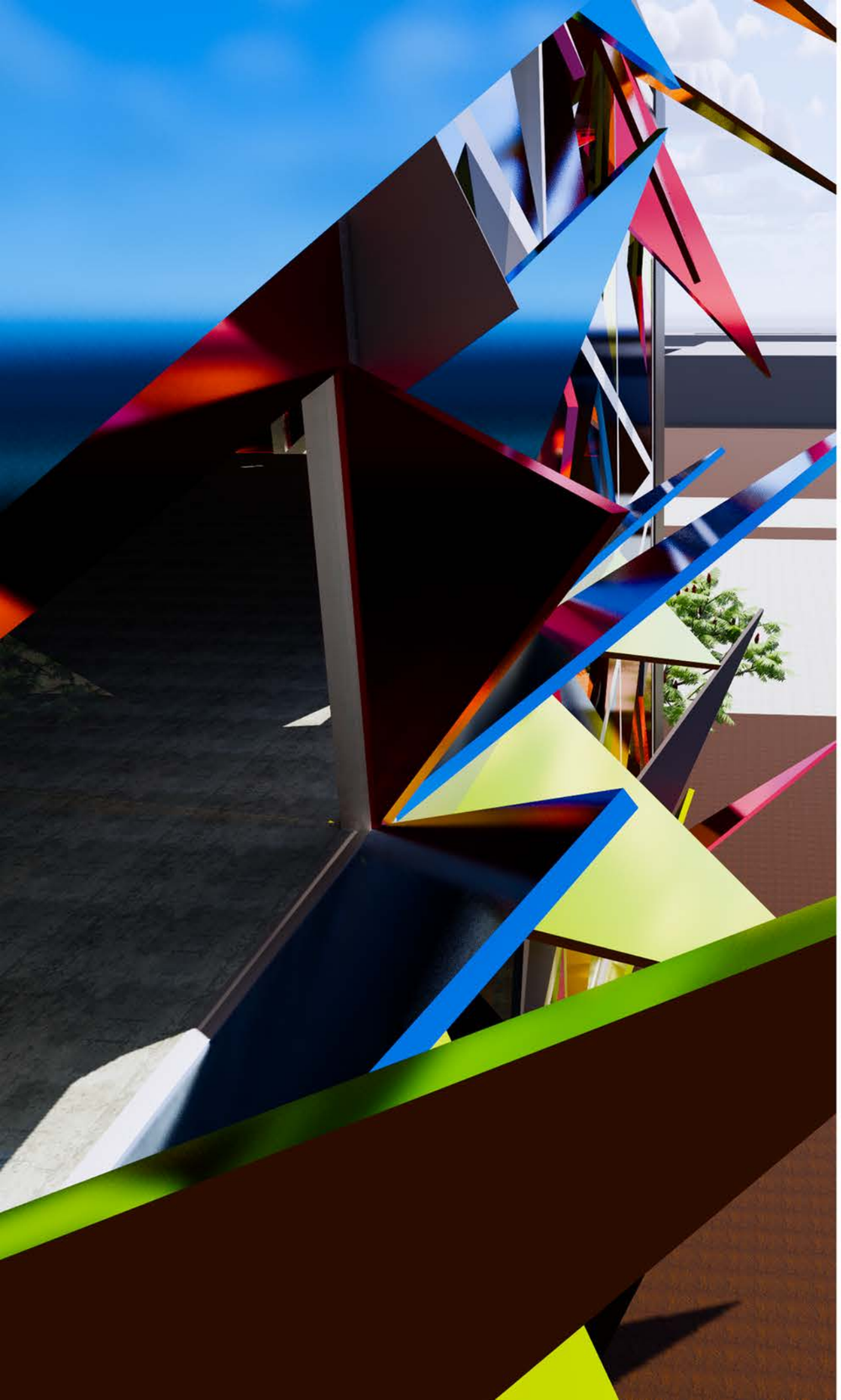
Futura Mechanica

Matthew Howard



Concept

Kids are the future of all endeavors. The children of today will be the pioneers, innovators, and trailblazers of tomorrow, standing on the shoulders of the present giants of industry, science, and engineering to become the giants of their own era. For them to accomplish this herculean task, a space must be provided to start them on the path to the future, to spark creativity, and to let imaginations run wild. This is what I have labored to produce; behold, Futura Mechanica for Steam Engine.

Through the use of modern materials and cutting-edge techniques, children will be exposed to best of what the present can offer. An emphasis is placed on exposing the inner workings of a building, shedding light on how things work in the real world, and perhaps how they could be improved going forward.

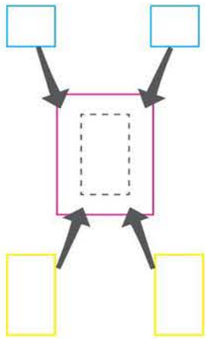
The Site

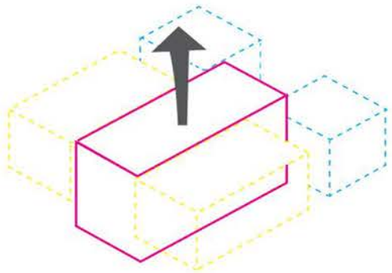
ADMIN

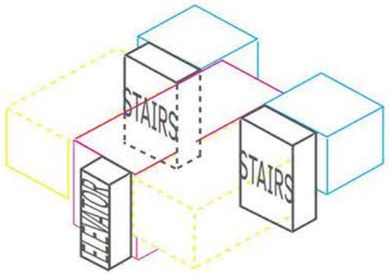
STUDIOS

PUBLIC

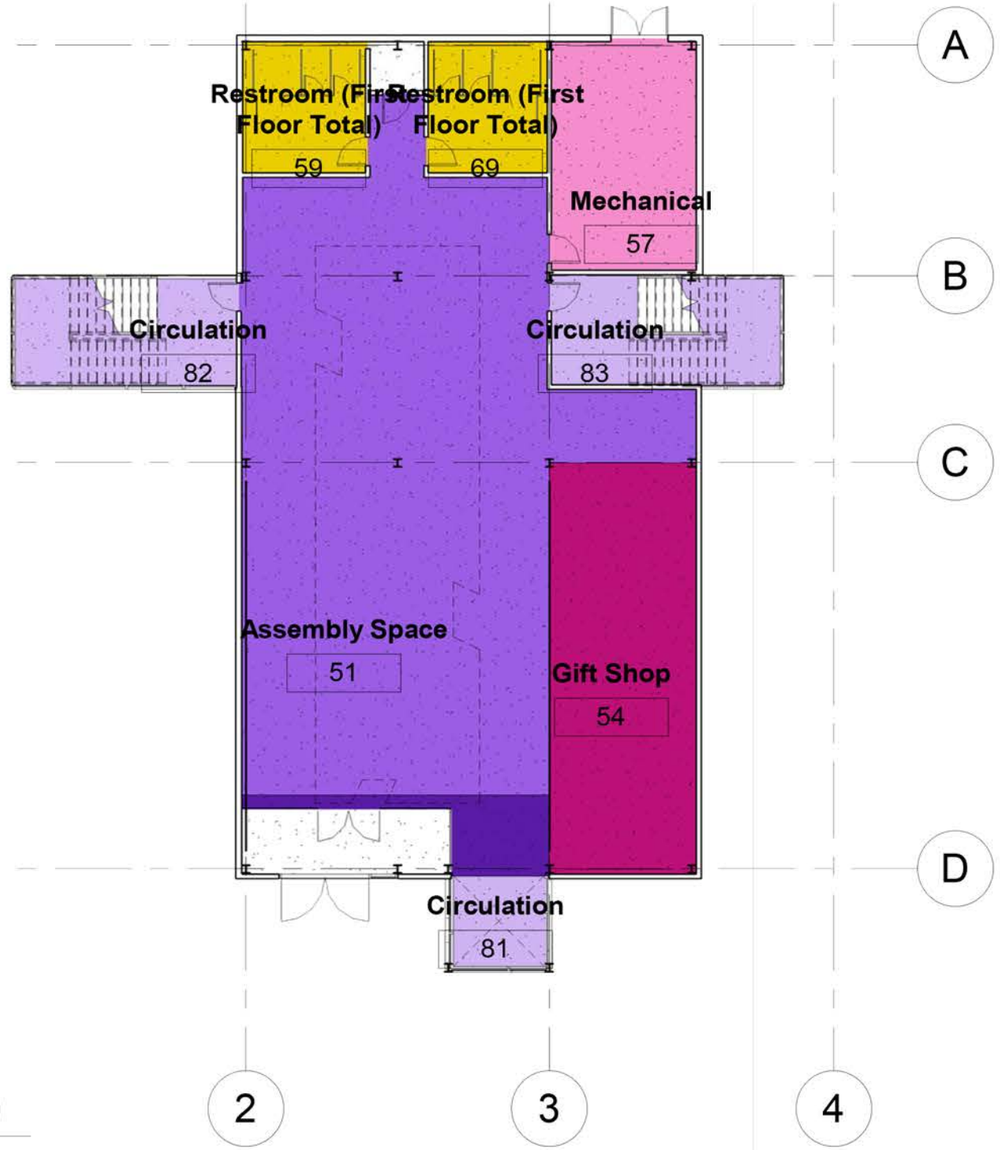
GATHERING SPACE



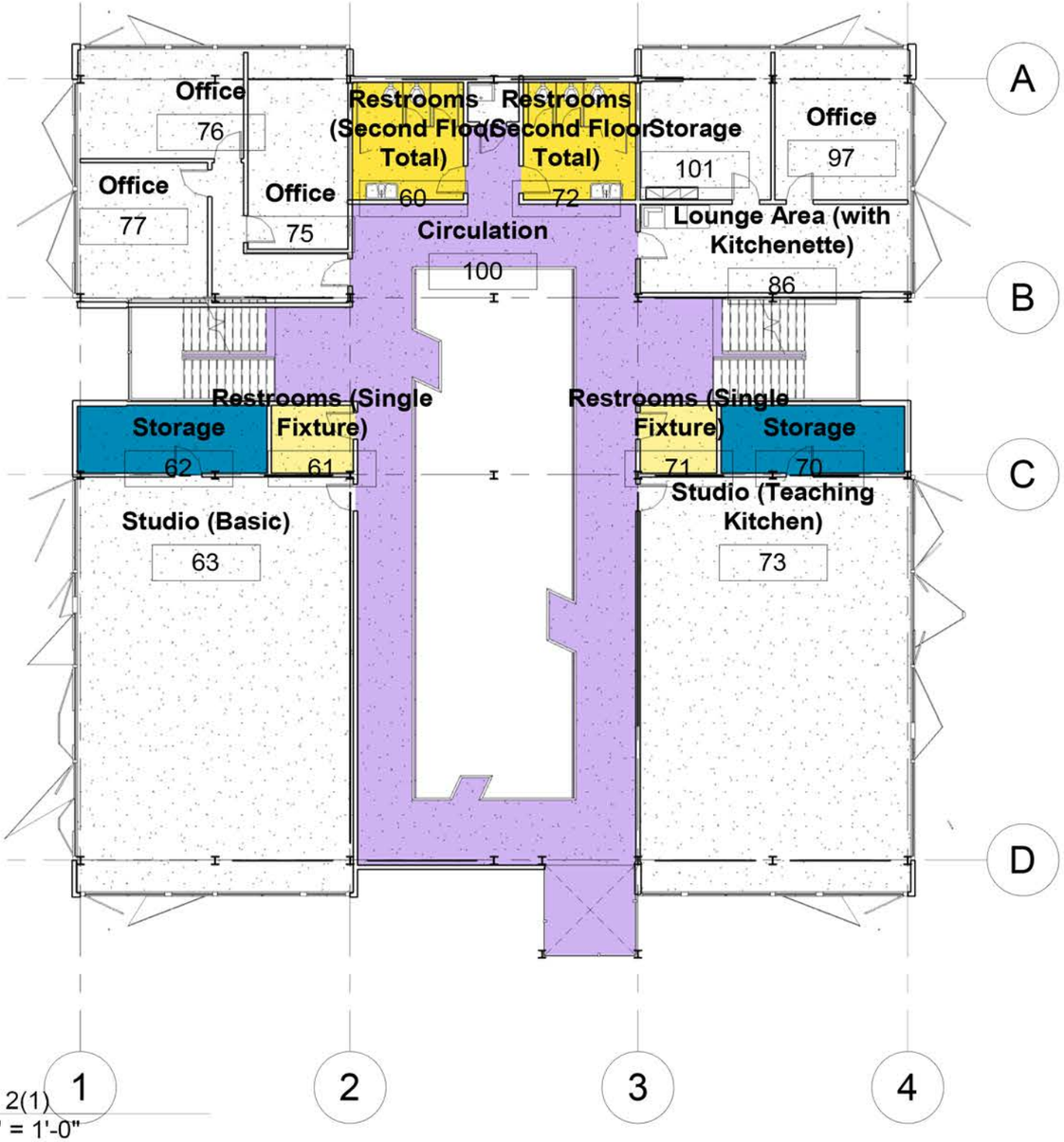




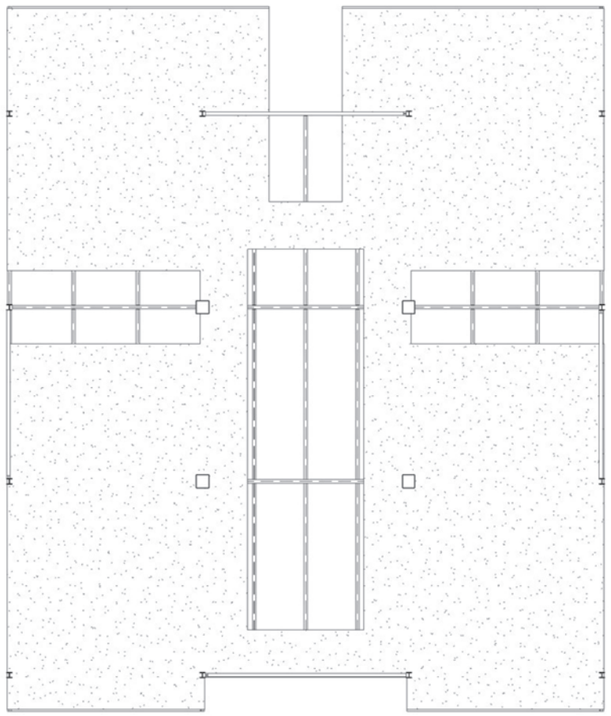
From SD



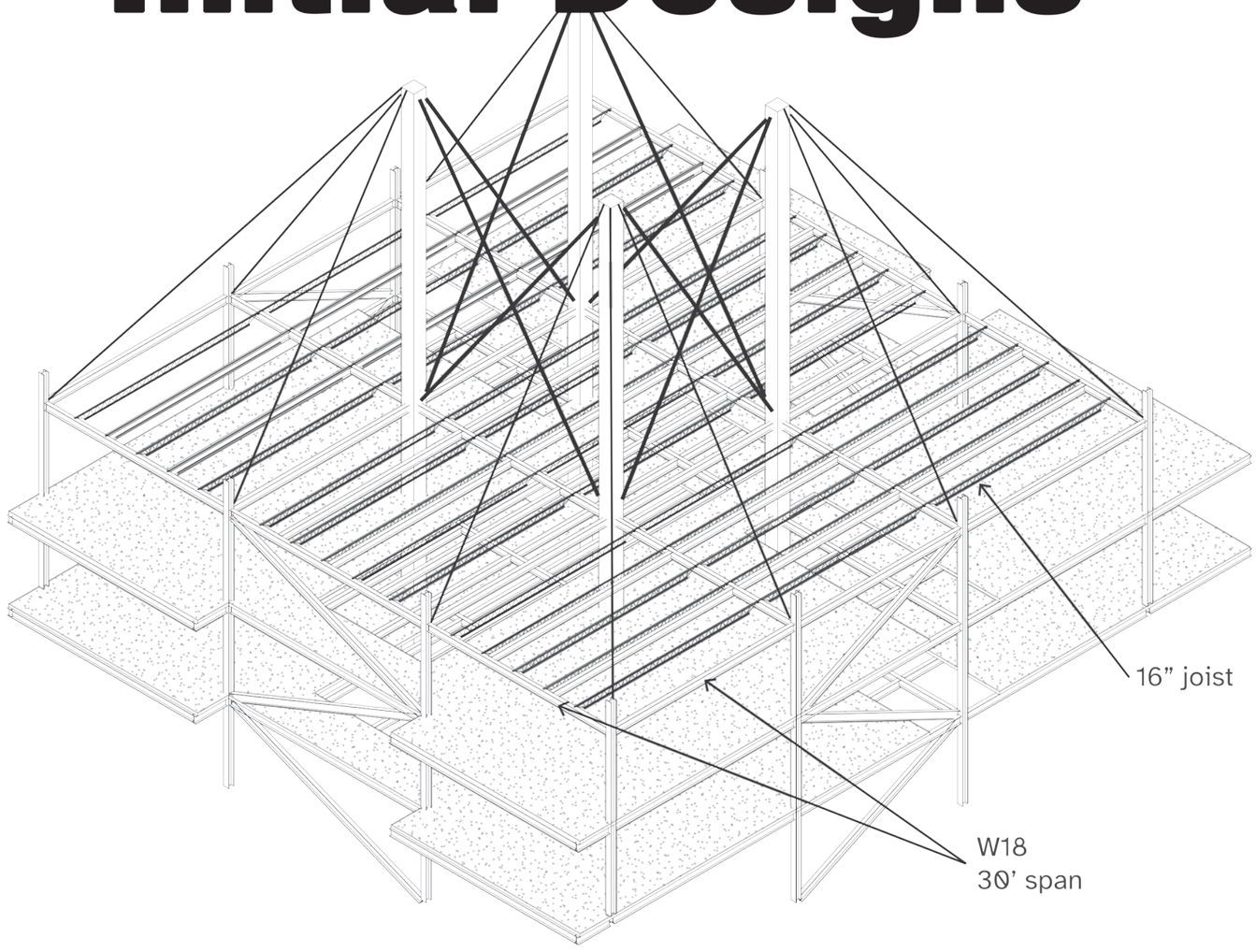
1 Level 1(1)
1/16" = 1'-0"

