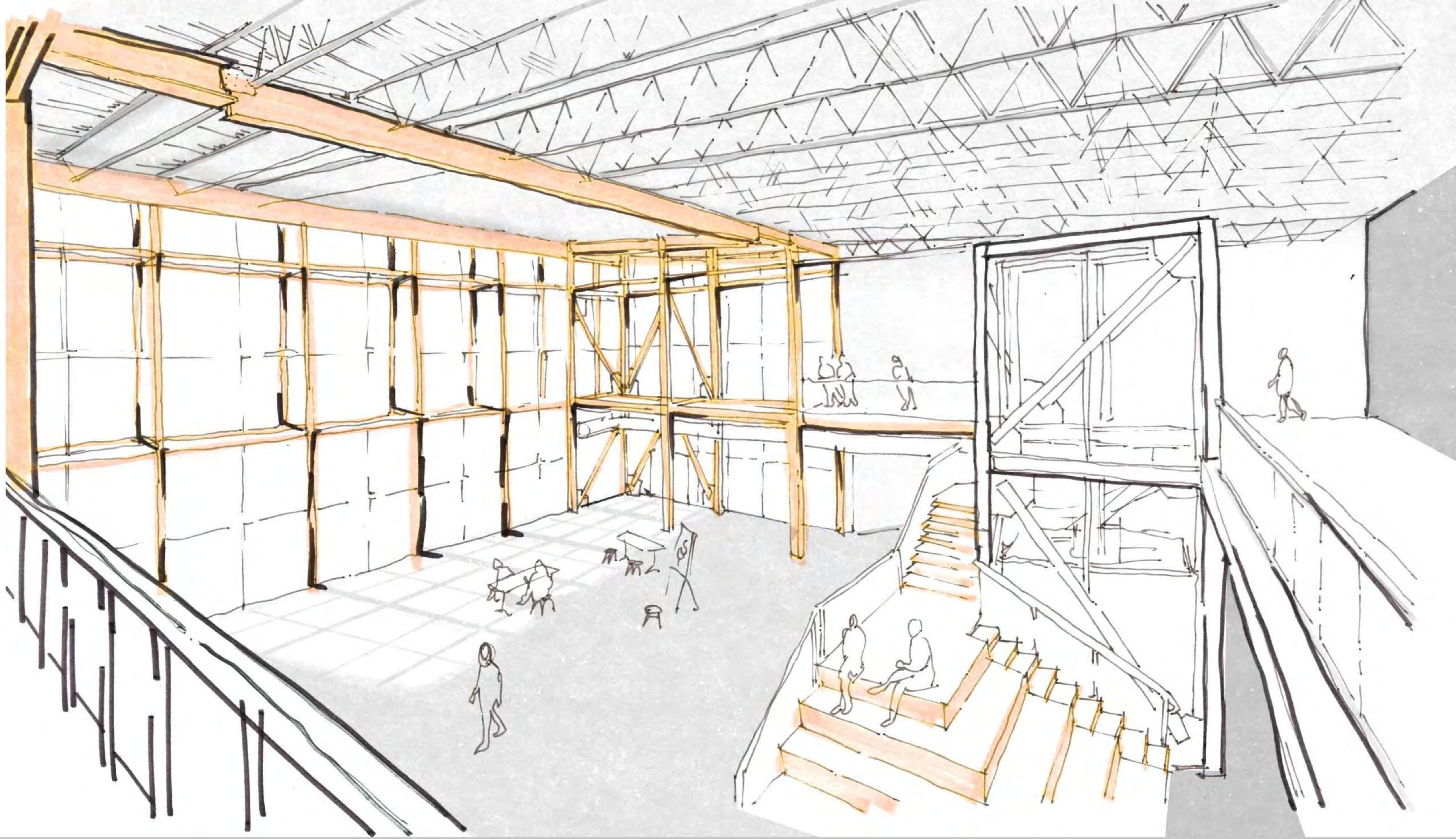

C. GUYER
DESIGN DEVELOPMENT

HONORS THESIS: S.T.E.A.M. ENGINE CENTER OKC

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Client and Project Summary:

Morgan Jones, an OSU and SoA graduate, is the founder of STEAM Engine of Oklahoma City, OK. This nonprofit helps connect 3rd through 8th grade students of the OKC metro to STEAM instruction (science, technology, engineering, art, and math) beyond what is available in schools. The main priority is to teach these students life-long soft skills, like critical thinking and problem solving, that they can continue to apply to issues they face later in life.

Overall, this organization reaches out to students that don't have access to STEAM education. In order to do this outreach, the organization seeks to have a center that generates enough profit to fund the outreach part of the programming. The goal is that the Center will educate students through a distributed museum style, rather than a strict classroom-style education. They'd like to emphasize independent learning and small group discoveries. They would like the building systems to be exposed for educational use. The program should also be organized around the learning studios and makers spaces.

Site Summary:

The site for this STEAM Engine Education Center is 4848 West Covell Rd in Edmond, OK. It is a 35 acre site near a church, elementary and middle schools, and residential neighborhood. This area of Edmond is anticipated to build-up in the coming years, especially in light commercial businesses along the main roads, with residential areas on the interior of the blocks.

Program Summary:

The Center needs to include the following:

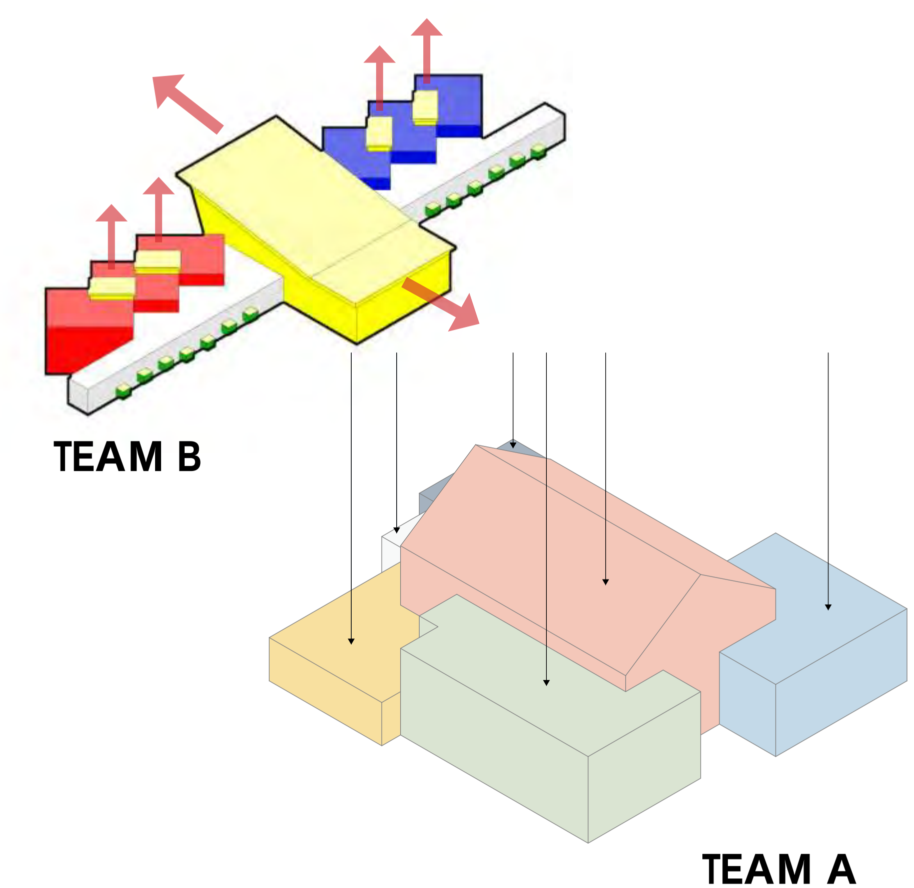
- Lobby space
- Gathering Space: 1500 - 3000 sf
- Gift Shop: 500 sf
- 4-6 Studios, ranging in size and function
  - Basic studio, kitchen studio, lab space, woodworking, etc.
- Outdoor Classroom/courtyard
- Terrace/rooftop area (optional)
- 4 office spaces
- 20 person boardroom
- plenty of storage

SCHEMATIC DESIGN

Duration: 6 Weeks
Style: 2 teams of 1 AE + 2 Arch

This phase of design had a strong emphasis on research, programming, and form. The engineering students (me!), were assigned to two teams of architects. In these teams, we concentrated on addressing programmatic needs, preliminary systems exploration including structures, MEP, and systems environmental performance.

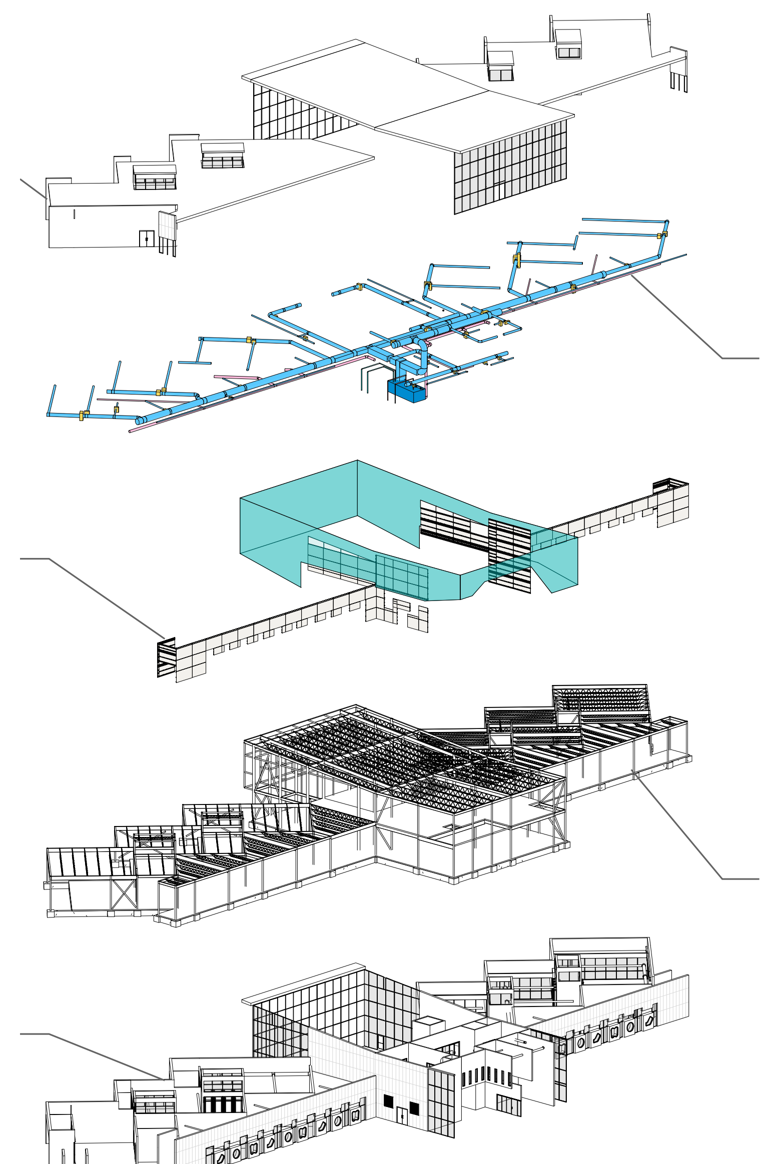
At the end of 6 weeks, the engineers picked one of the two designs they contributed to to further develop in DD and CDs. I chose the building developed in team B.



DESIGN DEVELOPMENT

Duration: 7 Weeks
Style: Individual

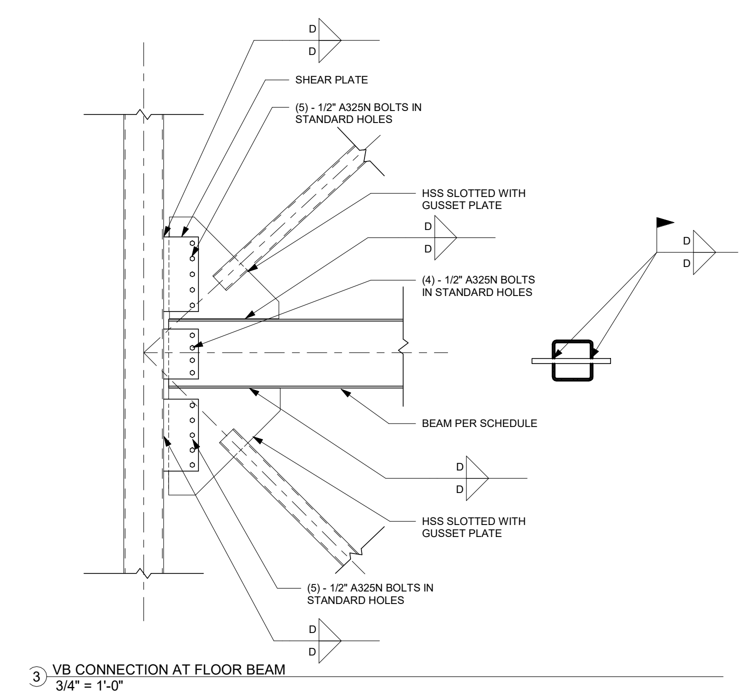
This phase focused greatly on systems development. Great detail was given to the mechanical systems, lighting systems, sprinklers, and daylighting. Engineers began to develop their analytical models (Risa3D) and performed their hand calculations for slabs, decks, joists, and composite members.



