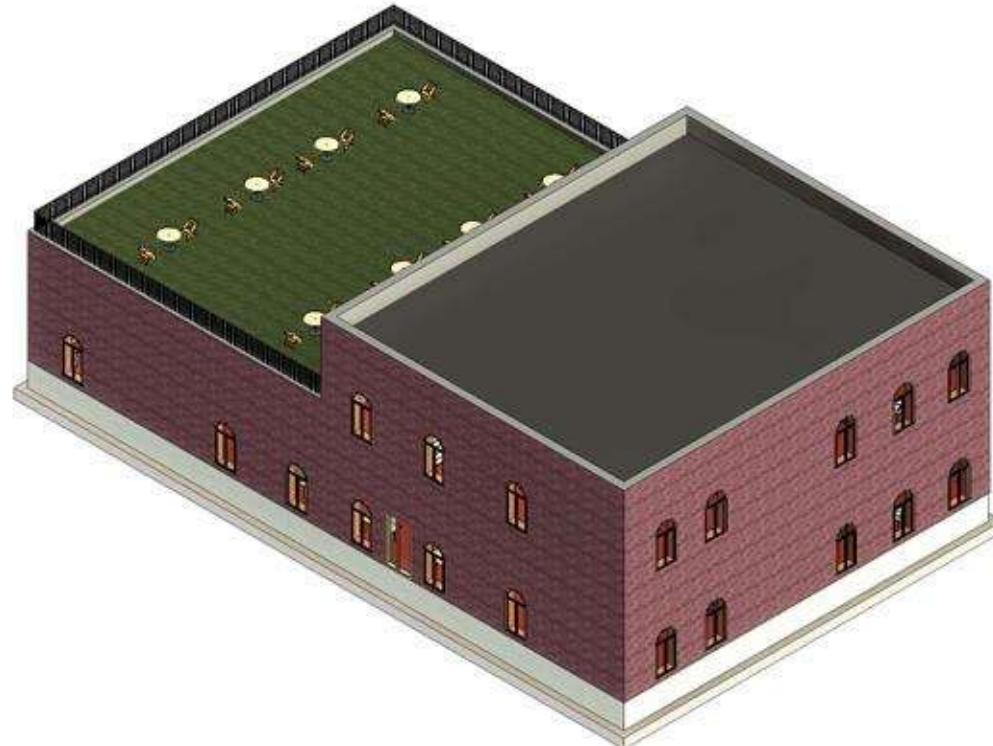


# KEYSTONE LIBRARY RENOVATION

BY OM PATEL



① 3D RENDERING

Autodesk® Revit®

[www.autodesk.com/revit](http://www.autodesk.com/revit)

Project Lead The Way  
Keystone Center

No.	Description	Date

## TITLE PAGE

Project number      Project Number

Date      Issue Date

Drawn by      Author

Checked by      Checker

A-0

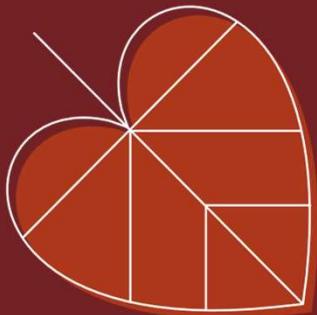
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- Keystone Library Spread Footing Analysis
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- A-2 Second Floor Plan
- A-3 Roof Plan
- A-4 Exterior Elevations
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# PROJECT DESCRIPTION



For this project, one must renovate a broken-down building into a public library that incorporates universal design elements, such as an elevator and handicap-accessible bathrooms, a second floor, and a publicly accessible green roof, all of which must follow the ordinances and building codes of Noblesville, Indiana. These ordinances include having two exits, due to the building's occupancy, and being built of non-combustible materials all of which are stated in section 303.4 following the assembly A-3 group regulations. Additionally, the building must have appropriate grading and stormwater management. The library must include a vestibule, a mechanical room, a history room, two meeting rooms, a staff restroom, a staff break area (that includes a kitchenette), a head librarian office, public restrooms, room for open stacks and computers, a children's help desk, a children's area, and a front desk. On the second floor, there must be public bathrooms and open area for bookstacks.

# LAND USE AND DEVELOPMENT REGULATIONS

2. The model code the building is based on is the International Building Code, 2012 Edition, First Printing and ANSI A117.1 Accessible and Usable Buildings and Facilities, 2009 Edition, First Printing.

## 3. Assembly A-4

4. For each of the four types of construction it specifies the fire-resistance rating requirements for exterior walls based on fire separation distance.

- Type 1 and 2, are made up of noncombustible materials.
- Type 3 is a type of construction where the exterior walls are made of noncombustible materials and the interior elements are any material permissible by the code.
- Type 4 construction is Heavy Timber exterior is noncombustible and interior building elements are of solid or laminated wood.
- Type 5 construction is structural elements, interior/exterior walls are of any material from the code.

The keystone library should be type 1 or 2 because it is the most fire resistant.

5. The least restrictive construction type for the keystone library would be type 1 because the height of the area is unlimited.

6. For the Keystone library's walls it would be beneficial to use metal studs and wooden gypsum wallboard. For the floor commercial carpet, vinyl, and/or tile. I think carpet would be the most effective as it makes the space feel lighter and helps with noise control.

7. The occupant load is 304.

8. The stairs must be at least 39.3 inches wide.

9. The minimum number of exits required is 2.

10. The library lies in the Planned Business Zone.

11. The planned business zone encourages well planned business uses and helps plan infrastructure. (1263 Table V. Zoning Map Changes)

12. The minimum lot size needs to be 20,000 sq. feet, meaning the library meets the regulations as the library has 290,545.2 sq. Feet.

13. For a 2-story building the maximum height is 30 feet.

14. Some information that is helpful when building the library is that the building's front should have access to the street and the dimensions of the library cannot change.

I researched the local code of ordinances and building codes to obtain important information needed to redesign the Keystone Building.

15. Yes, it is permitted to be built on the property.

16. The plan is needed for any improvement to the landscape.

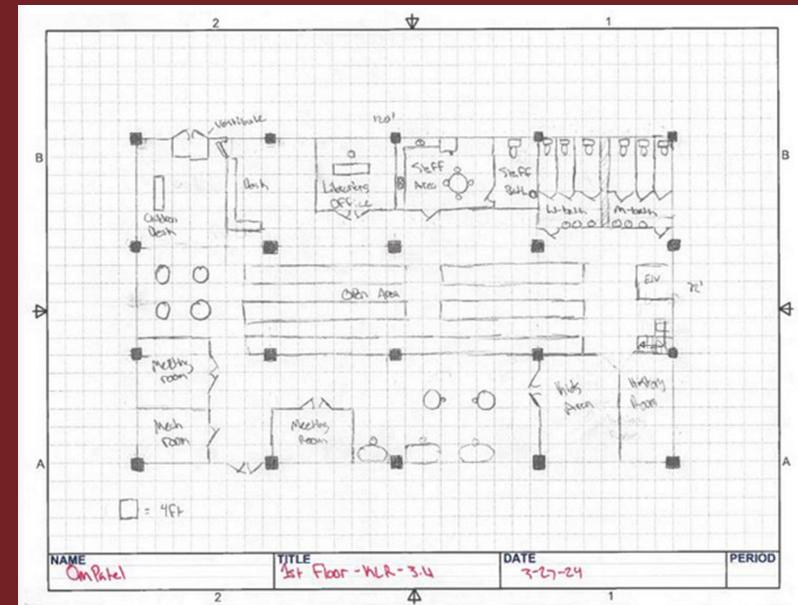
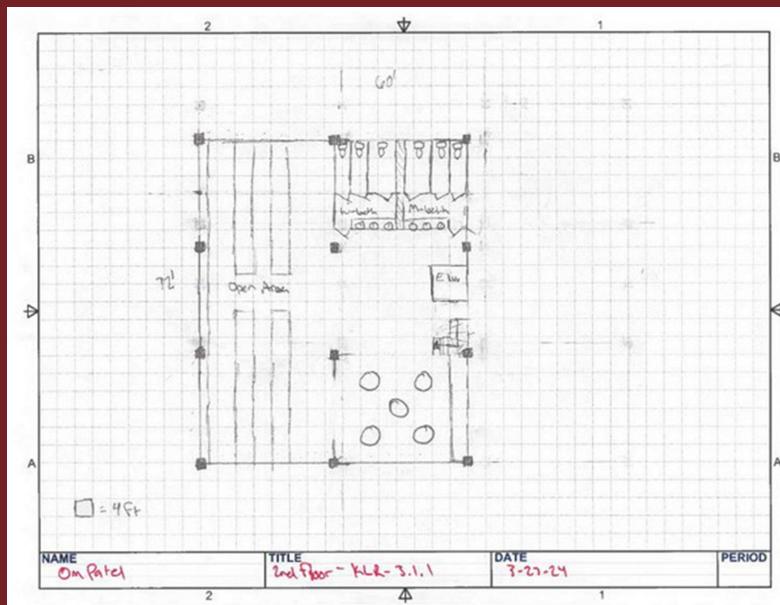
17. There needs to be a landscape plan for parking lots, building bases, screening.

## Conclusion:

1. It is important to research building codes as knowing the basic requirements helps the design meet the requirements in the preliminary stages of building the home.
2. Building codes provide safety for people, via egress and staircase requirements, which allows the flow of traffic to not be congested in emergencies.
3. Local ordinances control development as the cities and towns add more codes that a developer must follow.