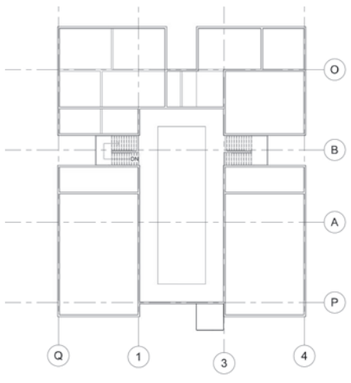


1 Level 2(1)
1/16" = 1'-0"

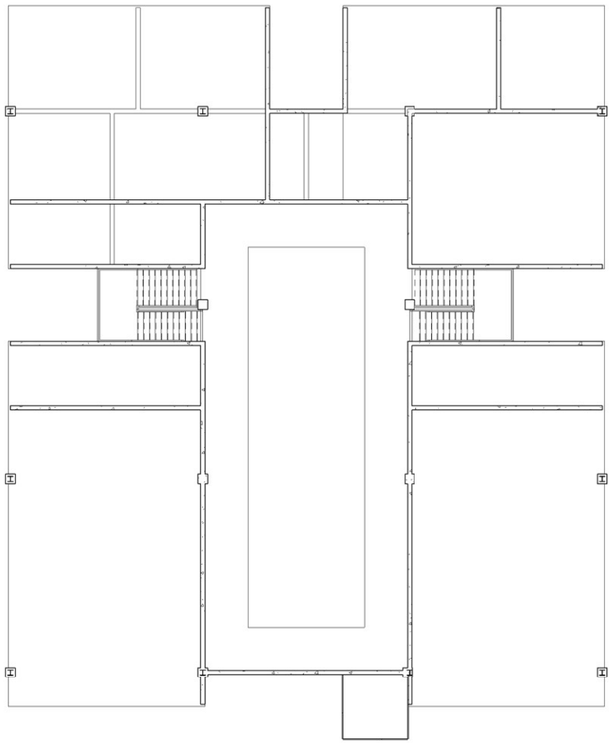


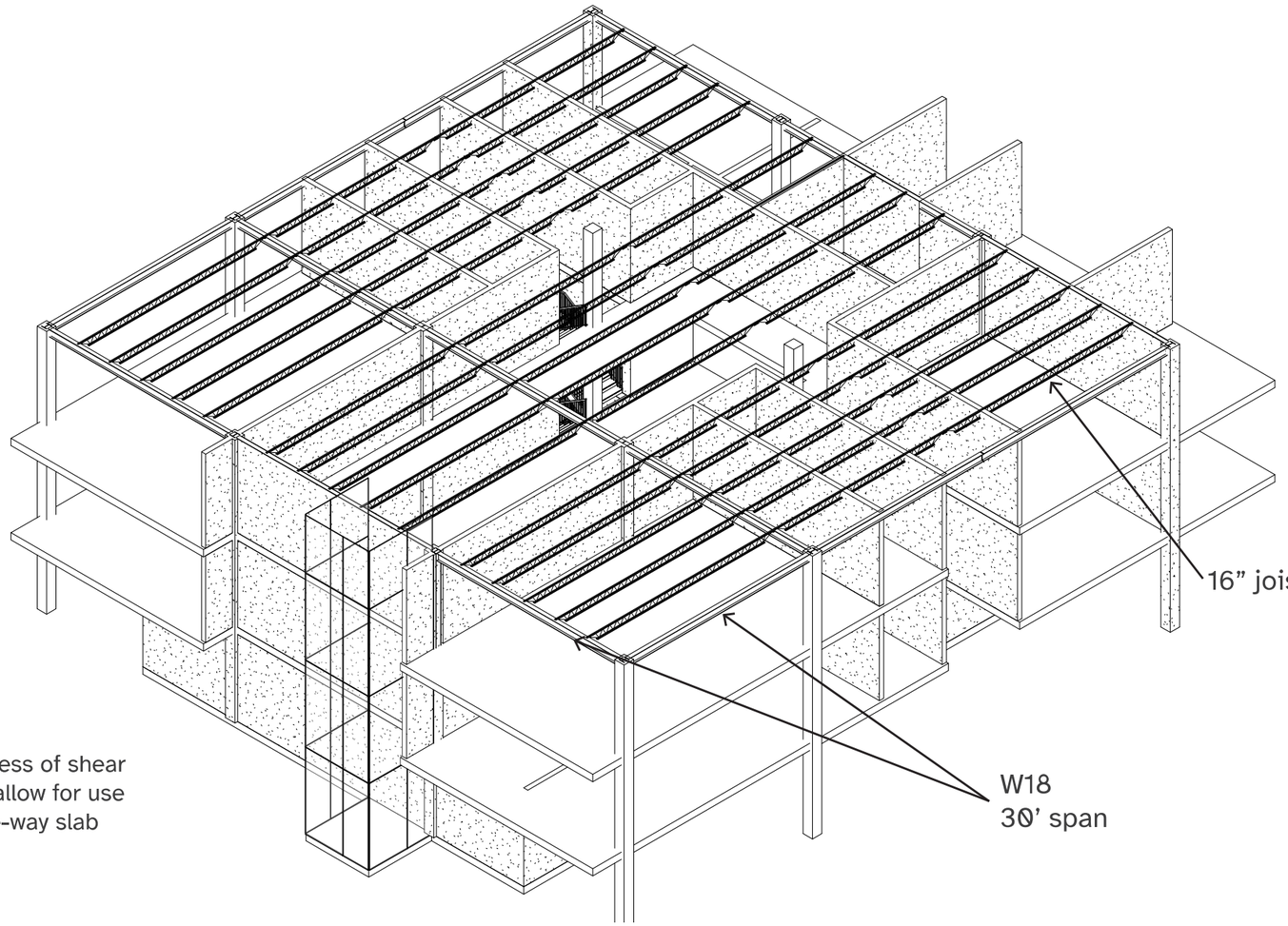
Initial Designs



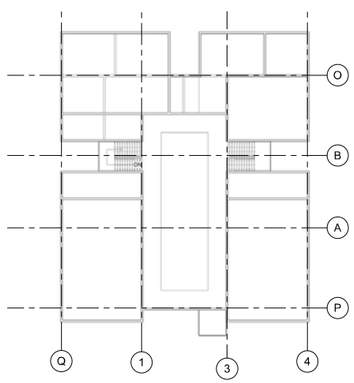


Creating a non-traditional structure was a way to carry out our concept by displaying various elements used for a structured system making possible the full use of the mechanical properties. The suspension structure also allows for an industrial look.
Lateral force resisting system: Braced Frames

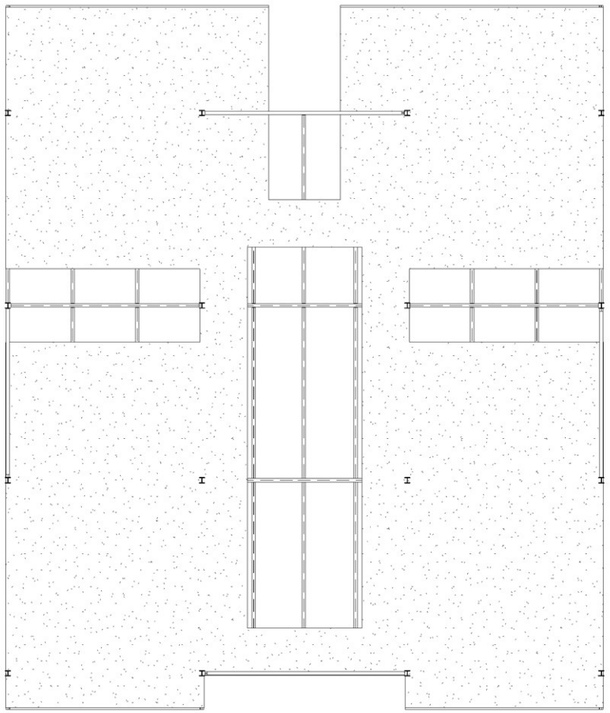


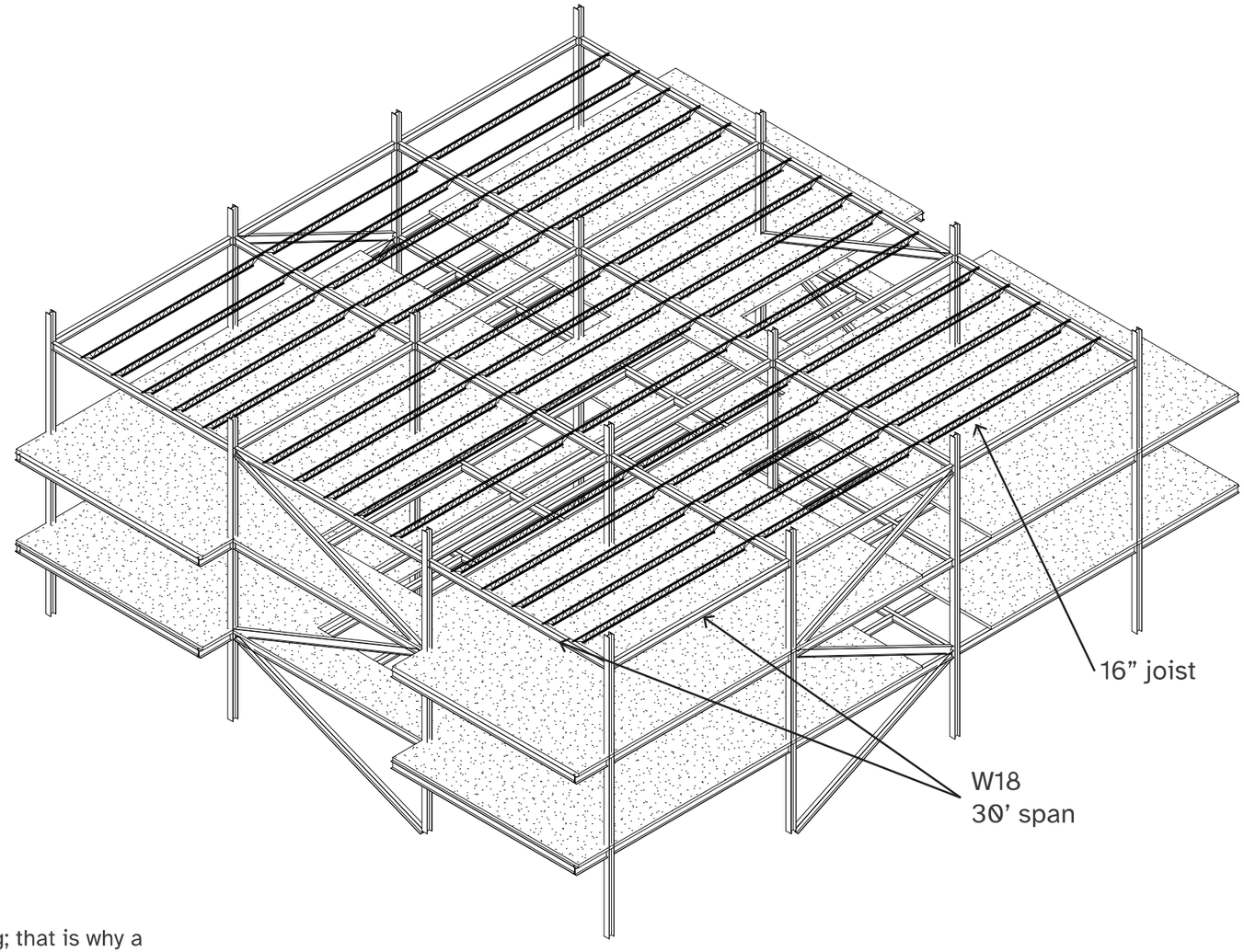


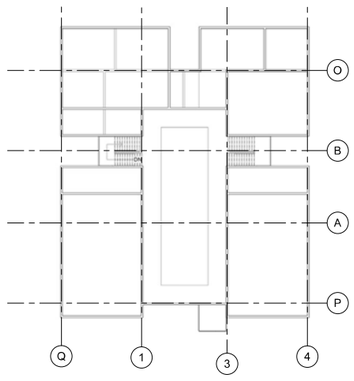
Nearness of shear walls allow for use of one-way slab



The slab for the concrete system is a one-way slab, allowing us to avoid using any concrete beams or girders. Using concrete will enable us to use it as a method for sound separators in loud studios. The reinforced concrete beam system is more durable than any other building material and method; it allows a building that will be long-lasting. Also, compared to the steel in structured, reinforced concrete doesn’t require skilled professional labor to install the structure.
Lateral force resisting system: Shear Walls



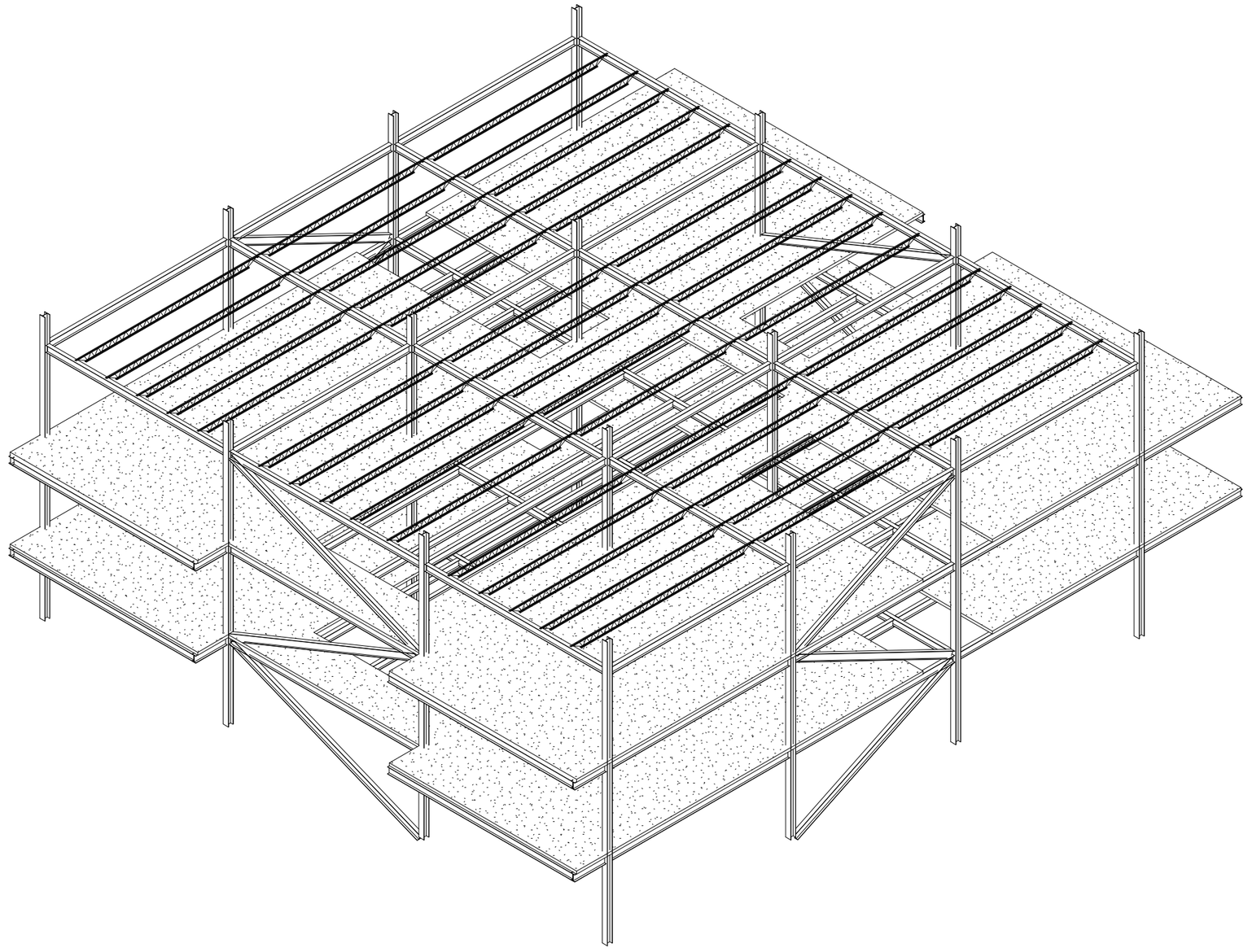




Part of our concept is to build height into our building; that is why a steel structure would give us higher stability to go up. In addition, we want to create a contemporary look, and steel would allow us to showcase the structural system beautifully. Finally, as steel has high flexural strength, it will enable the development of cantilevers which we are considering.
Lateral force resisting system: Braced Frame

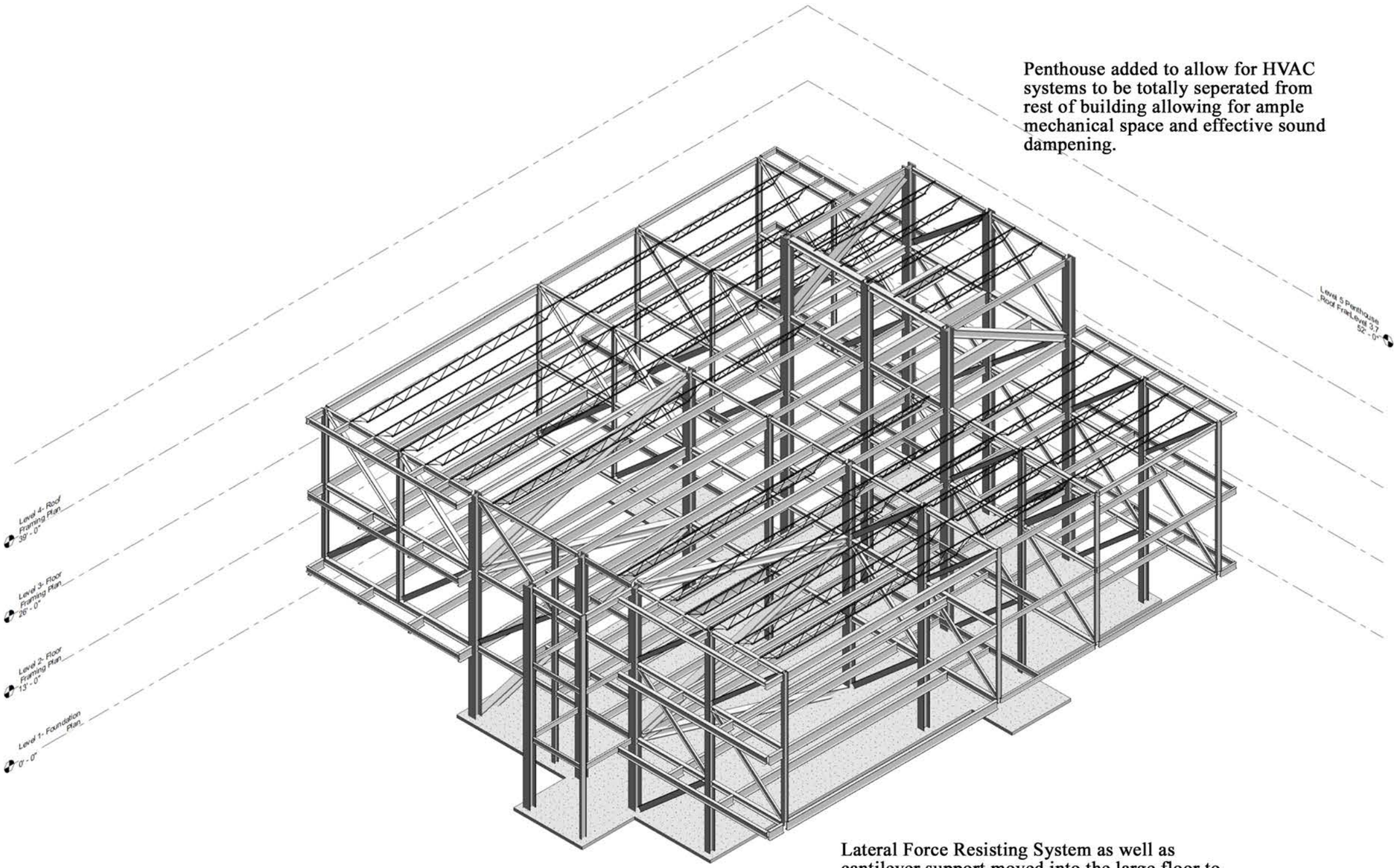
SD_4B

Steel
04



We selected the steel structural system because it’s flexibility moving forward in the design process. The steel frame is much more capable of accomplishing our desire for cantilevers around the building. This system can also be expressed architecturally to show the beauty of the steel structure. Construction of the steel structure will also be relatively fast allowing for a shorter construction period.

Final Steel Structure



Penthouse added to allow for HVAC systems to be totally seperated from rest of building allowing for ample mechanical space and effective sound dampening.

Lateral Force Resisting System as well as cantilever support moved into the large floor to ceiling trusses stretching across the buidling longitudinally. While transverse lateral support moved inward to underneath the cantilever at their joining with the overall structure.