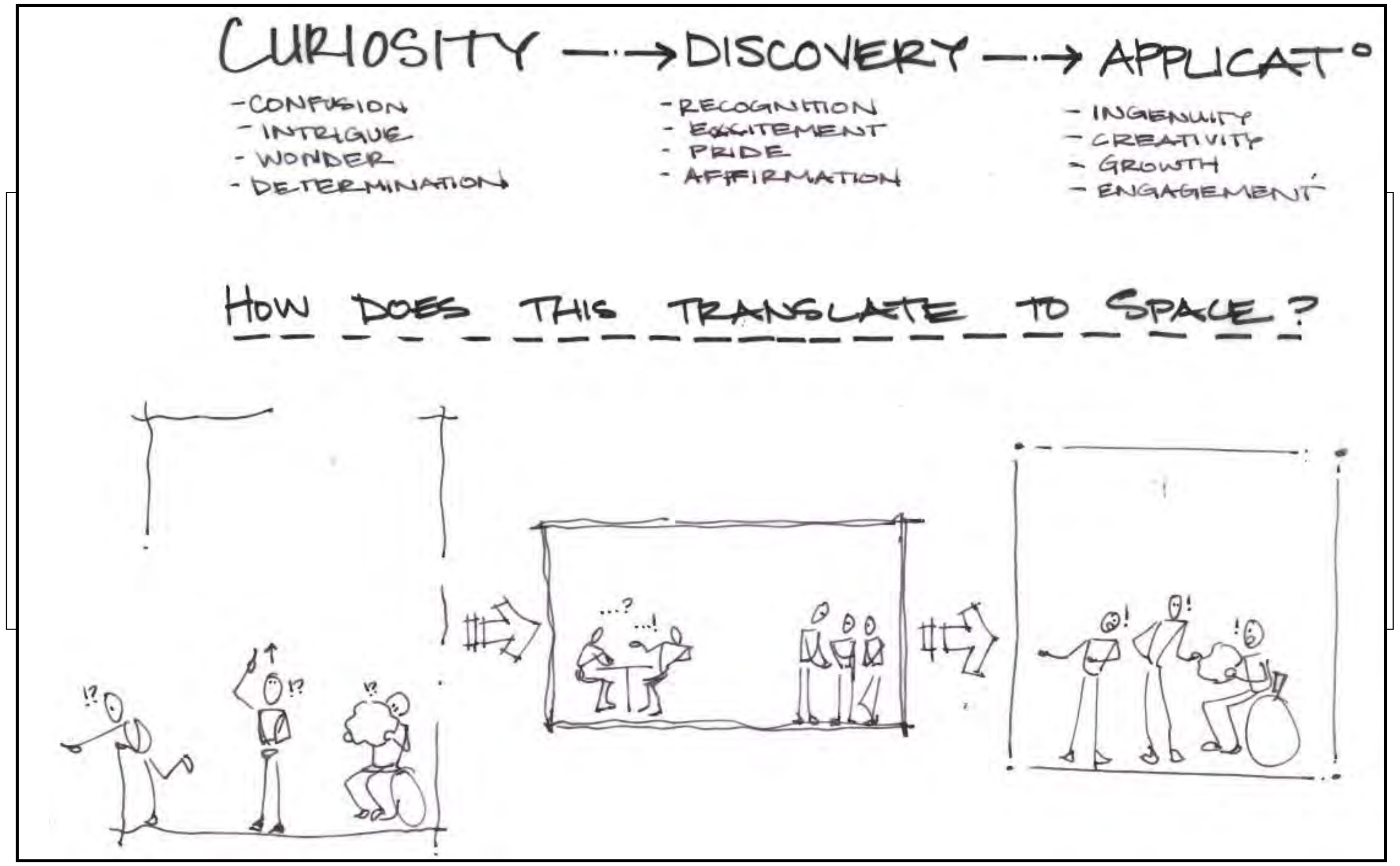
CONSTRUCTION DOCUMENTS

Duration: 8 Days
Style: Individual

For engineers, this was a busy phase including the completion of the analytical model - running the model with load combinations and various member sizes to size all the necessary building elements. Alongside the model design, engineers hand-sized foundation systems, and completed a full set of structural construction documents. At this phase, all members were either designed by hand or with the use of the analytical model, and were updated onto the framing plans. Structural details were required at foundation, floor, roof, and LFRS locations.



DESIGN PROCESS



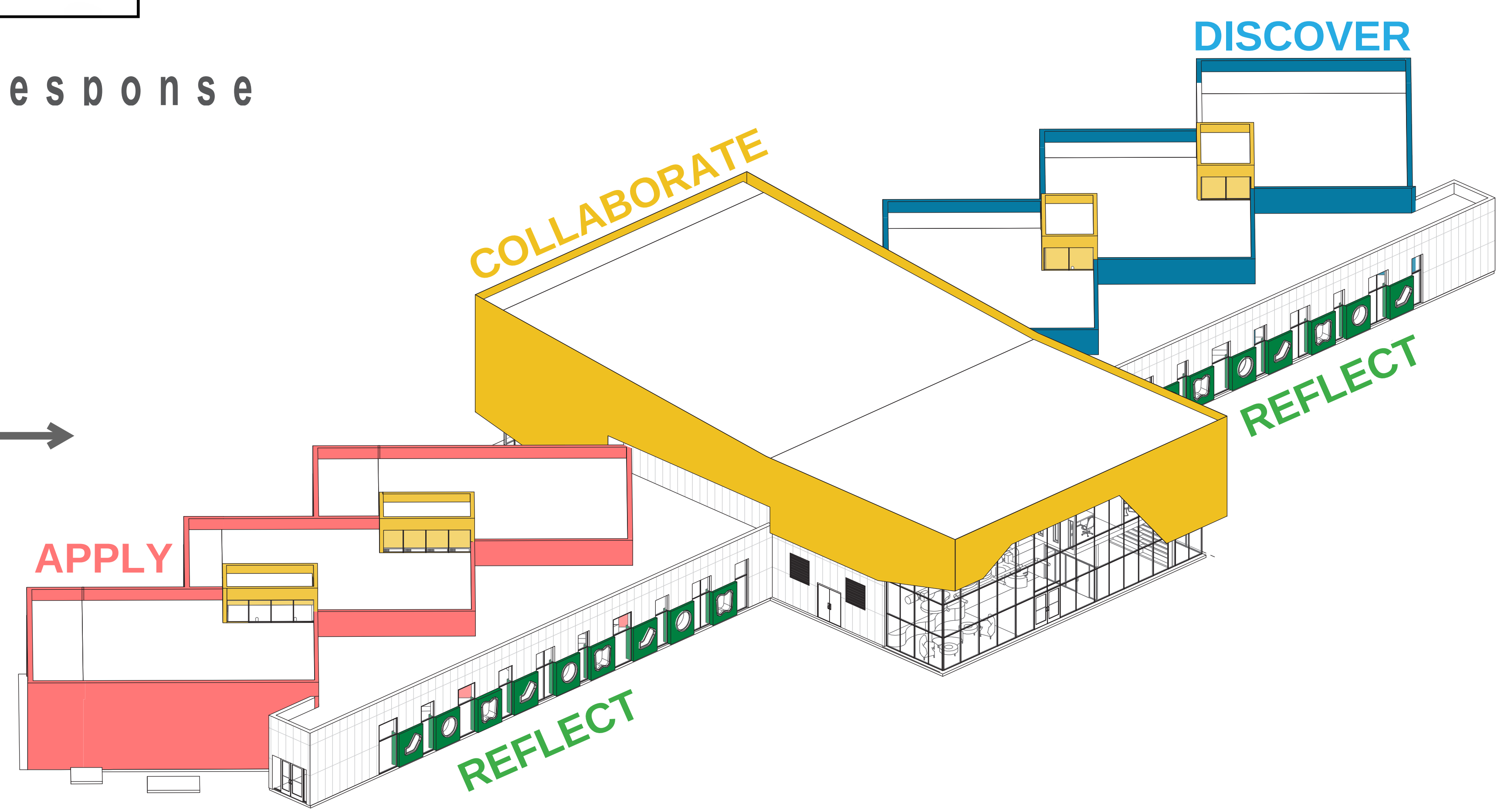
STEAM Engine's goal is to encourage the "Maker Movement" in our youth – a motion for independent learning and Do-It-Yourself problem solving – by creating collaborative environments for students to expand their knowledge. The core principles of the Maker Movement are Discovery, Application, Collaboration, and Reflection. STEAM Engine's pedagogy leads students through an iterative process that reinforces these principles: defining the topic (Discovery), creating and making (Application), working in teams (Collaboration), and presentation (Reflection).

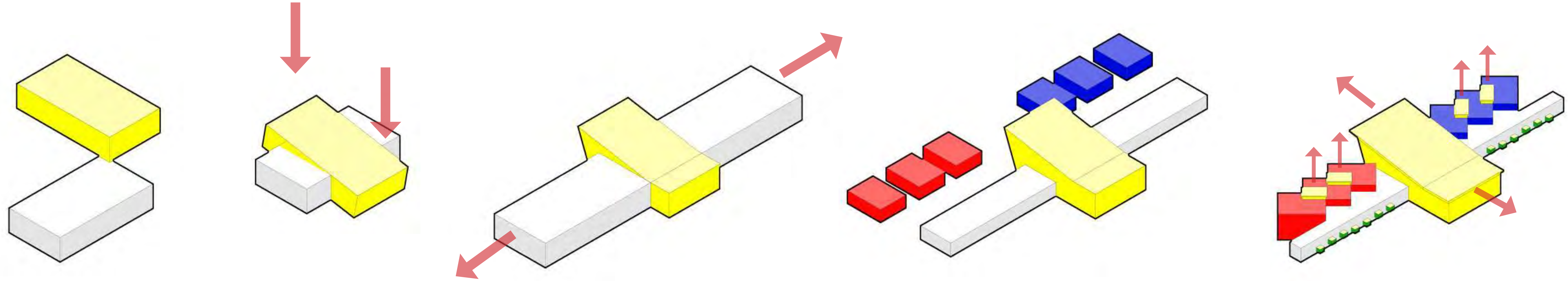
A series of **interlocking** studio spaces facilitate this process. Designed as **repetitive modules**, the studios are open, adaptable, and flexible. As the collaboration level changes, the interlocking of spaces gives students and teachers the ability to reshape the learning environment. This modular design creates a backdrop for spontaneous learning and creative use of the space.

MODULAR response

DISCOVERY	→	studio
APPLICATION		lab
COLLABORATION		gathering/collab
REFLECTION		intimate space

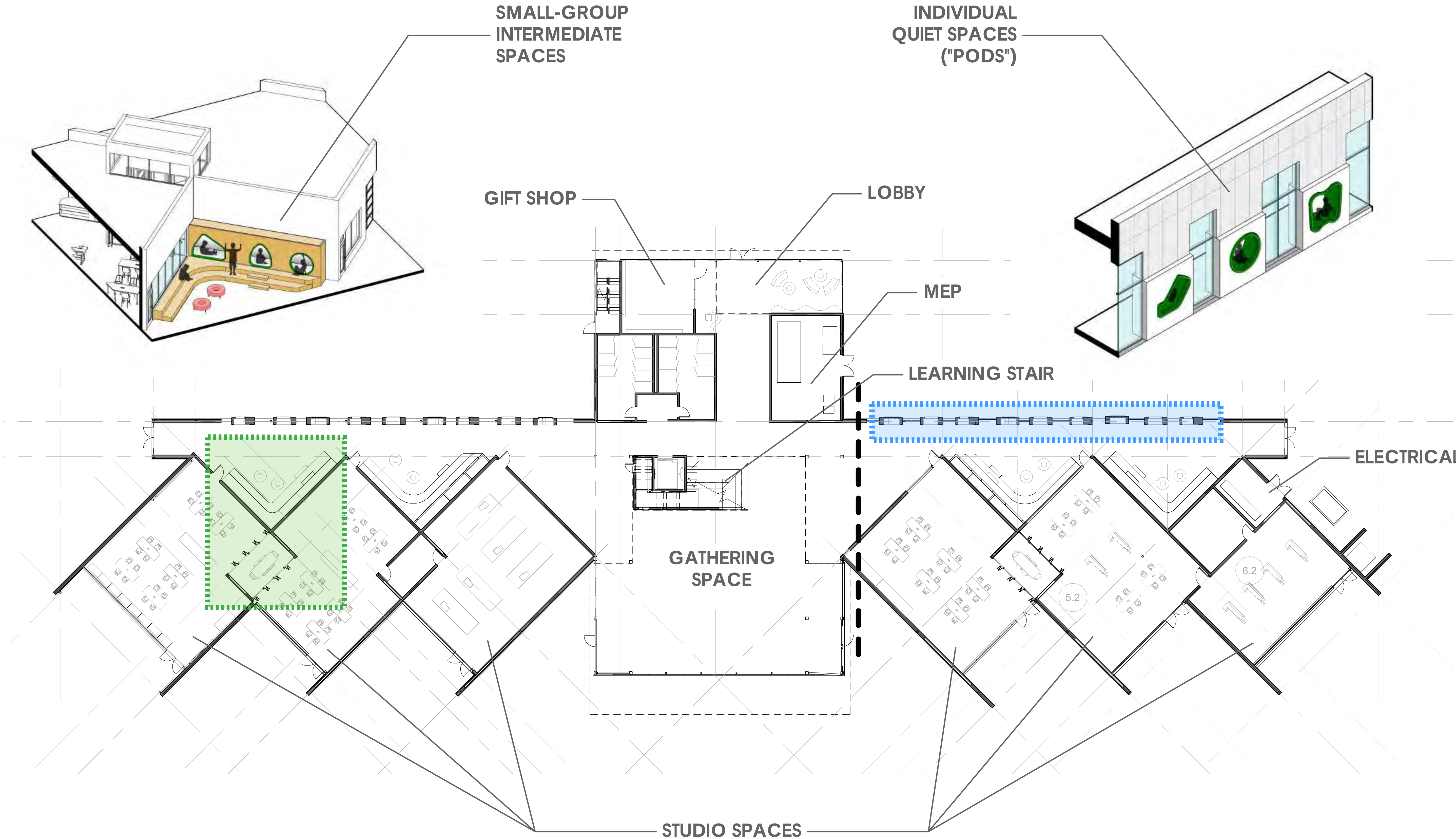
→



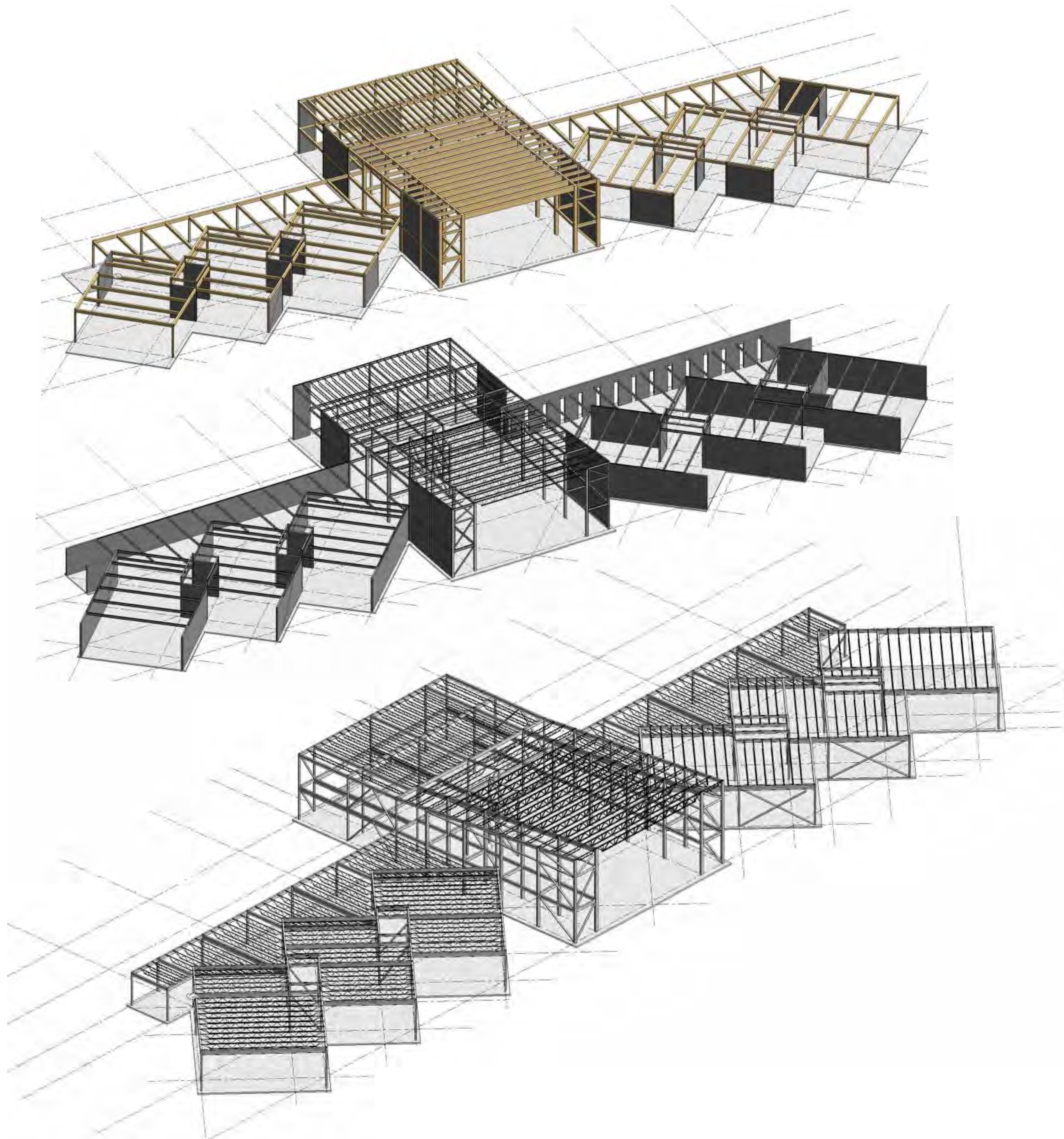


AS NOTED ABOVE, THE FORM REFLECTS THE MODULAR RESPONSE TO THE PREMISE AND CONCEPT. MANY FORM ITERATIONS WERE EXPLORED BEFORE SETTLING ON THIS SYMMETRICAL FORM WITH WINGS AND A CORE FOLLOWING A STRONG AXIS.

