Tier 2 Structural Evaluation
for the
Forest Service Building

Forest Service Building
507 25th Street, Ogden, UT 84401

Prepared For:
Ogden City
2549 S Washington Blvd, Ogden, UT 84401

A R W
ENGINEERS
structural consultants

Prepared by

ARW Engineers

December 4, 2023

PROFESSIONAL STRUCTURAL ENGINEER
No. 374996
Troy M. Dye
STATE OF UTAH
12/04/23

December 4, 2023

Ms. Sara Meess
Ogden City
2549 S Washington Blvd
Ogden, Utah

Re: Forest Service Building – Tier 2 Structural Evaluation
ARW Job # 23124

Dear Sara:

At your request, ARW Engineers has completed an ASCE 41-17 Tier 2 Structural Evaluation of the Forest Service Building located at 507 25th Street, Ogden, Utah (southeast corner of the intersection of Adams Avenue & 25th Street). The purpose of the evaluation is to determine, per the International Existing Building Code (IEBC), whether the existing structural lateral systems in the building are adequate to resist anticipated code-prescribed seismic forces. This report summarizes our evaluation process and findings and presents schematic structural upgrade concepts where appropriate. The findings in this report are based on the following:

- A Tier 1 Evaluation Report compiled by ARW Engineers and dated April 17, 2023
- A site investigation performed on October 11, 2023, by representatives of ARW Engineers
- An investigation of existing building drawings provided to ARW by Sanders Associates Architects on October 2, 2023

General Structural Description

The Forest Service Building was designed in the early 1930's by the same architect who designed Ogden High School and the Ogden Municipal Building, which are two other historic buildings located in Ogden. The Forest Service Building consists of four above-ground floor levels and one basement level. The footprint of the building is roughly square with approximate dimensions of 100-ft by 100-ft.

Above ground, Levels 1 and 2 are square in aspect ratio and occupy the entire footprint of the building, with an approximate area of 10,000 square-feet each. Levels 3 & 4 are U-shaped, with the opening facing to the south, and have an approximate area of 8,000 square-feet each. A three-story penthouse beginning at the main roof level is located centrally on the roof, with a tall brick chimney located at the southeast corner of the building.

The basement is partially below exterior grade, with ground level access on the south side. A wing of the basement is located at the southeast corner outside the main footprint of the building, with a parking area on top.

Gravity System Description

The summary provided in this section describes the elements that make up the gravity system, which are the structural elements involved in sustaining the floor and roof loads. The gravity system appears to have been in place for the lifetime of the building and has likely seen close to its design gravity loading within that time frame.

The floors consist of reinforced concrete pan-joists. The pan-joists are approximately 10 inches wide by 12 inches deep (measured from the bottom face of the slab). The width of the pan-joists tapers down to six inches at the midspan of each joist. The slab is three inches thick and is poured integral with the joists. Except for one area on Level 1, the pan-joists run east-west and are supported by reinforced concrete beams.

The reinforced concrete beams are approximately 12 inches wide by 21 inches deep (measured from the bottom face of the slab) and generally run north-south perpendicular to the pan-joists. The beams also appear to be poured integral with the pan joists, suggesting that the floor and roof systems are cast-in-place. The reinforced concrete beams are supported by 18-inch by 18-inch reinforced concrete columns that run continuously from the foundations to the roof. In addition to running north-south along each column line, the reinforced concrete beams also span from column to column along the perimeter of each level, forming a reinforced concrete frame.

Lateral System Description

The summary provided in this section describes the existing lateral system, which comprises the shear walls and diaphragms (floors & roof) that resist lateral (seismic) forces.

The shear walls are made up of unreinforced brick walls that infill the reinforced concrete frames around the perimeter of each level. The brick infill walls are approximately eight inches thick (i.e., two-wythe) with one layer of approximately four-inch-thick brick or terra cotta veneer. The veneer bypasses the exterior face of the reinforced concrete frames.

Door and window openings are present in nearly all unreinforced brick infill walls on the exterior of the building. Because of this, most sections of unreinforced brick wall between each opening (i.e. wall piers) provide negligible lateral force resistance. Most of the lateral force is resisted by the longer wall piers located at each corner and about 12 to 15 feet from each corner.

The diaphragms of each floor transfer the inertial forces of each level to the shear walls below. The diaphragms are made up of the slab section of the reinforced concrete pan-joists described in the Gravity System Description above.

Notably, Level 2 and the Main Roof/Penthouse level are currently the lower terminuses for select shear walls descending from levels above. The north, east, and west penthouse shear walls terminate at the Main Roof diaphragm, which then transfers the penthouse shear wall forces to the Level 4 shear walls along the perimeter of the Main Roof/Penthouse level. Similarly, the interior U-shaped walls of Levels 2, 3, and 4 terminate at the Level 2 diaphragm, which then transfers the upper-level forces to the exterior Level 1 shear walls.

Evaluation Procedure

Chapter 12 of the International Existing Building Code (IEBC) addresses the repair, alteration, relocation and change of occupancy of Historic Buildings:

- A historic building undergoing alterations or change of occupancy shall be investigated and evaluated. For buildings assigned to Seismic Design Category D, E or F, a structural evaluation describing, at a minimum, the vertical and horizontal elements of the lateral force-resisting system and any strengths or weaknesses therein shall be prepared. Additionally, the report shall describe each feature that is not in compliance with these provisions and shall demonstrate how the intent of these provisions is complied with in providing an equivalent level of safety. (IEBC 1201.2)
- Repairs to any portion of the historic building or structure shall be permitted with original or like materials and original methods of construction. (IEBC 1202.1)
- Historic buildings undergoing a change of occupancy which results in a building being assigned to a higher risk category shall satisfy the requirements of Section 1613 of the International Building Code for the new risk category using full seismic forces. (IEBC 1006.3)

Based on ARW's assessment during the October 11 site visit, the most recent building occupancy type was conventional office space. If the decision is made to increase occupancy risk per IEBC Chapter 12, this will trigger mandatory seismic upgrades for the structure.

ASCE 41-17 Tier 2 procedures were used to conduct an analysis of the building to determine potential structural deficiencies. The performance objective was Life Safety (LS) for the Basic Safety Earthquake 1E (BSE-1E), and Collapse Prevention (CP) for the Basic Safety Earthquake 2E (BSE-2E). These design earthquakes correspond to a 20% probability of occurrence in 50 years for BSE-1E, and a 5% probability of occurrence in 50 years for BSE-2E, based on available site-specific data. Schematic structural upgrade concepts were developed using the Equivalent Lateral Force procedure in ASCE 7-16, using a response modification factor (R) of 5 for new structural concrete shear walls, and an R of 8 for buckling-restrained braced frames (BRBF's).

Structural Deficiencies

The following is a summary list of structural deficiencies noted in the building:

1. Main Roof/Penthouse Level diaphragm
    - This diaphragm transfers forces from the penthouse walls above to the Level 4 walls below. Per refer to ASCE 41-17, Section 7.4.1.3.4, diaphragms of this type are force-controlled. By analysis, the force-controlled diaphragm is not adequate to transfer forces from the shear walls above to the shear walls below.
2. Level 2 diaphragm
    - This diaphragm transfers forces from the Level 2, Level 3, & Level 4 walls above to the Level 1 walls below. Per refer to ASCE 41-17, Section 7.4.1.3.4, diaphragms of this type are force-controlled. By analysis, the force-controlled diaphragm is not adequate to transfer forces from the shear walls above to the shear walls below.
3. Unreinforced brick infill shear walls
    - The unreinforced brick infill shear walls at each level are not adequate to transfer lateral forces to the foundations. This is a hazard due to the potential for an earthquake to crack and/or crush the existing shear wall system, amplifying the potential for lateral movement.
4. Unreinforced brick infill walls (out-of-plane)
    - The unreinforced brick infill walls are not anchored to the reinforced concrete frames. This is a hazard due to the potential for the infill brick walls to dislodge from the reinforced concrete frames and fall to the inside or outside of the building.
5. Chimney at southeast corner
    - The chimney is constructed of unreinforced brick and rises nearly 26 feet above the Main Roof/Penthouse level, with a base diameter of about 5.5 feet. There is potential for the unreinforced chimney walls to buckle and fall to the ground below during a seismic event.
6. Unreinforced brick/masonry interior partition walls
    - Interior brick or masonry partition (non-structural) walls are located at various locations throughout the building from the basement to the Mechanical Room in the penthouse. These are hazardous due to the potential for the walls to topple during a seismic event.
7. Miscellaneous penthouse deficiencies
    - The unreinforced brick infill shear walls at each penthouse level are not adequate to transfer lateral forces to the foundations. This is a hazard due to the potential for an earthquake to crack and/or crush the existing shear wall system, amplifying the potential for lateral movement.
    - The greenhouse roof structure is not braced adequately. Additionally, the roof structure is not attached adequately to the support lintel.

Recommended Structural Upgrades

The following is a summary list of schematic structural upgrade concepts corresponding to the above list of structural deficiencies:

1. Main Roof/Penthouse Level diaphragm
   - Option 1: Install a vertical lateral force resisting system directly below the lateral force resisting system above. This new lateral force resisting system can be a new concrete shear wall, masonry wall, or braced frames. The new lateral force resisting system should be continuous through all levels from the Main Roof/Penthouse Level down to the footing & foundation system. Executing this option will remove the requirement for this diaphragm to be force-controlled, likely reducing or removing the need to upgrade the diaphragm strength.
   - Option 2: Upgrade the diaphragm strength by installing fiber-reinforced polymer (FRP) wrap over the surface of the entire diaphragm. FRP applied to concrete is a useful way to increase the diaphragm strength; although, this would require removing all roof surfaces down to the structural concrete to apply the FRP.
   - Refer to Appendix B for a schematic representation of the options described above.
2. Level 2 diaphragm
   - Option 1: Install a vertical lateral force resisting system directly below the lateral force resisting system above. This new lateral force resisting system can be a new concrete shear wall, masonry wall, or braced frames. The new lateral force resisting system should be continuous through all levels from Level 2 down to the footing & foundation system. Executing this option will remove the requirement for this diaphragm to be force-controlled, likely reducing or removing the need to upgrade the diaphragm strength.
   - Option 2: Upgrade the diaphragm strength by installing fiber-reinforced polymer (FRP) wrap over the surface of the entire diaphragm. FRP applied to concrete is a useful way to increase the diaphragm strength; although, this would require removing all floor surfaces down to the structural concrete to apply the FRP. Furthermore, additional shear walls around the perimeter of the diaphragm would likely be required down to the footing & foundations.
   - Refer to Appendix B for a schematic representation of the options described above.
3. Unreinforced brick infill shear walls
   - Option 1: Install new concrete and/or shotcrete shear walls strategically between columns. This new shear wall will be designed to take all the lateral force from the shear walls and diaphragms above and transfer it to the footings & foundations below. The new shear walls will be installed both at exterior wall locations and between interior columns. Installing the shear wall between existing columns is ideal because the existing columns and the associated footings can be utilized to resist overturning forces using the self-weight of the building. If existing columns are not used in this way, it is likely that additional footing & foundation work will be needed to resist the overturning forces in the shear wall. Additionally, new concrete and/or shotcrete shear walls are ideal because they have similar stiffness properties as the existing unreinforced brick infill walls. Please refer to Appendix B for a schematic representation of the options described in this paragraph.
   - Option 2: Install new buckling-restrained braced frames (BRBF's). Installing BRBF's has the advantage of a more ductile system that will reduce the code-required design lateral force. However, this system is also considerably less stiff than the existing unreinforced brick infill walls. This means that the amount of movement required to engage the BRBF's is larger than the allowed amount of movement that can potentially crack and fail the unreinforced brick infill walls. To avoid this, deformation-compatibility requirements will need to be met, or the BRBF's will need to be stiffened significantly beyond what is required by the code for strength.
4. Unreinforced brick infill walls (out-of-plane)
   - Install new steel plates at the top and bottom of the existing unreinforced brick infill walls to anchor them to the concrete beam and floor slabs. Please refer to Appendix B for a schematic representation of the options described in this paragraph.

5. Chimney at southeast corner
    - Option 1: Reinforce the chimney walls. This can be done in a couple of ways. Core-drilled holes can be drilled vertically from the top of the chimney and filled with grout and steel reinforcing. Alternatively, a steel-reinforced circular shotcrete wall can be constructed inside of the chimney from the footing and foundations to the top of the chimney.
    - Option 2: The aspect ratio (i.e., ratio of the height to the diameter of the chimney) can be reduced, either by adding additional reinforced brick walls to the exterior of the chimney or removing a section of the chimney down to a lower elevation.
6. Unreinforced brick/masonry interior partition walls (out-of-plane)
    - Install new steel plates at the top of the partition walls to anchor them to the pan-joist slabs perpendicular to the plane of the wall.
7. Miscellaneous penthouse deficiencies
    - Install new concrete and/or shotcrete shear walls at all penthouse levels. Where possible, align the new shear walls vertically so no additional lateral bracing is required.
    - Provide additional steel bracing of the greenhouse roof structure. Provide new attachments of the roof structure to the concrete/masonry lintels.

Appendices

Appendices to this letter have been included as part of this report:

- Appendix A: Site investigation photos (taken during the October 11 investigation)
- Appendix B: Schematic structural upgrade concept plans and detail sketches
- Appendix C: Tier 2 calculations
- Appendix D: Tier 1 report and checklists

Thank you for the opportunity to report these findings and recommendations to you. Please do not hesitate to reach out if you have any questions regarding the information in this report.

Best Regards:

Tim Price
Structural Designer

Troy M. Dye, S.E.
Principal

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APPENDIX A
SITE INVESTIGATION PHOTOS

Photo 1 – View of unreinforced masonry chimney from southeast corner of building. Picture is taken from parking surface on top of basement wing.

Photo 2 – View of building from southwest corner.
Note the walk-out basement and basement wing.

Photo 3 – View of three-story penthouse from Main Roof.

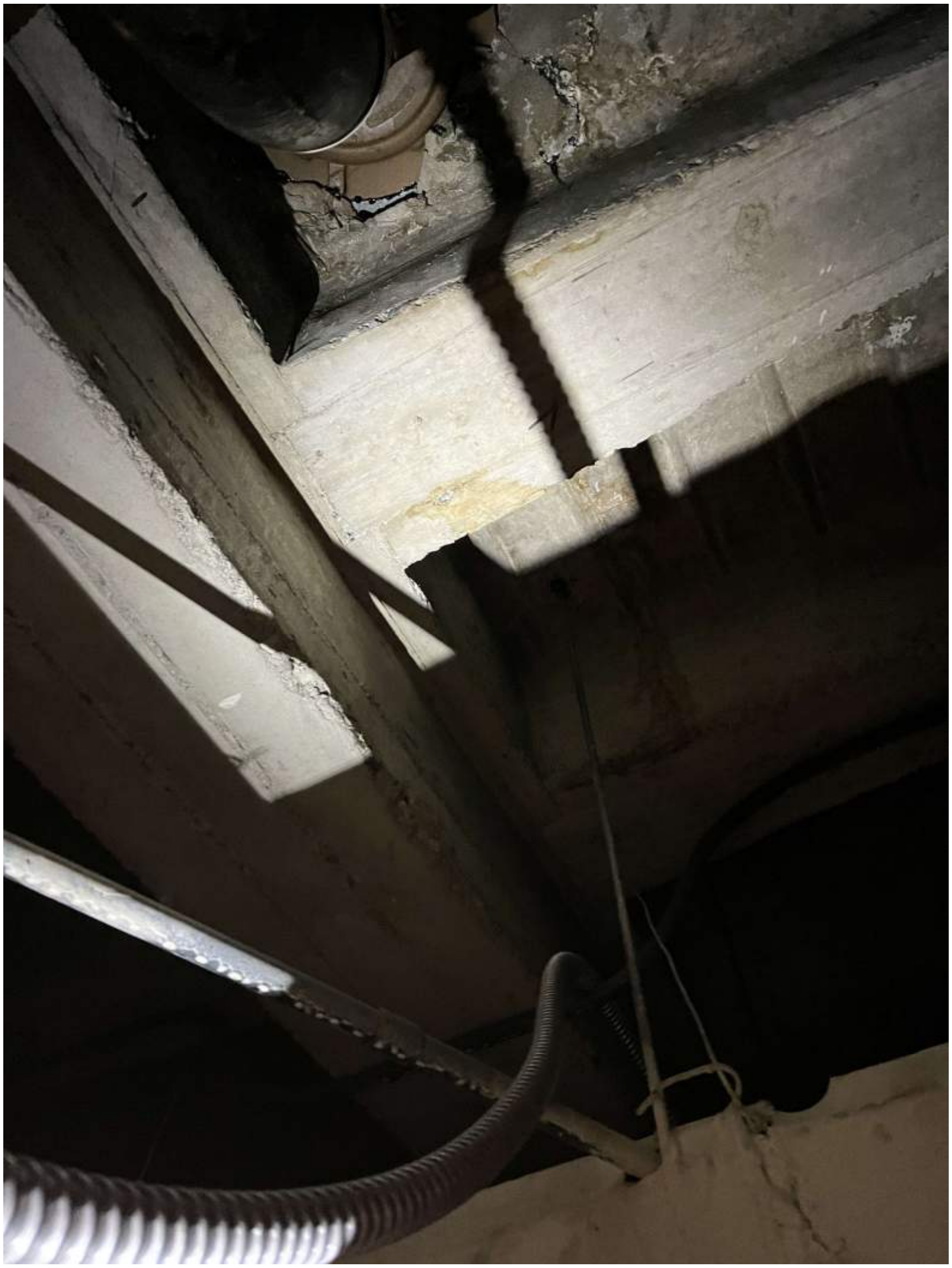


Photo 4 – View of typical pan-joist at Levels 2, 3, 4, and Main Roof/Penthouse.

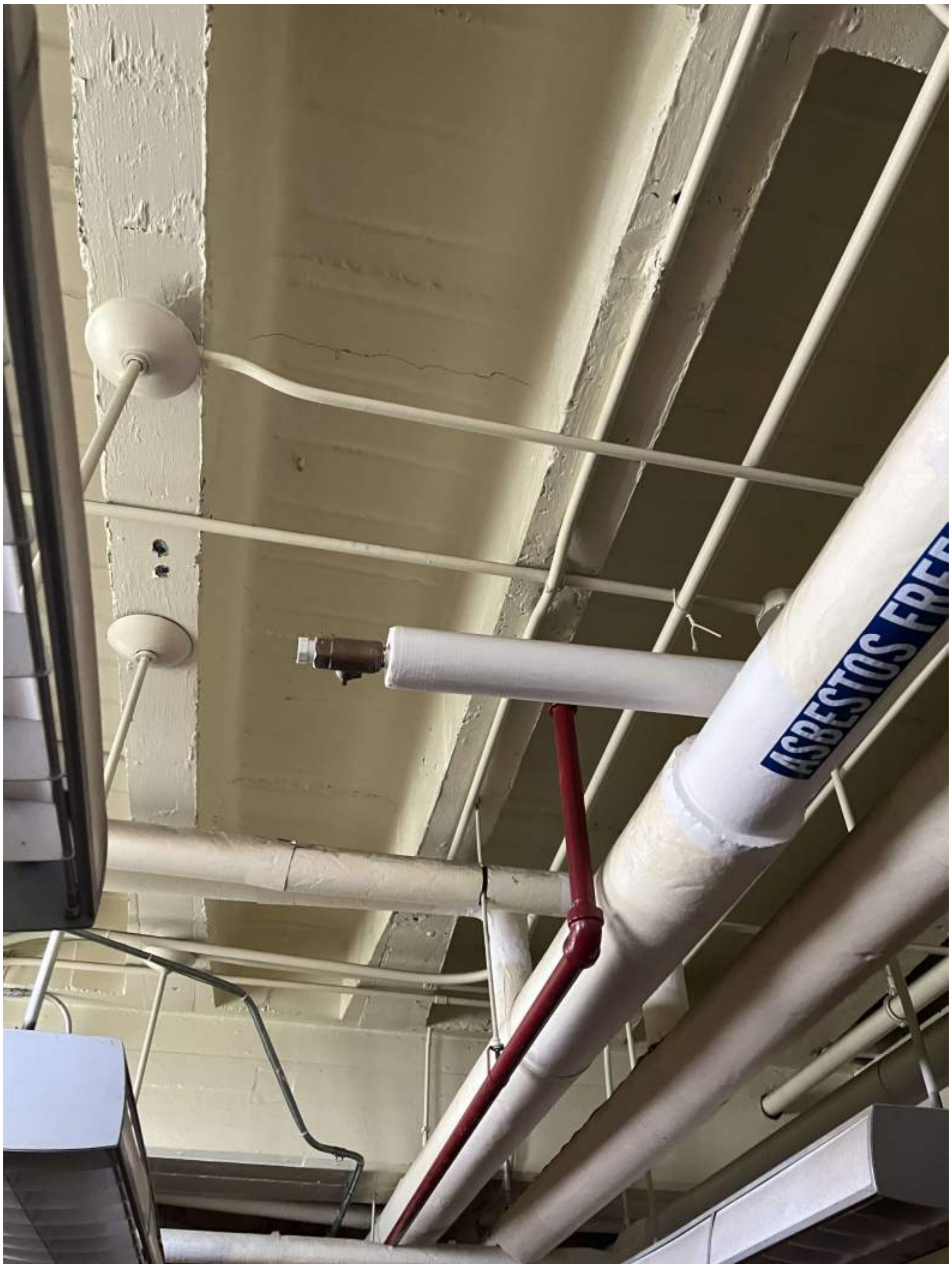


Photo 5 – View of Level 1 pan-joists from basement.

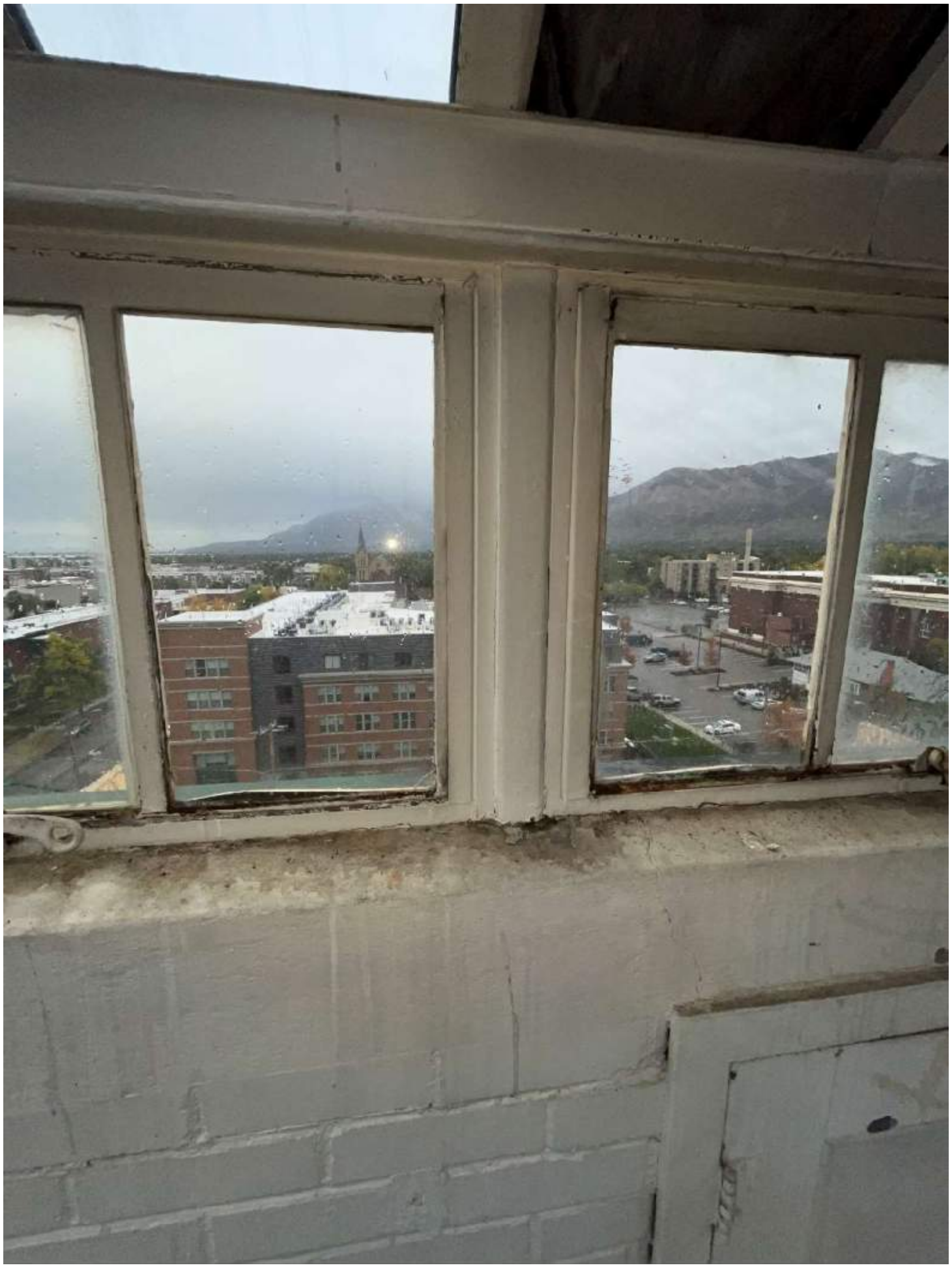


Photo 6 – Greenhouse roof structure attachment to lintel

Photo 7 – View of greenhouse roof structure.