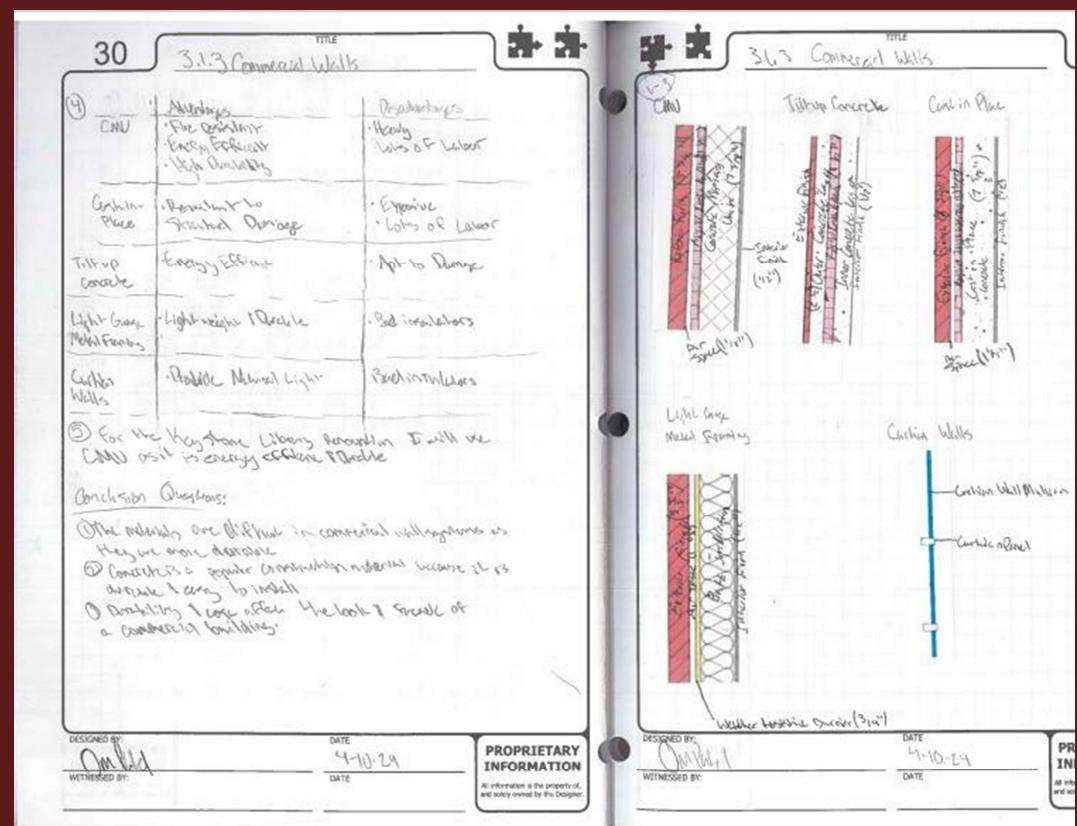
# SKETCHES

Before I remodeled the library, I created sketches of the first and second floor that incorporate the necessities and follow the constraints given for this project.

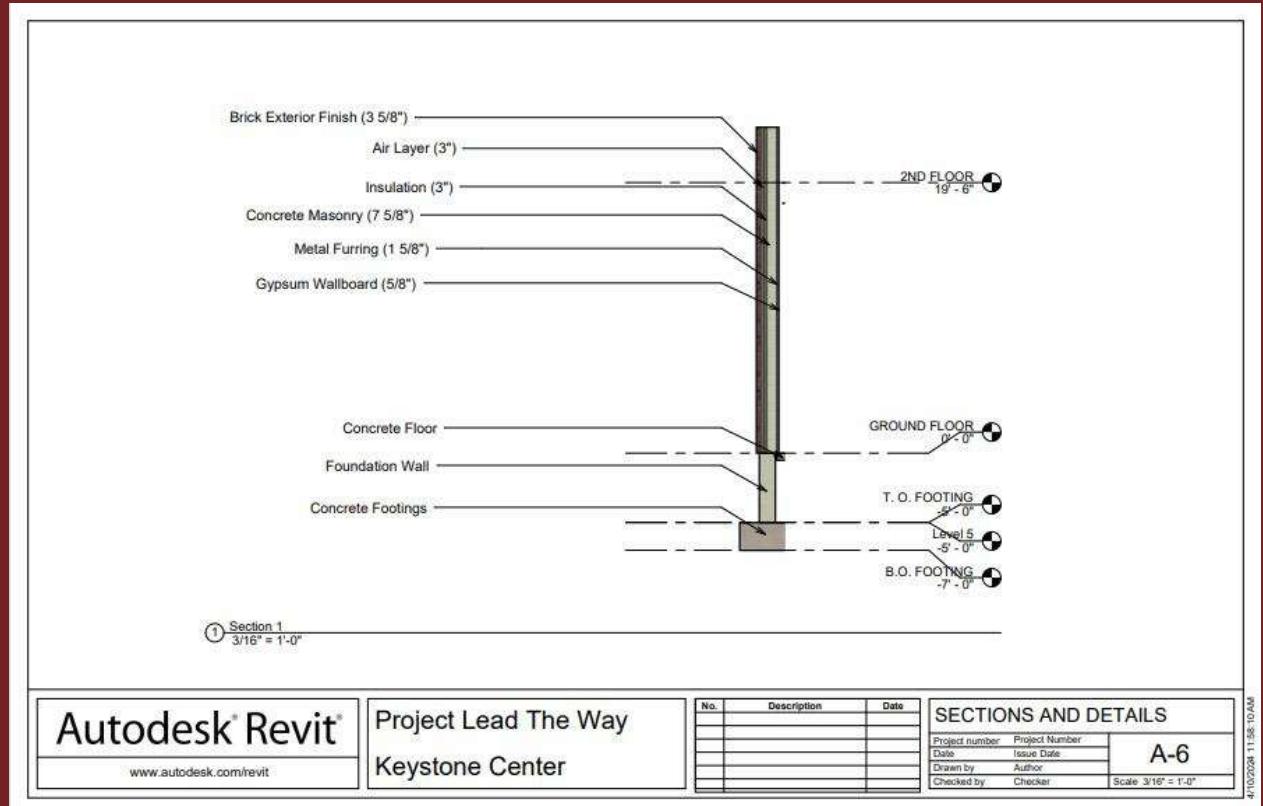


# COMMERCIAL WALL SYSTEMS

I examined the different parts that make up various commercial wall systems, integrating the best wall system, CMU wall, for the Keystone Library's purposes.



# COMMERCIAL WALL SYSTEMS



I would use EDPM roofing as it has been proven to be long lasting and lower energy costs. Furthermore, it is eco-friendly, cost effective and fire resistant.

3)

#### Granular Drainage System

- Does not require instant vegetation
- Biodiversity
- Average water retention
- Low maintenance
- Cost Effective

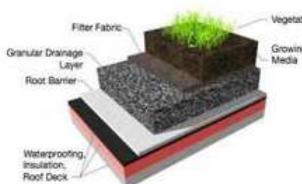
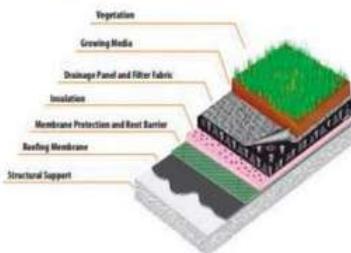


Figure 4-E:  
Typical layers of a multi-layer roof system with granular drainage layer.

#### Monolithic Platform System

- Does not require instant vegetation
- Biodiversity
- High water retention
- Low maintenance
- Allows for later installation of solar



I will use a granular drainage system as it is more cost effective than the monolithic platform system.

# COMMERCIAL ROOF SYSTEMS

I researched the necessary requirements to make a low-slope roof acceptable for human traffic and for use as a green roof. From my research I selected and integrated EDPM roofing material and a granular drainage system.

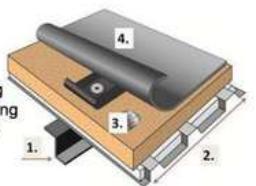
2)

#### EDPM Roofing

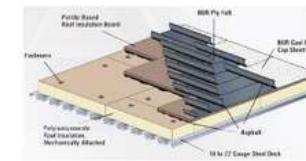
- Tough material that can withstand heavy foot traffic
- Often used as a recreational deck
- Energy Efficient



Built Up Roof (BUR)



- Alternating layers of asphalt and reinforcing fabric
- Efficient use of space and waterproofing
- Not aesthetically pleasing

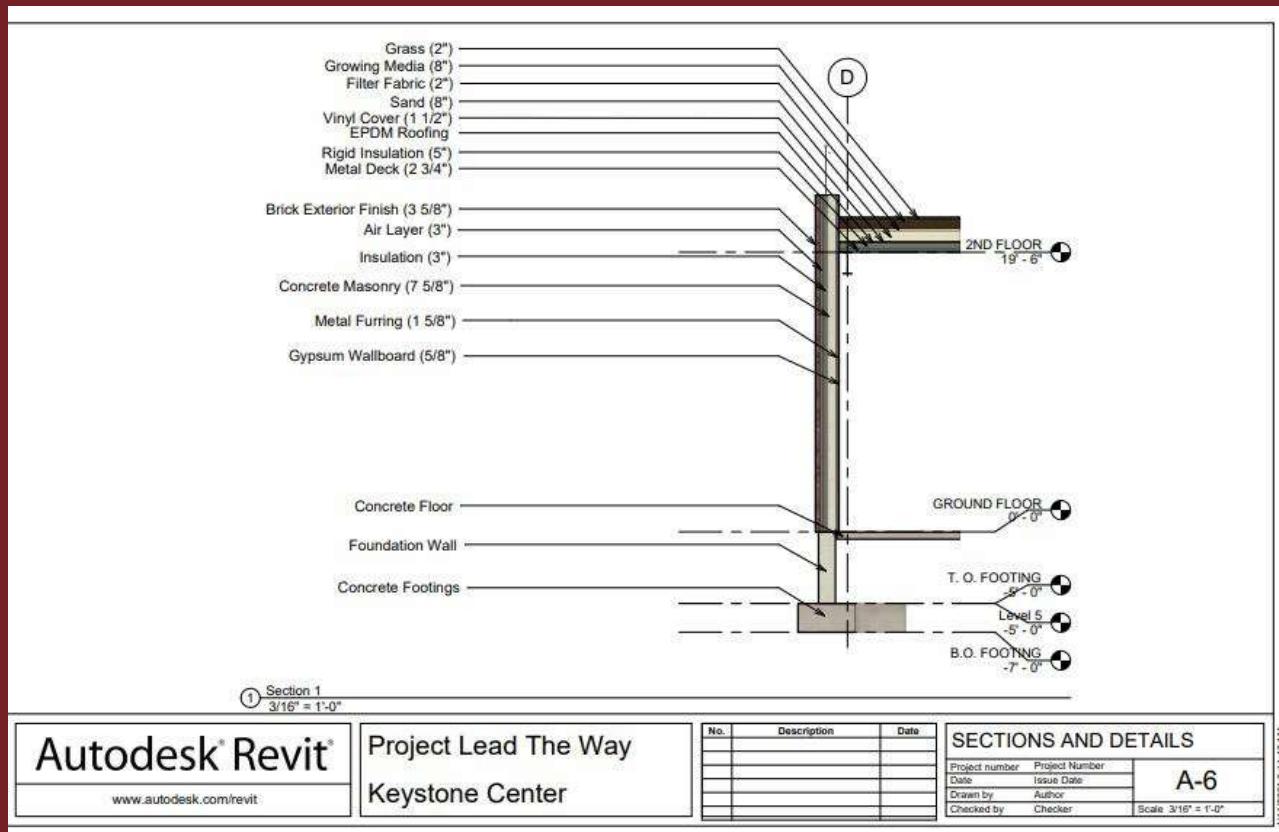


#### PVC Sheeting Materials (Vinyl)

- Low maintenance water proofing
- Resists pedestrian damage
- Problems occur with age and climate



# COMMERCIAL ROOF SYSTEMS

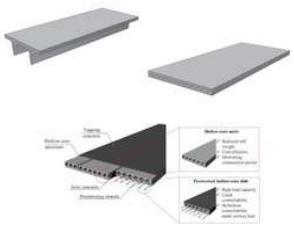


# COMMERCIAL FLOOR SYSTEMS

## Research

### Cast-in-Place

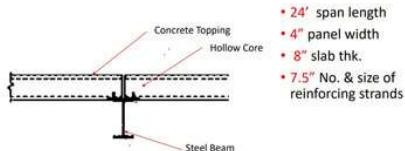
- Formed on site
- Can be shaped as needed



### Hollow Core Precast

- Created off site
- Transported to site
- Installed into the structure

### Hollow core precast concrete floor panels



I researched two potential elevated concrete floor systems for the Keystone Library Project and incorporated a composite slab design due to its durability and cost effectiveness.