SD FORM & AERIAL



SD FLOOR PLAN



THREE STRUCTURAL SYSTEMS WERE ORIGINALLY EXPLORED AND EVALUATED FOR COST, AVAILABILITY, CONSTRUCTABILITY, AND APPROPRIATENESS FOR THE DESIGN INTENT AND SCALE.

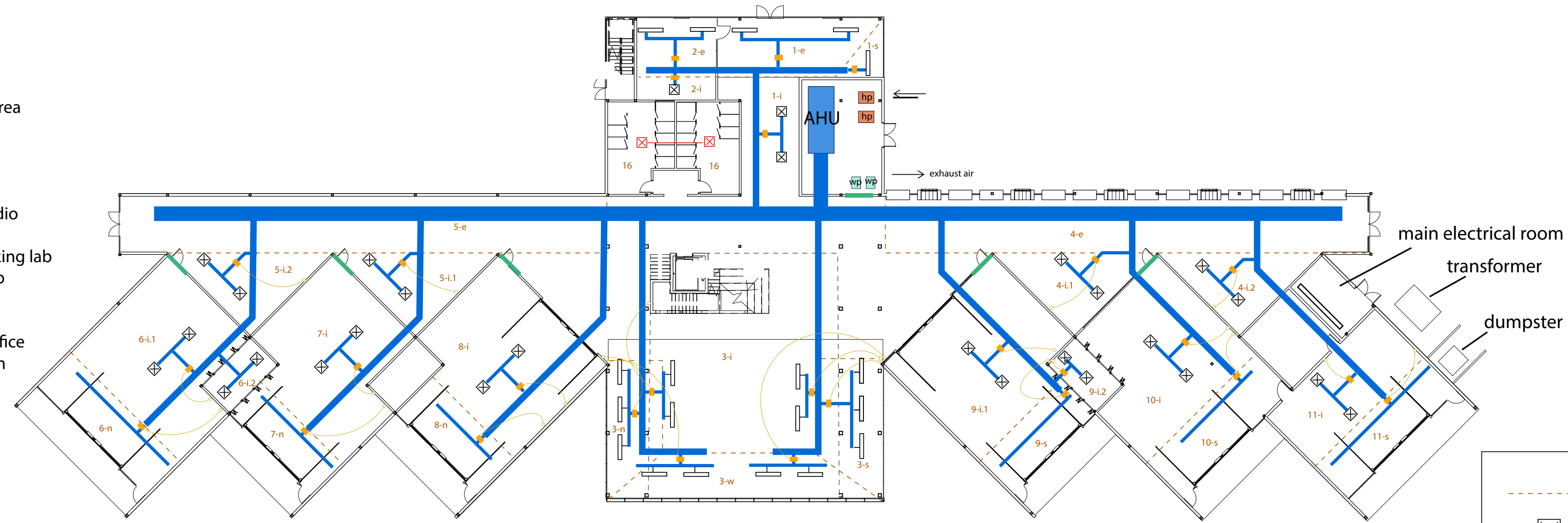
SYSTEM 1: WOOD FRAMING AND CONC. SHEAR WALLS
REJECTED BECAUSE TIMBER SYSTEMS DON'T MATCH THE DESIGN CONCEPT AESTHETIC, AND MASS-TIMBER MUST BE SOURCED FROM A GREAT DISTANCE BECAUSE IT IS NOT A LOCAL MATERIAL. TIMBER SPANS ARE DEEPER THAN STEEL SPANS, AND CONNECTION TO COCNRETE WALLS REQUIRES THOROUGH DETAILING.

SYSTEM 2: STEEL FRAMING AND CONC. LOAD-BEARING WALLS
REJECTED BECAUSE CONCRETE WALLS ARE HEAVY, AND THEY RESULT IN A MORE ROBUST FOUNDATION. STEEL HAS A LONG ORDER TIME, AND PREFABRICATED JOISTS ARE HEAVILY BACK-ORDERED DUE TO THE CURRENT SUPPLY CHAIN ISSUES. BECAUSE THE STEEL IS TO BE EXPOSED IN THE CORE AREA, FIREPROOFING CONSIDERATIONS ARE NECESSARY

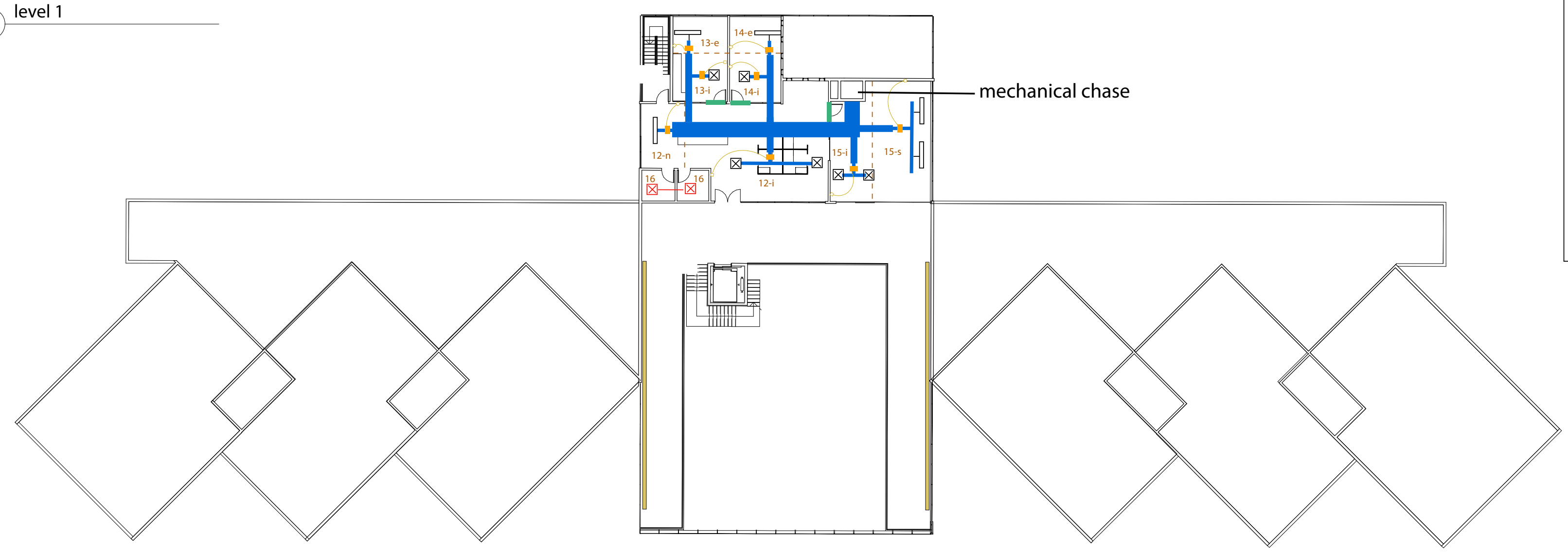
SYSTEM 3: ALL STEEL FRAMING, STEEL ROOF JOISTS, STEEL V-BRACE
SELECTED BECAUSE STRUCTURALLY, THIS SYSTEM IS EFFICIENT AND THE MATERIALS ARE CHEAP AND EASILY ACCESSIBLE FOR THE PROJECT LOCATION. THE SPANS OF THE STEEL ARE WITHIN THEIR EFFICIENT RANGE. STEEL BRACE FRAMES ARE THE BEST LATERAL SYSTEM FOR COORDINATION WITH THE ARCHITECTURAL PROGRAM, ALLOWING FOR DOORS TO FIT WITHIN THE BAY OF THE FRAME. STEEL STRUCTURES OFFER FLEXIBILITY IN FUTURE DESIGN.

FOUNDATIONS:
BASED ON THE GEOTECHNICAL REPORT FOR THE SITE, THE SUGGESTED FOUNDATION SYSTEM CONSISTS OF SHALLOW SPREAD FOOTINGS AND CONTINUOUS FOOTINGS. BECAUSE THIS PROJECT IS A MAXIMUM OF TWO STORIES, THE COLUMN AND FACADE LOADS ARE NOT EXTREME ENOUGH TO WARRANT DEEP FOUNDATIONS. AS SUCH, THE FOUNDATION WILL BE A COMBINATION OF 5-INCH CONCRETE SLAB ON GRADE, SPREAD FOOTINGS UNDER COLUMNS (MINIMUM OF 30 INCHES WIDE), CONTINUOUS FOOTINGS UNDER EXTERIOR WALLS.

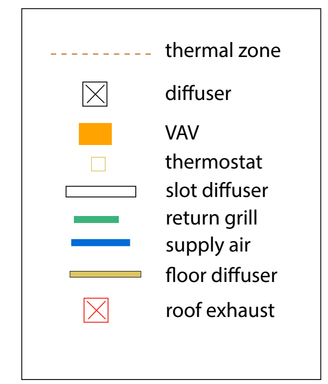
1. lobby
2. gift shop
3. gathering area
4. hallway
5. hallway
6. studio
7. studio
8. kitchen studio
9. lab
10. woodworking lab
11. wood shop
12. office
13. lounge
14. director office
15. boardroom
16. restroom



1 level 1



1 level 2



FOR SCHEMATIC DESIGN, A PRELIMINARY HVAC SYSTEM WAS SELECTED AND AN HVAC LAYOUT CONSTRUCTED. WE ALSO COMPARED A BASELINE ENERGY MODEL TO OUR SD MECH SYSTEM AND USAGE TO GET AN IDEA OF THE PERFORMANCE OF THE BUILDING.

WE RECEIVED FEEDBACK AT THIS TIME THAT WOULD ALLOW US TO CLEAN UP AND SIMPLIFY OUR HVAC PLAN IN THE DD PHASE, AND FURTHER CONSIDERATIONS OF WALL AND ROOF THERMAL RESISIVITY WOULD IMPROVE THE BUILDING PERFORMANCE EVEN FURTHER.

Envelope | Usage and Schedules | Building System | Energy Generation | General

Inputs

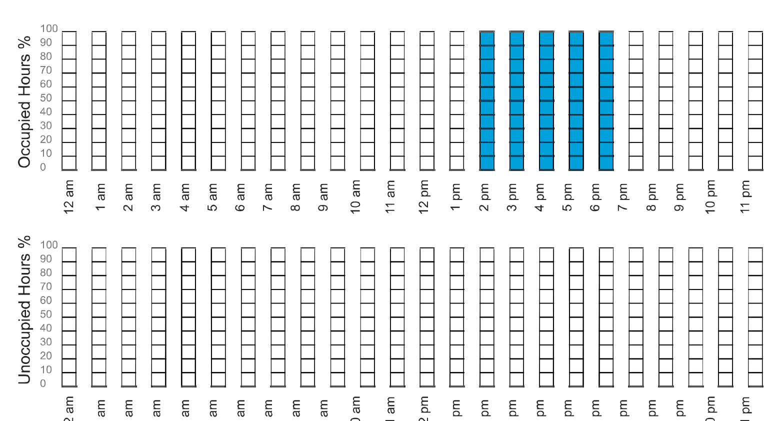
Daylight Sensors (%)	Sensors: 100%
Occupancy Sensors (%)	No Sensors: 0%
Lighting (W/ft²)	1.2
Lighting (Unoccu. Hrs) (W/ft²)	0.12
Exterior Lighting Power (Watts)	500.0 Zone 1 (Developed Area...
Appliance Use (W/ft²)	0.35
Appliance Use (Unoccu.) (W/ft²)	0
Metabolic Rate (MET Value)	Walking: 200
Heating Set-Point (F)	72
Heating Set back (F)	67
Cooling Set-Point (F)	75
Cooling Set back (F)	80
Total Occupants (Occupied Hours)	1265
Total Occupants (Unoccupied Hours)	2

Occupancy Schedules

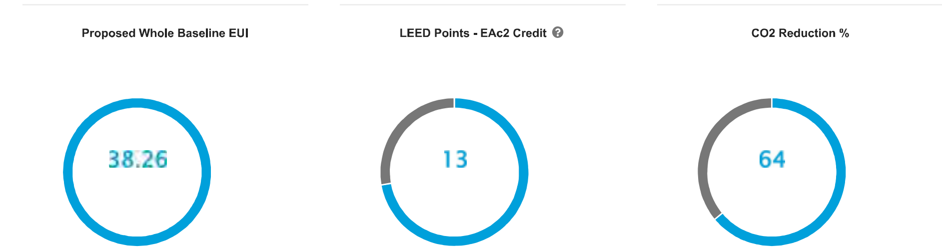
Months of Year - Full Occupancy

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Days of Week - Full Occupancy **Sun** Mon Tue Wed Thu Fri **Sat**



