-development storm water runoff. A detention or retention pond could be used, but with the sites proximity to a river this might not be the best option or use of space. Biofiltration swales or exfiltration trenches could be placed on site to direct the storm water to the nearby river while also infiltrating storm water into the surrounding soil. A combination of swales and a small retention pond could be a good option to reach the quantity and quality goals for the post-development discharge. The retention pond and/or the swales would be strategically placed to fit within our construction boundaries while being as efficient as possible.

VI. Final Design Details

Building Design

Wood framing

The wood framing was designed using NDS, SDPWS, and ASD. The wood trusses are designed to be 22” deep and built up out of 2x4 dimensional lumber. A truss fabricator provided loading span tables to determine the strength of these trusses depending on the span and depth. The corridors are framed with 2x12 dimensional lumber at 16” o.c.. All bearing walls are built from 2x6 studs with a double top plate that acts as a chord and collector. The shear walls are made from 19/32” thick OSB sheathing nailed to stud walls and tied to the floor below using Simpson hold-downs. The diaphragm is blocked and is made from ¾” thick OSB sheathing nailed to the joists below. A further in-depth overview of the wood framing is described in Appendix 2. See the structural framing plans for the third floor through the roof for wood framing layout and truss spacing.

Steel Framing

The largest steel girder used is a W30x116 which is directly under the bearing wall with the largest amount of tributary width. The smallest steel girder used is a W24x55, which occurs at non-load bearing perimeter walls. All joists spanning from girder to girder are W16x26. The interior columns are HSS10x10x1/2, while the exterior columns are HSS10x10x5/16 due to the smaller loading. A composite steel deck works compositely with the structural steel. The deck is a 2” deep metal deck with 3.5” of concrete topping. The moment connections are made by shop welding a plate to the bottom flange of the wide flange girders and then field welding that plate to the column, and then field welding a plate to the top flange of the wide flange and then to the column. The braced frames are HSS3x3x1/4 members in an x-bracing layout. In total, 167.85 kips of steel will be used for the structural steel podium. The steel was designed using ASD and following the AISC Construction Manual and specifications. A further in-depth overview can be found in Appendix 2. See the structural second-floor framing plan for all steel sizes and configuration.

Concrete Foundations and CMU Shafts

The foundations will be poured from a concrete mix with a compressive strength of 3000 psi and will be reinforced with grade 60 rebar. The spread footings will be 5’x5’x1’ with a top and bottom mat of reinforcement consisting of #5 rebar @ 9” o.c. in both directions. The continuous footings will be 3’ wide and 1’ thick with (3) #5 rebar continuous. The CMU walls will be 12” (11-⅝” thick), use ladder horizontal reinforcement @ 16” o.c., and will have a #5 and grouted cells @ 32” o.c.. The reinforcement in the CMU walls will then tie into the footings below to develop the necessary lap length. The concrete was designed for strength using LRFD and ACI 318-14. The CMU was designed using TMS 402. See Appendix 2 for a further in-depth overview, as well as the structural foundation plan for the footing schedule and layout.

Site Layout

Dimensions for design

The parking lot was designed by utilizing Title 12, Zoning Regulations, in Mason City's ordinances. The zoning regulations laid out how to set up the required number of stalls, dimensions of bays, and landscaping requirements for curb islands based on our site being a Z3 zone. For a Z3 zone, the minimum allowable stalls had to be equal to one space per dwelling. The condominium had 48 units total, so 48 stalls were added to the parking lot. Each parking stall was designed to be 9 feet wide and 18 ft. long. Parking stalls were also angled at 60° to meet a drive aisle width of 15.5 feet. The Americans with Disabilities Act also provided the required number of handicap spaces and the dimensions needed for the access aisle. Having a total of 48 normal parking stalls, the ADA required an additional 3 spaces for handicap parking. Two of the stalls would follow the same dimensions as a normal stall, but the third space would have a width increased to 11 feet and have a 5-foot hatched access aisle adjacent to the stall. Following APAI Chapter 3B, the soil classification was determined to be a moderate soil type with a CBR rating of 6. Using the soil classification, Chapter 5B provided the needed thickness of our base and subbase for an asphalt parking lot. The base of the parking lot was determined to be 4 in. with a 2-in. surface. The access road was designed following the same standards as the parking lot described above. The access road was given a base of 6 in. and a surface of 2 in. The access road was given a thicker base to increase the design life of the road. See Appendix 3 to check verifying dimensions and requirements. The parking lot layout and cross section are shown in plan view on Design Sheets 16 and 20. Access road requirements and values are described in detail in Appendix 4. The access road layout and cross section are shown in plan view on Design Sheets 18 and 19.

Grading for each design

Grading the parking lot followed Section 8B-1 of Iowa SUDAS design manual. A grade of 1% was selected to reduce the amount of fill needed while still matching existing elevation of the street. The parking lot is graded to allow water to flow from the top left and right corners to the center of the parking lot and down to an opening that will drain into the retention pond near 4th Street. Grading of the access road followed the same SUDAS section for the parking lot. A slope of 1% was selected to allow the water to runoff towards the street and flow down the street naturally towards the inlets provided at the end of 4th Street and North Carolina Ave. The required text used to design the grading of both the parking lot and access road are shown in Appendix 3 and 4. The final grading layout is shown on Design Sheet 13.

Drainage computations

Pre- and Post-development runoff volumes were both calculated using a modified rational method per Mason City Code Division 30 Appendix B - Criteria for Urban Storm Water Management. Per Mason City standards, runoff from both 5 years and 100-year storm events were estimated to yield peak flows of 4.06 and 7.26 cfs, respectively, in post-development from the near 2-acre lot. The change in peak flow resulted in roughly 4000 cubic feet of runoff that would need to be retained in order to match pre-development drainage conditions. A 3445 square foot wet retention basin would be placed on the south side of the lot, between the parking lot and sidewalk and would drain into a headwall until reaching a junction structure that will extend into the ground until it intersects with the existing main. Using the Hydraflow Express Extension in Autodesk to simulate these conditions, a 15” diameter circular concrete pipe will be required to convey the water from the retention basin to the storm water main - See Appendix 6 for supporting calculations.

VII. Engineer's Cost Estimate

Item	Quantity	Unit	Unit Price	Total
Demolition	3565	ft^2	$ 3.00	$ 10,695.00
Suburban Podium Construction	87725	ft^2	$ 160.00	$ 14,036,000
Site Grading	18582	yd^3	$ 3.00	$ 55,745
Combination Curb & Gutter	812	ft	$ 8.89	$ 7,219
Asphalt Surfaces	11212.5	ft^3	$ 11.00	$ 123,338
Concrete Sidewalks	1040	ft^2	$ 10.00	$ 10,400
Paint Pavement Markings 4"	1300	ft	$ 0.20	$ 260
Sewer Piping - 15" Dia	250	ft	$ 45.00	$ 11,250
Water Line Piping - 12" Dia	250	ft	$ 85.00	$ 21,250
Water Line Piping - 4" Dia	200	ft	$ 25.00	$ 5,000
New Manholes	1	ea	$ 3,500.00	$ 3,500
New Fire Hydrant Assembly	1	ea	$ 3,500.00	$ 3,500
Easements & Property Acquisition	---	---	---	$ 50,000
Construction Subtotal				**$ 14,338,157**
10% Contingencies	---	---	---	$ 1,433,816
20% Engineering and Administration	---	---	---	$ 2,867,631
Total Project Cost				**$ 18,639,604**

VIII. Appendices
Appendix 1: Site Layout Design

The site layout included a variety of tables and checks to make sure we were following both SUDAS and Mason City's Ordinances. Table 1, shown below, was used to verify that our coverage area did not exceed the limit of 60% of the total lot. Table 2 shows the computations that fall below a maximum of 60% coverage.

Table 1: Lot Occupation

c. LOT OCCUPATION	
Lot Width	25 ft. min., all other dispositions
	300 ft. max. to 40 ft. min. for edgeyard
Lot Coverage	60% max.
Lot Depth	400 ft. 100 ft. min.

Table 2: Lot Occupation Computation

Lot Coverage	
Parking Lot	21525
Access Roads	992
Building	17429
Sidewalk	3000
New Coverage	42946
Total Area Available	78749.4
Lot Occupation	55%

The building needed to be laid strategically on the site in order to follow the setbacks required by Mason City. These setbacks are shown in Table 3, and are shown on the completed site plan below.

Table 3: Building setbacks required through Mason City Zoning Ordinance

d. SETBACKS - PRINCIPAL BLDG.*	
d.1 Principal Front Setback	10 ft. min.
d.2 Secondary Front Setback	15 ft. min.
d.3 Side Setback	10 ft. total, 3 ft. min. one side for edgeyard disposition
	0 ft. min. on one side, 6 ft. min. on opposite side, sideyard disposition
	0 ft. min., splityard and rearyard dispositions
d.4 Rear Setback	25 ft. min.

For a new condominium development, certain landscaping was required to help with screening for the parking lot and building. The requirements were given in in Title 12, Chapter 16 of Mason City Ordinances.

A. LANDSCAPING REQUIRED:

1. The front, side and rear yards of each site not utilized for parking (where permitted) shall be landscaped utilizing an effective combination of trees, grass, ground cover and shrubbery. Undeveloped areas in the interior of the site shall be seeded with appropriate grasses or other suitable ground cover and maintained neat and orderly. All tree trimmings, stumps, and construction debris shall be promptly removed and not be accumulated or stored on-site.

2. Landscaping near street, alley and driveway intersections shall conform to the traffic visibility requirements of Section 12-16-6.

1. Prohibited in all parts of the City:

    a. Ornamental (Callery) Pear (Pyrus species and cultivars: Bradford, Cleveland Select, Redspire, Capital, etc.), except those varieties proven to be fire blight resistant.

    b. Ash (All species and cultivars)

    c. Poplar (Populus species)

    d. Ginkgo (Female only)

    e. Chinese Elm and Siberian Elm (Ulmus pumila). Elm species that are certified to be disease resistant may be planted.

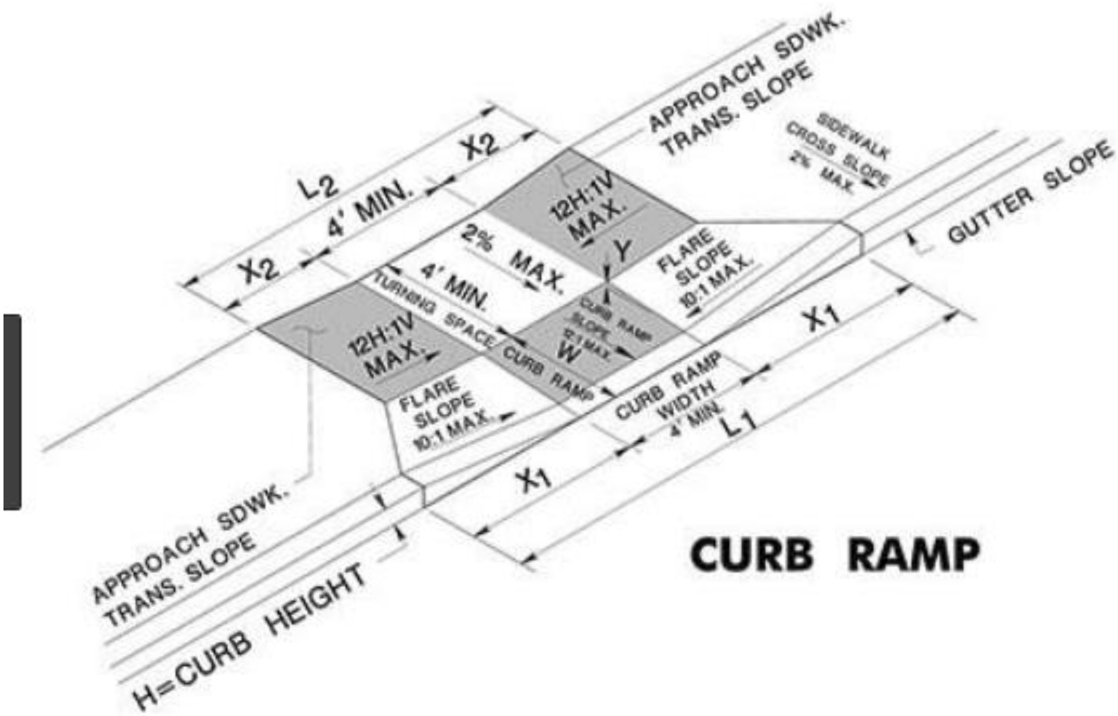
    f. Tree of Heaven (Ailanthus altissima)

    g. Austree (Salix alba x matsudana)

    h. Boxelder (Acer negundo)

    i. Mulberry (Morus species)

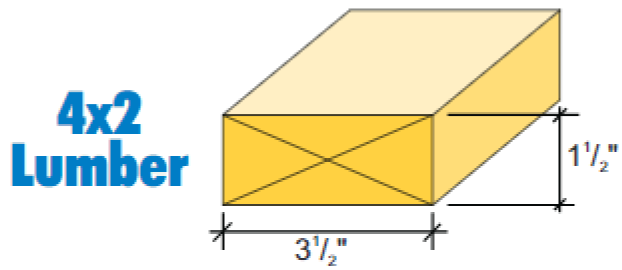
The site would also need to be ADA compliant. Sidewalk entrances would need a curb ramp that is modeled below.



Appendix 2: Building Design

The building structure consists of 4 floors of wood framing sat on a 1-story composite steel podium on top of a reinforced concrete foundation. The International Building Code (IBC) classifies this type of construction as Type V-A. This type of construction requires 1-hour fire rating for the exterior walls, structural frame, and floors. To achieve this, we called out a ⅝" gypsum board to be placed on the interior face of all exterior walls, on all bearing walls, and on the bottom side of all floor trusses. The IBC also states which codes need to be followed for each structural material. For wood framing, the National Design Specification (NDS) produced by the American Wood Council (AWC) is required. AWC also produces the Special Design Provisions for Wind and Seismic (SDPWS) for the design of wood structures for lateral loads. Structural steel design is required to be designed per the AISC Construction Manual. Structural concrete design is to be designed per ACI 318-14 and structural masonry is to be designed per TMS402/602. All design loads were found using ASCE 7-10, including live loads, dead loads, snow loads, wind loads, and seismic loads.

The top four floors of wood framing consist of wood trusses, dimension lumber joists, and bearing walls. All dimensional lumber used will be Douglas Fir Larch No. 2. The wood floor and roof trusses will be fabricated by an outside contractor, Alpine Engineered Products, which provided our design team with span tables, which are attached below. It was determined that all trusses will be 22" deep to accommodate the large spans between bearing walls in units. The span tables provided by the truss fabricator were used to layout the joist spacing. Although the trusses are almost 2 feet deep, the openings in the truss can be used to route mechanical ducts so no additional ceiling depth will be added.



Center Spacing	Deflection Limit	40 PSF Live Load 55 PSF Total Load — Truss Depth 12"	14"	16"	18"	20"	22"
16" o.c.	L/360	22'2"	24'11"	26'10"	28'8"	30'4"	31'11"
	L/480	20'2"	22'7"	24'11"	27'2"	29'4"	31'5"
19.2" o.c.	L/360	20'9"	22'8"	24'4"	26'0"	27'6"	29'0"
	L/480	18'11"	21'3"	23'6"	25'7"	27'6"	29'0"
24" o.c.	L/360	18'5"	20'1"	21'7"	23'1"	24'5"	25'9"
	L/480	17'7"	19'9"	21'7"	23'1"	24'5"	25'9"

All corridors will be framed with 2x12 joists spaced at 16" o.c., allowing a higher ceiling in the hallways. The trusses and joists all frame into bearing walls, which consist of 2x6 studs spaced at 16" o.c. for the majority of the bearing walls. A few bearing walls on the bottom floor of wood framing require the studs being spaced at 8" to accommodate for the additional loading from above.

SDPWS was used to design the diaphragm and shear walls of the condominium structure. Shear walls run both North to South and East to West, resisting wind in all directions. All shear walls use 19/32" OSB sheathing and Simpson tie-downs to transfer the loading to the floors below. The diaphragm for the structure is blocked and uses ¾" OSB sheathing with a ¾" gypcrete topping for soundproofing and fireproofing reasons. The lateral system also ties into the CMU elevator and stair shafts, which extend from the foundations to the top floor. The CMU supplies additional rigidity to the structure.

The images below show the calculations performed for the wood framing using MathCAD.

Condominium Development
Senior Design Project
Gravity Load Calcs

Loading Input *marked in this shade means self-input

Roof Live Load: $LL_{roof} := 20\ psf$ *ordinary flat roof*
Roof Dead Load: $DL_{roof} := 20\ psf$

Floor Live Load (apt): $LL_{floor} := 40\ psf$ *private rooms & corridors serving them*
Floor Dead Load (apt): $DL_{floor} := 15\ psf$

Ground snow load: $p_g := 40\ psf$ *snow map, looks right on line*
Snow Importance Factor: $I_s := 1$ *Risk Category II (less than 300 people)*
Exposure Factor: $C_e := 0.9$ *Fully exposed, category B*
Thermal Factor: $C_t := 1$
Flat Roof Snow Load: $p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\ psf$
$SL_{roof} := p_f = 25.2\ psf$
*snow load controls over roof live load

*note. Building is layed out symmetrically so only half the building is analyzed. There will be an identical load case on the opposite side of the building

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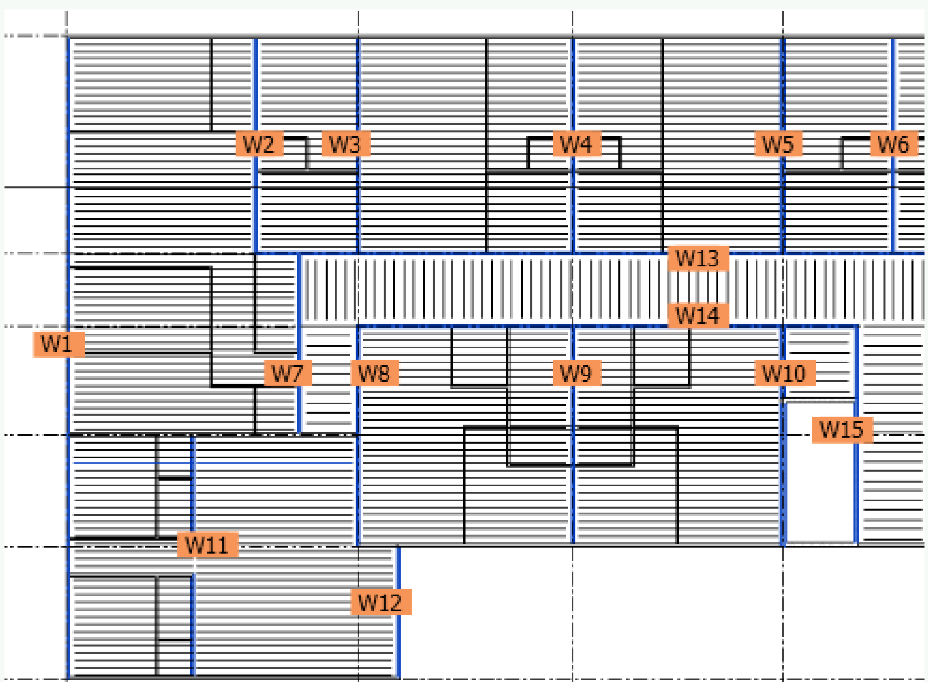
Wall Labeling

*for each continuous wall, only find the largest dist. load. for example, on W1 the joist span changes when the W2 jumps to W7. Only put down the largest trib width, which would be from w1 to w7



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Trib Width Inputs

*measuring wall to wall for w values, then trib is calculated
(w1=left or up, w2=right or down)

W1:	$w_1 := 0\ ft$	$w_2 := 31.5\ ft$	$t_{w1} := 0.5 \cdot (w_1 + w_2) = 15.75\ ft$
W2:	$w_1 := 25.5\ ft$	$w_2 := 14\ ft$	$t_{w2} := 0.5 \cdot (w_1 + w_2) = 19.75\ ft$
W3:	$w_1 := 14\ ft$	$w_2 := 29.25\ ft$	$t_{w3} := 0.5 \cdot (w_1 + w_2) = 21.625\ ft$
W4:	$w_1 := 29.25\ ft$	$w_2 := 28.67\ ft$	$t_{w4} := 0.5 \cdot (w_1 + w_2) = 28.96\ ft$
W5:	$w_1 := 28.67\ ft$	$w_2 := 15.2\ ft$	$t_{w5} := 0.5 \cdot (w_1 + w_2) = 21.935\ ft$
W6:	$w_1 := 15.2\ ft$	$w_2 := 15.2\ ft$	$t_{w6} := 0.5 \cdot (w_1 + w_2) = 15.2\ ft$
W7:	$w_1 := 31.5\ ft$	$w_2 := 8\ ft$	$t_{w7} := 0.5 \cdot (w_1 + w_2) = 19.75\ ft$
W8:	$w_1 := 8\ ft$	$w_2 := 29.25\ ft$	$t_{w8} := 0.5 \cdot (w_1 + w_2) = 18.625\ ft$
W9:	$w_1 := 29.25\ ft$	$w_2 := 28.67\ ft$	$t_{w9} := 0.5 \cdot (w_1 + w_2) = 28.96\ ft$
W10:	$w_1 := 28.67\ ft$	$w_2 := 10.2\ ft$	$t_{w10} := 0.5 \cdot (w_1 + w_2) = 19.435\ ft$
W11:	$w_1 := 17.25\ ft$	$w_2 := 28\ ft$	$t_{w11} := 0.5 \cdot (w_1 + w_2) = 22.625\ ft$
W12:	$w_1 := 28\ ft$	$w_2 := 0\ ft$	$t_{w12} := 0.5 \cdot (w_1 + w_2) = 14\ ft$
W13:	$w_1 := 0\ ft$	$w_2 := 10\ ft$	$t_{w13} := 0.5 \cdot (w_1 + w_2) = 5\ ft$
W14:	$w_1 := 10\ ft$	$w_2 := 0\ ft$	$t_{w14} := 0.5 \cdot (w_1 + w_2) = 5\ ft$
W15:	$w_1 := 10.2\ ft$	$w_2 := 10\ ft$	$t_{w15} := 0.5 \cdot (w_1 + w_2) = 10.1\ ft$

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Bearing Wall Calculations - ASD

W1:	Trib width:	$t_w := t_{w1}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.397\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.63\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.63\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.63\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.63\ \mathbf{klf}$
	LL On Steel	$w_{1LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 2.917\ \mathbf{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.315\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.236\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.236\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.236\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.236\ \mathbf{klf}$
	DL On Steel	$w_{1DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.26\ \mathbf{klf}$
W2:	Trib width:	$t_w := t_{w2}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.498\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.79\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.79\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.79\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.79\ \mathbf{klf}$
	LL On Steel	$w_{2LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 3.658\ \mathbf{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.395\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.296\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.296\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.296\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.296\ \mathbf{klf}$
	DL On Steel	$w_{2DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.58\ \mathbf{klf}$
W3:	Trib width:	$t_w := t_{w3}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.545\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.865\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.865\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.865\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.865\ \mathbf{klf}$
	LL On Steel	$w_{3LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 4.005\ \mathbf{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.433\ \mathbf{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.324\ \mathbf{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.324\ \mathbf{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.324\ \mathbf{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.324\ \mathbf{klf}$

	DL On Steel	$w_{3DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.73\ \boldsymbol{klf}$
W4:	Trib width:	$t_w := t_{w4}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.73\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 1.158\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 1.158\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 1.158\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 1.158\ \boldsymbol{klf}$
	LL On Steel	$w_{4LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 5.363\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.579\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.434\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.434\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.434\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.434\ \boldsymbol{klf}$
	DL On Steel	$w_{4DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 2.317\ \boldsymbol{klf}$
W5:	Trib width:	$t_w := t_{w5}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.553\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.877\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.877\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.877\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.877\ \boldsymbol{klf}$
	LL On Steel	$w_{5LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 4.062\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.439\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.329\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.329\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.329\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.329\ \boldsymbol{klf}$
	DL On Steel	$w_{5DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.755\ \boldsymbol{klf}$
W6:	Trib width:	$t_w := t_{w6}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.383\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.608\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.608\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.608\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.608\ \boldsymbol{klf}$
	LL On Steel	$w_{6LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 2.815\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.304\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.228\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.228\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.228\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.228\ \boldsymbol{klf}$

	DL On Steel	$w_{6DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.216$ ***klf***
W7:	Trib width:	$t_w := t_{w7}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.498$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.79$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.79$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.79$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.79$ ***klf***
	LL On Steel	$w_{7LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 3.658$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.395$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.296$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.296$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.296$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.296$ ***klf***
	DL On Steel	$w_{7DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.58$ ***klf***
W8:	Trib width:	$t_w := t_{w8}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.469$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.745$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.745$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.745$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.745$ ***klf***
	LL On Steel	$w_{8LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 3.449$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.373$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.279$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.279$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.279$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.279$ ***klf***
	DL On Steel	$w_{8DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.49$ ***klf***
W9:	Trib width:	$t_w := t_{w9}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.73$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 1.158$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 1.158$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 1.158$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 1.158$ ***klf***
	LL On Steel	$w_{9LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 5.363$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.579$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.434$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.434$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.434$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.434$ ***klf***

	DL On Steel	$w_{9DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 2.317$ ***klf***
W10:	Trib width:	$t_w := t_{w10}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.49$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.777$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.777$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.777$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.777$ ***klf***
	LL On Steel	$w_{10LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 3.599$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.389$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.292$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.292$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.292$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.292$ ***klf***
	DL On Steel	$w_{10DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.555$ ***klf***
W11:	Trib width:	$t_w := t_{w11}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.57$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.905$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.905$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.905$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.905$ ***klf***
	LL On Steel	$w_{11LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 4.19$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.453$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.339$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.339$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.339$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.339$ ***klf***
	DL On Steel	$w_{11DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.81$ ***klf***
W12:	Trib width:	$t_w := t_{w12}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.353$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.56$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.56$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.56$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.56$ ***klf***
	LL On Steel	$w_{12LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 2.593$ ***klf***
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.28$ ***klf***
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.21$ ***klf***
	4th framing:	$w_{4f} := w_{5f} = 0.21$ ***klf***
	3rd framing:	$w_{3f} := w_{5f} = 0.21$ ***klf***
	2nd framing:	$w_{2f} := w_{5f} = 0.21$ ***klf***

	DL On Steel	$w_{12DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.12\ \boldsymbol{klf}$
W13:	Trib width:	$t_w := t_{w13}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.126\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.2\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	LL On Steel	$w_{13LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 0.926\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.1\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.075\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	DL On Steel	$w_{13DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 0.4\ \boldsymbol{klf}$
W14:	Trib width:	$t_w := t_{w14}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.126\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.2\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.2\ \boldsymbol{klf}$
	LL On Steel	$w_{14LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 0.926\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.1\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.075\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.075\ \boldsymbol{klf}$
	DL On Steel	$w_{14DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 0.4\ \boldsymbol{klf}$
W15:	Trib width:	$t_w := t_{w15}$
	Roof framing:	$w_r := t_w \cdot (SL_{roof}) = 0.255\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (LL_{floor}) = 0.404\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.404\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.404\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.404\ \boldsymbol{klf}$
	LL On Steel	$w_{15LL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 1.871\ \boldsymbol{klf}$
	Roof framing:	$w_r := t_w \cdot (DL_{roof}) = 0.202\ \boldsymbol{klf}$
	5th framing:	$w_{5f} := t_w \cdot (DL_{floor}) = 0.152\ \boldsymbol{klf}$
	4th framing:	$w_{4f} := w_{5f} = 0.152\ \boldsymbol{klf}$
	3rd framing:	$w_{3f} := w_{5f} = 0.152\ \boldsymbol{klf}$
	2nd framing:	$w_{2f} := w_{5f} = 0.152\ \boldsymbol{klf}$

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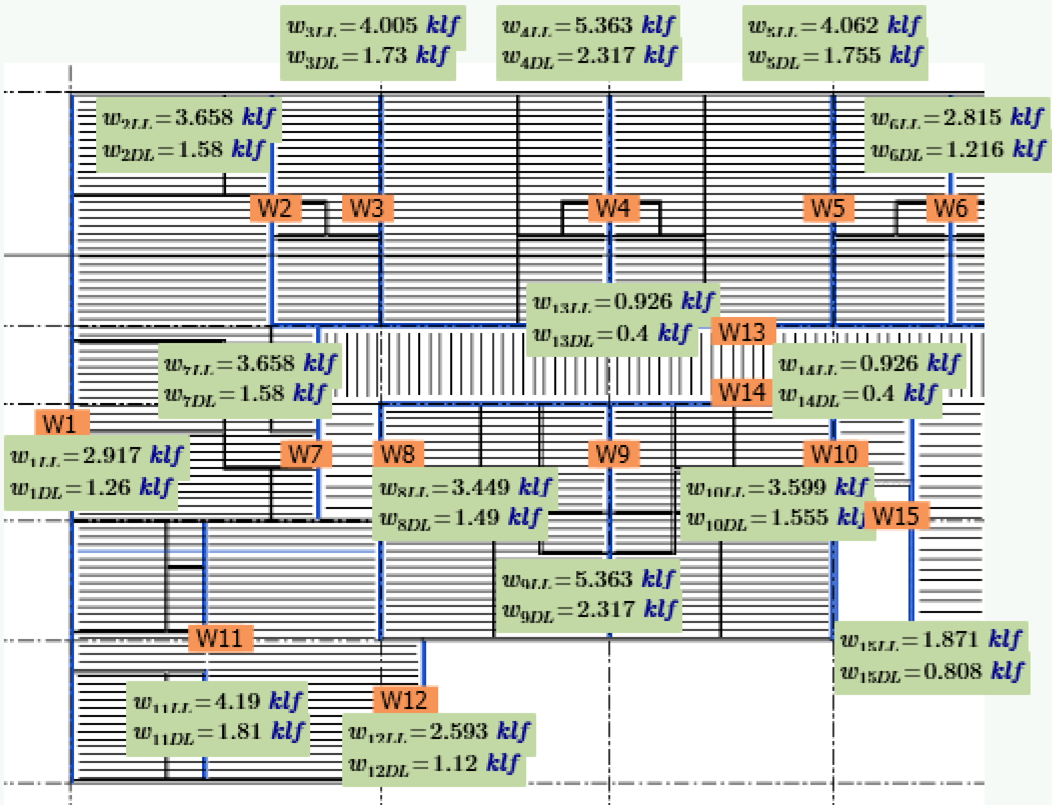
Gravity Load Calcs

DL On Steel $w_{15DL} := w_r + w_{5f} + w_{4f} + w_{3f} + w_{2f} = 0.808\ \mathbf{klf}$



Condominium Development
Senior Design Project
Lateral Load Calcs

Loading Input *marked in this shade means self-input

Basic wind speed (mph):	$V := 115$	ASCE7-10 Fig26.5-1A
Wind direct. factor:	$K_d := 0.85$	ASCE7-10 Sec 26.6
Exposure category:	B	ASCE7-10 Sec 26.7
Topographic factor:	$K_{zt} := 1$	ASCE7-10 Sec 26.8
Gust effect factor:	$G := 0.85$	ASCE7-10 Sec 26.9
Enclosure class:	Enclosed	ASCE7-10 Sec 26.10
Internal pressure coeff.	$GC_{pi} := 0.18$	ASCE7-10 Sec 26.11