### Composite Slab Design (cast-in-place concrete on metal decking)



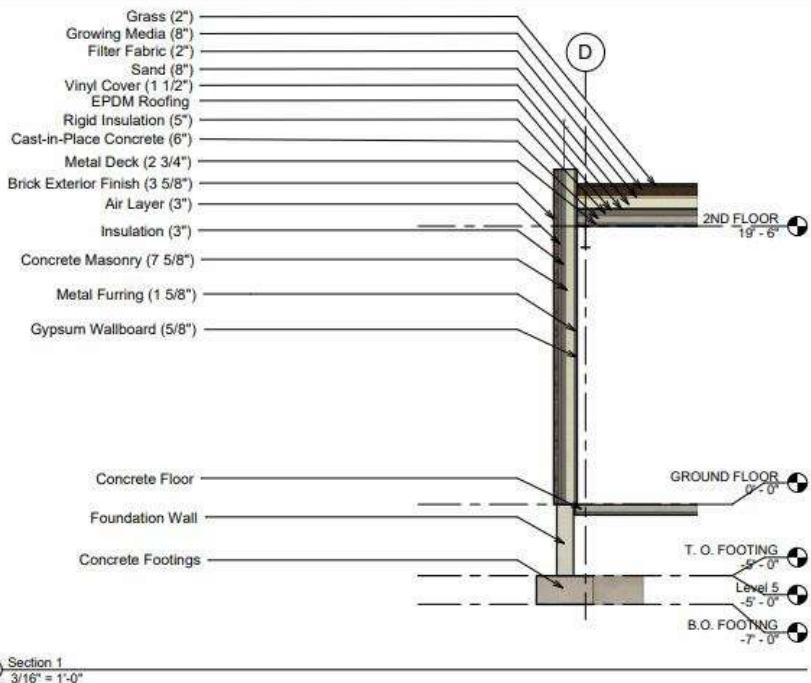
## Question 6

- I would use Composite Slab Design as it simple, efficient, and durable

## Conclusion

- 1) The materials used in a residential floor system are different from a commercial system as they have to be more durable and fire resistant.
- 2) The advantages of using precast concrete floor components are that they are more durable and higher quality.
- 3) Factors you should consider when designing a system for a building design is cost and durability.
- 4) To add more strength to a concrete floor they can change the span length and thickness of the floor. Additionally, engineers can use rebar to add more strength to a floor.

# COMMERCIAL FLOOR SYSTEMS



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Project Lead The Way  
Keystone Center

No.	Description	Date

## SECTIONS AND DETAILS

Project number	Project Number
Date	Issue Date
Drawn by	Author
Checked by	Checker

A-6

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# LOADS

Identified the design loads for each structural element in the Keystone Library to select structural elements such as roof decking and steel joists.

TITLE

24 3.2.2 Loads

① Ground Snow Load = 25 Occupancy Level: III  
 $p_s = 0.7 \cdot C_s \cdot C_e \cdot C_f \cdot I_s \cdot p_g$   
 $I_s = 1.1$

$p_s = 0.7 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 25$   
 $p_s = 19.25 \text{ psf}$

② Roof Live Load required by IBC = 20 psf or less  
③  $10 + 6.5 H(1.4 + (0.75 \cdot 5) + 3) = 24.65 \text{ psf}$   
 $H = 3.75$

④ Design Load:  $4(6.65 \text{ psf}) = 22 + 24.65$

⑤ Type: Double Span - 20

⑥  $4(16.5 \cdot 7) = 326.55 \text{ psf}$  - Interior  
 $4(16.5 \cdot 3.5) = 163.25 \text{ psf}$  - Exterior

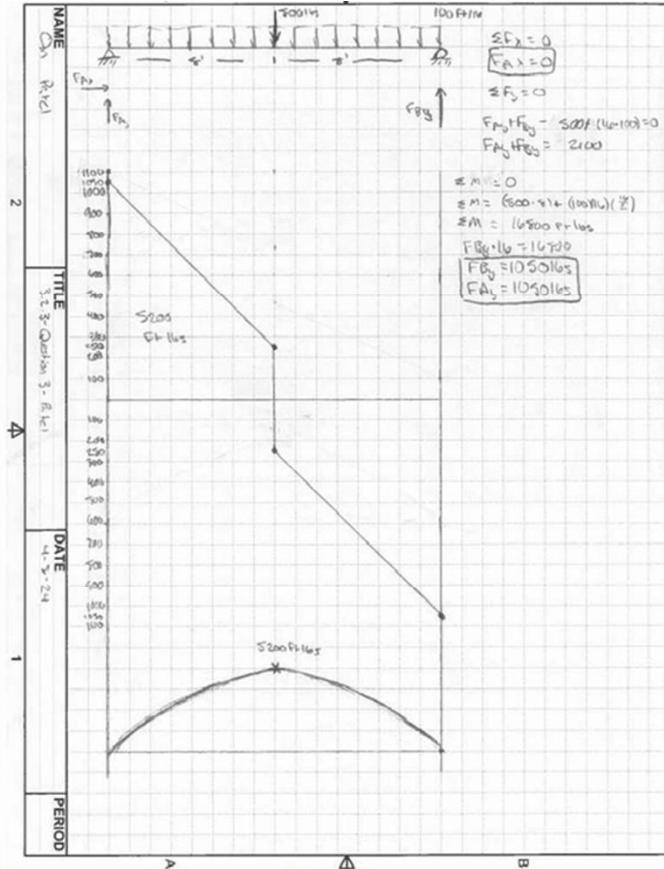
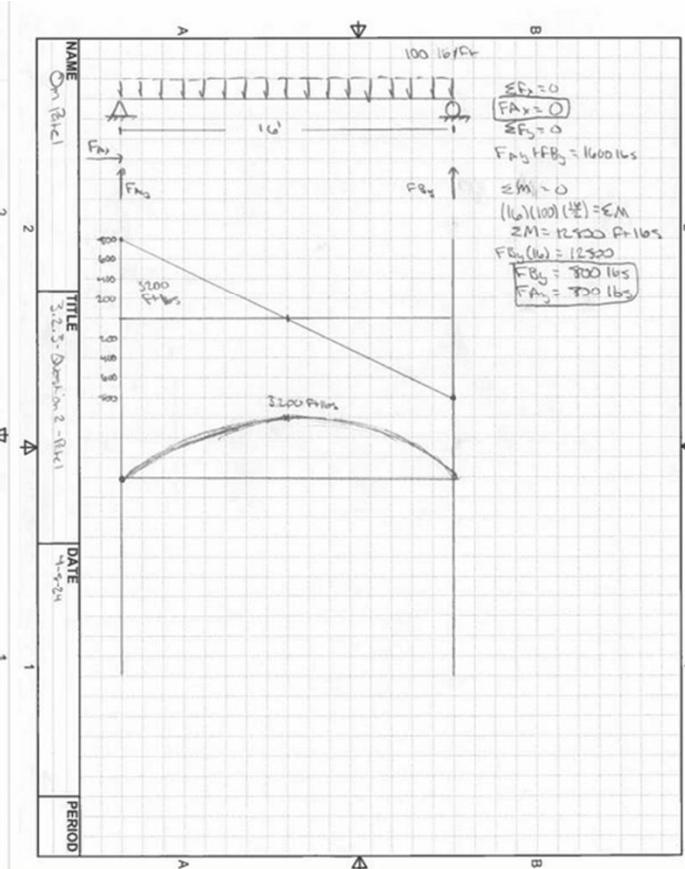
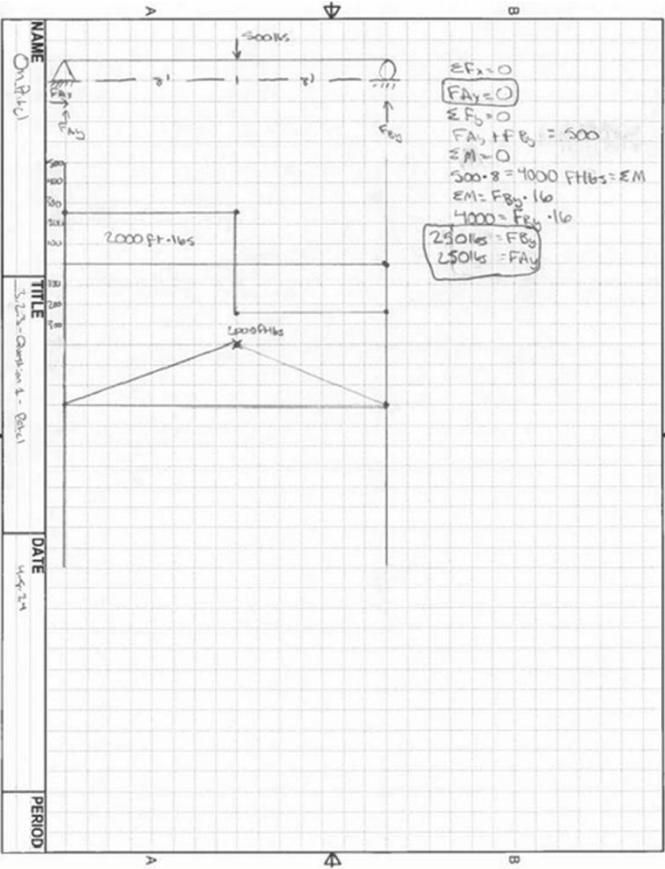
⑦ 16" Interior - 12 K 1 16" Exterior - 8 K 1  
20" Interior - 14 K 3 20" Exterior - 10 K 4