Baseline Energy



Education 38.26 kBtu/ft²/yr

Electricity $24437.67 /yr
Natural Gas $350.08 /yr

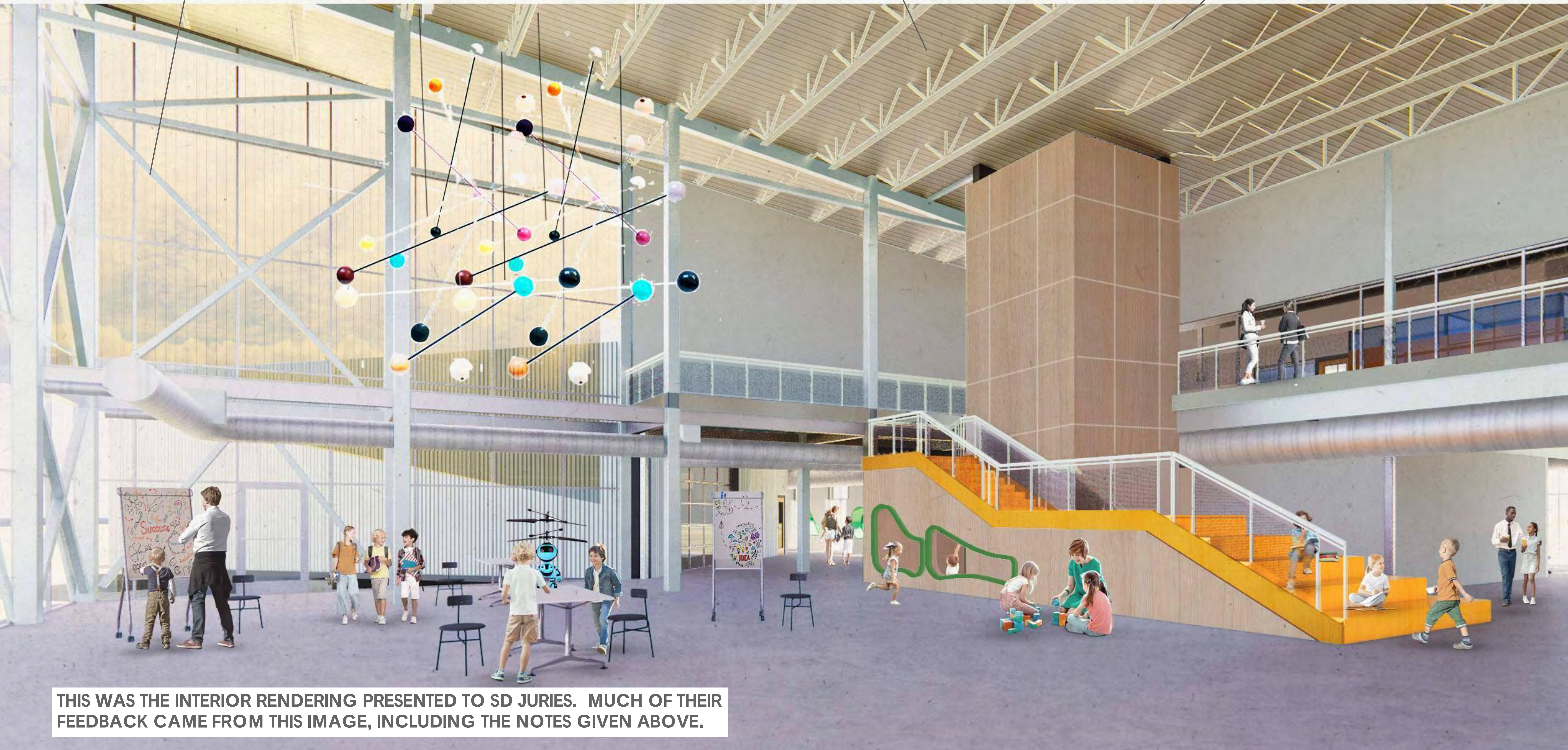
2030 Baseline Emissions 449 Tonne CO2e/yr
157.7 Tonne CO2e/yr
You Saved 44 Trucks of Ice/yr

SD MECH SYSTEMS

BRACING ADJUSTED FOR OVERTURNING

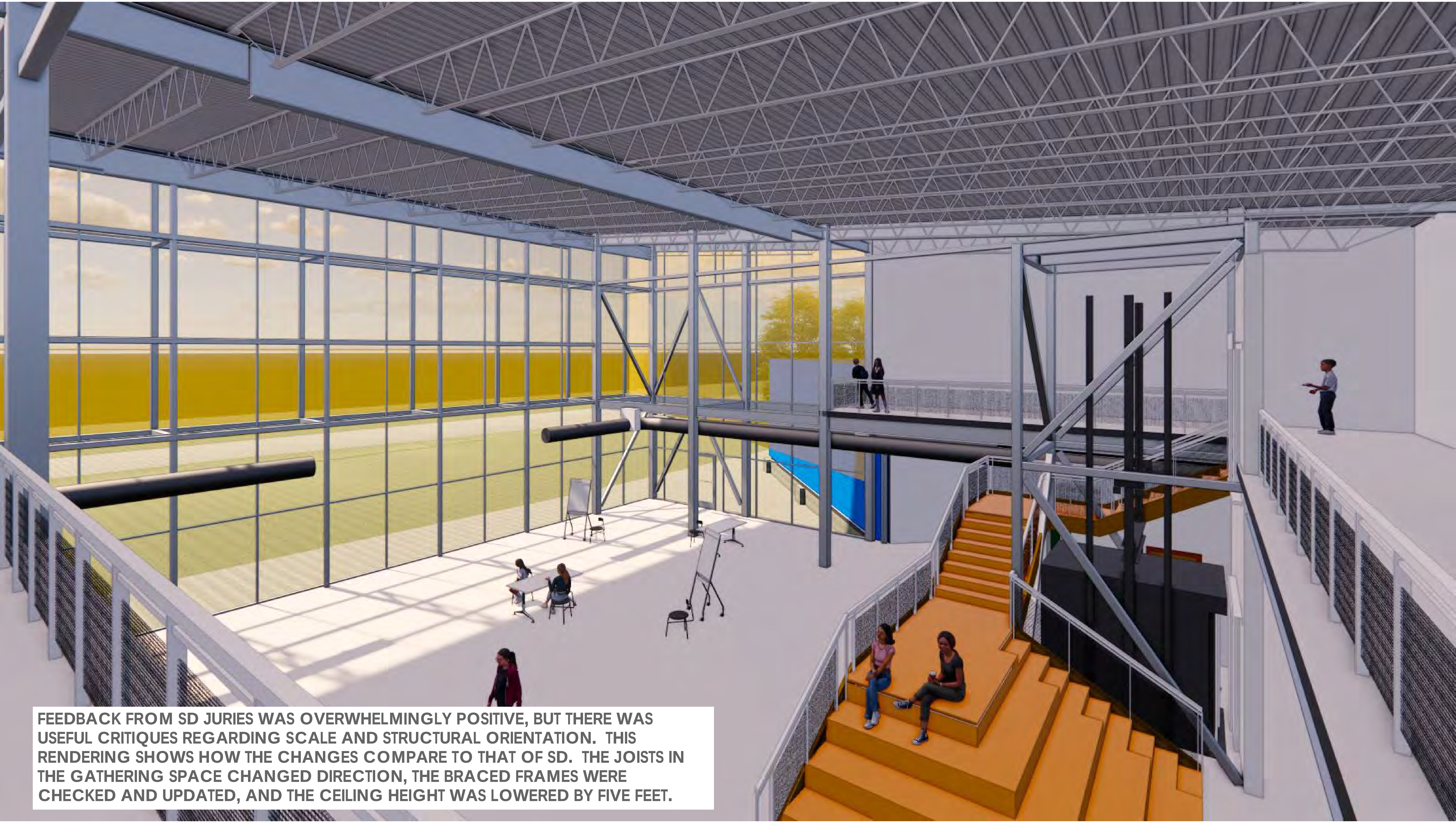
ROOF HEIGHT: TOO TALL FOR SCALE? REDUCED HEIGHT

CHANGED ORIENTATION OF ROOF FRAMING



THIS WAS THE INTERIOR RENDERING PRESENTED TO SD JURIES. MUCH OF THEIR FEEDBACK CAME FROM THIS IMAGE, INCLUDING THE NOTES GIVEN ABOVE.

FIXES TO SD



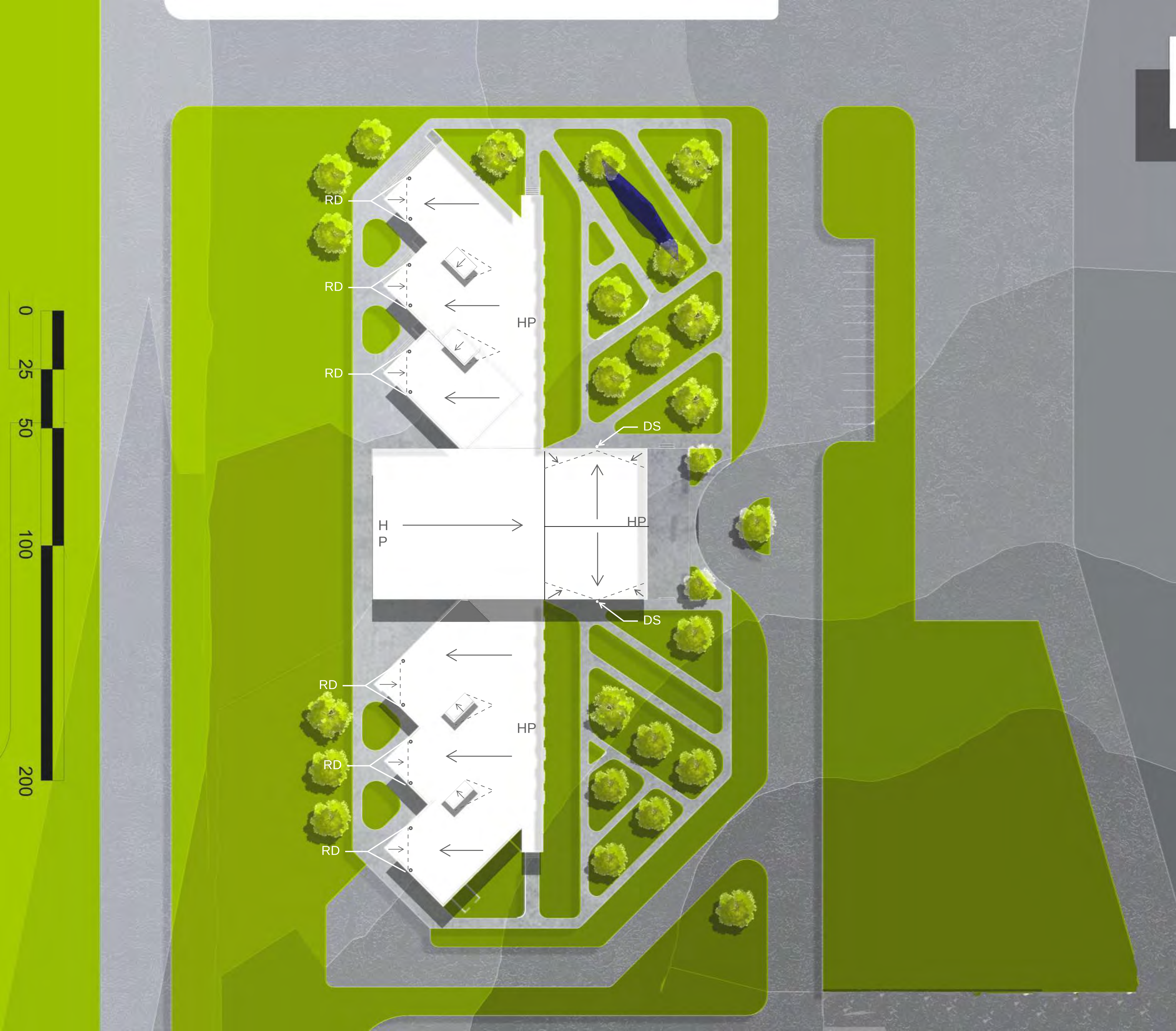
FEEDBACK FROM SD JURIES WAS OVERWHELMINGLY POSITIVE, BUT THERE WAS USEFUL CRITIQUES REGARDING SCALE AND STRUCTURAL ORIENTATION. THIS RENDERING SHOWS HOW THE CHANGES COMPARE TO THAT OF SD. THE JOISTS IN THE GATHERING SPACE CHANGED DIRECTION, THE BRACED FRAMES WERE CHECKED AND UPDATED, AND THE CEILING HEIGHT WAS LOWERED BY FIVE FEET.

DD CHANGES

THE ONLY CHANGES TO THE EXTERIOR BETWEEN SD AND DD WERE THE SHADING DEVICE. SEEN HERE, THE FRONT SHADING DEVICE HAS AN OVERHANG. THIS IS NO LONGER THE CASE IN DD, AS IT IS FLUSH TO THE CURTAIN WALL; HOWEVER, ON THE FAR SIDE, THE SHADING DEVICE RETAINS ITS OVERHANG OF 5 FT, WHICH WAS EXPLORED STRUCTURALLY.