*Using Directional Procedure

Total building height (ft): $H := 55$ $K_z := 0.83$ ASCE7-10 Table 27.3-1

Velocity pressure: $q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot 1\ psf = 23.885\ psf$
ASCE7-10 Eqn 27.3-1

External pressure coeff. $C_{p.wall} := 0.8$
$C_{p.roof} := -0.9$

*Just going to assume a uniform wind pressure for the total height of the building instead of staggering the pressure at each floor

Service wind pressures:
$p_{wall} := \left(q_z \cdot G \cdot C_{p.wall} - q_z \cdot GC_{pi}\right) \cdot 0.6 = 7.166\ psf$ on wall
$p_{roof} := \left(q_z \cdot G \cdot C_{p.roof} - q_z \cdot GC_{pi}\right) \cdot 0.6 = -13.543\ psf$ uplift
$p_{parapet} := p_{wall} \cdot 2.25 = 16.123\ psf$

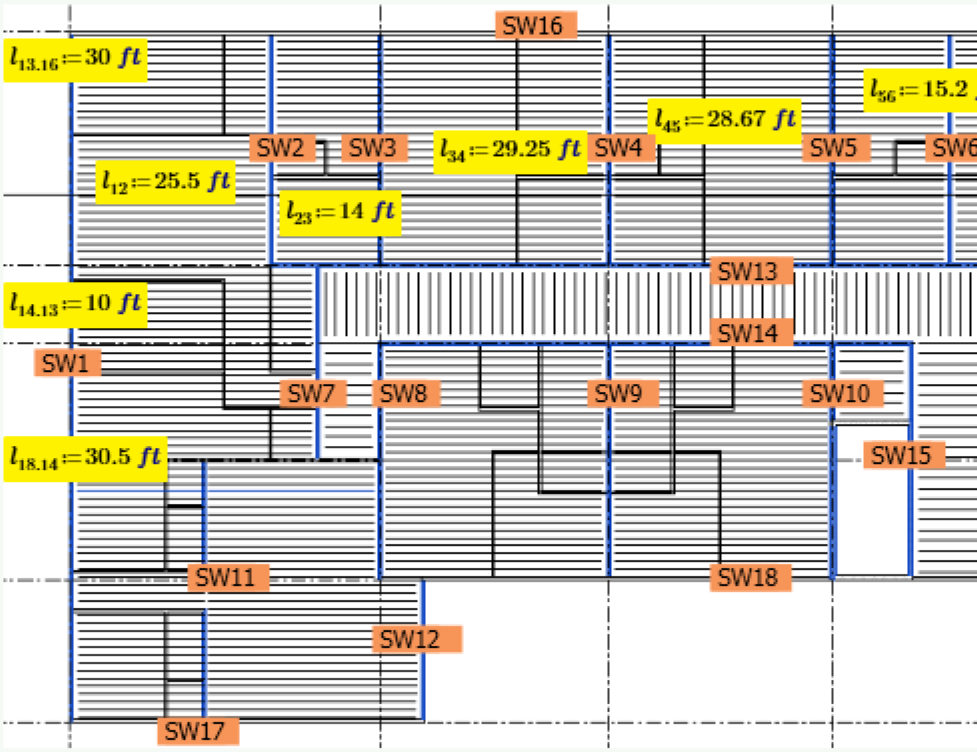
Floor-to-floor height: $h_{floor} := 11\ ft$

Parapet height: $h_{parapet} := 3\ ft$

Diaphragm loads

Roof: $w_{roof} := p_{parapet} \cdot h_{parapet} + p_{wall} \cdot 0.5 \cdot h_{floor} = 87.779\ plf$
Fifth floor: $w_5 := p_{wall} \cdot h_{floor} = 78.822\ plf$
Fourth floor: $w_4 := p_{wall} \cdot h_{floor} = 78.822\ plf$
Third floor: $w_3 := p_{wall} \cdot h_{floor} = 78.822\ plf$
Second floor: $w_2 := p_{wall} \cdot h_{floor} = 78.822\ plf$

Wall Labeling



Shear wall loading

*strategy: find controlling case for both wind directions and design each shear wall on that level for that case

North/South Wind: SW4 controls $l_w := 50\ ft$

Reaction forces:

Roof: $V_r := w_{roof} \cdot l_w = 4.389\ kip$
Fifth floor: $V_5 := w_5 \cdot l_w + V_r = 8.33\ kip$
Fourth floor: $V_4 := w_4 \cdot l_w + V_5 = 12.271\ kip$
Third floor: $V_3 := w_3 \cdot l_w + V_4 = 16.212\ kip$
Second floor: $V_2 := w_2 \cdot l_w + V_3 = 20.153\ kip$
*apply this point load on steel

Shear wall length: $b := 60\ ft$ (Wall between units, no openings)

Unit shears:

Roof: $v_5 := \frac{V_r}{b} = 73.149\ plf$

Fifth floor: $v_4 := \frac{V_5}{b} = 138.834\ plf$

Fourth floor: $v_3 := \frac{V_4}{b} = 204.519\ plf$

Third floor: $v_2 := \frac{V_3}{b} = 270.204\ plf$

East/West Wind: SW13/16 controls $l_w := 0.5 \cdot \left(l_{13.16} + l_{14.13}\right) = 20\ ft$

Reaction forces:

Roof: $V_r := w_{roof} \cdot l_w = 1.756\ kip$
Fifth floor: $V_5 := w_5 \cdot l_w + V_r = 3.332\ kip$
Fourth floor: $V_4 := w_4 \cdot l_w + V_5 = 4.908\ kip$
Third floor: $V_3 := w_3 \cdot l_w + V_4 = 6.485\ kip$
Second floor: $V_2 := w_2 \cdot l_w + V_3 = 8.061\ kip$
*apply this point load on steel

Shear wall length: $b := 0.5 \cdot 225\ ft = 112.5\ ft$ (ext wall, assuming half of wall is lost to openings)

Condominium Development
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Lateral Load Calcs

Unit shears:

Roof: $v_5 := \frac{V_r}{b} = 15.605\ plf$

Fifth floor: $v_4 := \frac{V_5}{b} = 29.618\ plf$

Fourth floor: $v_3 := \frac{V_4}{b} = 43.631\ plf$

Third floor: $v_2 := \frac{V_3}{b} = 57.643\ plf$

Controlling 2x6 @ 16" o.c. bearing wall check
JK
3/12/2018

Checking bearing wall of second floor framing for combined axial and bending

Wall information: 2x6 @ 16" o.c. $L := 11\ ft \quad t_w := 16\ in \quad b := 1.5\ in \quad d := 5.5\ in$

Axial force (loads from above):

$P_{linear} := 4000\ plf \qquad P := P_{linear} \cdot t_w = 5333.3\ lbf$

Bending force (wind load picked up by sheathing, distributed to studs):

$p_{service} := 20\ psf \qquad w := p_{service} \cdot t_w = 26.7\ plf$

Douglas Fir No. 2 properties: $F_b := 900\ psi \quad F_c := 1350\ psi \quad E_{min} := 580\ ksi$

$E := 1600000$ (leave unit-less, for calc below)

Stresses on stud: $S := \dfrac{b \cdot d^2}{6} = 7.56\ in^3$

$M := \dfrac{\left(w \cdot L^2\right)}{8} = 4840\ lbf \cdot in \quad f_b := \dfrac{M}{S} = 640\ psi$

$Area := b \cdot d = 8.3\ in^2 \qquad f_c := \dfrac{P}{Area} = 646.5\ psi$

Adjustment factors:

$C_{D.b} := 1.6$	(Table 2.3.2, wind)
$C_{D.c} := 1.15$	(Table 2.3.2, snow)
$C_M := 1$	(no wet service)
$C_t := 1$	(no temp issues)
$C_L := 1$	(assume ends held in position)
$C_{F.b} := 1.3$	(Table 4A, 2x6, bending)
$C_{F.c} := 1.1$	(Table 4A, 2x6, compression)
$C_{fu} := 1$	(not on wide face)
$C_i := 1$	(no incising)
$C_r := 1.15$	(studs spaced less than 24")
$C_P := 1$	(assume its supported throughout length)
$C_T := 1 + \dfrac{2300 \cdot 96}{.59 \cdot E} = 1.2$	(Eqn 4.4-1, le>96" so le=96" for this)

$F'_b := F_b \cdot C_{D.b} \cdot C_M \cdot C_t \cdot C_L \cdot C_{F.b} \cdot C_{fu} \cdot C_i \cdot C_r = 2152.8\ psi$

$F'_c := F_c \cdot C_{D.c} \cdot C_M \cdot C_t \cdot C_{F.c} \cdot C_i \cdot C_P = 1707.8\ psi$

$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = 715661\ psi$

Controlling 2x6 @ 16" o.c. bearing wall check
JK
3/12/2018

NDS 3.9.2 Bending and Axial Compression

Effective length: $K := 1$ $l_{e1} := K \cdot L = 11\ ft$

Check fc < Fce1:

$f_c = 646.5\ psi$ < $F_{cE1} := \dfrac{0.822 \cdot E'_{min}}{\left(\dfrac{l_{e1}}{d}\right)^2} = 1021.3\ psi$ OK

Check Eqn 3.9-3:

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_b}{F'_b \cdot \left(1 - \left(\frac{f_c}{F_{cE1}}\right)\right)} = 0.95 \quad < 1$$ OK

Controlling 2x6 @ 8" o.c. bearing wall check
JK
3/12/2018

Checking bearing wall of second floor framing for combined axial and bending

Wall information: 2x6 @ 16" o.c. $L := 11\ ft$ $t_w := 8\ in$ $b := 1.5\ in$ $d := 5.5\ in$

Axial force (loads from above):

$P_{linear} := 7600\ plf$ $P := P_{linear} \cdot t_w = 5066.7\ lbf$

Bending force (wind load picked up by sheathing, distributed to studs):

$p_{service} := 20\ psf$ $w := p_{service} \cdot t_w = 13.3\ plf$

Douglas Fir No. 2 properties: $F_b := 900\ psi$ $F_c := 1350\ psi$ $E_{min} := 580\ ksi$

$E := 1600000$ (leave unit-less, for calc below)

Stresses on stud: $S := \dfrac{b \cdot d^2}{6} = 7.56\ in^3$

$M := \dfrac{(w \cdot L^2)}{8} = 2420\ lbf \cdot in$ $f_b := \dfrac{M}{S} = 320\ psi$

$Area := b \cdot d = 8.3\ in^2$ $f_c := \dfrac{P}{Area} = 614.1\ psi$

Adjustment factors:

$C_{D.b} := 1.6$	(Table 2.3.2, wind)
$C_{D.c} := 1.15$	(Table 2.3.2, snow)
$C_M := 1$	(no wet service)
$C_t := 1$	(no temp issues)
$C_L := 1$	(assume ends held in position)
$C_{F.b} := 1.3$	(Table 4A, 2x6, bending)
$C_{F.c} := 1.1$	(Table 4A, 2x6, compression)
$C_{fu} := 1$	(not on wide face)
$C_i := 1$	(no incising)
$C_r := 1.15$	(studs spaced less than 24")
$C_P := 1$	(assume its supported throughout length)
$C_T := 1 + \dfrac{2300 \cdot 96}{.59 \cdot E} = 1.2$	(Eqn 4.4-1, le>96" so le=96" for this)

$F'_b := F_b \cdot C_{D.b} \cdot C_M \cdot C_t \cdot C_L \cdot C_{F.b} \cdot C_{fu} \cdot C_i \cdot C_r = 2152.8\ psi$

$F'_c := F_c \cdot C_{D.c} \cdot C_M \cdot C_t \cdot C_{F.c} \cdot C_i \cdot C_P = 1707.8\ psi$

$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = 715661\ psi$

Controlling 2x6 @ 8" o.c. bearing wall check
JK
3/12/2018

NDS 3.9.2 Bending and Axial Compression

Effective length: $K := 1$ $l_{e1} := K \cdot L = 11\ ft$

Check fc < Fce1:

$f_c = 614.1\ psi$ < $F_{cE1} := \dfrac{0.822 \cdot E'_{min}}{\left(\dfrac{l_{e1}}{d}\right)^2} = 1021.3\ psi$ OK

Check Eqn 3.9-3:

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_b}{F'_b \cdot \left(1 - \left(\dfrac{f_c}{F_{cE1}}\right)\right)} = 0.5 < 1$$ OK

Condo - Exterior Load-Bearing Balcony Header
JK
3/12/2018

DFL No. 2 Design Values

$v1 := \text{"PASS"}$
$v2 := \text{"FAIL"}$

$F_b := 900\ psi$ $\quad F_v := 180\ psi$ $\quad E := 1600\ ksi$

Size of member: $b := 3 \cdot 1.5\ in$ $\quad d := 11.25\ in$ $\quad L := 8\ ft$

$$I := \frac{b \cdot d^3}{12} = 533.94\ in^4$$

Adjustment Factors

Load duration factor: $C_D := 1$
Size factor: $C_F := 1$
Wet service factor: $C_M := 1$
Repetitive member factor: $C_r := 1$
Assuming: $C_t := 1$ $\quad C_{fu} := 1$ $\quad C_i := 1$ $\quad C_L := 1$

Loading / trib: $w_{LL} := 0.63\ klf$ $\quad w_{DL} := 0.236\ klf$ *from GravityLoadCalcs
$w := w_{LL} + w_{DL}$

Bending Check

Max moment in joist: $M := \frac{w \cdot L^2}{8} = 6928.0\ lbf \cdot ft$

Working bending stress: $f_b := \frac{6 \cdot M}{b \cdot d^2} = 875.84\ psi$

Adjusted Design Value $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r = 900.00\ psi$

$\text{if}\left(F'_b > f_b, v1, v2\right) = \text{"PASS"}$ $\quad \frac{f_b}{F'_b} = 0.97$

Shear Check

Max shear force $V_{max} := \frac{w \cdot L}{2} = 3464.00\ lbf$

Working Shear Stress $f_v := \frac{3 \cdot V_{max}}{2 \cdot b \cdot d} = 102.64\ psi$

Adjusted Design Value $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 180.00\ psi$

$\text{if}\left(F'_v > f_v, v1, v2\right) = \text{"PASS"}$ $\quad \frac{f_v}{F'_v} = 0.57$

Condo - Exterior Load-Bearing Balcony Header
JK
3/12/2018

Deflection Check

Live load defl.

$$\delta_L := \frac{5 \cdot (w_{LL}) \cdot L^4}{384 \cdot E \cdot I} = 0.07\ in$$

$$\Delta_L := \frac{L}{360} = 0.267\ in \qquad \frac{\delta_L}{\Delta_L} = 0.25$$

$$\text{if}\left(\Delta_L > \delta_L, v1, v2\right) = \text{"PASS"}$$

Creep + LL defl.

$$\delta_D := \frac{5 \cdot (w_{DL}) \cdot L^4}{384 \cdot E \cdot I} = 0.03\ in \qquad \delta_{tot} := \delta_L + \delta_D = 0.09\ in$$

$$\Delta_{tot} := \frac{L}{240} = 0.400\ in \qquad \frac{\delta_{tot}}{\Delta_{tot}} = 0.23$$

$$\text{if}\left(\Delta_{tot} > \delta_{tot}, v1, v2\right) = \text{"PASS"}$$

Condo - Exterior Load-Bearing Interior Door Header
JK
3/12/2018

DFL No. 2 Design Values

$v1 := \text{"PASS"}$
$v2 := \text{"FAIL"}$

$F_b := 900\ psi$ $F_v := 180\ psi$ $E := 1600\ ksi$

Size of member: $b := 3 \cdot 1.5\ in$ $d := 5.5\ in$ $L := 3.5\ ft$

$$I := \frac{b \cdot d^3}{12} = 62.39\ in^4$$

Adjustment Factors

Load duration factor: $C_D := 1$
Size factor: $C_F := 1.3$
Wet service factor: $C_M := 1$
Repetitive member factor: $C_r := 1$
Assuming: $C_t := 1$ $C_{fu} := 1$ $C_i := 1$ $C_L := 1$

Loading / trib: $w_{LL} := 0.865\ klf$ $w_{DL} := 0.324\ klf$ *from GravityLoadCalcs
$w := w_{LL} + w_{DL}$

Bending Check

Max moment in joist: $M := \frac{w \cdot L^2}{8} = 1820.7\ lbf \cdot ft$

Working bending stress: $f_b := \frac{6 \cdot M}{b \cdot d^2} = 962.99\ psi$

Adjusted Design Value $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r = 1170.00\ psi$

$\text{if}\left(F'_b > f_b, v1, v2\right) = \text{"PASS"}$ $\frac{f_b}{F'_b} = 0.82$

Shear Check

Max shear force $V_{max} := \frac{w \cdot L}{2} = 2080.75\ lbf$

Working Shear Stress $f_v := \frac{3 \cdot V_{max}}{2 \cdot b \cdot d} = 126.11\ psi$

Adjusted Design Value $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 180.00\ psi$

$\text{if}\left(F'_v > f_v, v1, v2\right) = \text{"PASS"}$ $\frac{f_v}{F'_v} = 0.70$

Condo - Exterior Load-Bearing Interior Door Header
JK
3/12/2018

Deflection Check

Live load defl.

$$\delta_L := \frac{5 \cdot (w_{LL}) \cdot L^4}{384 \cdot E \cdot I} = 0.03\ in$$

$$\Delta_L := \frac{L}{360} = 0.117\ in \qquad \frac{\delta_L}{\Delta_L} = 0.25$$

$$\text{if}\left(\Delta_L > \delta_L, v1, v2\right) = \text{"PASS"}$$

Creep + LL defl.

$$\delta_D := \frac{5 \cdot (w_{DL}) \cdot L^4}{384 \cdot E \cdot I} = 0.01\ in \qquad \delta_{tot} := \delta_L + \delta_D = 0.04\ in$$

$$\Delta_{tot} := \frac{L}{240} = 0.175\ in \qquad \frac{\delta_{tot}}{\Delta_{tot}} = 0.23$$

$$\text{if}\left(\Delta_{tot} > \delta_{tot}, v1, v2\right) = \text{"PASS"}$$

Condo - Exterior Load-Bearing Window Header
JK
3/12/2018

DFL No. 2 Design Values

$v1 := \text{"PASS"}$
$v2 := \text{"FAIL"}$

$F_b := 900\ psi$ $\quad F_v := 180\ psi$ $\quad E := 1600\ ksi$

Size of member: $b := 3 \cdot 1.5\ in$ $\quad d := 5.5\ in$ $\quad L := 3.5\ ft$

$$I := \frac{b \cdot d^3}{12} = 62.39\ in^4$$

Adjustment Factors

Load duration factor: $C_D := 1$
Size factor: $C_F := 1.3$
Wet service factor: $C_M := 1$
Repetitive member factor: $C_r := 1$
Assuming: $C_t := 1$ $\quad C_{fu} := 1$ $\quad C_i := 1$ $\quad C_L := 1$

Loading / trib: $w_{LL} := 0.63\ klf$ $\quad w_{DL} := 0.236\ klf$ *from GravityLoadCalcs
$w := w_{LL} + w_{DL}$

Bending Check

Max moment in joist: $M := \frac{w \cdot L^2}{8} = 1326.1\ lbf \cdot ft$

Working bending stress: $f_b := \frac{6 \cdot M}{b \cdot d^2} = 701.39\ psi$

Adjusted Design Value $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r = 1170.00\ psi$

$\text{if}\left(F'_b > f_b, v1, v2\right) = \text{"PASS"}$ $\quad \frac{f_b}{F'_b} = 0.60$

Shear Check

Max shear force $V_{max} := \frac{w \cdot L}{2} = 1515.50\ lbf$

Working Shear Stress $f_v := \frac{3 \cdot V_{max}}{2 \cdot b \cdot d} = 91.85\ psi$

Adjusted Design Value $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 180.00\ psi$

$\text{if}\left(F'_v > f_v, v1, v2\right) = \text{"PASS"}$ $\quad \frac{f_v}{F'_v} = 0.51$

Condo - Exterior Load-Bearing Window Header
JK
3/12/2018

Deflection Check

Live load defl.

$$\delta_L := \frac{5 \cdot (w_{LL}) \cdot L^4}{384 \cdot E \cdot I} = 0.02\ in$$

$$\Delta_L := \frac{L}{360} = 0.117\ in \qquad \frac{\delta_L}{\Delta_L} = 0.18$$

$$\text{if}\left(\Delta_L > \delta_L, v1, v2\right) = \text{"PASS"}$$

Creep + LL defl.

$$\delta_D := \frac{5 \cdot (w_{DL}) \cdot L^4}{384 \cdot E \cdot I} = 0.01\ in \qquad \delta_{tot} := \delta_L + \delta_D = 0.03\ in$$

$$\Delta_{tot} := \frac{L}{240} = 0.175\ in \qquad \frac{\delta_{tot}}{\Delta_{tot}} = 0.17$$

$$\text{if}\left(\Delta_{tot} > \delta_{tot}, v1, v2\right) = \text{"PASS"}$$

Condo - Beam In Bottom Corner Units
JK
3/12/2018

DFL No. 2 Design Values

$v1 := \text{"PASS"}$
$v2 := \text{"FAIL"}$

$F_b := 900\ psi$ $F_v := 180\ psi$ $E := 1600\ ksi$

Size of member: $b := 3 \cdot 1.5\ in$ $d := 9.25\ in$ $L := 5.5\ ft$

$$I := \frac{b \cdot d^3}{12} = 296.79\ in^4$$

Adjustment Factors

Load duration factor: $C_D := 1$
Size factor: $C_F := 1.1$
Wet service factor: $C_M := 1$
Repetitive member factor: $C_r := 1$
Assuming: $C_t := 1$ $C_{fu} := 1$ $C_i := 1$ $C_L := 1$

Loading / trib: $w_{LL} := 0.905\ klf$ $w_{DL} := 0.339\ klf$ *from GravityLoadCalcs
$w := w_{LL} + w_{DL}$

Bending Check

Max moment in joist: $M := \frac{w \cdot L^2}{8} = 4703.9\ lbf \cdot ft$

Working bending stress: $f_b := \frac{6 \cdot M}{b \cdot d^2} = 879.61\ psi$

Adjusted Design Value $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r = 990.00\ psi$

$\text{if}\left(F'_b > f_b, v1, v2\right) = \text{"PASS"}$ $\frac{f_b}{F'_b} = 0.89$

Shear Check

Max shear force $V_{max} := \frac{w \cdot L}{2} = 3421.00\ lbf$

Working Shear Stress $f_v := \frac{3 \cdot V_{max}}{2 \cdot b \cdot d} = 123.28\ psi$

Adjusted Design Value $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 180.00\ psi$

$\text{if}\left(F'_v > f_v, v1, v2\right) = \text{"PASS"}$ $\frac{f_v}{F'_v} = 0.68$

Condo - Beam In Bottom Corner Units
JK
3/12/2018

Deflection Check

Live load defl.

$$\delta_L := \frac{5 \cdot (w_{LL}) \cdot L^4}{384 \cdot E \cdot I} = 0.04\ in$$

$$\Delta_L := \frac{L}{360} = 0.183\ in \qquad \frac{\delta_L}{\Delta_L} = 0.21$$

$$\text{if}\left(\Delta_L > \delta_L, v1, v2\right) = \text{“PASS”}$$

Creep + LL defl.

$$\delta_D := \frac{5 \cdot (w_{DL}) \cdot L^4}{384 \cdot E \cdot I} = 0.01\ in \qquad \delta_{tot} := \delta_L + \delta_D = 0.05\ in$$

$$\Delta_{tot} := \frac{L}{240} = 0.275\ in \qquad \frac{\delta_{tot}}{\Delta_{tot}} = 0.20$$

$$\text{if}\left(\Delta_{tot} > \delta_{tot}, v1, v2\right) = \text{“PASS”}$$

Condo - Beams In Cooridor
JK
3/12/2018

DFL No. 2 Design Values

$v1 := \text{"PASS"}$
$v2 := \text{"FAIL"}$

$F_b := 900\ psi$ $\quad F_v := 180\ psi$ $\quad E := 1600\ ksi$

Size of member: $b := 2 \cdot 1.5\ in$ $\quad d := 11.25\ in$ $\quad L := 10\ ft$

$$I := \frac{b \cdot d^3}{12} = 355.96\ in^4$$

Adjustment Factors

Load duration factor: $C_D := 1$
Size factor: $C_F := 1$
Wet service factor: $C_M := 1$
Repetitive member factor: $C_r := 1$
Assuming: $C_t := 1$ $\quad C_{fu} := 1$ $\quad C_i := 1$ $\quad C_L := 1$

Loading / trib: $DL := 15\ psf$ $\quad LL := 40\ psf$ $\quad t_w := 5\ ft$
$w := (DL + LL) \cdot t_w = 275.00\ plf$

Bending Check

Max moment in joist: $M := \frac{w \cdot L^2}{8} = 3437.5\ lbf \cdot ft$

Working bending stress: $f_b := \frac{6 \cdot M}{b \cdot d^2} = 651.85\ psi$

Adjusted Design Value $F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r = 900.00\ psi$

$\text{if}\left(F'_b > f_b, v1, v2\right) = \text{"PASS"}$ $\qquad \frac{f_b}{F'_b} = 0.72$

Shear Check

Max shear force $V_{max} := \frac{w \cdot L}{2} = 1375.00\ lbf$

Working Shear Stress $f_v := \frac{3 \cdot V_{max}}{2 \cdot b \cdot d} = 61.11\ psi$

Adjusted Design Value $F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 180.00\ psi$

$\text{if}\left(F'_v > f_v, v1, v2\right) = \text{"PASS"}$ $\qquad \frac{f_v}{F'_v} = 0.34$

Condo - Beams In Cooridor
JK
3/12/2018

Deflection Check

Live load defl.

$$\delta_L := \frac{5 \cdot (LL \cdot t_w) \cdot L^4}{384 \cdot E \cdot I} = 0.08\ in$$

$$\Delta_L := \frac{L}{360} = 0.333\ in \qquad \frac{\delta_L}{\Delta_L} = 0.24$$

$$\text{if}\left(\Delta_L > \delta_L, v1, v2\right) = \text{“PASS”}$$

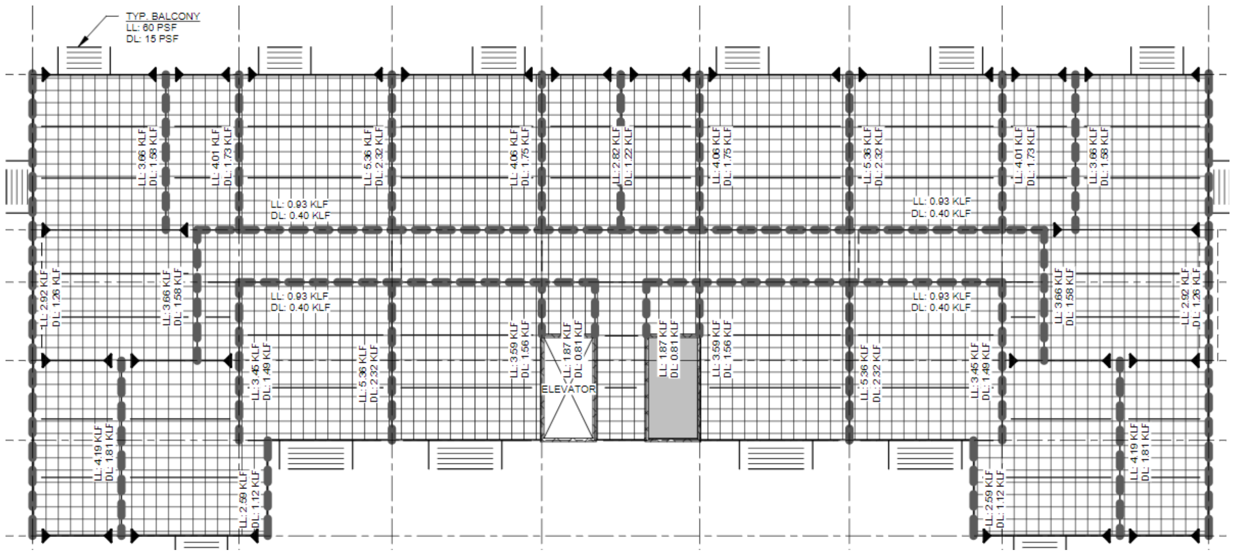
Creep + LL defl.

$$\delta_D := \frac{5 \cdot (DL \cdot t_w) \cdot L^4}{384 \cdot E \cdot I} = 0.03\ in \qquad \delta_{tot} := \delta_L + \delta_D = 0.11\ in$$

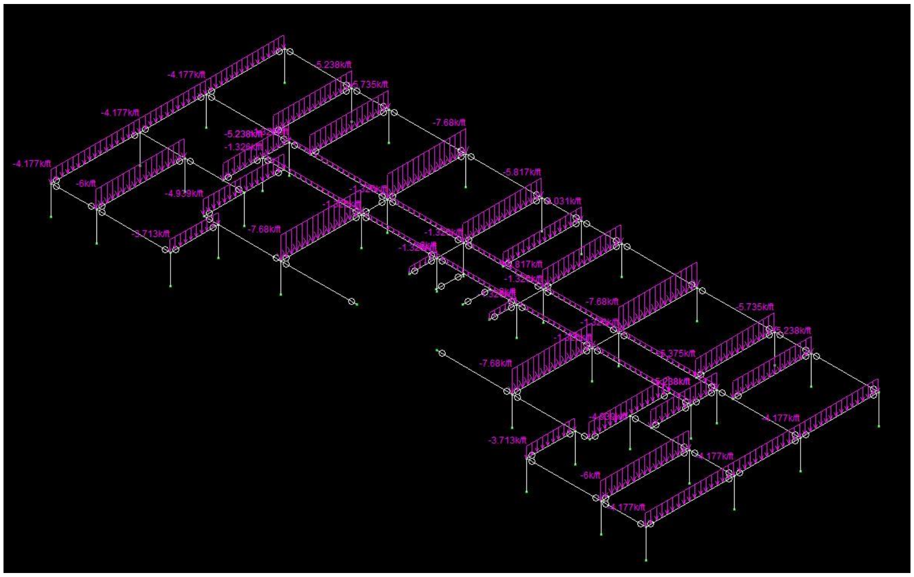
$$\Delta_{tot} := \frac{L}{240} = 0.500\ in \qquad \frac{\delta_{tot}}{\Delta_{tot}} = 0.22$$

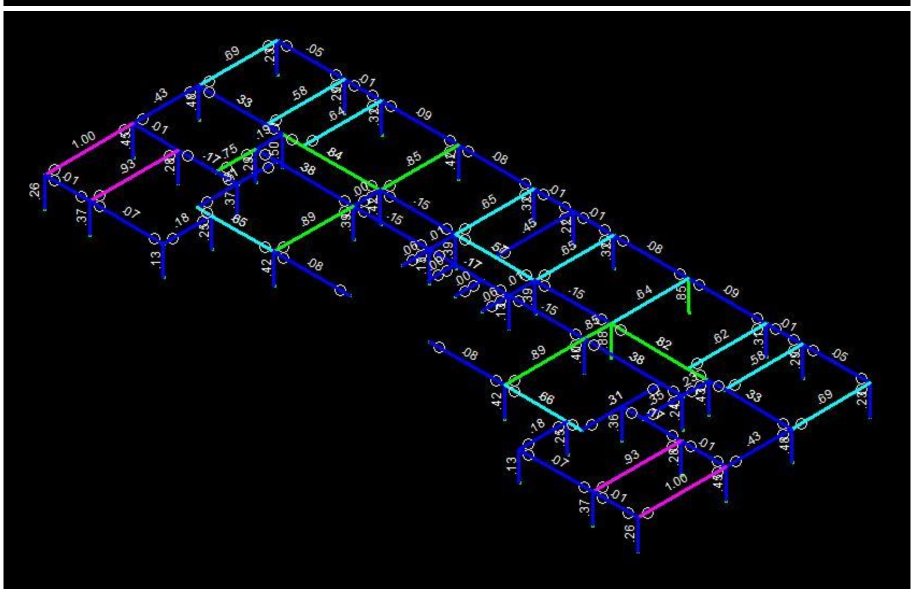
$$\text{if}\left(\Delta_{tot} > \delta_{tot}, v1, v2\right) = \text{“PASS”}$$

The loading for the wood framing gets transferred to the steel below by aligning wide flange steel girders underneath each bearing wall and by installing Simpson shear wall connections between steel and the shears walls on the second floor. The loading diagram for the steel framing is attached below. The main objective in laying out the steel framing was to create as much open space as possible. Because of this, girders span the full length of bearing walls between supports. At the end of each girder is an HSS column. HSS10x10x1/2 are used for all interior columns and HSS10x10x5/16 are used for exterior columns. Wide flange steel joists span from girder to girder. A composite deck is used on top of the steel framing to add additional strength and reduce the necessary member sizes. A 2” deep VLI deck with a 3.5” deep concrete topping is connected with shear studs to the structural steel, creating a stable and strong podium. The 3.5” of concrete is necessary for fire-proofing reasons and is much stronger than necessary. Due to the spans of over 30ft and taking over 5klf for its whole length, the largest sized girder is a W30x116. This beam is particularly heavy and deep, but is necessary to pick up the bearing walls. To account for the depth of the wide flange girders, the first-floor height is 15 feet so there will still be over 12 feet of head space from the top of slab.