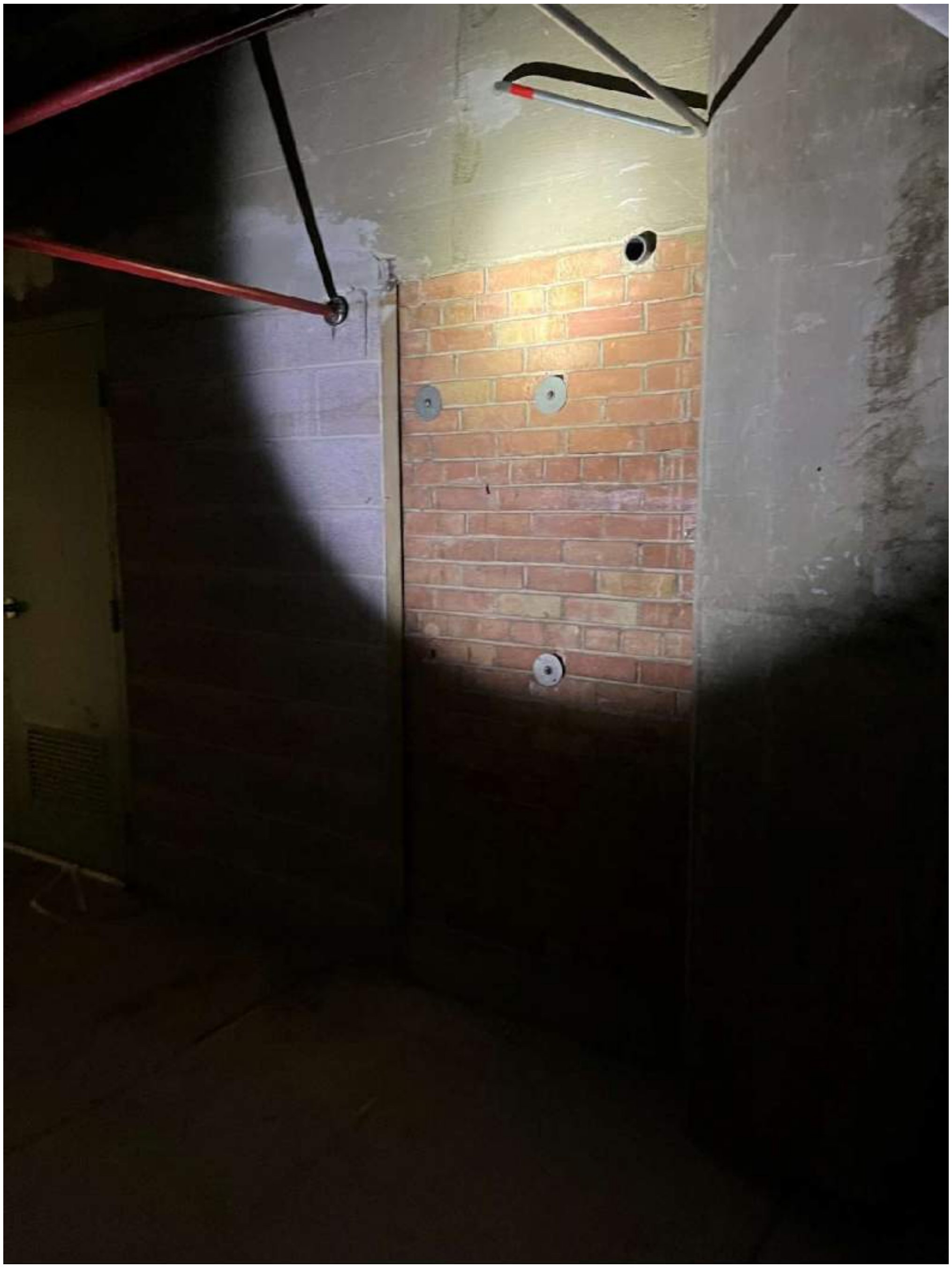
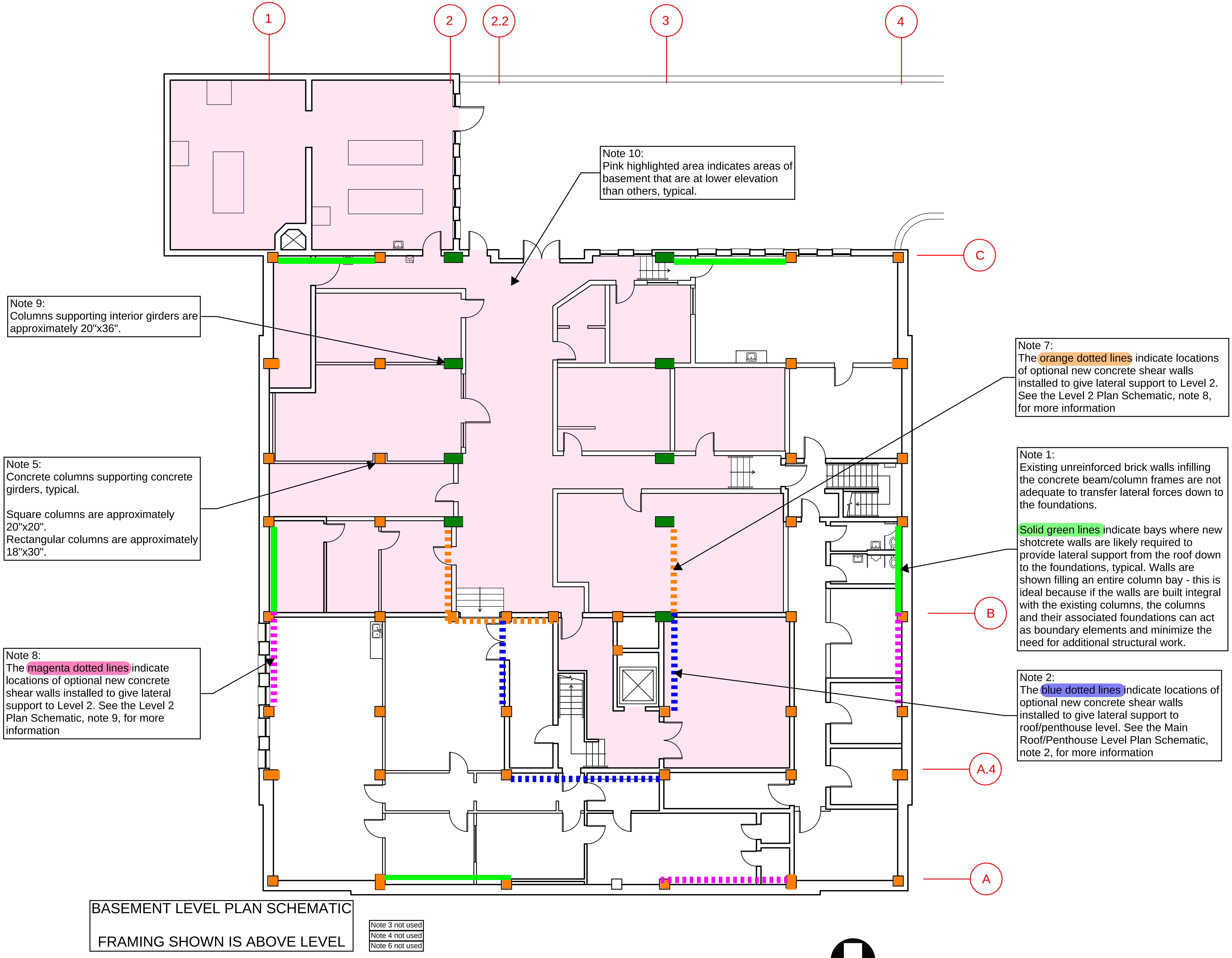


Photo 8 – View of interior partition walls.

APPENDIX B
SCHEMATIC STRUCTURAL UPGRADE PLANS & DETAIL SKETCHES



1
2
2.2
3
4
C
B
A.4
A
Note 10:
Pink highlighted area indicates areas of basement that are at lower elevation than others, typical.
Note 9:
Columns supporting interior girders are approximately 20"x36".
Note 7:
The orange dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to Level 2. See the Level 2 Plan Schematic, note 8, for more information
Note 1:
Existing unreinforced brick walls infilling the concrete beam/column frames are not adequate to transfer lateral forces down to the foundations.
Solid green lines indicate bays where new shotcrete walls are likely required to provide lateral support from the roof down to the foundations, typical. Walls are shown filling an entire column bay - this is ideal because if the walls are built integral with the existing columns, the columns can act as boundary elements and minimize the need for additional structural work.
Note 5:
Concrete columns supporting concrete girders, typical.
Square columns are approximately 20"x20".
Rectangular columns are approximately 18"x30".
Note 8:
The magenta dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to Level 2. See the Level 2 Plan Schematic, note 9, for more information
Note 2:
The blue dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to roof/penthouse level. See the Main Roof/Penthouse Level Plan Schematic, note 2, for more information
BASEMENT LEVEL PLAN SCHEMATIC
FRAMING SHOWN IS ABOVE LEVEL
Note 3 not used
Note 4 not used
Note 6 not used

Note 9:
Interior girders supporting north/south running pan joists have approximate dimensions of 20" wide x 46" deep.

Columns supporting these interior girders are approximately 20"x36".

Note 5:
Concrete columns supporting concrete girders, typical.

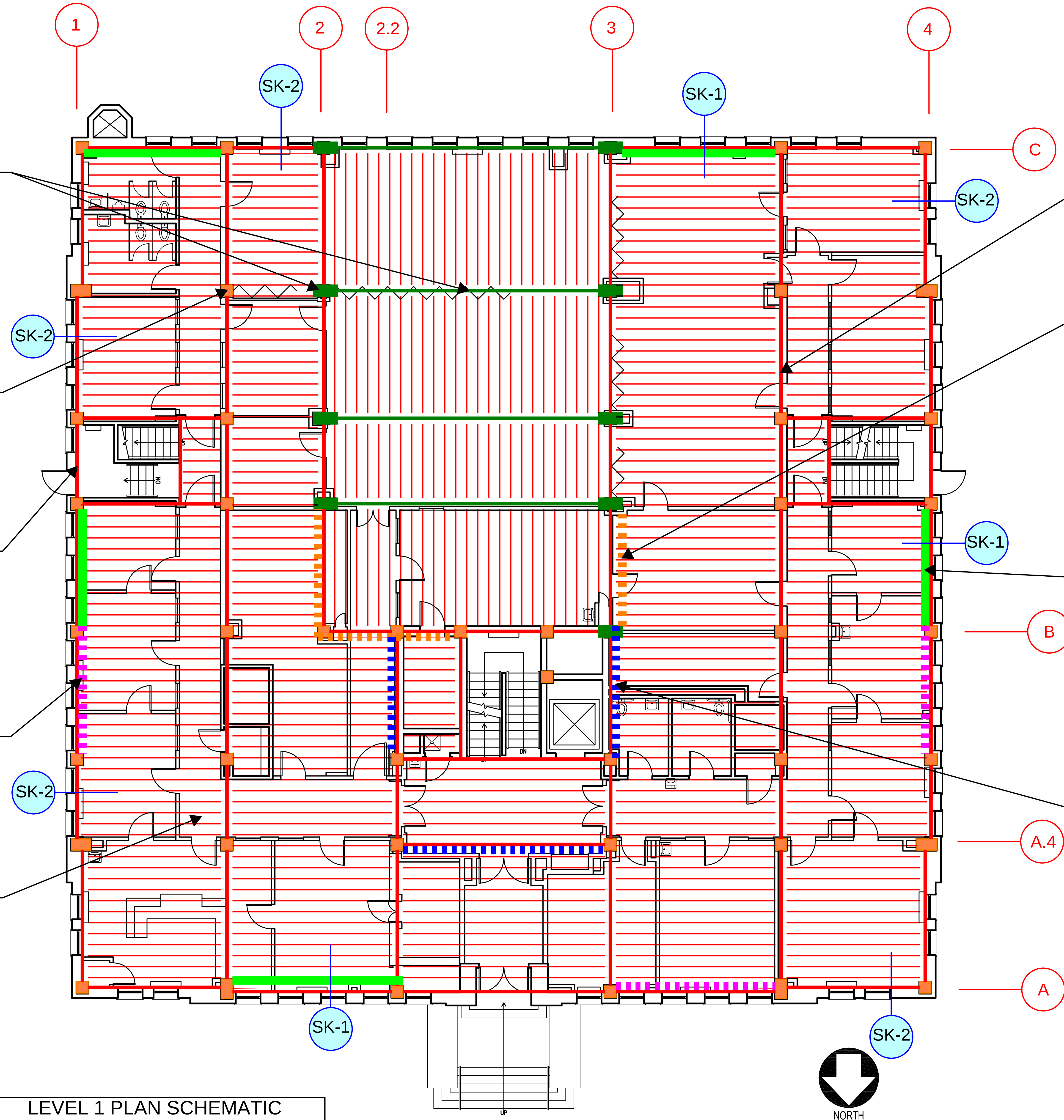
Square columns are approximately 20"x20".
Rectangular columns are approximately 18"x30".

Note 6:
Concrete beams/girders along outer perimeter of building forming frames with columns, typical.

Concrete frames are infilled with unreinforced brick walls, typical.

Note 8:
The magenta dotted lines indicate locations of optional new concrete shear walls to give lateral support to Level 2. See the Level 2 Schematic, Note 8, for more information.

Note 3:
East/west running concrete pan joists consisting of a 3" slab above 10" wide x 12" deep "joists," necking to 6" wide @ mid-span, spaced at 26"oc, typical.



Note 4:
Concrete girders running north/south down length of the building, supporting concrete pan joists, typical.

Note 7:
The orange dotted lines indicate locations of optional new concrete shear walls to give lateral support to Level 2. See the Level 2 Schematic, Note 7, for more information.

Note 1:
Existing unreinforced brick walls infilling the concrete beam/column frames are not adequate to transfer lateral forces down to the foundations.

Solid green lines indicate bays where new shotcrete walls are likely required to provide lateral support from the roof down to the foundations, typical. Walls are shown filling an entire column bay - this is ideal because if the walls are built integral with the existing columns, the columns and their associated foundations can act as boundary elements and minimize the need for additional structural work.

Note 2:
The blue dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to the roof/penthouse level. See the Main Roof/Penthouse Level Plan Schematic, Note 2, for more information

LEVEL 1 PLAN SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL

Note 4:
Concrete girders running north/south down length of the building, supporting concrete pan joists, typical. Dimensions are approximately 12" wide x 21" deep.

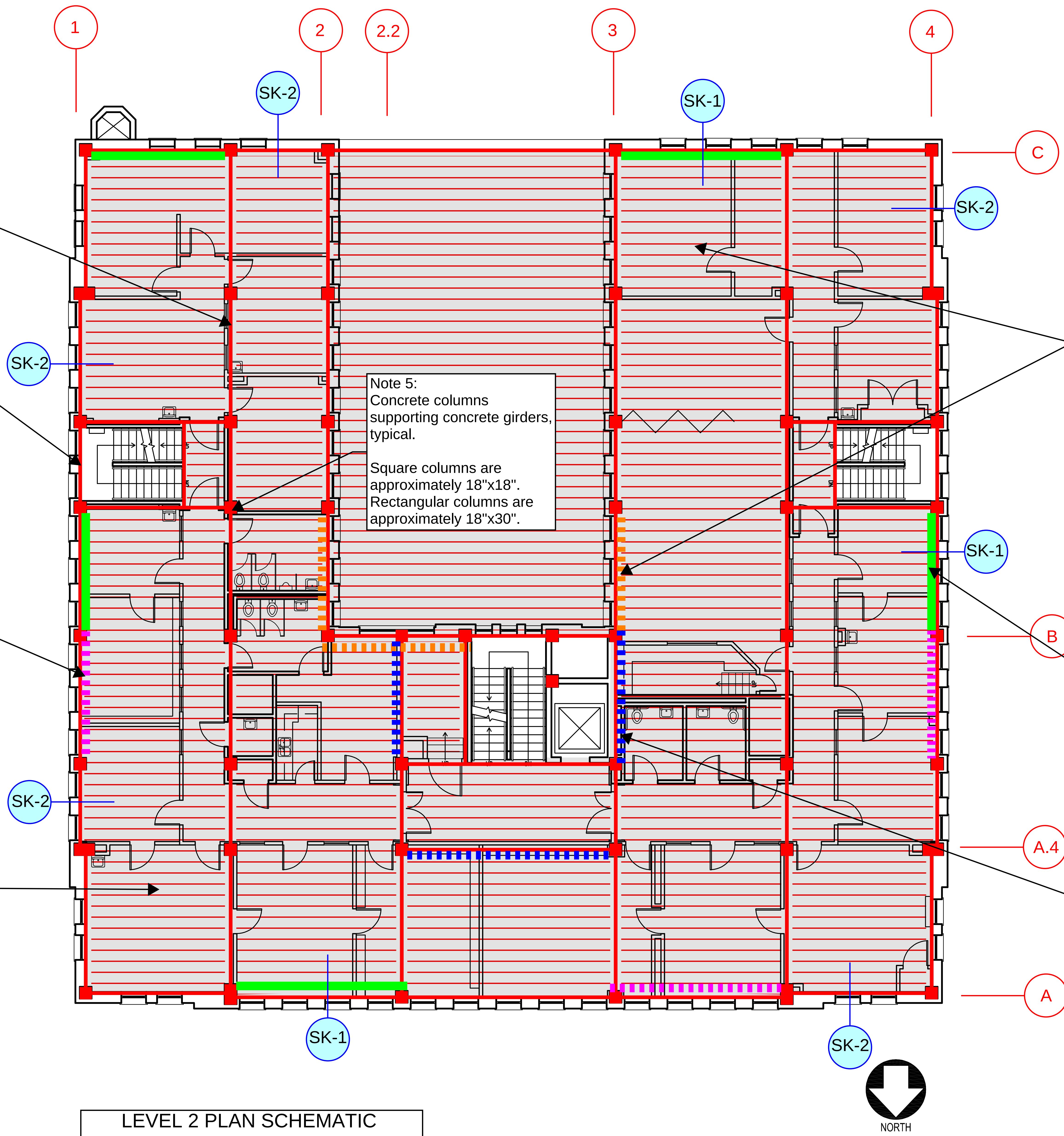
Note 6:
Concrete beams/girders along outer perimeter of building forming frames with columns, typical. Dimensions are approximately 12" wide x 21" deep.

Concrete frames are infilled with unreinforced brick walls, typical.

Note 8:
If the decision is made to upgrade the Level 2 concrete diaphragm with FRP, additional shear walls are likely needed around the perimeter of the building below Level 2 to support the combined loads of the U-shaped levels and the square-shaped levels.

The dotted magenta lines indicate bays where new concrete/shotcrete walls would likely need to be installed from Level 2 to the foundation in conjunction with upgrading the Level 2 diaphragm with FRP. See Note 7 on this sheet.

Note 3:
East/west running concrete pan joists consisting of a 3" slab above 10" wide x 12" deep "joists," necking to 6" wide @ mid-span, spaced at 26"oc, typical.



Note 5:
Concrete columns supporting concrete girders, typical.

Square columns are approximately 18"x18". Rectangular columns are approximately 18"x30".

Note 7:
The concrete diaphragm at this level is not adequate to transfer forces from the outer walls of the U-shaped levels above to the outer walls of the square-shaped levels below.

ARW recommends new concrete shear walls be installed from Level 2 to the foundation. This is indicated by the dotted orange lines, typical.

Alternatively, FRP can be installed over the entirety of Level 2 (floor & roof areas included) to increase the diaphragm strength. This is indicated by the light-grey shading over the entire level. In addition to upgrading the Level 2 diaphragm, additional concrete/shotcrete walls would likely be needed. See Note 8 on this sheet for more information.

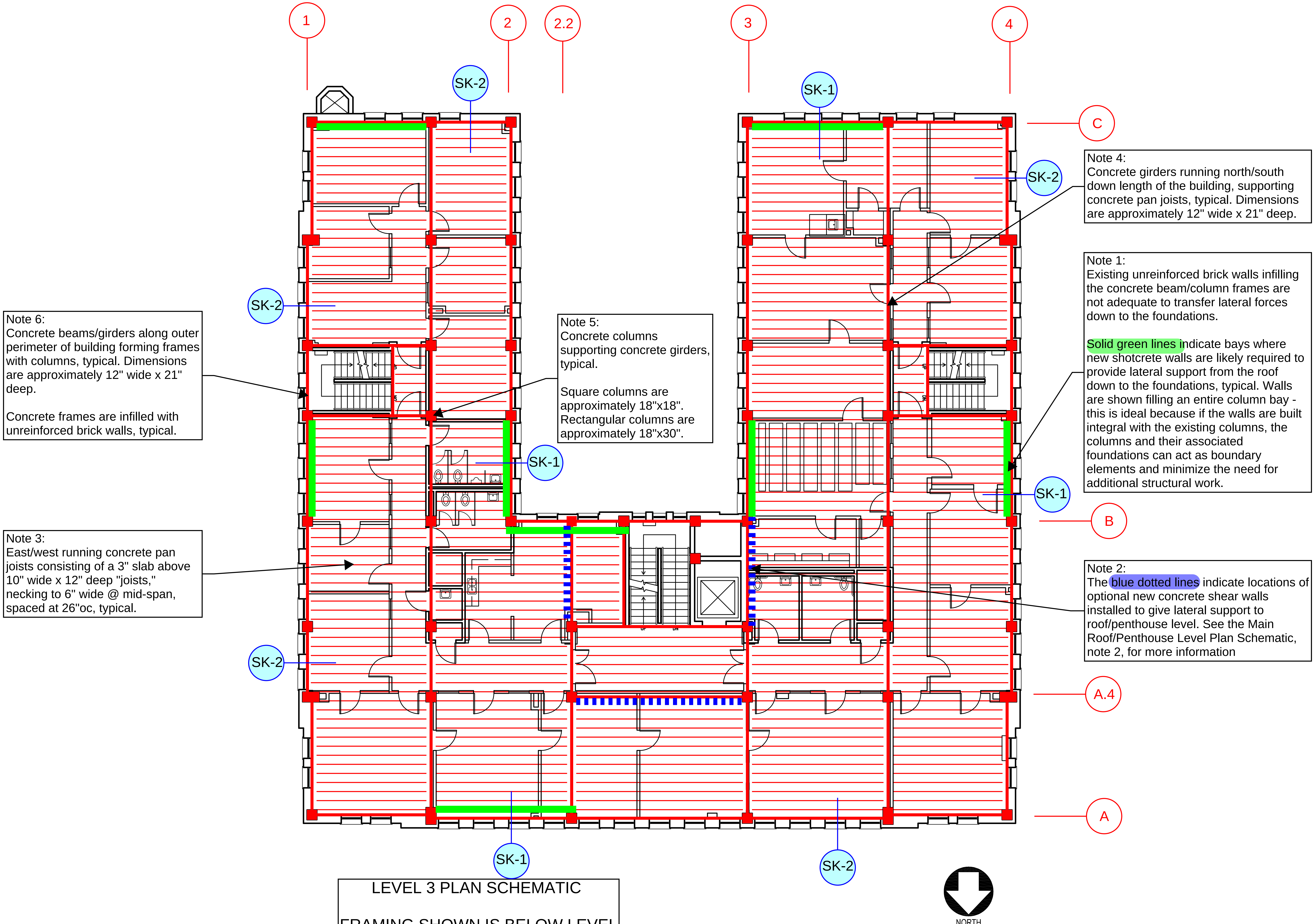
Note 1:
Existing unreinforced brick walls infilling the concrete beam/column frames are not adequate to transfer lateral forces down to the foundations.

Solid green lines indicate bays where new shotcrete walls are likely required to provide lateral support from the roof down to the foundations, typical. Walls are shown filling an entire column bay - this is ideal because if the walls are built integral with the existing columns, the columns and their associated foundations can act as boundary elements and minimize the need for additional structural work.

Note 2:
The blue dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to roof/penthouse level. See the Main Roof/Penthouse Level Plan Schematic, note 2, for more information.

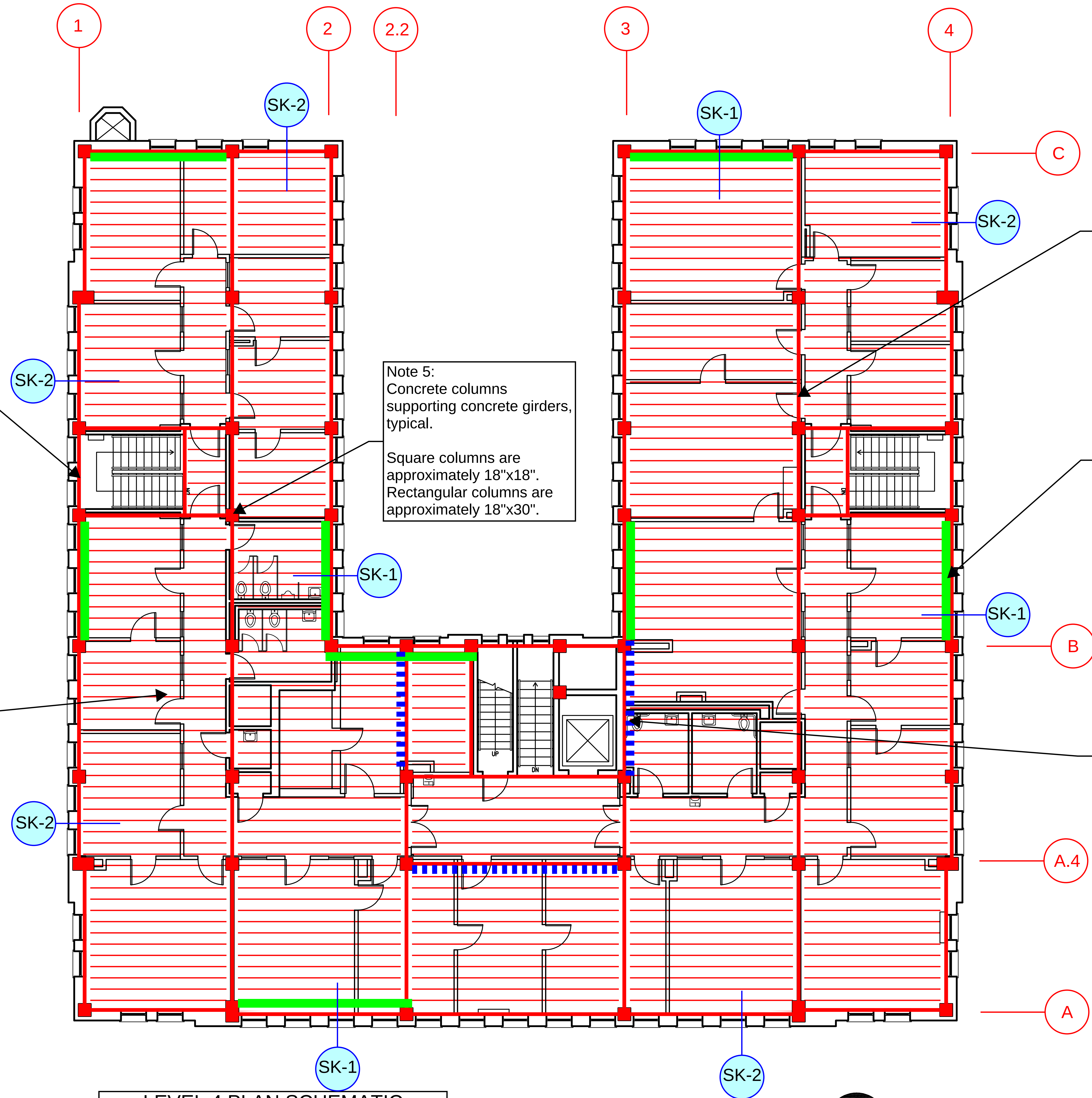
LEVEL 2 PLAN SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL



LEVEL 3 PLAN SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL



Note 1:
Existing unreinforced brick walls infilling the concrete beam/column frames are not adequate to transfer lateral forces down to the foundations.

Solid green lines indicate bays where new shotcrete walls are likely required to provide lateral support from the roof down to the foundations, typical. Walls are shown filling an entire column bay - this is ideal because if the walls are built integral with the existing columns, the columns and their associated foundations can act as boundary elements and minimize the need for additional structural work.

Note 2:
The blue dotted lines indicate locations of optional new concrete shear walls installed to give lateral support to roof/penthouse level. See the Main Roof/Penthouse Level Plan Schematic, note 2, for more information

Note 3:
East/west running concrete pan joists consisting of a 3" slab above 10" wide x 12" deep "joists," necking to 6" wide @ mid-span, spaced at 26"oc, typical.

Note 4:
Concrete girders running north/south down length of the building, supporting concrete pan joists, typical. Dimensions are approximately 12" wide x 21" deep.

Note 5:
Concrete columns supporting concrete girders, typical.

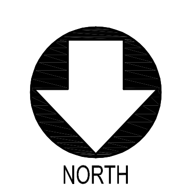
Square columns are approximately 18"x18". Rectangular columns are approximately 18"x30".