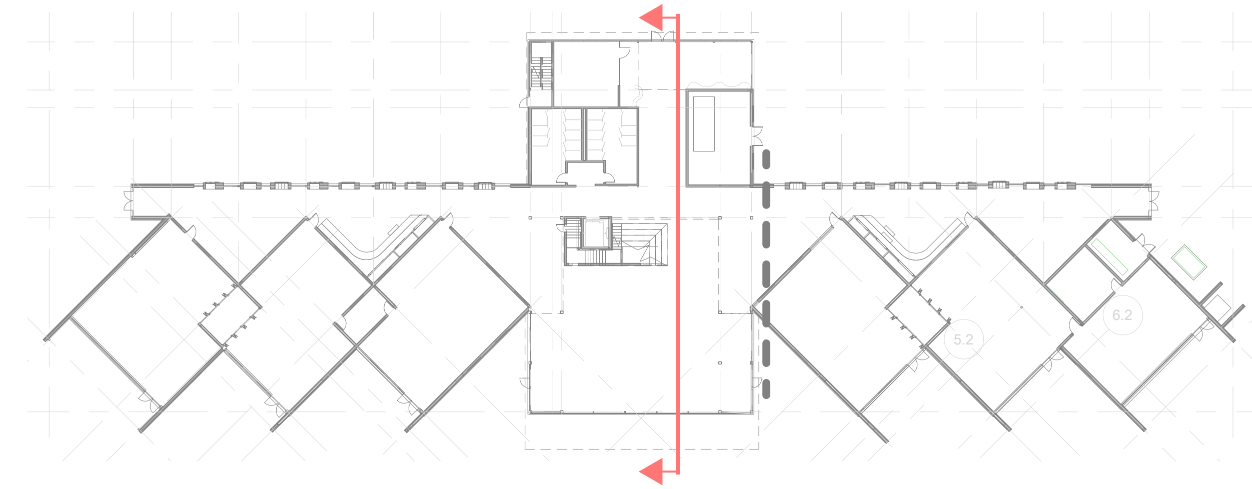
EXTEIROR PERSPECTIVE

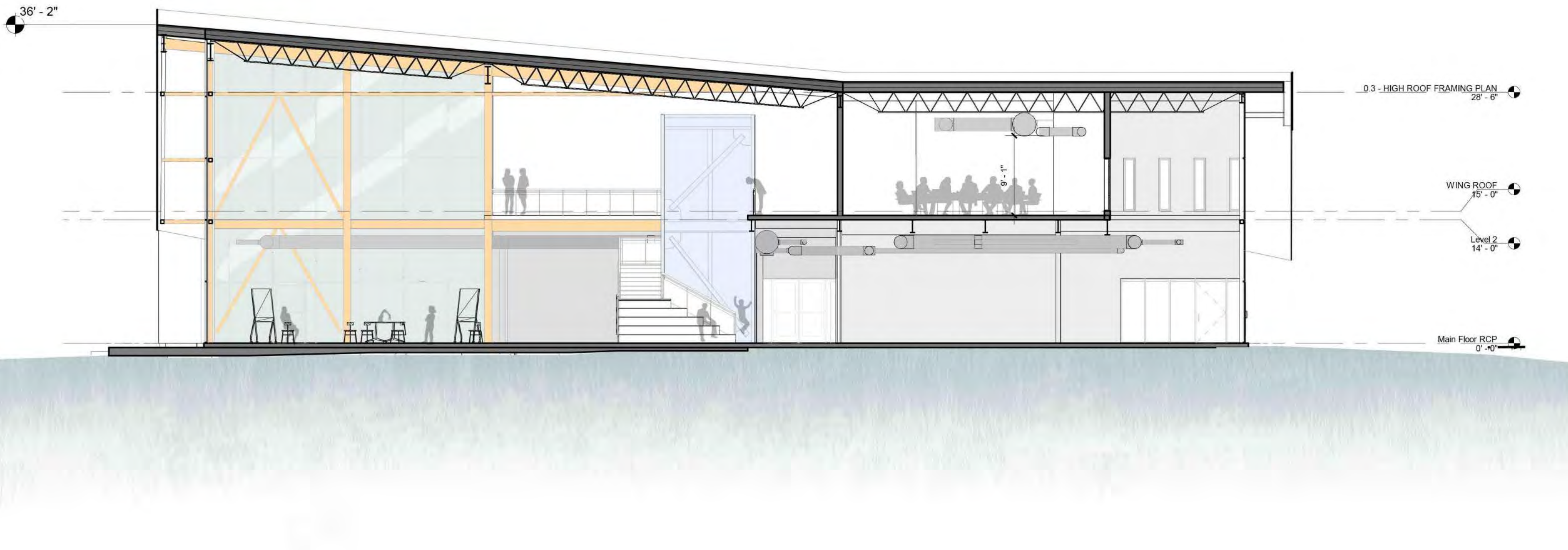
UNCHANGED FROM SD



ROOF DRAINAGE WAS TAUGHT AND EXPLORED IN DD. THIS IS THE THIRD ITERATION OF ROOF DRAINAGE, AFTER HAVING RECEIVED FEEDBACK FROM PROFESSORS AND INDUSTRY PROFESIONALS. ULTIMATELY, ITS EASIEST TO HAVE THE STRUCTURE FACILITATE THE SLOPE OF THE ROOF FOR DRAINAGE, RATHER THAN RELYING ON TAPERED INSLUATION. AS SUCH, THE STRUCTURE WAS UPDATED FOR MINIMUM SLOPE.

SITE PLAN + DRAINAGE





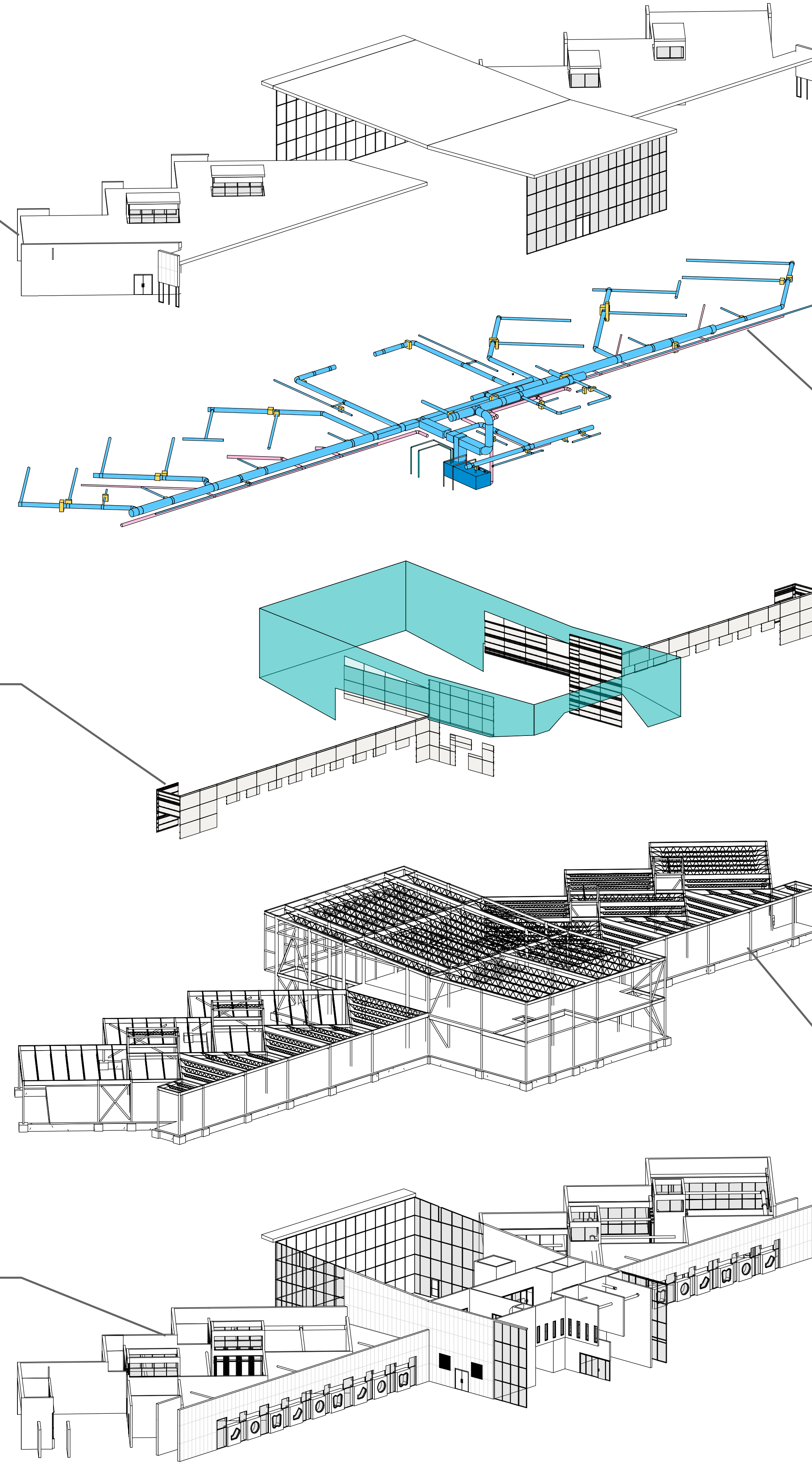
TRANSVERSE BUILDING SECTION

MUCH OF DESIGN DEVELOPMENT WAS CONCENTRATED ON THE FOCUS SPACE. FOR THIS PROJECT, I SELECTED THE NORTHERN STUDIO SPACE. FOR THIS SPACE, WE DESIGNED THE LIGHTING, DAYLIGHTING, WALL AND ROOF SECTIONS, THERMAL RESISTIVITY OF THE ENVELOP, AND AN RCP INCLUDING FIRE SUPPRESSION.

SHOWN HERE, THE SYSTEMS (HVAC, LIGHTING, STRUCTURE) ARE AN INTEGRAL PART OF THE DESIGN CONCEPT. THE GOAL IS THAT STUDENTS MAY LEARN FROM THE EXPOSURE OF THE SYSTEMS AROUND THEM.

THE STRUCTURE IS BLUE BECASE I PERSONALLY LIKE WHEN THE STRUCTURE IS EXPOSED AND ACCENTUATED!

FOCUS SPACE



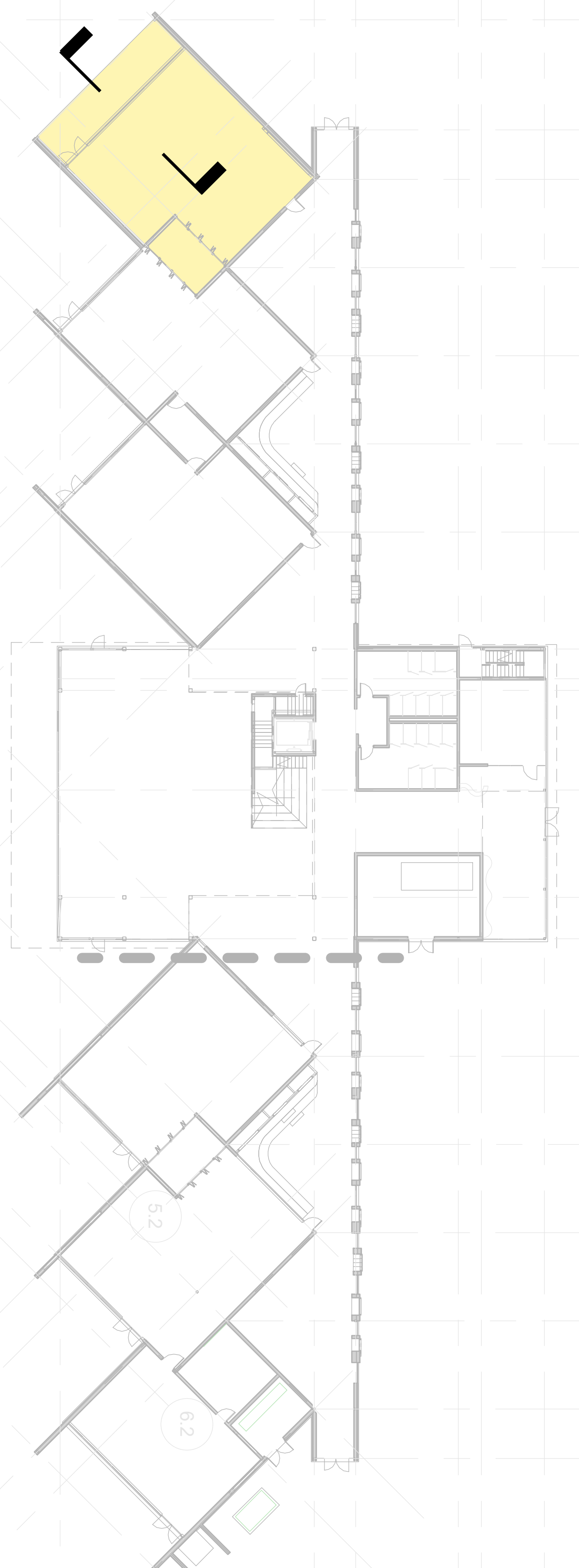
A GREAT DEAL OF TIME IN DD WAS SPENT DEVELOPIING THE SYSTEMS. SOME SYSTEMS, LIKE THE HVAC PLAN, WERE EVALUATED FOR THE WHOLE BUILDING, WHEREAS OTHERS (LIGHTING, DAYLIGHTING, FIRE SUPPRESSION, ETC) WERE ONLY DEVELOPED FOR THE SO-CALLED FOCUS SPACE.

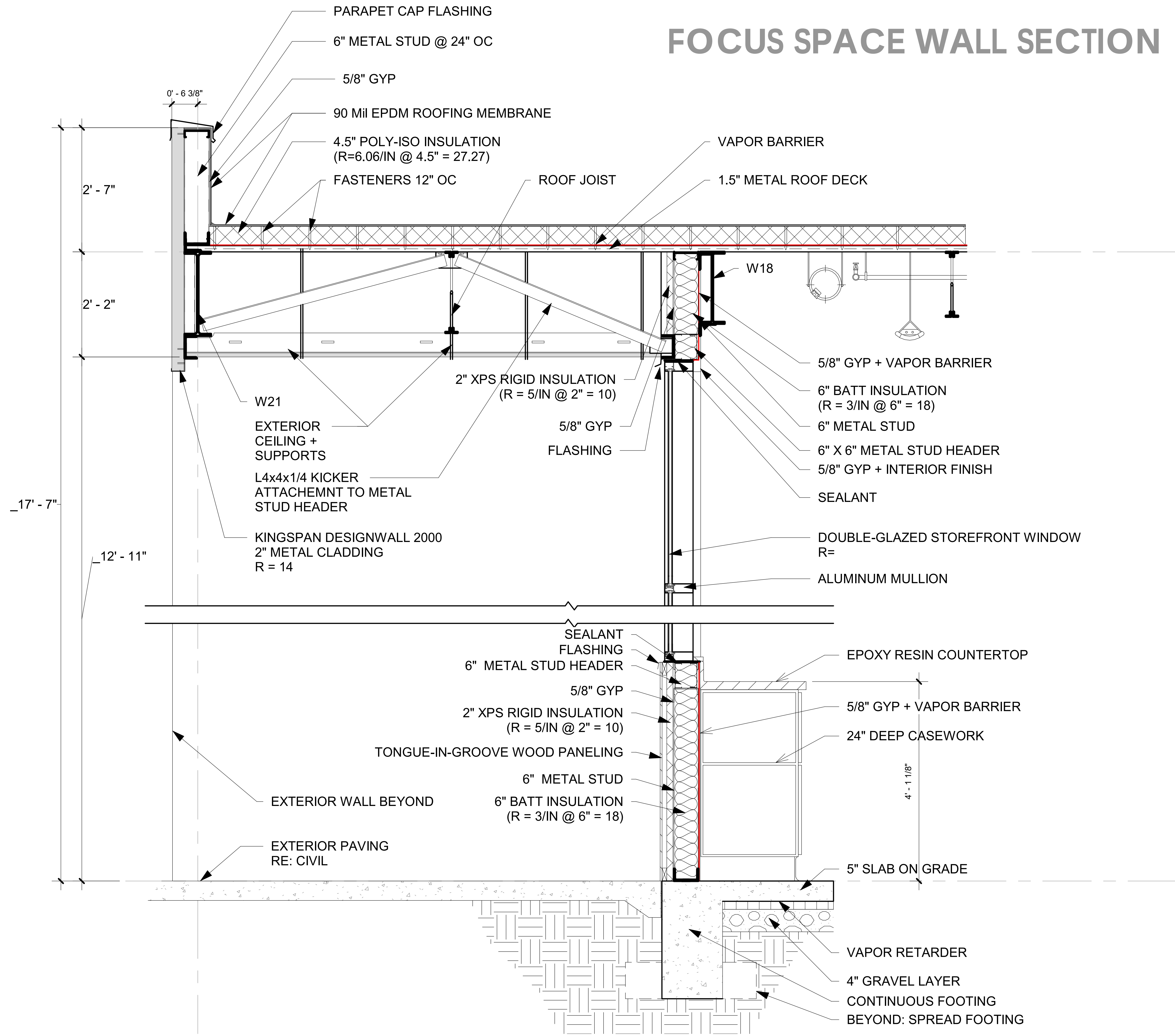
MANY OF THESE COMPONENTS WERE DUE TO OUR PROFESSORS INDIVIDUALLY, AND WE RECEIVED FEEDBACK ON EACH BEFORE COMPILING IT ALL IN AN HVAC AND PERFORMANCE PACKAGE.