The steel lateral system consists of a combination of moment frames and braced frames. Moment frames are used along the north and south walls to keep as much window space open as possible to view the bluff to the north. HSS tubes were used in an x-bracing configuration along the east and west walls to resist the wind load against the larger face of the building. There are 2 exterior braced frames and 2 interior braced frames. The steel lateral system also ties into the CMU shafts, making the podium very strong and rigid both laterally and vertically. All structural analysis was conducted in RISA-3D, which is a finite element analysis software with all AISC shapes and their properties loaded in. After the geometry, end connections, load cases, and load combinations are established, the software sizes the optimal members for the envelope of load cases. The loading and bending unity for members are shown in the screenshots below. Wind loads were also placed in both directions to verify the lateral system could satisfy the drift limit of H/600, or ⅓ of an inch. With the lateral system described above, the maximum story drift is ¼” of an inch.





A Geotech report conducted by Terracon determined that limestone is around 2-4ft deep for the entire site. The plan is to excavate down to limestone and then pour the foundations. Concrete strength will control for the foundations due to the immense bearing pressure of limestone of 35,000 psf. Each column will have a spread footing poured with mat reinforcement on top and bottom. All spread footings were sized to be 5 feet by 5 feet squares and 1 foot thick. The mat reinforcement was designed to be #5 @ 9” o.c. in both directions. A continuous footing and stem wall will be poured around the perimeter to tie into the slab on grade and for the glass curtain wall to tie into. The slab on grade will be 5” thick with a welded wire fabric reinforcement (WWF).

Appendix 3: Parking Lot Design

The location of our site was determined to be a Z3 zone or a General Urban District. This required that we followed Table 5 when determining the number of parking stalls required. The APA also required that we assign a set number of handicap stalls based on the number of stalls on the lot and those requirements are shown in Table 6. The report of number of stalls is summarized in the parking bay report.

Table 5: Required number of stalls per dwelling based on the zoning of the construction site

Function	Districts						
	Z1	Z2	Z3	Z4	Z5	Z6	Z7
RESIDENTIAL	2/Dwelling	1.5/Dwelling	1/Dwelling	1.5/Dwelling	na	na	
LODGING	1/room	1/room	1/room	1/room	na	na	
OFFICE*	na	2/1000 sq. ft.	2/1000 sq. ft.	4/1000 sq. ft.	na	4/1000 sq. ft.	
RETAIL*	2/1000 sq. ft.	2/1000 sq. ft.	2/1000 sq. ft.	4/1000 sq. ft.	na	4/1000 sq. ft.	
CIVIC	To be determined						
OTHER	To be determined					Min. 1 per 2 employees of longest shift plus 1/2,000 sq. ft. max. for principal building	To be determined
PARKING SETBACKS							
PRINCIPAL FRONT YARD		30 ft.	10 ft.	10 ft.	na	10 ft.	
SECONDARY FRONT YARD		10 ft.	10 ft.	10 ft.	na	30 ft.	
SIDEYARD		10 ft.	10 ft.	10 ft.	na	15 ft.	
REARYARD		10 ft.	10 ft.	10 ft./15 ft.**	na	25 ft./60 ft.**	

Table 6: Required handicap stalls compared to total number of parking stalls

Total Number of Parking Spaces in Parking Facility (Lot or Garage)	Minimum Total Number of Accessible Parking Spaces Required	Minimum Number of Van Accessible Parking Spaces
1 - 25	1	1
26 - 50	2	1
51 - 75	3	1

Parking Bay Report

Standard	Bay type	Vehicle ...	Service ...	Zone	Count	%
Parking Standards (Mason City)	Standard	Large C...	A	(Unnam...	48	94.12
Parking Standards (Mason City)	Accessible	Large C...	A	(Unnam...	2	3.92
Parking Standards (Mason City)	Accessible by Van	Large C...	A	(Unnam...	1	1.96
Total Stalls					51	100.00%

Customize... Export Close Help

Just like the site layout, the parking lot needed to follow given setbacks. The required setbacks are shown above at the bottom of Table 5. The layout of the final parking lot is shown in the plan sheets which provide the necessary setbacks.

Parking dimensions followed Mason City ordinances and APA requirements for normal and handicap spots. These are described and shown below. The entire parking lot is in accordance with these dimensions.

I. Off-Street Parking Dimensions:

1. Motorcycle and Scooter Parking Space Width: 4 ft. min.
2. Motorcycle and Scooter Parking Space Length: 8 ft. min.
3. Vehicle Parking Space Width: 9 ft. min.
4. Vehicle Parking Space Length: 18 ft. min to 20 ft. max
5. Width of two-way drive aisle serving any parking space: 24 ft. min to 26 ft. max.
6. Width of one-way drive aisle serving greater than 60 degree parking spaces: 24 ft. min. to 25 ft. max.
7. Width of one-way drive aisle serving less than 60 degree parking spaces: 15.5 ft. min. to 16.5 ft. max.

1. **Accessible Parking Spaces:** The 2010 Standards identify two types of accessible parking spaces for vehicles - car and van-accessible parking spaces. The minimum dimensions and common requirements for each are provided below and in Figure 8B-1.02.

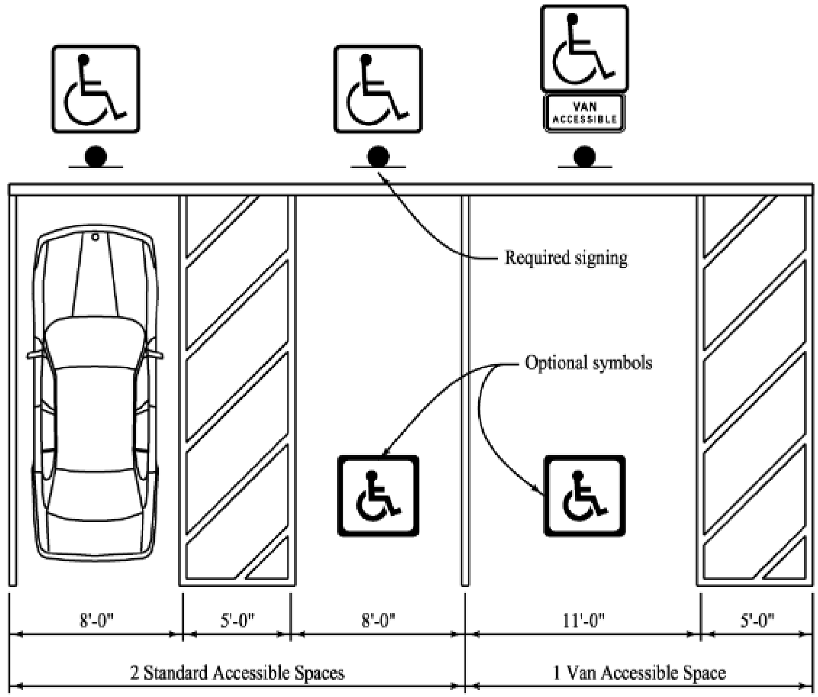
   a. **Car Accessible Spaces:** Minimum width of 96 inches (8 feet 0 inches)

   b. **Van-accessible Spaces:** Minimum width of 132 inches (11 feet 0 inches)

   c. **Access Aisle:** An adjacent access aisle is required for both car and van-accessible spaces. Two parking spaces may share an individual access aisle.
      1) **Width:** The minimum width of the access aisle is 60 inches (5 feet 0 inches). If the width of the access aisle is increased to 96 inches, the width of an adjacent van-accessible parking space may be reduced from 132 inches to 96 inches. With proper layout, this allows for a reduction in the total width consumed by two adjacent van-accessible spaces.
      2) **Length:** The access aisle must extend the full length of the parking spaces they serve.
      3) **Marking:** The access aisle must be marked; however, the 2010 Standards do not indicate the type of pavement marking required. Typically, the aisle is striped at an angle. While not required, the adjacent stalls may be painted with the international symbol of accessibility (wheelchair symbol) to aid motorist in identifying the space as being reserved.

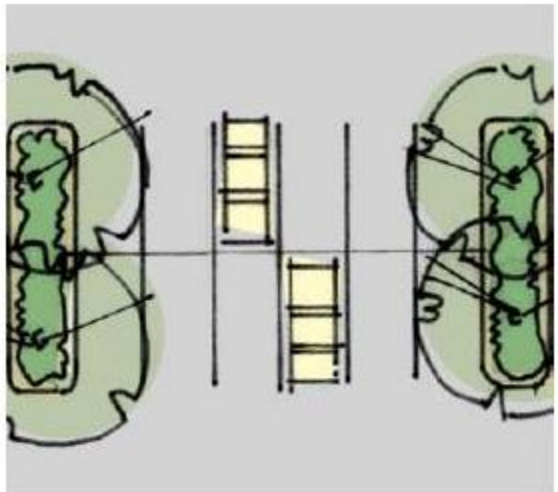
   d. **Signing:** Accessible parking spaces must be designated with signs showing the international symbol of accessibility. Signs for van accessible spaces should also contain the designation "van accessible." Signs must be installed a minimum of 60 inches from the bottom of the sign to the ground surface. Additional signage related to enforcement or parking fines is not required by ADA.

Figure 8B-1.02: Accessible Space Dimensions

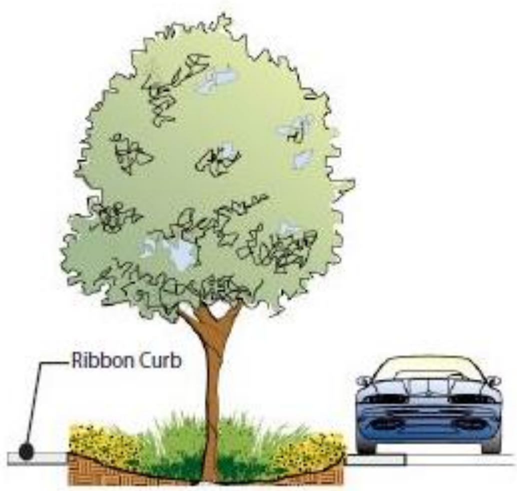


The parking lot also required having curb islands or peninsulas. The requirements of these curb islands are described below.

Parking bays of twelve (12) spaces or more in length shall be subdivided by intermediate landscape islands or peninsulas. Landscape islands/peninsulas shall provide at least one (1) parking space width of landscape area (10 feet wide by 18 feet long island or peninsula for a single bay or 10 feet wide by 36 feet long island for a double bay). The Administrative Officer may permit peninsulas or islands of lesser length to allow for safe turning radii within parking lot aisles and drives. (Ord. 13-14, 4-2-2013; amd. 2017 Code)



Double parking bays with a length of six (6) or more double-parking spaces shall terminate at each end with a planting area of a minimum of a double-parking space of landscape area.



A minimum of one (1) deciduous shade tree or two (2) ornamental trees, salt tolerant low shrubs and/or perennial grasses or flowers shall be planted in each island. Where possible, planting islands should be depressed and surrounded by flat, ribbon curbs to facilitate storm water filtering.

The islands are shown on the site layout. They appear as hatch marks, but they would be modeled as islands with necessary ribbon curb around them to help redirect water.

The parking lot needed to be graded to effectively move water off its surface. Utilizing Chapter 8B-1 of SUDAS, our team could select a grade that followed the requirements and get the water off the parking lot surface. The general requirements are shown below in the taken text from SUDAS.

Stormwater runoff from parking lots serving other than single and two family dwellings should not be discharged directly into the street; such runoff should be collected internally or discharged to an adjacent drainage way. After providing detention, when required, the collected stormwater may be discharged to the public storm sewer, ditch, or other conveyance. Stormwater runoff discharged to the street over the back of the curb or through a parking lot entrance, should be minimized. Check with the local jurisdiction for their stormwater requirements.

Where narrow (less than 10 feet wide) raised islands are provided, their presence should generally be disregarded when determining the runoff coefficient or curve number for the parking lot as they provide little benefit in reducing runoff. Wider islands, or islands that are depressed to collect stormwater runoff, are encouraged and may be taken into consideration when determining the runoff potential.

Pavement slopes of 1.5% should be provided to ensure proper drainage and eliminate standing water and icy conditions. Minimum pavement slopes of 0.6% may be used, however since the potential for flat areas is greater, additional measures to address drainage, such as slotted drains or pervious pavement, may be necessary. Slopes greater than 2% in areas between the parking lot destination and the accessible parking stalls should be avoided as they create a situation where constructing an accessible route is difficult. Slopes greater than 5% are discouraged.

Our design selected a 1 % slope that would move water from the Northeast and Northwest corners to the center of the parking lot. A 1% slope would then be used to get the water to drain south and into the designed retention pond.

The parking lot thickness was determined by utilizing APAI chapter 3B and 5B. Chapter 3B was used to compare the terracon soil report to a given soil class. The site where the condominium was located consisted of mostly sandy lean clay. A sandy lean clay followed a subgrade class of moderate with a CBR of 6. Utilizing this information, and the total number of spots in the parking lot, a required base and surface was selected using Table 7 shown below.

Table 7: Thickness chart for parking lots

A. For Asphalt Concrete Base Pavements

Design Criteria*			Thickness in Inches Hot Mix Asphalt		
Traffic Class (Spaces)	**Subgrade Class**	**CBR**	**Base**	**Surface**	**Total**
II	Good	9	3.0	1.0	4.0
(50-500 spaces)	Moderate	6	3.5	1.5	5.0
	Poor	3	4.5	1.5	6.0
III	Good	9	3.5	1.5	5.0
(500 & Above spaces)	Moderate	6	4.5	1.5	6.0
	Poor	3	5.5	1.5	7.0

The final design of the parking lot was given a 4-in. base and 2 in. surface to extend the design life.

Appendix 4: Access Road Design

The access road was designed following the same standards as the parking lot. Refer to the parking dimensions outlined in Appendix 3. A drive aisle of 15.5 feet was kept for the access road. A drive apron of 23.5 feet was selected by recommendation from Mason Cities city engineer.

The drainage of the access road also followed the same procedure as the parking lot. A 1% slope was maintained to get the water to drain down the access road and to the street. The water would then proceed to flow down the street towards an inlet.

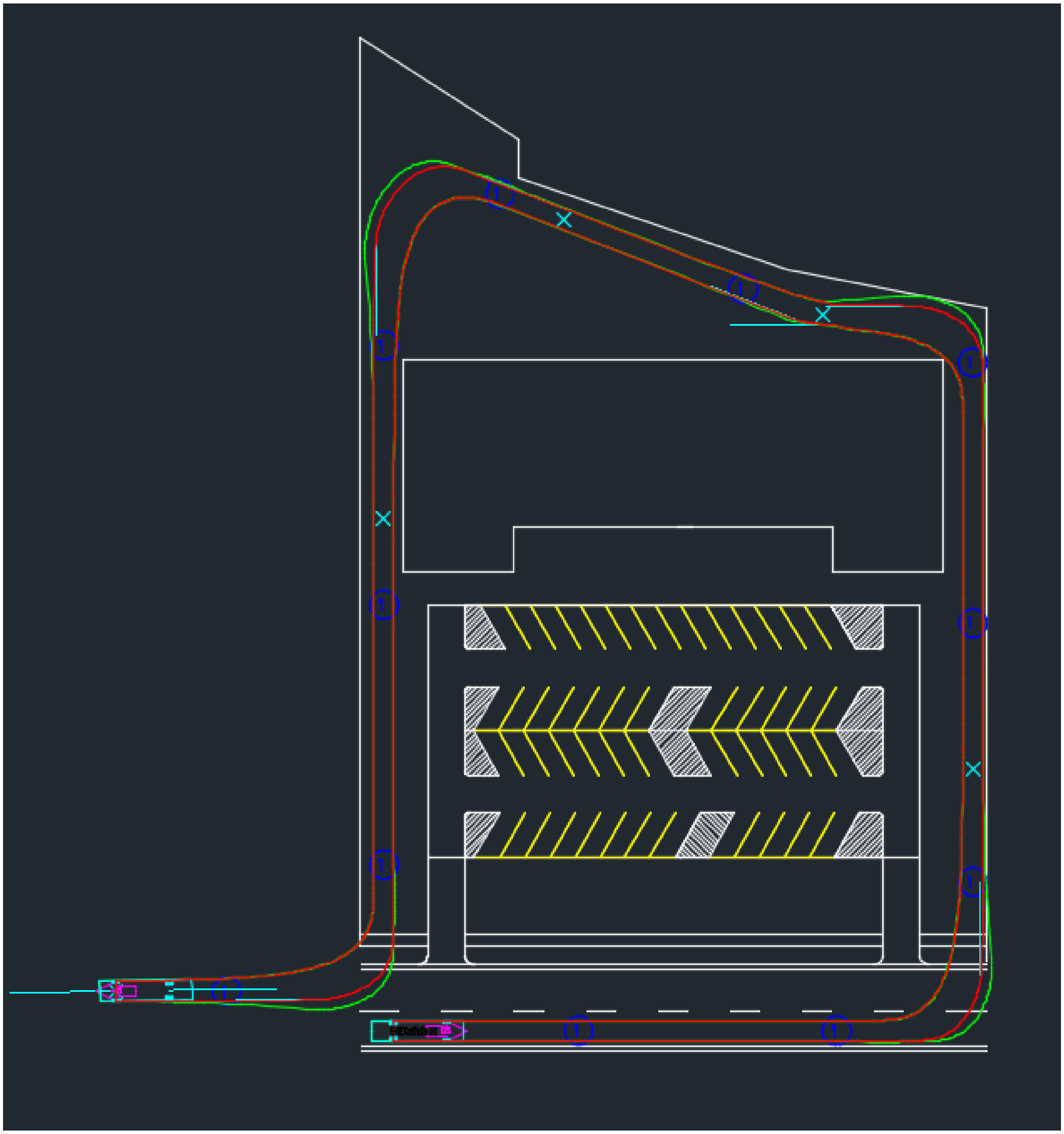
The pavement thickness of the access road followed APAI chapter 3B and 4B. Chapter 3B was used again to select the subgrade class. The access road would only be used to get to the parking lot, so the ADT would be between 50-200. Having these known, Table 8 was used to select a needed thickness for the access road.

Table 8: Thickness chart for an access road

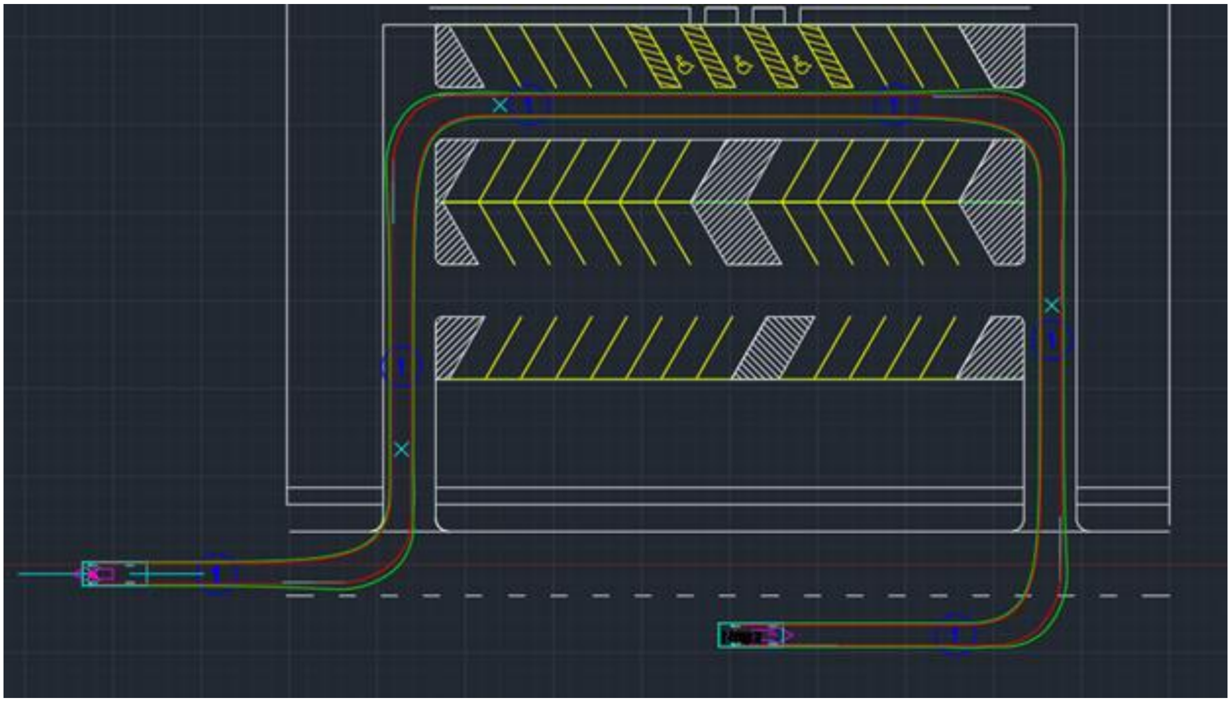
A. For Asphalt Concrete Base Pavements					
Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	Subgrade CBR	Base	Surface	Total
II (50-200 ADT)	Good	9	4.0	1.0	5.0
	Moderate	6	5.0	1.0	6.0
	Poor	3	5.5	1.5	7.0
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5

The final design of the access road was given a 6-in. base and 2 in. surface to extend the design life.

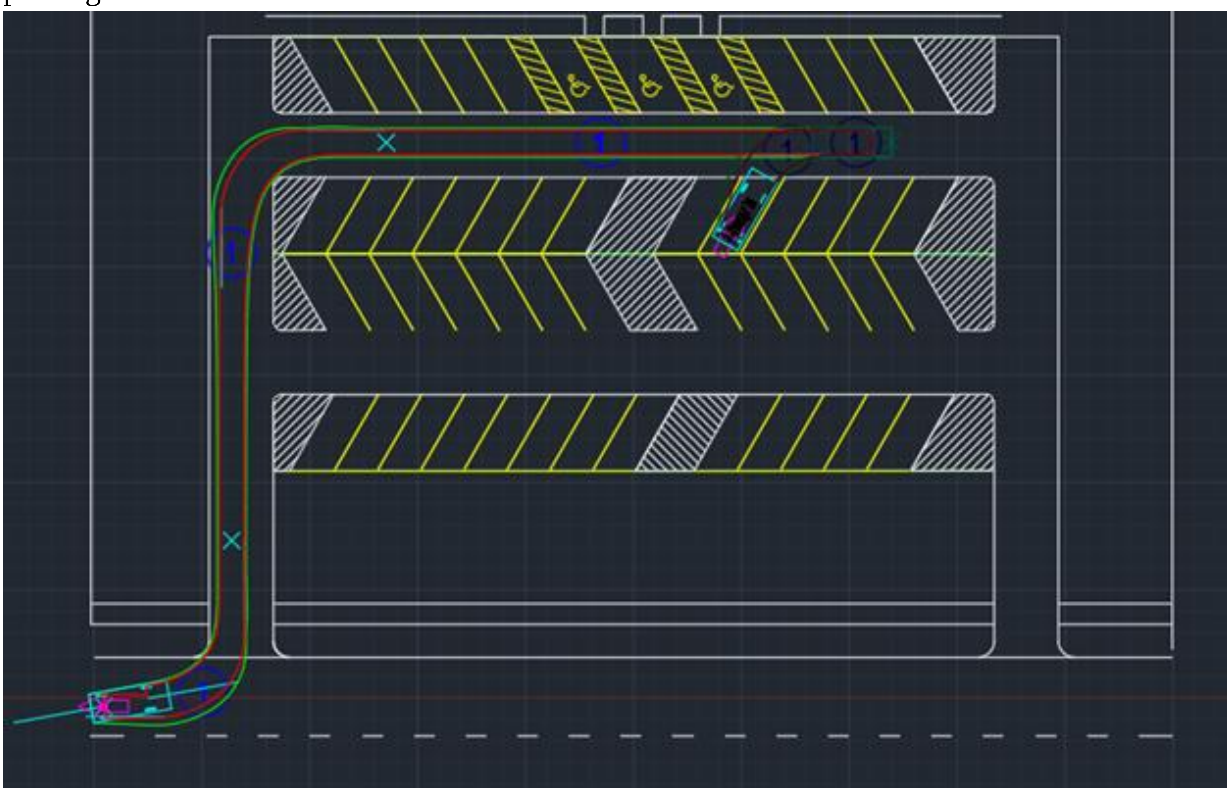
Appendix 5: Swept Path Analysis



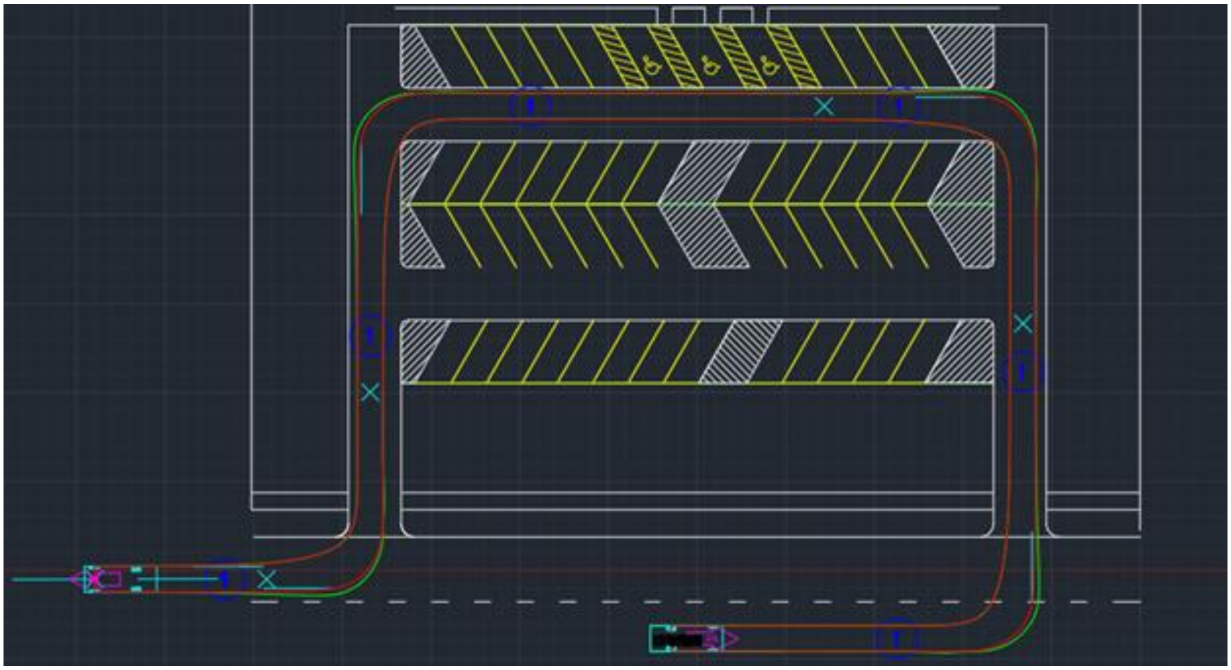
Standard fire truck entering the site and maneuvering around the building



Typical passenger vehicle entering through the access road and then maneuvering through the parking lot.



Typical passenger vehicle backing out of a parking stall and exiting the parking lot through the access road exit.



Garbage truck entering the parking lot and maneuvering through the lot.

Appendix 6: Hydraulic Design

Pre- and post-development runoff was calculated using both the rational method per SUDAS Section 2B for drainage areas smaller than forty acres and a modified rational method outlined in Mason City Code Title 30 Appendix B. The method following Mason City code yielded a considerably higher runoff volume and so these conditions were assumed and were set as the design control value.

A wet retention pond was designed based on SUDAS Section 2D to control the runoff to match pre-development discharge conditions. The pond will be located on the south side of the lot and will have a 3444 square foot surface with a 5:1 side slope.

A concrete drainage structure was designed to convey the runoff differential from the retention pond into the pre-existing storm water main. A 15” diameter concrete pipe will be adequate in conveying the excess discharge at a velocity of 7.581 feet per second. The design velocity was calculated using Manning’s equation while assuming a Manning coefficient of 0.013 for rough concrete material and non-pressurized flow.