Matthew Howard

STEAM Engine Facility

April 28

Edmond, OK

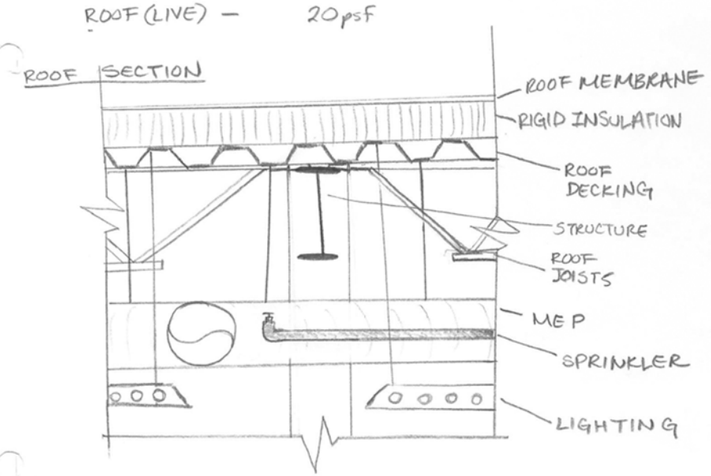
Design Loads

DESIGN LOADS

ROOF (DEAD)	PSF
JOISTS + STRUCTURE -	5
DECKING -	2
RIGID INSULATION -	3
MEP -	4
SPRINKLERS -	3
LIGHTING -	1
ROOF MEMBRANE -	1
COLLATERAL -	3
TOTAL -	22 psf

ROOF (LIVE) — 20psf

ROOF SECTION

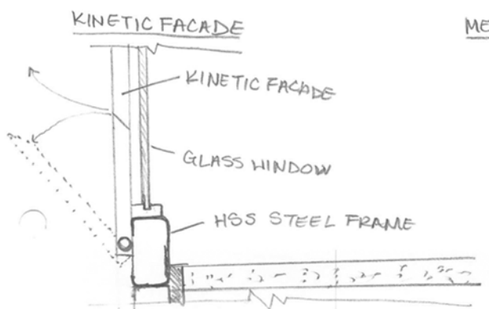


FACADE (DEAD)	PSF
HSS STEEL FRAME -	8
GLASS WINDOW -	15
KINETIC FACADE -	4
COLLATERAL -	3
TOTAL -	30 psf

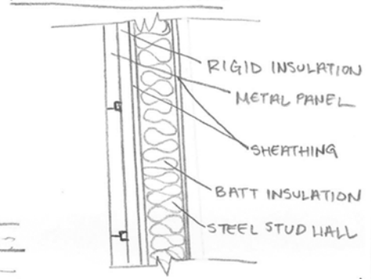
METAL PANEL -	3
SHEATHING -	6
RIGID INSULATION -	3
BATT INSULATION -	1
STEEL STUD WALL -	2
COLLATERAL -	3
TOTAL	18 psf

LL = 15 psf

KINETIC FACADE



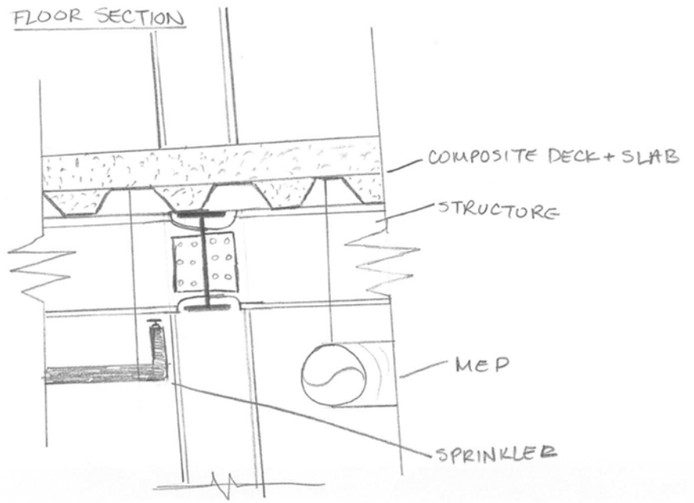
METAL PANEL FACADE



FLOOR (DEAD)	PSF	
COMPOSITE DECK -	63	3.5" NWC + 3" deck
STRUCTURE -	7	
MEP -	4	
SPRINKLER SYSTEM -	3	
COLLATERAL -	3	
TOTAL	80	

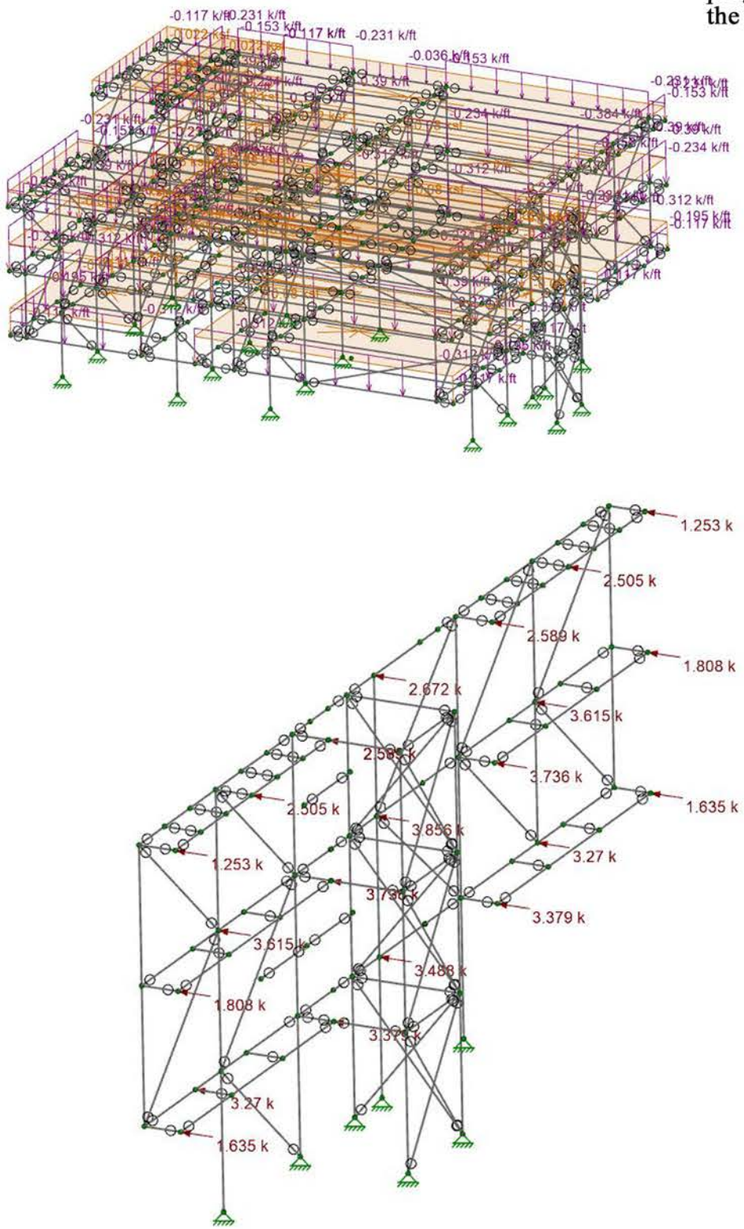
FLOOR (LIVE) — 40 psf (CLASSROOM)
15 psf (PARTITION)

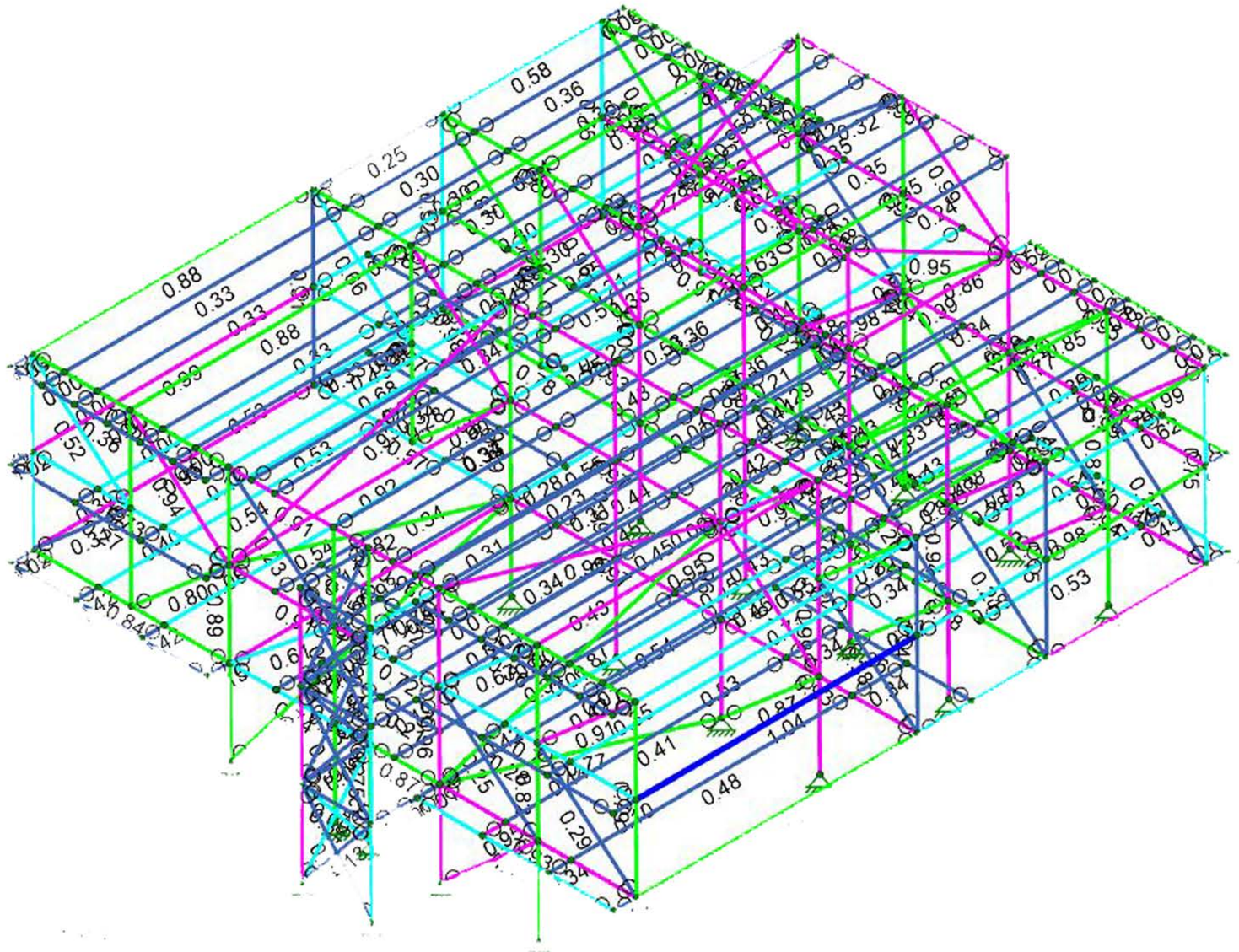
FLOOR SECTION



Structural Analysis

For the structural analysis of the proposed design, RISA 3D was utilized. The composite members as well as the roof joists were designed by hand as the program is unable to design those members itself. However, the truss members, bottom and top chord, and web member, were designed as non-composite members within the program. Loads were applied and analysis run. For the unity check performed on the right, analysis was run until all members fell within code.

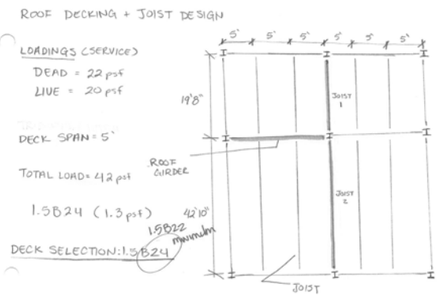




Composite/Joist Calculation

ROOF DECKING + JOIST DESIGN

LOADINGS (SERVICE)
DEAD = 22 psf
LIVE = 20 psf



DECK SPAN = 5'

TOTAL LOAD = 42 psf

1.5B24 (1.3 psf) 42'10"
1.5B22 minimum

DECK SELECTION: 1.5B24

JOIST TRIB WIDTH = 5' ∴ $\frac{TL}{LL} = \frac{5(42)}{5(20)} = \frac{210\ plf}{100\ plf}$

JOIST SPAN = 19'8" ≈ 19.67' ≈ 20'
↳ JOIST 12K1 (J1)

JOIST SPAN = 42'10" ≈ 42.83' ≈ 43'
↳ JOIST 22K10 (J2)

COMPOSITE BEAM + GIRDER DESIGN

DESIGN LOADS BEAM 1 & 2

DL = 63+7 = 70 psf
LL = 20 psf (CONSTRUCTION)

$w_u = 1.6(70)+1.6(20) = 116$ psf

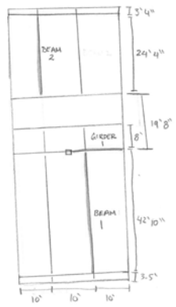
DURING CONSTRUCTION (PRECOMPOSITE)

- AFTER CONSTRUCTION

DL = 80 psf
LL = 40+20 = 60 psf
↑ PARTITION

∴ $w_u = 1.2(80)+1.6(60) = 192$ psf

AFTER CONSTRUCTION (COMPOSITE)



PER FIRE CODE 3½" NWC ON 3" DECK

DL = 80 - 70 = 10 psf
LL = 50 psf
PARTITION = 20 psf
80 psf → S_L

- 6½" TOTAL SLAB DEPTH
- UNSHORED SPAN = 10'
- SUPERIMPOSED LIVE LOAD ≥ 80 psf

DECKING = 3VLI20
SLAB = 3½ NWC w/ 6x6-W2.1 x W2.1 REINFORCEMENT

PRECOMPOSITE (B1)

$w_u = 116$ psf ⇒ .116 ksf (10') = 1.16 k/ft
$w_d = (70\ psf)(10') = .7$ k/ft

$M_u = \frac{1.16(42.83)^2}{8} = 265.99$ k-ft ≈ 266 k-ft

∴ $Z_x = \frac{266(12)}{.9(50)} = 70.93\ in^3$

T3.2 ⇒ W16x40
I_x = 518 in⁴
ϕV_n = 146 k
A = 11.8 in²

$\Delta_{DL} = \frac{5wL^4}{384EI} = \frac{5(.7/12)(42.83\cdot12)^4}{384(29\times10^3)(518)} = 3.528"$

CAMBER = 3.5"

COMPOSITE

$w_u = 10'(192\ psf) = 1.92$ k/ft, $w_{sl} = 10'(80\ psf) = .8$ k/ft

$M_u = \frac{1.92(42.83)^2}{8} = 440.26$ k-ft

$b_E = \frac{L}{4} = \frac{42.83}{4} = 10.54' \Rightarrow 10' = b_E$ (CENTER TO CENTER BEAM SPACING)

ASSUME $Y_1 = 0$ & $Y_2 = 5.5$ (T3.19)

$\phi M_n = 597$ k-ft FOR W16x40 COMP BEAM

$a = \frac{A_s F_y}{.85 f'_c b_E} = \frac{11.8(50)}{.85(3)(120")} = 1.93"$

$Y_{2\,actual} = 6.5" - \frac{a}{2} = 6.5 - \frac{1.93}{2} = 5.535 > 5.5$
∴ ADEQUATE FOR MOMENT

$V_u = \frac{1.92(42.83)}{2} = 411.12^k < \phi V_n = 146^k$ ∴ ADEQUATE FOR SHEAR

FROM T3-20
$I_{LB} = 1590\ in^4$ (PREVIOUS ASSUMPTIONS APPLIED)

$\Delta_{SL} = \frac{5(.8/12)(42.85\cdot12)^4}{384(29\times10^3)(1590)} = 1.31"$

∴ $\Delta_{TL} = 1.31" + (3.528 - 3.5) = 1.338$

$\frac{L}{360} = \frac{42.83(12)}{360} = 1.428 > \Delta_{TL}$ ∴ OKAY FOR LL

HEADED STUD ANCHORS (HSA)

(T3-19) $\Sigma Q_n = 590$ k

(T3-21) $Q_n = 21^k$ (1 ANCHOR PER RIB)

REQ'D = $\frac{2\Sigma Q_n}{Q_n} = \frac{2(590)}{21} = 56.19 \Rightarrow 58$ studs

W16x40 LC = 3.5" > 1/58 - 3/4" DIA HSA'S
BEAM 1
LARGE CAMBER - CAN'T TRY (WIDX40 ½ TPI) TO CANCEL CAMBER

PRECOMPOSITE (B2)

$w_{LL} = 1.16$ k/ft
$w_D = .7$ k/ft

$M_u = \frac{1.16(24.3)^2}{8} = 85.62$ k-ft ≈ 86 k-ft

∴ $Z_x = \frac{86(12)}{.9(50)} = 22.93\ in^3$

T3.2 ⇒ W12x19
I_x = 130 in⁴
ϕV_n = 86 k
A = 5.57 in²

$\Delta_{DL} = \frac{5wL^4}{384EI} = \frac{5(.7/12)(24.3\cdot12)^4}{384(29\times10^3)(130)} = 1.45"$

CAMBER = 1.25"

COMPOSITE

$w_u = 1.92$ k/ft, $w_{sl} = .8$ k/ft

$M_u = \frac{1.92(24.3)^2}{8} = 141.72$ k-ft

$b_E = \frac{L}{4} = \frac{24.3}{4} = 6.1' \Rightarrow 10'$ (CENTER TO CENTER SPACING)

ASSUME $Y_1 = 0$ & $Y_2 = 5.5$ (T3.19)

$\phi M_n = 242$ k-ft FOR W12x19 COMPOSITE BEAM

$a = \frac{A_s F_y}{.85 f'_c b_E} = \frac{5.57(50)}{.85(3)(120")} = .91"$

$Y_{2\,actual} = 6.5 - \frac{a}{2} = 6.5 - \frac{.91}{2} = 6.045" > 5.5$
∴ ADEQUATE FOR MOMENT

$V_u = \frac{1.92(24.3)}{2} = 23.3^k < \phi V_n = 86^k$ ∴ ADEQUATE FOR SHEAR

FROM T3-20
$I_{LB} = 505\ in^4$ (PREVIOUS ASSUMPTIONS APPLIED)

$\Delta_{SL} = \frac{5(.8/12)(24.3\cdot12)^4}{384(29\times10^3)(505)} = .43"$

∴ $\Delta_{TL} = .43 + (1.45 - 1.25) = .63$

$\frac{L}{360} = \frac{24.3(12)}{360} = .81" > .63"$ ∴ OKAY FOR LL

HSAs

(T3-19) $\Sigma Q_n = 279^k$

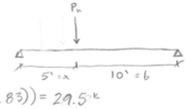
(T3-21) $Q_n = 21^k$ (1 ANCHOR PER RIB)

REQ'D = $\frac{2(\Sigma Q_n)}{Q_n} = \frac{2(279)}{21} = 26.57 \approx 28$ studs

W12x19 LC = 1.25" > 1/28 3/4" DIA HSA's
BEAM 2
W14x22?

PRECOMPOSITE (G1)

$b_E = \frac{15'}{4} = 3.75'$



$P_u = 1.16(\frac{1}{2}(8+42.83)) = 29.5^k$

$P_D = .7(\frac{1}{2}(8+42.85)) = 17.79^k$

$M_u = \frac{P_u b}{l} = \frac{29.5(5)(10)}{15} = 98.3$ k-ft

∴ $Z_x = \frac{98.3(12)}{.9(50)} = 26.2\ in^3$

TRY W12x22 A = 6.48 in²
I_x = 156 in⁴
ϕV_n 95.9 k

$\Delta_{DL} = \frac{P_u b(a+2b)\sqrt{3a(a+2b)}}{27EIl}$

$\frac{17.79(60)(120)\sqrt{(60+2(120))}\sqrt{3(60)[60+2(120)]}}{27(29\times10^3)(93.9)(15\cdot12)}$

= .661" → CAMBER .5"

COMPOSITE

$P_u = 1.92(\frac{1}{2}(8+42.83)) = 48.8^k$

$P_D = .8(\frac{1}{2}(8+42.83)) = 20.332$

$M_u = \frac{P_u b}{l} = \frac{48.8(5)(10)}{15} = 162.7$ k-ft

$V_u = \frac{P_b}{l} = \frac{48.8(10)}{15} = 32.5^k < \phi V_n = 95.9^k$

ASSUME Y1 = 0 & Y2 = 5.5
FROM T3-19
$\phi M_n = 283$ k-ft > $M_u = 162.7$ k-ft
∴ INITIAL CHECK ADEQUATE

$Y2_{actual} = a = \frac{A_s F_y}{.85 f'_c b_E} = \frac{6.48(50)}{.85(3)(45)} = 2.82"$

∴ $Y_2 = 6.5 - \frac{2.82}{2} = 5.09 \Rightarrow$ ASSUME Y2 = 5.0

FROM T3-19
$\phi M_n = 271$ k-ft > $M_u = 162.7$ k-ft
∴ OKAY FOR FLEXURE

FROM T3-20
$I_{LB} = 559\ in^4$

$\Delta_{SL} = \frac{P_u b(a+2b)\sqrt{3a(a+2b)}}{27EIl}$

$= \frac{20.332(5)(10)(5+2(10))\sqrt{3(5)[5+2(10)]}}{27(29000)(156)(15)}$

= .464"