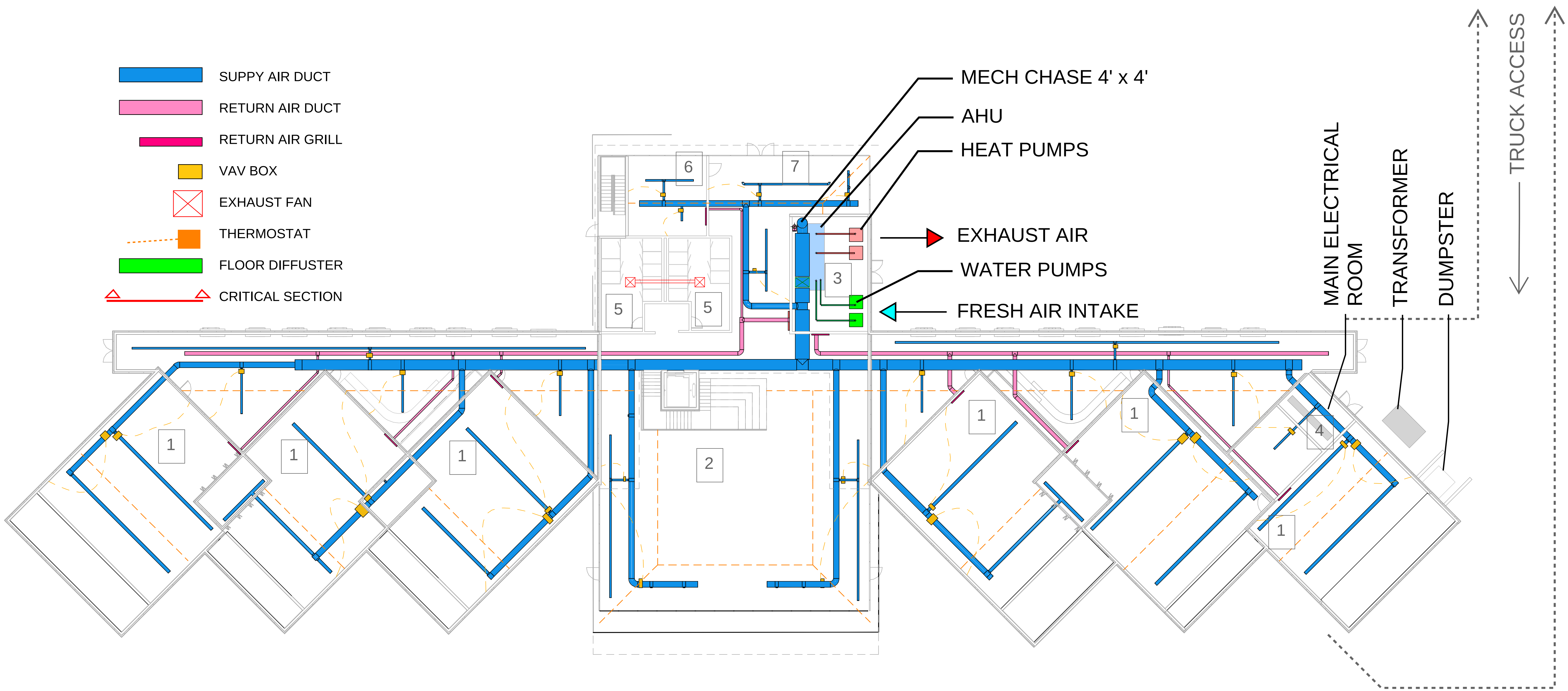
THE FOLLOWING PAGES HIGHLIGHT THE DIFFERENT ASPECTS OF THE HVAC AND PERFORMANCE CALCULATIONS AND PLANNING.

DD MEP SYSTEMS

FOCUS SPACE WALL SECTION



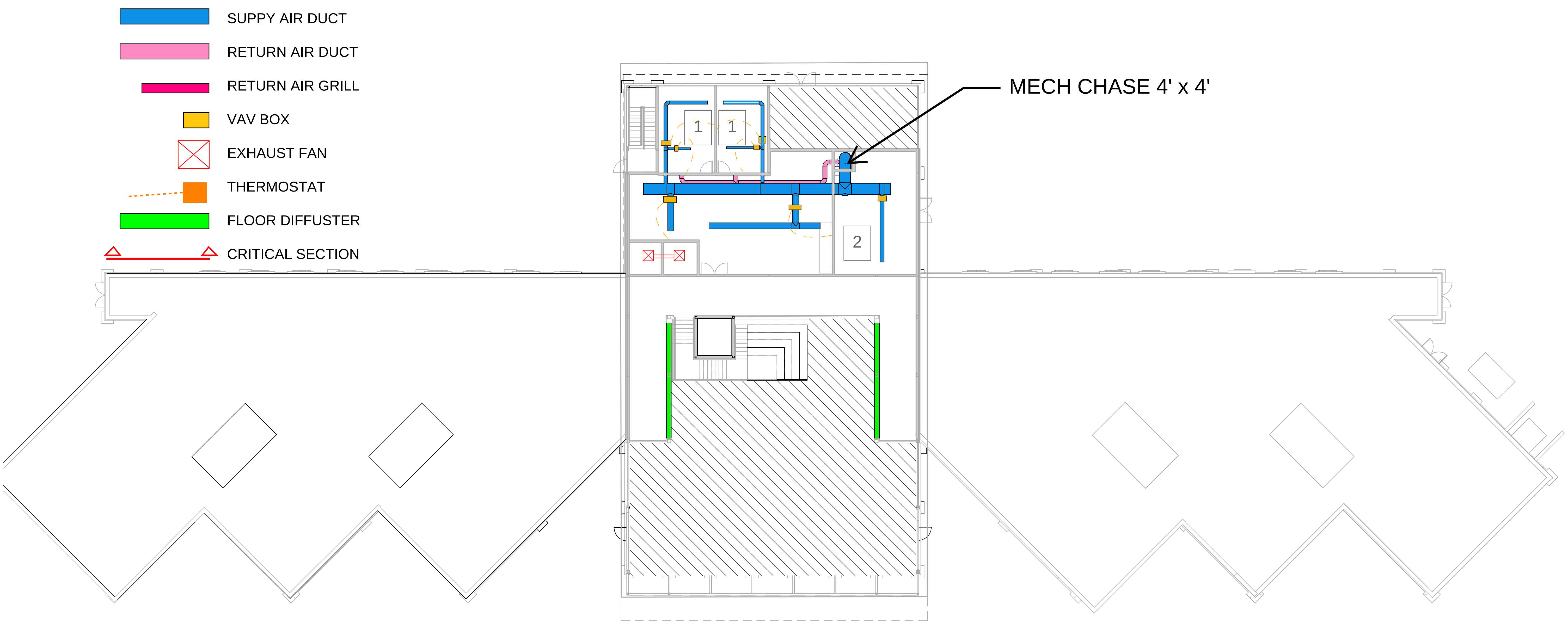




1ST FLOOR HVAC PLAN

1: STUDIO/LAB/CLASSROOM
2: GATHERING
3: MECH & SATELLITE ELEC ROOM
4: ELEC ROOM
5: RESTROOM
6: GIFTSHOP
7: ENTRY

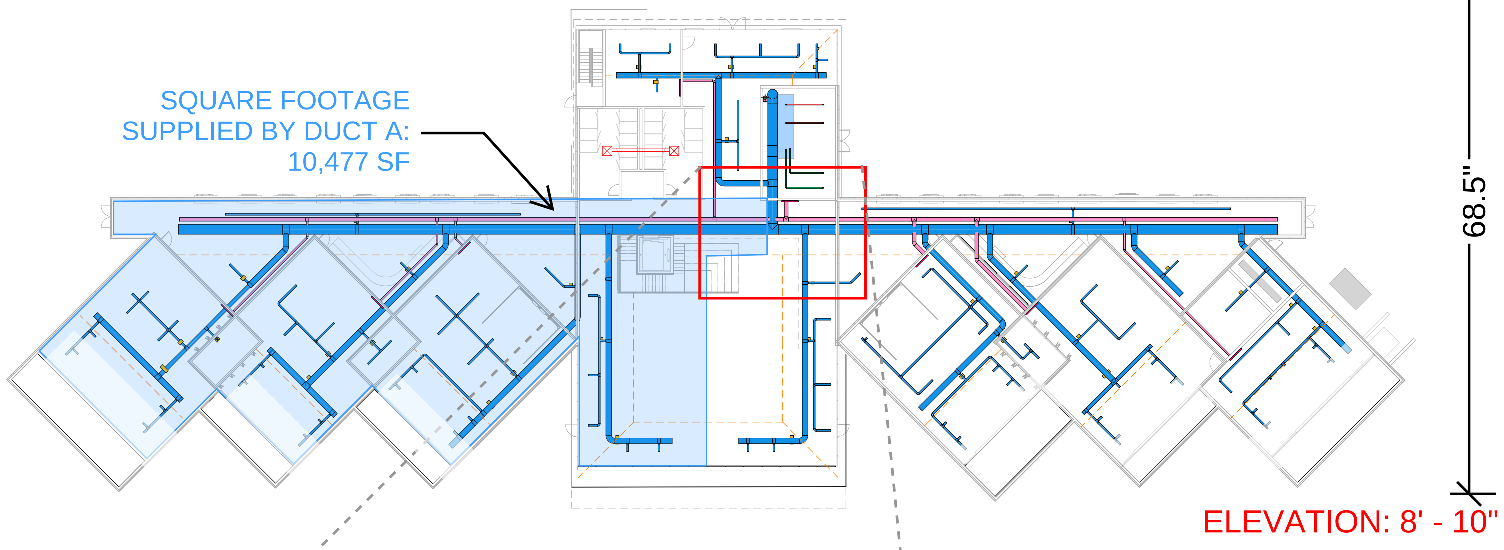
MEP - GROUND FLOOR

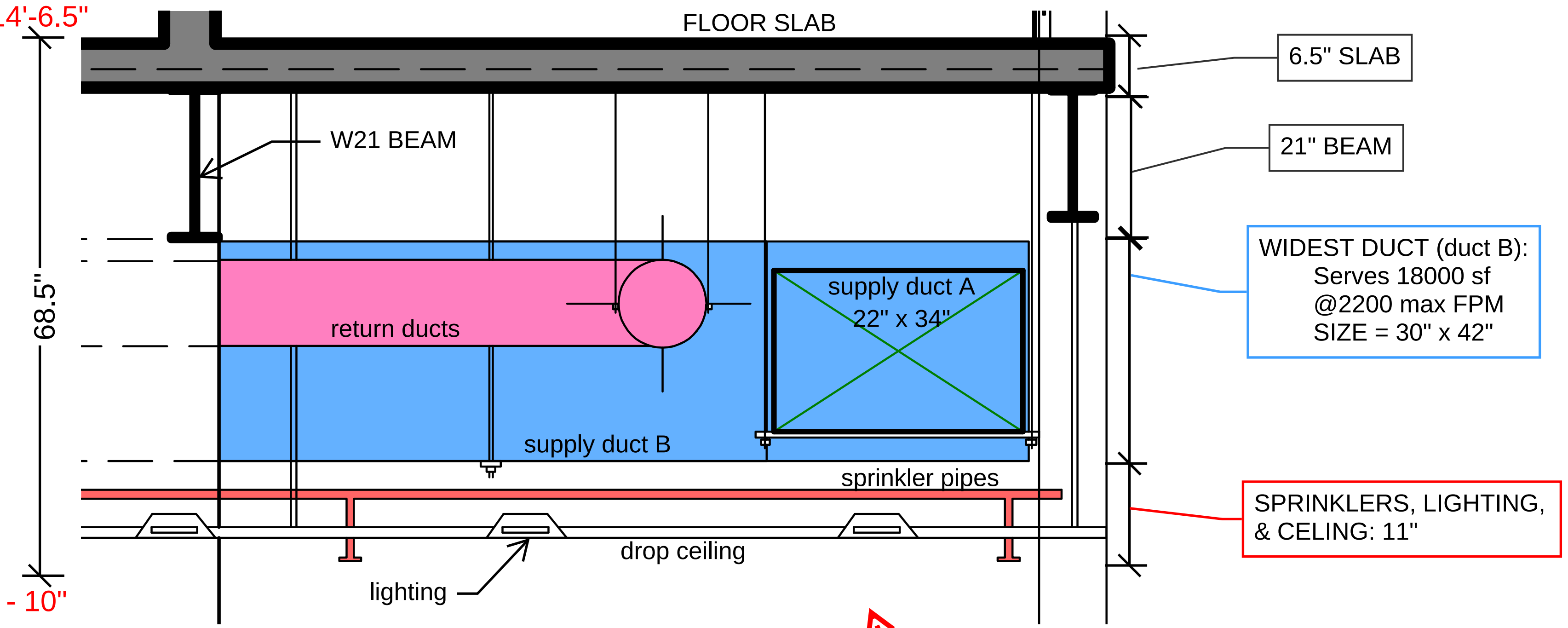


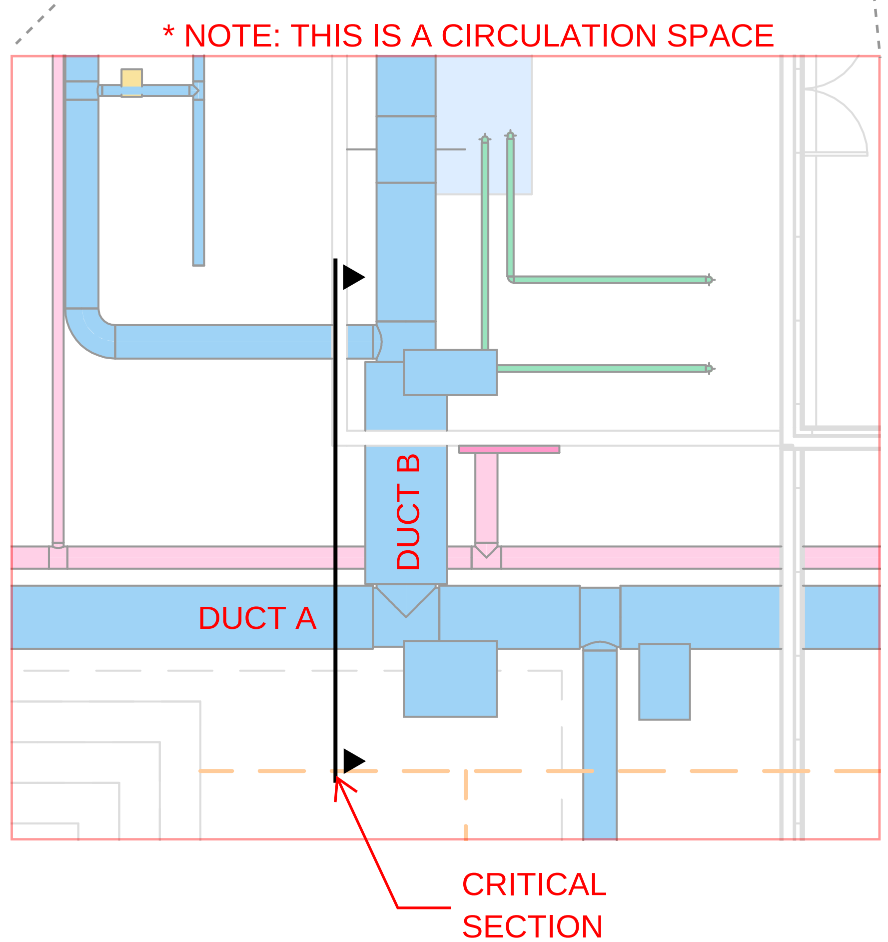
2ND FLOOR HVAC PLAN

1: OFFICE
2: CONFERENCE ROOM

MEP - ELEVATED FLOOR







Online Ductulator

Duct type: Metal (selected) / Ductboard / Flex

Size by: Friction rate / Velocity (selected)