Table 9: Storm water Runoff Estimations

SUDAS Section 2B

Design for 5 yr storm

Pre-Development		Post-Development	
C [-]	0.623385	C [-]	0.776698
i [in/hr]	4.12	i [in/hr]	4.12
A [ac]	1.885652	A [ac]	1.885652
Q [ft^3/s]	4.843005	Q [ft^3/s]	6.034079
Total	4.843005	Total	6.034079
Difference		1.191073	cfs
Volume		1071.966	ft^3

Pre-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.95	0.125987
Open Space, Good condition (grass cover 50% to 75%)	0.6	1.759665
Composite Coefficient	0.623385	

Post-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.95	0.951974
Open Space, Good condition (grass cover 50% to 75%)	0.6	0.933678
Composite Coefficient	0.776698	

Design for 100 yr storm

Pre-Development		Post-Development	
C [-]	0.765367	C [-]	0.866116
i [in/hr]	7.68	i [in/hr]	7.68
A [ac]	1.885652	A [ac]	1.885652
Q [ft^3/s]	11.0839	Q [ft^3/s]	12.54292
Total	11.0839	Total	12.54292
Difference		1.459024	cfs
Volume		1313.121	ft^3

Pre-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.98	0.125987
Open Space, Good condition (grass cover 50% to 75%)	0.75	1.759665
Composite Coefficient	0.765367	

Post-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.98	0.951974
Open Space, Good condition (grass cover 50% to 75%)	0.75	0.933678
Composite Coefficient	0.866116	

Mason City Title 30 - Appendix B

Design for 5 yr storm

Pre-Development		Post-Development	
C [-]	0.20011	C [-]	0.528639
i [in/hr]	4.08	i [in/hr]	4.08
A [ac]	1.885652	A [ac]	1.885652
Cf [-]	1	Cf [-]	1
Q [ft^3/s]	1.53954	Q [ft^3/s]	4.06706
Total	1.53954	Total	4.06706
Difference		2.527521	cfs
Volume		2274.769	ft^3

Pre-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.9	0.125987
Lawns, Heavy Soil, Flat: <=2%	0.15	1.759665
Composite Coefficient	0.20011	

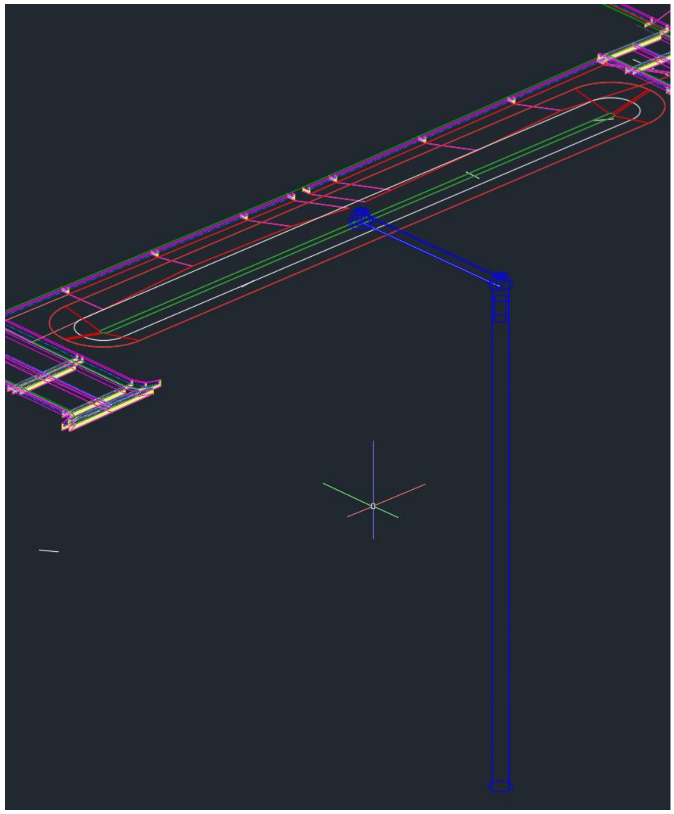
Post-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.9	0.951974
Lawns, Heavy Soil, Flat: <=2%	0.15	0.933678
Composite Coefficient	0.528639	

Design for 100 yr storm

Pre-Development		Post-Development	
C [-]	0.20011	C [-]	0.528639
i [in/hr]	7.28	i [in/hr]	7.28
A [ac]	1.885652	A [ac]	1.885652
Cf [-]	1.25	Cf [-]	1.25
Q [ft^3/s]	2.747022	Q [ft^3/s]	7.256912
Total	2.747022	Total	7.256912
Difference		4.50989	cfs
Volume		4058.901	ft^3

Pre-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.9	0.125987
Lawns, Heavy Soil, Flat: <=2%	0.15	1.759665
Composite Coefficient	0.20011	

Post-Development Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways, etc.	0.9	0.951974
Lawns, Heavy Soil, Flat: <=2%	0.15	0.933678
Composite Coefficient	0.528639	



CAD drawing of retention pond and conveyance system

Modeled Pipe:

$$D := \frac{15}{12}\ in \qquad n := 0.013$$

$$A := \frac{\pi}{4} \cdot D^2 = 1.227\ in^2 \qquad S := 0.02\ \frac{ft}{ft}$$

Estimate Pipe 2/3 Full

$$P := 3.821\ ft$$

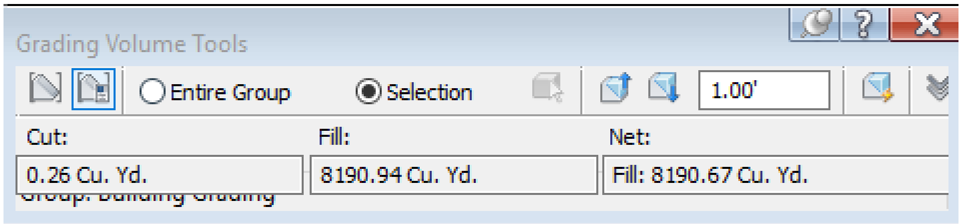
$$R := \frac{A}{P} = 0.321\ ft$$

$$Q := \frac{1.486 \cdot A \cdot R^{\frac{2}{3}}}{n} \cdot S^{\frac{1}{2}} = 9.304\ \frac{ft^3}{s}$$

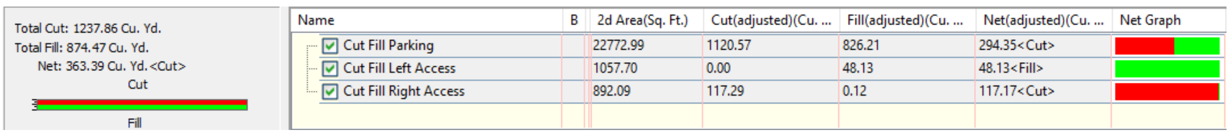
$$V := \frac{Q}{A} = 7.581\ \frac{ft}{s}$$

Pipe flow rate estimation

Appendix 7: Cost Estimate

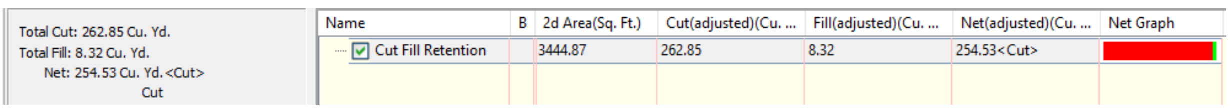


Building infill and surrounding grading



Name	B	2d Area(Sq. Ft.)	Cut(adjusted)(Cu. ...	Fill(adjusted)(Cu. ...	Net(adjusted)(Cu. ...	Net Graph
Cut Fill Parking		22772.99	1120.57	826.21	294.35<Cut>	
Cut Fill Left Access		1057.70	0.00	48.13	48.13<Fill>	
Cut Fill Right Access		892.09	117.29	0.12	117.17<Cut>	

Parking lot and access road cut and fill



Name	B	2d Area(Sq. Ft.)	Cut(adjusted)(Cu. ...	Fill(adjusted)(Cu. ...	Net(adjusted)(Cu. ...	Net Graph
Cut Fill Retention		3444.87	262.85	8.32	254.53<Cut>	

Retention pond cut and fill

The final cost estimate contained a variety of other materials needed to complete the project, but they were estimated based on the size of our project. The cut and fill requirements are estimates for work that would need to be done. The west side of the property has a significant elevation change that would require land acquisition to allow for grading to existing elevation, or a retention wall would need to be added. The front face of the building also has minor grading that needed to be applied since the elevation change would only be 0.25ft.

Appendix 8: Bibliography

American Concrete Institute, *ACI 318-14 Building Code Requirements for Structural Concrete and Commentary*

American Institute of Steel Construction, *AISC Steel Construction Manual*

American Society of Civil Engineering, *ASCE7-10 Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

American Wood Council, *National Design Specifications for Wood Construction*

American Wood Council, *Special Design Provisions for Wind and Seismic*

Americans With Disabilities Act, Accessible Parking http://adata.org/factsheet/parking

Asphalt Paving Association, Chapter 3 Design Considerations http://www.apai.net/Files/content/DesignGuide/Chapter_3B.pdf

Asphalt Paving Association, Chapter 4 Thickness Design http://www.apai.net/Files/content/DesignGuide/Chapter_4B.pdf

Asphalt Paving Association, Chapter 5 Parking Lot Design http://www.apai.net/Files/content/DesignGuide/Chapter_5B.pdf

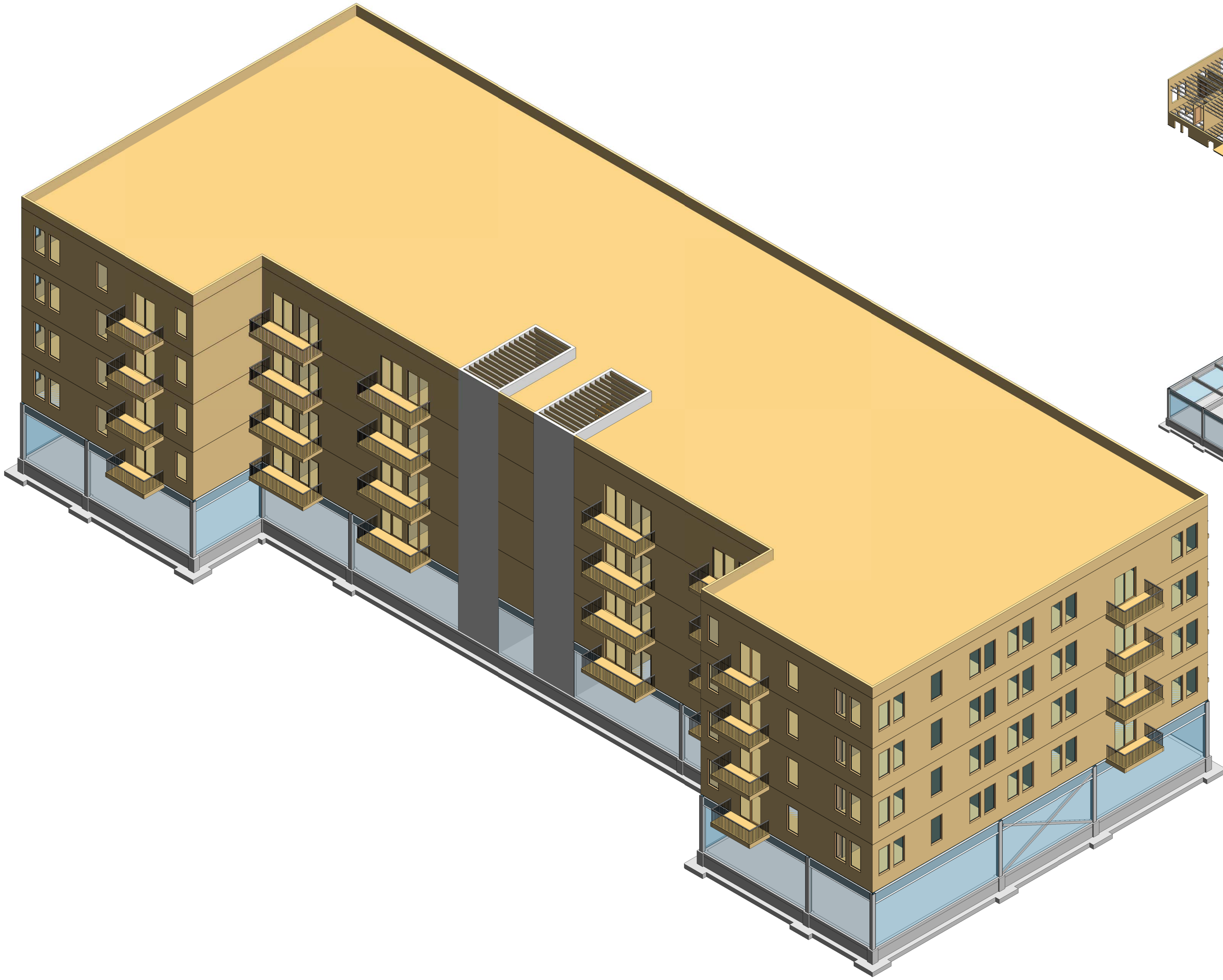
City Code, Mason City, IA http://www.sterlingcodifiers.com/codebook/index.php?book_id=382

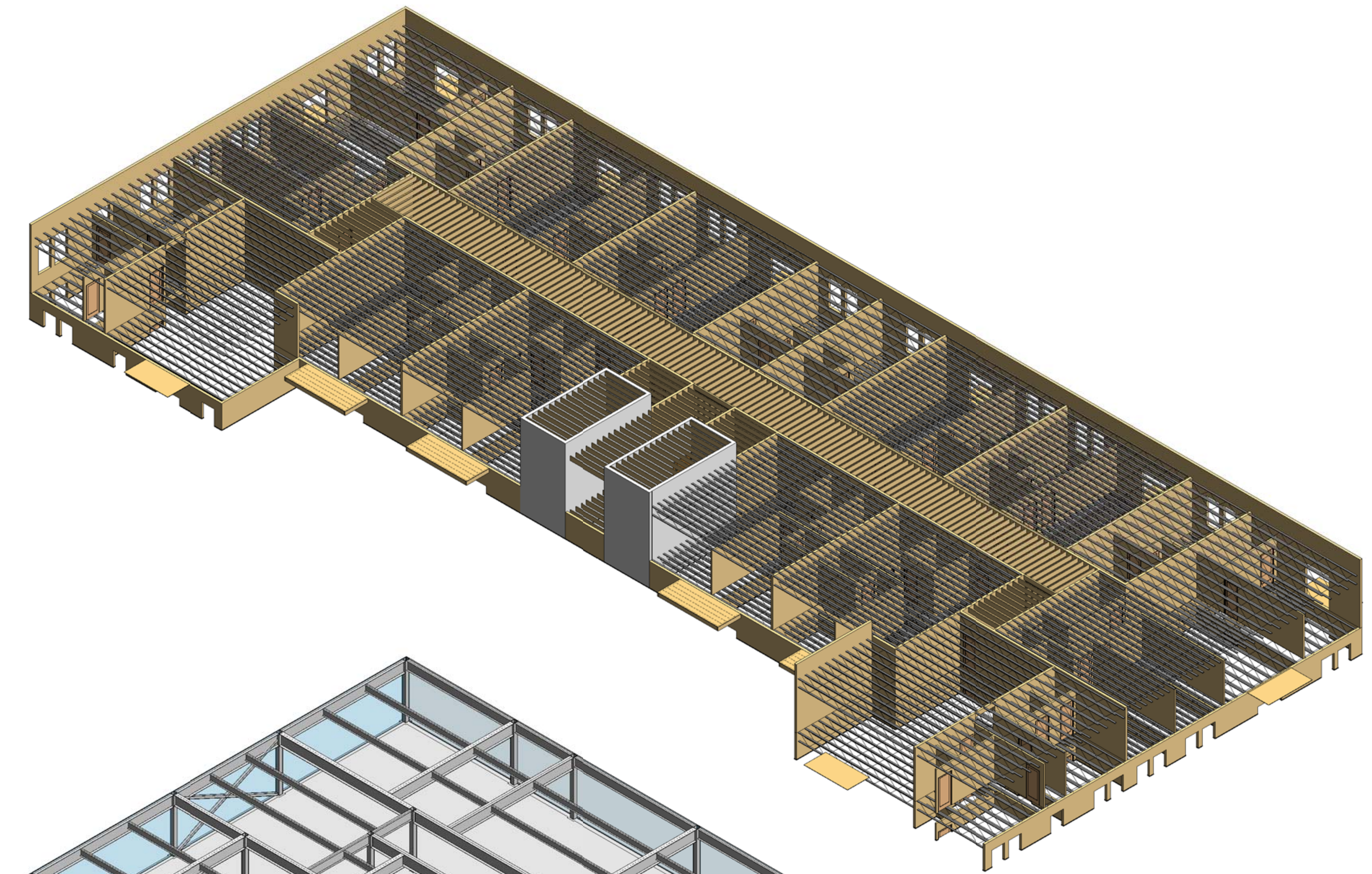
International Code Council, *International Building Code 2015*

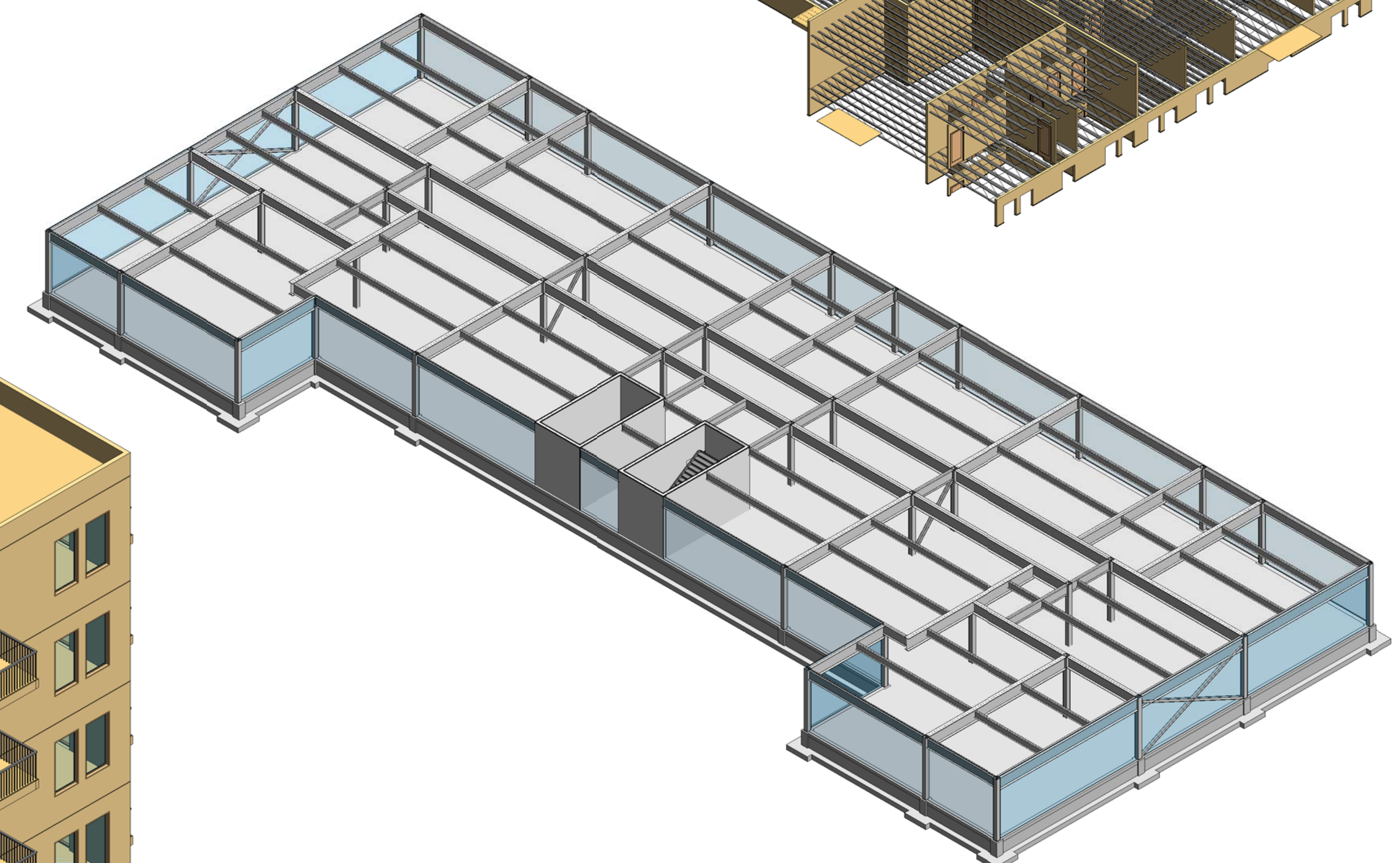
Iowa Statewide Urban Design and Standards Chapter 8B Parking Lot Layout and design http://www.iowasudas.org/manuals/design/Chapter08/8B-1.pdf

The Masonry Society, *TMS 402/602 Building Code Requirements and Specification for Masonry Structures*

Title 12 Zoning Ordinance, Mason City, IA https://masoncity.municipalcms.com/files/documents/ZoningOrdinance16-T-02Amended10-4-20161198121055102716PM.pdf







NOTES:
1. IN ISOMETRIC VIEWS, NOT ALL STRUCTURAL ELEMENTS ARE SHOWN. SEE FRAMING PLANS FOR ALL STRUCTURAL ELEMENTS.

MASON CITY CONDOMINIUM DEVELOPMENT

PROJECT:	CEE:4850
DATE :	05/04/2018
DRAWN BY:	DHNJ ENGINEERS
REVISION:	

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CONDOMINIUM DEVELOPMENT

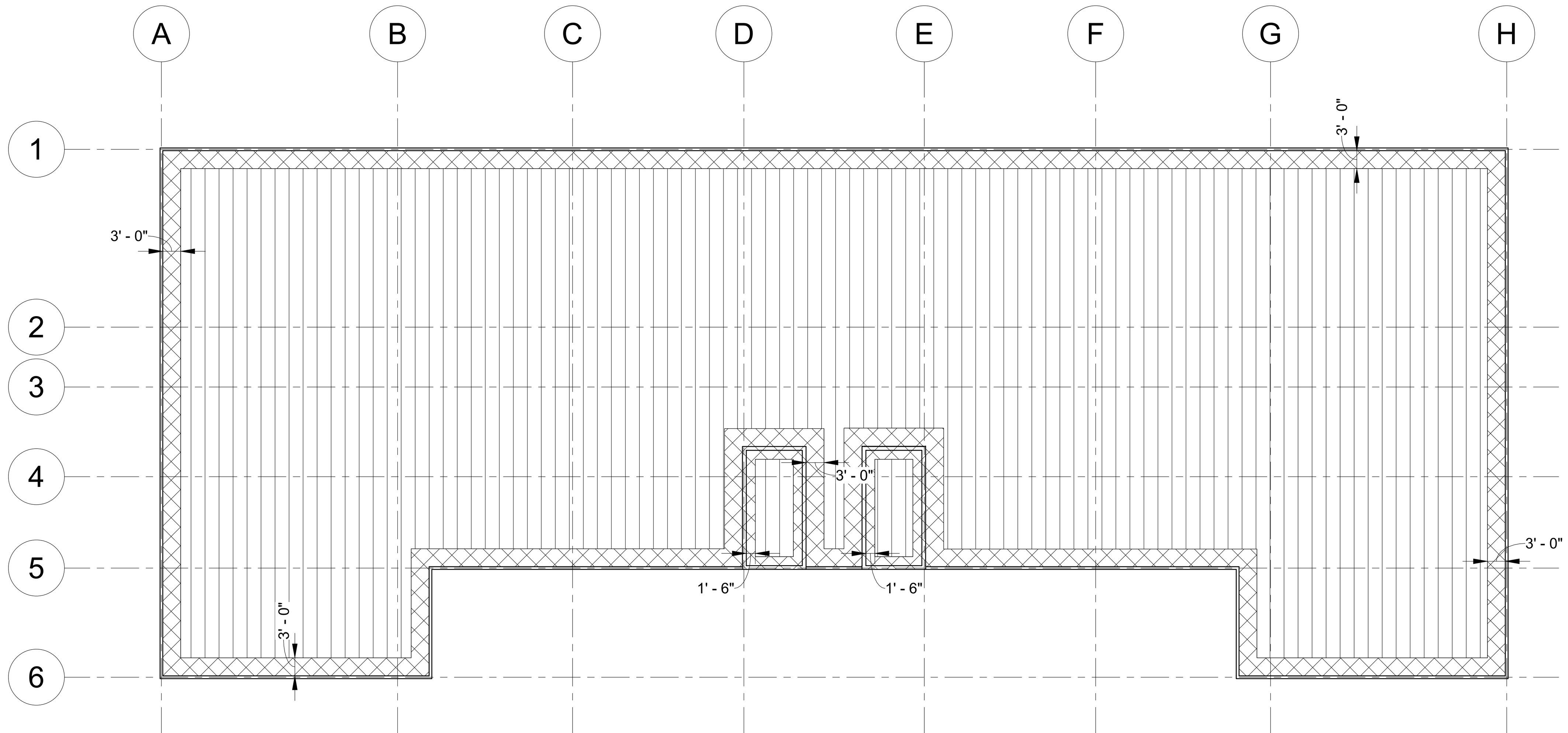
540 4TH ST NE
MASON CITY, IA 50401

SHEET NAME

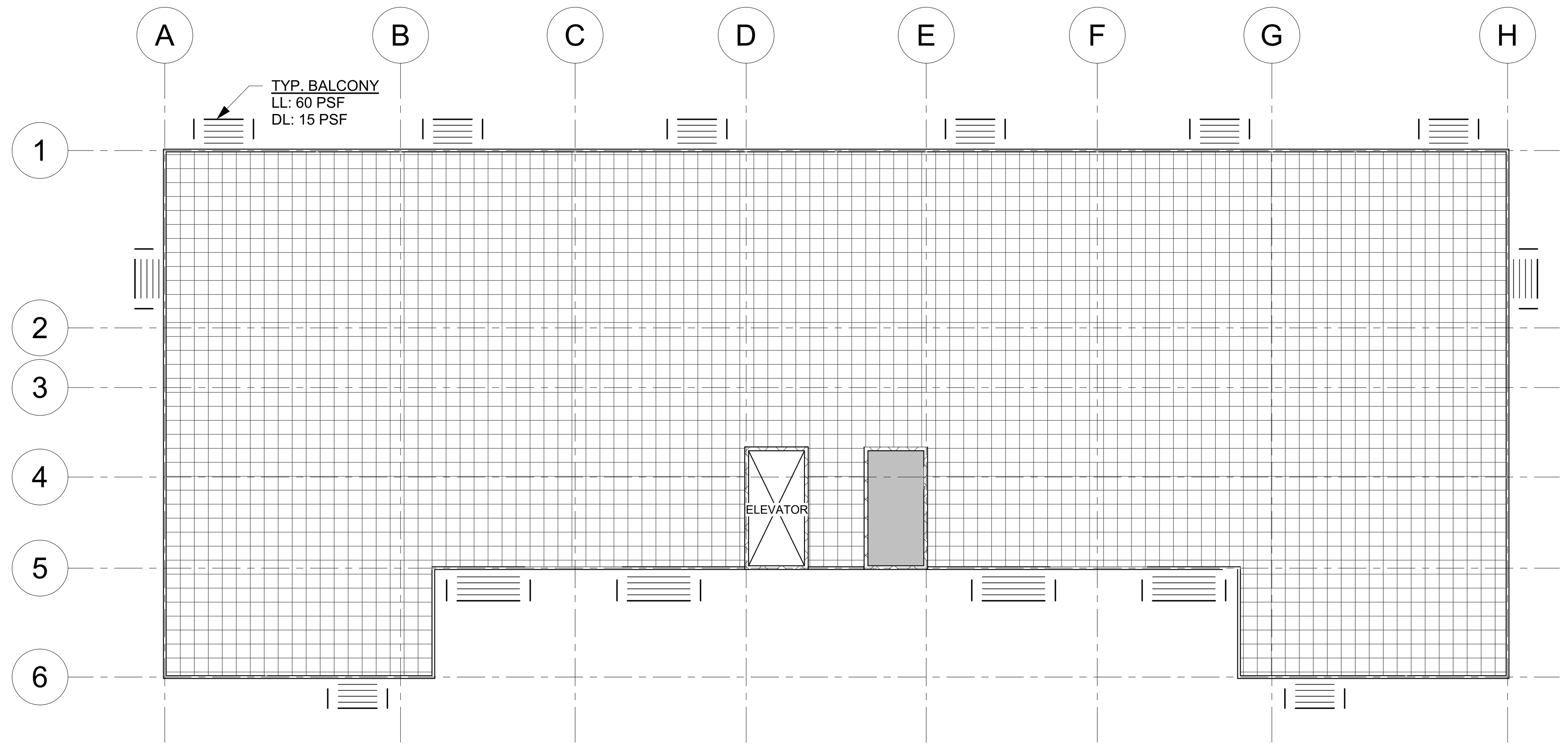
COVER PAGE

SHEET NO.