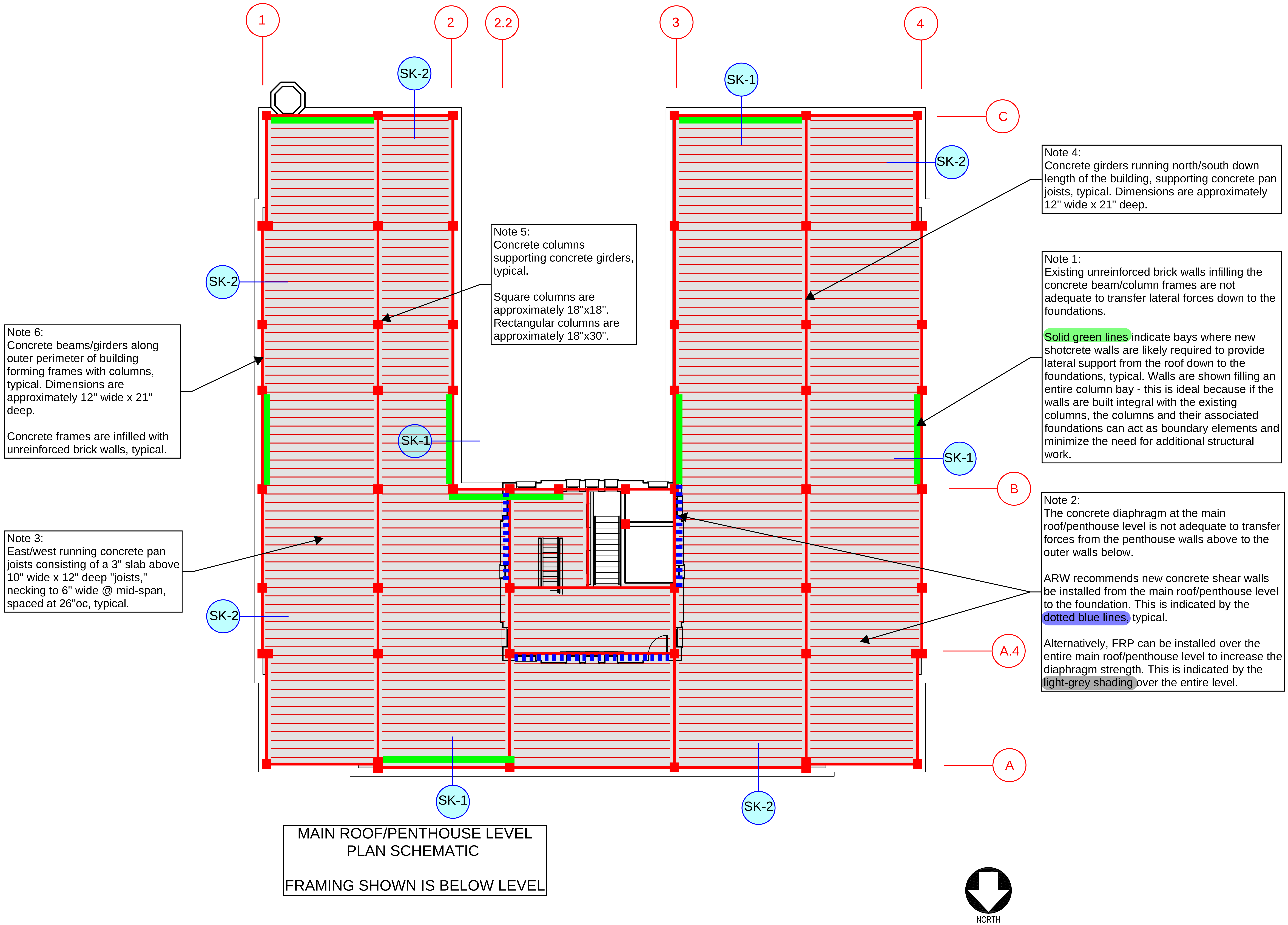
Note 6:
Concrete beams/girders along outer perimeter of building forming frames with columns, typical. Dimensions are approximately 12" wide x 21" deep.

Concrete frames are infilled with unreinforced brick walls, typical.

LEVEL 4 PLAN SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL



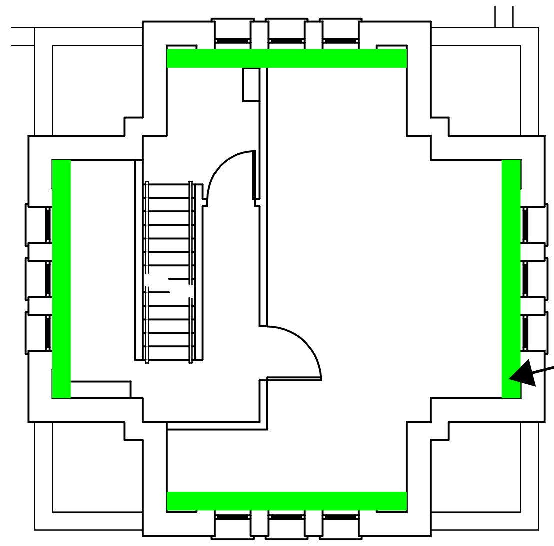


MAIN ROOF/PENTHOUSE LEVEL
PLAN SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL

MECHANICAL ROOM LEVEL PLAN
SCHEMATIC

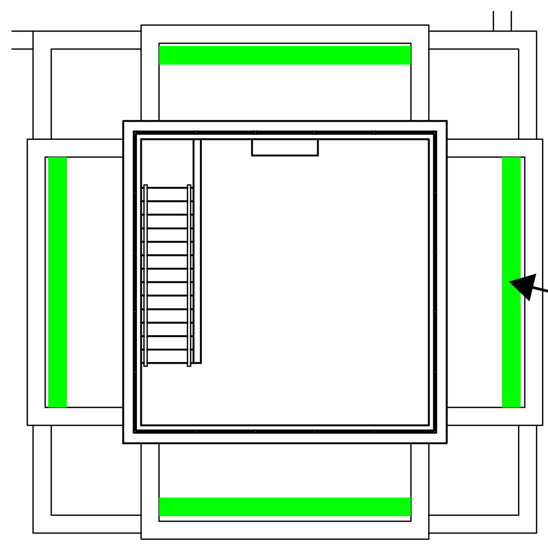
FRAMING SHOWN IS BELOW LEVEL



Note 1:
Add shotcrete walls as new lateral force resisting system, typical

GREENHOUSE LEVEL PLAN
SCHEMATIC

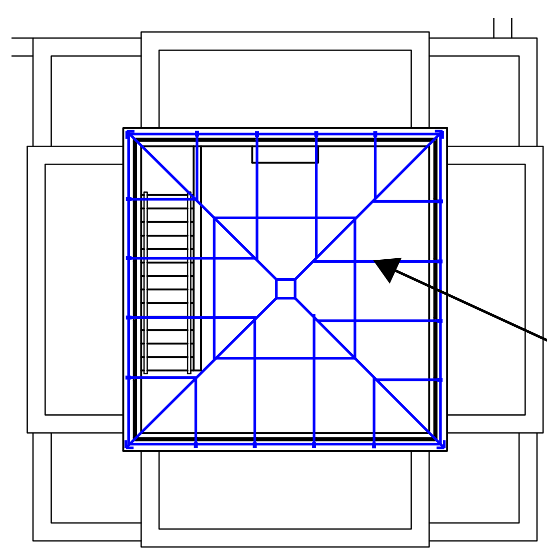
FRAMING SHOWN IS BELOW LEVEL



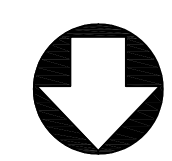
Note 1:
Add shotcrete walls as new lateral force resisting system, typical

GREENHOUSE ROOF PLAN
SCHEMATIC

FRAMING SHOWN IS BELOW LEVEL



Note 2: Light-gage steel stick-framed roof is not braced adequately. Add hot-rolled steel bracing at strategic locations, typical.
Provide positive attachments of roof framing to concrete/brick lintel.



NORTH

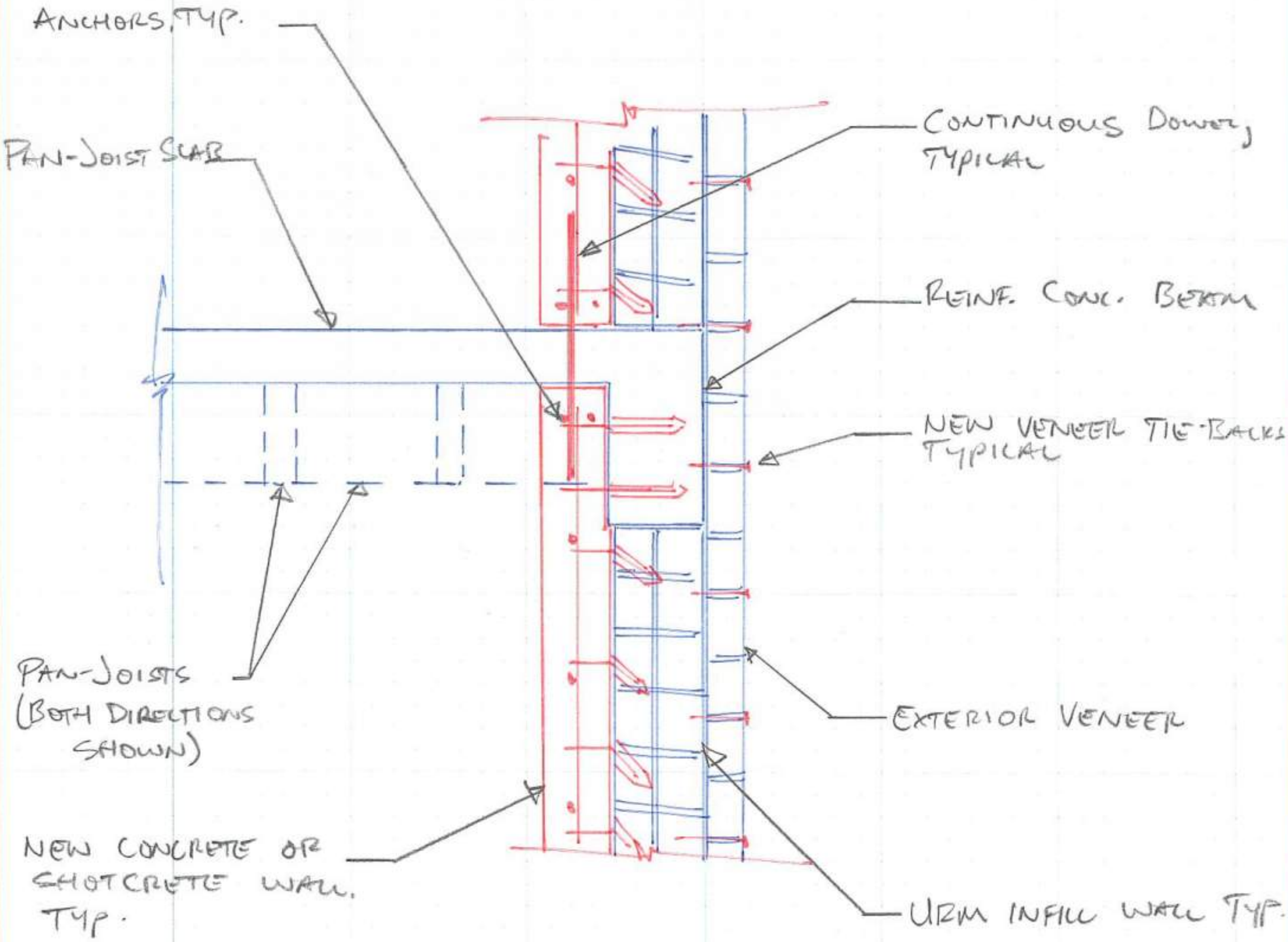
ARW ENGINEERS
structural consultants

Project No. 23124 Sheet No.

Project FOREST SERVICE BUILDING

Prepared By TDP. Date

SKETCH 1



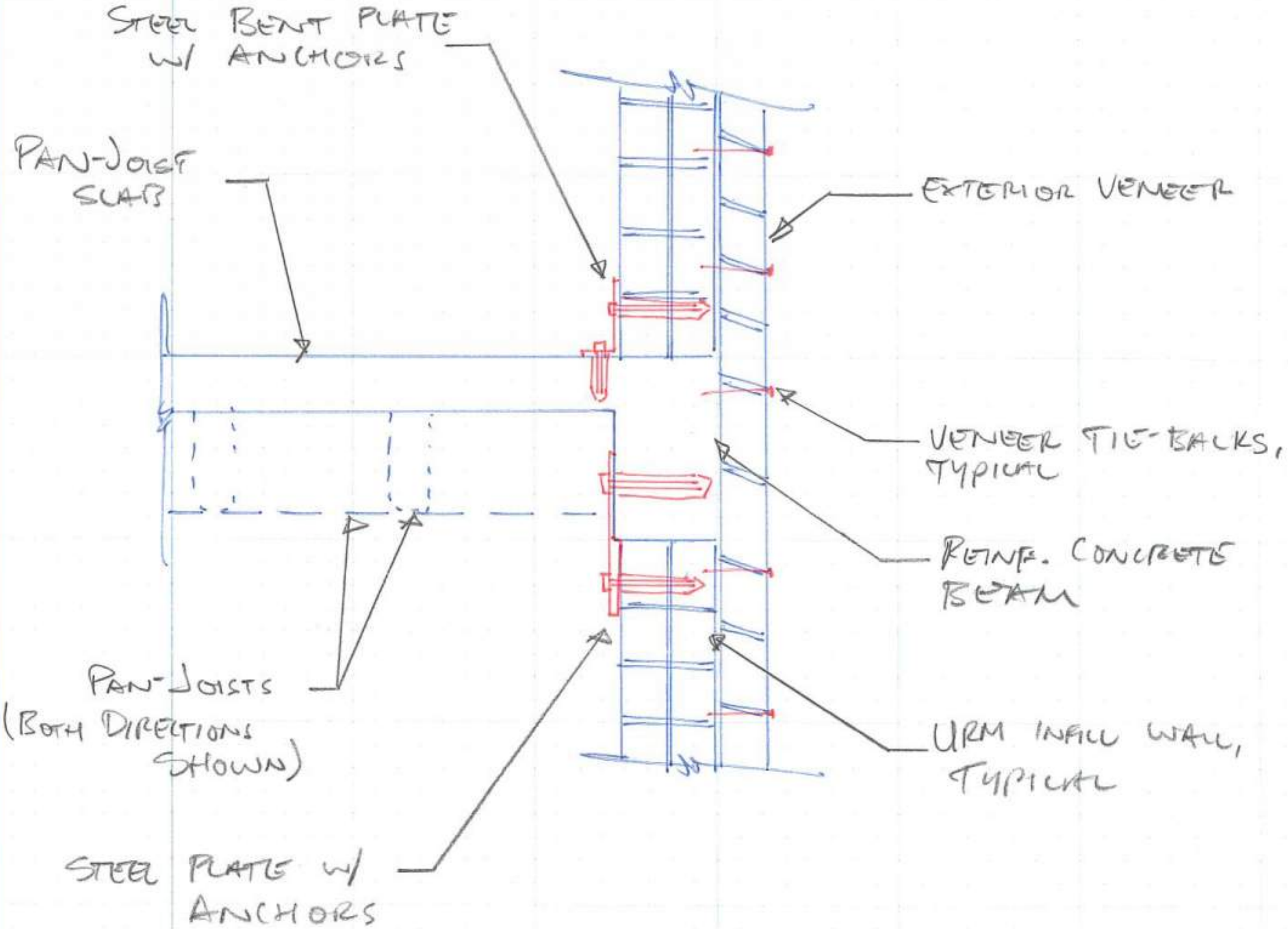
ARW ENGINEERS
structural consultants

Project No. 23124 Sheet No.

Project FOREST SERVICE BUILDING

Prepared By TDP Date

SKETCH 2



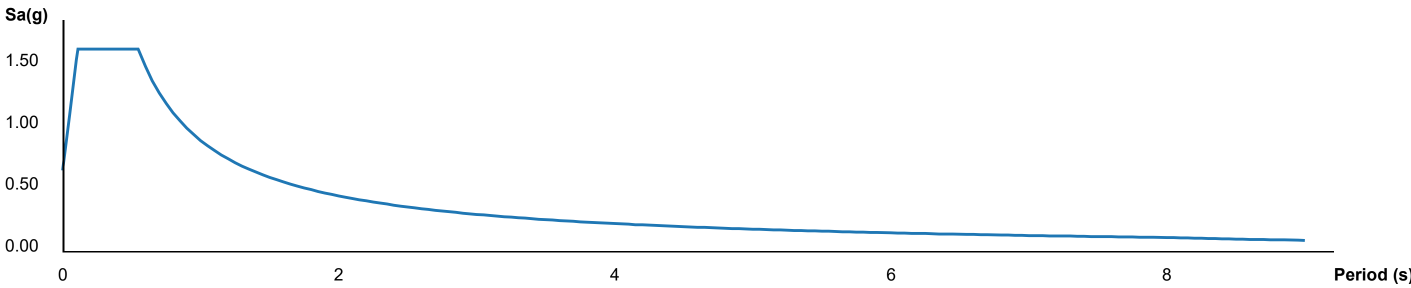
APPENDIX C
TIER 2 CALCULATIONS

ATC Hazards by Location

Search Information

Address:	507 25th St, Ogden, UT 84401, USA
Coordinates:	41.220388, -111.9671722
Elevation:	4372 ft
Timestamp:	2023-10-26T01:31:58.412Z
Hazard Type:	Seismic
Reference Document:	ASCE41-17
Site Class:	D-default
Custom Probability:	

Horizontal Response Spectrum - Hazard Level BSE-2N



Hazard Level BSE-2N

Name	Value	Description
SsUH	1.582	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
CR_S	0.863	Coefficient of risk (0.2s)
SsRT	1.364	Probabilistic risk-targeted ground motion (0.2s)
SsD	2.968	Factored deterministic acceleration value (0.2s)
S_S	1.364	MCE_R ground motion (period=0.2s)
F_a	1.2	Site amplification factor at 0.2s
S_{XS}	1.637	Site modified spectral response (0.2s)
S1UH	0.566	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
CR_1	0.879	Coefficient of risk (1.0s)
S1RT	0.498	Probabilistic risk-targeted ground motion (1.0s)
S1D	1.255	Factored deterministic acceleration value (1.0s)
S_1	0.498	MCE_R ground motion (period=1.0s)
F_v	1.802	Site amplification factor at 1.0s
S_{X1}	0.897	Site modified spectral response (1.0s)

Hazard Level BSE-1N

Name	Value	Description
S_{XS}	1.091	Site modified spectral response (0.2s)
S_{X1}	0.598	Site modified spectral response (1.0s)

Hazard Level BSE-2E

Name	Value	Description
S_S	0.867	MCE_R ground motion (period=0.2s)
F_a	1.2	Site amplification factor at 0.2s
S_{XS}	1.041	Site modified spectral response (0.2s)
S_1	0.3	MCE_R ground motion (period=1.0s)
F_v	2.001	Site amplification factor at 1.0s
S_{X1}	0.599	Site modified spectral response (1.0s)

Hazard Level BSE-1E

Name	Value	Description
S_S	0.254	MCE_R ground motion (period=0.2s)
F_a	1.597	Site amplification factor at 0.2s
S_{XS}	0.405	Site modified spectral response (0.2s)
S_1	0.088	MCE_R ground motion (period=1.0s)
F_v	2.4	Site amplification factor at 1.0s
S_{X1}	0.21	Site modified spectral response (1.0s)

T_L Data

Name	Value	Description
T_L	8	Long-period transition period (s)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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08-Nov-23

ASCE 41-17 SEISMIC DESIGN/EVALUATION OF LATERAL SYSTEM

Version Date: June 30, 2020 | Updated by: Steven Petroff, SE | Reviewed by: Scott Porter, SE

ENGINEERS
structural consultants

JOB TITLE:	Forest Service Building	JOB #:	23124
BUILDING LOCATION:	507 E 25th St, Ogden, UT	PREPARED BY:	TDP

Building Risk Category	II		
Performance Level-	Life Safety	**Performance Level-**	Collapse Prevention
Seismic Hazard Level-	BSE-1E (20% in 50yr)	**Seismic Hazard Level-**	BSE-2E (5% in 50yr)
S_s =	0.254	**S_s =**	0.867
S_1 =	0.088	**S_1 =**	0.3
F_a =	1.597	**F_a =**	1.2
F_v =	2.4	**F_v =**	2.001

See ASCE 41-17 Section 2.3.1 for Structural Performance Levels and Ranges

Largest Demand to Capacity Ratio for the overall system

DCR_{MAX} =	1.00	**DCR_{MAX} =**	1.00

08-Nov-23

ASCE 41-17 PSUEDO LATERAL FORCE, LINEAR STATIC PROCEDURE (LSP)

Version Date: June 30, 2020

JOB TITLE: Forest Service Building
BUILDING LOCATION: 507 E 25th St, Ogden, UT

JOB #: 23124
PREPARED BY: TDP

ASCE 41-17 Psuedo Lateral Force Per Linear Static Procedure

Building Period (ASCE 41-17 Section 7.4.1.2)

Building Height (H):	35.0	ft
Period Coefficient (Ct):	0.020	
Height Coefficient (β):	0.75	
Bldg. Period (T):	0.29	sec

Mapped Acceleration Factors (ASCE 41-17 Section 2.4)

BSE-1E (20% in 50yr)		BSE-2E (5% in 50yr)	
S_s =	0.25	S_s =	0.87
S_1 =	0.09	S_1 =	0.30
F_a =	1.60	F_a =	1.20
F_v =	2.40	F_v =	2.00

Base Shear Coefficient (BSE-1E (20% in 50yr) - ASCE 41-17 Section 7.4.1)

Response Acceleration Parameters: (ASCE 41-17 Section 2.4.1.6)

$S_{XS} = S_s{*}F_a$ = 0.41

$S_{X1} = S_1{*}F_V$ = 0.21

$$T_s = \frac{S_{x1}}{S_{xs}}$$

T_s = 0.52 sec

To = 0.10 sec

Effective viscous damping ratio (Section 2.4.1.7.1) β = 0.05

$$B_1 = \frac{4}{5.6 - \ln(100 * \beta)}$$

B_1 = 1.00

S_a = 0.40

BSE-1E (20% in 50yr) Psuedo Lateral Force - Section 7.4.1.3.1

Modification Factors:

DCR_{max} = 1.00

Effective mass factor C_m = 1 (ASCE 41-17 Table 7-4)
Site Class Factor a = 60 (Section 7.4.1.3.1)

$$\mu_{strength} = \frac{DCR_{max}}{1.5} C_m \geq 1.0$$

$\mu_{strength}$ = 1.00

For periods greater than 1.0 s, $C_1 = 1.0$.

$$C_1 = 1 + \frac{\mu_{strength} - 1}{aT_e^2}$$

C_1 = 1.00

For periods greater than 0.7 s, $C_2 = 1.0$;

$$C_2 = 1 + \frac{1}{800}\left(\frac{\mu_{strength} - 1}{T_e}\right)^2$$

C_2 = 1.00

BSE-1E (20% in 50yr) Psuedo Lateral Force Coefficient

$$V = C_1 * C_2 * C_m * S_a * W$$

V = 0.40 x W

ASCE 41-17 PSUEDO LATERAL FORCE (CONT'D)

Version Date: June 30, 2020

08-Nov-23
2:32 PM

JOB TITLE: Forest Service Building
BUILDING LOCATION: 507 E 25th St, Ogden, UT

JOB #: 23124
PREPARED BY: TDP

Base Shear Coefficient (BSE-2E (5% in 50yr) - ASCE 41-17 Section 7.4.1)

Response Acceleration Parameters: (ASCE 41-17 Section 2.4.1.6)

$S_{XS} = S_s*F_a =$ 1.04

$S_{X1} = S_1*F_V =$ 0.60

$$T_s = \frac{S_{x1}}{S}$$ $T_s =$ 0.58 sec

$$T_o = 0.2 * T_s$$ To = 0.12 sec

Effective viscous damping ratio (Section 2.4.1.7.1) β = 0.05

$$B_1 = \frac{4}{5.6 - \ln(100 * \beta)}$$ $B_1 =$ 1.00

See Section 1.6.1.5 for Sa calculation) $S_a =$ 1.04

BSE-2E (5% in 50yr) Psuedo Lateral Force - Section 7.4.1.3.1

Modification Factors:

$DCR_{max} =$ 1.00

Effective mass factor $C_m =$ 1 (ASCE 41-17 Table 7-4)
Site Class Factor a = 60 (Section 7.4.1.3.1)

$$\mu_{strength} = \frac{DCR_{max}}{1.5} C_m \geq 1.0$$ $\mu_{strength} =$ 1.00

For periods greater than 1.0 s, $C_1 = 1.0$.

$$C_1 = 1 + \frac{\mu_{strength} - 1}{aT_e^2}$$ $C_1 =$ 1.00

For periods greater than 0.7 s, $C_2 = 1.0$;

$$C_2 = 1 + \frac{1}{800}\left(\frac{\mu_{strength} - 1}{T_e}\right)^2$$ $C_2 =$ 1.00

BSE-2E (5% in 50yr) Psuedo Lateral Force Coefficient

$$V = C_1 * C_2 * C_m * S_a * W$$ V = 1.04 x W

	Diaph. (kips)	+N/S Only (kips)	+E/W Only (kips)	Total N/S Seis. Wt. (kips)	Total E/W Seis. Wt. (kips)	h (ft)
Greenhouse	21.26	16.23	16.23	37.49	37.49	83.0000
Mechanical	29.51	14.68	14.68	44.19	44.19	73.5833
Penthouse/Main Roof	625.13	70.32	109.98	695.45	735.11	64.2500
Level 4	615.75	57.44	89.83	673.19	705.58	50.2500
Level 3	615.75	50.15	78.44	665.90	694.19	39.0000
Level 2	771.00	66.48	81.80	837.48	852.80	26.7500
Level 1	771.00	132.10	173.33	903.10	944.33	14.5000
				3856.80	4013.69	

Cs = 1.000

Indicates vertical distributions correspond to Effective Seismic Weight Level forces

N/S Vertical Distribution (ASCE 7-16 Section 12.8.3)

Vn/s (kips) = 3856.80

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	77.66
Mechanical	44.19	73.5833	3979.717	2.1%	81.25
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	1192.01
Level 4	673.19	50.2500	43897.155	23.2%	896.18
Level 3	665.90	39.0000	33478.657	17.7%	683.48
Level 2	837.48	26.7500	28773.271	15.2%	587.42
Level 1	903.10	14.5000	16594.667	8.8%	338.79
			188915.398	100.0%	3856.80

E/W Vertical Distribution (ASCE 7-16 Section 12.8.3)

Ve/w (kips) = 4013.69

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	1.9%	77.40
Mechanical	44.19	73.5833	3979.717	2.0%	80.97
Penthouse/Main Roof	735.11	64.2500	61803.020	31.3%	1257.44
Level 4	705.58	50.2500	46063.283	23.4%	937.20
Level 3	694.19	39.0000	34937.259	17.7%	710.83
Level 2	852.80	26.7500	29312.893	14.9%	596.40
Level 1	944.33	14.5000	17371.643	8.8%	353.44
			197272.029	100.0%	4013.69

	Diaph. (kips)	+N/S Only (kips)	+E/W Only (kips)	Total N/S Seis. Wt. (kips)	Total E/W Seis. Wt. (kips)	h (ft)
Greenhouse	21.26	16.23	16.23	37.49	37.49	83.0000
Mechanical	29.51	14.68	14.68	44.19	44.19	73.5833
Penthouse/Main Roof	625.13	70.32	109.98	695.45	735.11	64.2500
Level 4	615.75	57.44	89.83	673.19	705.58	50.2500
Level 3	615.75	50.15	78.44	665.90	694.19	39.0000
Level 2	771.00	66.48	81.80	837.48	852.80	26.7500
Level 1	771.00	132.10	173.33	903.10	944.33	14.5000
				3856.80	4013.69	