$\Delta_{TL} = .464 + (.661 - .5)) = .625"$

$\frac{L}{288} = \frac{15(12)}{288} = .625"$ → ADEQUATE FOR DEFLECTION

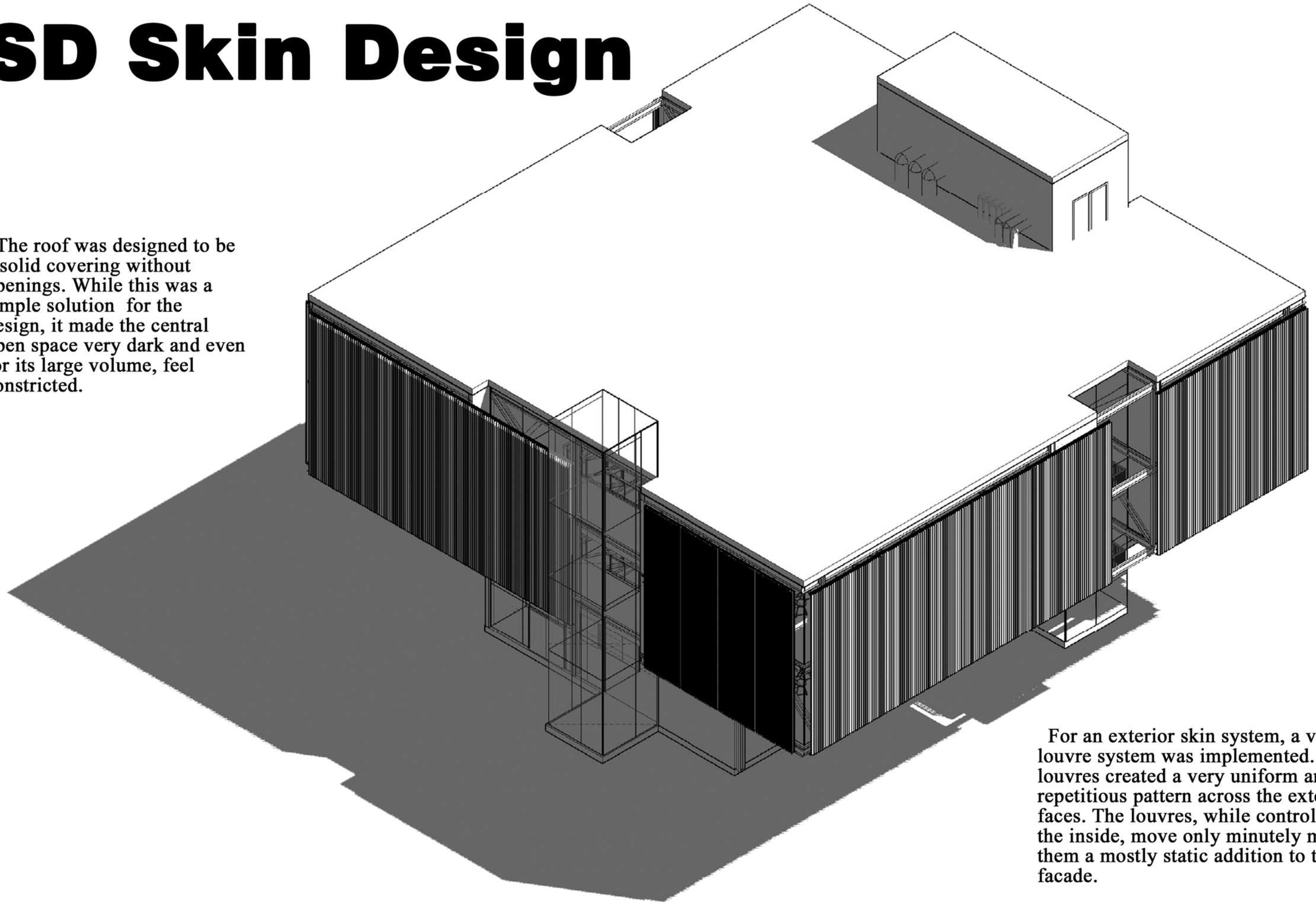
HSAs

$\Sigma Q_n = 324^k$
$Q_n = 21^k$
REQ'D = $\frac{2\Sigma Q_n}{Q_n} = \frac{2(324)}{21} = 30.85$

USE W12x22 LC = .5" > 1/32 3/4" DIA HSA's
GIRDER 1
W14x22 - SAME PRICE, HIGHER ILB

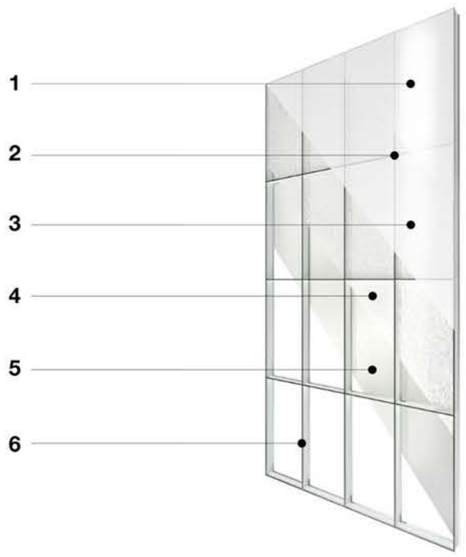
SD Skin Design

The roof was designed to be a solid covering without openings. While this was a simple solution for the design, it made the central open space very dark and even for its large volume, feel constricted.



For an exterior skin system, a vertical louvre system was implemented. The louvres created a very uniform and repetitious pattern across the exterior faces. The louvres, while controlled from the inside, move only minutely making them a mostly static addition to the facade.

Changes in DD



Kalwall Cutaway Diagram

1) Kalwall Weatherable Coating (KWS) technology aids in the panel's self-cleaning properties and provides additional resistance to UV and heat exposure for lasting performance

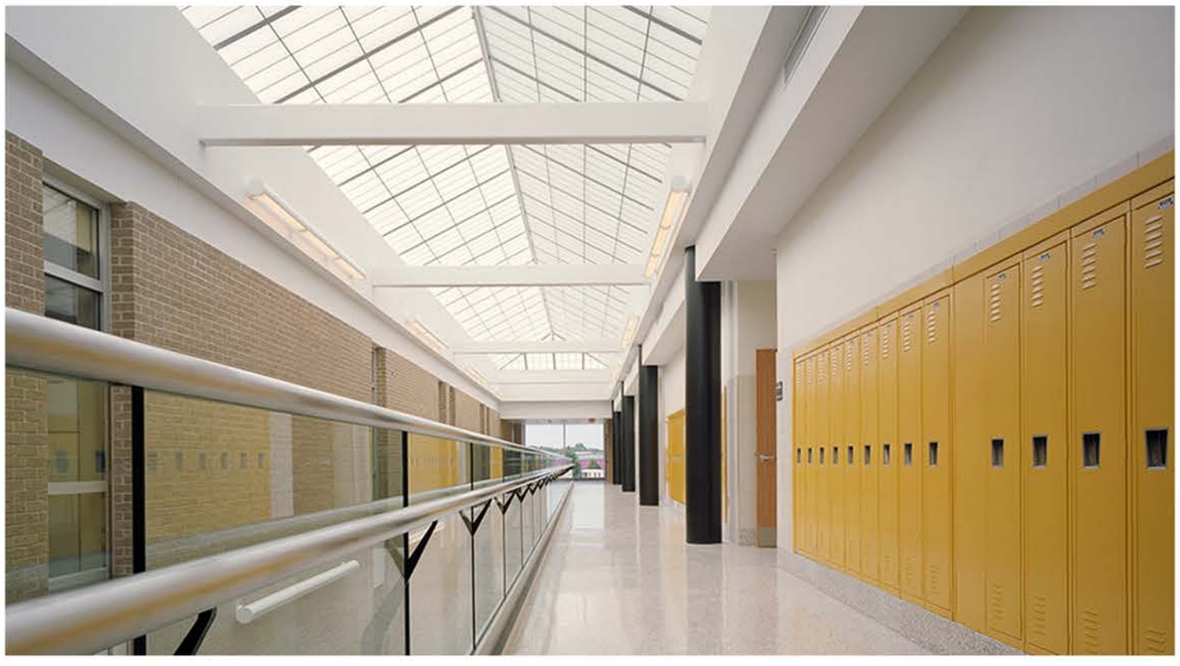
2) The Bond Line between interior and exterior FRP face sheets and grid-core utilizes our proprietary adhesive technology

3) Color stable, exterior **Fiber-Reinforced Polymer FRP face sheet** with a permanent glass veil erosion barrier to eliminate fiberbloom

4) **Translucent Insulation (TI)** options, including Cabot's Lumira™ aerogel offer exceptional thermal up to 0.05 U

5) Interior shatterproof **Fiber-Reinforced Polymer (FRP) face sheet** formulated to meet finish, flame and smoke requirements of the toughest international codes

6) Aluminum or thermally-broken **Grid Core** composed of a series of interlocking I-beams



A Kalwall Skylight in the central roof area directly above the Assembly Area was added.

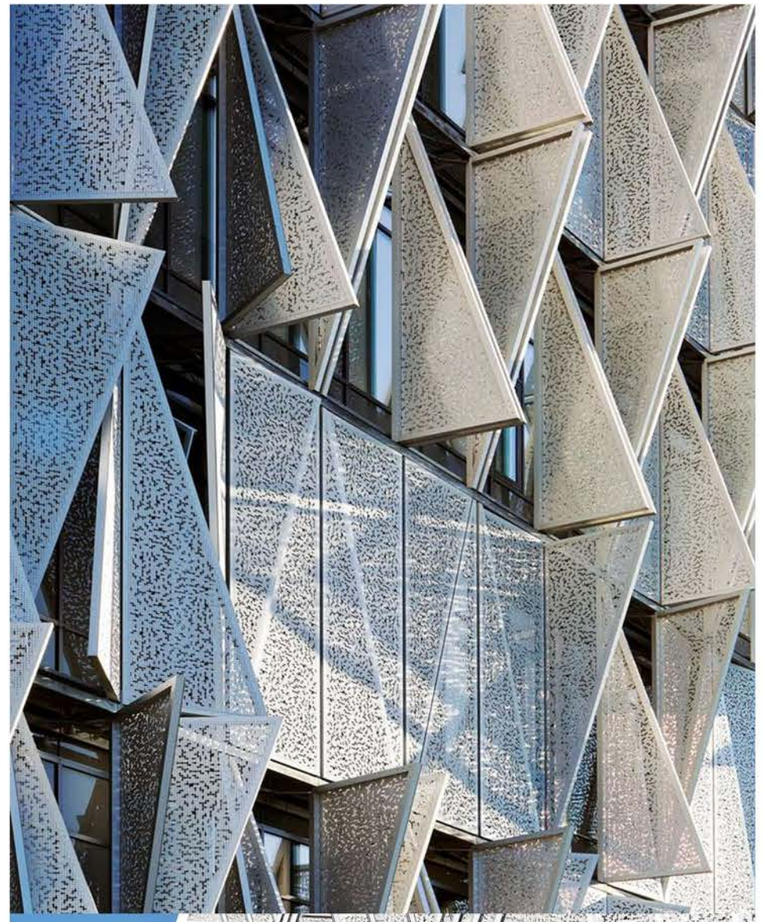
Kalwall allows for the infiltraion of natural light but limits the light to a level which provides optimum light levels withi nthe space and reduces glare.

Instead of the louvre system explored in SD, a kinetic panel facade was employed during Design Development phase.

The kinetic panel system allows for the light entering the space, mostly the Maker-Spaces, to be regulated per the occupant's preference.

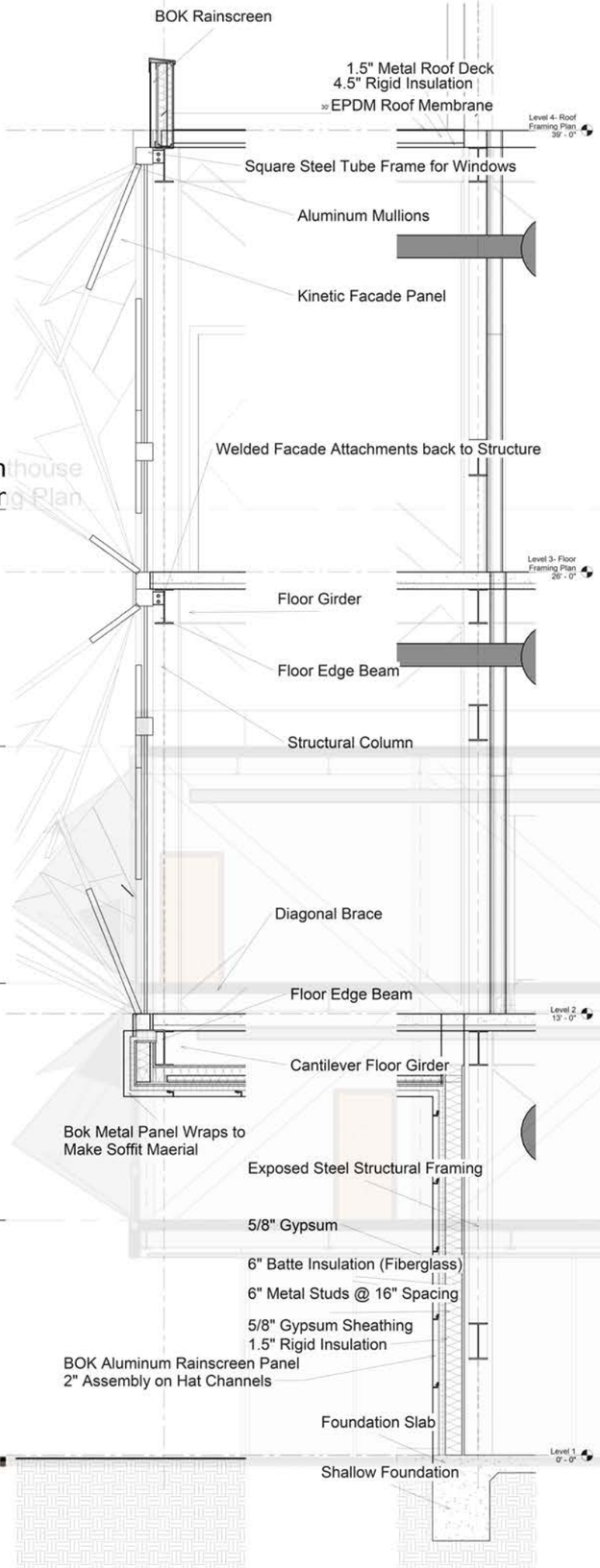
In addition, the moving panels add a flare and more dynamic quality to the exterior of the building increasing the viual interest.

The inspiration for the design of the kinetic facade stemmed from the kinetic facade on the Kolding Building at the University of Southern Denmark.

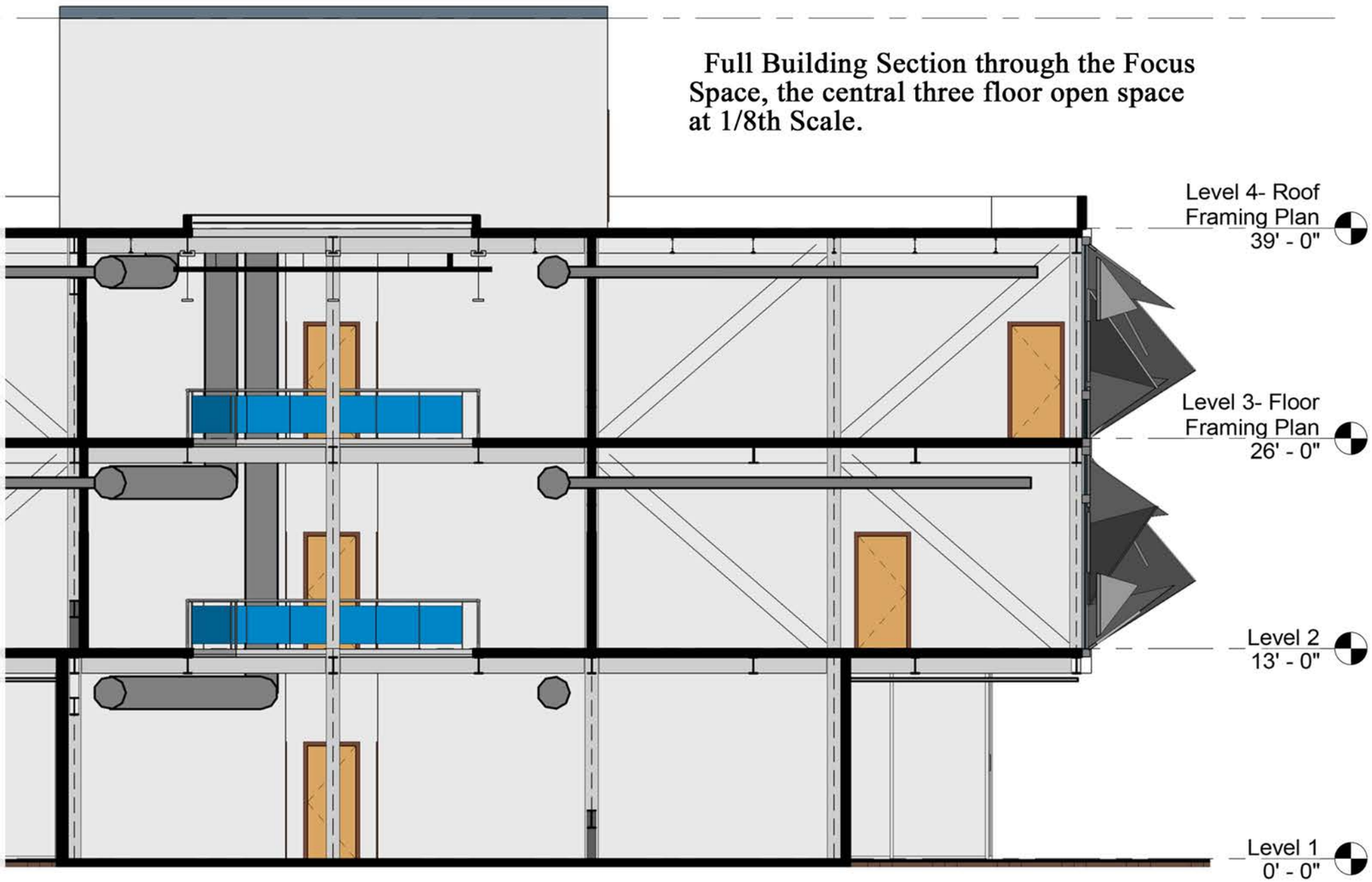


Sections

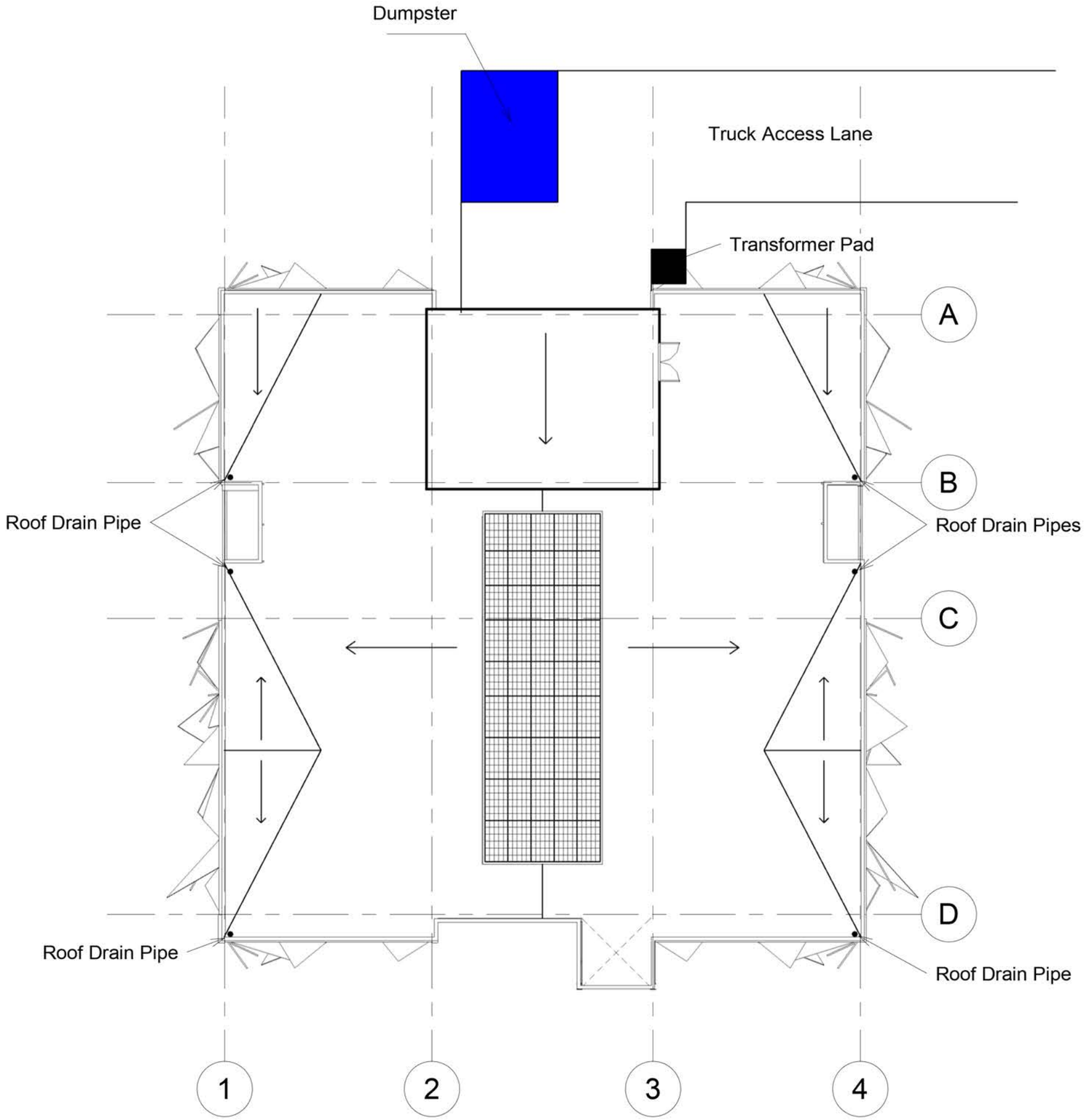
Wall Section detailing layers of the wall and cantilever soffit



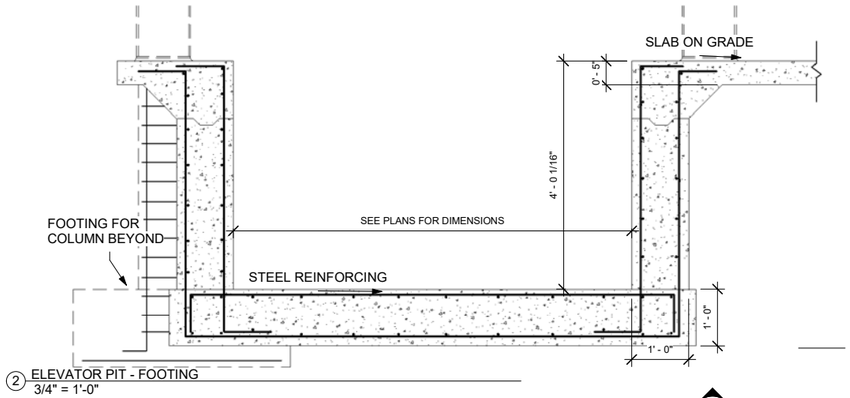
Full Building Section through the Focus Space, the central three floor open space at 1/8th Scale.