⑧ Ground snow load for Library  
 $p_s = 0.7 \cdot 1 \cdot 1 \cdot 1 \cdot 4 \cdot 20$   
 $p_s = 15.9$   
 $p_s = 22$   
Dead Load = 24.65  
Design Load = 46.65  
Type 22 Simple Span  
 $4(16.5 \cdot 5) = 233.25 \text{ psf}$  - Interior  $4(16.5 \cdot 2.5) = 116.25 \text{ psf}$  - Exterior

DESIGNED BY: *[Signature]* DATE: *4/18/24*

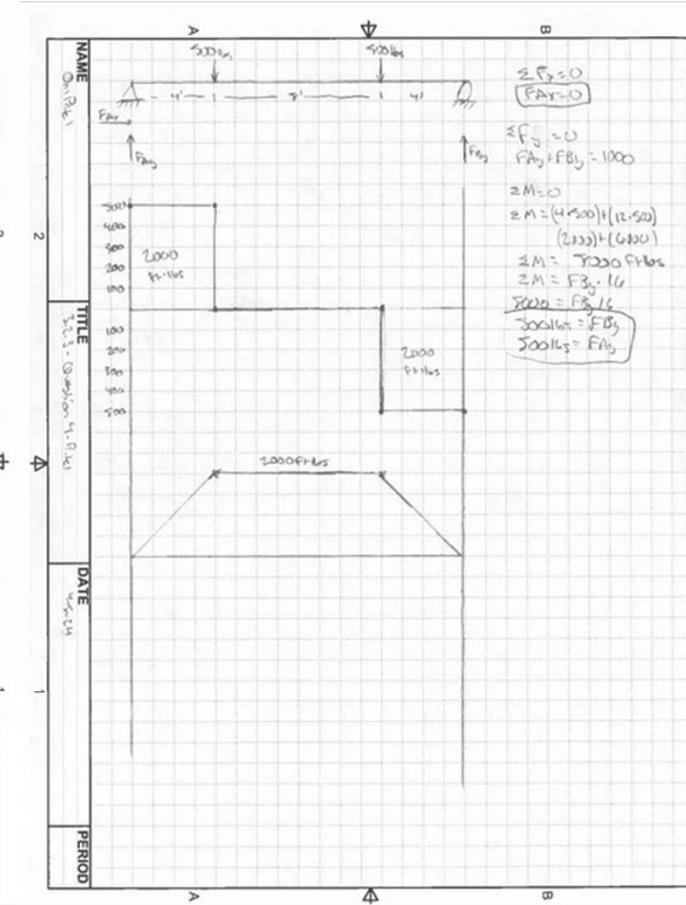
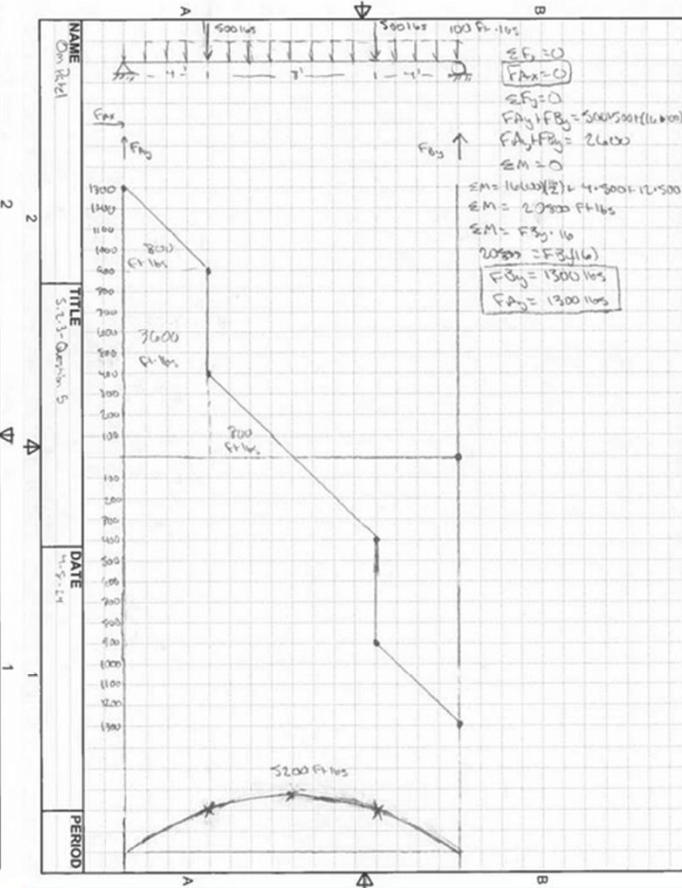
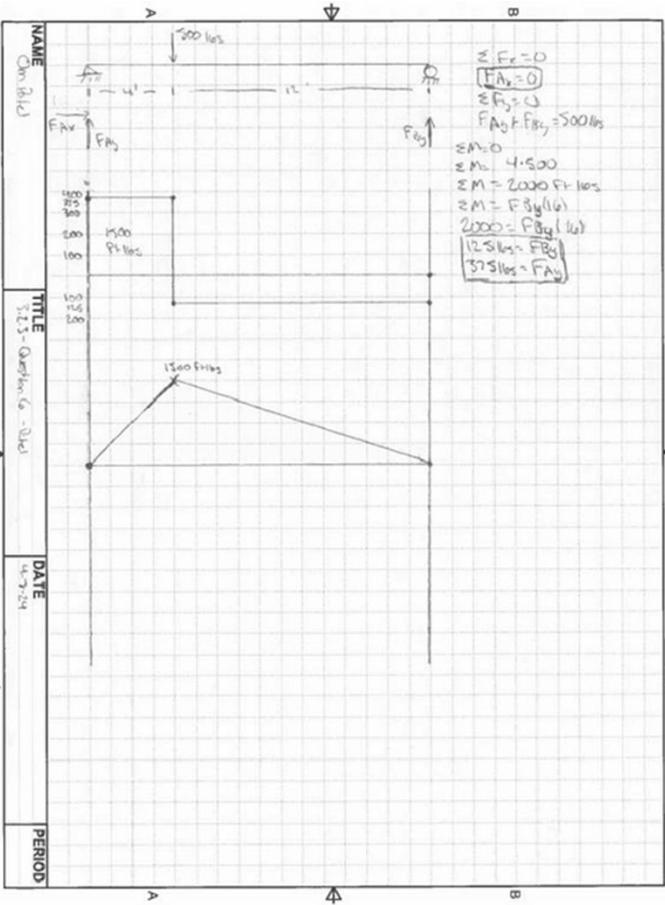
WITNESSED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

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## BEAM ANALYSIS

I analyzed beams to determine the beam strength necessary to resist the applied loads and then created shear and moment diagrams to visualize the beams distribution of mass, allowing for optimization and prevention of design failures.



# BEAM ANALYSIS

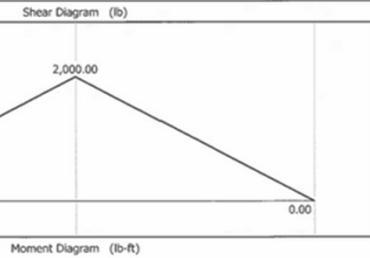
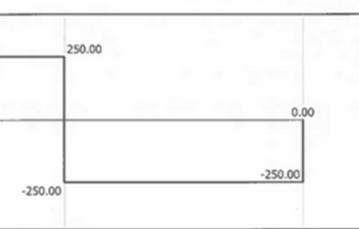
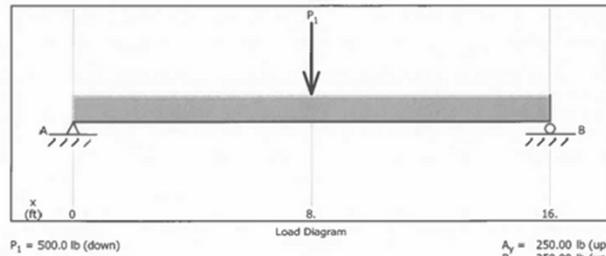
# BEAM ANALYSIS SHORTCUTS

I used mathematical formulas to simplify the process of finding reaction forces and maximum moments. I also used MDSolids to create shear and bending moment diagrams that any engineer can analyze.

29

TITLE		
3.2.4 Beam Analysis Shortcuts		
<p><b>Figure 1:</b></p> <p>Reaction: <math>R_{Ax} = 250 \text{ lbs}</math>  <math>R_{By} = 250 \text{ lbs}</math></p> <p>Moment: <math>2000 \text{ Ft-lbs}</math></p>	<p>Reaction: <math>\frac{P}{2} = \frac{500}{2} = 250</math></p> <p>Max: <math>\frac{Pf}{4} = \frac{500 \cdot 16}{4} = 2000</math></p>	
<p><b>Figure 2:</b></p> <p>Reaction: <math>R_{Ax} = 800 \text{ lbs}</math>  <math>R_{By} = 900 \text{ lbs}</math></p> <p>Moment: <math>3200 \text{ Ft-lbs}</math></p>	<p>Reaction: <math>\frac{wl}{2} = \frac{130 \cdot 16}{2} = 800</math></p> <p>Max: <math>\frac{wl^2}{8} = \frac{100 \cdot 16^2}{8} = 3200</math></p>	
<p><b>Figure 3:</b></p> <p>Reaction: <math>R_{Ax} = 1050 \text{ lbs}</math>  <math>R_{By} = 1050 \text{ lbs}</math></p> <p>Moment: <math>5200 \text{ Ft-lbs}</math></p>	<p>Reaction: <math>\frac{P}{2} + \frac{wl}{2} = \frac{500}{2} + \frac{100 \cdot 16}{2}</math>  <math>250 + 800 = 1050</math></p> <p>Max: <math>\frac{Pf}{4} + \frac{wl^2}{8} = \frac{500 \cdot 16}{4} + \frac{100 \cdot 16^2}{8}</math>  <math>2000 + 3200 = 5200</math></p>	
<p><b>Figure 4:</b></p> <p>Reaction: <math>R_{Ax} = 500 \text{ lbs}</math>  <math>R_{By} = 500 \text{ lbs}</math></p> <p>Moment: <math>2000 \text{ Ft-lbs}</math></p>	<p>Reaction: <math>P = \frac{wl}{2} = \frac{500 \cdot 16}{2} = 4000</math>  <math>300 + 100 = 1300</math></p> <p>Max: <math>P = \frac{wl^2}{8} = \frac{500 \cdot 16^2}{8} = 5200</math></p>	
<p><b>Figure 5:</b></p> <p>Reaction: <math>R_{Ax} = R_{By} = 1300 \text{ lbs}</math></p> <p>Max: <math>5200 \text{ Ft-lbs}</math></p>	<p>Reaction A: <math>\frac{P}{L} = \frac{500 \cdot 16}{16} = 500</math>  <math>375</math></p> <p>Reaction B: <math>\frac{PA}{L} = \frac{500 \cdot 16}{16} = 500</math>  <math>125</math></p> <p>Max: <math>\frac{Pf}{4} = \frac{500 \cdot 16}{4} = 1500</math></p>	
<small>DESIGNED BY: Owen</small>	<small>WITNESSED BY: None</small>	<small>DATE: 4-9-24</small>
		<small>PROPRIETARY INFORMATION</small>
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Figure 1