Cs = 0.400

Effective multiplier based on BSE-1E level earthquake

N/S Vertical Distribution (ASCE 7-16 Section 12.8.3) Vn/s (kips) = 1542.72

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	31.07
Mechanical	44.19	73.5833	3979.717	2.1%	32.50
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	476.81
Level 4	673.19	50.2500	43897.155	23.2%	358.47
Level 3	665.90	39.0000	33478.657	17.7%	273.39
Level 2	837.48	26.7500	28773.271	15.2%	234.97
Level 1	903.10	14.5000	16594.667	8.8%	135.52
			188915.398	100.0%	1542.72

E/W Vertical Distribution (ASCE 7-16 Section 12.8.3) Ve/w (kips) = 1605.48

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	1.9%	30.96
Mechanical	44.19	73.5833	3979.717	2.0%	32.39
Penthouse/Main Roof	735.11	64.2500	61803.020	31.3%	502.98
Level 4	705.58	50.2500	46063.283	23.4%	374.88
Level 3	694.19	39.0000	34937.259	17.7%	284.33
Level 2	852.80	26.7500	29312.893	14.9%	238.56
Level 1	944.33	14.5000	17371.643	8.8%	141.38
			197272.029	100.0%	1605.48

N/S Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	31.07	0.21824	0.829	0.43648	0.829	31.07
Mechanical	44.19	81.68	63.57	0.21824	0.778	0.43648	0.778	34.39
Penthouse/Main Roof	695.45	777.13	540.37	0.21824	0.695	0.43648	0.695	483.58
Level 4	673.19	1450.32	898.84	0.21824	0.620	0.43648	0.620	417.21
Level 3	665.90	2116.22	1172.24	0.21824	0.554	0.43648	0.554	368.86
Level 2	837.48	2953.70	1407.20	0.21824	0.476	0.43648	0.476	398.99
Level 1	903.10	3856.80	1542.72	0.21824	0.400	0.43648	0.400	361.24

E/W Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	30.96	0.21824	0.826	0.43648	0.826	30.96
Mechanical	44.19	81.68	63.35	0.21824	0.776	0.43648	0.776	34.27
Penthouse/Main Roof	735.11	816.79	566.33	0.21824	0.693	0.43648	0.693	509.69
Level 4	705.58	1522.37	941.21	0.21824	0.618	0.43648	0.618	436.23
Level 3	694.19	2216.56	1225.54	0.21824	0.553	0.43648	0.553	383.82
Level 2	852.80	3069.36	1464.10	0.21824	0.477	0.43648	0.477	406.79
Level 1	944.33	4013.69	1605.48	0.21824	0.400	0.43648	0.400	377.73

	Diaph. (kips)	+N/S Only (kips)	+E/W Only (kips)	Total N/S Seis. Wt. (kips)	Total E/W Seis. Wt. (kips)	h (ft)
Greenhouse	21.26	16.23	16.23	37.49	37.49	83.0000
Mechanical	29.51	14.68	14.68	44.19	44.19	73.5833
Penthouse/Main Roof	625.13	70.32	109.98	695.45	735.11	64.2500
Level 4	615.75	57.44	89.83	673.19	705.58	50.2500
Level 3	615.75	50.15	78.44	665.90	694.19	39.0000
Level 2	771.00	66.48	81.80	837.48	852.80	26.7500
Level 1	771.00	132.10	173.33	903.10	944.33	14.5000
				3856.80	4013.69	

Cs = 1.040

Effective multiplier based on BSE-2E level earthquake

N/S Vertical Distribution (ASCE 7-16 Section 12.8.3)

Vn/s (kips) = 4011.07

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	80.77
Mechanical	44.19	73.5833	3979.717	2.1%	84.50
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	1239.69
Level 4	673.19	50.2500	43897.155	23.2%	932.03
Level 3	665.90	39.0000	33478.657	17.7%	710.82
Level 2	837.48	26.7500	28773.271	15.2%	610.92
Level 1	903.10	14.5000	16594.667	8.8%	352.34
			188915.398	100.0%	4011.07

E/W Vertical Distribution (ASCE 7-16 Section 12.8.3)

Ve/w (kips) = 4174.24

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	1.9%	80.50
Mechanical	44.19	73.5833	3979.717	2.0%	84.21
Penthouse/Main Roof	735.11	64.2500	61803.020	31.3%	1307.74
Level 4	705.58	50.2500	46063.283	23.4%	974.69
Level 3	694.19	39.0000	34937.259	17.7%	739.27
Level 2	852.80	26.7500	29312.893	14.9%	620.26
Level 1	944.33	14.5000	17371.643	8.8%	367.58
			197272.029	100.0%	4174.24

N/S Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	80.77	0	2.154	0	2.154	80.77
Mechanical	44.19	81.68	165.27	0	2.023	0	2.023	89.41
Penthouse/Main Roof	695.45	777.13	1404.96	0	1.808	0	1.808	1257.30
Level 4	673.19	1450.32	2336.99	0	1.611	0	1.611	1084.75
Level 3	665.90	2116.22	3047.82	0	1.440	0	1.440	959.04
Level 2	837.48	2953.70	3658.73	0	1.239	0	1.239	1037.38
Level 1	903.10	3856.80	4011.07	0	1.040	0	1.040	939.22

E/W Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	80.50	0	2.147	0	2.147	80.50
Mechanical	44.19	81.68	164.71	0	2.016	0	2.016	89.11
Penthouse/Main Roof	735.11	816.79	1472.45	0	1.803	0	1.803	1325.20
Level 4	705.58	1522.37	2447.14	0	1.607	0	1.607	1134.19
Level 3	694.19	2216.56	3186.40	0	1.438	0	1.438	997.93
Level 2	852.80	3069.36	3806.66	0	1.240	0	1.240	1057.65
Level 1	944.33	4013.69	4174.24	0	1.040	0	1.040	982.10

ARW ENGINEERS
structural consultants

Project No. 23124 Sheet No.
Project FOREST SERVICE BLDG.
Prepared By TDP. Date

LATERAL ANALYSIS

83'-0"		GREEN HOUSE LEVEL	W_{EFF} = 48.47^k
	9'-5"		
73'-7"		MECHANICAL ROOM LEVEL	W_{EFF} = 43.61^k
	9'-4"		
64'-3"		PENTHOUSE/MAIN ROOF	W_{EFF} 793.55^k
	14'-0"		
50'-3"		LEVEL 4	W_{EFF} = 763.02^k
	11'-3"		
39'-0"		LEVEL 3	W_{EFF} = 818.58^k
	12'-3"		
26'-9"		LEVEL 2	W_{EFF} = 919.28^k
	12'-3"		
14'-6"		LEVEL 1	W_{EFF} =
	14'-6"		
		BASEMENT	

ARW ENGINEERS
structural consultants

Project No. ______ Sheet No. ______
Project ______
Prepared By ______ Date ______

GREENHOUSE

3" SLAB = 38 psf] => (38 psf)(520 sf) = 19.76^k
AREA = 520 psf]

PERIMETER BRICK WALL = 8" BRICK : (35 psf)(5'-0")(70'-0") = 12.25^k

PARAPETS = (8" BRICK = 35 psf)(1'-6")(100'-0") = 5.25^k

½ WALL BELOW = (12" BRICK = 40 psf)(9'-5"/2)(110'-0") = 20.72^k
WINDOWS = (12 WINDOWS)(2'-0" × 6'-0")(40 psf) = 5.76^k (SUBTRACT)
14.96^k

W_EFF = 19.76 + 12.25 + 14.96 + (1.5^k GLASS STRUCTURE)
= 48.47^k

MECHANICAL

3" SLAB = (38 psf)(645 sf) = 24.51^k

½ WALL ABOVE = 14.96^k

½ WALL BELOW = (12" BRICK = 40 psf)(9'-4"/2)(110'-0") = 20.54^k
WINDOWS: (12)(2'-0" × 6'-0")(40 psf) = 5.76^k
(4)(3'-4" × 6'-0")(40 psf) = 3.20^k
= 11.88^k

PARAPET = (8" BRICK = 35 psf)(1'-6")(48'-0") = 2.52^k

W_EFF = 24.21 + 11.88 + 2.52 + (5^k EQUIPMENT)
= 43.61^k

PENTHOUSE/ROOF

ROOF PAN JOISTS = 60% VOID → BEST SCALED GUESS
↳ 15" DEEP TOTAL
↳ (.4)(15/12 150 pcf) = 75 psf

(75 psf)(8520 − 185 sf) = 625.13^k

½ WALL ABOVE = 11.88^k

½ WALL BELOW = (12" BRICK = 40 psf)(14'-0"/2)(534'-0") = 149.52^k
WINDOW = (83)(3'-4" × 6'-0")(40 psf) = 59.76^k
= (3)(2'-0" × 6'-0")(40 psf) = 1.44^k
88.32^k

PARAPET = (40 psf)(534'-0")(3'-9") = 80.10^k

W_EFF = 793.55^k

②

LEVEL 4 FLOOR PAN JOIST = $.4(\frac{15}{12}\ 150\ pcf) = 75$ PSF] – 615.75^k
8210 SF

$\frac{1}{2}$ WALL ABOVE = 88.32^k

$\frac{1}{2}$ WALL BELOW = (12" BRICK = 40 psf)(11'-3"/2)(534'-0") = 120.15^k
-59.76^k
-1.44^k
58.95^k

$W_{EFF} = 763.02^k$

LEVEL 3 FLOOR = 615.75^k

$\frac{1}{2}$ WALL ABOVE = 58.95^k

$\frac{1}{2}$ WALL BELOW = (12" BRICK = 40 psf)(12'-3"/2)(534'-0") = 130.83^k
-59.76^k
-1.44^k
69.63^k

$W_{EFF} = 818.58^k$

LEVEL 2 FLOOR = 615.75^k

$\frac{1}{2}$ WALL ABOVE = 69.63^k

$\frac{1}{2}$ WALL BELOW = (12" BRICK = 40 psf)($\frac{12'\text{-}3"}{2}$)(418'-0") = 102.41^k

WINDOW = (28)(3'-0" × 6'-0")(40 psf) = 20.16^k
(1)(9'-0" × 6'-0")(40 psf) = 2.16
(3)(2'-0" × 6'-0")(40 psf) = 1.44
78.65^k

ROOF = 75 psf(2070 sf) = 155.25^k

$W_{EFF} = 919.28^k$

(3)

A R W ENGINEERS
structural consultants

Project No. ______ Sheet No. ______
Project ______
Prepared By ______ Date ______

LEVEL 1

FLOOR = 75 psf (2070 + 8210 SF) = 771.00^k

½ WALL ABOVE = 78.65^k

½ WALL BELOW = (12" CONC = 225 psf)(6'-8"/2)(313'-0") = 234.75^k

− (25)(3'-0" × 2'-0")(225 psf) = 33.75^k

+ (12" BRICK = 40 psf)(14'-6"/2)(105'-0") = 30.45^k

− (6.5)(3'-0" × 6'-0")(40 psf) = 4.68^k

226.77^k

W_EFF = 1076.45^k

WEIGHT DISTRIBUTION
FOR VERTICAL DISTRIBUTION

GREENHOUSE DIAPH = 19.76^k
N/S WALLS = $\frac{1}{2}(12.25 + 5.25 + 14.96) = 16.23^k$
E/W WALLS = " (") = 16.23^k

MECHANICAL DIAPH = 24.51^k
N/S WALLS = $\frac{1}{2}(14.96 + 11.88 + 2.52) = 14.68^k$
E/W WALLS = " (") = 14.68

PENTHOUSE/MAIN ROOF DIAPH = 625.13^k N/S = 39% E/W = 61%
N/S WALLS = $.39(11.88 + 88.32 + 80.10) = 70.32^k$
E/W WALLS = .61 (") = 109.98^k

LEVEL 4 DIAPH = 615.75^k
N/S WALLS = $.39(88.32 + 58.95) = 57.44^k$
E/W WALLS = .61 (") = 89.83^k

LEVEL 3 DIAPH = 615.75
N/S WALLS = $.39(58.95 + 69.63) = 50.15^k$
E/W WALLS = .61 (") = 78.44^k

LEVEL 2 DIAPH = $615.75 + 155.25 = 771.00^k$
N/S WALLS = $.39(69.63) + .50(78.65) = 66.48^k$
E/W WALLS = .61 (") + .50 (") = 81.80^k

LEVEL 1 DIAPH = 771.00^k
N/S WALLS = $.5(78.65) + (30.45 - 4.68) + \frac{1}{3}(234.75 - 33.75) = 132.10^k$
E/W WALLS = $.5(78.65) + \frac{2}{3}(234.75 - 33.75) = 173.33^k$

BLUE = TOTAL ALONG
WALL LINE
AT THIS LEVEL

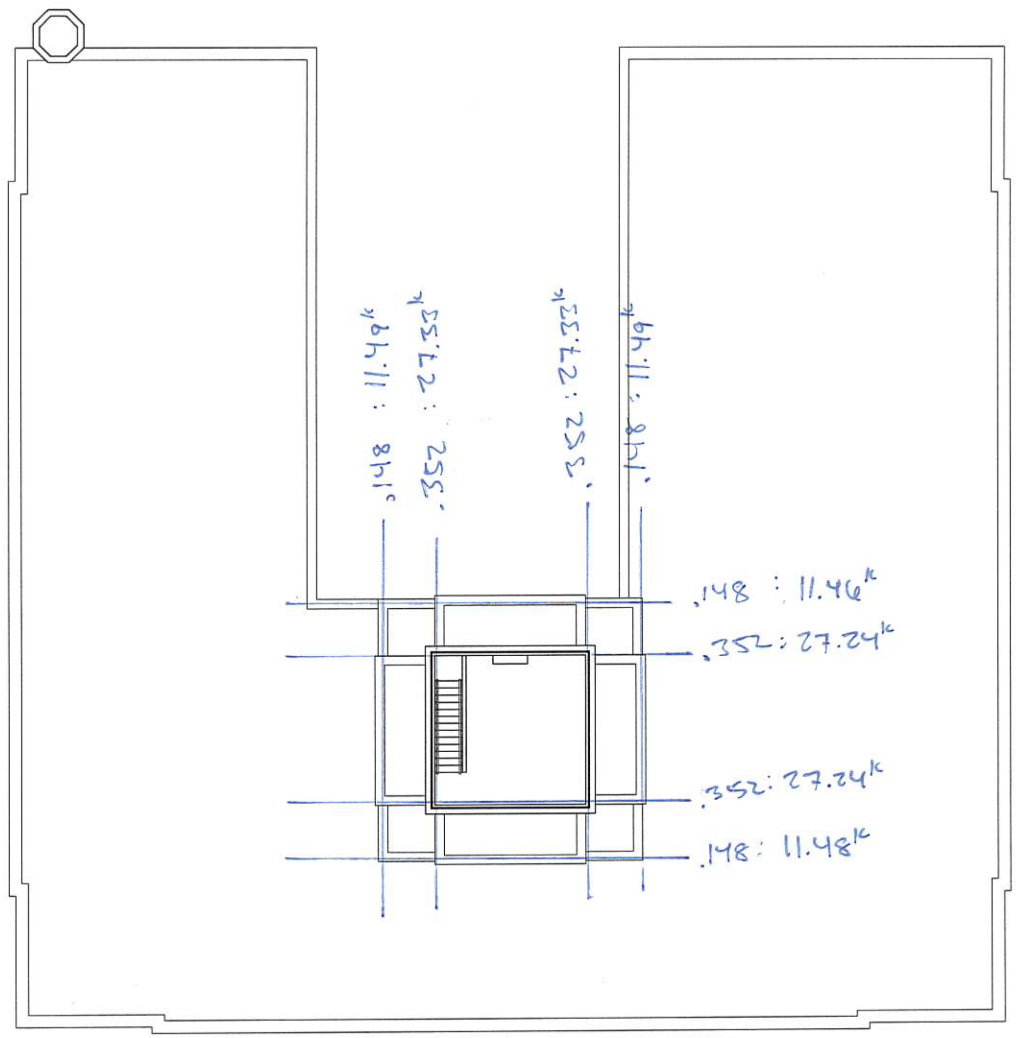
BLACK = CUMMULATIVE
AT THIS LEVEL
FROM ROOF DOWN