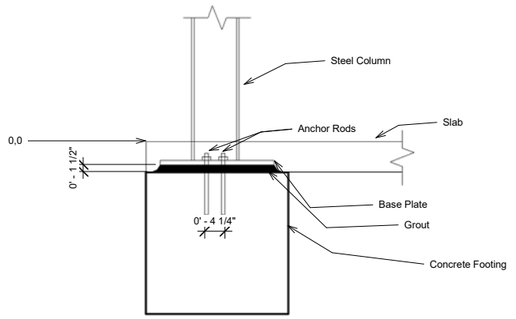
Roof Drainage Plan + Service Plan



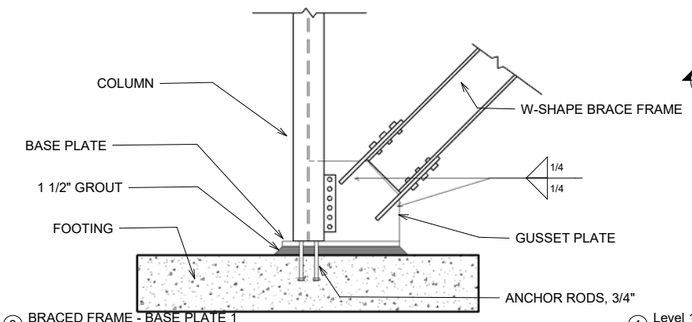
1 Site Plan + Drainage
1/16" = 1'-0"



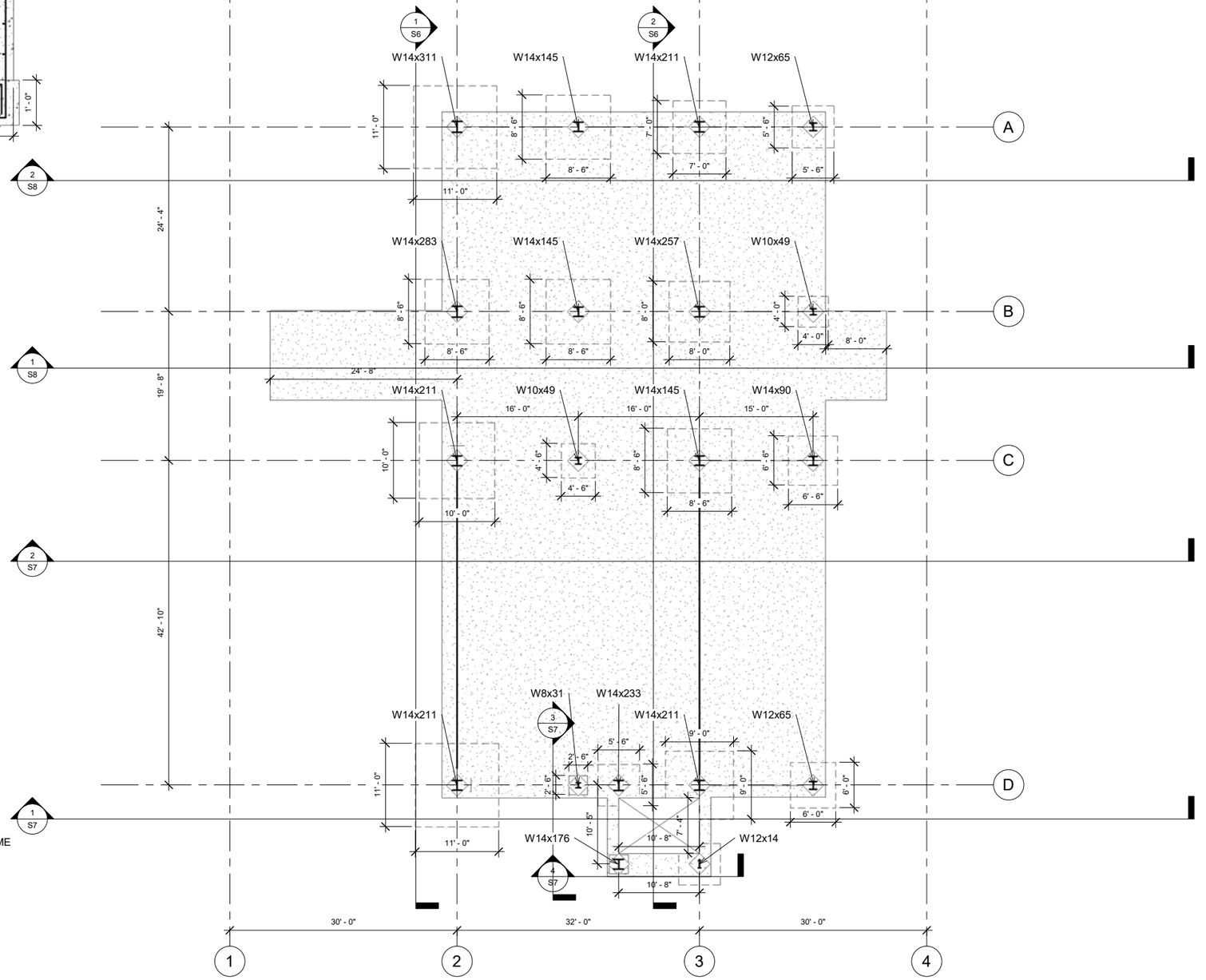
2 ELEVATOR PIT - FOOTING
3/4" = 1'-0"



4 FOUNDATION DETAIL
3/4" = 1'-0"



3 BRACED FRAME - BASE PLATE 1
3/4" = 1'-0"



N

1 Level 1- Foundation Plan
1/8" = 1'-0"

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S1

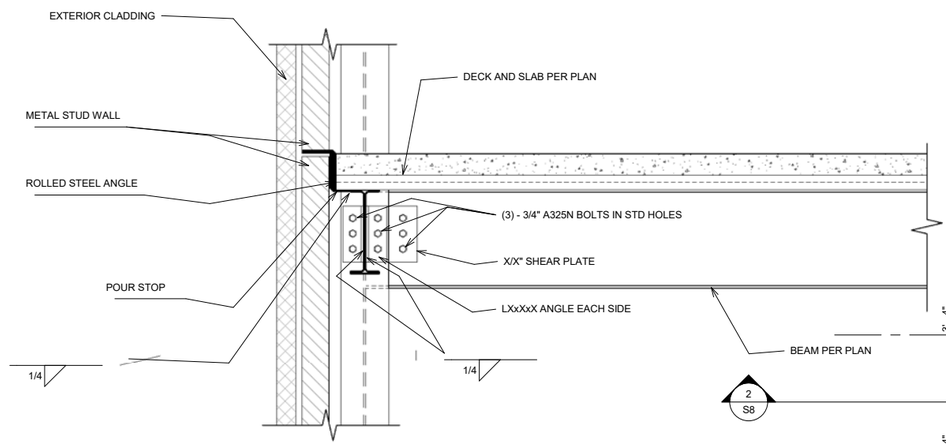
FOUNDATION PLAN NOTES

1.FINISH FLOOR ELEVATION IS 100'-0" (RELATIVE TO DATUM 100-0).

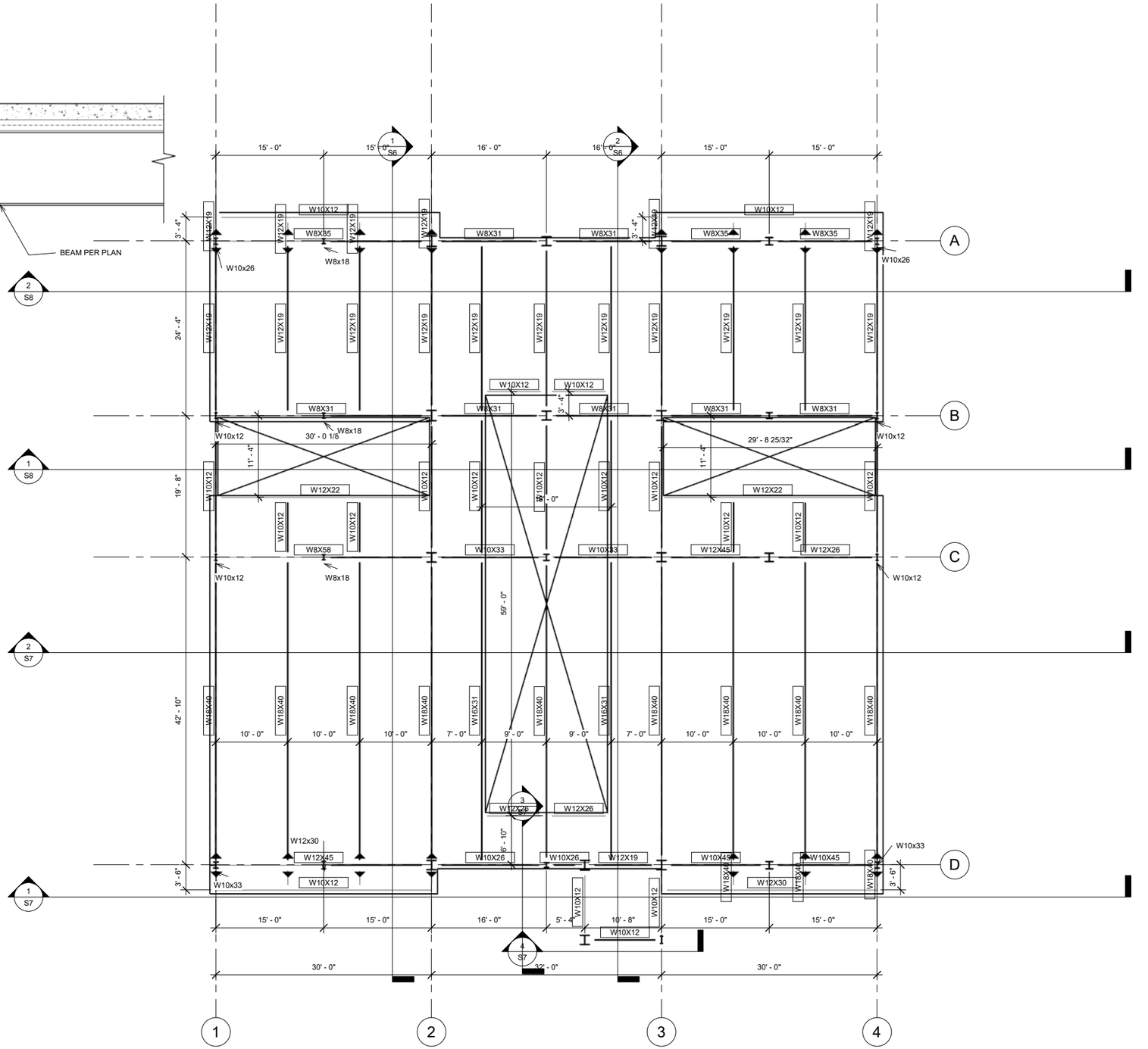
2.TOP OF CONCRETE SLAB IS FINISH FLOOR UNLESS SHOWN OTHERWISE.

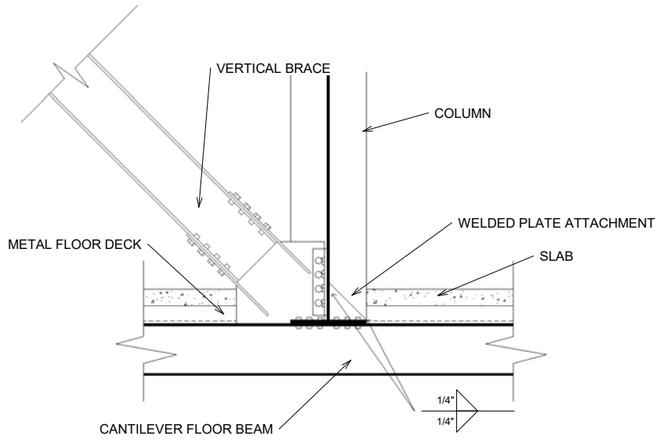
3.TYPICAL CONCRETE SLAB THICKNESS IS 6", REINFORCED WITH #4 @ 18" O.C.E.W. UNLESS NOTED OTHERWISE.

4.SHEET INDEX:



② EDGE FLOOR GIRDER FRAMING DETAIL
3/4" = 1'-0"





③ SUPPORTED COLUMN
3/4" = 1'-0"

① Level 2- Floor Framing Plan
1/8" = 1'-0"

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S2

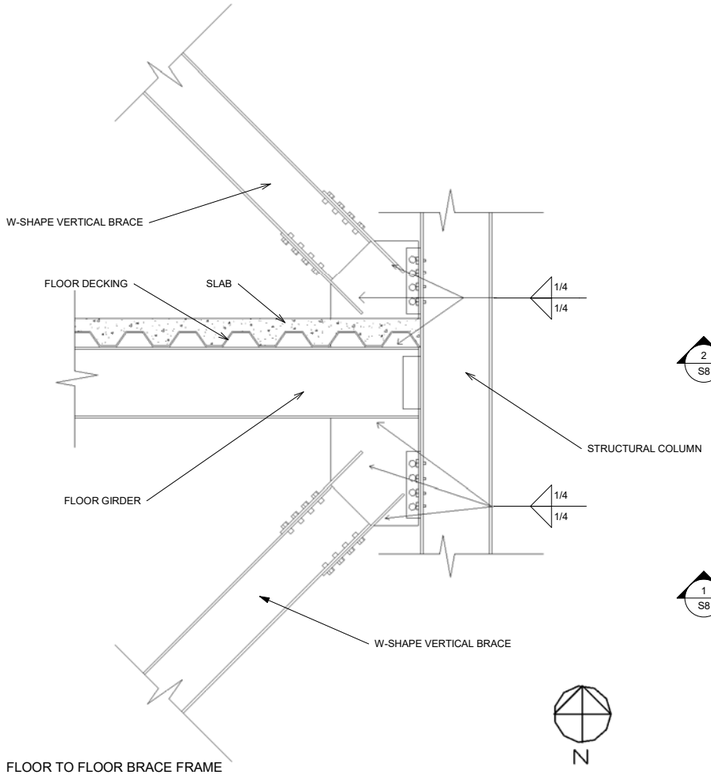
FLOOR FRAMING PLAN NOTES

1.FINISH FLOOR ELEVATION (RELATIVE TO DATUM 100-0) IS:
SECOND FLOOR 112-6
THIRD FLOOR 114-0
FOURTH FLOOR 115-6

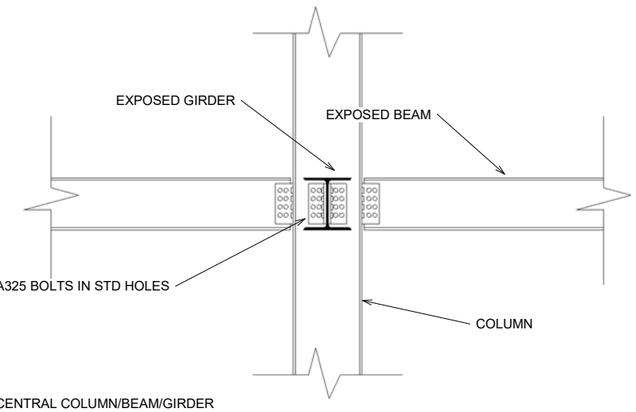
2.TOP OF CONCRETE SLAB IS FINISH FLOOR UNLESS SHOWN OR NOTED OTHERWISE.

3.SLAB THICKNESS IS 3 1/2" NORMAL WEIGHT CONCRETE ON 3" COMPOSITE DECK (6 1/2" TOTAL THICKNESS) REINFORCED WITH #4 BAR REINFORCEMENT.

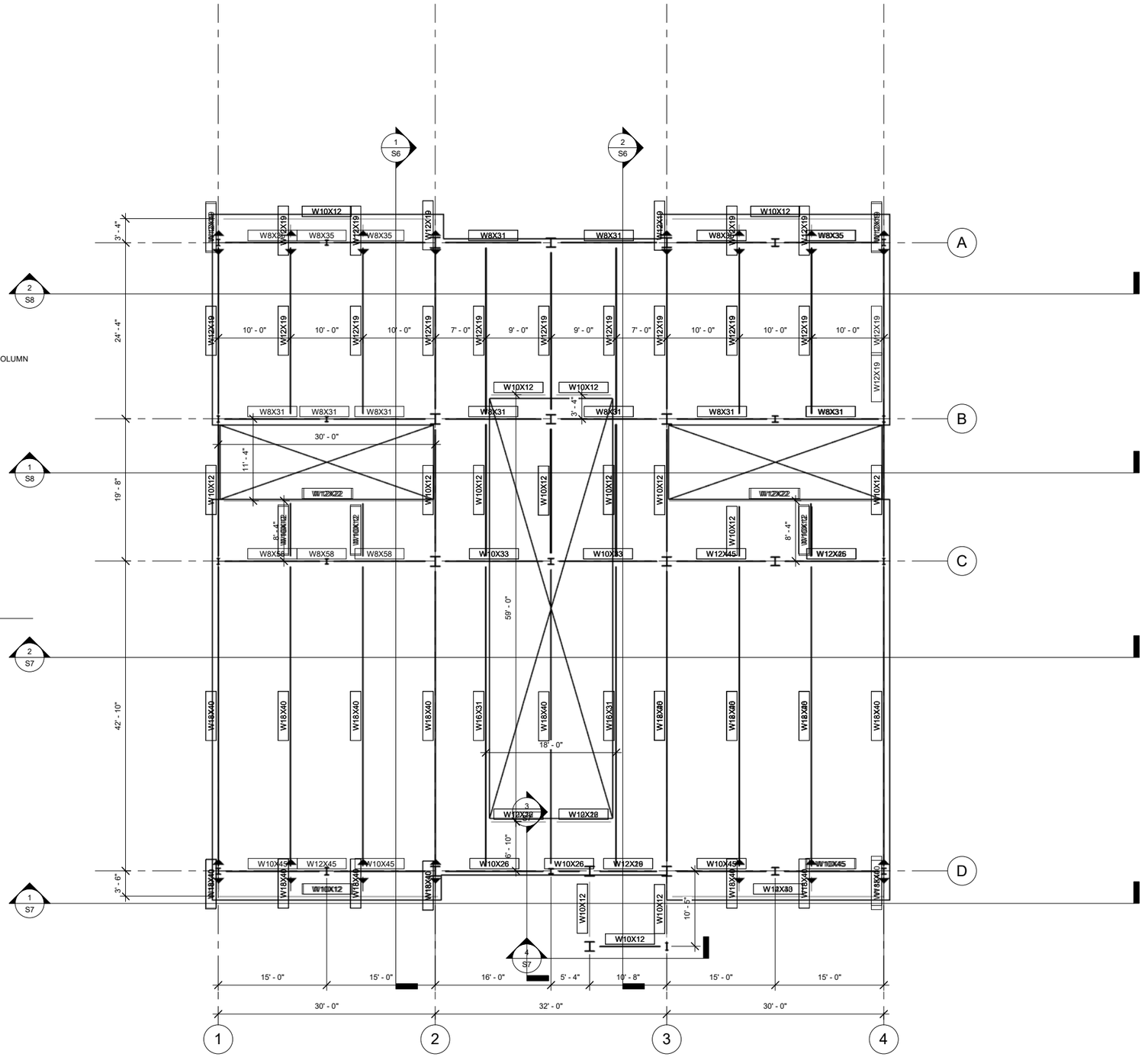
4.SHEET INDEX:
GENERAL STRUCTURAL NOTES S1.01
SCHEDULES S4.01
TYPICAL DETAILS S3.01, S4.01, S4.02



FLOOR TO FLOOR BRACE FRAME CONNECTION
2 3/4" = 1'-0"



CENTRAL COLUMN/BEAM/GIRDER CONNECTION
3 3/4" = 1'-0"



Level 3- Floor Framing Plan
1 1/8" = 1'-0"

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S3

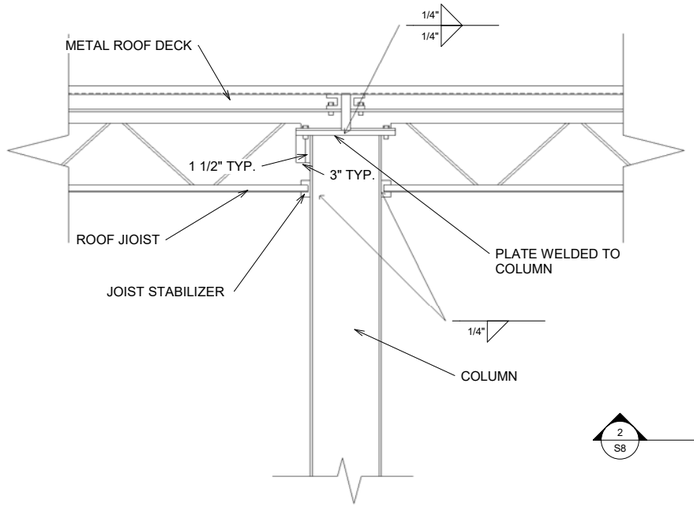
FLOOR FRAMING PLAN NOTES

1.FINISH FLOOR ELEVATION (RELATIVE TO DATUM 100-0) IS:
SECOND FLOOR 112-6
THIRD FLOOR 114-0
FOURTH FLOOR 115-6

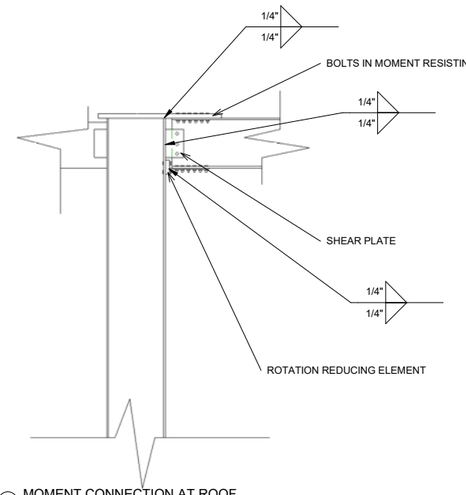
2.TOP OF CONCRETE SLAB IS FINISH FLOOR UNLESS SHOWN OR NOTED OTHERWISE.