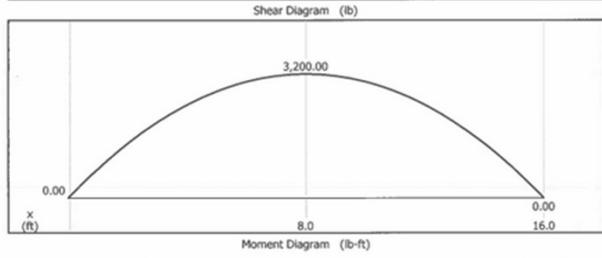
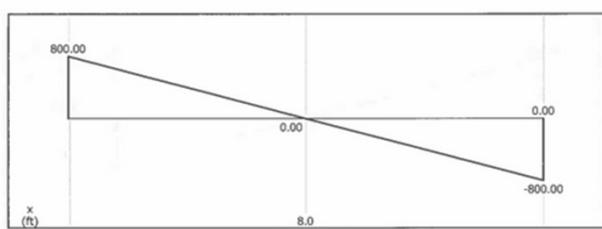
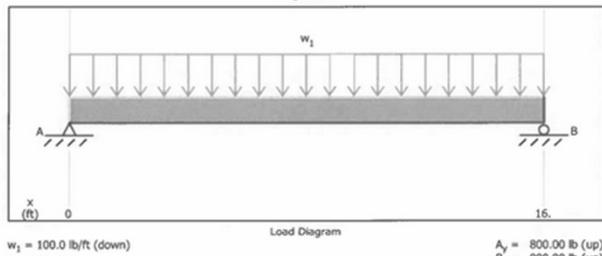


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Figure 2

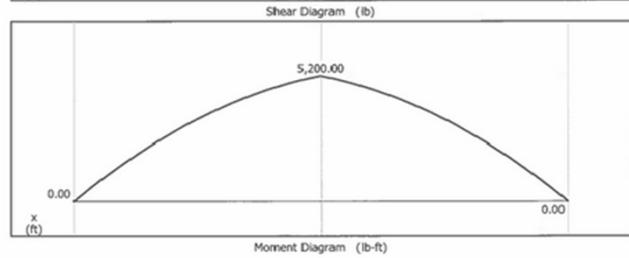
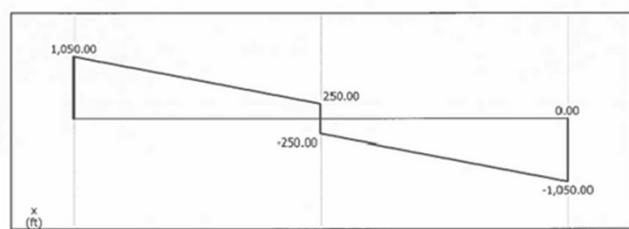
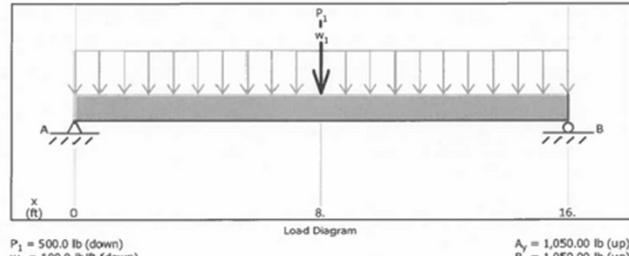


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Figure 3



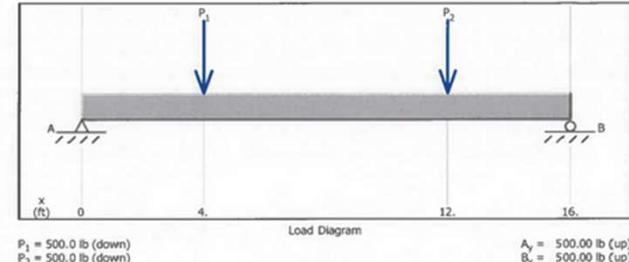
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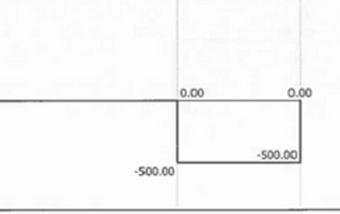
# BEAM ANALYSIS SHORTCUTS

Figure 4

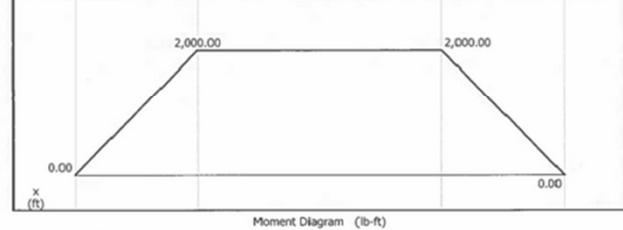


Load Diagram

$A_y = 500.00 \text{ lb (up)}$   
 $B_y = 500.00 \text{ lb (up)}$



Shear Diagram (lb)

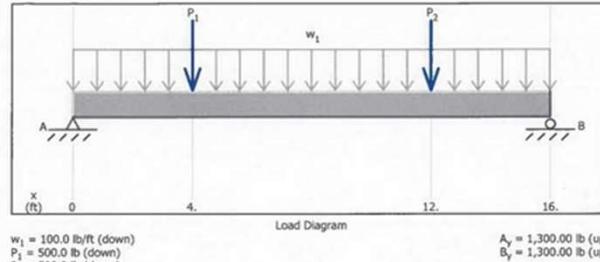


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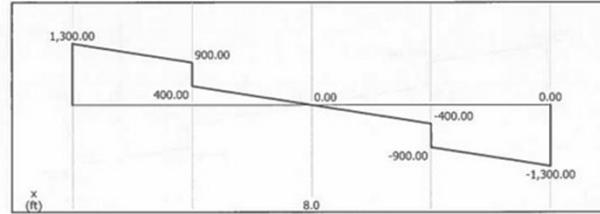
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Figure 5

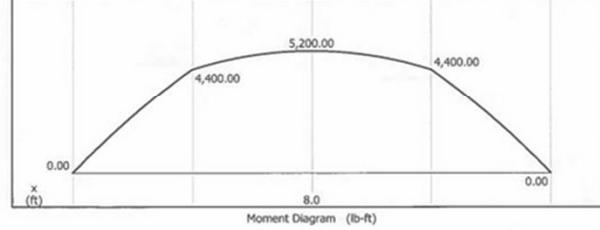


Load Diagram

$A_y = 1,300.00 \text{ lb (up)}$   
 $B_y = 1,300.00 \text{ lb (up)}$



Shear Diagram (lb)

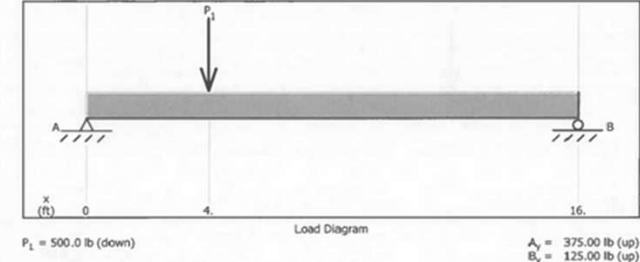


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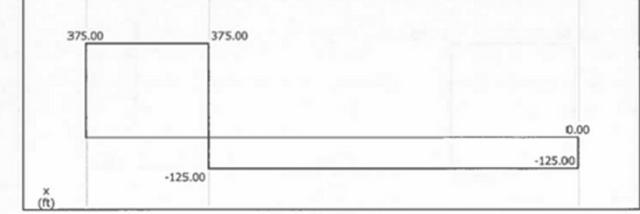
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Figure 6

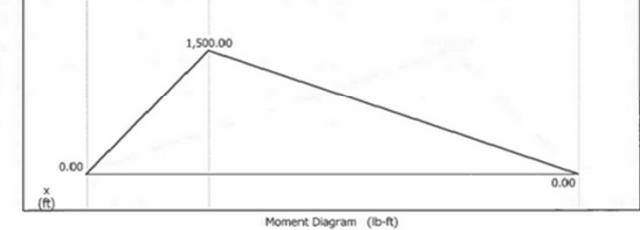


Load Diagram

$A_y = 375.00 \text{ lb (up)}$   
 $B_y = 125.00 \text{ lb (up)}$



Shear Diagram (lb)