GREEN = FORCE FROM
SHEAR WALL
ABOVE

GREENHOUSE

$F_{N/S} = 77.65^k$

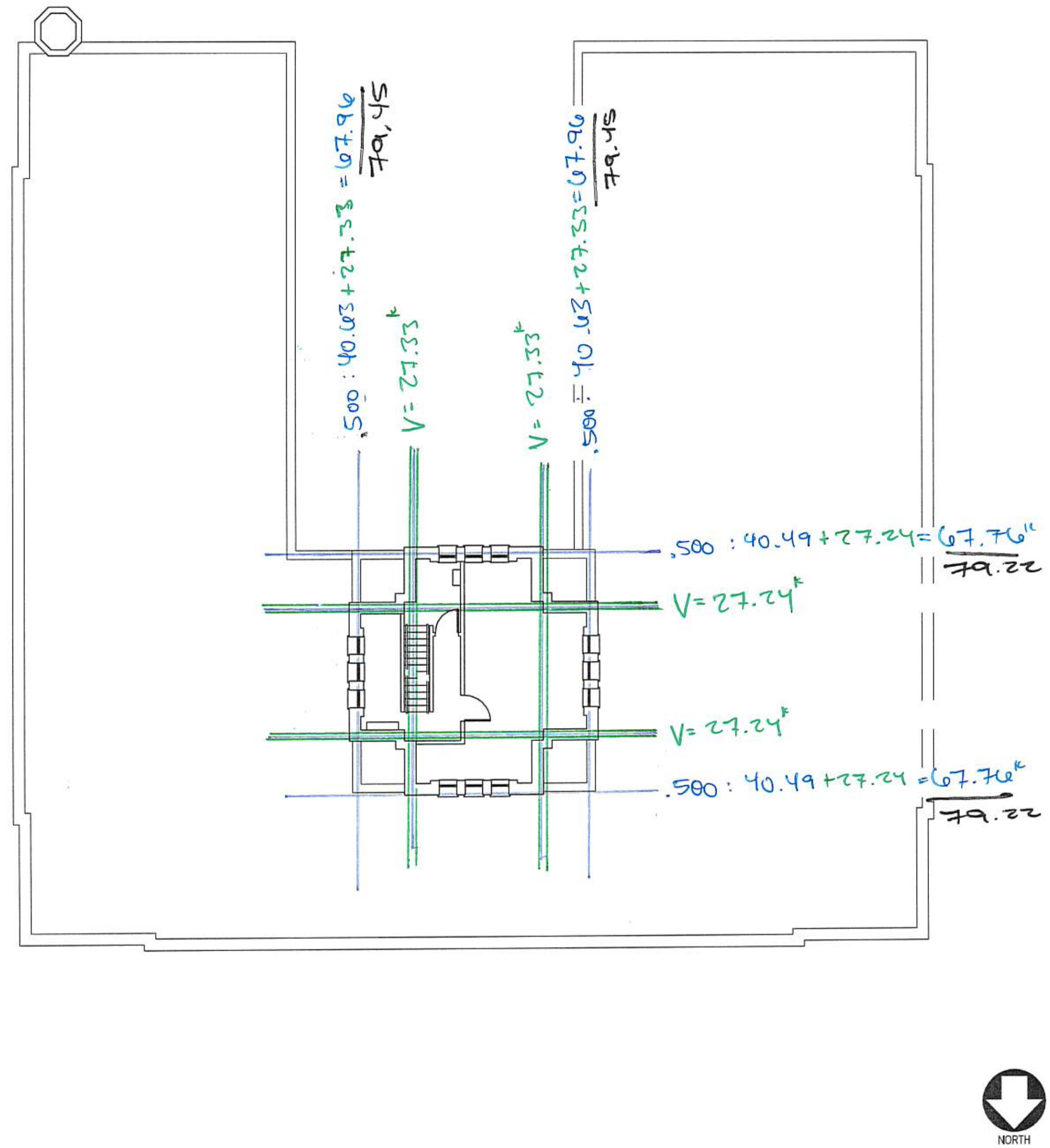
$F_{E/W} = 77.40^k$



MECHANICAL

$F_{N/S} = 81.25^k$

$F_{E/W} = 80.97^k$

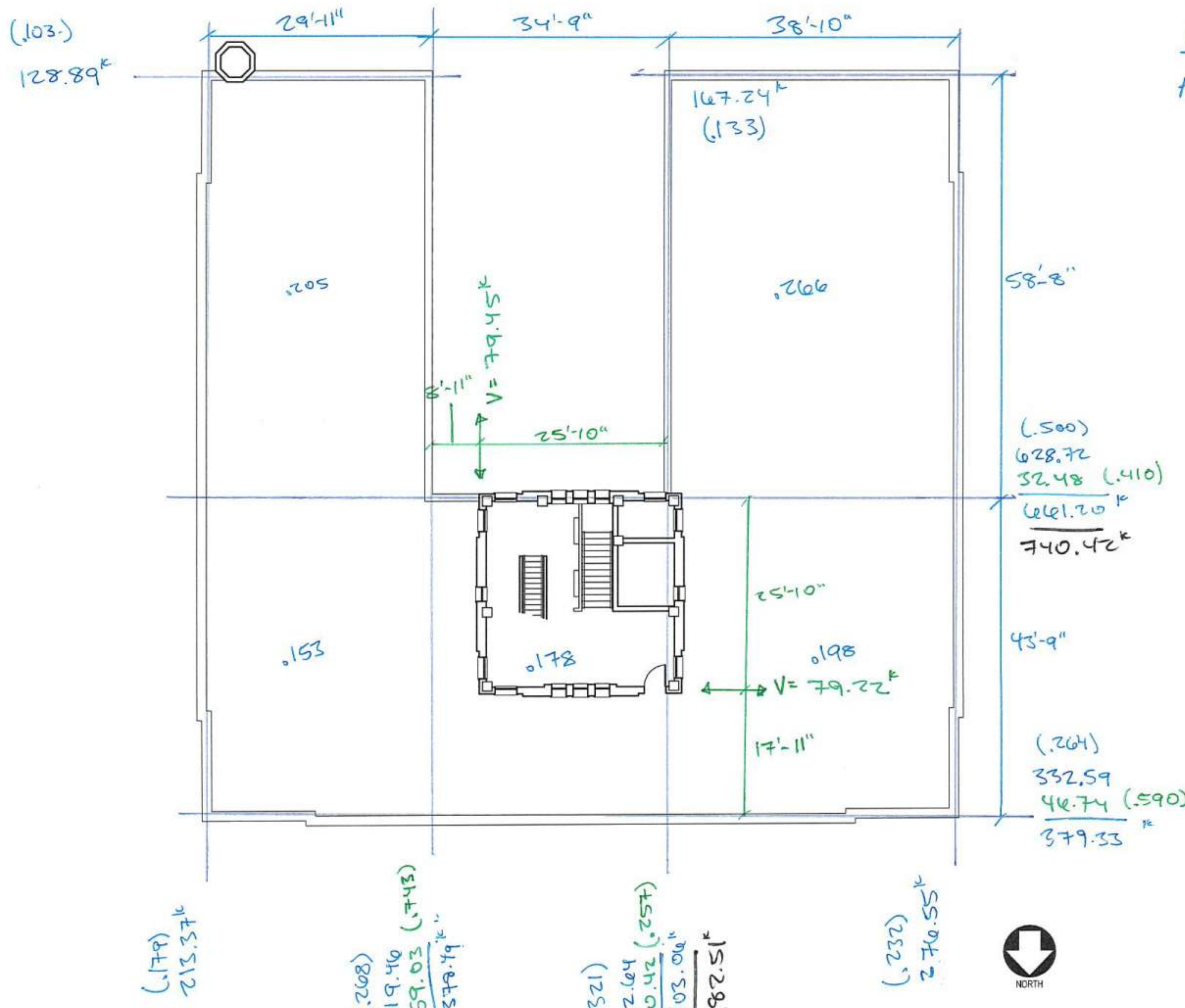


PENTHOUSE/MAIN ROOF

$F_{N/S} = 1192.01^k$

$F_{E/W} = 1257.44^k$

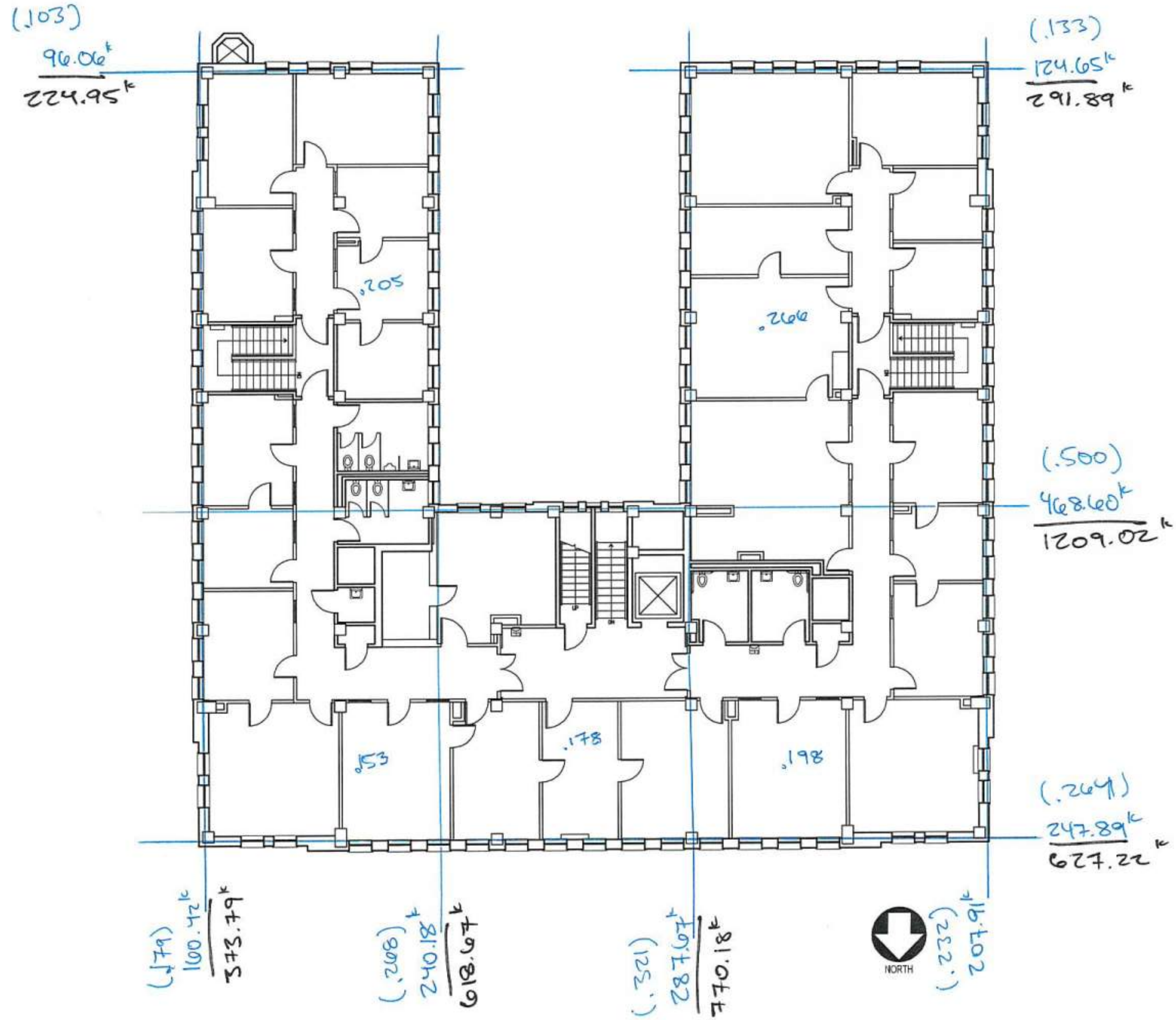
A=8561

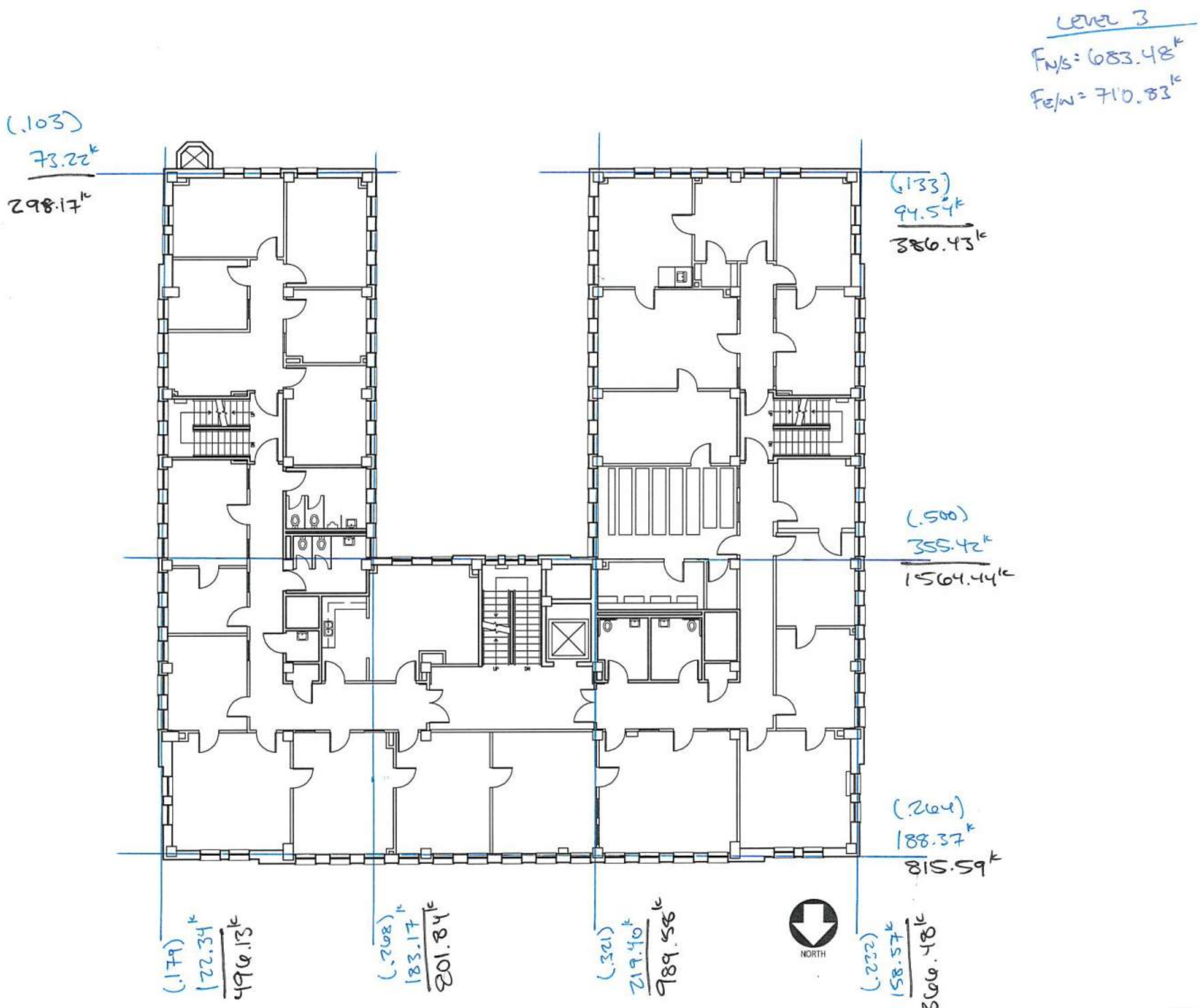


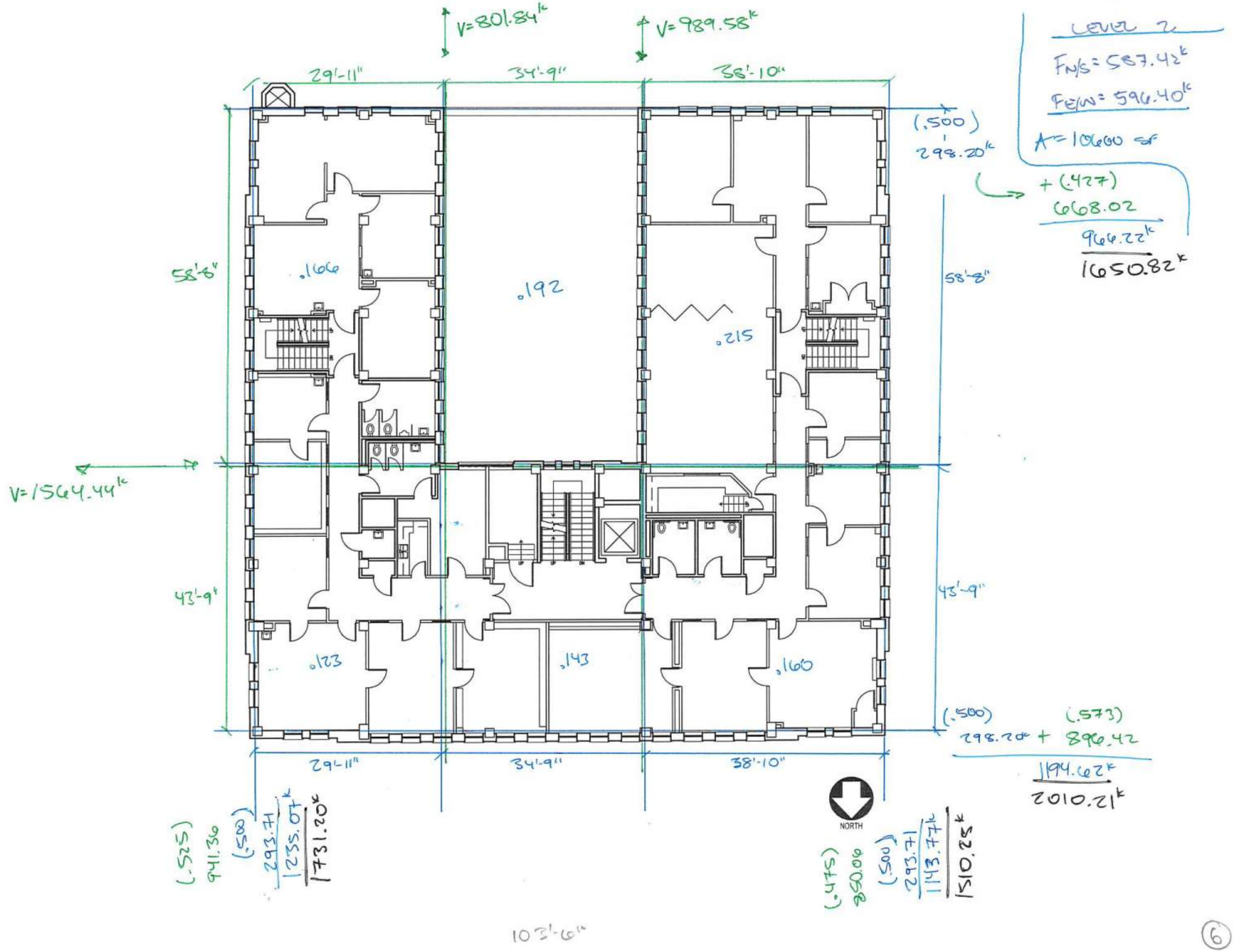
LEVEL 4

$F_{N/S} = 896.18^k$

$F_{E/W} = 937.20^k$




Level 3
$F_{N/S}$ = 683.48k
$F_{E/W}$ = 710.83k
(.103)
73.22k
298.17k
(.133)
94.54k
386.43k
(.500)
355.42k
1564.44k
(.264)
188.37k
815.59k
(.179)
122.34k
496.13k
(.268)
183.17k
801.84k
(.321)
219.40k
989.58k
(.222)
158.57k
566.48k
NORTH
UP
DN

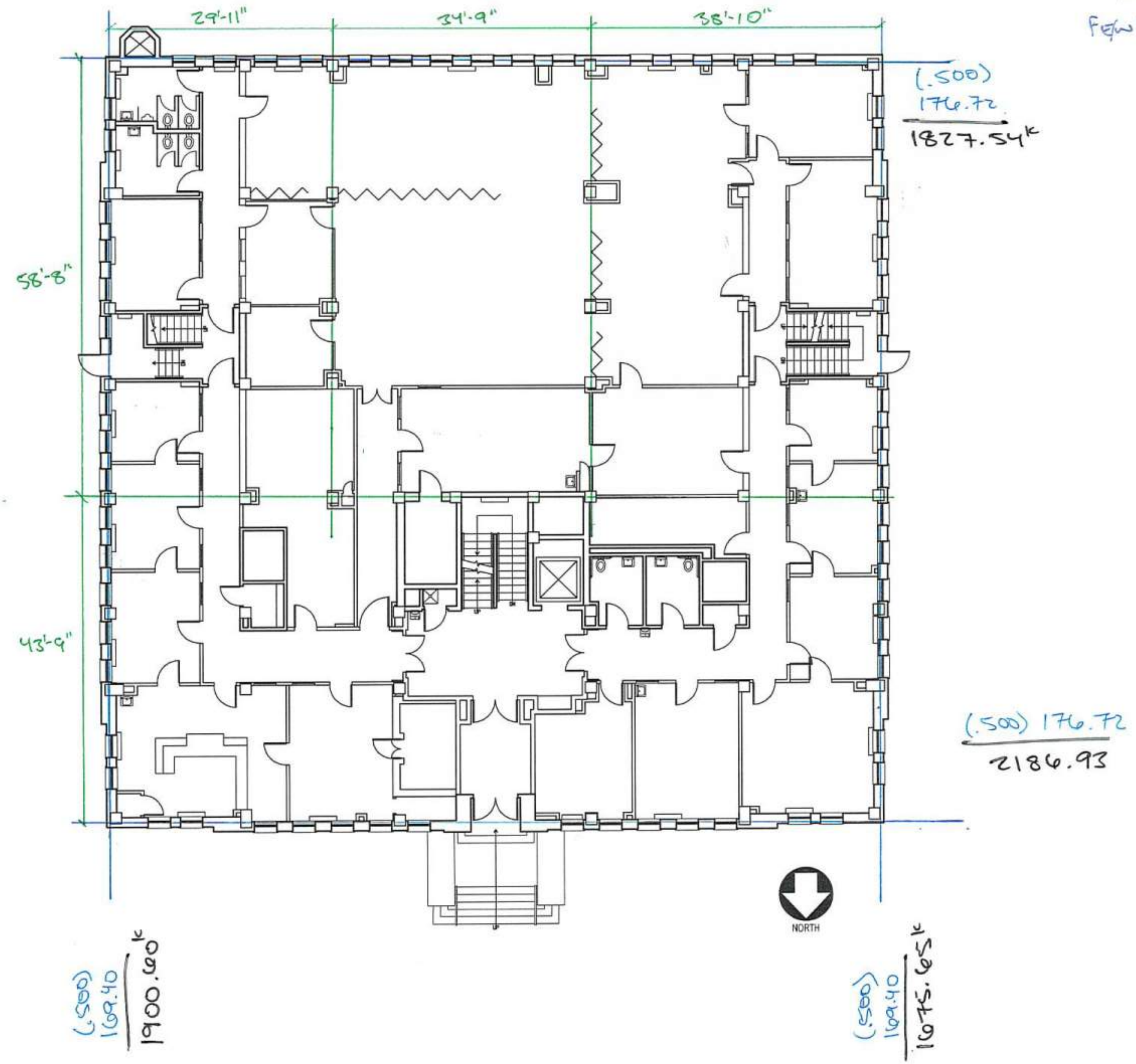


LEVEL 2
FN/S = 587.42k
FE/W = 596.40k
A = 10600 sf
V = 801.84k
V = 989.58k
V = 1564.44k
29'-11"
34'-9"
38'-10"
58'-8"
43'-9"
102'-5"
103'-6"
.166
.192
.215
.123
.143
.166
(.500)
298.20k
+ (.427)
668.02
966.22k
1650.82k
(.500) (.573)
298.20 + 896.42
1194.62k
2010.21k
(.525)
941.36
(.500)
293.71k
1235.07k
1731.20k
(.475)
850.06
(.500)
293.71
1143.77k
1510.25k
NORTH

LEVEL 1

$F_{N/S} = 338.79^k$

$F_{E/W} = 353.44^k$



(LEVEL 1 SPOT CHECK) URM HAND CHECK (PER ASCE 41-17)

MAX FORCE IN SHEAR WALLS = 2185.44k (WEFF - LEVEL VALUE)
BY RELATIVE RIGIDITY, THE LONGEST 7'0" PIER TAKES 22% OF TOTAL WALL LINE FORCE IN NORTH WALL

W = .22(2185.44k) = 480.80k → (2185 VALUE SLIGHTLY DIFFERENT THAN 2186 VALUE ON PREVIOUS PAGE DUE TO CALC EDITS)

→ FROM PSEUDO LATERAL FORCE SPREAD SHEET:

BSE-1E (LS)	BSE-2E (CP)	
V = 0.4 W = 192.32k	V = 1.04 W = 500.03k	(Q_{UD})

CHECK IN-PLANE ROCKING (SEC. 11.3.2.2.1)

$Q_{CE} = .9(\alpha P_D + .5 P_w)\frac{L}{h_{eff}}$

$\alpha = 1.0$ (FIXED-FIXED)
$P_D = 2.30^k$ (SUPERIMPOSED DL ABOVE)
$P_w = 1.68^k$ (WALL SELF WT.)
$L = 7'0"$, $h_{eff} = 6'0"$ ⇒ $L/h = 1.167$, $h/L = 0.857$

$Q_{CE} = 3.30^k$

FIND m-FACTORS (TABLE 11-3) (USE KNOWLEDGE FACTOR k = 0.75) (↳ PER SEC. 6.2.4)

BSE-1E (LS)

$f_a/f_{lm} = \frac{2.30^k/(1'0" \times 7'0") = .329 \text{ ksf}}{\text{ASSUME } 1.5 \text{ ksf}} = .219 > .04$ → FORCE CONTROLLED (SEE SECTIONS 7.5.2.1.2 & 7.5.2.2.2)

↳ $\chi Q_{UD} / C_1C_2J$ = 113.64k
$\chi = 1.3$ (LIFE SAFETY, EQ. 7-35)
$C_1C_2 = 1.1$ (TABLE 7-3)
$J = 2.0$ (HIGH SEISMIC, EQ 7-35)

BSE-2E (CP)

(SAME AS BSE-1E) → $\chi = 1.0$ (COLLAPSE PREV.), $C_1C_2 = 1.1$, $J = 2.0$ ⇒ 227.29k

CHECK DCR

BSE-1E (LS)	BSE-2E (CP)
$DCR = \frac{Q_{UD}}{Q_{CE}} = \frac{113.64^k}{3.30^k} = 34.44$	$DCR = \frac{227.29^k}{3.30^k} = 68.88$
34.44 > k = 0.75	68.88 > k = 0.75
∴ UPGRADE REQ'D	∴ UPGRADE REQ'D

(LEVEL 4 SPOT CHECK) URM HAND CHECK (PER ASCE 41-17)

MAX FORCE IN SHEAR WALLS = 379.33 k (W_{EFF} - LEVEL VALUE)
BY RELATIVE RIGIDITY, THE LONGEST 7'-0" PIER TAKES 22% OF TOTAL WALL LINE FORCE IN NORTH WALL

W = .22 (379.33 k) = 82.13 k

→ FROM PSUEDO LATERAL FORCE SPREAD SHEET:

BSE-1E (LS): V = 0.4 W = 32.85 k

BSE-2E (CP): V = 1.04 W = 85.42 k (Q_{UD})

CHECK IN-PLANE ROCKING (SEC. 11.3.2.2.1)

$$Q_{CE} = .9(\alpha P_D + .5 P_W)\frac{L}{h_{eff}}$$

α = 1.0 (FIXED-FIXED)
P_D = 3.40 k (SUPERIMPOSED DL ABOVE)
P_W = 1.68 k (WALL SELF WT.)
L = 7'-0"
h_{eff} = 6'-0" ⇒ L/h = 1.167, h/L = 0.857

Q_{CE} = 4.45 k

FIND m-FACTORS (TABLE 11-3) (USE KNOWLEDGE FACTOR k = 0.75)
↳ (PER SEC. 6.2.4)

BSE-1E (LS)

$$f_a/f'_m = \frac{3.40^k/(1'\text{-}0" \times 7'\text{-}0") = .485 \text{ ksf}}{\text{ASSUME } 1.5 \text{ ksf}} = .323 > .04 \rightarrow \text{FORCE CONTROLLED}$$

↳ SEE SEC. 7.5.2.1.2 & 7.5.2.2.2

↳ $\frac{\chi Q_{UD}}{C_1 C_2 J}$, χ = 1.3, C_1C_2 = 1.1, J = 2.0 ⇒ 19.42 k

BSE-2E (CP)

(SAME AS BSE-1E) → $\frac{\chi Q_{UD}}{C_1 C_2 J}$, χ = 1.0, C_1C_2 = 1.1, J = 2.0 ⇒ 38.83 k

CHECK DCR

BSE-1E (LS)

$$DCR = \frac{Q_{UD}}{Q_{CE}} = \frac{19.42^k}{4.45^k} = 4.36$$

4.36 > k = 0.75

∴ UPGRADE REQ'D

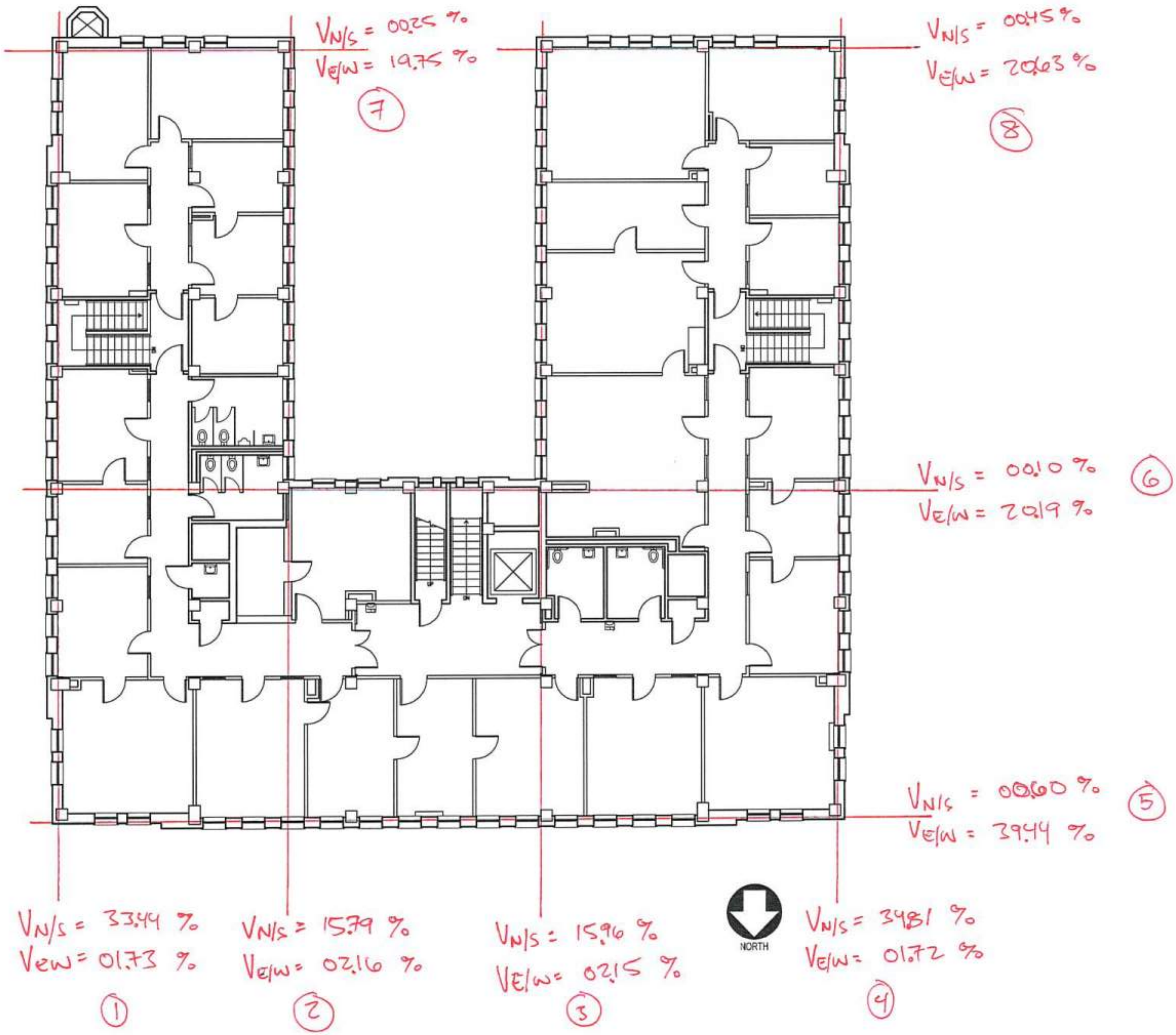
BSE-2E (CP)

$$DCR = \frac{38.83^k}{4.45^k} = 8.73$$

8.73 > k = 0.75

∴ UPGRADE REQ'D

% OF HYPOTHETICAL FORCE TO EACH WALL USING RIGID DIAPHRAGM ANALYSIS



①

(LEVEL = MAIN ROOF)

CONC. DIAPH CHECK (PER ASCE 41-17)

	BSE-1E	BSE-2E
F_{px} N/S	483.58^k	1257.30^k
F_{px} E/W	509.69^k	1325.20^k

→ DIAPH VERT DISTRIBUTION

N/S WORST CASE v_{dia}: (HYPOTHETICAL FORCES)

④ = 34.81^k/(58'-8" + 43'-9") = 340 plf (> LINE ①)
(58'-8" + 43'-9" → 102'-5")

② & ③ CHECK → 340 plf(43'-9") = 14.88^k < 15.79^k
→ LINE ④ CONTROLS (N/S)

E/W WORST CASE v_{dia}: (HYPOTHETICAL)

⑤ = 39.44^k/(29'-11" + 34'-9" + 38'-10") = 381 plf
(29'-11" + 34'-9" + 38'-10" → 103'-6")

⑥ CHECK → 381 plf(34'-9") = 13.24^k < 20.19^k
→ LINE ⑤ CONTROLS

⑦ = 19.75^k/29'-11" = 660 plf (GOVERNS E/W)

⑧ = 20.63^k/38'-10" = 531 plf

BSE-1E

N/S = 0.3481(483.58^k/102'-5") = 1644 plf → Q_E _N/S

E/W = 0.1975(509.69^k/29'-11") = 3365 plf → Q_E E/W (E/W GOVERNS)

BSE-2E

N/S = .3481(1257.30^k/102'-5") = 4274 plf → Q_E _N/S

E/W = .1975(1325.20^k/29'-11") = 8749 plf → Q_E _E/W (E/W GOVERNS)

↑ THESE REDUCTION FACTORS CORRESPOND TO PROPORTIONAL FORCES @ WALL LINES FOR RIGID DIAPH. ANALYSIS

DIAPH CHECK CONT. (MAIN ROOF LEVEL)

CHECK DIAPH. STRENGTH (PER ACI 318-19, SEC. 12.5.3)

$\phi V_n = \phi A_{cv}(2\lambda\sqrt{f'_c} + \rho_t f_y) \leq \phi 8 A_{cv}\sqrt{f'_c}$

(EQ 12.5.3.3) (EQ 12.5.3.4)

$\phi = .75$
$A_{cv} = 3"$ THICK
(OMIT LENGTH TO GET PLF)
$f'_c = 3000$ (ASSUME)
$\rho_t = 0.00$ (ASSUME NEARLY 0 REINF.)
$f_y = 60$ KSI

$\phi V_n = 2957$ PLF

CHECK DCR's

→ BECAUSE THE MAIN ROOF DIAPHRAGM TRANSFERS FORCE FROM THE PENTHOUSE WALLS TO OUTER WALLS, THE DIAPH IS FORCE-CONTROLLED PER SEC. 7.4.1.3.4 OF ASCE 41-17.

BSE-1E: $Q_{UF} = \dfrac{\chi Q_E}{C_1 C_2 J}$

$\chi = 1.3$ (LIFE SAFETY)
$C_1 C_2 = 1.1$
$J = 2.0$

= 971 PLF (N/S) & 1989 PLF (E/W) ← VALUES FROM PREVIOUS PAGE ADJUSTED PER Q_{UF} EQ.

$DCR_{N/S} = \dfrac{971 \text{ PLF}}{2957 \text{ PLF}} = 0.328$ $DCR_{E/W} = \dfrac{1989}{2957} = .672$ → GOVERNS BSE-1E

DCR = 0.672 < k = 0.75 ∴ OK

BSE-2E: Q_{UF} = 1943 PLF (N/S) & 3976 PLF (E/W) ($\chi = 1.0$ CP) ← SEE ABOVE

$DCR_{N/S} < DCR_{E/W} = \dfrac{3976}{2957} = 1.34$

DCR = 1.34 > k = 0.75 ∴ UPGRADE REQ'D ←

QUICK DIAPH CHECKS BASED ON PREVIOUS CALC

LEVEL 4 DIAPH: (DEFORMATION CONTROLLED)

BSE-1E

$N/S = (358.47/476.81) \times 1644 = 1236$ plf $\rightarrow Q_{E\_N/S}$

$E/W = (374.88/509.69) \times 3365 = 2475$ plf $\rightarrow Q_{E\_E/W}$

BSE-2E

$N/S = (932.03/1257.30) \times 4274 = 3169$ plf $\rightarrow Q_{E\_N/S}$

$E/W = (974.69/1325.20) \times 8749 = 6435$ plf $\rightarrow Q_{E\_E/W}$

$\phi V_N = 2957$ plf $\longrightarrow Q_{CE}$

PER SEC. 10.10.2.4, USE TABLE 10-22 m-factors FOR SHEAR

BSE-1E, m = 2 (LS)

$DCR_{N/S} = \frac{1236}{2957} = 0.42$

$DCR_{E/W} = \frac{2475}{2957} = 0.84$

$0.84 < km = 1.5$

∴ NO UPGRADE REQ'D

BSE-2E, m = 3 (CP)

$DCR_{N/S} = \frac{3169}{2957} = 1.07$

$DCR_{E/W} = \frac{6435}{2957} = 2.18$

$2.18 < km = 2.25$ (use k = .75)

∴ NO UPGRADE REQ'D

↳ LEVEL 4 VALUES ARE WORST-CASE AMONG DEFORMATION-CONTROLLED DIAPHRAGMS.

(4)

DIAPH CHECK CONT.

LEVEL 2 ⟶ FORCE-CONTROLLED DUE TO SHEAR WALLS IN CENTER OF BUILDING TERMINATING @ LEVEL 2.