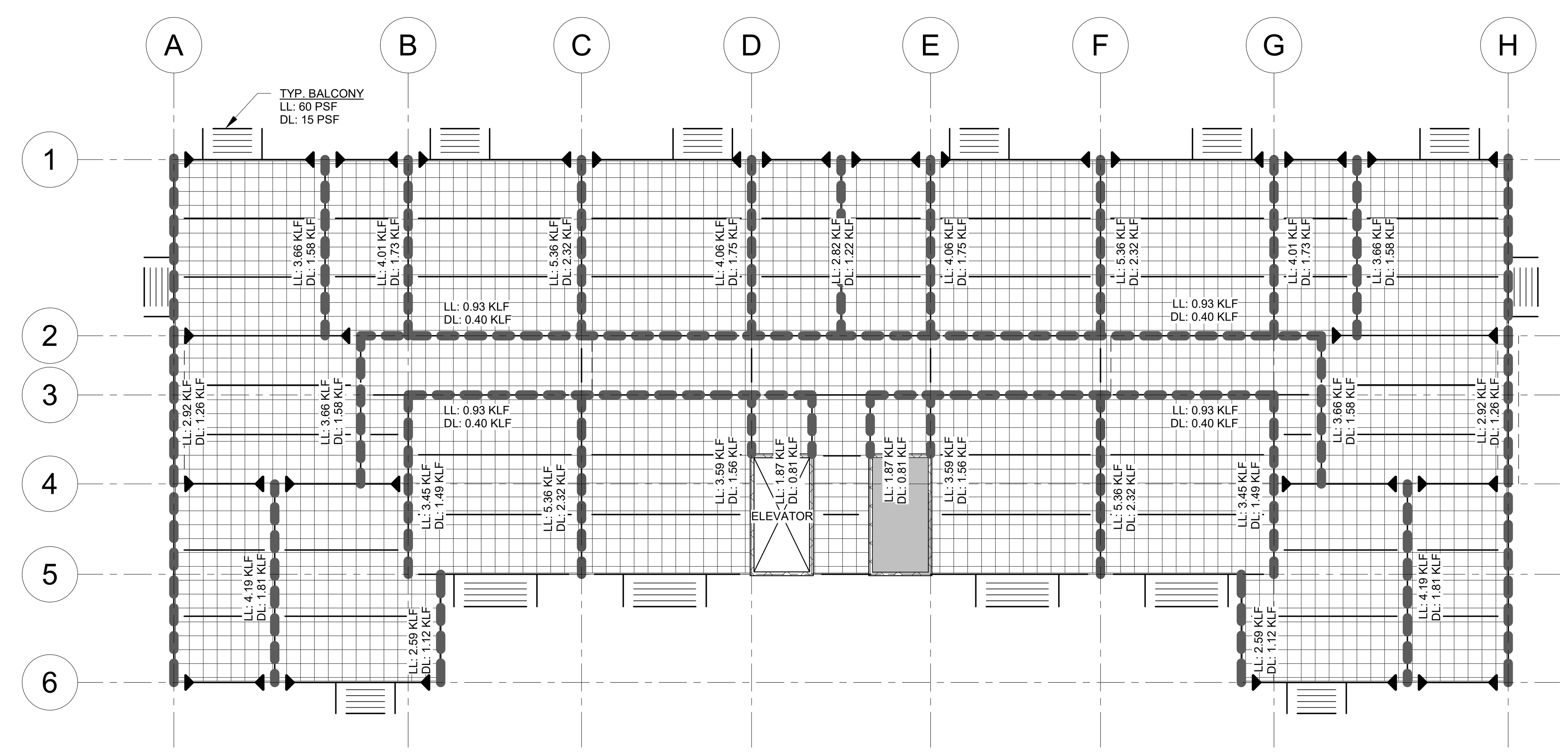
S.0



1 LOADING DIAGRAM - ROOF
1 : 225



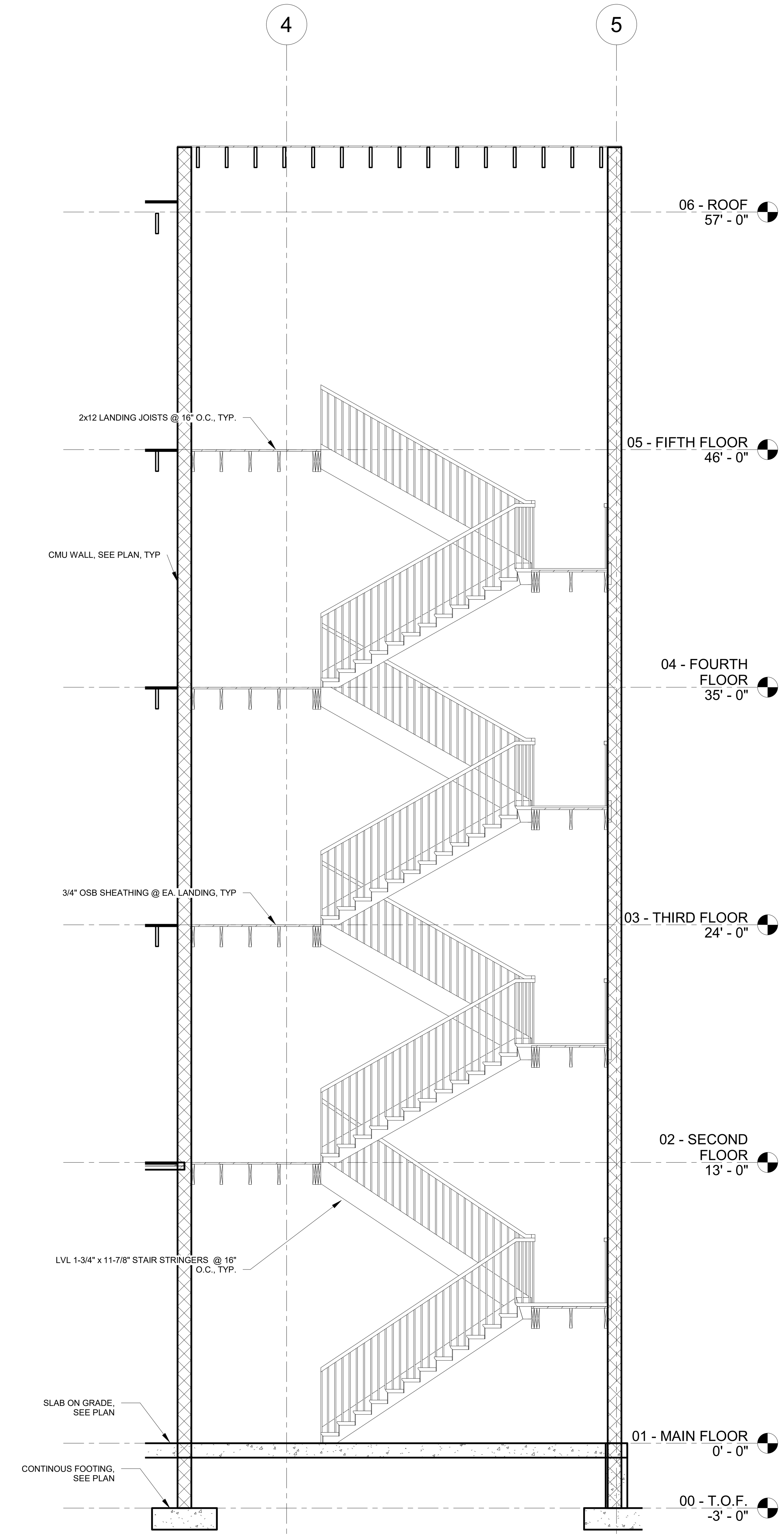
2 LOADING DIAGRAM - TYP FLOOR
1 : 225



3 LOADING DIAGRAM - STEEL
1 : 225

LOADING DIAGRAM SCHEDULE			
MARK	LL	DL	NOTES
	25	20	@ ROOF
	35	20	@ ROOF w/ SNOW DRIFT
	40	15	@ TYP. FLOOR
	100	15	@ STAIRS

NOTES:
1. ALL LOADS SHOWN ARE GRAVITY LOADS ONLY
2. LENGTH OF SNOW DRIFT SHOWN BY DIMENSION ON PLAN
3. DASHED LINES ONLY SHOW LOADING FROM BEARING WALLS. STEEL WITHOUT LOADING FROM BEARING WALLS STILL SUPPORTS DEAD LOAD OF WALL ABOVE



4 STAIR ELEVATION
1 : 45

PROJECT: CEE:4850
DATE : 05/04/2018
DRAWN BY: DHNJ ENGINEERS
REVISION:

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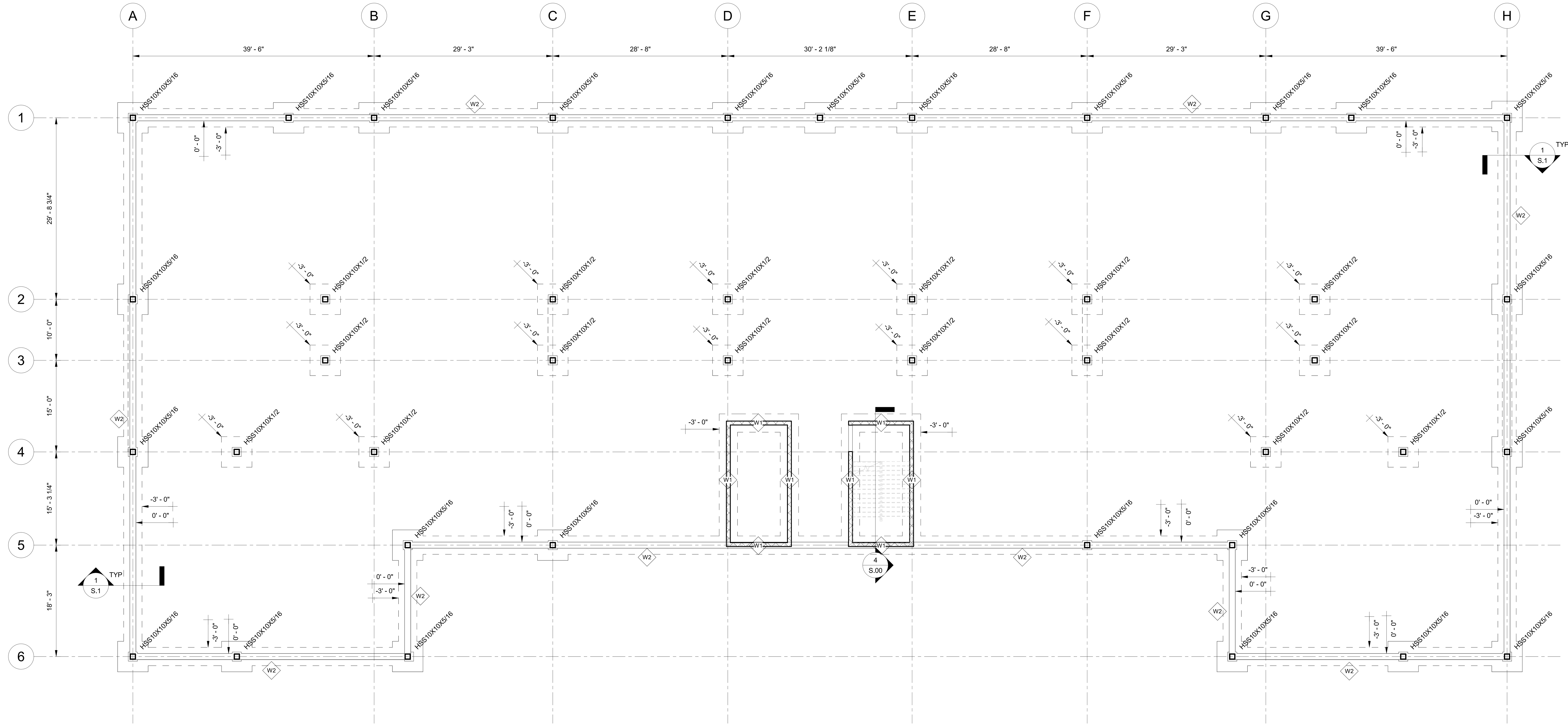
SHEET NAME

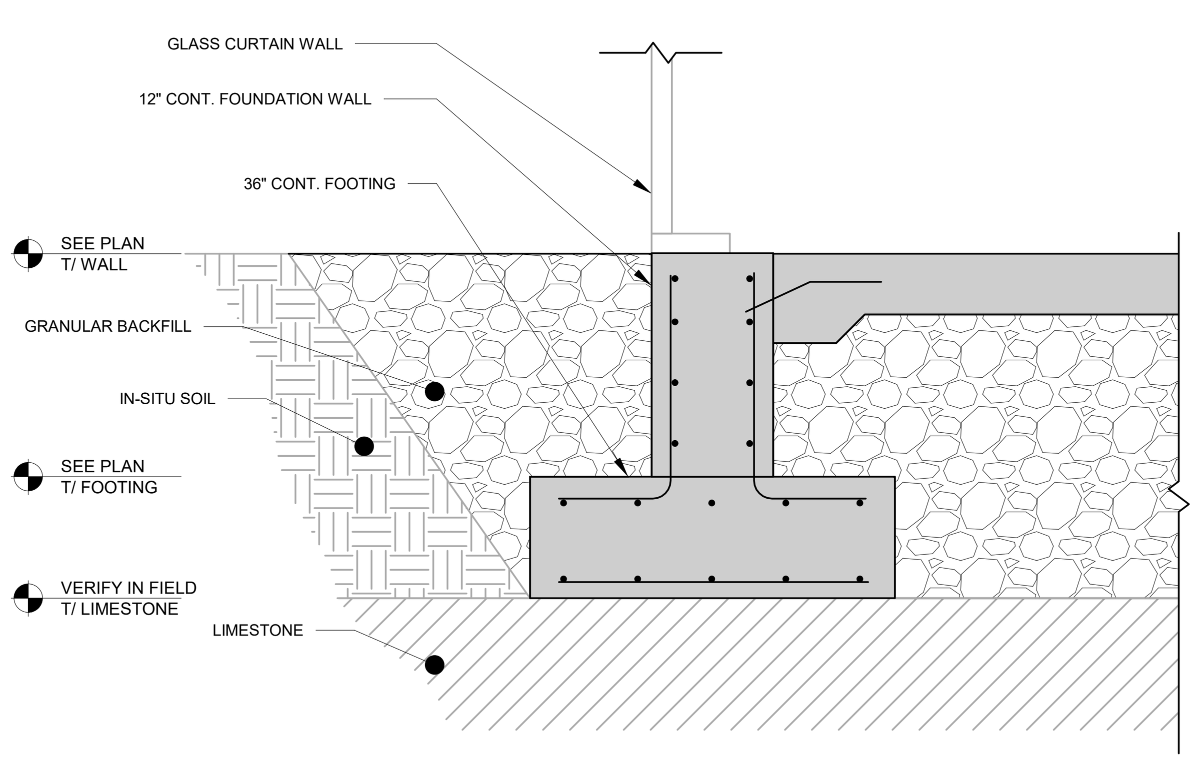
LOADING DIAGRAMS

SHEET NO.

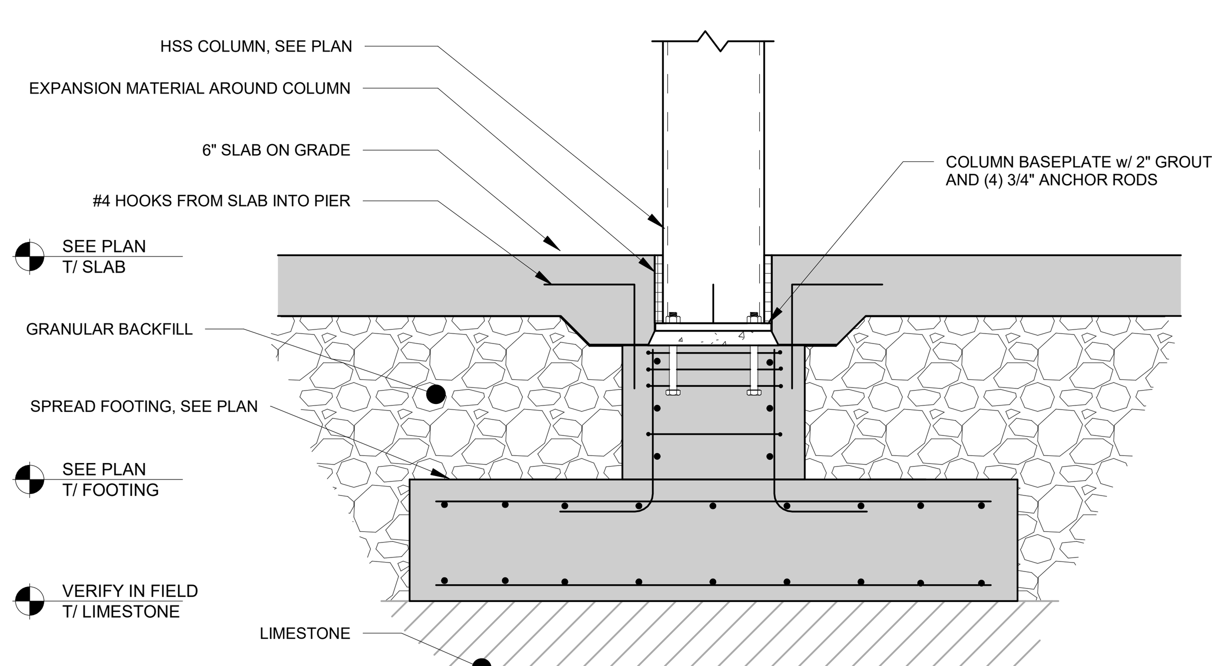
S.00



A 01- FOUNDATION PLAN
1 : 100



1 FOUNDATION WALL DETAIL
1 : 15



2 SPREAD FOOTING DETAIL
1 : 15

FOOTING SCHEDULE				
MARK	SIZE	TOP MAT	BOTTOM MAT	NOTES
SF1	SPREAD FOOTING: 60"x60"x12" (BxWxT)	#5 @ 9" O.C. BOTH WAYS	#5 @ 9" O.C. BOTH WAYS	@ COLUMNS
CF1	CONTINUOUS FOOTING: 36"x12" (BxT)	---	(3) #5 CONT.	@ FOUNDATION PERIMETER

NOTES:
1. ALL SPREAD FOOTINGS ARE SF1 AND ALL CONTINUOUS FOOTINGS ARE CF1 U.N.O.

CONCRETE & CMU WALL SCHEDULE				
MARK	SIZE	HORIZONTAL REINF.	VERTICAL REINF.	NOTES
W1	CMU: 12" THICK	LADDER TYPE @ 16" O.C.	GROUT + (1) #5 @ 32" O.C.	@ STAIRS & ELEVATOR
W2	CONCRETE: 12" THICK	#5 @ 12" O.C.	#5 @ 12" O.C.	@ FOUNDATION PERIMETER

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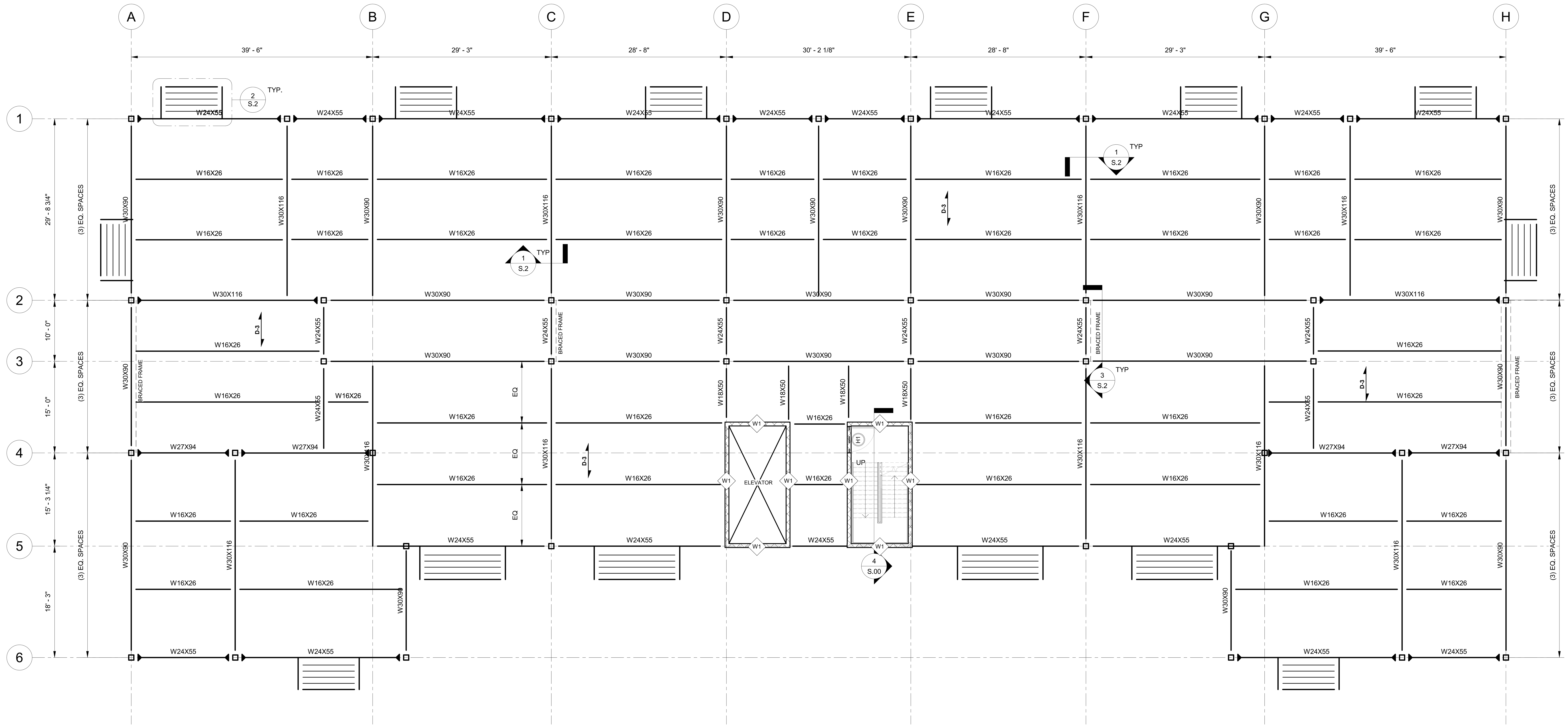
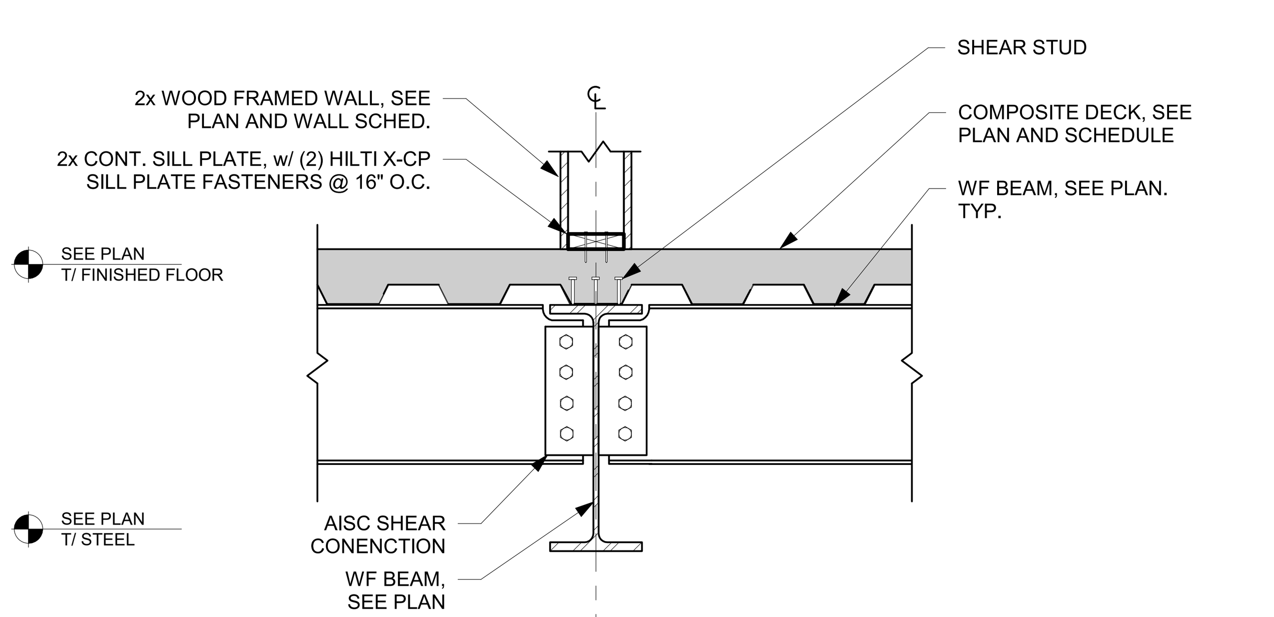
SHEET NAME
FOUNDATION PLAN

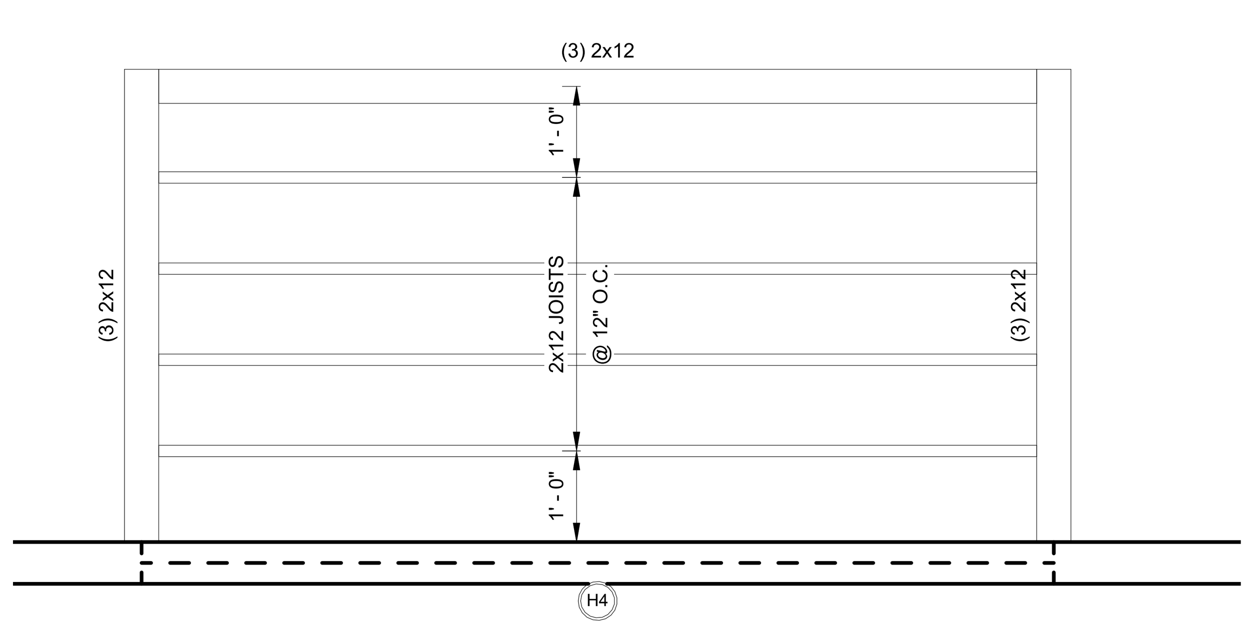
SHEET NO.
S.1



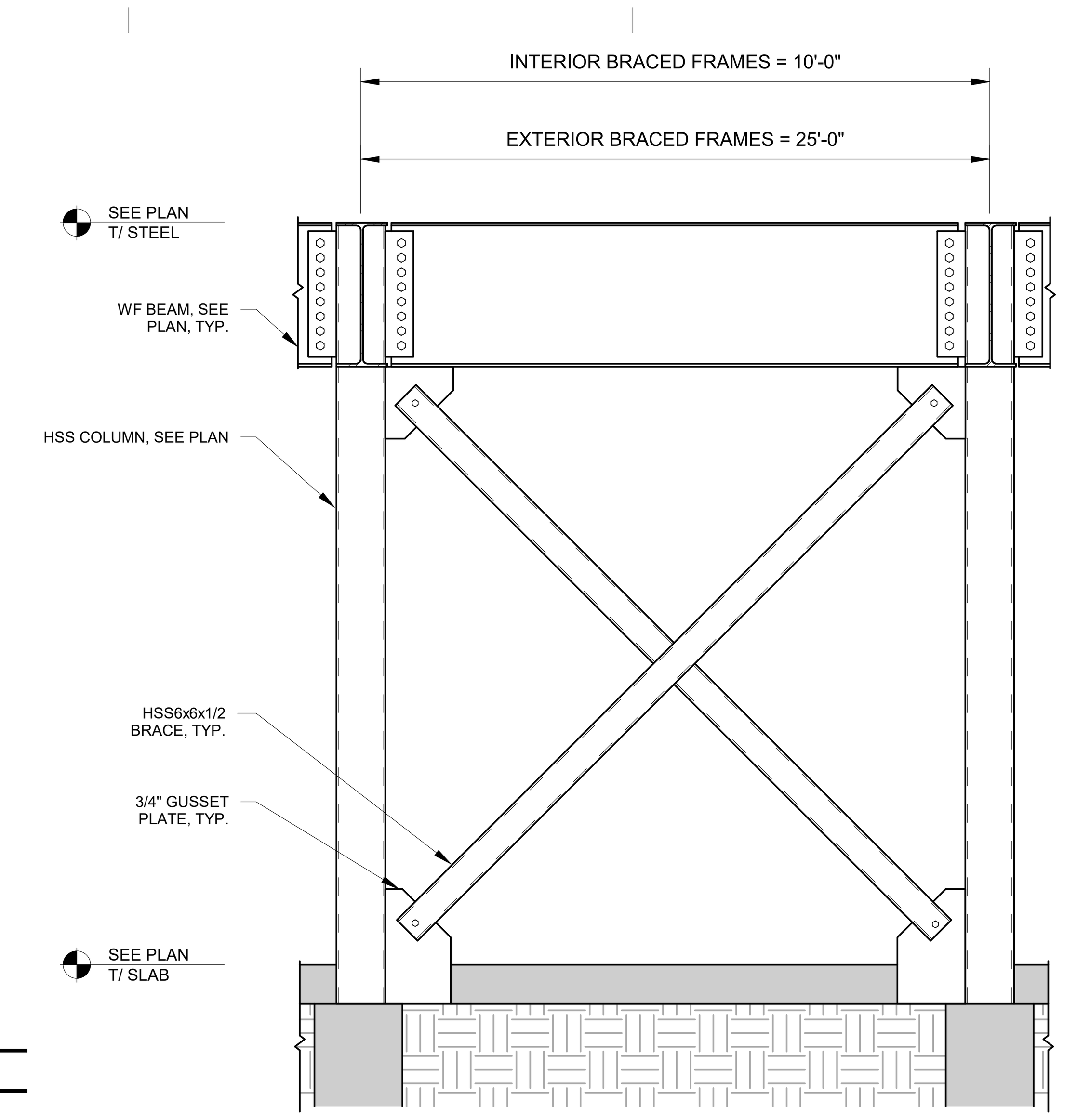
A 02 - SECOND FLOOR FRAMING PLAN
1 : 100



1 WOOD BEARING ON STEEL
1 : 15



2 TYP. BALCONY FRAMING
1 : 20



3 TYP. BRACED FRAME
1 : 30

DECKING SCHEDULE						
MARK	TYPE	FASTENER SIZE	SPACING		BLOCKING	NOTES
			EDGE	FIELD		
D-1	3/4" OSB SHEATHING	10d	6"	12"	BLOCKED	AT ROOF
D-2	3/4" OSB SHEATHING w/ 3/4" GYPCRETE	10d	6"	6"	BLOCKED	AT FLOORS 3/4/5
D-3	2VLI DECK w/ 3.5" NW CONCRETE	---	---	---	---	AT FLOOR 2