Velocity: 2200 fpm

Duct TEL : 100 ft. * include fittings in the Duct TEL

Enter either: CFM: (selected) or Duct Size:

CFM: 10500

Calculate

Diameter = 29.6" Friction Rate = 0.196

Convert Rectangular duct to Round Equivalent

Side 1: inches Side 2: inches

Find equivalent round

Convert Round duct to Rectangular Equivalent

Diameter: 29.5 inches Side 1: 22 inches (must enter one side to get the other)

Find second side

Second side: 33.5 "

USE 22" x 34" DUCT A

Online Ductulator

Duct type: Metal (selected) / Ductboard / Flex

Size by: Friction rate / Velocity (selected)

Velocity: 2200 fpm

Duct TEL : 100 ft. * include fittings in the Duct TEL

Enter either: CFM: (selected) or Duct Size:

CFM: 18000

Calculate

Diameter = 38.7" Friction Rate = 0.142

Convert Rectangular duct to Round Equivalent

Side 1: inches Side 2: inches

Find equivalent round

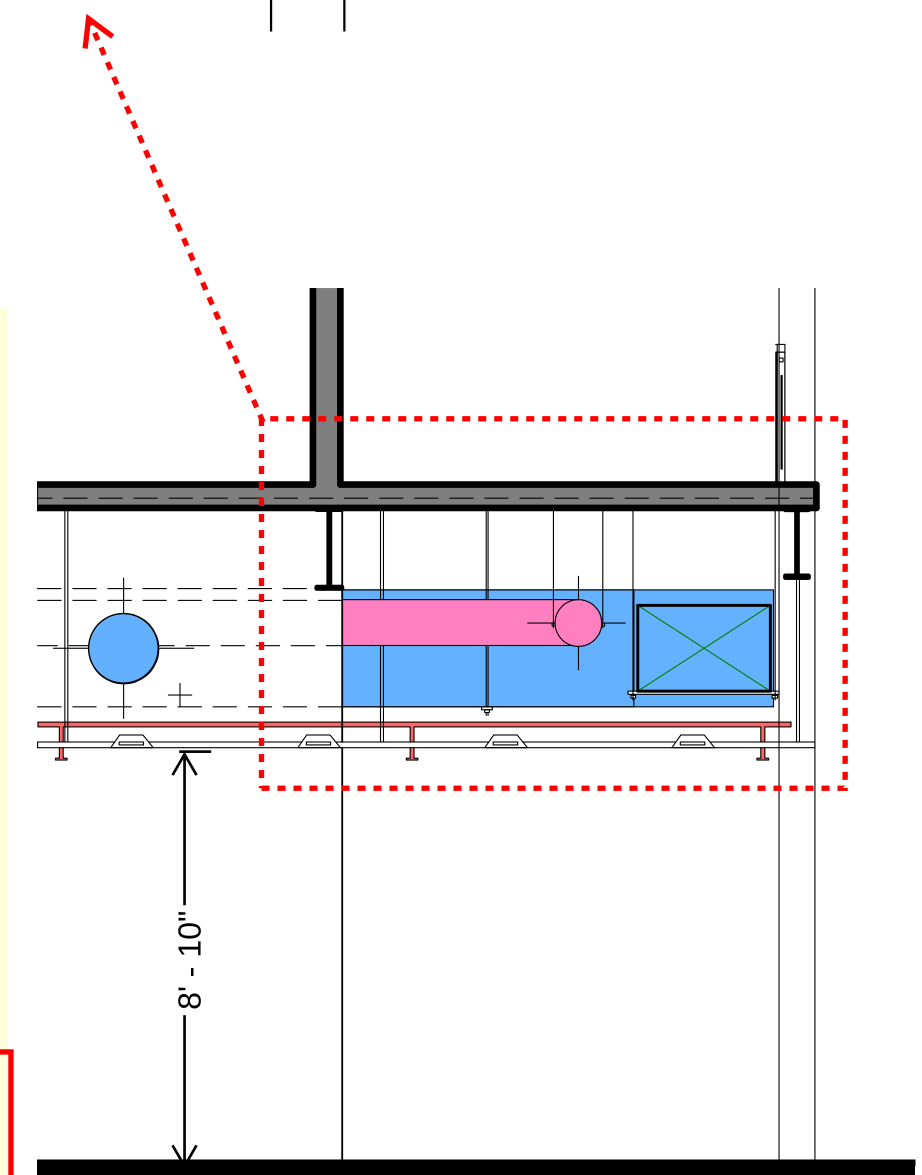
Convert Round duct to Rectangular Equivalent

Diameter: 38.7 inches Side 1: 30 inches (must enter one side to get the other)

Find second side

Second side: 42.1 "

USE 30" x 42" DUCT B



MEP CALCS - CRITICAL SECTION

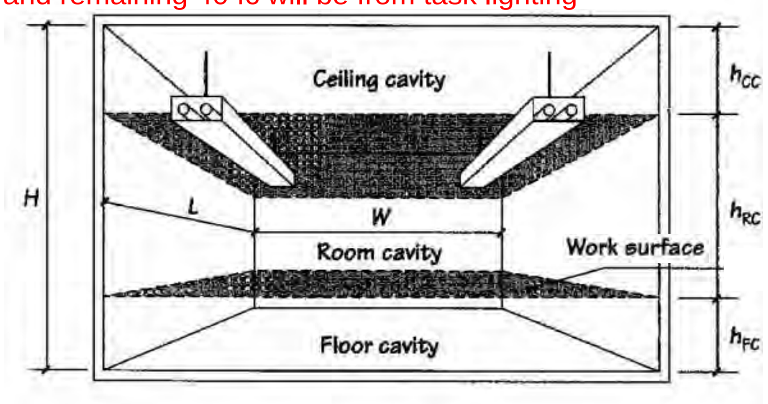
AVERAGE ILLUMINANCE WORKSHEET-ELECTRIC LIGHTING
[LUMEN METHOD-SIMPLIFIED]

Designer: CHARLIE GUYER Space type: STUDIO/CLASSROOM/LABORATORY

PHOTOMETRIC DATA

* 30 fc will be provided from general lighting, and remaining 40 fc will be from task lighting

IESNA Illuminance category: U 70 (Use 30)
IESNA Recommended illuminance (average): ↓ (fc)
[Refer to IESNA tables]
Lamp type: LED
Recommended spacing ratio: 0º = 1.18; 90º = 1.24
Lumen output from one lamp (initial): 5266 (lumens)
Number of lamps per luminaire: 1 (lamps)
Fixture efficiency: 100 (%)
Lumen output from one luminaire: 5266 (lumens)



ROOM DESIGN

L = 44.5 (ft)
W = 41 (ft)
H = 15 (ft)
Ceiling cavity reflectance = CCR = 80 (%)
Room cavity reflectance (walls) = RCR = 50 (%)
Assumed floor cavity reflectance = FCR = *20* (%)

h_{CC} = 4 (ft)
h_{RC} = 8.5 (ft)
h_{FC} = 30" = 2.5' (ft)
*work surface height will range from 30" to 40"

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] = 41 + 1/3 * (44.5-41) = 42.2 ft
RCR = (10 x h_{RC}) / W_{sq} = (10 * 8.5) / 42.2 = 2.01

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

CU = 0.73 = 73%

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
= 5266 * .73 * .65 = 2498 lumens

d. Determine total lumens needed on the workplane:
Total lumens needed on the workplane = Recommended illuminance x area
= 30 * 44.5 * 41 = 54735 lumens

e. Determine needed number of luminaires:
Number of luminaires = Total lumens needed on the workplane/useful lumens from one luminaire

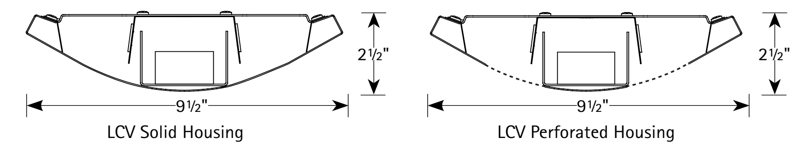
Number of luminaires = 54735 / 2498 = 21.9 .... try 20

Actual illumination level provided = 30 * (20/21.9) = 27.38 fc
Light load = (20 * 43 watts) / (44.5 * 41)sf = 0.47 watt/sf < 1.11 maximum for Laboratory per IECC
Light load index = (0.47 watt/sf) / (27.38 fc) = 0.0172 watt/sf*fc
Covered area per luminaire = (44.5 * 41)sf / (20luminaires) = 91.2 sf/luminaire
System's overall efficiency = 1.0 * 0.73 * 0.65 = 0.475 = 47.5%

ALERA LIGHTING

CURV LED
LED, Indirect, Indirect/Direct Distribution

CROSS SECTION



PHOTOMETRIC DATA

LUMINAIRE DATA Test 16.02449

Luminaire	LCV-35ML-PERF LCV Curv LED, Curves 9.5" X 48" LED with perforated housing and opal overlay
Ballast	XI040C110V054BST1
Ballast Factor	1.00
Lamp	LED
Fixture Lumens	5266
Watts	43
Mounting	Pendant
Shielding Angle	0° = 90 90° = 90
Spacing Criterion	0° = 1.18 90° = 1.24
Luminous Opening in Feet	Length: 3.56 Width: 0.60 Height: 0.06

ZONAL LUMEN SUMMARY

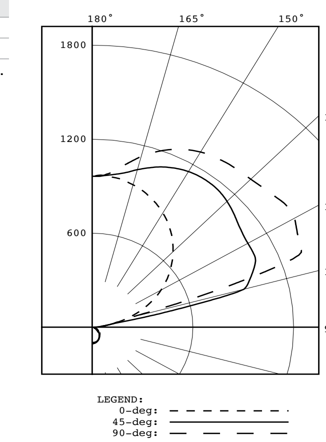
Zone	Lumens	% Fixt.
0-30	78	1.5
0-40	124	2.4
0-60	209	4.0
0-90	271	5.2
90-120	1633	31.0
90-130	2568	48.8
90-150	4101	77.9
90-180	4995	94.8
0-180	5266	100.0

ENERGY DATA

Total Luminaire Efficiency	100.0%
Total Lumens Per Watt	121.2
ANSI/IESNA RP-1-2004 Compliance	Yes-VDT Intensive Use
Comparative Yearly Lighting Energy Cost per 1000 Lumens	$2.40 based on 3000 hrs. and $0.08 per KWH