3.SLAB THICKNESS IS 3 1/2" NORMAL WEIGHT CONCRETE ON 3" COMPOSITE DECK (6 1/2" TOTAL THICKNESS) REINFORCED WITH #4 BAR REINFORCEMENT.

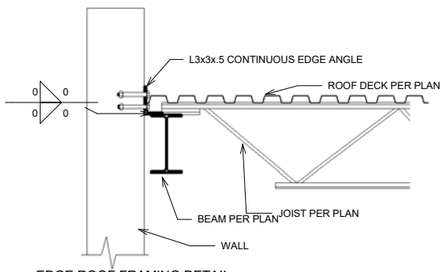
4.SHEET INDEX:
GENERAL STRUCTURAL NOTES S1.01
SCHEDULES S4.01
TYPICAL DETAILS S3.01, S4.01, S4.02



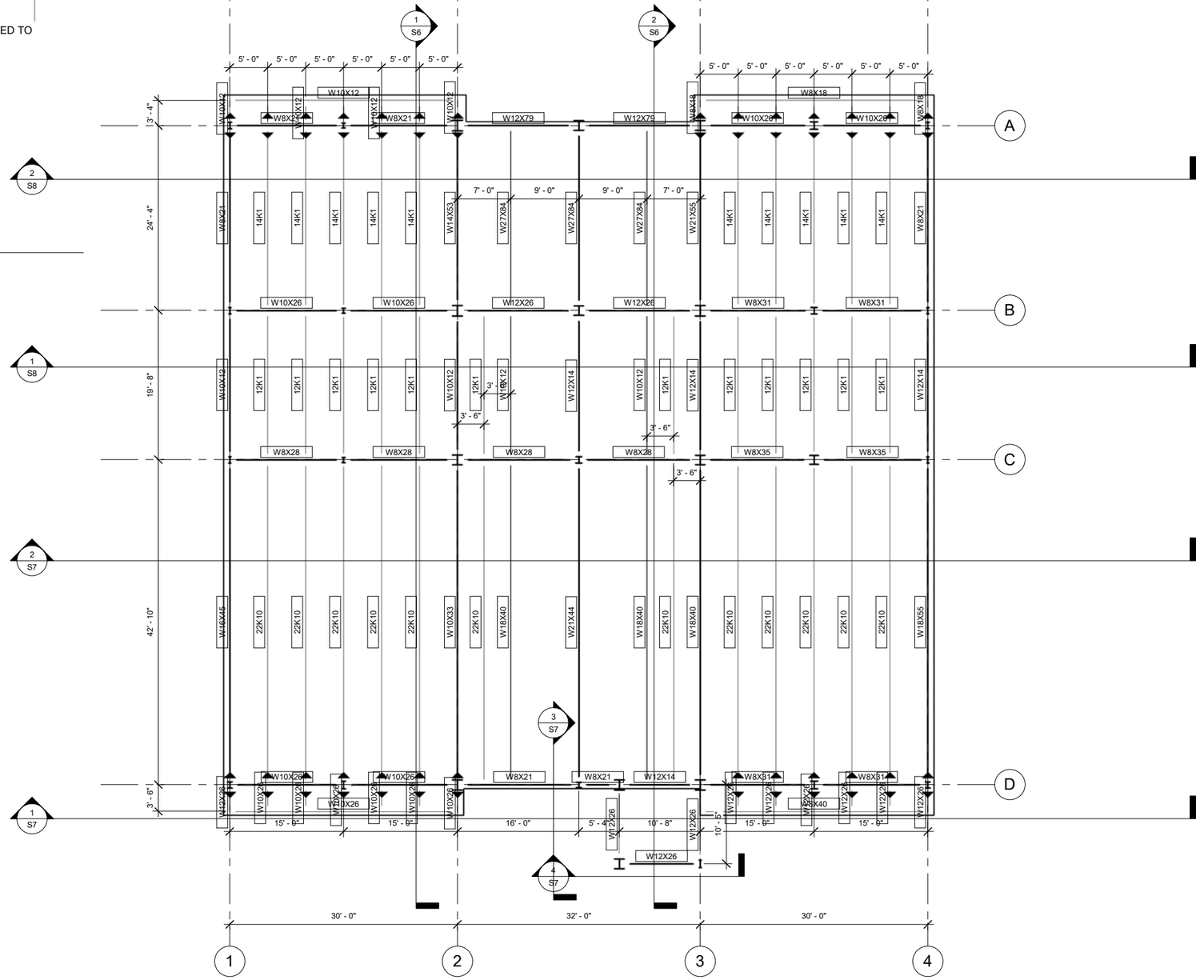
2 ROOF JOIST TO INTERIOR COLUMN
3/4" = 1'-0"



3 MOMENT CONNECTION AT ROOF
3/4" = 1'-0"



4 EDGE ROOF FRAMING DETAIL
3/4" = 1'-0"



1 Level 4- Roof Framing Plan
1/8" = 1'-0"

N

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S4

ROOF FRAMING PLAN NOTES

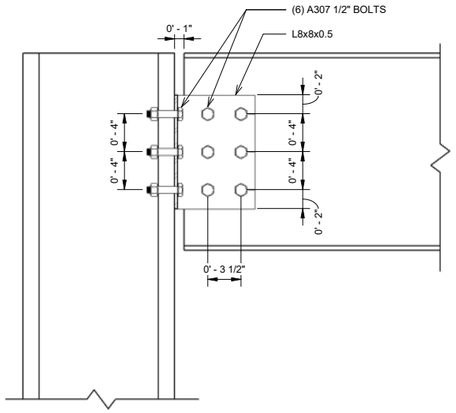
1.TOP OF ROOF STRUCTURE IS SLOPED FOR DRAINAGE.

2.UNLESS NOTED OTHERWISE, STEEL JOISTS SHALL BE CENTERED ON AND EQUALLY SPACE BETWEEN COLUMN CENTERLINES.

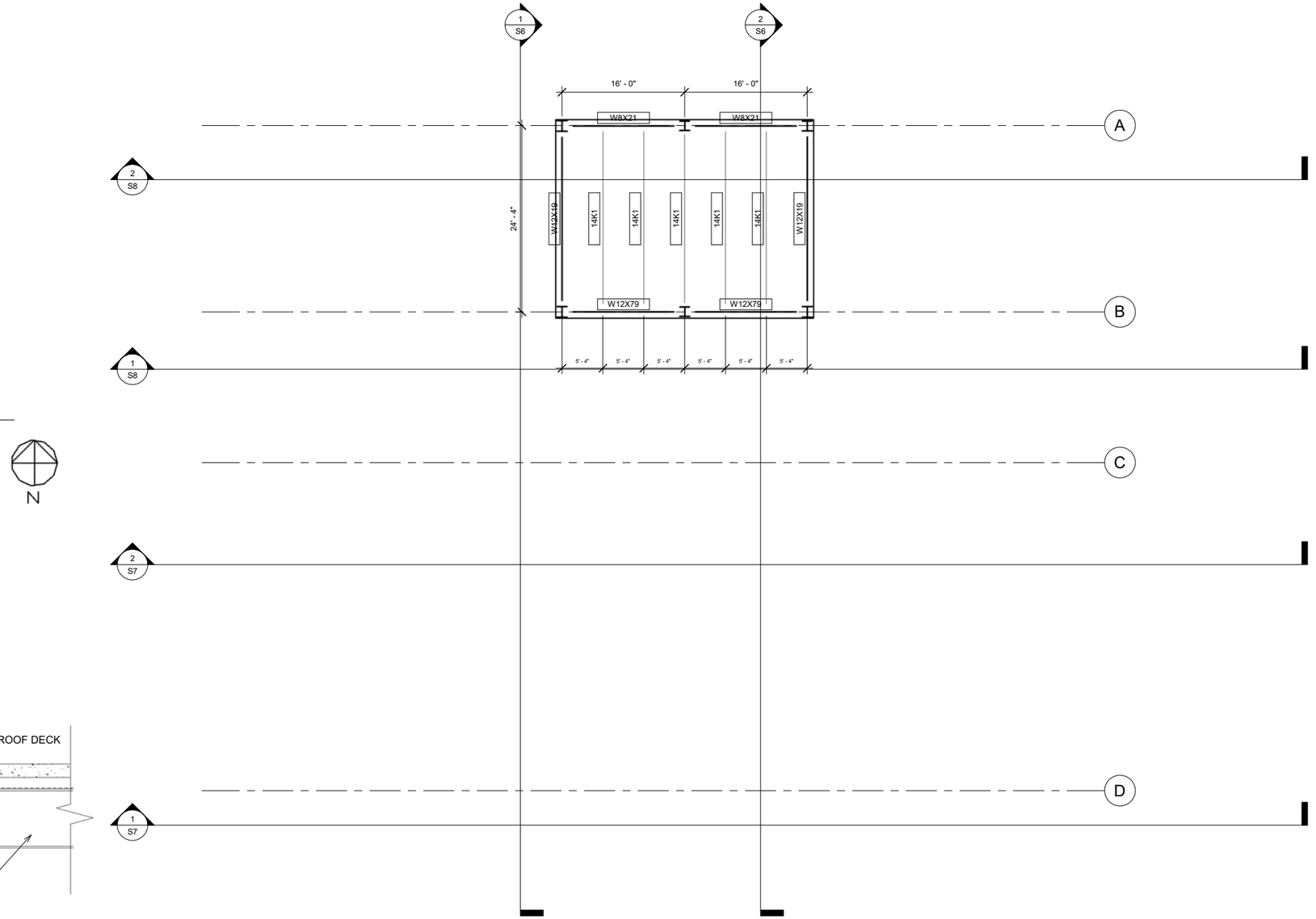
3.JOISTS SUPPORTING MECHANICAL EQUIPMENT SHALL BEDESIGNED FOR TYPICAL ROOF LOADINGS PLUS A CONCENTRATED LOAD OF 60% OF INDICATED EQUIPMENT WEIGHT PLACE AT ANY
PANEL POINT.

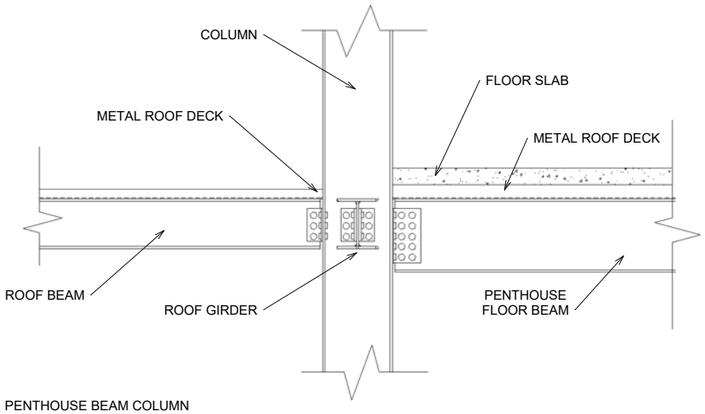
4.DESIGN STEEL JOISTS FOR A NET UPLIFT OF 22.2 POUNDS PER SQUARE FOOT (psf) FOR WIND LOADING.

5.SHEET INDEX:



2 ROOF GIRDER TO COLUMN
1 1/2" = 1'-0"





3 PENTHOUSE BEAM COLUMN
CONNECTION
3/4" = 1'-0"

1 Level 5 Penthouse Roof Framing Plan
1/8" = 1'-0"

N

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S5

ROOF FRAMING PLAN NOTES

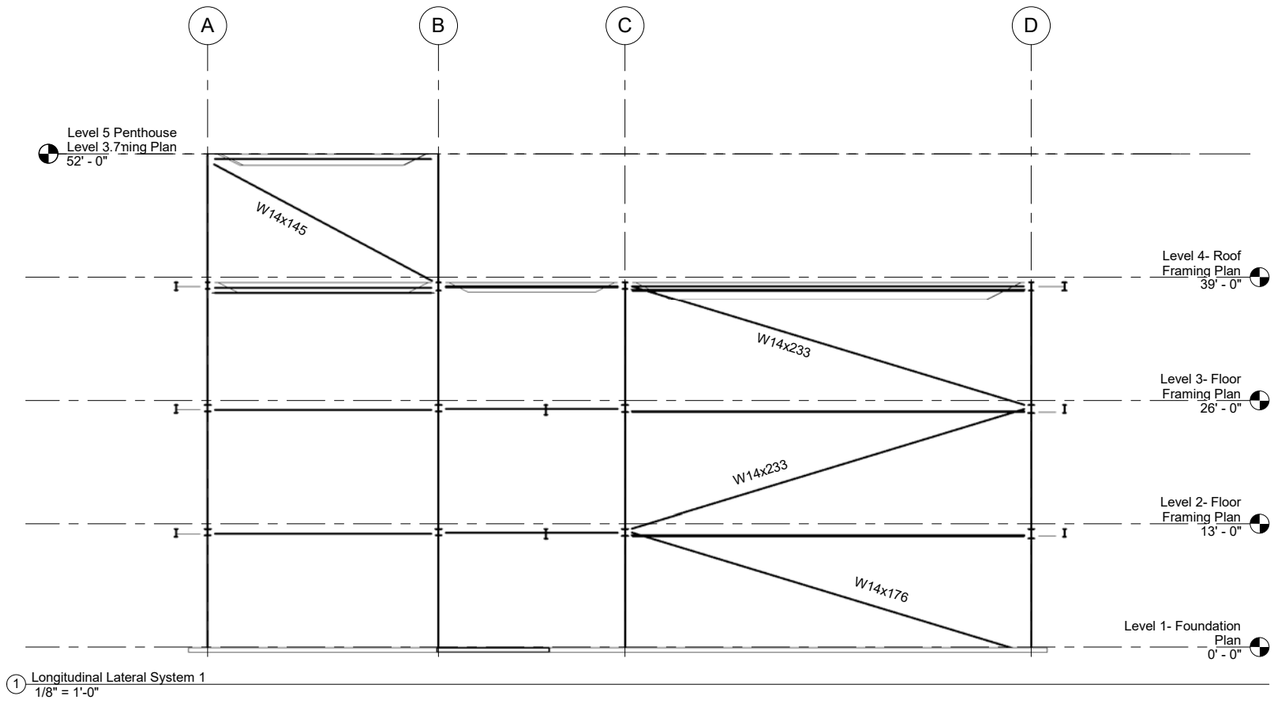
1.TOP OF ROOF STRUCTURE IS SLOPED FOR DRAINAGE.

2.UNLESS NOTED OTHERWISE, STEEL JOISTS SHALL BE CENTERED ON AND EQUALLY SPACE BETWEEN COLUMN CENTERLINES.

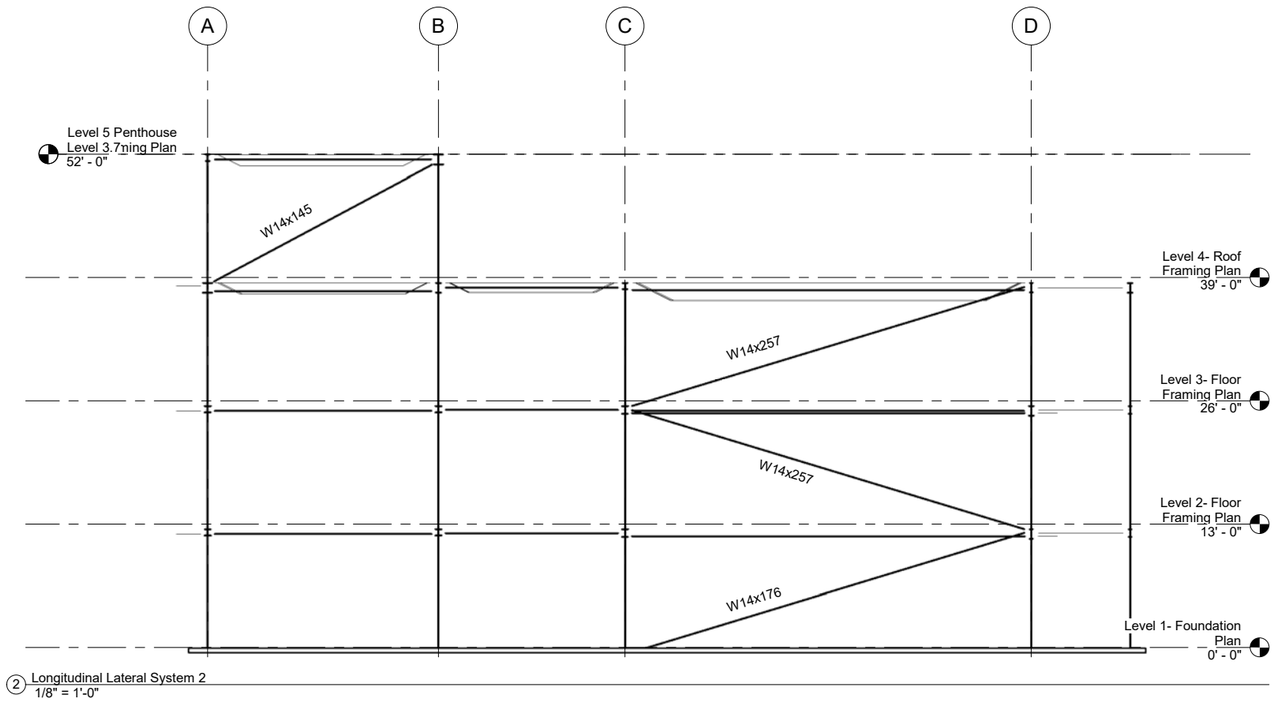
3.JOISTS SUPPORTING MECHANICAL EQUIPMENT SHALL BE DESIGNED FOR TYPICAL ROOF LOADINGS PLUS A CONCENTRATED LOAD OF 60% OF INDICATED EQUIPMENT WEIGHT PLACE AT ANY PANEL POINT.

4.DESIGN STEEL JOISTS FOR A NET UPLIFT OF 22.2 POUNDS PER SQUARE FOOT (psf) FOR WIND LOADING.