PROJECT: CEE:4850
DATE : 05/04/2018
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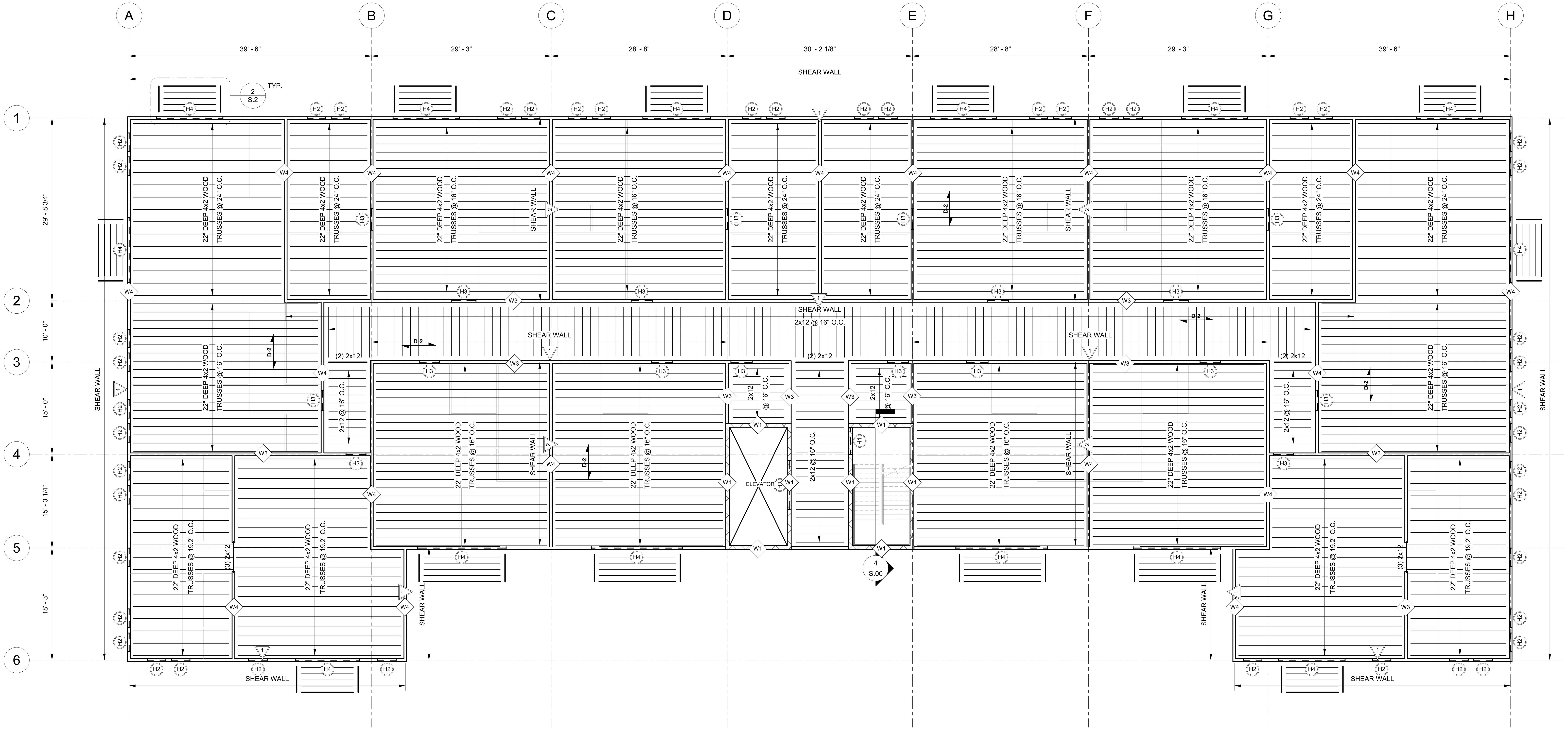
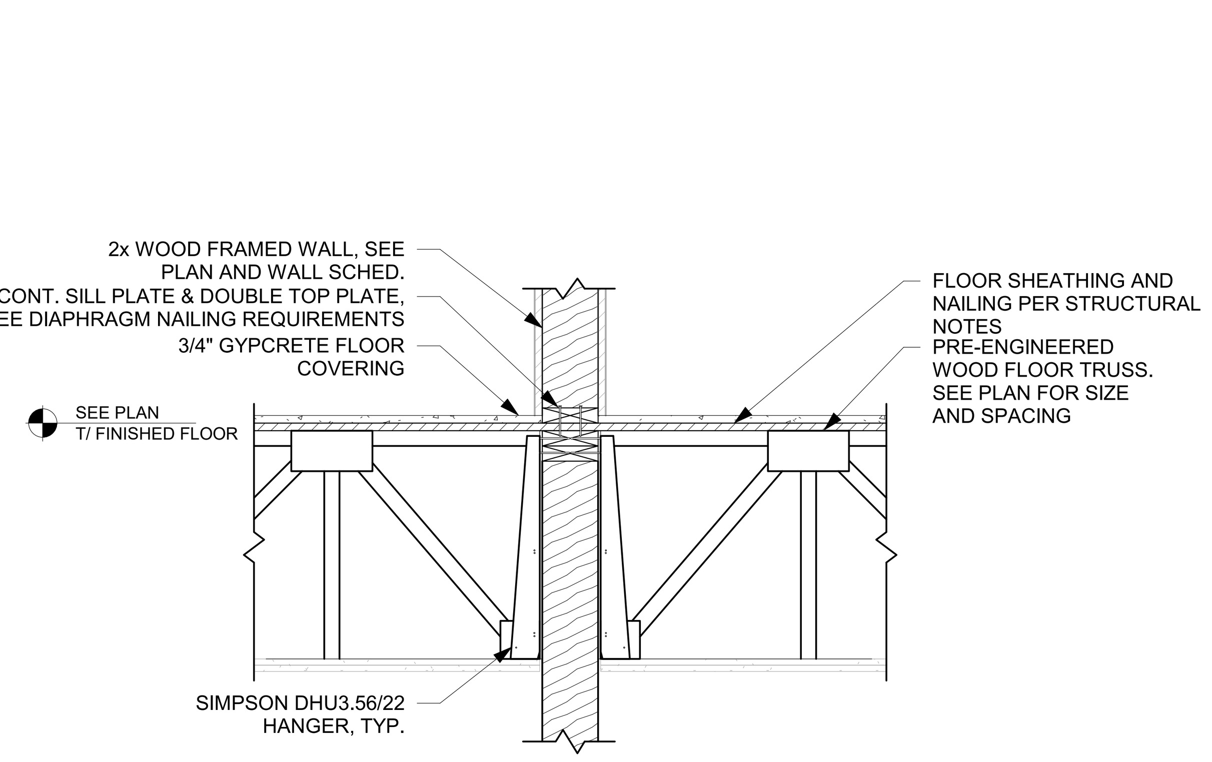
SHEET NAME
SECOND FLOOR FRAMING PLAN

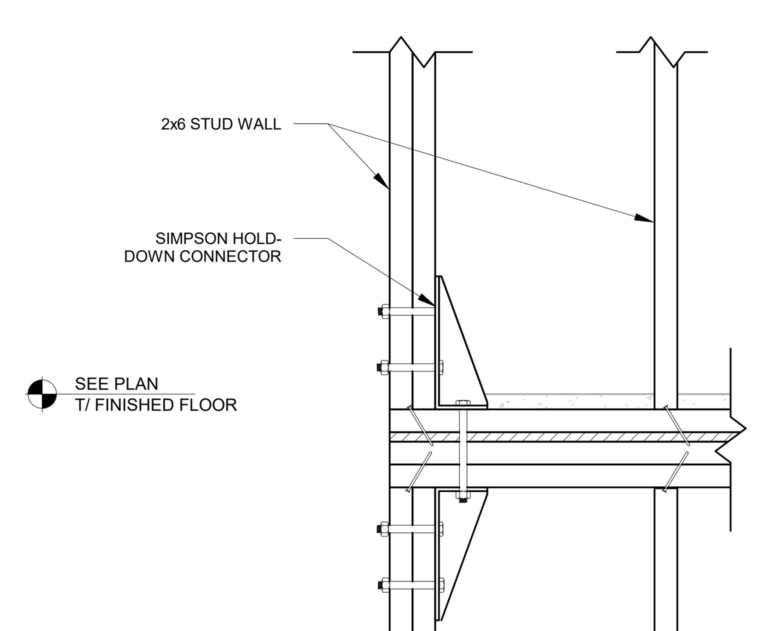
SHEET NO.
S.2



A 03 - THIRD FLOOR FRAMING PLAN
1 : 100



1 TYP. BEARING WALL
1 : 15



2 TYP. SHEAR WALL
1 : 10

HEADER SCHEDULE

MARK	SIZE	GEOMETRY	NOTES
H1	CMU: (2) COURSE BOND BEAM w/ (2) #5 CONT. @ BOTTOM, 8" MIN BEARING	BOND BEAM (2) #5 CONT. REBAR	@ STAIRS & ELEVATOR
H2	(3) PLY 2x6 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ WINDOWS
H3	(3) PLY 2x8 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ INTERIOR DOORS
H4	(3) PLY 2x12 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ BALCONY OPENINGS

WOOD BEARING/SHEAR WALL SCHEDULE

MARKS	W3	W4	1	2
STUD SIZE AND SPACING	2x6 @ 16" O.C.	2x6 @ 8" O.C.	SEE WALL SIZE TAG	SEE WALL SIZE TAG
SHEATHING TYPE	SEE SHEAR WALL TAG	SEE SHEAR WALL TAG	19/32" OSB	19/32" OSB
BLOCKED OR UNBLOCKED	BLOCKED	BLOCKED	BLOCKED	BLOCKED
NAILING	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 4" O.C. EDGES
HOLD DOWN (LOCATIONS SHOWN AS * ON PLAN)	HOLD DOWNS NOT REQUIRED	HOLD DOWNS NOT REQUIRED	SEE PLAN	SEE PLAN

PROJECT:	CEE:4850
DATE :	05/04/2018
DRAWN BY:	DHNJ ENGINEERS
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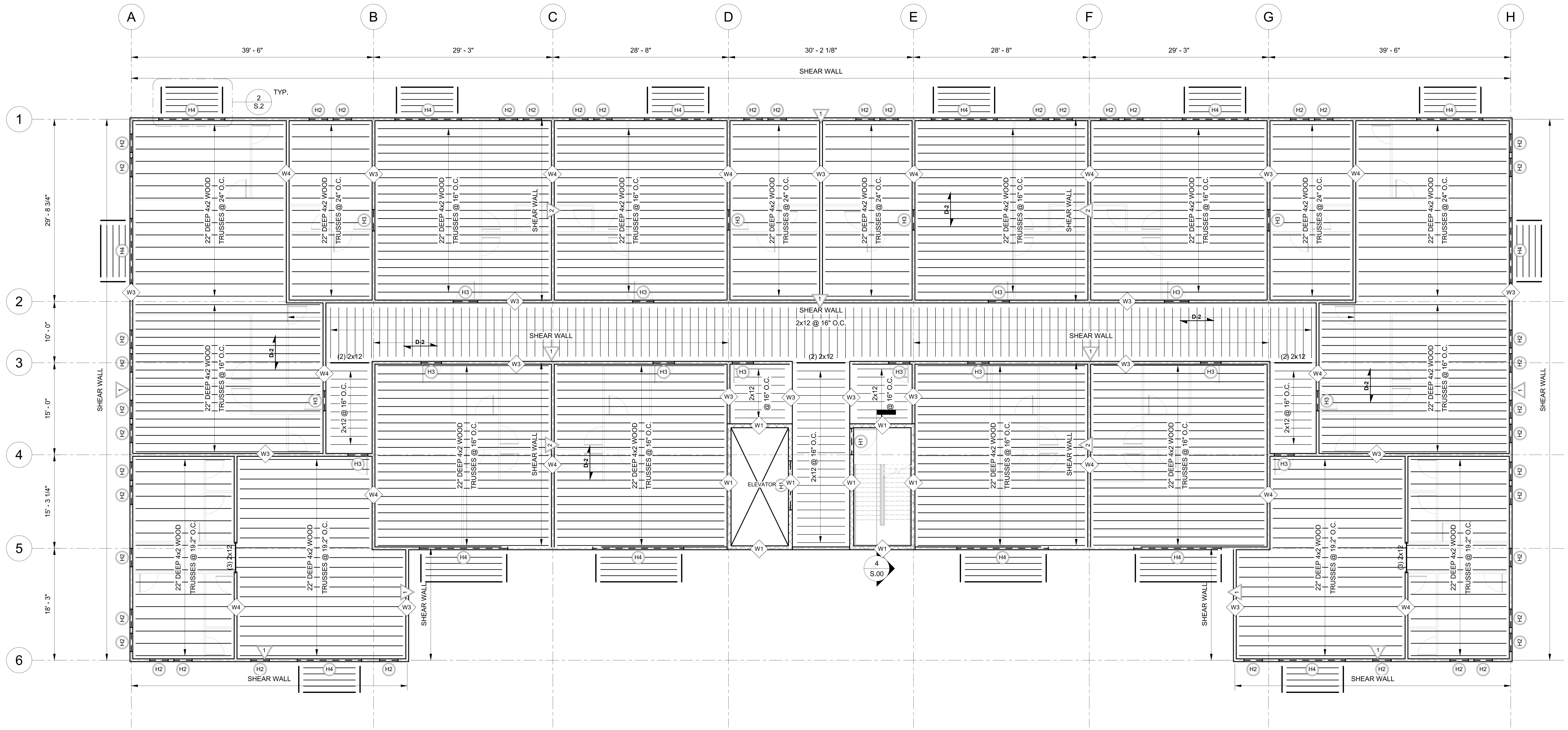
SHEET NAME

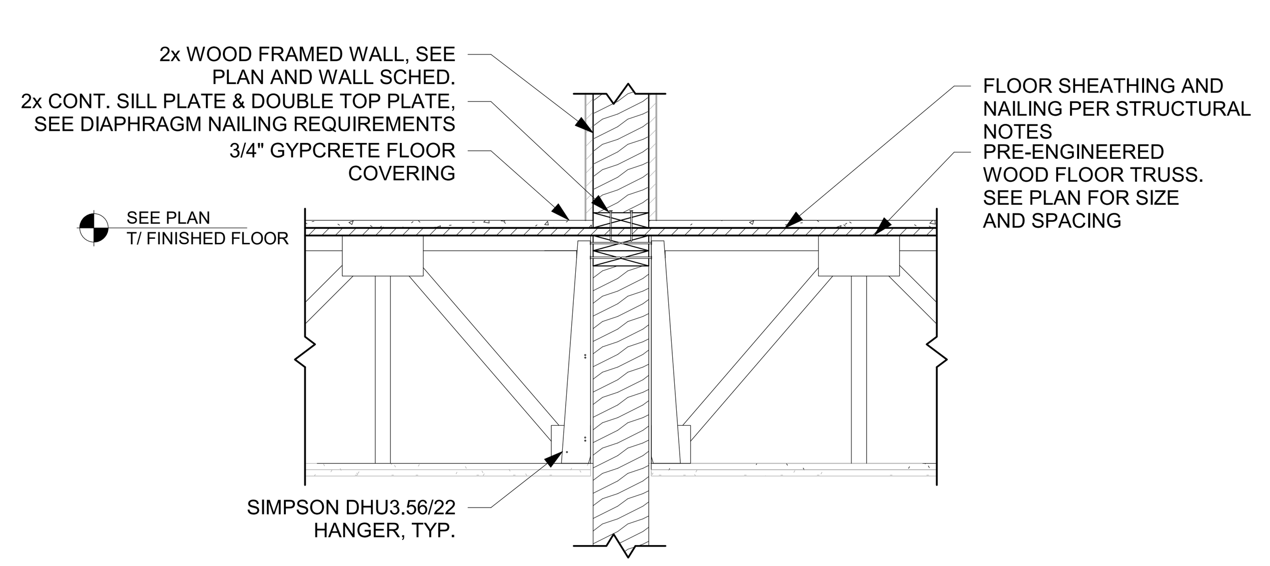
THIRD FLOOR FRAMING PLAN

SHEET NO.

S.3



A 04 - FOURTH FLOOR FRAMING PLAN
1 : 100



1 TYP. BEARING WALL
1 : 15

WOOD BEARING/SHEAR WALL SCHEDULE

MARKS	W3	W4	1	2
STUD SIZE AND SPACING	2x6 @ 16" O.C.	2x6 @ 8" O.C.	SEE WALL SIZE TAG	SEE WALL SIZE TAG
SHEATHING TYPE	SEE SHEAR WALL TAG	SEE SHEAR WALL TAG	19/32" OSB	19/32" OSB
BLOCKED OR UNBLOCKED	BLOCKED	BLOCKED	BLOCKED	BLOCKED
NAILING	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 4" O.C. EDGES
HOLD DOWN (LOCATIONS SHOWN AS * ON PLAN)	HOLD DOWNS NOT REQUIRED	HOLD DOWNS NOT REQUIRED	SEE PLAN	SEE PLAN

DECKING SCHEDULE

MARK	TYPE	FASTENER SIZE	SPACING		BLOCKING	NOTES
			EDGE	FIELD		
D-1	3/4" OSB SHEATHING	10d	6"	12"	BLOCKED	AT ROOF
D-2	3/4" OSB SHEATHING w/ 3/4" GYPCRETE	10d	6"	6"	BLOCKED	AT FLOORS 3/4/5
D-3	2VLI DECK w/ 3.5" NW CONCRETE	---	---	---	---	AT FLOOR 2

HEADER SCHEDULE

MARK	SIZE	GEOMETRY	NOTES
H1	CMU: (2) COURSE BOND BEAM w/ (2) #5 CONT. @ BOTTOM, 8" MIN BEARING	BOND BEAM (2) #5 CONT. REBAR	@ STAIRS & ELEVATOR
H2	(3) PLY 2x6 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ WINDOWS
H3	(3) PLY 2x8 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ INTERIOR DOORS
H4	(3) PLY 2x12 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ BALCONY OPENINGS

PROJECT: CEE:4850
DATE : 05/04/2018
DRAWN BY: DHNJ ENGINEERS
REVISION:

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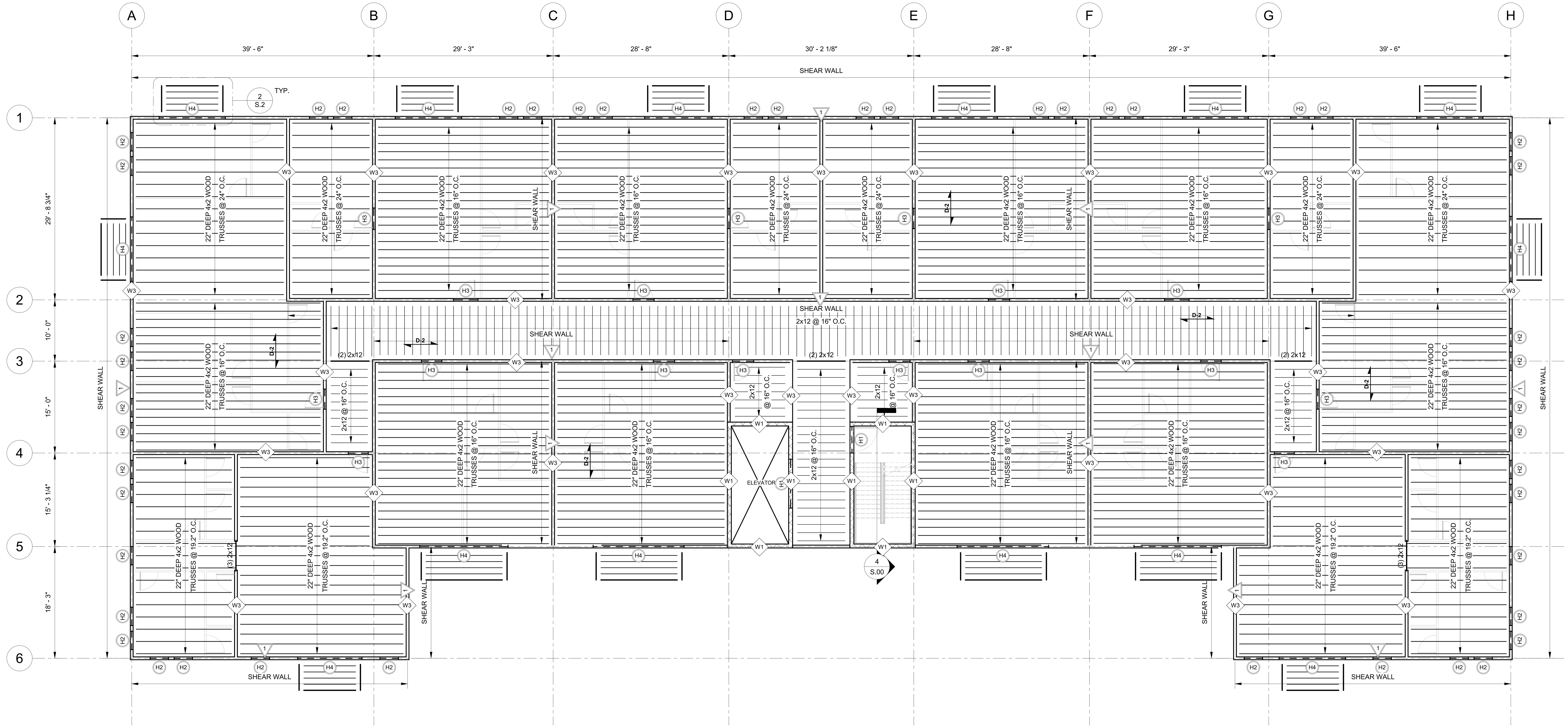
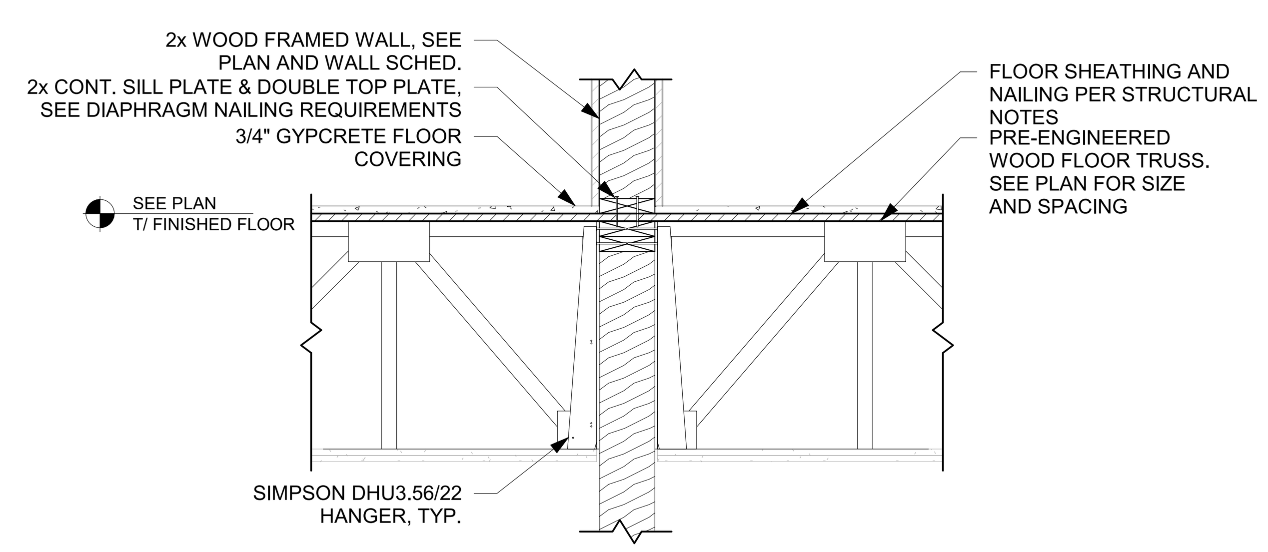
SHEET NAME
FOURTH FLOOR FRAMING PLAN

SHEET NO.
S.4



05 - FIFTH FLOOR FRAMING PLAN
1 : 100



1 TYP. BEARING WALL
1 : 15

WOOD BEARING/SHEAR WALL SCHEDULE

MARKS	W3	W4	1	2
STUD SIZE AND SPACING	2x6 @ 16" O.C.	2x6 @ 8" O.C.	SEE WALL SIZE TAG	SEE WALL SIZE TAG
SHEATHING TYPE	SEE SHEAR WALL TAG	SEE SHEAR WALL TAG	19/32" OSB	19/32" OSB
BLOCKED OR UNBLOCKED	BLOCKED	BLOCKED	BLOCKED	BLOCKED
NAILING	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 4" O.C. EDGES
HOLD DOWN (LOCATIONS SHOWN AS * ON PLAN)	HOLD DOWNS NOT REQUIRED	HOLD DOWNS NOT REQUIRED	SEE PLAN	SEE PLAN

DECKING SCHEDULE

MARK	TYPE	FASTENER SIZE	SPACING		BLOCKING	NOTES
			EDGE	FIELD		
D-1	3/4" OSB SHEATHING	10d	6"	12"	BLOCKED	AT ROOF
D-2	3/4" OSB SHEATHING w/ 3/4" GYPCRETE	10d	6"	6"	BLOCKED	AT FLOORS 3/4/5
D-3	2VLI DECK w/ 3.5" NW CONCRETE	---	---	---	---	AT FLOOR 2

HEADER SCHEDULE

MARK	SIZE	GEOMETRY	NOTES
H1	CMU: (2) COURSE BOND BEAM w/ (2) #5 CONT. @ BOTTOM, 8" MIN BEARING	BOND BEAM (2) #5 CONT. REBAR	@ STAIRS & ELEVATOR
H2	(3) PLY 2x6 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ WINDOWS
H3	(3) PLY 2x8 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ INTERIOR DOORS
H4	(3) PLY 2x12 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ BALCONY OPENINGS

PROJECT: CEE:4850
DATE : 05/04/2018
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540 4TH ST NE
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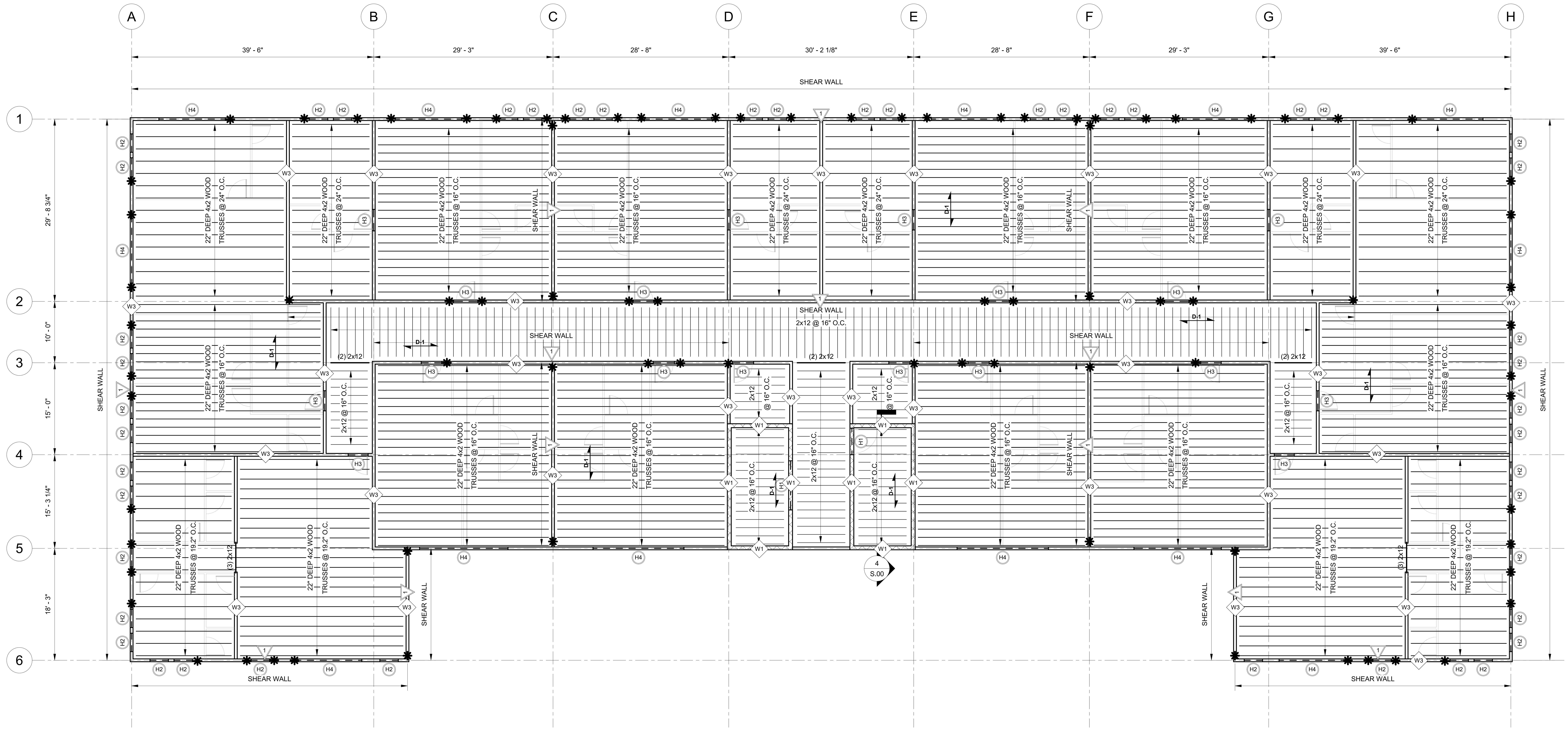
SHEET NAME

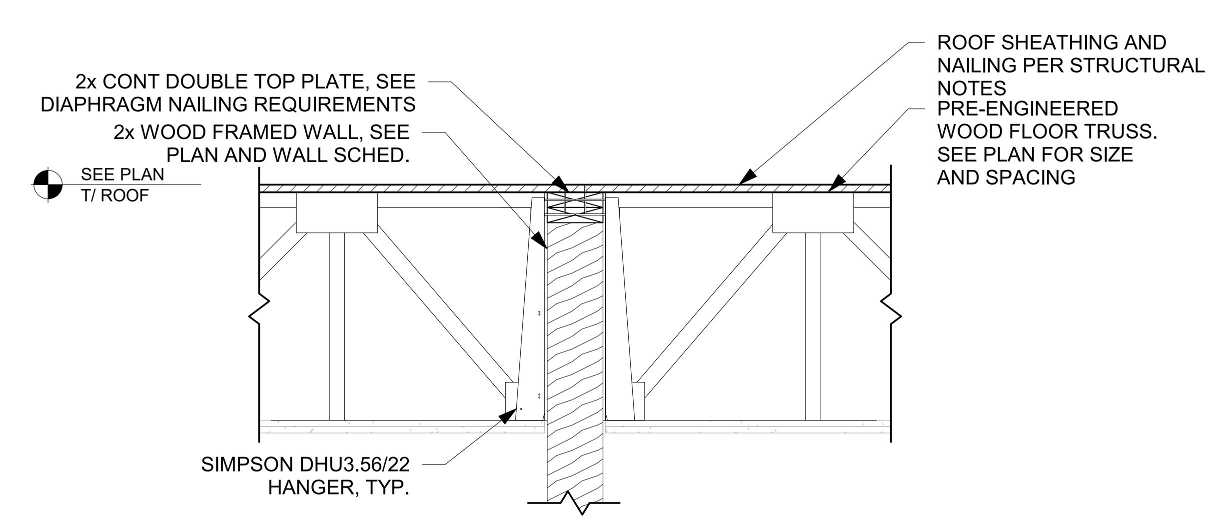
FIFTH FLOOR FRAMING PLAN

SHEET NO.