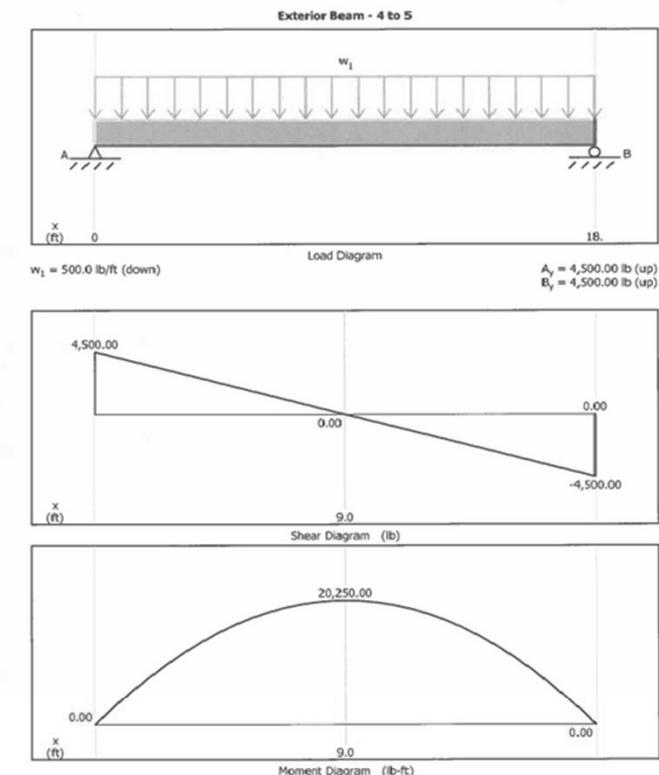
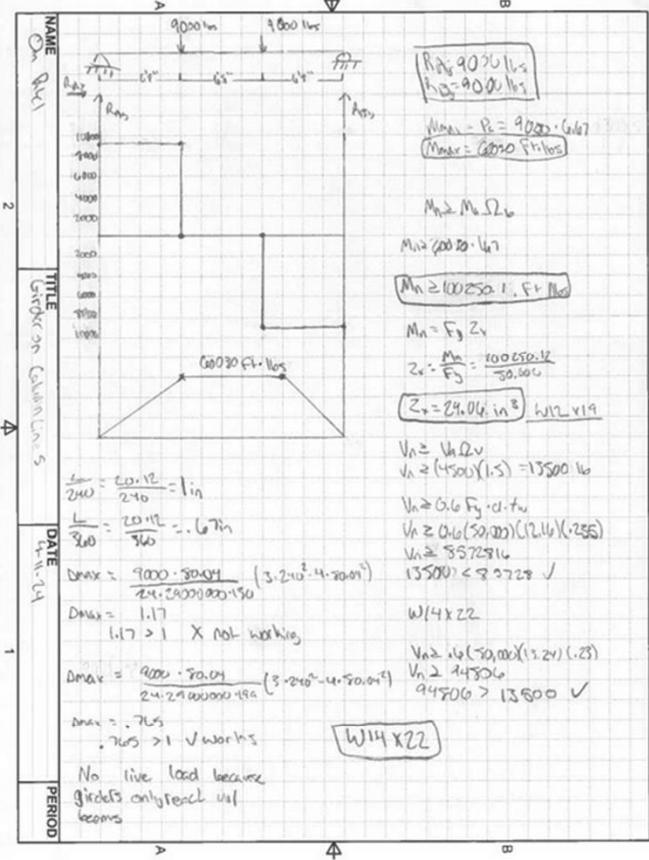
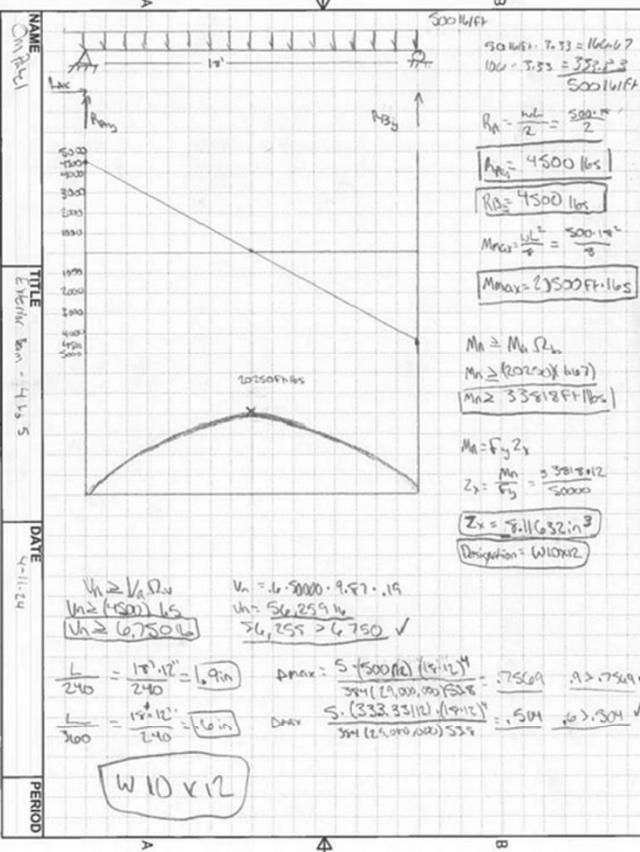


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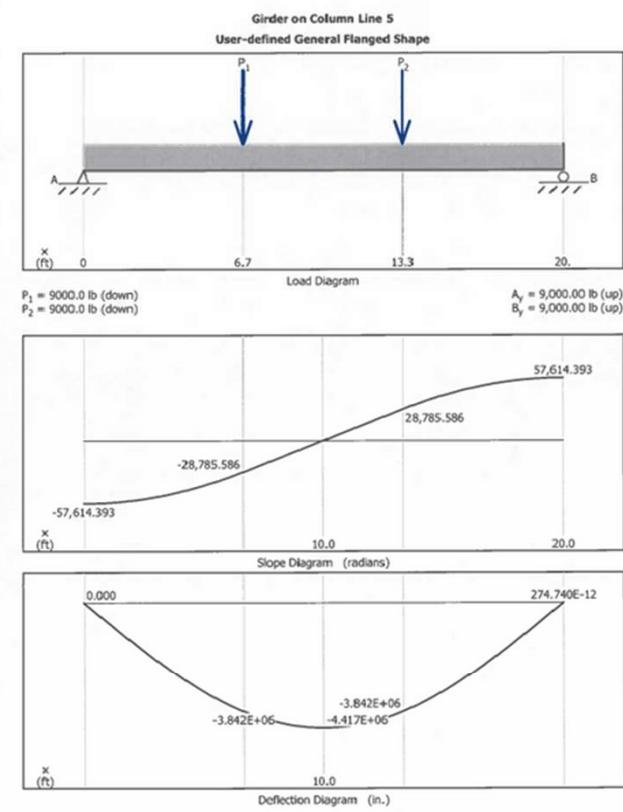
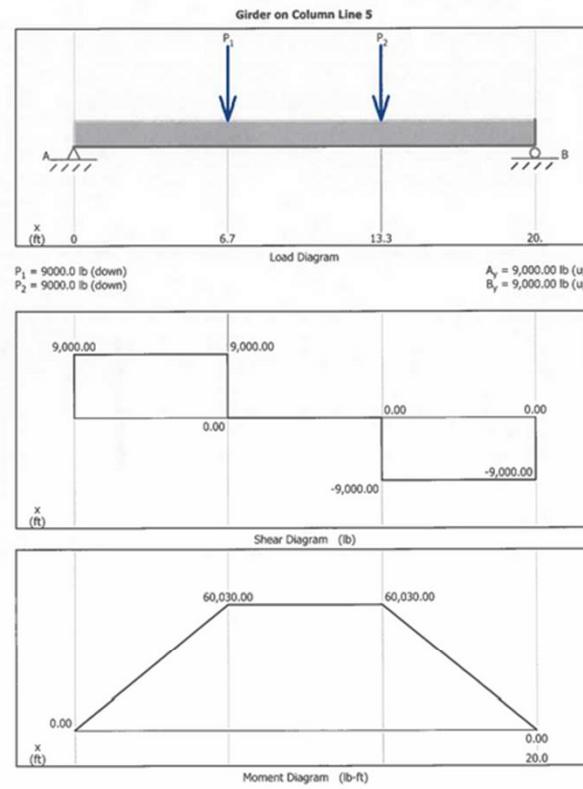
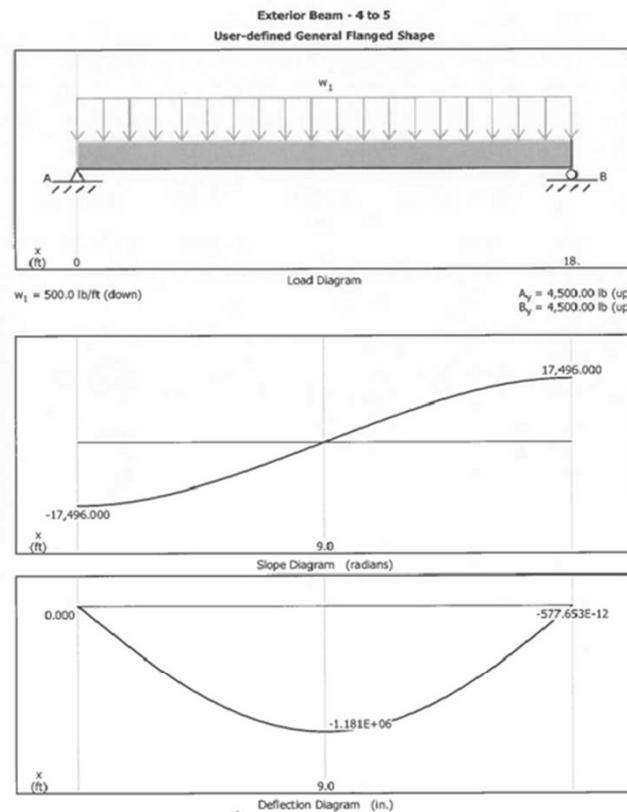
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# BEAM ANALYSIS SHORTCUTS



# BEAM DESIGN

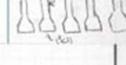
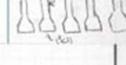
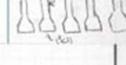
Selecting a cost-effective beam design that will provide enough shear and bending strength to limit deflection, using beam analysis methods.