5.SHEET INDEX:



1 Longitudinal Lateral System 1
1/8" = 1'-0"



2 Longitudinal Lateral System 2
1/8" = 1'-0"

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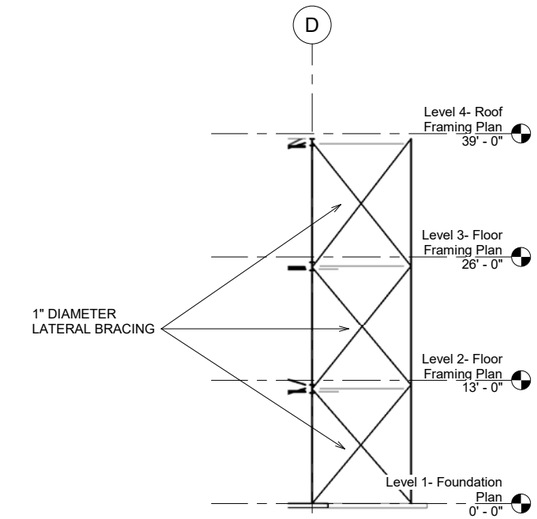
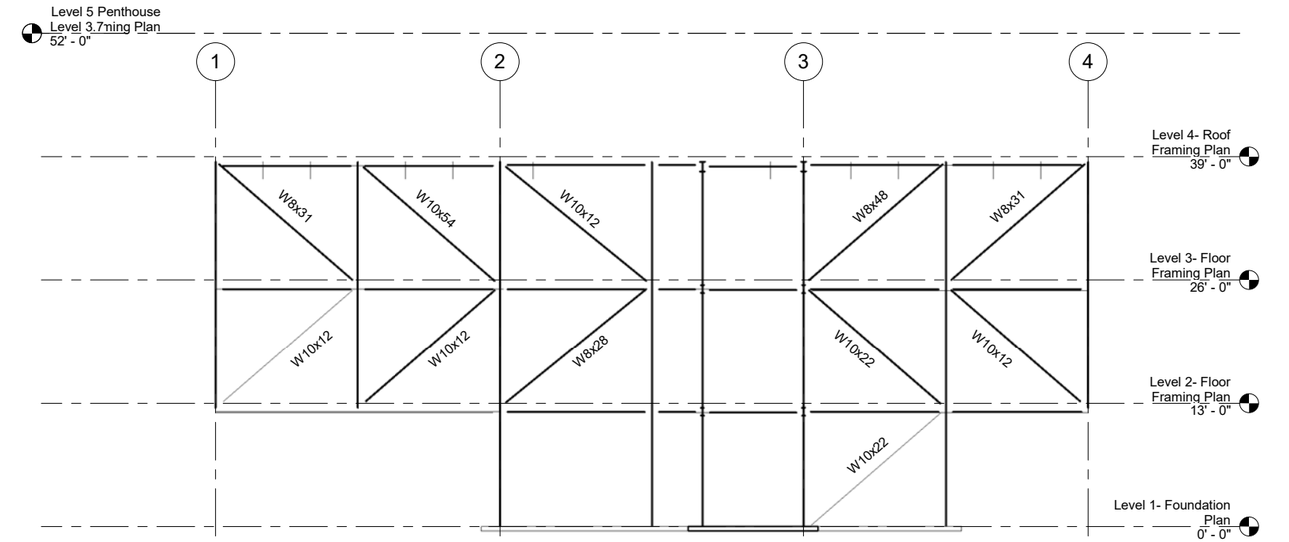
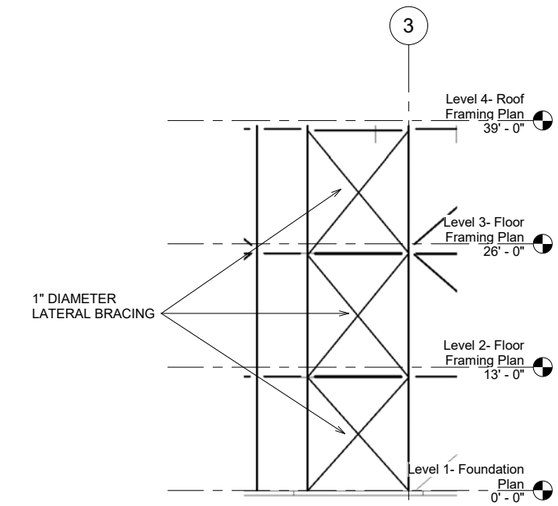


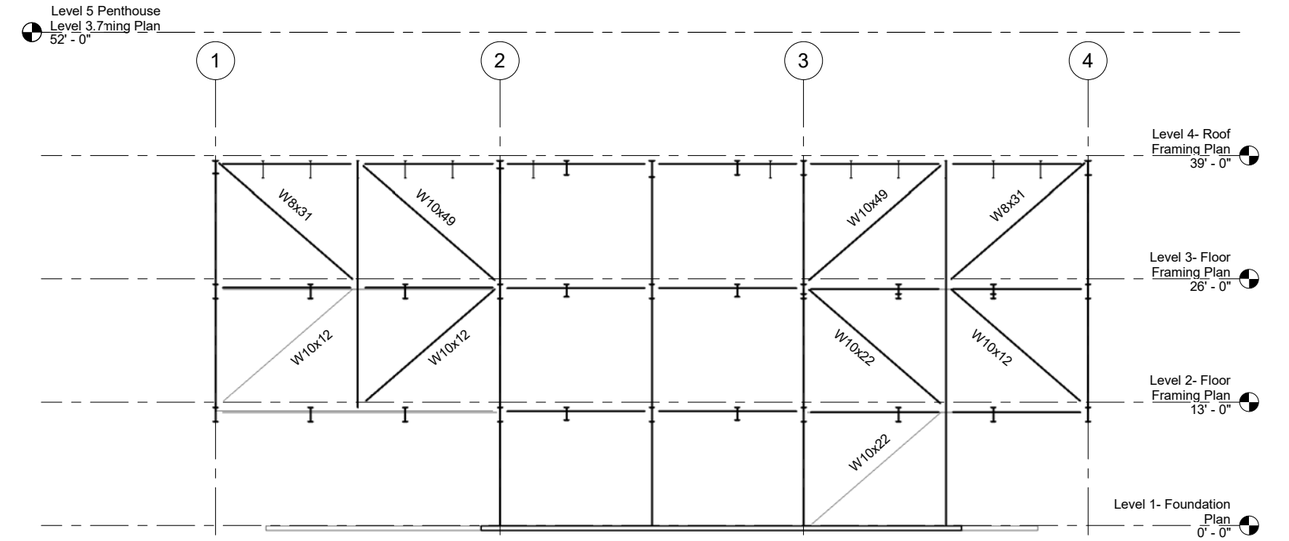
3 Elevator Longitudinal Lateral System
1/8" = 1'-0"



1 Transverse Lateral System 1
1/8" = 1'-0"



4 Elevator Transverse Lateral System
1/8" = 1'-0"



2 Transverse Lateral System 2
1/8" = 1'-0"

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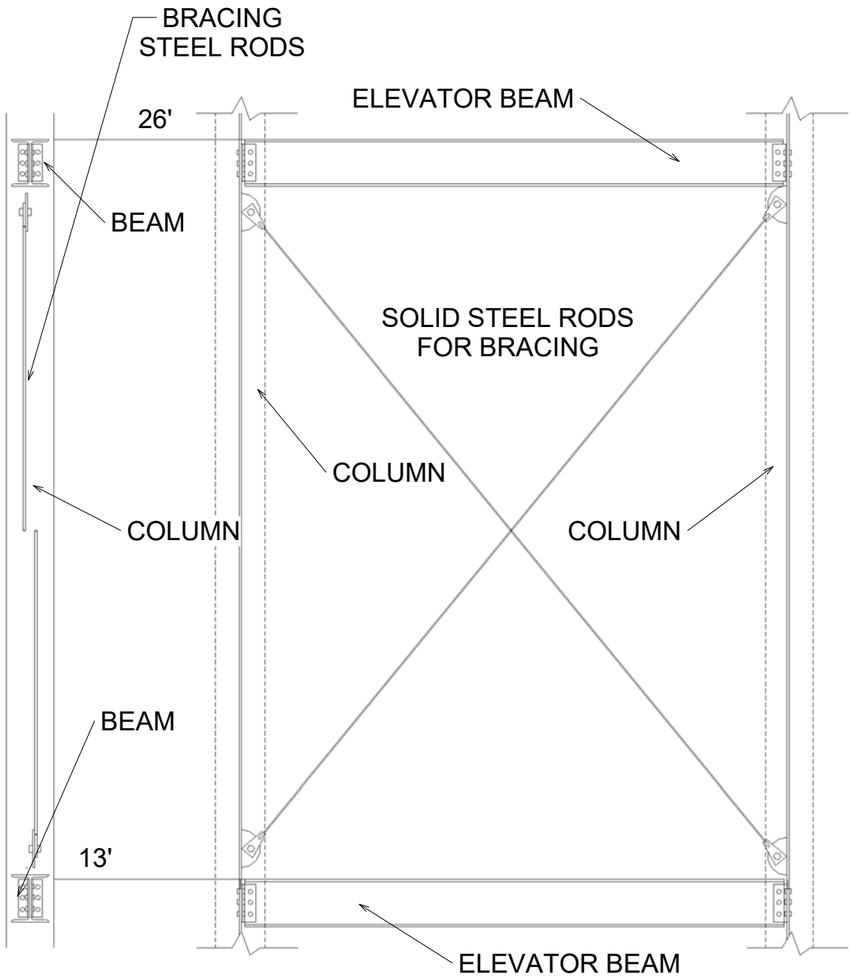
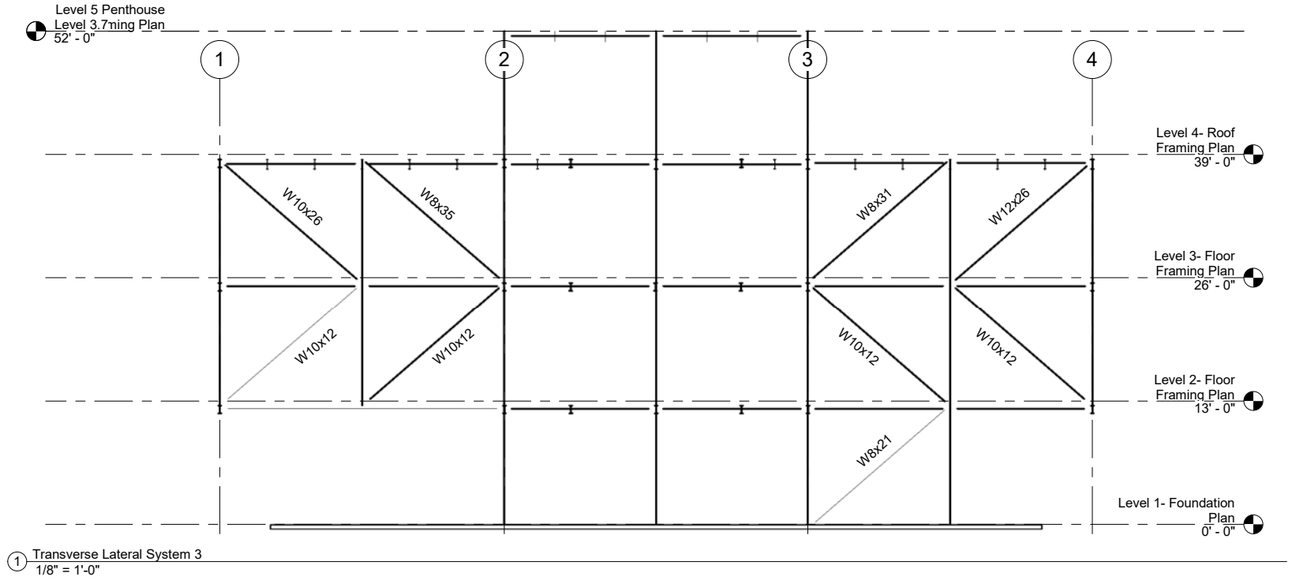
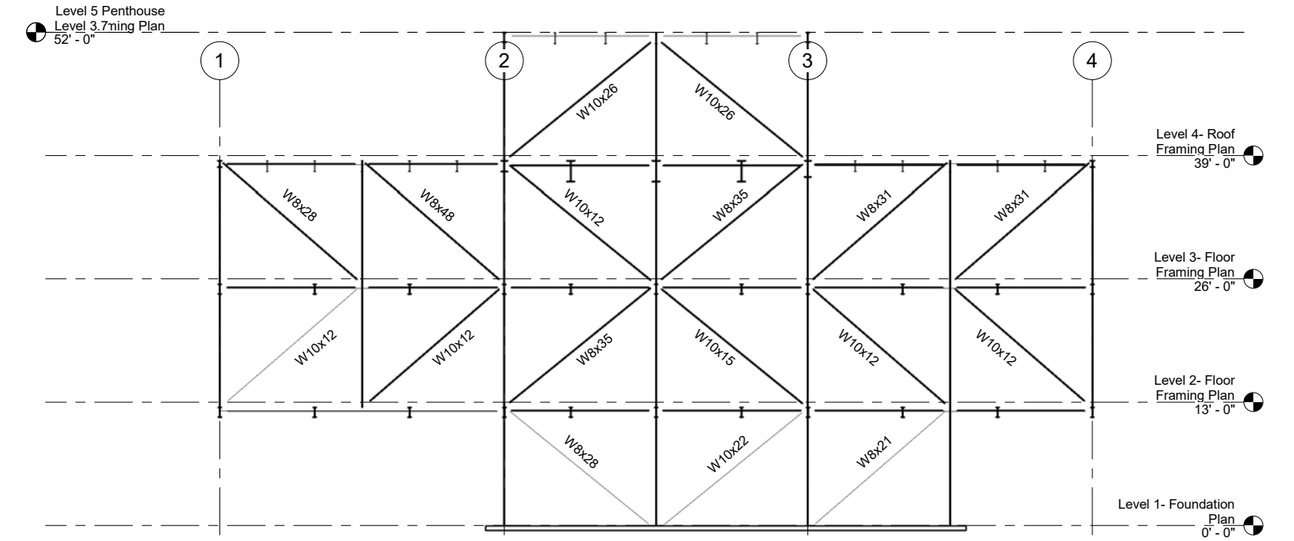


3 ELEVATOR LATERAL SYSTEM 1 AND 2
3/4" = 1'-0"



1 Transverse Lateral System 3
1/8" = 1'-0"



2 Transverse Lateral System 4
1/8" = 1'-0"

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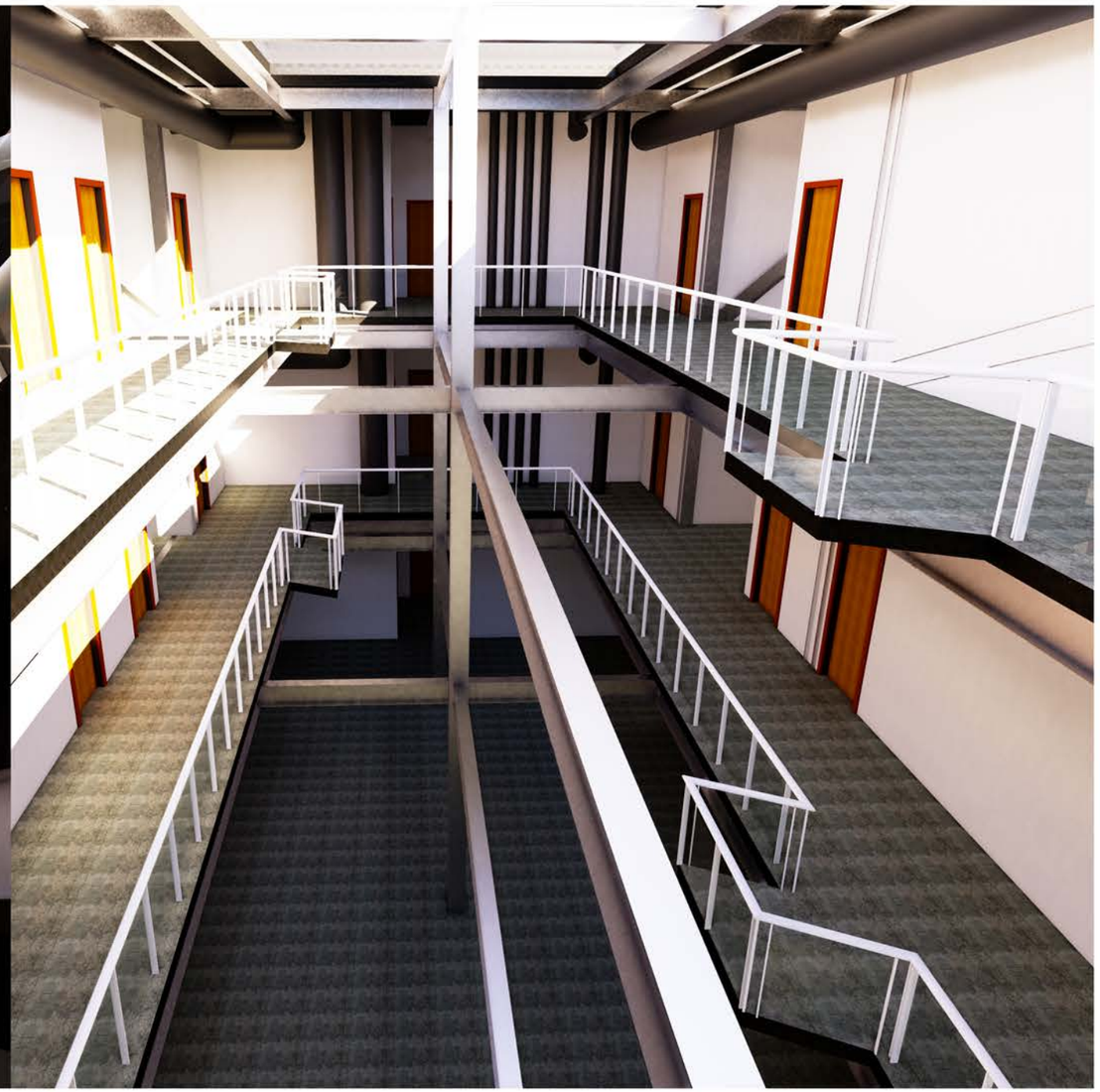
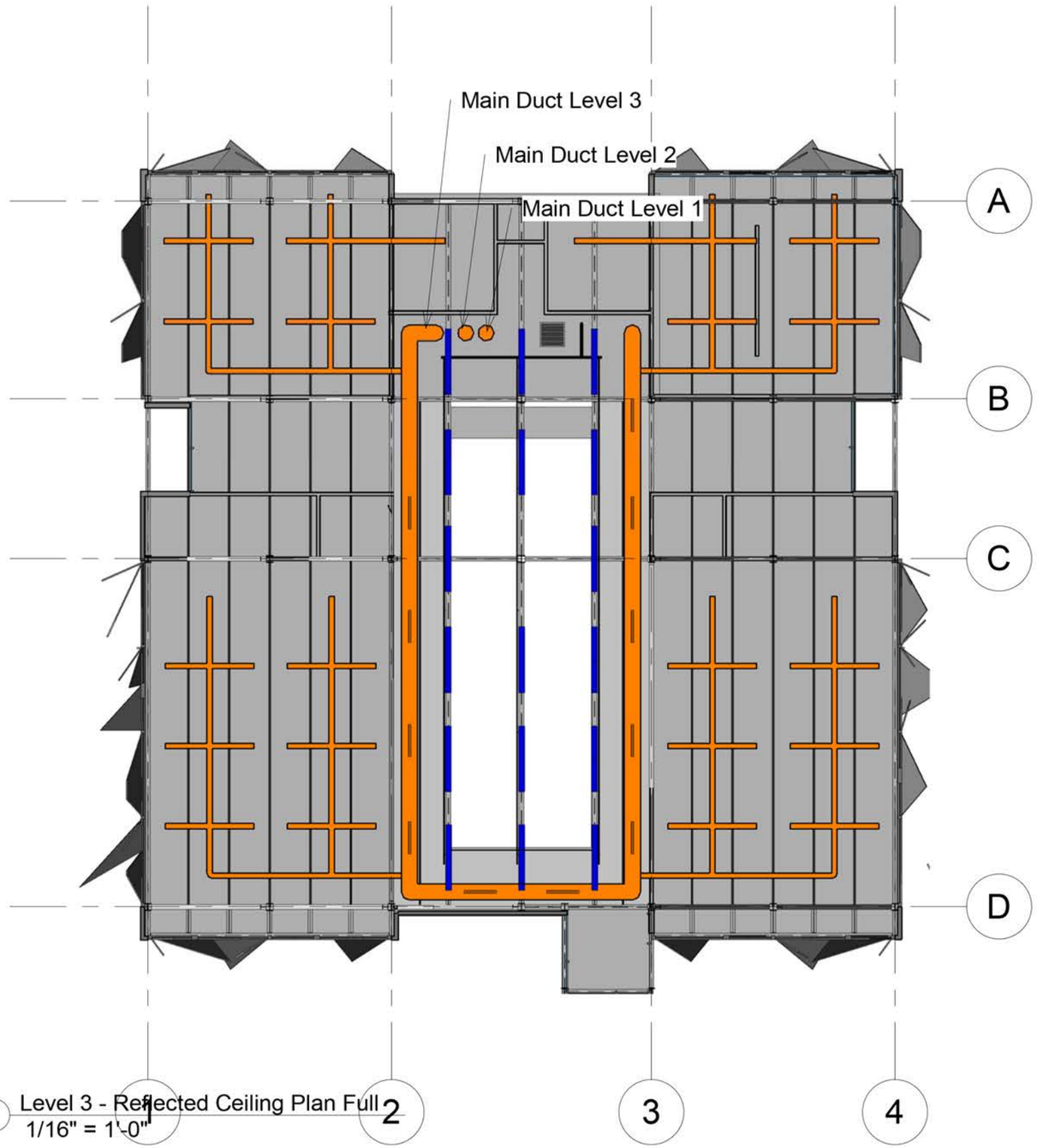
Structural Integration