$\phi V_n = 2957$ plf ⟶ Q_{CE}

BSE-1E

$N/S = [.5(234.97) + 941.36]/102'\text{-}5'' = 10339$ plf ⟶ $Q_{E-N/S}$ (N/S GOVERNS)

$E/W = [.5(238.56) + 896.42]/103'\text{-}6'' = 9814$ plf ⟶ $Q_{E-E/W}$

BSE-2E

$N/S = [.5(610.92) + 941.36]/102'\text{-}5'' = 12174$ plf ⟶ $Q_{E-N/S}$ (N/S GOVERNS)

$E/W = [.5(620.26) + 896.42]/103'\text{-}6'' = 11658$ plf ⟶ $Q_{E-E/W}$

BSE-1E

$$Q_{UD} = \frac{\chi Q_E}{C_1 C_2 J} = \frac{1.3(10339)}{1.1(2.0)} = 6110 \text{ plf}$$

$$DCR = \frac{6110}{2957} = 2.07 \longrightarrow 2.07 > k = 0.75$$

∴ UPGRADE REQ'D

BSE-2E

$$Q_{UD} = \frac{1.0(12174)}{1.1(2.0)} = 5534 \text{ plf}$$

$$DCR = \frac{5534}{2957} = 1.88 \longrightarrow 1.88 > k = 0.77$$

∴ UPGRADE REQ'D

(5)

A R W ENGINEERS
structural consultants

Project No. 23124 Sheet No.
Project FOREST SERVICE BLDG
Prepared By TDP. Date

SUMMARY OF CONC. DIAPH.

LEVEL	FORCE/DEFORMATION	UPGRADE?
MAIN ROOF	FORCE CONTROLLED	REQ'D
LEVEL 4	DEFORMATION	NOT REQ'D
LEVEL 3	DEFORMATION	NOT REQ'D
LEVEL 2	FORCE	REQ'D
LEVEL 1	DEFORMATION	NOT REQ'D

CHECK CONCRETE FRAMES
WITH MASONRY INFILL (PER ASCE 41-17)

~~MASONRY INFILL IN-PLANE (SEC. 11.4.2.3)~~

~~FIND INFILL LATERAL STIFFNESS~~

~~$K_{inf} = 1/\left(\frac{1}{K_{inf\_f}}\right)+\left(\frac{1}{K_{inf\_s}}\right)$ (EQ 11-32)~~

~~$\hookrightarrow K_{inf\_f} = \frac{3E_{me}I_{inf}}{h^3_{inf}}$~~

~~$E_{me} = 700f'_m \ldots f'_m \approx 2.1$ ksi (ASSUMED)~~
~~$= 1470$ ksi~~
~~$I_{inf} = bh^3/12$ $b = .75(8") = 6"$~~
~~$h = 8'-10"$~~

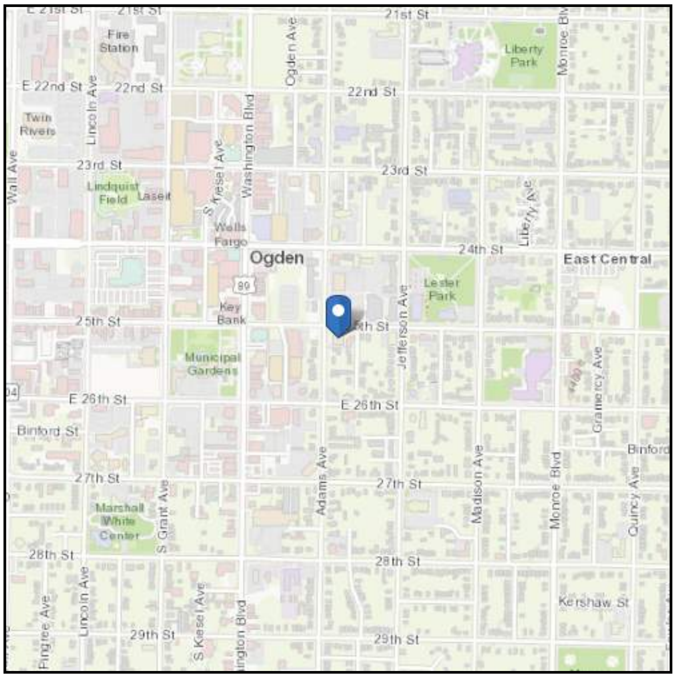
→ CHECKING FRAMES WITH INFILL ASSUMED NOT TO BE AN ISSUE SINCE ALL INFILL BAYS HAVE WINDOWS, SO COMPRESSION STRUTS WILL NOT FORM. DEFORMATION COMPATIBILITY CHECKS LIKELY STILL REQ'D FOR UPGRADES.

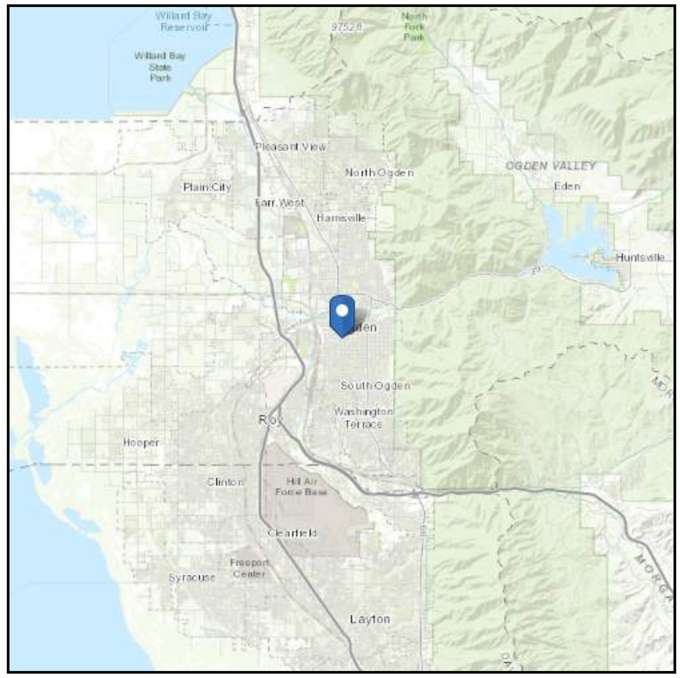
ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Default (see Section 11.4.3)

Latitude: 41.220265
Longitude: -111.96717
Elevation: 4366.684299940585 ft (NAVD 88)





Seismic

Site Soil Class:	D - Default (see Section 11.4.3)		
Results:			
S_S :	1.364	S_{D1} :	~~N/A~~ Sd1 = 0.598
S_1 :	0.498	T_L :	8
F_a :	1.2	PGA :	0.618
F_v :	~~N/A~~ Fv = 1.802	PGA_M :	0.742
S_{MS} :	1.637	F_{PGA} :	1.2
S_{M1} :	~~N/A~~ Sm1 = 0.897	I_e :	1
S_{DS} :	1.091	C_v :	1.373

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Thu Nov 02 2023

Date Source: USGS Seismic Design Maps

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	Diaph. (kips)	+N/S Only (kips)	+E/W Only (kips)	Total N/S Seis. Wt. (kips)	Total E/W Seis. Wt. (kips)	h (ft)
Greenhouse	21.26	16.23	16.23	37.49	37.49	83.0000
Mechanical	29.51	14.68	14.68	44.19	44.19	73.5833
Penthouse/Main Roof	625.13	70.32	109.98	695.45	735.11	64.2500
Level 4	615.75	57.44	89.83	673.19	705.58	50.2500
Level 3	615.75	50.15	78.44	665.90	694.19	39.0000
Level 2	771.00	66.48	81.80	837.48	852.80	26.7500
Level 1	771.00	132.10	173.33	903.10	944.33	14.5000
				3856.8	4013.69	

k =	1.025
Sds =	1.091
Ie =	1
Cs =	0.218

k =	1.025	T =	0.550	TL =	8
Ss =	1.364	S1 =	0.498	Risk Category =	II
Fa =	1.2	Fv =	1.802		
Sds =	1.091	Sd1 =	0.598		
Ie =	1	R =	5	*Table 11.6-1*	*D*
Cs =	0.218	Design Category =	D	*Table 11.6-2*	*D*

R=5
Special Reinf. Concrete Shear Walls
(concrete/shotcrete wall option)

N/S Vertical Distribution (ASCE 7-16 Section 12.8.3)

Vn/s (kips) = 839.10

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	16.90
Mechanical	44.19	73.5833	3979.717	2.1%	17.68
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	259.34
Level 4	673.19	50.2500	43897.155	23.2%	194.98
Level 3	665.90	39.0000	33478.657	17.7%	148.70
Level 2	837.48	26.7500	28773.271	15.2%	127.80
Level 1	903.10	14.5000	16594.667	8.8%	73.71
			188915.398	100.0%	839.10

E/W Vertical Distribution (ASCE 7-16 Section 12.8.3)

Ve/w (kips) = 873.23

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	17.58
Mechanical	44.19	73.5833	3979.717	2.1%	18.40
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	269.89
Level 4	673.19	50.2500	43897.155	23.2%	202.91
Level 3	665.90	39.0000	33478.657	17.7%	154.75
Level 2	837.48	26.7500	28773.271	15.2%	133.00
Level 1	903.10	14.5000	16594.667	8.8%	76.71
			188915.398	100.0%	873.23

N/S Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	16.90	0.21824	0.451	0.43648	0.436	16.36
Mechanical	44.19	81.68	34.57	0.21824	0.423	0.43648	0.423	18.70
Penthouse/Main Roof	695.45	777.13	293.91	0.21824	0.378	0.43648	0.378	263.02
Level 4	673.19	1450.32	488.89	0.21824	0.337	0.43648	0.337	226.92
Level 3	665.90	2116.22	637.59	0.21824	0.301	0.43648	0.301	200.63
Level 2	837.48	2953.70	765.39	0.21824	0.259	0.43648	0.259	217.01
Level 1	903.10	3856.80	839.10	0.21824	0.218	0.43648	0.218	197.09

E/W Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	17.58	0.21824	0.469	0.43648	0.436	16.36
Mechanical	44.19	81.68	35.98	0.21824	0.440	0.43648	0.436	19.29
Penthouse/Main Roof	735.11	816.79	305.87	0.21824	0.374	0.43648	0.374	275.28
Level 4	705.58	1522.37	508.77	0.21824	0.334	0.43648	0.334	235.80
Level 3	694.19	2216.56	663.52	0.21824	0.299	0.43648	0.299	207.80
Level 2	852.80	3069.36	796.52	0.21824	0.260	0.43648	0.260	221.31
Level 1	944.33	4013.69	873.23	0.21824	0.218	0.43648	0.218	206.09

	Diaph. (kips)	+N/S Only (kips)	+E/W Only (kips)	Total N/S Seis. Wt. (kips)	Total E/W Seis. Wt. (kips)	h (ft)
Greenhouse	21.26	16.23	16.23	37.49	37.49	83.0000
Mechanical	29.51	14.68	14.68	44.19	44.19	73.5833
Penthouse/Main Roof	625.13	70.32	109.98	695.45	735.11	64.2500
Level 4	615.75	57.44	89.83	673.19	705.58	50.2500
Level 3	615.75	50.15	78.44	665.90	694.19	39.0000
Level 2	771.00	66.48	81.80	837.48	852.80	26.7500
Level 1	771.00	132.10	173.33	903.10	944.33	14.5000
				3856.8	4013.69	

k =	1.025
Sds =	1.091
Ie =	1
Cs =	0.136

k =	1.025	T =	0.550	TL =	8		
Ss =	1.364	S1 =	0.498	Risk Category =	II		
Fa =	1.2	Fv =	1.802				
Sds =	1.091	Sd1 =	0.598				
Ie =	1	R =	8	*Table 11.6-1*	*D*		
Cs =	0.136	Design Category =	D	*Table 11.6-2*	*D*		

R=8
Buckling-restrained braced frames

N/S Vertical Distribution (ASCE 7-16 Section 12.8.3)

Vn/s (kips) = 524.43

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	10.56
Mechanical	44.19	73.5833	3979.717	2.1%	11.05
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	162.09
Level 4	673.19	50.2500	43897.155	23.2%	121.86
Level 3	665.90	39.0000	33478.657	17.7%	92.94
Level 2	837.48	26.7500	28773.271	15.2%	79.88
Level 1	903.10	14.5000	16594.667	8.8%	46.07
			188915.398	100.0%	524.43

E/W Vertical Distribution (ASCE 7-16 Section 12.8.3)

Ve/w (kips) = 545.77

Level	w (kips)	h (ft)	wh^k (k-ft)	Cv	Fx (kips)
Greenhouse	37.49	83.0000	3804.215	2.0%	10.99
Mechanical	44.19	73.5833	3979.717	2.1%	11.50
Penthouse/Main Roof	695.45	64.2500	58387.716	30.9%	168.68
Level 4	673.19	50.2500	43897.155	23.2%	126.82
Level 3	665.90	39.0000	33478.657	17.7%	96.72
Level 2	837.48	26.7500	28773.271	15.2%	83.12
Level 1	903.10	14.5000	16594.667	8.8%	47.94
			188915.398	100.0%	545.77

N/S Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	10.56	0.21824	0.282	0.43648	0.282	10.56
Mechanical	44.19	81.68	21.61	0.21824	0.265	0.43648	0.265	11.69
Penthouse/Main Roof	695.45	777.13	183.69	0.21824	0.236	0.43648	0.236	164.39
Level 4	673.19	1450.32	305.55	0.21824	0.211	0.43648	0.218	146.92
Level 3	665.90	2116.22	398.49	0.21824	0.188	0.43648	0.218	145.33
Level 2	837.48	2953.70	478.37	0.21824	0.162	0.43648	0.218	182.77
Level 1	903.10	3856.80	524.43	0.21824	0.136	0.43648	0.218	197.09

E/W Seismic Diphragm Forces (ASCE 7-16 Section 12.10)

Level	wi (kips)	Σw (kips)	ΣF (ft)	0.2*Sds*Ie	ΣF/Σw	0.4*Sds*Ie	Use...	Fpx (kips)
Greenhouse	37.49	37.49	10.99	0.21824	0.293	0.43648	0.293	10.99
Mechanical	44.19	81.68	22.49	0.21824	0.275	0.43648	0.275	12.17
Penthouse/Main Roof	735.11	816.79	191.17	0.21824	0.234	0.43648	0.234	172.05
Level 4	705.58	1522.37	317.98	0.21824	0.209	0.43648	0.218	153.99
Level 3	694.19	2216.56	414.70	0.21824	0.187	0.43648	0.218	151.50
Level 2	852.80	3069.36	497.83	0.21824	0.162	0.43648	0.218	186.12
Level 1	944.33	4013.69	545.77	0.21824	0.136	0.43648	0.218	206.09

APPLIED FORCES FOR NEW CONC. WALL ANALYSIS

NORTH WALL, LEVEL 4:

ROOF $W_{EFF\_E/W}$ = 1257.44^k

RIGID DIAPH MULTIPLIER @ NORTH WALL: 0.395

TRIBUTARY FORCE TO NORTH WALL FROM PENTHOUSE ABOVE = 46.74^k

SEISMIC RESPONSE COEFF. FOR R=5 : 0.218

$$V = 0.218\left[\left(.395 \times 1257.44^k\right) + 46.74^k\right] = 118.47^k$$

NORTH WALL, LEVEL 1

ROOF $W_{EFF\_E/W}$ = 1257.44^k

LEVEL 4 $W_{EFF\_E/W}$ = 937.20^k

LEVEL 3 $W_{EFF\_E/W}$ = 710.23^k

LEVEL 2 $W_{EFF\_E/W}$ = 596.40^k

RIGID DIAPH. MULTIPLIER (LEVELS 3, 4, ROOF) = 0.395

TRIBUTARY MULTIPLIER (LEVEL 2) = 0.500

TRIB FORCE TO NORTH WALL FROM PENTHOUSE = 46.74^k

TRIB FORCE TO NORTH WALL FROM U-SHAPED WALLS @ LEVEL 2 = 896.42^k

SEISMIC RESPONSE COEFF. = 0.218 (R=5)

$$V = 0.218\left[.395\left(1257.44^k + 937.20^k + 710.83^k\right) + .5\left(596.40^k\right) + 46.74 + 896.42^k\right] = 520.81^k$$

E-W WALL @ STAIR, LEVEL 2

ROOF W_{eff} - e/w = 1257.44^k

LEVEL 4 " = 937.20^k

LEVEL 3 " = 710.83^k

RIGID DIAPH MULTIPLIER = 0.202

TRIBUTARY FROM PENT = 32.48^k

SW @ PENT. = 79.22^k

SEIS. RESPONCE COEFF = 0.218 (R=5)

$$V = 0.218\left[.202(1257.44^k + 937.20^k + 710.83^k) + 32.48^k + 79.22^k\right] = 152.30^k$$

ACI 318-14 CONCRETE SHEAR PIERS STRENGTH DESIGN

08-Nov-23

Version Date: July 14, 2022 Author: Arek Higgs Reviewed By: Josh Blazzard

JOB TITLE: Forest Service Building JOB #: 23124

WALL LOCATION: North Wall, Level 4 DESIGNED BY:

TOTAL LAT. FORCE (ULTIMATE)=	118.4675	kips	S_{ds}=	1.091	F_y:	60000 psi	Pre-cast:	No
SEISMIC DESIGN CATEGORY. (A-F) :	D		R=	5.0	f'$_c$:	4500 psi	Wall Pier(s):	No
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75		Ie=	1.00	Wall Density δ (pcf):	150		
ϕ FOR BENDING: (ACI 21.2.1, Table 21.2.1 (h))	0.9		Ω=	2.5	λ:	1.0		
OVERALL WALL LENGTH (ft):	19.17				HEIGHT/LENGTH OF OVERALL WALL:	0.73		
OVERALL WALL HEIGHT (ft):	14.00				ac: (FOR OVERALL WALL):	3.00		
ϕ*V_n MAX (kips) FOR COMBINED PIERS: (ACI 18.10.4.4)	926	OK			Wall Seismic Self Weight Included In Shear Force?	NO		

PIER I.D. #	1	2	3	4	5	6	7	8	9
PIER HEIGHT (ft):	14.00								
PIER LENGTH (ft):	19.17								
NOMINAL PIER THICKNESS (in):	10.00								
TOTAL VERTICAL LOAD- P (ASD) (k):	0.00								
Wall Self Weight (psf)	125.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional Weight on Wall (psf)	2044.70								
Total Wall Weight (psf)	2169.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIXITY TYPE (F-F = 2, F-P = 1):	1								
EFFECTIVE LENGTH FACTOR: (ACI 11.5.4.2)	0.80								
EFFECTIVE LENGTH "d" (ft):	15.33336	0	0	0	0	0	0	0	0
β_1=	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825
UNIFORM DEAD LOAD ON PIER (k/ft):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGIDITY DATA									
HEIGHT/LENGTH:	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$(H/L)^3$:	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RELATIVE DEFLECTION: (NOT ACTUAL PIER DEFLECTION)	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL WALL DEFLECTION:					0.011				
RIGIDTY = 1/DEFL. :	89.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUM. RIGIDITIES:					89.7				
% OF FORCE TO PIER:	100%	0%	0%	0%	0%	0%	0%	0%	0%
V_u = SHEAR/PIER (kips):	245.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M / (V * DEPTH):	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUMMARY									
REINFORCING									
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75								
VERTICAL PLAN GROSS AREA OF CONCRETE, A_{cv} (in^2):	2300	0	0	0	0	0	0	0	0
HORIZONTAL PLAN GROSS AREA OF CONCRETE (in^2):	1680	0	0	0	0	0	0	0	0
MIN. HORIZ. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_t)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MIN. VERT. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_l)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ϕ*V_n MAX (kips): (ACI 11.5.4.3 and 18.10.4.4)	1157	0	0	0	0	0	0	0	0
ϕ*V_c MAX (kips): (ACI 11.5.4.5)	185	0	0	0	0	0	0	0	0
NEEDED HORIZ. REINF. (in^2/ft): (ACI 11.5.4.8 and 22.5.10.1)	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HORIZONTAL BAR SIZE:	**#5 Bar**								
VERTICAL BAR SIZE:	**#5 Bar**								
REINFORCING SPACING									
l_w/3 (in):	77	0	0	0	0	0	0	0	0
l_w/5 (in):	46	0	0	0	0	0	0	0	0
3h (in):	30	0	0	0	0	0	0	0	0
MAX. SPACING OF HORIZ. REINF. (in): (ACI 11.7.3.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MAX. SPACING OF VERT. REINF. (in): (ACI 11.7.2.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Actual Spacing of Horiz. Reinf. (in)	**12**								
Actual Spacing of Vert. Reinf. (in)	**12**								
Actual Horizontal Area of Steel Provided (in^2/ft):	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual Vertical Area of Steel Provided (in^2/ft):	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horizontal Steel Required (in^2/ft):	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vertical Steel Required (in^2/ft):	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horiz. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vert. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SHEAR CAPACITY									
2*A_{cv}*SQRT(f'$_c$) (kips):	309	0	0	0	0	0	0	0	0
2 LAYERS OF REINF. REQ'D?: (ACI 11.7.2.3 and 18.10.2.2)	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2 LAYERS OF REINF. USED? If row 66 is YES, Enter YES	**YES**								
α_c: (ACI 18.10.4.1)	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ϕ*V_n MAX (kips): (ACI EQ. 18.10.4.1)	882	0	0	0	0	0	0	0	0
MAXIMUM SHEAR CHECK:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Shear Strength Vn (kips):	**817**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
FLEXURAL REINFORCING									
Resisting Moment From Wall Self Wt. = (0.9-0.2Sds)(MrSW); (k-ft)	3804	0	0	0	0	0	0	0	0
Overturning Moment, M =Vh+C_s(SW)h/2 (k-ft):	2548	0	0	0	0	0	0	0	0
MAXIMUM MOMENT, M_u =Vh-(0.9-0.2S_{ds})(M_{rDL} + M_{rSW}); (k-ft):	0	0	0	0	0	0	0	0	0
$A_{s,req}$ (in^2):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REQUIRED FLEXURAL STEEL, A_s (in^2):	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

FLEXURAL REINFORCEMENT USED

Flexural Bar Used	**#6 Bar**								
Diameter of Bar:	0.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
A_s/Bar (in^2):	0.44	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
# of Rows of Bars in Boundary (minimum 2):	2								
Center-to-Center Spacing of Bars in Boundary (in):	3								
Clear Spacing Check:	**OK**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
TOTAL # OF BARS Required:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Min User Specified # of Bars:	**10**								
LENGTH OF BOUNDARY (in):	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Boundary Length Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AREA OF STEEL PROVIDED (in^2):	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLEXURAL STEEL PROVIDED CHECK	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Flexural Capacity Mn (k-ft):	3972	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn (k-ft):	**3575**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cracking Moment Mcr (k-ft):	3697	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn>Mcr	**Mcr>PhiMr**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SPECIAL BOUNDARY ELEMENTS (ACI 18.10.6)

(ACI 18.10.6.2 is not considered in this analysis)

(ACI 18.10.6.3)									
GROSS MOMENT OF INERTIA OF PIER Ig (in^4):	########	0	0	0	0	0	0	0	0
SECTION MODULUS OF PIER (in^3):	88,167	0	0	0	0	0	0	0	0
BENDING STRESS, f_b (psi):	0	0	0	0	0	0	0	0	0
AXIAL STRESS, f_a (psi):	253	0	0	0	0	0	0	0	0
EXTREME FIBER COMP. STRESS (psi):	253	0	0	0	0	0	0	0	0
$0.2f'_c$	900	0	0	0	0	0	0	0	0
SPECIAL BOUNDARY ELEMENTS REQ'D?:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(ACI 18.10.6.4)									
a (in):	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c (in):	8.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a) Min Length of Boundary Element (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(b) Min width of compression zone (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(c) Minimum Width of Compression Zone (in,):	N/A	0	0	0	0	0	0	0	0
Min Compression Zone Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(e) Transverse Reinforcement per 18.7.5.2(a)-(e) & 18.7.5.3 Req'd:	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(f) Required Amount of Transverse Reinforcement A_{sh2}:	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie Bar Size:	**#3 Bar**								
Maximum Tie Bar Spacing (in):	**3.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Vertical Tie Bar Spacing Used (in):	**4.0**								
A_{sh2} Provided (in^2):	0.22	0	0	0	0	0	0	0	0
A_{sh2} Sufficient:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(g) Required Footing Thickenss:	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(h) Development of Horizontal Wall Reinf. Req'd @ Boundary:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Horizontal Wall Reinf. Ends into Boundary:	Straight								
Min Length of Boundary Element for Development:	N/A	0	0	0	0	0	0	0	0

WHEN SPECIAL BOUNDARY ELEMENTS ARE NOT REQ'D

(ACI 18.10.6.5)									
$400/F_y$: (ACI 18.10.6.5(a))	0.0067	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ρ BOUNDARY ELEMENT:	0.0293	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Provisions of 18.7.5.2(a)-(e) Required?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES NEEDED?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES SPACING (ACI 18.10.6.5(a))	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRANS. BARS REQUIRED TO HAVE HOOKS? (ACI 18.10.6.5(b))	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

ARW ENGINEERS structural consultants

ACI 318-14 CONCRETE SHEAR PIERS STRENGTH DESIGN

08-Nov-23

Version Date: July 14, 2022 Author: Arek Higgs Reviewed By: Josh Blazzard

JOB TITLE:	Forest Service Building	JOB #:	23124
WALL LOCATION:	North Wall, Level 1	DESIGNED BY:	

TOTAL LAT. FORCE (ULTIMATE)=	520.8065	kips	S_{ds}=	1.091	F_y:	60000 psi	Pre-cast:	No
SEISMIC DESIGN CATEGORY. (A-F) :	D		R=	5.0	f'$_c$:	4500 psi	Wall Pier(s):	No
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75		Ie=	1.00	Wall Density δ (pcf):	150		
ϕ FOR BENDING: (ACI 21.2.1, Table 21.2.1 (h))	0.9		Ω=	2.5	λ:	1.0		
OVERALL WALL LENGTH (ft):	19.17		HEIGHT/LENGTH OF OVERALL WALL:			0.64		
OVERALL WALL HEIGHT (ft):	12.25		ac: (FOR OVERALL WALL):			3.00		
ϕ*V_n MAX (kips) FOR COMBINED PIERS: (ACI 18.10.4.4)	926	OK	Wall Seismic Self Weight Included In Shear Force?				NO	