S.5



A 06 - ROOF FRAMING PLAN
1 : 100



1 TYP. BEARING WALL @ ROOF
1 : 15

WOOD BEARING/SHEAR WALL SCHEDULE

MARKS	W3	W4	1	2
STUD SIZE AND SPACING	2x6 @ 16" O.C.	2x6 @ 8" O.C.	SEE WALL SIZE TAG	SEE WALL SIZE TAG
SHEATHING TYPE	SEE SHEAR WALL TAG	SEE SHEAR WALL TAG	19/32" OSB	19/32" OSB
BLOCKED OR UNBLOCKED	BLOCKED	BLOCKED	BLOCKED	BLOCKED
NAILING	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 6" O.C. EDGES	10d @ 4" O.C. EDGES
HOLD DOWN (LOCATIONS SHOWN AS * ON PLAN)	HOLD DOWNS NOT REQUIRED	HOLD DOWNS NOT REQUIRED	SEE PLAN	SEE PLAN

DECKING SCHEDULE

MARK	TYPE	FASTENER SIZE	SPACING		BLOCKING	NOTES
			EDGE	FIELD		
D-1	3/4" OSB SHEATHING	10d	6"	12"	BLOCKED	AT ROOF
D-2	3/4" OSB SHEATHING w/ 3/4" GYPCRETE	10d	6"	6"	BLOCKED	AT FLOORS 3/4/5
D-3	2VLI DECK w/ 3.5" NW CONCRETE	---	---	---	---	AT FLOOR 2

HEADER SCHEDULE

MARK	SIZE	GEOMETRY	NOTES
H1	CMU: (2) COURSE BOND BEAM w/ (2) #5 CONT. @ BOTTOM, 8" MIN BEARING	BOND BEAM; (2) #5 CONT. REBAR	@ STAIRS & ELEVATOR
H2	(3) PLY 2x6 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ WINDOWS
H3	(3) PLY 2x8 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ INTERIOR DOORS
H4	(3) PLY 2x12 w/ (2) 2x6 FULL HEIGHT STUDS + (2) 2x6 JACK STUDS @ EA. JAMB	HEADER	@ BALCONY OPENINGS

PROJECT: CEE:4850
DATE: 05/04/2018
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CONDOMINIUM DEVELOPMENT

540 4TH ST NE
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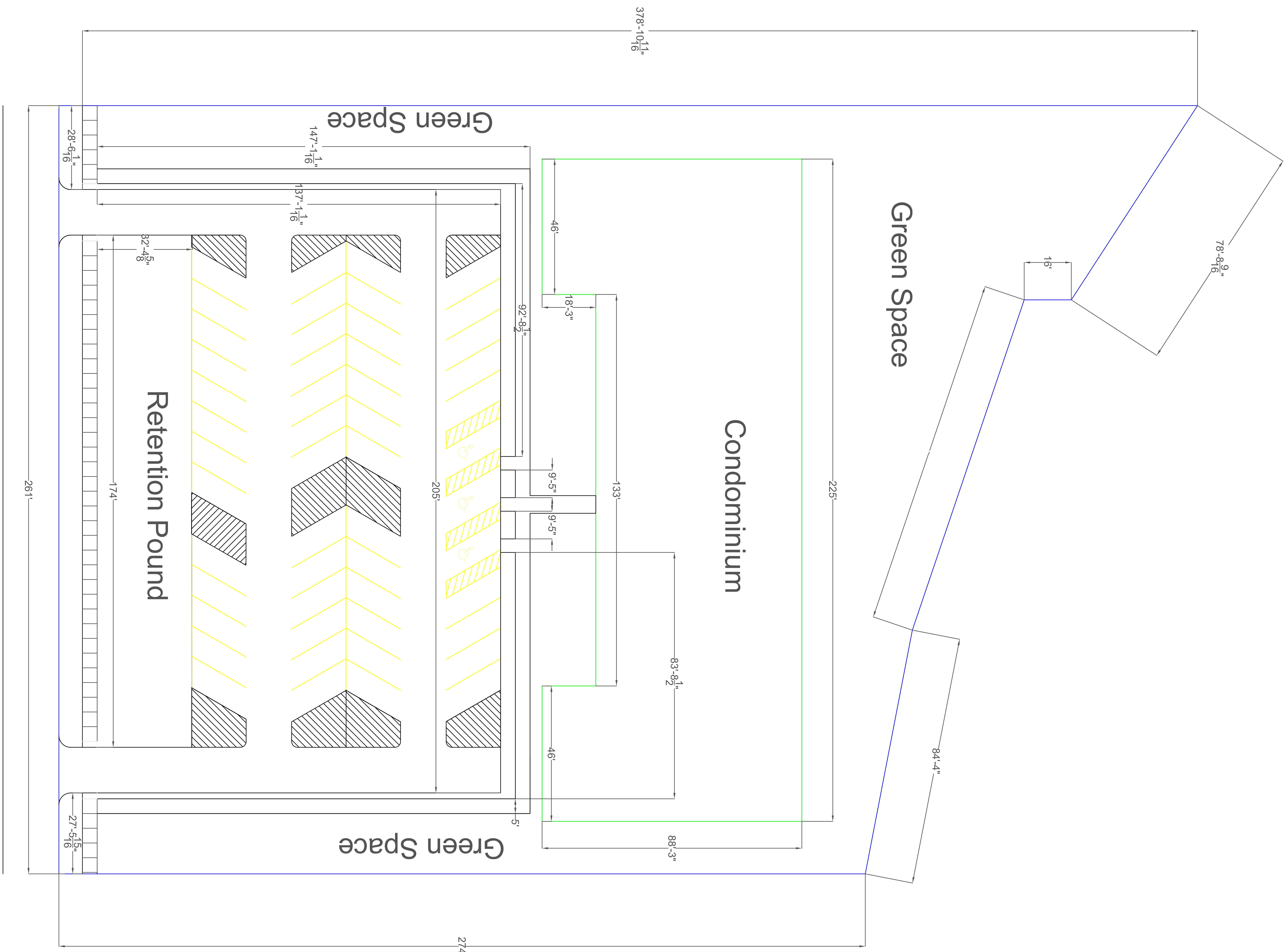
SHEET NAME

ROOF FRAMING PLAN

SHEET NO.

S.6


Skarpness Phot
540 4th Street Northeast



SHEET NO.

No.2

SHEET NAME

Construction Site

Condo Development

540 4th ST NE
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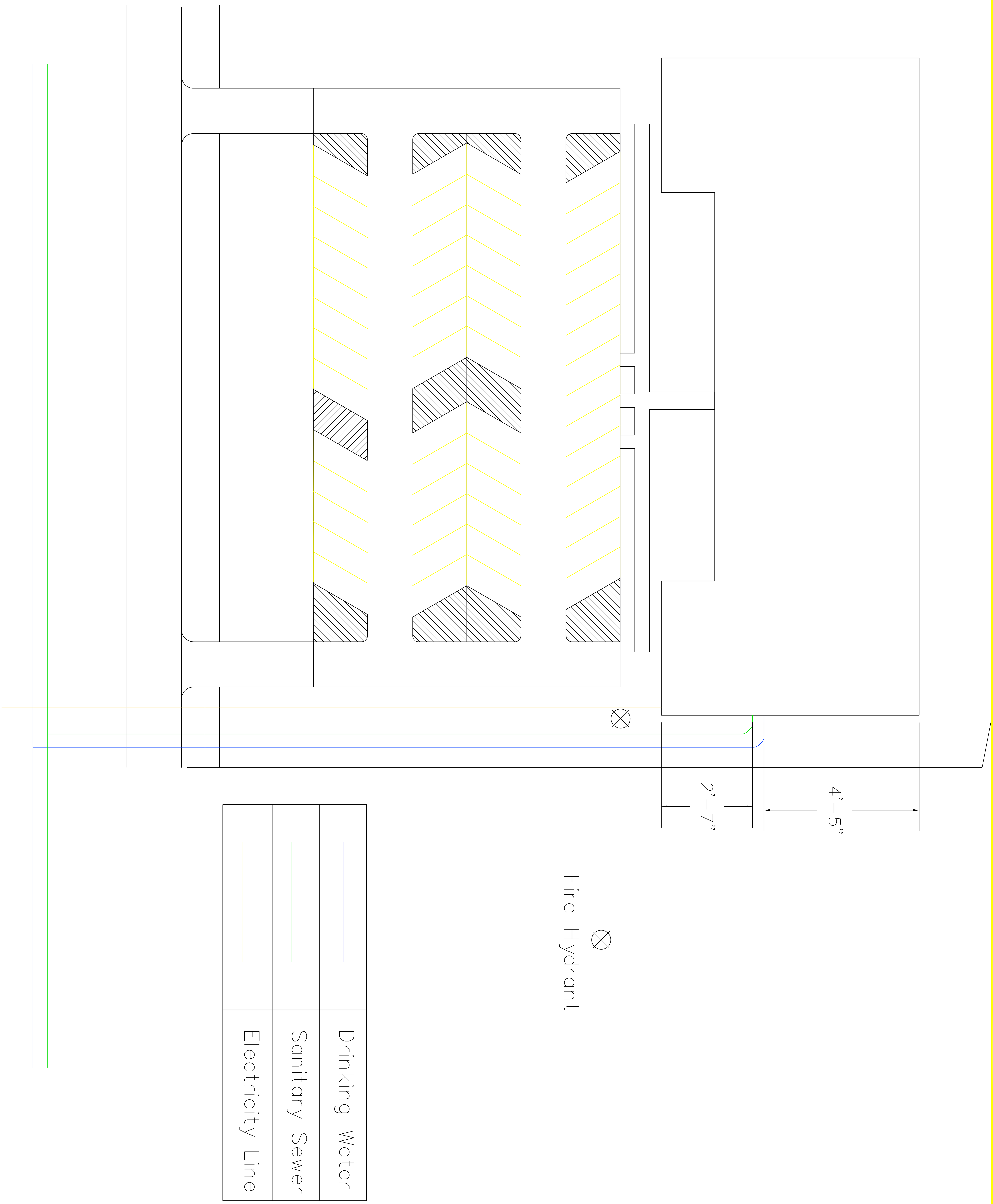
PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Noah Kalter
REVISION:	



SHEET NO.

No.3

SHEET NAME

Future Utility location

condo Development

540 4th ST NE
Mason city, IA

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PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Noah Kalter
REVISION:	

SHEET NO.
No.4

SHEET NAME
Existing Elevation

Condo Development

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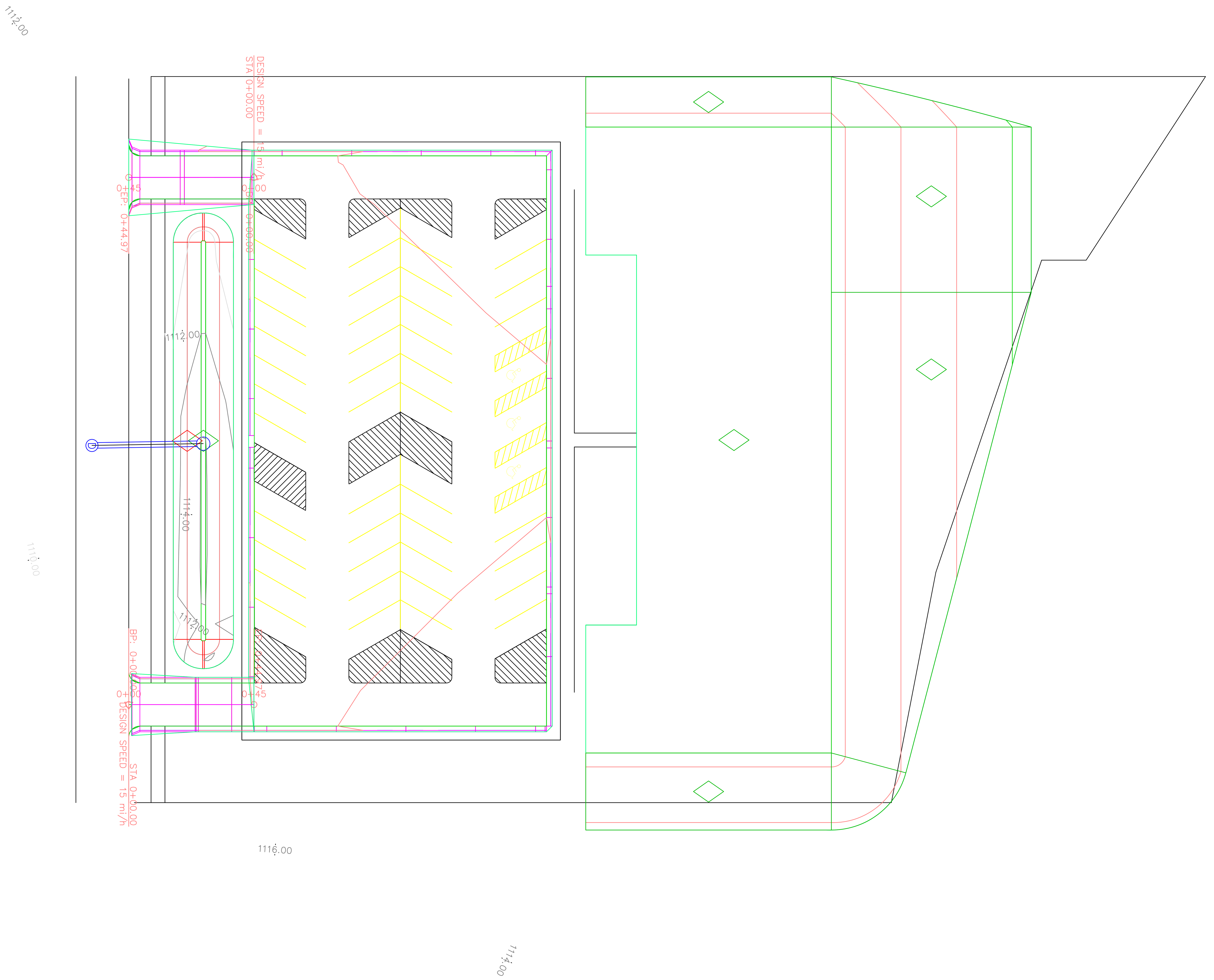
PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Noah kalter
REVISION:	



SHEET NO.	SHEET NAME				
No.5	Future Grading	**Condo Development** 540 4th ST NE Mason city, IA	EDUCATIONAL - NOT FOR CONSTRUCTION	CEE logo BW - noText.tif	PROJECT: CEE: 4850 DATE : 04/19/2018 DRAWN BY: Noah Kalter REVISION:

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Design for 5 yr storm			
Pre-Development		Post-Development	
C [-]	0.2001	C [-]	0.5286
i [in/hr]	4.08	i [in/hr]	4.08
A [ac]	1.8857	A [ac]	1.8857
Cf [-]	1	Cf [-]	1
Q [ft^3/s]	1.5395	Q [ft^3/s]	4.0671
Total	1.5395	Total	4.0671
Difference		2.5275	cfs
Volume	2274.8	ft^3	

Pre-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.126
Lawns, Heavy Soil, Flat: <=2%	0.15	1.7597
Composite	0.2001	

Post-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.952
Lawns, Heavy Soil, Flat: <=2%	0.15	0.9337
Composite Coefficient	0.5286	

Design for 10 yr storm			
Pre-Development		Post-Development	
C [-]	0.2001	C [-]	0.5286
i [in/hr]	4.76	i [in/hr]	4.76
A [ac]	1.8857	A [ac]	1.8857
Cf [-]	1	Cf [-]	1
Q [ft^3/s]	1.7961	Q [ft^3/s]	4.7449
Total	1.7961	Total	4.7449
Difference		2.9488	cfs
Volume	2653.9	ft^3	

Pre-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.126
Lawns, Heavy Soil, Flat: <=2%	0.15	1.7597
Composite	0.2001	

Post-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.952
Lawns, Heavy Soil, Flat: <=2%	0.15	0.9337
Composite Coefficient	0.5286	

Design for 100 yr storm			
Pre-Development		Post-Development	
C [-]	0.2001	C [-]	0.5286
i [in/hr]	7.28	i [in/hr]	7.28
A [ac]	1.8857	A [ac]	1.8857
Cf [-]	1.25	Cf [-]	1.25
Q [ft^3/s]	2.747	Q [ft^3/s]	7.2569
Total	2.747	Total	7.2569
Difference		4.5099	cfs
Volume	4058.9	ft^3	

Pre-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.126
Lawns, Heavy Soil, Flat: <=2%	0.15	1.7597
Composite	0.2001	

Post-Development		
Runoff Coefficients		Area [ac]
Parking lots, roofs, driveways,	0.9	0.952
Lawns, Heavy Soil, Flat: <=2%	0.15	0.9337
Composite Coefficient	0.5286	

CONVERTION sqft to	40671	ft
	0.9337	ac

Use the above set of calculations for stormwater runoff estimation

Site Drainage

Design for 5 yr storm	
C [-]	0.9
i [in/hr]	4.08
A [ac]	0.4940582
Cf [-]	1
Q [ft^3/s]	1.8141818

Design for 100 yr storm	
C [-]	0.9
i [in/hr]	7.28
A [ac]	0.4940582
Cf [-]	1.25
Q [ft^3/s]	4.0463369

CONVERT	21521.2	ft
ION sqft	0.49406	ac

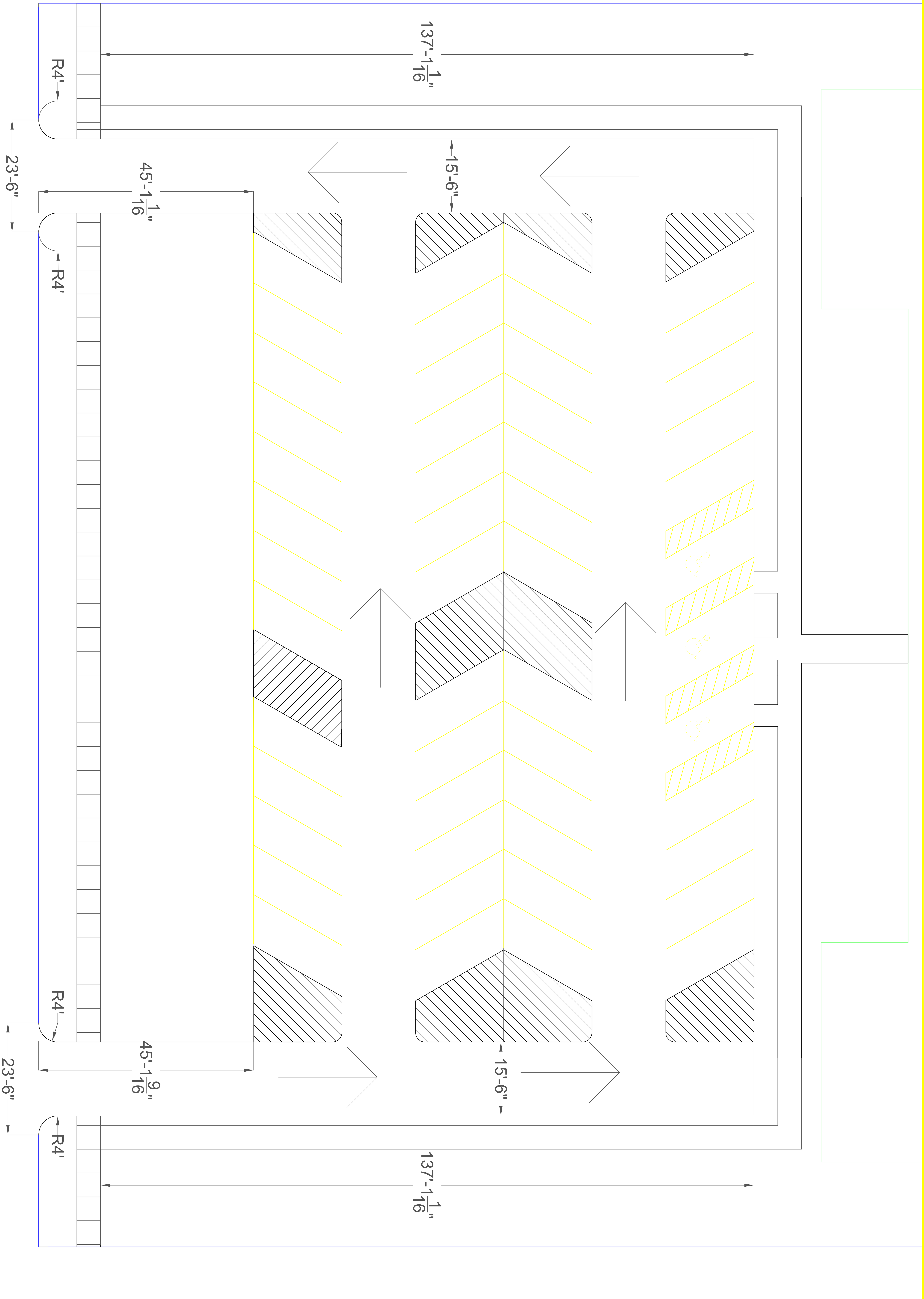
Parking Lot Drainage

Design for 5 yr storm	
C [-]	0.9
i [in/hr]	4.08
A [ac]	0.4940582
Cf [-]	1
Q [ft^3/s]	1.8141818

Design for 100 yr storm	
C [-]	0.9
i [in/hr]	7.28
A [ac]	0.4940582
Cf [-]	1.25
Q [ft^3/s]	4.0463369

CONVERT	21521.2	ft
ION sqft	0.49406	ac

Access Road Drainage



SHEET NO.
No.07

SHEET NAME
Access Road

Condo Development

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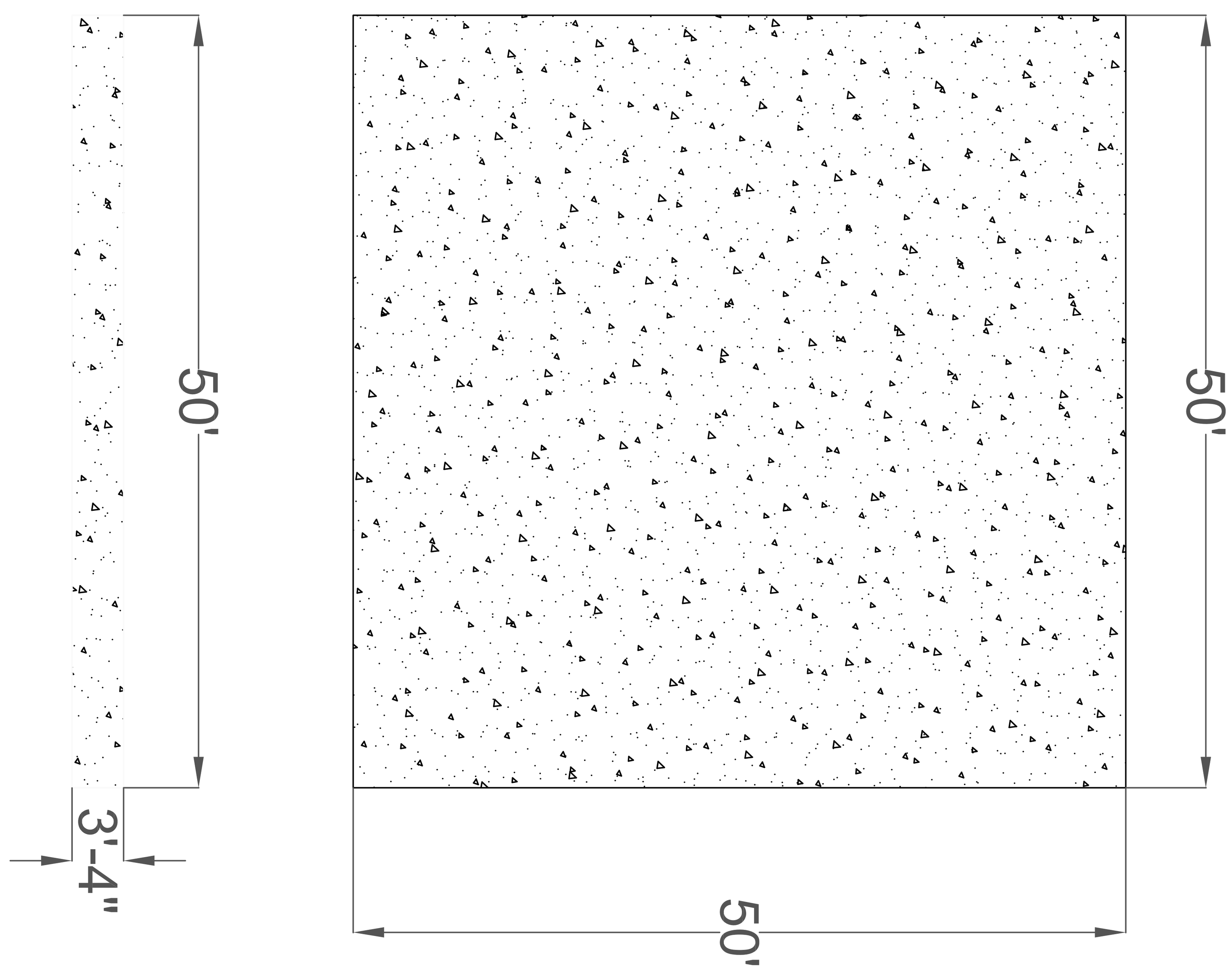
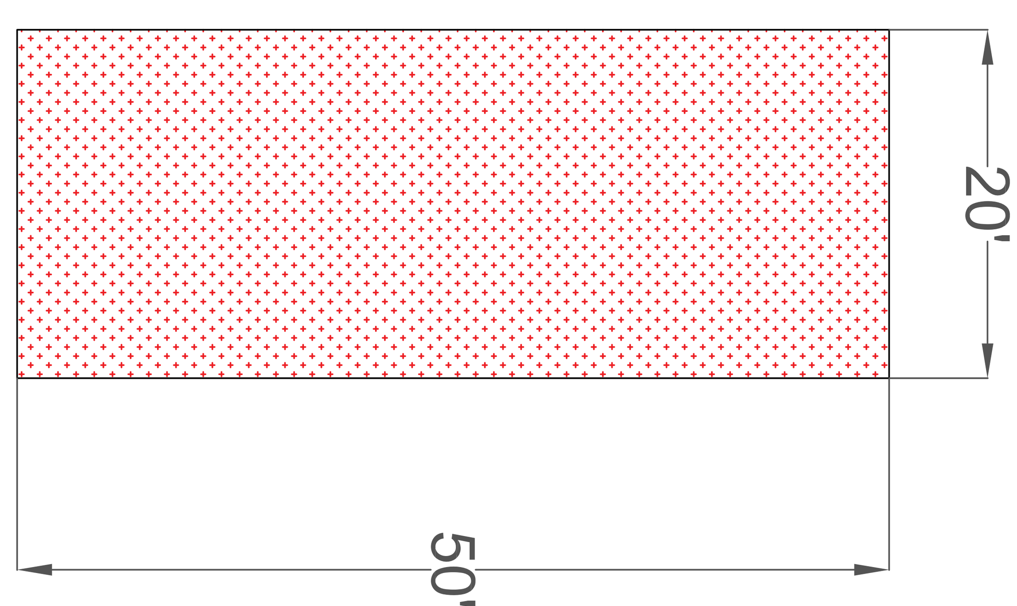
PHONE: 319.335.5647
FAX: 319.335.5660
EMAIL: civil-hawks@uiowa.edu

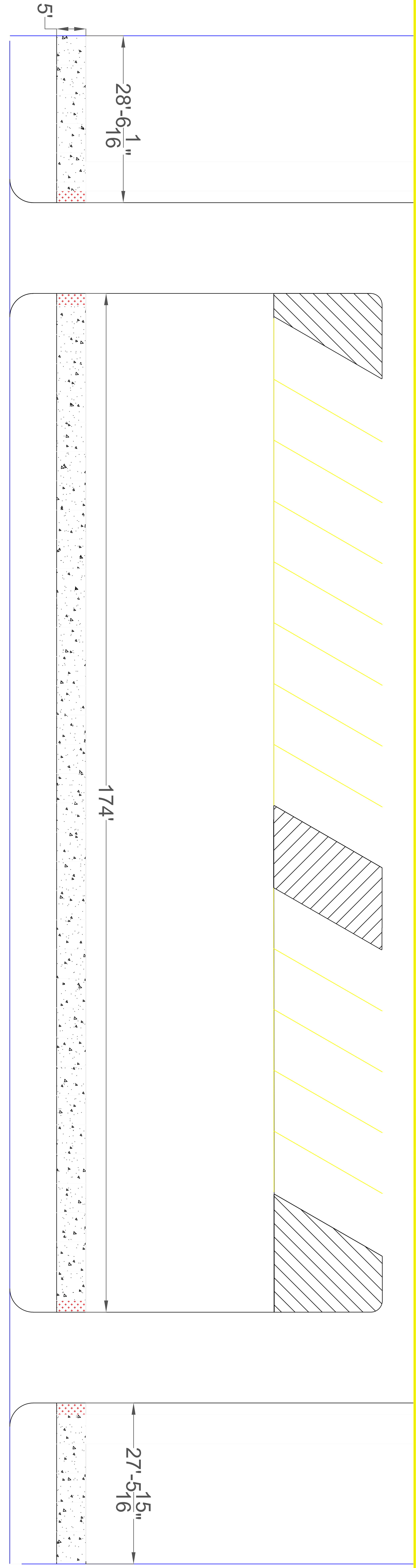
PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Noah Kalter
REVISION:	

Concrete Slab Cross Section [Scale: 10:1]



Detectable Warning Cross Section [Scale: 10:1]





SHEET NO.