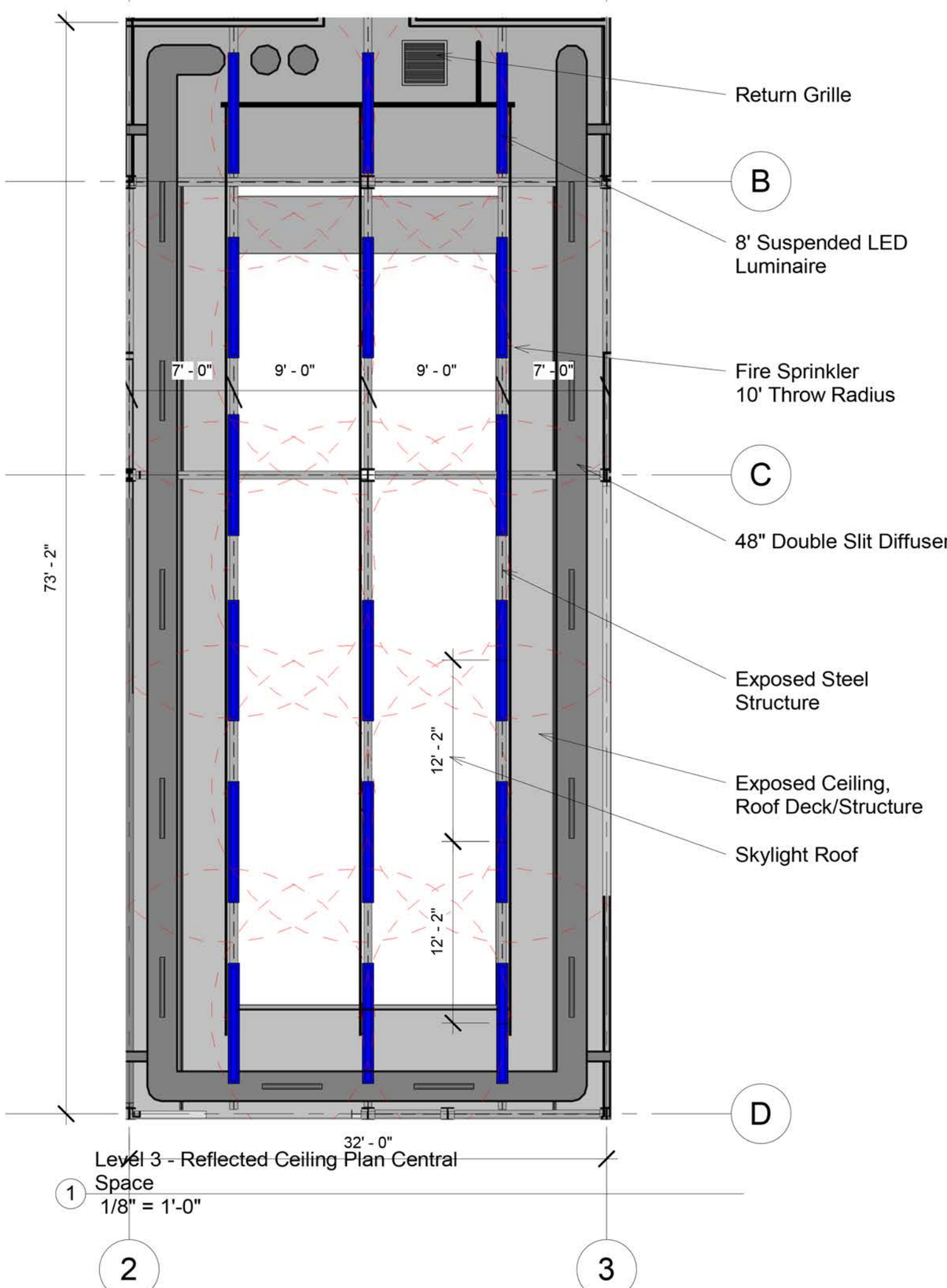


Duct Plan

Shown here is a duct plan for the third level of the building. The duct layout for the second floor is the same. The first floor is also the same except for the branch ducts are not present leaving only the main duct in place.



1 Level 3 - Reflected Ceiling Plan Full
1/16" = 1'-0"



1 Level 3 - Reflected Ceiling Plan Central Space
1/8" = 1'-0"

ARCH 4263 / 5262
Space Use: Lab/Studio
Student Names: Matthew Howard

Daylighting lab test results

Sky Condition: Standard CIE Overcast Sky

Light Sensor #	Multiplier	Meter's Reading	illumination level under artificial sky dome: lux	illumination level under artificial sky dome: fc	sensor's serial number
1	2.9210	27.2	79 lux	7.4 fc	PH 8355
2	2.8313	31.6	89 lux	8.3 fc	PH 8356
3	2.8248	33.0	93 lux	8.7 fc	PH 8357
4	2.9378	31.4	92 lux	8.6 fc	PH 8358
5	2.9792	26.8	80 lux	7.4 fc	PH 8359
6	2.7992	6.4	18 lux	1.7 fc	PH 8360
7	2.9673	20.6	61 lux	5.7 fc	PH 8361
8	2.9431	31.6	93 lux	8.6 fc	PH 8362
(single sensor) 9	2.7651	267.3	739 lux	68.7 fc	PH 8363
Outside (under dome)	2.7390	269.8	739 lux	68.7 fc	PH 8364

Measured outside illuminance = 68.7 fc

[NOTE]: This is the outside horizontal illuminance under the artificial sky dome in the lab, and not the standard illuminance at the location of your building.

Daylight Factor for VT= 0.70

For models tested with glass or trace paper

1	10.75%
2	12.11%
3	12.61%
4	12.48%
5	10.80%
6	2.42%
7	8.27%
8	12.59%
(single sensor) # 9	

Daylight Factor

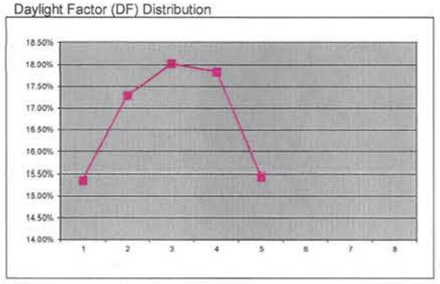
excluding effect of glass VT

15.36%
17.30%
18.02%
17.83%
15.43%

Average sens # 1 to 8: 16.79%

Ratio of Max. to Min.: 1.17

Daylight Factor (DF) Distribution



Calculated Predicted Illuminance at Design Condition

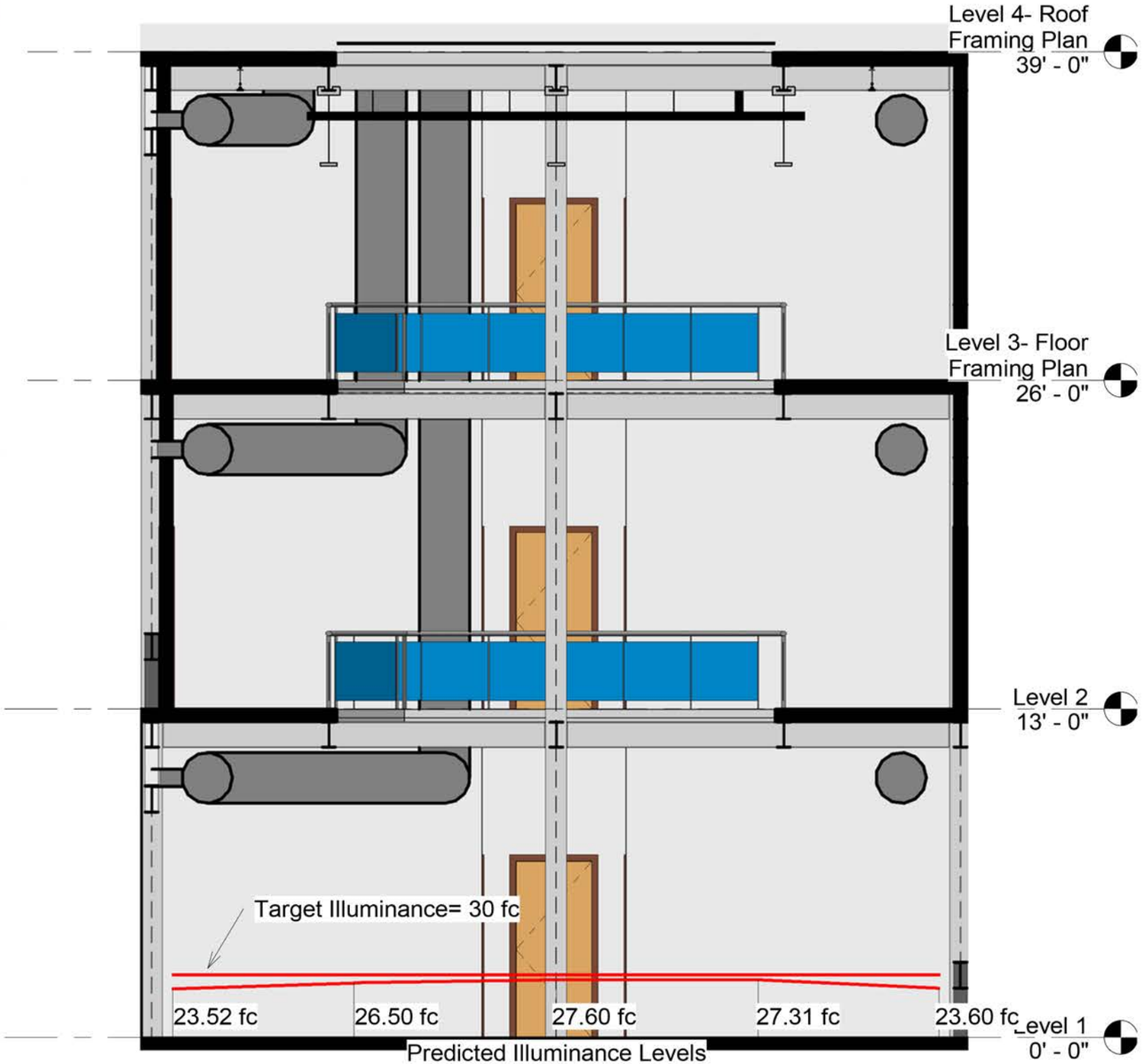
	1	2	3	4	5
Standard Illumination Level (2:00pm March/Sept 21st)	1386	1386	1386	1386	1386
Daylight Factor	0.1536	0.173	0.1802	0.1783	0.1543
VT Glass	0.13	0.13	0.13	0.13	0.13
M Glass	0.85	0.85	0.85	0.85	0.85
Predicted Illumination Level	23.52	26.50	27.60	27.31	23.63
Target Illumination Level	30	30	30	30	30
Using Kalwall Transluscent Panels for Skylight					

Glass Performance Data

Performance Data: 2-3/4" (70mm) Panel

FRP Face Sheet Combinations		Visible Light Transmission (VLT) % by NFRC 202				
Exterior FRP	Interior FRP	0.53 U	0.29 | **0.23 U**	0.22 | **0.14 U**	0.18 | **0.10 U**	**0.05 U**
Crystal	White	37%	26%	13%	7%	20%
White	White	23%	16%	9%	4%	14%
Crystal	Crystal	58%	35%	14%	9%	N/A

Solar Heat Gain Coefficient @ 0° by NFRC 201				
0.53 U	0.29 | **0.23 U**	0.22 | **0.14 U**	0.18 | **0.10 U**	**0.05 U**
0.44	0.30	0.15	0.09	0.27
0.30	0.22	0.11	0.08	0.20
0.60	0.39	0.15	0.10	N/A



1 Focus Space Section Copy 1
3/16" = 1'-0"

AVERAGE ILLUMINANCE WORKSHEET-ELECTRIC LIGHTING
[LUMEN METHOD-SIMPLIFIED]

Designer: Matthew Howard Space type: Central Atrium

PHOTOMETRIC DATA

IESNA Illuminance category: Lobby

IESNA Recommended illuminance (average): 25 (fc)

[*Refer to IESNA tables*]

Lamp type: LED

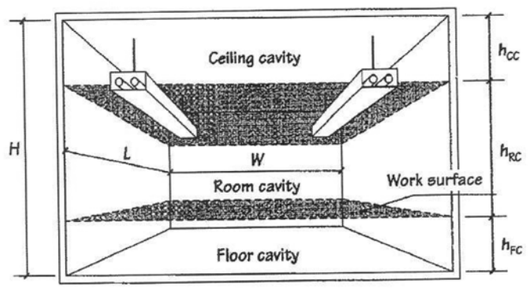
Recommended spacing ratio Default 1.0 both ways

Lumen output from one lamp (initial): 6000 (lumens)

Number of lamps per luminaire: 1 (lamps)

Fixture efficiency: 100 (%)

Lumen output from one luminaire: 9598 (lumens)



h_{CC} = 11 (ft)

h_{RC} = 32.5 (ft)

h_{FC} = 2.5 (ft)

ROOM DESIGN

L = 73.17 (ft)

W = 32 (ft)

H = 3.9 (ft)

Ceiling cavity reflectance = CCR = 80 (%)

Room cavity reflectance (walls) = RCR = 50 (%)

Assumed floor cavity reflectance = FCR = 20 (%)

SIZING OF THE SYSTEM

a. Effect of room geometry: Determine equivalent-square room length (W_{sq}), and the Room Cavity Ratio (RCR).

W_{sq} = W + [(L-W) / 3] = 32 + [(73.17 - 32)/3] = 45.723

RCR = (10 x h_{RC}) / W_{sq} = (10 x 32.5) / 45.723 = 7.108

From manufacturer's data, obtain the Coefficient of Utilization (CU) of this luminaire in this space.

CU = 47.568%

b. Effect of maintenance conditions of the space and the system (includes ballast factor): Estimate LLF.

Light Loss Factor = **LLF** = Good conditions = 0.65 (Circle one)
Average conditions = 0.55
Poor conditions = 0.45

c. Calculate useful lumens from one luminaire (on the workplane):

Useful lumens from one luminaire = Lumen output from one luminaire x CU x LLF
= 9598 x .47568 x .65 = 2967.6 lumens

d. Determine total lumens needed on the workplane:

Total lumens needed on the workplane = Recommended illuminance x area
= 25 x (73.17 x 32) = 58,536 lumens

e. Determine needed number of luminaires:

Number of luminaires = Total lumens needed on the workplane/useful lumens from one luminaire

Number of luminaires = 58,536 / 2967.6 = 19.72 ≈ 17 luminaires

Actual illumination level provided = 25 (17/19.72) = 21.55 fc

Light load = (17 x 50)/(73.17 x 32) = .363 W/SF > .086

Light load index = .363 / 21.55 = .0168 W/SF · fc

Covered area per luminaire = (73.17 x 32) / 17 = 137.73 SF/luminaire

System's overall efficiency = 100% · .47568 · .65 = .309 ≈ 31%

Lumination® LED Luminaires

Suspended Luminaire - LOP Series

Photometric Data

Project Name

Date Type

Notes

PHOTOMETRIC DATA: LOP 30% UP / 70% DOWN

CANDLEPOWER SUMMARY			
ANGLE	0°	45°	90°
45°	3607	3619	3575
55°	3397	3397	3364
65°	3131	3128	3089
75°	2762	2771	2635
85°	2207	2061	1770

ZONAL LUMEN SUMMARY	
ZONE	LUMENS
0-10	236.87
10-20	673.17
20-30	1003.47
30-40	1184.1
40-50	1200.37
50-60	1060.79
60-70	793.74
70-80	449.13
80-90	118.37
90-100	83.25
100-110	272.51
110-120	422.47
120-130	502.76
130-140	492.84
140-150	440.01
150-160	354.57
160-170	230.71
170-180	80.87

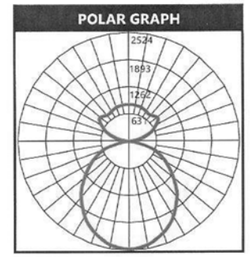
COEFFICIENTS OF UTILIZATION-ZONAL CAVITY METHOD																			
RC	80%				70%				50%				30%				10%		0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%	0%
0	112	112	112	112	106	106	106	106	94	94	94	84	84	84	74	74	74	70	
1	102	98	94	90	96	93	89	86	83	80	78	74	72	70	66	64	63	59	
2	93	85	79	73	88	81	75	70	73	68	64	65	61	58	58	55	53	49	
3	85	75	67	61	80	71	64	59	64	58	54	57	53	49	51	48	45	41	
4	78	66	58	52	73	63	56	50	57	51	46	51	46	42	46	42	39	36	
5	71	59	51	44	67	56	49	43	51	45	40	46	41	37	41	37	34	31	
6	66	53	45	39	62	51	43	37	46	39	35	41	36	32	37	33	30	27	
7	61	48	40	34	57	46	38	33	42	35	31	38	32	28	34	30	26	24	
8	57	44	36	30	53	42	34	29	38	32	27	35	29	25	31	27	24	21	
9	53	40	32	27	50	38	31	26	35	29	25	32	27	23	29	24	21	19	
10	49	37	29	24	47	35	28	24	32	26	22	29	24	21	27	22	19	17	

NOTE: Floor Cavity Reflectance: 20%

ZONAL LUMEN SUMMARY			
ZONE	LUMENS	% OF LAMP	% OF FIXTURE
0-20	910.04	N.A.	9.5
0-30	1913.51	N.A.	19.9
0-40	3097.61	N.A.	32.3
0-60	5358.77	N.A.	55.8
0-80	6601.64	N.A.	68.8
0-90	6720.01	N.A.	70

Total Luminaire Efficiency = N.A.%

POLAR GRAPH



OPTICAL SYSTEM

Lumens:	3000 lm - 9600 lm
Distribution:	Up light/Down light ratio options: 70%/30%; 30%/70%; 50%/50%; 20%/80% (convertible options)
Wattage:	24-95 Watts
Efficacy:	Up to 110LPW
CCT:	3000K, 3500K, 4000K, 5000K
CRI:	83, 90+ TriGain®

For Product or Technical Questions:

Email: lightingprodinfo@gecurrent.com

Phone: +1 888 694 3533, option 2

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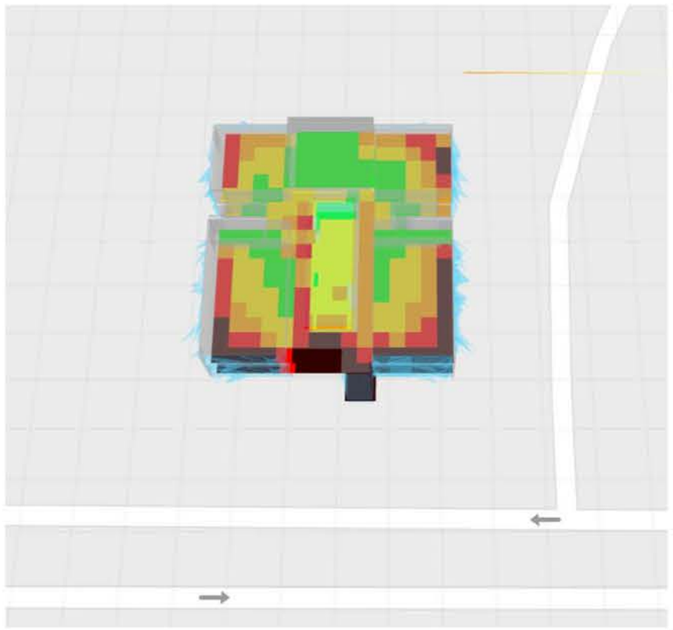
IND380 (Rev 04/23/21)

Whole Building Environmental Performance- Current Design (Model C)

ASE: 70%



sDA: 72%