PIER I.D. #	1	2	3	4	5	6	7	8	9
PIER HEIGHT (ft):	12.25								
PIER LENGTH (ft):	19.17								
NOMINAL PIER THICKNESS (in):	10.00								
TOTAL VERTICAL LOAD- P (ASD) (k):	0.00								
Wall Self Weight (psf)	125.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional Weight on Wall (psf)	4312.51								
Total Wall Weight (psf)	4437.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIXITY TYPE (F-F = 2, F-P = 1):	1								
EFFECTIVE LENGTH FACTOR: (ACI 11.5.4.2)	0.80								
EFFECTIVE LENGTH "d" (ft):	15.33336	0	0	0	0	0	0	0	0
β_1=	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825
UNIFORM DEAD LOAD ON PIER (k/ft):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGIDITY DATA									
HEIGHT/LENGTH:	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$(H/L)^3$:	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RELATIVE DEFLECTION: (NOT ACTUAL PIER DEFLECTION)	0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL WALL DEFLECTION:					0.039				
RIGIDTY = 1/DEFL. :	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUM. RIGIDITIES:					26.0				
% OF FORCE TO PIER:	100%	0%	0%	0%	0%	0%	0%	0%	0%
V_u = SHEAR/PIER (kips):	748.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M / (V * DEPTH):	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUMMARY									
REINFORCING									
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75								
VERTICAL PLAN GROSS AREA OF CONCRETE, A_{cv} (in^2):	2300	0	0	0	0	0	0	0	0
HORIZONTAL PLAN GROSS AREA OF CONCRETE (in^2):	1470	0	0	0	0	0	0	0	0
MIN. HORIZ. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_t)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MIN. VERT. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_l)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ϕ*V_n MAX (kips): (ACI 11.5.4.3 and 18.10.4.4)	1157	0	0	0	0	0	0	0	0
ϕ*V_c MAX (kips): (ACI 11.5.4.5)	185	0	0	0	0	0	0	0	0
NEEDED HORIZ. REINF. (in^2/ft): (ACI 11.5.4.8 and 22.5.10.1)	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HORIZONTAL BAR SIZE:	**#5 Bar**								
VERTICAL BAR SIZE:	**#5 Bar**								
REINFORCING SPACING									
l_w/3 (in):	77	0	0	0	0	0	0	0	0
l_w/5 (in):	46	0	0	0	0	0	0	0	0
3h (in):	30	0	0	0	0	0	0	0	0
MAX. SPACING OF HORIZ. REINF. (in): (ACI 11.7.3.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MAX. SPACING OF VERT. REINF. (in): (ACI 11.7.2.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Actual Spacing of Horiz. Reinf. (in)	**8**								
Actual Spacing of Vert. Reinf. (in)	**12**								
Actual Horizontal Area of Steel Provided (in^2/ft):	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual Vertical Area of Steel Provided (in^2/ft):	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horizontal Steel Required (in^2/ft):	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vertical Steel Required (in^2/ft):	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horiz. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vert. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SHEAR CAPACITY									
2*A_{cv}*SQRT(f'$_c$) (kips):	309	0	0	0	0	0	0	0	0
2 LAYERS OF REINF. REQ'D?: (ACI 11.7.2.3 and 18.10.2.2)	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2 LAYERS OF REINF. USED? If row 66 is YES, Enter YES	**YES**								
α_c: (ACI 18.10.4.1)	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ϕ*V_n MAX (kips): (ACI EQ. 18.10.4.1)	1149	0	0	0	0	0	0	0	0
MAXIMUM SHEAR CHECK:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Shear Strength Vn (kips):	**1102**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
FLEXURAL REINFORCING									
Resisting Moment From Wall Self Wt. = (0.9-0.2Sds)(MrSW); (k-ft)	6808	0	0	0	0	0	0	0	0
Overturning Moment, M =Vh+C_s(SW)h/2 (k-ft):	7772	0	0	0	0	0	0	0	0
MAXIMUM MOMENT, M_u =Vh-(0.9-0.2S_{ds})(M_{rDL} + M_{rSW}); (k-ft):	965	0	0	0	0	0	0	0	0
$A_{s,req}$ (in^2):	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REQUIRED FLEXURAL STEEL, A_s (in^2):	**1.17**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

FLEXURAL REINFORCEMENT USED

Flexural Bar Used	**#6 Bar**								
Diameter of Bar:	0.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
A_s/Bar (in^2):	0.44	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
# of Rows of Bars in Boundary (minimum 2):	2								
Center-to-Center Spacing of Bars in Boundary (in):	3								
Clear Spacing Check:	**OK**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
TOTAL # OF BARS Required:	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Min User Specified # of Bars:	**12**								
LENGTH OF BOUNDARY (in):	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Boundary Length Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AREA OF STEEL PROVIDED (in^2):	5.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLEXURAL STEEL PROVIDED CHECK	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Flexural Capacity Mn (k-ft):	4748	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn (k-ft):	**4273**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cracking Moment Mcr (k-ft):	3697	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn>Mcr	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SPECIAL BOUNDARY ELEMENTS (ACI 18.10.6)

(ACI 18.10.6.2 is not considered in this analysis)

(ACI 18.10.6.3)

GROSS MOMENT OF INERTIA OF PIER Ig (in^4):	########	0	0	0	0	0	0	0	0
SECTION MODULUS OF PIER (in^3):	88,167	0	0	0	0	0	0	0	0
BENDING STRESS, f_b (psi):	131	0	0	0	0	0	0	0	0
AXIAL STRESS, f_a (psi):	453	0	0	0	0	0	0	0	0
EXTREME FIBER COMP. STRESS (psi):	584	0	0	0	0	0	0	0	0
$0.2f'_c$	900	0	0	0	0	0	0	0	0
SPECIAL BOUNDARY ELEMENTS REQ'D?:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

(ACI 18.10.6.4)

a (in):	8.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c (in):	10.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a) Min Length of Boundary Element (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(b) Min width of compression zone (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(c) Minimum Width of Compression Zone (in,):	N/A	0	0	0	0	0	0	0	0
Min Compression Zone Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(e) Transverse Reinforcement per 18.7.5.2(a)-(e) & 18.7.5.3 Req'd:	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(f) Required Amount of Transverse Reinforcement A_{sh2}:	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie Bar Size:	**#4 Bar**								
Maximum Tie Bar Spacing (in):	**3.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Vertical Tie Bar Spacing Used (in):	**3.0**								
A_{sh2} Provided (in^2):	0.4	0	0	0	0	0	0	0	0
A_{sh2} Sufficient:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(g) Required Footing Thickenss:	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(h) Development of Horizontal Wall Reinf. Req'd @ Boundary:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Horizontal Wall Reinf. Ends into Boundary:	Hooked								
Min Length of Boundary Element for Development:	N/A	0	0	0	0	0	0	0	0

WHEN SPECIAL BOUNDARY ELEMENTS ARE NOT REQ'D

(ACI 18.10.6.5)

$400/F_y$: (ACI 18.10.6.5(a))	0.0067	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ρ BOUNDARY ELEMENT:	0.0293	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Provisions of 18.7.5.2(a)-(e) Required?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES NEEDED?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES SPACING (ACI 18.10.6.5(a))	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRANS. BARS REQUIRED TO HAVE HOOKS? (ACI 18.10.6.5(b))	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

ARW ENGINEERS

ACI 318-14 CONCRETE SHEAR PIERS STRENGTH DESIGN

08-Nov-23

Version Date: July 14, 2022 Author: Arek Higgs Reviewed By: Josh Blazzard

JOB TITLE:	Forest Service Building	JOB #:	23124
WALL LOCATION:	E-W Wall @ Stair, Level 2	DESIGNED BY:	

TOTAL LAT. FORCE (ULTIMATE)=	152.2959	kips	S_{ds}=	1.091	F_y:	60000 psi	Pre-cast:	No
SEISMIC DESIGN CATEGORY. (A-F) :	D		R=	5.0	f'$_c$:	4500 psi	Wall Pier(s):	No
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75		Ie=	1.00	Wall Density δ (pcf):	150		
ϕ FOR BENDING: (ACI 21.2.1, Table 21.2.1 (h))	0.9		Ω=	2.5	λ:	1.0		
OVERALL WALL LENGTH (ft):	15.08				HEIGHT/LENGTH OF OVERALL WALL:	0.81		
OVERALL WALL HEIGHT (ft):	12.25				ac: (FOR OVERALL WALL):	3.00		
ϕ*V_n MAX (kips) FOR COMBINED PIERS: (ACI 18.10.4.4)	729	OK			Wall Seismic Self Weight Included In Shear Force?	NO		

PIER I.D. #	1	2	3	4	5	6	7	8	9
PIER HEIGHT (ft):	12.25								
PIER LENGTH (ft):	15.08								
NOMINAL PIER THICKNESS (in):	10.00								
TOTAL VERTICAL LOAD- P (ASD) (k):	0.00								
Wall Self Weight (psf)	125.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional Weight on Wall (psf)	3393.74								
Total Wall Weight (psf)	3518.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIXITY TYPE (F-F = 2, F-P = 1):	1								
EFFECTIVE LENGTH FACTOR: (ACI 11.5.4.2)	0.80								
EFFECTIVE LENGTH "d" (ft):	12.06664	0	0	0	0	0	0	0	0
β_1=	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825
UNIFORM DEAD LOAD ON PIER (k/ft):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGIDITY DATA									
HEIGHT/LENGTH:	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(H/L)^3 :	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RELATIVE DEFLECTION: (NOT ACTUAL PIER DEFLECTION)	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL WALL DEFLECTION:					0.018				
RIGIDTY = 1/DEFL. :	56.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUM. RIGIDITIES:					56.9				
% OF FORCE TO PIER:	100%	0%	0%	0%	0%	0%	0%	0%	0%
V_u = SHEAR/PIER (kips):	294.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M / (V * DEPTH):	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUMMARY									
REINFORCING									
ϕ FOR SHEAR: (ACI 21.2.1, Table 21.2.1 (b))	0.75								
VERTICAL PLAN GROSS AREA OF CONCRETE, A_{cv} (in^2):	1810	0	0	0	0	0	0	0	0
HORIZONTAL PLAN GROSS AREA OF CONCRETE (in^2):	1470	0	0	0	0	0	0	0	0
MIN. HORIZ. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_t)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MIN. VERT. REINF. RATIO: (ACI 18.10.2.1, 11.6.1 and 11.6.2) (ρ_l)	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ϕ*V_n MAX (kips): (ACI 11.5.4.3 and 18.10.4.4)	911	0	0	0	0	0	0	0	0
ϕ*V_c MAX (kips): (ACI 11.5.4.5)	146	0	0	0	0	0	0	0	0
NEEDED HORIZ. REINF. (in^2/ft): (ACI 11.5.4.8 and 22.5.10.1)	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HORIZONTAL BAR SIZE:	**#5 Bar**								
VERTICAL BAR SIZE:	**#5 Bar**								
REINFORCING SPACING									
l_w/3 (in):	60	0	0	0	0	0	0	0	0
l_w/5 (in):	36	0	0	0	0	0	0	0	0
3h (in):	30	0	0	0	0	0	0	0	0
MAX. SPACING OF HORIZ. REINF. (in): (ACI 11.7.3.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MAX. SPACING OF VERT. REINF. (in): (ACI 11.7.2.1)	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Actual Spacing of Horiz. Reinf. (in)	**12**								
Actual Spacing of Vert. Reinf. (in)	**12**								
Actual Horizontal Area of Steel Provided (in^2/ft):	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual Vertical Area of Steel Provided (in^2/ft):	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horizontal Steel Required (in^2/ft):	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vertical Steel Required (in^2/ft):	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horiz. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vert. Steel Acceptance Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SHEAR CAPACITY									
2*A_{cv}*SQRT(f'$_c$) (kips):	243	0	0	0	0	0	0	0	0
2 LAYERS OF REINF. REQ'D?: (ACI 11.7.2.3 and 18.10.2.2)	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2 LAYERS OF REINF. USED? If row 66 is YES, Enter YES	**YES**								
α_c: (ACI 18.10.4.1)	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ϕ*V_n MAX (kips): (ACI EQ. 18.10.4.1)	694	0	0	0	0	0	0	0	0
MAXIMUM SHEAR CHECK:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Shear Strength Vn (kips):	**643**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
FLEXURAL REINFORCING									
Resisting Moment From Wall Self Wt. = (0.9-0.2Sds)(MrSW); (k-ft)	3343	0	0	0	0	0	0	0	0
Overturning Moment, M =Vh+C_s(SW)h/2 (k-ft):	2735	0	0	0	0	0	0	0	0
MAXIMUM MOMENT, M_u =Vh-(0.9-0.2S_{ds})(M_{rDL} + M_{rSW}); (k-ft):	0	0	0	0	0	0	0	0	0
$A_{s,req}$ (in^2):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REQUIRED FLEXURAL STEEL, A_s (in^2):	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

FLEXURAL REINFORCEMENT USED

Flexural Bar Used	**#6 Bar**								
Diameter of Bar:	0.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
A_s/Bar (in^2):	0.44	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
# of Rows of Bars in Boundary (minimum 2):	2								
Center-to-Center Spacing of Bars in Boundary (in):	3								
Clear Spacing Check:	**OK**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
TOTAL # OF BARS Required:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Min User Specified # of Bars:	**12**								
LENGTH OF BOUNDARY (in):	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Boundary Length Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AREA OF STEEL PROVIDED (in^2):	5.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLEXURAL STEEL PROVIDED CHECK	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nominal Flexural Capacity Mn (k-ft):	3713	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn (k-ft):	**3342**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cracking Moment Mcr (k-ft):	2289	0	0	0	0	0	0	0	0
Factored Flexural Capacity ΦMn>Mcr	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SPECIAL BOUNDARY ELEMENTS (ACI 18.10.6)

(ACI 18.10.6.2 is not considered in this analysis)

(ACI 18.10.6.3)

GROSS MOMENT OF INERTIA OF PIER Ig (in^4):	4,941,418	0	0	0	0	0	0	0	0
SECTION MODULUS OF PIER (in^3):	54,601	0	0	0	0	0	0	0	0
BENDING STRESS, f_b (psi):	0	0	0	0	0	0	0	0	0
AXIAL STRESS, f_a (psi):	359	0	0	0	0	0	0	0	0
EXTREME FIBER COMP. STRESS (psi):	359	0	0	0	0	0	0	0	0
$0.2f'_c$	900	0	0	0	0	0	0	0	0
SPECIAL BOUNDARY ELEMENTS REQ'D?:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

(ACI 18.10.6.4)

a (in):	8.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c (in):	10.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a) Min Length of Boundary Element (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(b) Min width of compression zone (in.):	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(c) Minimum Width of Compression Zone (in,):	N/A	0	0	0	0	0	0	0	0
Min Compression Zone Check:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(e) Transverse Reinforcement per 18.7.5.2(a)-(e) & 18.7.5.3 Req'd:	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(f) Required Amount of Transverse Reinforcement A_{sh2}:	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie Bar Size:	**#4 Bar**								
Maximum Tie Bar Spacing (in):	**3.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Vertical Tie Bar Spacing Used (in):	**3.0**								
A_{sh2} Provided (in^2):	0.4	0	0	0	0	0	0	0	0
A_{sh2} Sufficient:	**OK**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(g) Required Footing Thickenss:	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(h) Development of Horizontal Wall Reinf. Req'd @ Boundary:	**NO**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Horizontal Wall Reinf. Ends into Boundary:	Hooked								
Min Length of Boundary Element for Development:	N/A	0	0	0	0	0	0	0	0

WHEN SPECIAL BOUNDARY ELEMENTS ARE NOT REQ'D

(ACI 18.10.6.5)

400/F_y: (ACI 18.10.6.5(a))	0.0067	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ρ BOUNDARY ELEMENT:	0.0293	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Provisions of 18.7.5.2(a)-(e) Required?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES NEEDED?	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TRANSVERSE TIES SPACING (ACI 18.10.6.5(a))	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRANS. BARS REQUIRED TO HAVE HOOKS? (ACI 18.10.6.5(b))	**YES**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

APPENDIX D
TIER 1 REPORT & CHECKLISTS

April 17, 2023

Sara Mees
Ogden City
2549 S Washington Blvd
Ogden, UT 84401

Re: 507 25th Street Limited Structural Evaluation
23124

Dear Sara:

At your request we have completed a limited structural evaluation and observation of the Forest Service Building located at 507 25th Street in Ogden, UT. The purpose of the evaluation was to determine in a very cursory way the structural gravity and lateral system of the building and determine if the exterior walls are attached to the floor and roof diaphragms. Neither advanced analysis techniques nor observation of existing structural elements by removing finished materials were performed as part of this limited visual evaluation. This evaluation only refers to structural elements, conditions and concerns. Architectural, Mechanical, Electrical or other important building factors are beyond the scope of this evaluation and report. The observation visit to the existing building was completed on April 10, 2023 in your presence.

Evaluation Process

The limited structural evaluation was accomplished by the following: 1) A site observation of the existing conditions visually reviewing any visible structural conditions such as materials, structural element types, general sizes and limited observation of framing connections. The site observation did not include the removal of any finished material or surfaces to view obscured structural elements. 2) Using engineering experience from multiple previous building evaluations reasoned assumptions regarding the existing building structural condition were made in order to provide "next step" recommendations to the client. As noted above, the evaluation process was intended to be cursory and preliminary. Detailed investigations, modeling and analysis were not completed. Additional in-depth evaluation alternatives are available if deemed necessary by the client.

Building Description

The Forest Service Building is located at 507 25th Street in Ogden, UT. The building has a square footprint in the basement and 1st floor with a U-shaped footprint at the 2nd, 3rd and 4th floors. A three-story penthouse tower is centrally located on the flat roof. Parapet walls surround the flat roof with a tall brick chimney located at the southeast corner of the building. The following summarizes the structure:

- Constructed in 1934
- Approximately 51,000 sq ft
- Reinforced concrete-frame structure with unreinforced masonry infill walls
- Brick veneer and terra-cotta exterior finishes
- Building listed in the National Register of Historic Places

Photo 1 – Front Elevation

Evaluation Results

Utah code 15A-3-801 states that during a re-roof project, unreinforced masonry parapets need to be braced and anchored back to the roof diaphragm. This seismic upgrade appears to have been completed (see Photo 2).

Chapter 12 of the International Existing Building Code (IEBC) addresses the repair, alteration, relocation and change of occupancy of Historic Buildings.

- A historic building undergoing alterations or change of occupancy shall be investigated and evaluated. For buildings assigned to Seismic Design Category D, E or F, a structural evaluation describing, at a minimum, the vertical and horizontal elements of the lateral force-resisting system and any strengths or weaknesses therein shall be prepared. Additionally, the report shall describe each feature that is not in compliance with these provisions and shall demonstrate how the intent of these provisions is complied with in providing an equivalent level of safety. (IEBC 1201.2)
- Repairs to any portion of the historic building or structure shall be permitted with original or like materials and original methods of construction. (IEBC 1202.1)
- Historic buildings undergoing a change of occupancy which results in a building being assigned to a higher risk category shall satisfy the requirements of Section 1613 of the International Building Code for the new risk category using full seismic forces. (IEBC 1006.3)

The following observations were made of the vertical and horizontal elements of the lateral force-resisting system.

- The vertical lateral force-resisting system consists of reinforced concrete-frame infilled with unreinforced masonry walls.
- The horizontal lateral force-resisting system consists of reinforced concrete diaphragms at the floors and roof.
- Reinforcement of the concrete-frames could not be observed. However, it is typical that these types of concrete frames built in the 1930 do not have adequate vertical and horizontal ties to meet ductility requirements of current codes.

The following observations were made of potential weaknesses of the structural elements.

- The unreinforced masonry infill walls are not positively attached to the concrete-frames (see Photo 3).
- The unreinforced masonry chimney exceeds the maximum height-to-width ratio and is not positively attached to the roof and floor diaphragms (see Photo 4).
- The unreinforced masonry partition walls are not braced at the top.

Photo 2 – Unreinforced masonry parapets braced back to roof diaphragm

Photo 3 – Unreinforced masonry infill walls at concrete-frame

Photo 4 – Unreinforced masonry chimney

Conclusions

Based on the limited evaluation and observation completed for the Forest Service Building, it is our professional opinion that the structure lacks the necessary strength and construction detailing to resist significant seismic (earthquake) forces.

The tall chimney at the southeast corner of the building is at risk of collapse during a moderate to significant seismic (earthquake) event.

The unreinforced masonry infill walls could become a falling hazard during a moderate to significant seismic (earthquake) event.

If mandatory seismic upgrades are not triggered due to a change in occupancy per IEBC 1006.3, the building owner may voluntarily upgrade elements of the structure to achieve a higher performance level during a seismic event. For this building some of these upgrades could include:

- Attach infill masonry walls to concrete-frames
- Strengthen the vertical lateral system by adding shear walls or braced frames placed strategically around the U-shaped structure
- Brace, anchor and/or reinforce the unreinforced masonry chimney
- Remove or brace tops of unreinforced masonry partition walls

If you have any questions concerning the contents of this report, please contact us at your earliest convenience. ARW Engineers would be happy to provide any additional assistance desired.

Sincerely,

Troy M. Dye, SE
Principal

23124_evalrpt_20230417

ARW ENGINEERS
structural consultants

Job Name: **507 25th Street Seismic Study** Date: **November 1, 2023**

Building Address: **507 25th Street** Page: **1** of **2**

Job Number: **23124** Prepared By: **TMD**

ASCE 41-17-2 COLLAPSE PREVENTION BASIC CONFIGURATION CHECKLIST

VERY LOW SEISMICITY: BUILDING SYSTEM-GENERAL

C	NC	N/A	U	Item	Comments
☐	☒	☐	☐	LOAD PATH: The structure contains a complete, well defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
☐	☐	☒	☐	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.5% of the height of the shorter building in low seismicity, 1.0% in moderate seismicity, and 3/0% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)	
☐	☐	☒	☐	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)	

VERY LOW SEISMICITY: BUILDING CONFIGURATION

C	NC	N/A	U	Item	Comments
☒	☐	☐	☐	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A.2.2.2. Tier 2: Sec. 5.4.2.1)	**Shear walls lengths and thicknesses are equal from 1st floor to roof and therefore the shear strengths are similar at each story.**
☒	☐	☐	☐	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)	**Shear walls lengths and thickness are equal from 1st floor to roof and therefore the stiffnesses are similar at each story.**
☐	☒	☐	☐	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)	**East and west walls of courtyard bear on beams and diaphragm at 2nd floor. No walls below.**
☐	☒	☐	☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)	**"U" shaped floor plans at 3rd, 4th and roof levels.** **Offset at 2nd level (58ft) / (103ft) = 56% > 30%**
☒	☐	☐	☐	MASS: There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)	**2nd floor mass = 838 kips** **3rd floor mass = 666 kips** **(838 – 666) / 666 = 0.25 < 0.5**
☒	☐	☐	☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)	**3rd, 4th, roof** **CM = 52ft (X) & 46ft (Y)** **CR = 51ft (X) & 40ft (Y)** **X = 1ft < 0.2(104ft) = 21ft** **Y = 6ft < 0.2(103ft) = 21ft**

ASCE 41-17-2 COLLAPSE PREVENTION BASIC CONFIGURATION CHECKLIST

C	NC	N/A	U		Comments
				LOW SEISMICITY: (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR VERY LOW SEISMICITY)	
				GEOLOGIC SITE HAZARDS	
☐	☒	☐	☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2 m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: Sec. 5.4.3.1)	**High liquefaction potential**
☒	☐	☐	☐	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movement without failure. (Commentary: Sec. A 6.1.2. Tier 2: Sec. 5.4.3.1)	
☒	☐	☐	☐	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: Sec. 5.4.3.1)	
				MODERATE AND HIGH SEISMICITY: (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)	
				FOUNDATION CONFIGURATION	
☒	☐	☐	☐	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)	**(103ft)/(58ft) = 1.78 > 0.6(1.637) = 0.98**
☐	☐	☐	☒	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)	

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Job Name: 507 25th Street Seismic Study | Date: November 1, 2023

Building Address: 507 25th Street | Page: 1 of 3

Job Number: 23124 | Prepared By: TMD

ASCE 41-17-26 COLLAPSE PREVENTION STRUCTURAL CHECKLIST FOR BUILDING TYPES C3 AND C3A

C	NC	N/A	Low and Moderate Seismicity	Comments
			SEISMIC-FORCE-RESISTING SYSTEM	
☒	☐	☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2 Sec. 5.5.1.1)	
☐	☐	☒	SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than of 70 lb/in.^{2} (0.48 MPa). (Commentary: Sec. A 3.2.4.1. Tier 2: Sec. 5.5.3.1.1)	
☐	☒	☐	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than 30 lb/in.^{2} (0.21 MPa) for clay units and 70 lb/in.^{2} (0.48 Pa)for concrete units. Bays with openings greater than 25% of the wall area shall not be included in A_w of Eq. (4-8). (Commentary: Sec. A 3.2.5.1. Tier 2: Sec. 5.5.3.1.1)	**Most exterior bays have openings greater than 25% of wall area and therefore cannot be included in Aw.** **V1 = 951 psi (LS) & 679 psi (CP) > 30 psi**
☒	☐	☐	INFILL WALL CONNECTIONS: Masonry is in full contact with frame. (Commentary: A.3.2.6.1. Tier 2: Sec. 5.5.3.5.1. and 5.5.3.5.3)	
			CONNECTIONS	
☐	☒	☐	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of loads to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)	
☐	☒	☐	CONCRETE COLUMNS: All concrete columns are doweled into the foundation with a minimum of 4 bars. (Commentary: Sec. A.5.3.2. Tier 2: Sec. 5.7.3.1)	**Condition unknown**
			HIGH SEISMICITY: COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW AND MODERATE SEISMICITY.	
			SEISMIC-FORCE-RESISTING SYSTEM	
☐	☒	☐	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)	**Reinforcement in concrete members unknown and therefore check cannot be performed.**
☐	☒	☐	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3)	**Reinforcement in concrete members unknown and therefore check cannot be performed.**
☐	☒	☐	PROPORTIONS: The height-to-thickness ratio of the unreinforced infill walls at each story is less than 9. (Commentary: Sec. A.3.2.6.2. Tier 2: Sec. 5.5.3.1.2)	**(12ft)(12in) / (12in thick) = 12 > 9**
☒	☐	☐	CAVITY WALLS: The infill walls are not of cavity construction. (Commentary: Sec. A.3.2.6.3. Tier 2: Sec. 5.5.3.5.2)	

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Job Name:	507 25th Street Seismic Study	Date:	November 1, 2023
Building Address:	507 25th Street	Page:	2 of 3
Job Number:	23124	Prepared By:	TMD

ASCE 41-17-26 COLLAPSE PREVENTION STRUCTURAL CHECKLIST FOR BUILDING TYPES C3 AND C3A

C	NC	N/A	Low and Moderate Seismicity	Comments
			SEISMIC-FORCE-RESISTING SYSTEM	
☒	☐	☐	INFILL WALLS: The infill walls are continuous to the soffits of the frame beams and to the columns to either side. (Commentary: Sec. A.3.2.6.4. Tier 2: Sec. 5.5.3.5.3)	
			DIAPHRAGMS (FLEXIBLE OR STIFF)	
☒	☐	☐	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)	
☐	☒	☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	**Interior stair and elevator openings more than 25% of wall length at inside portion of "U" shaped building.**
☐	☒	☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	**Stair openings adjacent to exterior shear walls are wider than 8ft.**
			FLEXIBLE DIAPHRAGMS	
☐	☐	☒	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)	
☐	☐	☒	STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
☐	☐	☒	SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	
☐	☐	☒	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2 Sec. 5.6.2)	
☐	☐	☒	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	
			CONNECTIONS	
☐	☐	☒	UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement, and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5)	

Job Name: 507 25th Street Seismic Study
Date: November 1, 2023
Building Address: 507 25th Street

Job Number: 23124 Prepared By: TMD

ASCE 41-17-26 COLLAPSE PREVENTION STRUCTURAL CHECKLIST FOR BUILDING TYPES C3 AND C3A

C	NC	N/A	Low and Moderate Seismicity	Comments
			SEISMIC-FORCE-RESISTING SYSTEM	
☐	☐	☒	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)	

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Job Name: 507 25th Street Seismic Study Date: November 1, 2023