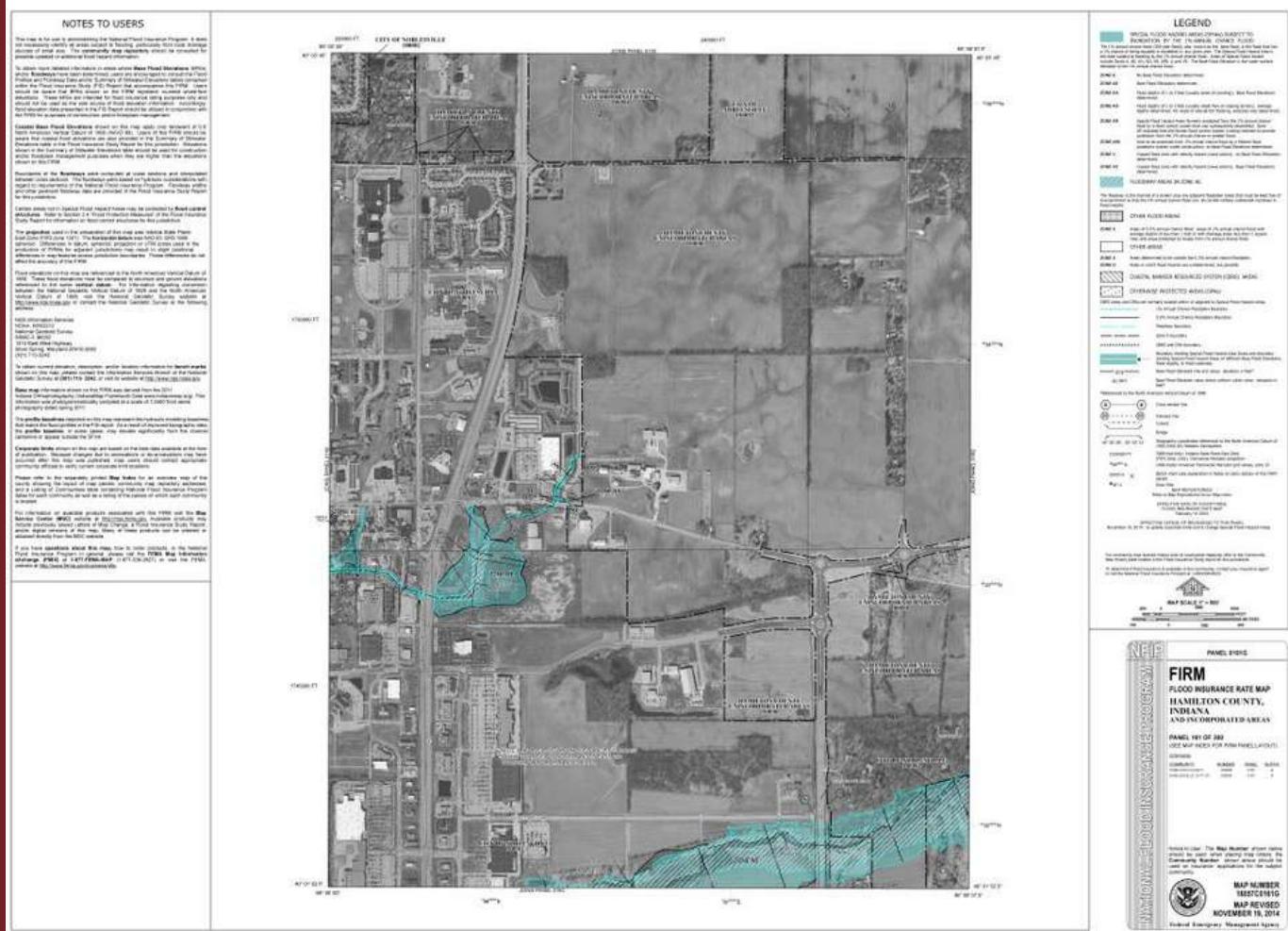
# BEAM DESIGN

# FOUNDATION TYPES AND CONSIDERATIONS

Investigated soil and environmental conditions for a site to provide the information necessary to select one of the many foundation types

32 3.2.8 Foundation Types																											
<p>① The building is in a P zone.</p> <p>This means the building is in an area where floods are not significant during the soil selection stage. The building must be dry foundations by dealing the back fill materials have flood characteristics.</p> <p>Conclusion:</p> <ul style="list-style-type: none"><li>② Wind and application of loads affect the design of a structure via the size and shape of the building.</li><li>③ The soil type determines what soil is suitable for specific structures.</li><li>④ The foundation type influences the depth &amp; width of the foundation.</li><li>⑤ The physical factors of soil of a specific location are being shown and given through tables.</li></ul>																											
<p>DESIGNED BY: <u>John Doe</u> DATE: <u>4/22/24</u></p> <p>WITNESSED BY: _____ DATE: _____</p> <p><b>PROPRIETARY INFORMATION</b> All information is the property of and solely owned by the Designer.</p>																											
33 3.2.8 Foundation Types																											
<table border="1"><thead><tr><th>Typical Foundation Systems/Usage</th><th>Diagram/Sketch</th></tr></thead><tbody><tr><td>Continuous StripFooting with Foundation Wall</td><td></td></tr><tr><td>Usage: Light Frame Construction Under Foundation Walls</td><td></td></tr><tr><td>SpreadFooting with Pier</td><td></td></tr><tr><td>Usage: Using under non-site bearing soils</td><td></td></tr><tr><td>Slab-on-Grade with Thickened Edge</td><td></td></tr><tr><td>Usage: Shallow foot depths or when foundation is weak</td><td></td></tr><tr><td>Mat/Floating Foundation</td><td></td></tr><tr><td>Usage: Heavy loads on weak soil</td><td></td></tr><tr><td>Pile and Pile Cap</td><td></td></tr><tr><td>Usage: Heavy shallow soil over relatively soft soils</td><td></td></tr><tr><td>Cast-in-Situ Pile and Grade Beam</td><td></td></tr><tr><td>Usage: Weak shallow and relatively soft soil at intermediate depth</td><td></td></tr></tbody></table>		Typical Foundation Systems/Usage	Diagram/Sketch	Continuous StripFooting with Foundation Wall		Usage: Light Frame Construction Under Foundation Walls		SpreadFooting with Pier		Usage: Using under non-site bearing soils		Slab-on-Grade with Thickened Edge		Usage: Shallow foot depths or when foundation is weak		Mat/Floating Foundation		Usage: Heavy loads on weak soil		Pile and Pile Cap		Usage: Heavy shallow soil over relatively soft soils		Cast-in-Situ Pile and Grade Beam		Usage: Weak shallow and relatively soft soil at intermediate depth	
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# FOUNDATION TYPES AND CONSIDERATIONS



# SIZING A SPREAD FOOTING

I used the site-specific soil information to size spread footings for several different buildings

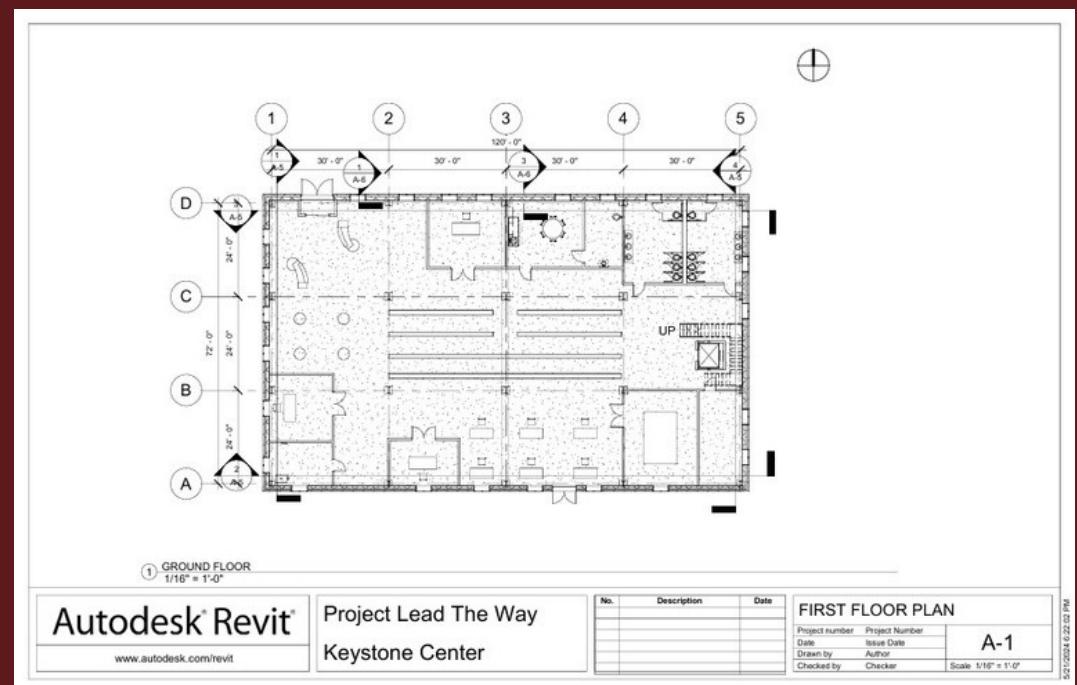
<p><b>34</b></p> <p><u>3-2.9 Single Spread Footing</u></p> <p>① <math>q = \frac{P}{A}</math> <math>A = 1500</math></p> <p><math>q = \frac{30000}{24}</math> <math>q = 1250</math></p> <p>The footing cannot safely carry the column.</p> <p><math>P_{ed} = 1500 \times 150</math> <math>225 = 15 \times 150</math></p> <p><math>q_{ed} = 1500 - 225 = 1275</math></p> <p><math>\frac{32000}{1275} = 25.1</math> <math>24 &gt; 25.1 \times</math></p> <p>② <math>P = 3000</math> allowable = 2000 <math>t = 1.75</math> <math>1.75 \times 150 = 262.5</math> <math>2000 - 262.5 = 1737.5</math></p> <p><math>\frac{3000}{1737.5} = A</math> <math>A = 3.1</math> <math>3.1^2 \times 1.75 = 2.2</math></p> <p><u><math>2' \times 2' \times 1' 9''</math> wide</u></p> <p>③ <math>P = 22000</math> <math>t = 2</math> <math>2 \times 150 = 300</math> allowable = 1500 <math>1500 - 300 = 1200</math> <math>1200 = \frac{22000}{A}</math> <math>A = 12.33</math></p> <p><u><math>2' 6'' \text{ radius} \times 1' 4'' \text{ wide}</math></u></p>	<p><b>35</b></p> <p><u>3-2.9 Single Spread Footing</u></p> <p>④ <math>45000 = P</math> <math>t = 12.25</math> <math>t = 1.75</math> <math>1.75 \times 150 = 225</math> <math>2500 - 225 = 2275</math></p> <p><math>\frac{45000}{2275} = 19.78</math> <math>12.25 &lt; 19.78 \times</math></p> <p>The bearing is not adequate to carry the loads.</p> <p><u>Conclusion</u></p> <p>⑤ In an area where a column will be very close to adjacent footings, nearby back-to-back, a foundation would have to change its foundation type.</p> <p>⑥ Path continuous stepped spread footings both distribute the load of a column, however spread column footings are typical columns.</p>	
<small>DESIGNED BY: [Signature]</small>	<small>DATE: 4-22-19</small>	<small>PROPRIETARY INFORMATION</small> <small>All information is the property of, and solely owned by the designer.</small>
<small>RECHECKED BY: [Signature]</small>	<small>DATE: 4-22-19</small>	<small>PROPRIETARY INFORMATION</small> <small>All information is the property of, and solely owned by the designer.</small>