No.8

SHEET NAME

Sidewalk

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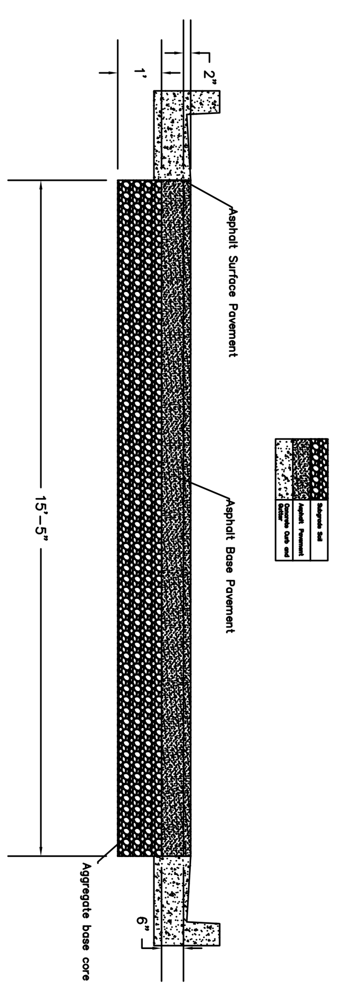
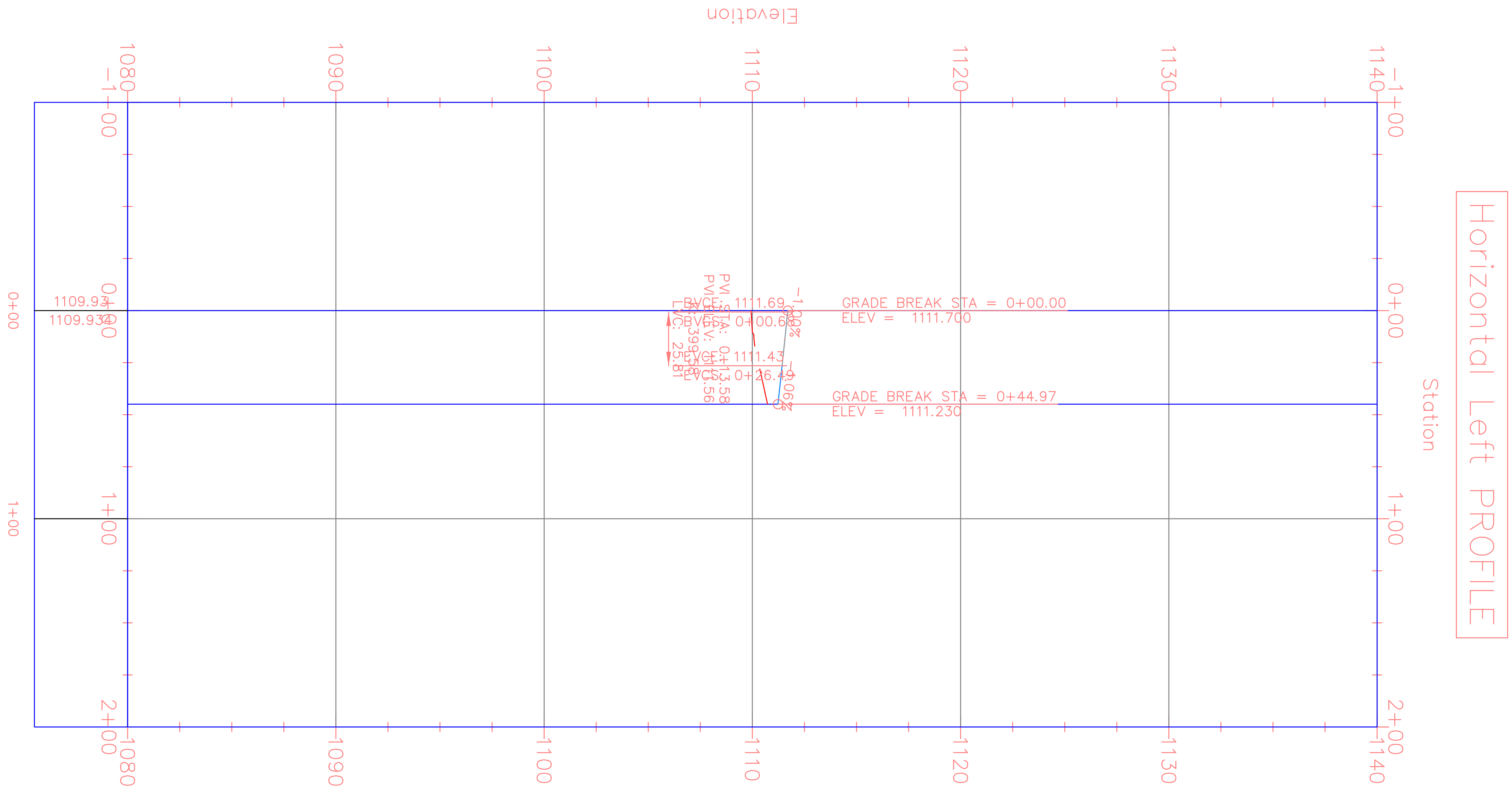
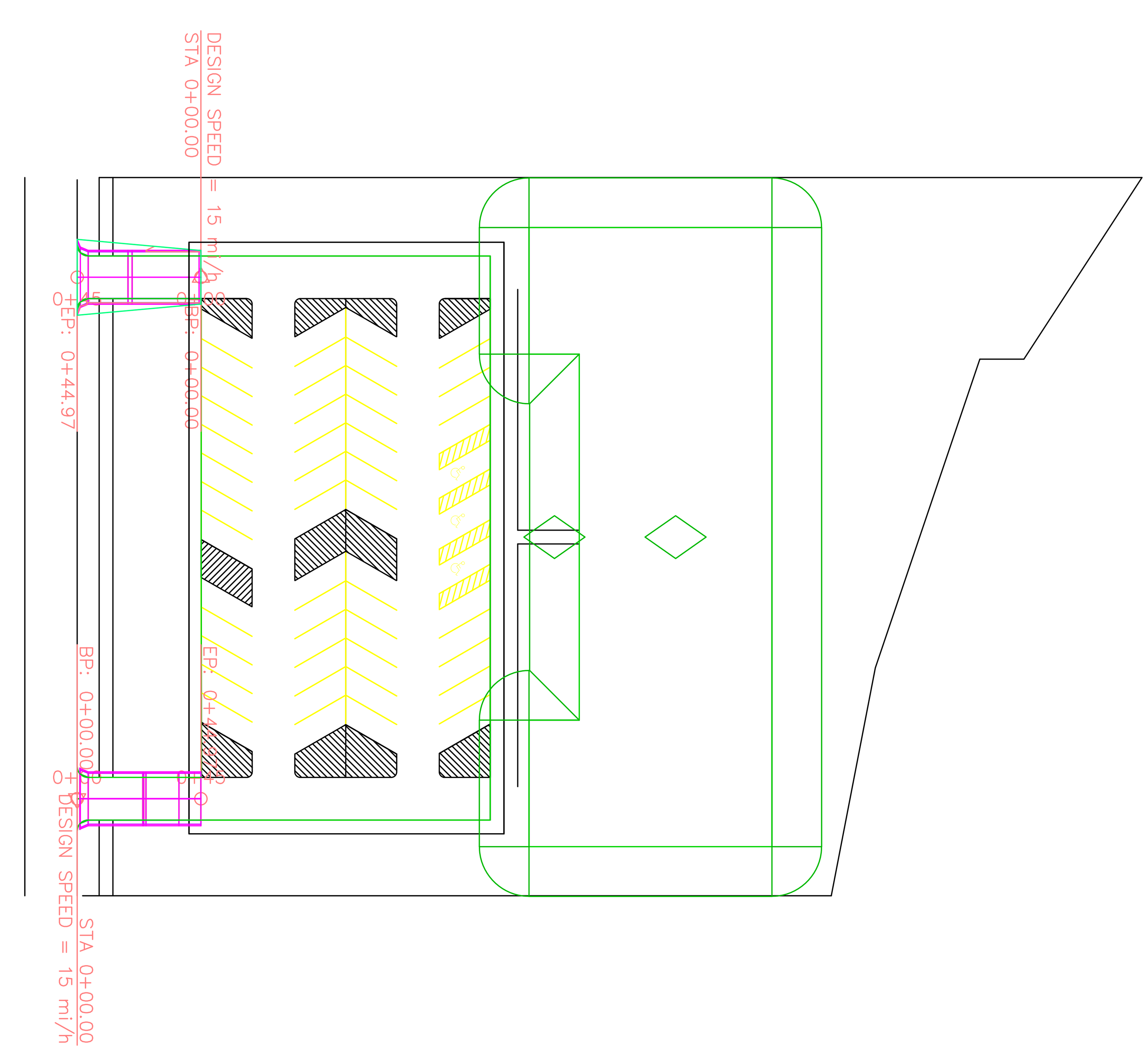
PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Hanjie Laing
REVISION:	







SHEET NO.

No.9

SHEET NAME

Left Hori & Verti Align

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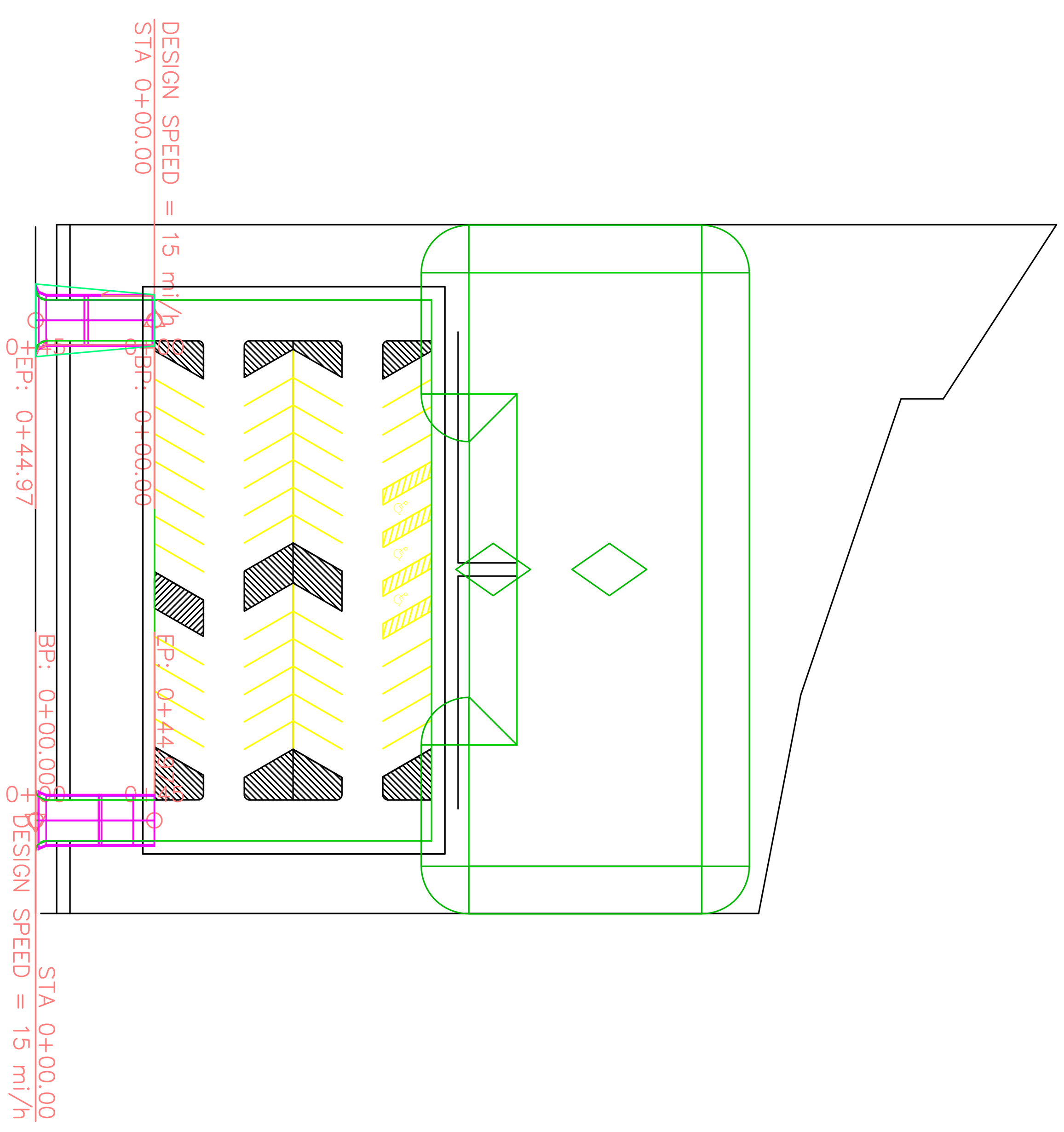
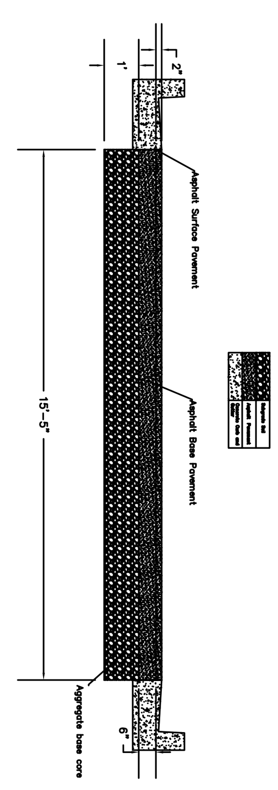
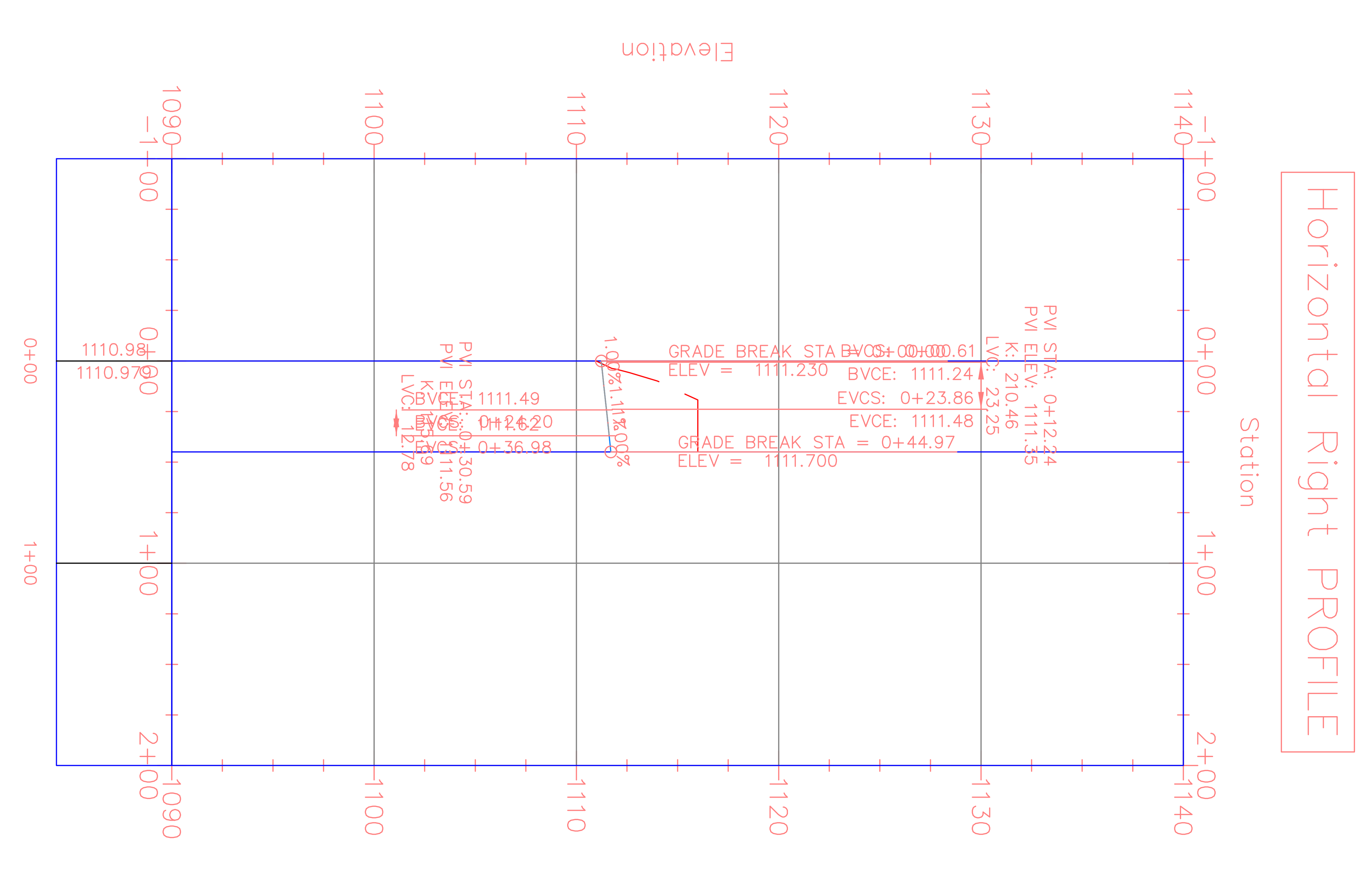
PROJECT:	CEE: 4850
DATE :	04/19/2018
DRAWN BY:	Noah Kalter
REVISION:	







SHEET NO.	**No.10**
SHEET NAME	Right Hori & Verti Alig

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PROJECT:	CEE: 4850
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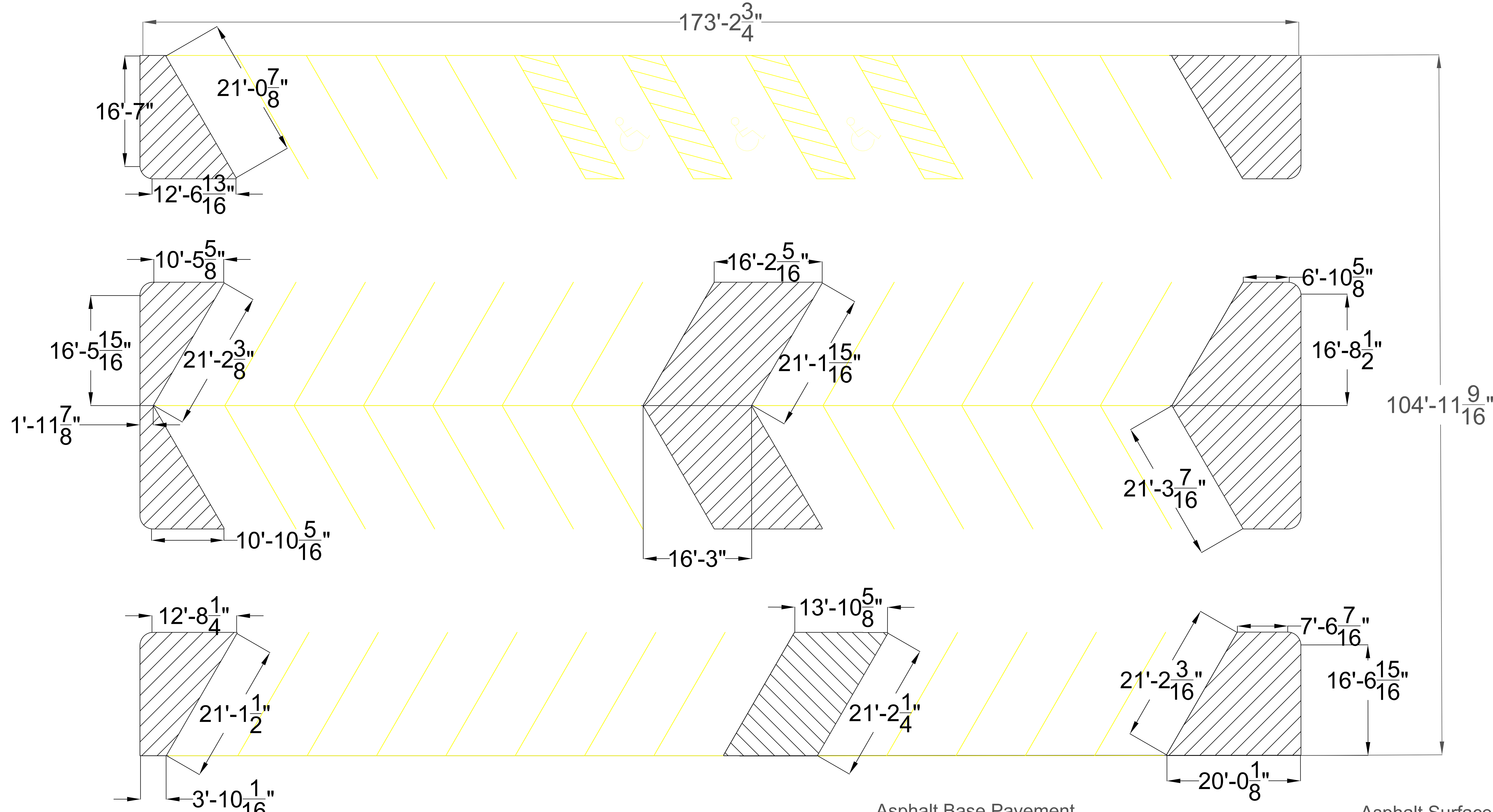
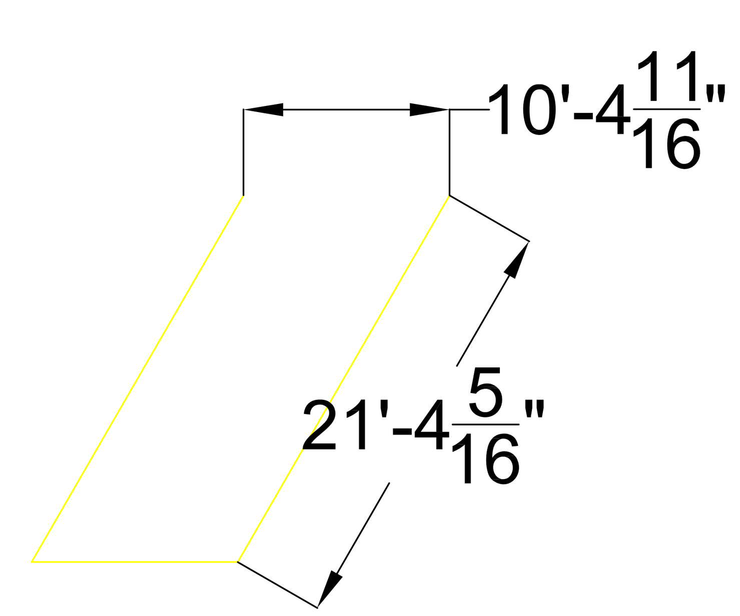
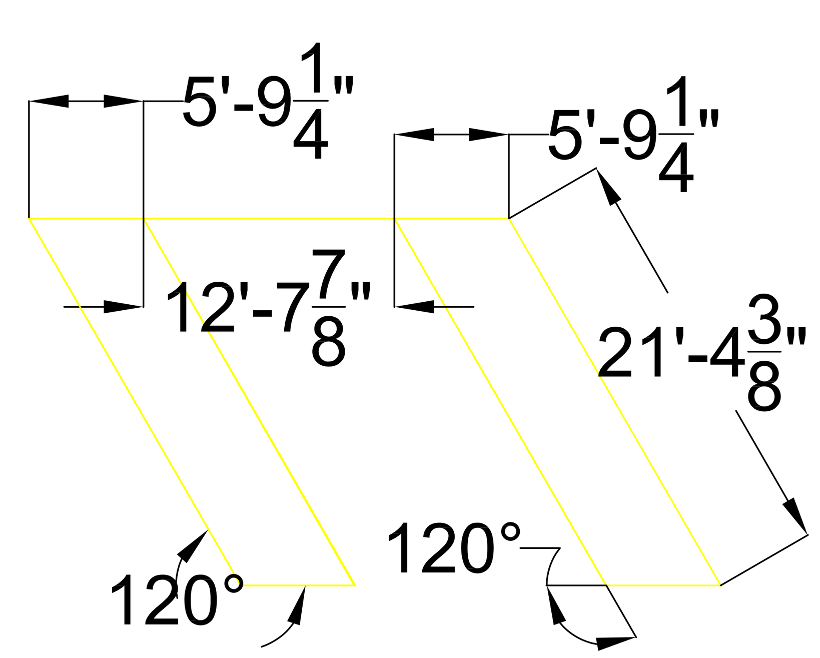
DRAWN BY:	Noah Kalter
REVISION:	

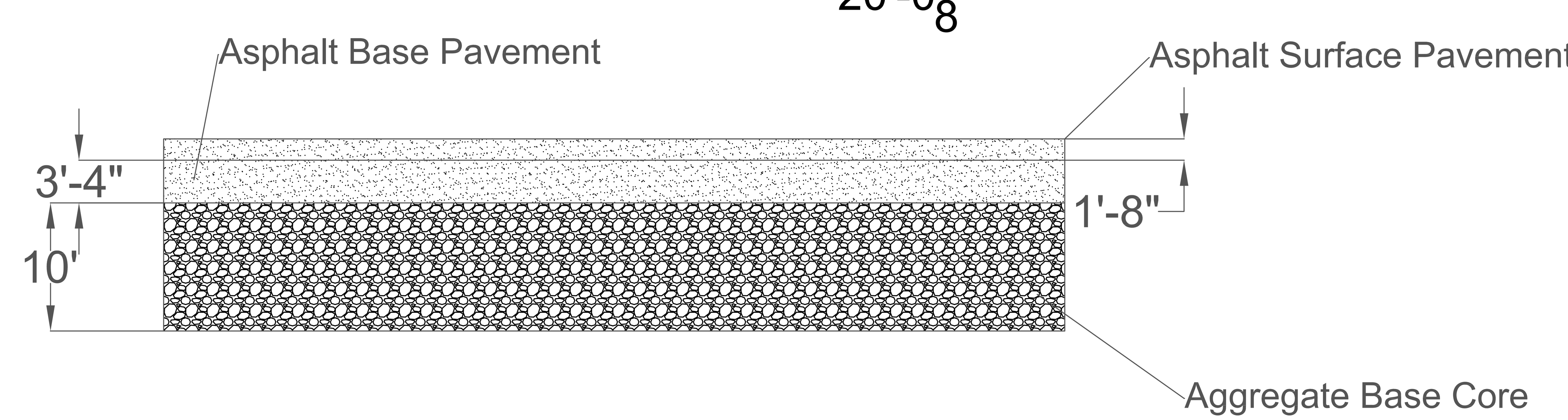




Single Stall



Handicap



Parking Lot Pavement Cross Section

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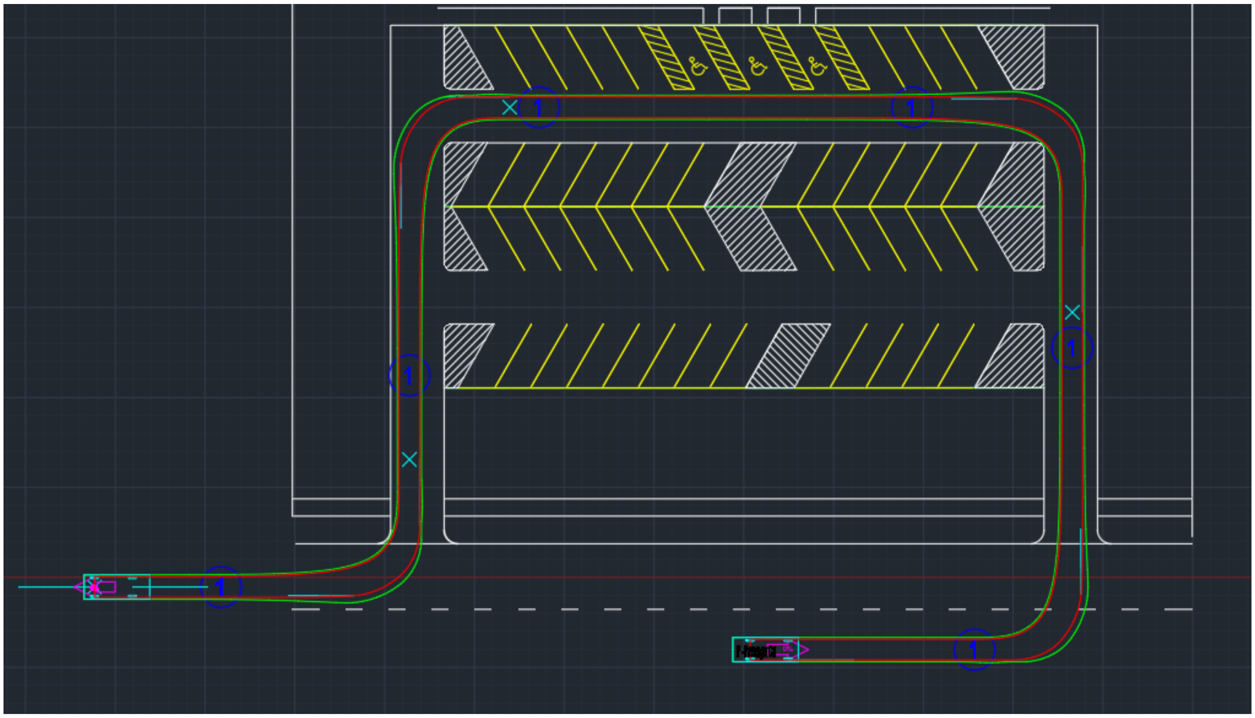
PROJECT:	CEE: 4850
DATE :	05/04/2018
DRAWN BY:	Noah Kalter
REVISION:	

Condo Development

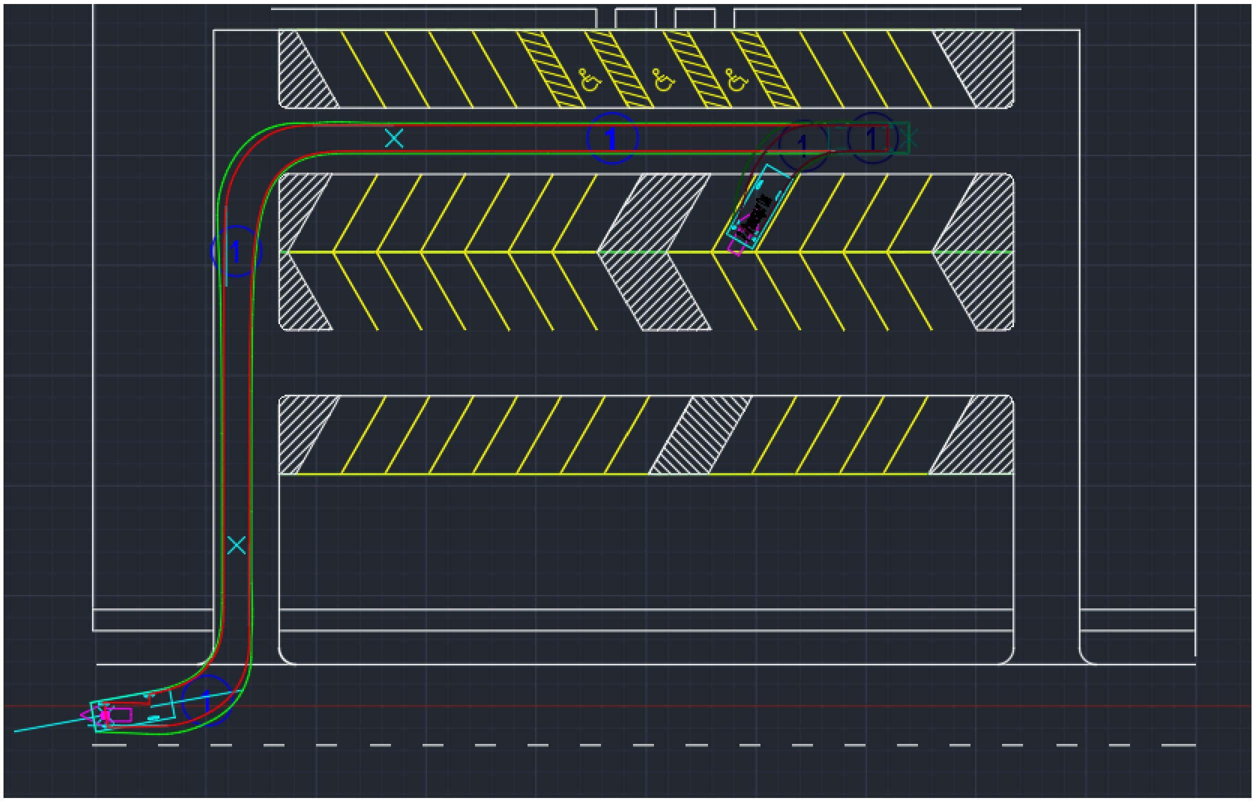
540 4th ST NE
Mason city, IA

SHEET NAME
Parking Lot

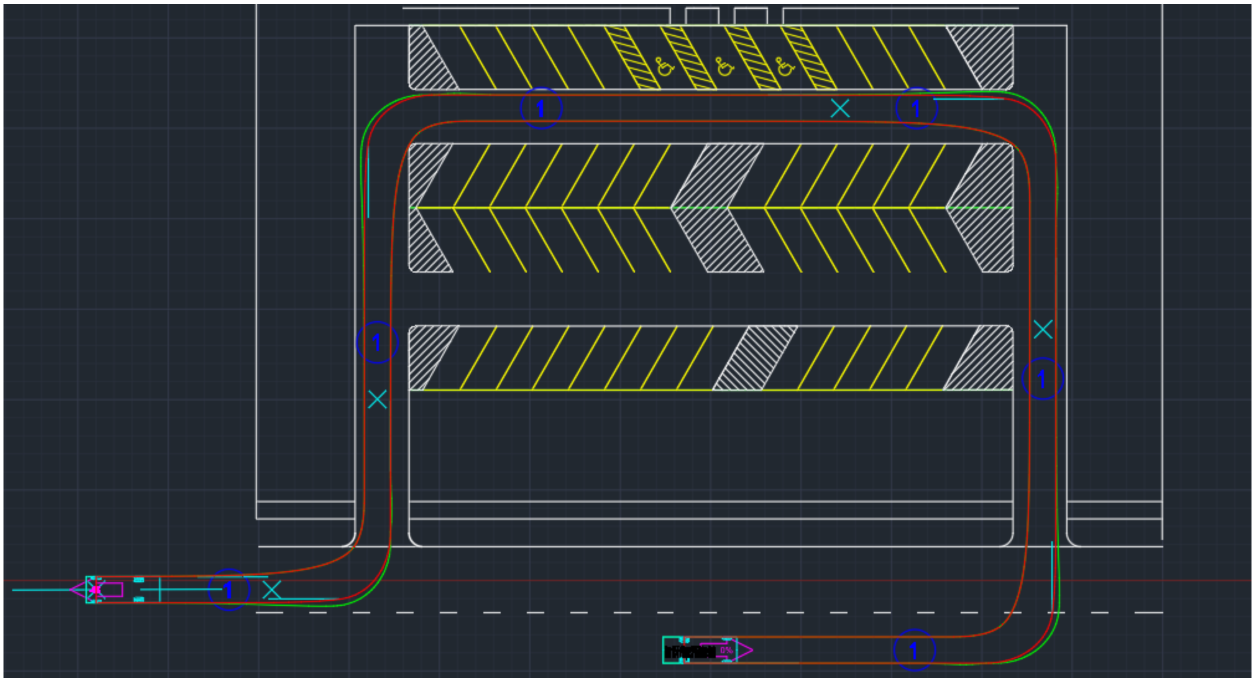
SHEET NO.
No.11



Passenger car going through the lanes



Parked passenger car backing out and proceeding to leave the lot



Garbage truck entering and exiting the parking lot