Building Address: 507 25th Street

Job Number: 23124 Prepared By: TMD

ASCE 41-17-38 NONSTRUCTURAL CHECKLIST

C	NC	N/A	U		Comments
				LIFE SAFETY SYSTEMS	
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. FIRE SUPPRESSION PIPING: Fire suppression piping is anchored and braced in accordance with NFPA-13. (Commentary: Sec. A.7.13.1. Tier 2: Sec. 13.7.4)	
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Fire suppression piping has flexible couplings in accordance with NFPA-13. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.4)	
☐	☐	☒	☐	HR-not required; LS-LMH; PR-LMH. EMERGENCY POWER: Equipment used to power or control life safety systems is anchored or braced. (Commentary: Sec. A.7.12.1. Tier 2: Sec. 13.7.7)	
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. STAIRS AND SMOKE DUCTS: Stair pressurization and smoke control ducts are braced and have flexible connections at seismic joints. (Commentary: Sec. A.7.14.1.Tier 2: Sec. 13.7.6)	
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. SPRINKLER CEILING CLEARANCE: Penetrations through panelized ceilings for fire suppression devices provide clearances in accordance with NFPA-13. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.4)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-LMH. EMERGENCY LIGHTING: Emergency and egress lighting equipment is anchored or braced. (Commentary: Sec. A.7.3.1. Tier 2: Sec. 13.7.9)	
				HAZARDOUS MATERIALS	
☐	☐	☒	☐	HR-LMH; LS-LMH; PR-LMH. HAZARDOUS MATERIAL EQUIPMENT: Equipment mounted on vibration isolators and containing hazardous material is equipped with restraints or snubbers. (Commentary: Sec. A.7.12.2. Tier 2: 13.7.1)	
☐	☐	☒	☐	HR-LMH; LS-LMH; PR-LMH. HAZARDOUS MATERIAL STORAGE: Breakage containers that hold hazardous material, including gas cylinders, are restrained by latched doors, shelf lips, wires or other methods. (Commentary: Sec. A.7.15.1. Tier 2: Sec. 13.8.4)	
☐	☐	☒	☐	HR-MH; LS-LMH; PR-LMH. HAZARDOUS MATERIAL DISTRIBUTION: Piping or ductwork conveying hazardous materials is braced or otherwise protected from damage that would allow hazardous material release. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3. and 13.7.5)	
☐	☐	☐	☒	HR-MH; LS-LMH; PR-LMH. SHUT-OFF VALVES: Piping containing hazardous material, including natural gas, has shut-off valves or other devices to limit spills or leaks. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.3. and 13.7.5)	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown
Performance Level: HR = Hazards Reduced, LS = Life Safety, and PR = Position Retention
Level of Seismicity: L = Low, M = Moderate, and H = High

ASCE 41-17-38 NONSTRUCTURAL CHECKLIST

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-LMH; LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Hazardous material ductwork and piping, including natural gas piping, has flexible couplings. (Commentary: Sec. A.7.15.4. Tier 2: Sec. 13.7.3. and 13.7.5)	
☐	☐	☒	☐	HR-MH; LS-LMH; PR-LMH. PIPING OR DUCTS CROSSING SEISMIC JOINTS: Piping or ductwork carrying hazardous material that either crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.13.6. Tier 2: Sec. 13.7.3, 13.7.5, and 13.7.6)	

PARTITIONS

C	NC	N/A	U		Comments
☐	☒	☐	☐	HR-LMH; LS-LMH; PR-LMH. UNREINFORCED MASONRY: Unreinforced masonry or hollow-clay tile partitions are braced at a spacing of at most 10 ft (3.0 m) in Low or Moderate Seismicity, or at most 6ft (1.8 m) in High Seismicity. (Commentary: Sec. A.7.1.1. Tier 2: Sec. 13.6.2)	
☐	☒	☐	☐	HR-LMH; LS-LMH; PR-LMH. HEAVY PARTITIONS SUPPORTED BY CEILINGS: The tops of masonry or hollow-clay tile partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A. 7.2.1. Tier 2: Sec. 13.6.2)	
☐	☐	☒	☐	HR-not required; LS-MH; PR-MH. DRIGT: Rigid cementitious partitions are detailed to accommodate the following drift ratios: in steel moment frame, concrete moment frame, and wood frame buildings, 0.02; in other buildings, 0.005. (Commentary A. 7.1.2 Tier 2: Sec. 13.6.2)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-MH. LIGHT PARTITIONS SUPPORTED BY CEILINGS: The tops of gypsum board partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A.7.2.1. Tier 2: Sec. 13.6.2)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. STRUCTURAL SEPARATIONS: Partitions that cross structural separations have seismic or control joints. (Commentary: Sec. A.7.1.3. Tier 2: Sec. 13.6.2)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-MH. TOPS: The tops of ceiling-high framed or panelized partitions have lateral bracing to the structure at a spacing equal to or less than 6 ft (1.8 m). (Commentary: Sec. A.7.1.4. Tier 2: Sec. 13.6.2)	

CEILINGS

C	NC	N/A	U		Comments
☐	☐	☒	☐	HR-H; LS-LMH; PR-LMH. SUSPENDED LATH AND PLASTER: Suspended lath and plaster ceilings have attachments that resist seismic forces for every 12 ft^2 (1.1 m^2) of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)	

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C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. SUSPENDED GYPSUM BOARD: Suspended gypsum board ceilings have attachments that resist seismic forces for every 12 ft ^{2} (1.1 m^2) of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-MH. INTEGRATED CEILINGS: Integrated suspended ceilings with continuous areas greater than 144 ft ^{2}, (13.4m^2) and ceilings of smaller areas that are not surrounded by restraining partitions, are laterally restrained at a spacing no greater than 12 ft (3.6 m) with members attached to the structure above. Each restraint location has a minimum of four diagonal wires and compression struts, or diagonal members capable of resisting compression. (Commentary: Sec. A.7.2.2. Tier 2: Sec. 13.6.4)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-MH. EDGE CLEARANCE: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft ^{2} (13.4 m^2) have clearances from the enclosing wall or partition of at least the following: in Moderate Seismicity, ½ in.(13 mm); in High Seismicity, ¾ in.(19mm). (Commentary: Sec. A.7.2.4. Tier 2: Sec. 13.6.4)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. CONTINUITY ACROSS STRUCTURE JOINTS: The ceiling system does not cross any seismic joint and is not attached to multiple independent structures. (Commentary: Sec. A.7.2.5. Tier 2: Sec. 13.6.4)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. EDGE SUPPORT: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft ^{2} (13.4 m^2) are supported by closure angles or channels not less than 2 in. (51 mm) wide. (Commentary: Sec. A.7.2.6. Tier 2: Sec. 13.6.4)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-H. SEISMIC JOINTS: Acoustical tile or lay-in panel ceilings have seismic separation joints such that each continuous portion of the ceiling is no more than 2,500 ft^2 (232.3 m^2) and has a ratio of long-to-short dimension no more than 4-1. (Commentary: Sec. A.7.2.7. Tier 2: 13.6.4)	

LIGHT FIXTURES

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-MH; PR-MH. INDEPENDENT SUPPORT: Light fixtures that weigh more per square foot than the ceiling they penetrate are supported independent of the grid ceiling suspension system by a minimum of two wires at diagonally opposite corners of each fixture: (Commentary: Sec. A.7.3.2. Tier 2: Sec. 13.6.4. and 13.7.9)	

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C	NC	N/A	U		Comments
☐	☐	☒	☐	HR-not required; LS-not required; PR-H. PENDANT SUPPORTS: Light fixtures on pendant supports are attached at a spacing equal to or less than 6 ft. Unbraced suspended fixtures are free to allow a 360-degree range of motion at an angle not less than 45 degrees from horizontal without contacting adjacent components. Alternatively, if rigidly supported and/or braced, they are free to move the structure to which they are attached without damaging adjoining components. Additionally, the connection to the structure is capable of accommodating the movement without failure. (Commentary: A.7.3.3. Tier 2: Sec. 13.7.9)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. LENS COVERS: Lens covers on light fixtures are attached with safety devices. (Commentary: Sec. A.7.3.4. Tier 2: Sec. 13.7.9)	

CLADDING AND GLAZING

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-MH; LS-MH; PR-MH. CLADDING ANCHORS: Cladding components weighing more than 10 lb/ft^2 (0.48 kN/m^2) are mechanically anchored to the structure at a spacing equal to or less than the following: for Life Safety in Moderate Seismicity, 6 ft; (1.8 m); for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 ft. (1.2 m). (Commentary: Sec. A.7.4.1. Tier 2: Sec. 13.6.1)	
☐	☐	☒	☐	HR-not required; LS-MH; PR-MH. CLADDING ISOLATION: For steel or concrete moment frame buildings, panel connections are detailed to accommodate a story drift ratio by the use of rods attached to framing with oversize holes or slotted holes of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02, and the rods have a length-to-diameter ratio of 4.0 or less. (Commentary: Sec. A.7.4.3. Tier 2: Section 13.6.1)	
☐	☐	☒	☐	HR-MH; LS-MH; PR-MH. MULTI-STORY PANELS: For multi-story panels attached at more than one floor level, panel connections are detailed to accommodate a story drift ratio by the use of rods attached to framing with oversize holes or slotted holes of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02, and the rods have a length-to-diameter ratio of 4.0 or less. (Commentary: Sec. A.7.4.4. Tier 2: Sec. 13.6.1)	
☐	☐	☒	☐	HR-not required; LS-MH; PR-MH. THREADED RODS: Threaded rods for panel connections detailed to accommodate drift by bending of the rod have a length-to-diameter ratio greater than 0.06 times the story height in inches for Life Safety in Moderate Seismicity and 0.12 times the story height in inches for Life Safety in High Seismicity and Position Retention in any seismicity. (Commentary: Sec. A.7.4.9. Tier 2: Sec. 13.6.1)	

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C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-MH; LS-MH; PR-MH. PANEL CONNECTIONS: Cladding panels are anchored out-of-plane with a minimum number of connections for each wall panel, as follows: for Life Safety in Moderate Seismicity, 2 connections; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 connections. (Commentary: Sec. A.7.4.5. Tier 2: Sec. 13.6.1.4)	
☐	☐	☐	☒	HR-MH; LS-MH; PR-MH. BEARING CONNECTIONS: Where bearing connections are used, there is a minimum of two bearing connections for each cladding panel. (Commentary: Sec. A.7.4.6. Tier 2: sec. 13.6.1.4)	
☐	☐	☐	☒	HR-MH; LS-MH; PR-MH. INSERTS: Where concrete cladding components use inserts, the inserts have positive anchorage or are anchored to reinforcing steel. (Commentary: Sec. A.7.4.7. Tier 2: Sec. 13.6.1.4)	
☐	☐	☒	☐	HR-not required; LS-MH; PR-MH. OVERHEAD GLAZING: Glazing panes of any size in curtain walls and individual interior or exterior panes more than 16 ft^2 (1.5 m^2) in area are laminated annealed or laminated heat-strengthened glass and are detailed to remain in the frame when cracked. (Commentary: Sec. A.7.4.8. Tier 2: Sec. 13.6.1.5)	

MASONRY VENEER

C	NC	N/A	U		Comments
☐	☒	☐	☐	HR-not required; LS-LMH; PR-LMH. TIES: Masonry veneer is connected to the backup with corrosion-resistant ties. There is a minimum of one tie for every 2-2/3 ft^2 (0.25 m^2) and the ties have spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 36 in. (914 mm); for Life Safety in High Seismicity and for Position Retention in any seismicity, 24 in. (610 mm). (Commentary: Sec. A.7.5.1. Tier 2: Sec. 13.6.1.2)	**Ties typically not used during this era of construction**
☐	☒	☐	☐	HR-not required; LS-LMH; PR-LMH. SHELF ANGLES: Masonry veneer is supported by shelf angles or other elements at each floor above the ground floor. (Commentary: Sec. A.7.5.2. Tier 2: Sec. 13.6.1.2)	
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. WEAKENED PLANES: Masonry veneer is anchored to the backup adjacent to weakened planes, such as at the locations of flashing. (Commentary: Sec. A.7.5.3. Tier 2: Sec. 13.6.1.2)	
☐	☒	☐	☐	HR-LMH; LS-LMH; PR-LMH. UNREINFORCED MASONRY BACKUP: There is no unreinforced masonry backup. (Commentary: Sec. A.7.7.2. Tier 2: Sec. 13.6.1.1. and 13.6.1.2)	
☐	☐	☒	☐	HR-not required; LS-MH; PR-MH. STUD TRACKS: For veneer with cold-formed steel stud backup, stud tracks are fastened to the structure at a spacing equal to or less than 24 in. (610 mm) on center. (Commentary: Sec. A.7.6.1. Tier 2: Sec 13.6.1.1. and 13.6.1.2)	

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☐	☒	☐	☒	HR-not required; LSLMH; PR-MH. ANCHORAGE: For veneer with concrete block or masonry backup, the backup is positively anchored to the structure at a horizontal spacing equal to or less than 4 ft along the floors and roof. (Commentary: Sec. A.7.7.1. Tier 2: Sec. 13.6.1.1. and 13.6.1.2)	**Ties typically not used during this era of construction**
☐	☐	☒	☐	HR-not required; LS-not required PR-MH. WEEP HOLES: In veneer anchored to stud walls, the veneer has functioning weep holes and base flashing. (Commentary: Sec. A.7.5.6. Tier 2: Sec. 13.6.1.2)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. OPENINGS: For veneer with cold-formed-steel stud backup, steel studs frame window and door openings. (Commentary: Sec. A.7.6.2. Tier 2: Sec. 13.6.1.1. and 13.6.1.2)	

PARAPETS, CORNICES, ORNAMENTATION, AND APPENDAGES

C	NC	N/A	U		Comments
☒	☐	☐	☐	HR-LMH; LS-LMH; PR-LMH. URM PARAPETS OR CORNICES: Laterally unsupported unreinforced masonry parapets or cornices have height-thickness ratios no greater than the following: for Life Safety in Low or Moderate Seismicity, 2.5; for Life Safety in High Seismicity and for Position Retention in any seismicity, 1.5. (Commentary: Sec. A.7.8.1. Tier 2: Sec. 13.6.5)	**Parapets are braced back to roof diaphragm using steel angles**
☐	☐	☒	☐	HR-not required; LS-LMH; PR-LMH. CANOPIES: Canopies at building exits are anchored to the structure at a spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 10 f (3.0 m); for Life Safety in High Seismicity and for Position Retention in any seismicity, 6 ft. (1.8 m). (Commentary: Sec. A.7.8.2. Tier 2: Sec. 13.6.6)	
☐	☐	☒	☐	HR-H; LS-MH; PR-LMH. CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 have vertical reinforcement. (Commentary: Sec. A.7.8.3. Tier 2: Sec. 13.6.5)	
☒	☐	☐	☐	HR-MH; LS-MH; PR-LMH. APPENDAGES: Cornices, parapets, signs, and other ornamentation or appendages that extend above the highest point of anchorage to the structure or cantilever from components are reinforced and anchored to the structural system at a spacing equal to or less than 6 ft. 1.8 m). This evaluation statement item does not apply to parapets or cornices covered by other evaluation statements. (Commentary: Sec. A.7.8.4. Tier 2: Sec. 13.6.6)	**Parapets are braced back to roof diaphragm using steel angles**

MASONRY CHIMNEYS

C	NC	N/A	U		Comments
☐	☒	☐	☐	HR-LMH; LS-LMH; PR-LMH. URM CHIMNEYS: Unreinforced masonry chimneys extend above the roof surface no more than the following: for Life Safety Low or Moderate Seismicity, 3 times the least dimension of the chimney; for Life Safety in High Seismicity and for Position Retention in any seismicity, 2 times the least dimension of the chimney. . (Commentary: Sec. A.7.9.1. Tier 2: 13.6.7)	**(26ft) / (5.5ft) = 4.7 ft > 2**

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown
Performance Level: HR = Hazards Reduced, LS = Life Safety, and PR = Position Retention
Level of Seismicity: L = Low, M = Moderate, and H = High

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C	NC	N/A	U		Comments
☐	☒	☐	☐	HR-LMH; LS-LMH; PR-LMH. ANCHORAGE: Masonry chimneys are anchored at each floor level, at the topmost ceiling level, and at the roof. (Commentary: Sec. A.7.9.2. Tier 2: 13.6.7)	**No anchorage to roof diaphragm**

STAIRS

C	NC	N/A	U		Comments
☐	☒	☐	☐	HR-not required; LS-LMH; PR-LMH. STAIR ENCLOSURES: Hollow-clay tile or unreinforced masonry walls around stair enclosures are restrained out-of-plane and have height-to-thickness ratios not greater than the following: for Life Safety in Low or Moderate Seismicity, 15-to-1; for Life Safety in High Seismicity and for Position Retention in and seismicity, 12-to-1. (Commentary: Sec. A.7.10.1. Tier 2: Sec. 13.6.2 and 13.6.8)	**URM walls around stair enclosures**
☐	☐	☐	☒	HR-not required; LS-LMH; PR-LMH. STAIR DETAILS: The connection between the stairs and the structure does not rely on post-installed anchors in concrete or masonry, and the stair details are capable of accommodating the drift calculated using the Quick Check procedure of Section 4.4.3.1 for moment-frame structures or 0.5 in. for all other structures without including any lateral stiffness contribution from the stairs. (Commentary: Sec. A.7.10.2. Tier 2: 13.6.8)	

CONTENTS AND FURNISHINGS

C	NC	N/A	U		Comments
☐	☐	☒	☐	HR-LMH; LS-MH; PR-MH. INDUSTRIAL STORAGE RACKS: Industrial storage racks or pallet racks more than 12 ft high meet the requirements on ANSI/MH 16.1 as modified by ASCE 7 Chapter 15. (Commentary: Sec. A.7.11.1. Tier 2: Sec. 13.8.1)	
☐	☐	☒	☐	HR-not required; LS-H; PR-MH. TALL NARROW CONTENTS: Contents more than 6 ft (1.8 m) high with a height-to-depth or height-to-width ratio greater than 3-to-1 are anchored to the structure or to each other. (Commentary: Sec. A.7.11.2. Tier 2: Sec. 13.8.2)	
☐	☐	☒	☐	HR-not required; LS-H; PR-H. FALL-PRONE CONTENTS: Equipment, stored items, or other contents weighing more than 20 lb. (9.1 kg) whose center of mass is more than 4 ft (1.2 m) above the adjacent floor level are braced or otherwise restrained. (Commentary: Sec. A.7.11.3 Tier 2: Sec. 13.8.2)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. ACCESS FLOORS: Access floors more than 9 in. (229 m) high are braced. (Commentary: Sec. A.7.11.4. Tier 2: Sec. 13.6.10)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. EQUIPTMENT ON ACCESS FLOORS: Equipment and other contents supported by access floor systems are anchored or braced to the structure independent of the access floor. (Commentary: Sec. A.7.11.5. Tier 2: Sec. 13.7.7. and 13.6.10)	

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C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-not required; PR-H SUSPENDED CONTENTS: Items suspended without lateral bracing are free to swing from or move with the structure from which they are suspended without damaging themselves or adjoining components. (Commentary: Sec. A.7.11.6. Tier 2: Sec. 13.8.2)	

MECHANICAL AND ELECTRICAL EQUIPMENT

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-H; PR-H. FALL-PRONE EQUIPMENT: Equipment weighing more than 20 lb. (9.1 kg) whose center of mass is more than 4 ft (1.2 m) above the adjacent floor level, and which is not in-line equipment, is braced. (Commentary: Sec. A.7.12.4. Tier 2: 13.7.1. and 13.7.7)	
☐	☐	☐	☒	HR-not required; LS-H; PR-H. IN-LINE EQUIPMENT: Equipment installed in-line with a duct or piping system, with an operating weight more than 75 lb. (34.0 kg), is supported and laterally braced independent of the duct or piping system. (Commentary: Sec. A.7.12.5. Tier 2: Sec. 13.7.1)	
☐	☐	☐	☒	HR-not required; LS-H; PR-MH. TALL NARROW EQUIPMENT: Equipment more than 6 ft (1.8 m) high with a height-to-depth or height-to-width ratio greater than 3-to-1 is anchored to the floor slab or adjacent structural walls. (Commentary: Sec. A.7.12.6. Tier 2: Sec. 13.7.1. and 13.7.7)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-MH. MECHANICAL DOORS: Mechanically operated doors are detailed to operate at a story drift ratio of 0.01. (Commentary: Sec. A.7.12.7. Tier 2: Sec. 13.6.9)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. SUSPENDED EQUIPMENT: Equipment suspended without lateral bracing is free to swing from or move with the structure from which it is suspended without damaging itself or adjoining components. (Commentary: Sec. A.7.12.8. Tier 2: Sec. 13.7.1. and 13.7.7.)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. VIBRATION ISOLATORS: Equipment mounted on vibration isolators is equipped with horizontal restraints or snubbers and with vertical restraints to resist overturning. (Commentary: Sec. A.7.12.9. Tier 2: Sec. 13.7.1)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. HEAVY EQUIPMENT: Floor-supported or platform-supported equipment weighing more than 400 lb is anchored to the structure. (Commentary: Sec. A.7.12.10. Tier 2: 13.7.1. and 13.7.7)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. ELECTRICAL EQUIPMENT: Electrical equipment is laterally braced to the structure: (Commentary: Sec. A.7.12.11. Tier 2: 13.7.7)	

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C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. CONDUIT COUPLINGS: Conduit greater than 2.5 in. (64 mm) trade size that is attached to panels, cabinets, or other equipment and is subject to relative seismic displacement has flexible couplings or connections. (Commentary: Sec. A.7.12.12. Tier 2: 13.7.8)	

PIPING

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. FLEXIBLE COUPLINGS: Fluid and gas piping has flexible couplings. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.3. and 13.7.5)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. FLUID AND GAS PIPING: Fluid and gas piping is anchored and braced to the structure to limit spills or leaks. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3. and 13.7.5)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. CLAMPS: One-sided C-clamps that support piping larger than 2.5 in. (64 mm) in diameter are restrained. (Commentary: Sec. A. 7.13.5. Tier 2: Sec. 13.7.3. and 13.7.5)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-H. PIPING CROSSING SEISMIC JOINTS: Piping that crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.13.6. Tier 2: Sec. 13.7.3 and 13.7.5)	

DUCTS

C	NC	N/A	U		Comments
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. DUCT BRACING: Rectangular ductwork larger than 6 ft^2 (0.56 m^2) in cross-sectional area and round ducts larger than 28 in. (711 mm) in diameter are braced. The maximum spacing of transverse bracing does not exceed 30 ft. (9.2 m). The maximum spacing of longitudinal bracing does not exceed 60 ft (18.3 m). (Commentary: Sec. A.7.14.2. Tier 2: Sec. 13.7.6)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. DUCT SUPPORT: Ducts are not supported by piping or electrical conduit. (Commentary: Sec. A.7.14.3. Tier 2: Sec. 13.7.6)	
☐	☐	☒	☐	HR-not required; LS-not required; PR-H. DUCTS CROSSING SEISMIC JOINTS: Ducts that cross seismic joints or isolation planes or are connected to independent structures have couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.14.4. Tier 2: Sec. 13.7.6)	

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				ELEVATORS	
☐	☐	☐	☒	HR-not required; LS-H; PR-H. RETAINER GUARDS: Sheaves and drums have cable retainer guards. (Commentary: Sec. A.7.16.1. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-H; PR-H. RETAINER PLATE: A retainer plate is present at the top and bottom of both car and counterweight. (Commentary: Sec. A.7.16.2. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. ELEVATOR EQUIPMENT: Equipment, piping, and other components that are part of the elevator system are anchored. (Commentary: Sec. A.7.16.3. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. SEISMIC SWITCH: Elevators capable of operating at speeds of 150 ft/min (0.30 m/min) or faster are equipped with seismic switches that meet the requirements of ASME A17.1 or have trigger levels set to 20% of the acceleration of gravity at the base of the structure and 50% of the acceleration of gravity in other locations. (Commentary: Sec. A.7.16.4. Tier 2: 13.7.11)	
☐	☒	☐	☐	HR-not required; LS-not required; PR-H. SHAFT WALLS: Elevator shaft walls are anchored and reinforced to prevent toppling into the shaft during strong shaking. (Commentary: Sec. A.7.16.5. Tier 2; 13.7.11)	**Shaft walls are URM**
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. COUNTERWEIGHT RAILS: All counterweight rails and divider beams are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.6. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. BRACKETS: The brackets that tie the car rails and the counterweight rail to the structure are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.7. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. SPREADER BRACKET: Spreader brackets are not used to resist seismic forces. (Commentary: Sec. A.7.16.8. Tier 2: 13.7.11)	
☐	☐	☐	☒	HR-not required; LS-not required; PR-H. GO-SLOW ELEVATORS: The building has a go-slow elevator system. (Commentary: Sec. A.7.16.9. Tier 2: 13.7.11)	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown
Performance Level: HR = Hazards Reduced, LS = Life Safety, and PR = Position Retention
Level of Seismicity: L = Low, M = Moderate, and H = High

SHEAR STRESS IN SHEAR WALLS

$$V_j^{AVG} = \frac{1}{M_s}\left(\frac{V_j}{A_W}\right)$$ [4.8 ASCE 41-17]

$M_{s_{LS}} = 1.25$

$M_{s_{CP}} = 1.75$

LS $V_1 = \frac{1}{1.25}\left(\frac{7367^k}{6192 in^2}\right) = 951$ PSI

EXCEEDS 30 PSI

CP $V_1 = \frac{1}{1.75}\left(\frac{7367^k}{6192 in^2}\right) = 679$ PSI

EXCEEDS 30 PSI

N-S

		A_W
EAST	5'(12)(12")(3) =	2160 IN²
E & W OF COURT	4'(12)(12")(2) =	1152 IN²
WEST	5'(12)(12")(4) =	2880 IN²
		6192 IN²

E-W

SOUTH	(9' + 7' + 9.5')(12)(12") =	3672 IN²
NORTH	5'(12)(12")(4) =	2880 IN²
		6552 IN²

$V = C S_a W$

$C = 1.0$ C3 >4 STORIES

$S_a = \frac{S_{X1}}{T}$

$V = (1)(1.637)(4500^k)$

$V = 7367^k$

BSE-2N

$S_{X1} = 0.897$

$T = C_t h_n^{\beta}$

$C_t = 0.02$

$h_n = 50$ FT

$\beta = 0.75$

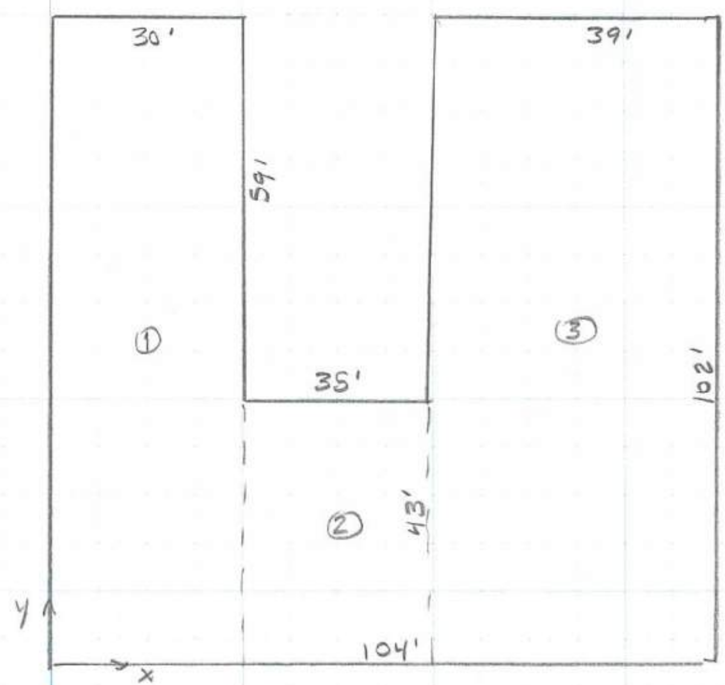
$T = 0.376$

$S_a = 2.39 \leq S_{XS} = 1.637$

$W = 4500$ K

ARW ENGINEERS structural consultants

Project No. 23124 Sheet No.
Project 507 25th Street
Prepared By TMD Date 11/02/23



$A_1 = 30(102) = 3060$
$y_1 = \frac{102}{2} = 51$

$A_2 = 35(43) = 1505$
$y_2 = \frac{43}{2} = 22$

$A_3 = (39)(102) = 3978$
$y_3 = \frac{102}{2} = 51$

$\bar{y} = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{A_1 + A_2 + A_3}$

$\bar{y} = 45.9$ FT