# KEYSTONE LIBRARY SPREAD FOOTING ANALYSIS

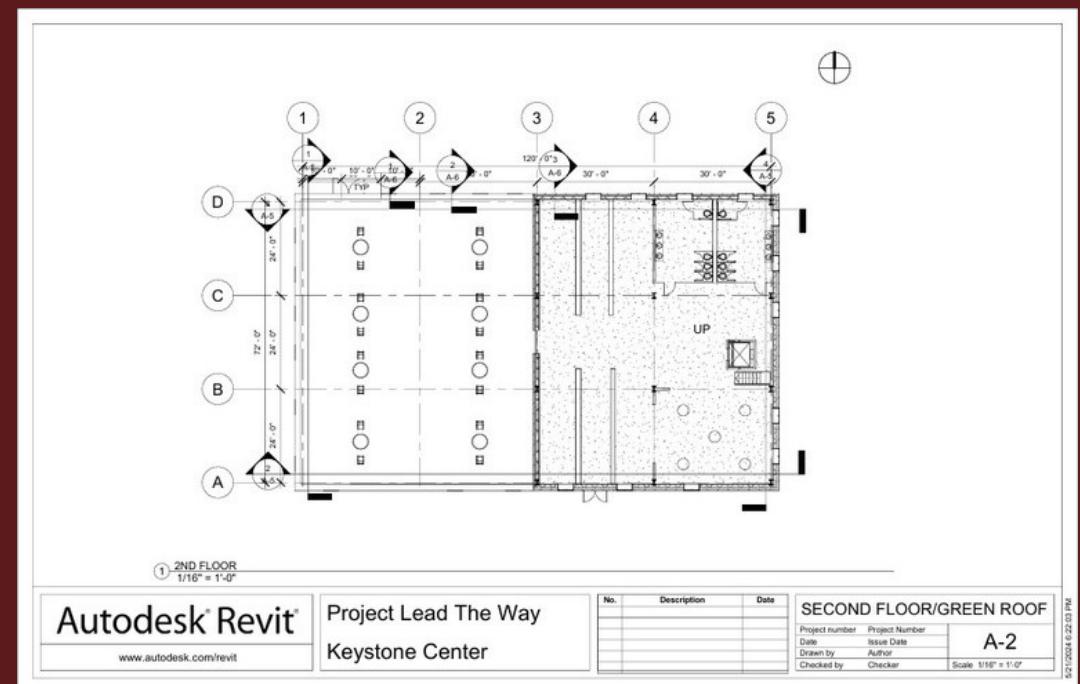
Checked the existing footings on the Keystone Library site, in which I found that many needed to be replaced to adequately support the columns and building.

<p><b>36</b></p> <p>Interior Column on Line 4</p> <p>Column Load = 150,000 lbs Trussing Area = 710 ft<sup>2</sup> Root Load = 710,680 - 44,800 lbs Interior Beam Load = 25,800 lbs Interior Girder Load = 31,600 lbs</p> $150,000 + (25,800 \cdot 2) + (31,600 \cdot 2) = 241,400 \text{ lbs} = \text{Column Load}$ <p>Existing Footing: 7' x 7' x 24" 40 ft<sup>2</sup>      <math>\frac{241,400}{3200} = 74.3 \text{ psf}^2</math></p> <p><math>g = 3200</math></p> $150 \cdot 2 = 300 \quad 3500 \cdot 300 = 10500$ <p><math>7' \times 7' \times 8</math>      <math>\frac{10500}{48 \times 7 \times 24} = 2.1</math></p> <p><u>Conclusion</u></p> <p>(1) The adequacy of the wall load up to per ASCE 31-16 the footing cannot carry its load.</p> <p><u>Original footing does not work</u></p> <p>DESIGNED BY: <i>[Signature]</i>      DATE: <i>4-22-14</i>      PROPRIETARY INFORMATION: All information is the property of [redacted] and solely owned by the Designer.</p> <p>WITNESSED BY: _____</p>	<p><b>37</b></p> <p>Interior Column on Line 2</p> <p>Interior Column Load = 25,800 lbs Trussing Area = 51,100 ft<sup>2</sup> <math>25,800 \cdot 2 + 31,600 \cdot 2 = 104,800 \text{ lbs}</math></p> <p>Existing Footing: 7' x 7' x 24" 40 ft<sup>2</sup>      <math>\frac{104,800}{3200} = 48.375 \text{ psf}^2</math></p> <p><math>g = 3200</math> <math>3500 - 300 = 3200</math></p> <p><u>Original Footing works!</u></p> <p>7' x 7' x 24"</p> <p><u>Interior Column on Line 3</u></p> <p>Trussing Area = 360 ft<sup>2</sup> Root Load = 23,400 lbs Interior Beam Load = 25,800 lbs Interior Girder Load = 31,600 lbs</p> $25,800 \cdot 2 + 31,600 \cdot 2 + 27,400 + 30,215 = 255,600$ <p>Existing Footing: 7' x 7' x 24" 40 ft<sup>2</sup>      <math>\frac{255,600}{3200} = 79.875 \text{ psf}^2</math></p> <p><math>g = 3200</math> <math>3500 - 300 = 3200</math></p> <p><u>Original Footing does not work</u></p> <p><math>7' \times 7' \times 24'</math>      <math>3200 \times 79.875 = 255,600</math></p> <p>DESIGNED BY: <i>[Signature]</i>      DATE: <i>4-22-14</i>      PROPRIETARY INFORMATION: All information is the property of [redacted] and solely owned by the Designer.</p> <p>WITNESSED BY: _____</p>
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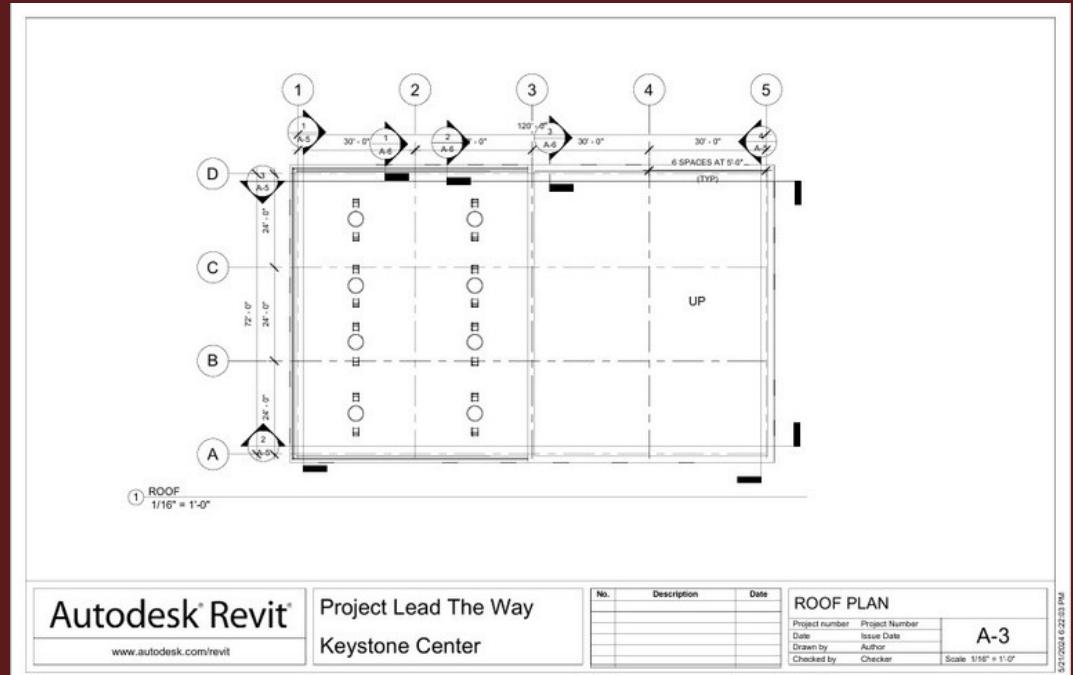
# A-1 FIRST FLOOR PLAN



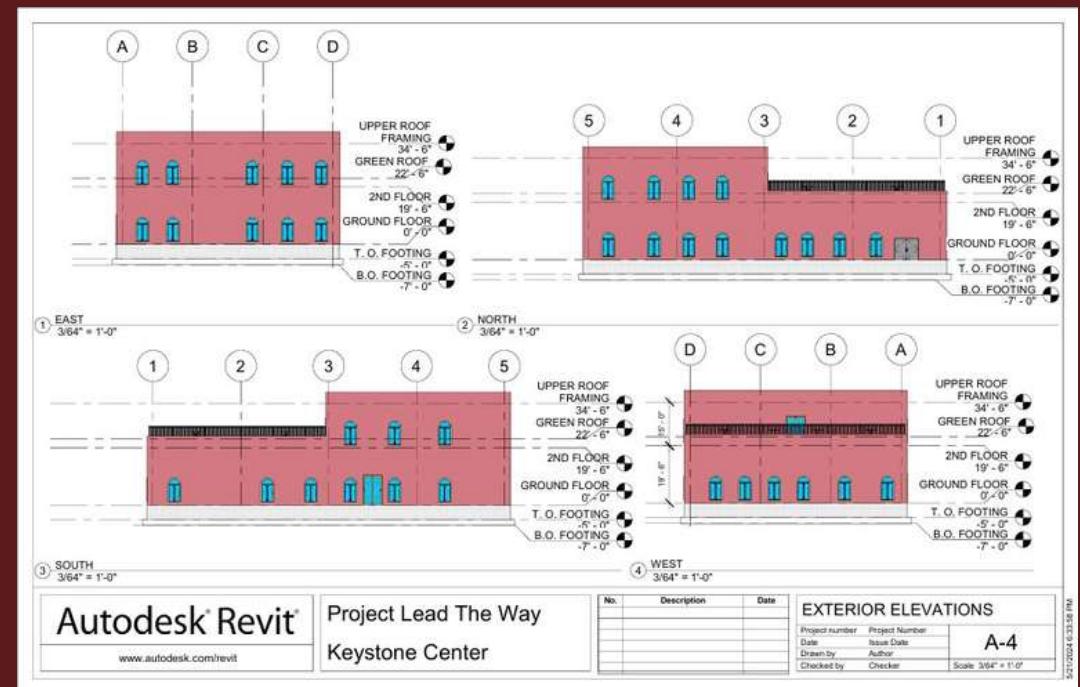
# A-2 SECOND FLOOR PLAN



# A-3 ROOF PLAN



# A-4 EXTERIOR ELEVATIONS



# A-5 INTERIOR ELEVATIONS

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The image displays four interior elevation drawings, each labeled with a number and a title:

- 1. INTERIOR EAST**  
1/16" = 1'-0"
- 2. INTERIOR NORTH**  
1/16" = 1'-0"
- 3. INTERIOR SOUTH**  
1/16" = 1'-0"
- 4. INTERIOR WEST**  
1/16" = 1'-0"

Below the drawings is a footer section:

<b>Autodesk® Revit®</b> www.autodesk.com/revit	<b>Project Lead The Way</b> <b>Keystone Center</b>	<table border="1"><thead><tr><th>No.</th><th>Description</th><th>Date</th></tr></thead><tbody><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td></tr></tbody></table>	No.	Description	Date										<b>INTERIOR ELEVATIONS</b> Project number: _____ Project Number: _____ Date: _____ Issue Date: _____ Drawn by: _____ Author: _____ Checked by: _____ Checker: _____ Scale: 1/16" = 1'-0" A-5 10/20/2024 6:22:10 PM
No.	Description	Date													

# A-6 SECTION VIEWS