Efficacy: luminous flux = lumens/watt = 121.2

INDOOR CANDELA PLOT



Test Date 9/23/16

PHOTOMETRIC DATA

Coefficients Of Utilization - Zonal Cavity Method

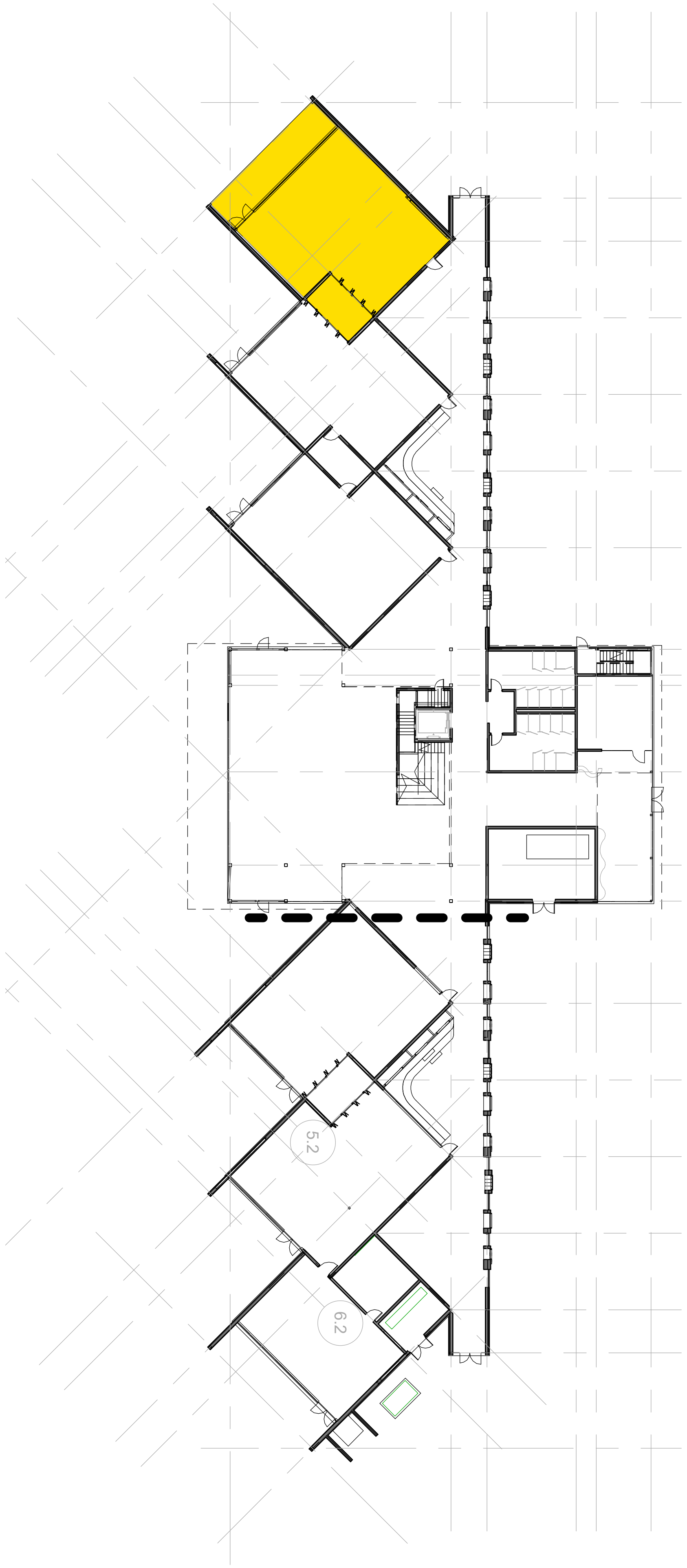
Effective Floor Cavity Reflectance: 20%

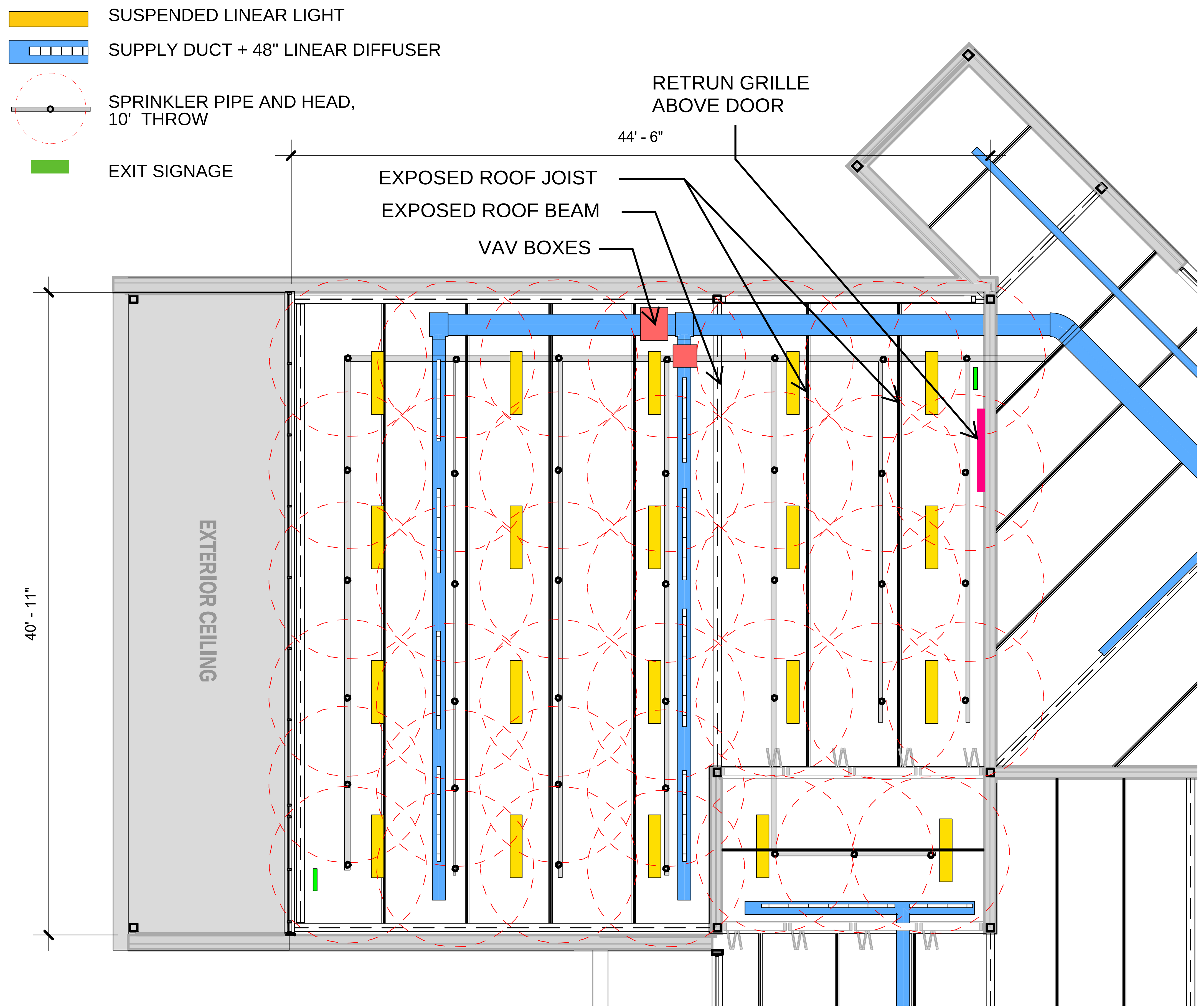
RCC %:	80				70				50			30			10			0
RW %:	70	50	30	0	70	50	30	0	50	30	20	50	30	20	50	30	20	0
RCR: 0	.96	.96	.96	.96	.83	.83	.83	.05	.58	.58	.58	.36	.36	.36	.15	.15	.15	.05
1	.88	.84	.80	.77	.75	.72	.69	.04	.51	.49	.47	.31	.30	.29	.13	.13	.12	.04
2	.80	.73	.67	.63	.69	.63	.58	.04	.44	.42	.39	.27	.26	.24	.11	.11	.10	.04
3	.73	.64	.57	.52	.62	.55	.50	.03	.39	.36	.33	.24	.22	.21	.10	.09	.09	.03
4	.66	.56	.49	.44	.57	.49	.43	.03	.35	.31	.28	.21	.19	.17	.09	.08	.08	.03
5	.61	.50	.42	.37	.52	.43	.37	.02	.31	.27	.24	.19	.17	.15	.08	.07	.06	.02
6	.56	.44	.37	.32	.48	.39	.32	.02	.27	.23	.20	.17	.15	.13	.07	.06	.06	.02
7	.51	.40	.33	.27	.44	.35	.28	.02	.25	.21	.18	.15	.13	.11	.07	.06	.05	.02
8	.47	.36	.29	.24	.41	.31	.25	.02	.22	.18	.15	.14	.12	.10	.06	.05	.04	.02
9	.44	.33	.26	.21	.38	.28	.22	.01	.20	.16	.14	.13	.10	.09	.05	.05	.04	.01
10	.41	.30	.23	.18	.35	.26	.20	.01	.18	.15	.12	.12	.09	.08	.05	.04	.03	.01

https://www.visual-3d.com/tools/photometricviewer/default.aspx?sessionid=111525

LIGHTING CALCS

FOCUS SPACE REFLECTED CEILING PLAN





NORTHERN STUDIO RCP

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	6.6	19 lux	1.8 fc	PH 8355
2	2.8313	10.5	30 lux	2.8 fc	PH 8356
3	2.8248	12.3	35 lux	3.2 fc	PH 8357
4	2.9378	11.4	33 lux	3.1 fc	PH 8358
5	2.9792	10.6	32 lux	2.9 fc	PH 8359
6	2.7992	10.4	29 lux	2.7 fc	PH 8360
7	2.9673	9.4	28 lux	2.6 fc	PH 8361
8	2.9431	9.1	27 lux	2.5 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= 1.00

For models tested with glass or trace paper

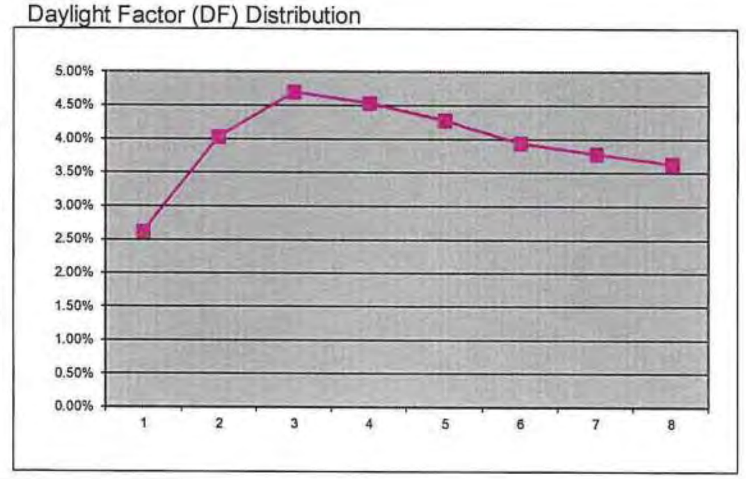
Daylight Factor

excluding effect of glass VT

Sensor	Daylight Factor for VT= 1.00	Daylight Factor excluding effect of glass VT
1	2.61%	2.61%
2	4.02%	4.02%
3	4.70%	4.70%
4	4.53%	4.53%
5	4.27%	4.27%
6	3.94%	3.94%
7	3.77%	3.77%
8	3.62%	3.62%
(single sensor) # 9		

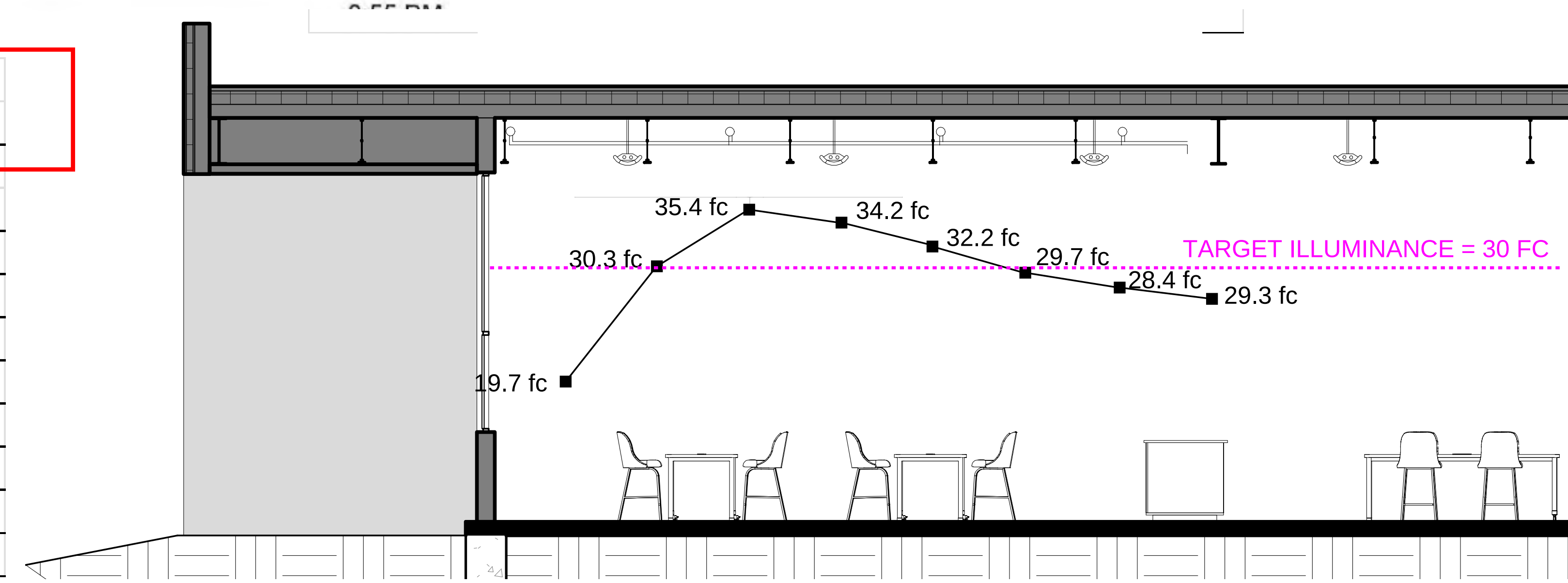
Average sens # 1 to 8	Ratio of Max. to Min.
3.93%	1.80

Daylight Factor (DF) Distribution

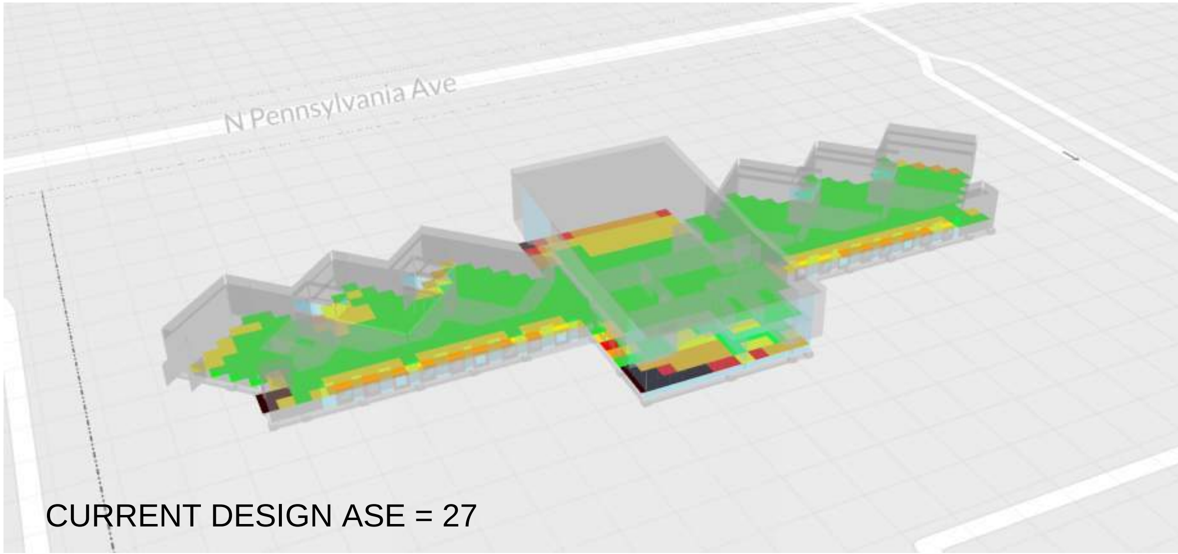


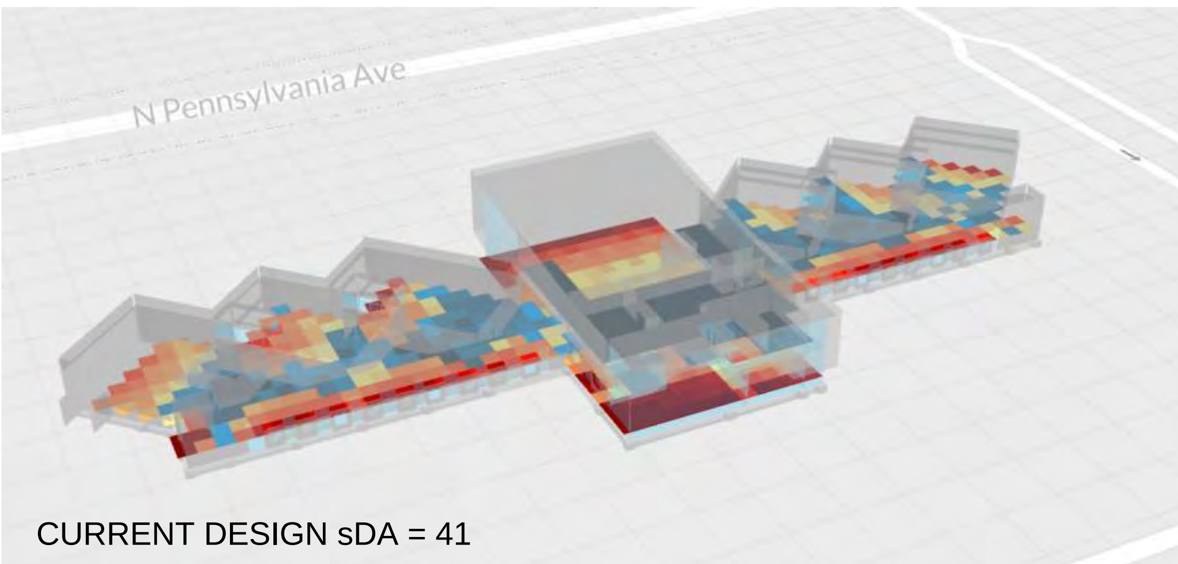
OSU School of Architecture, Daylighting Laboratory 3/29/2022

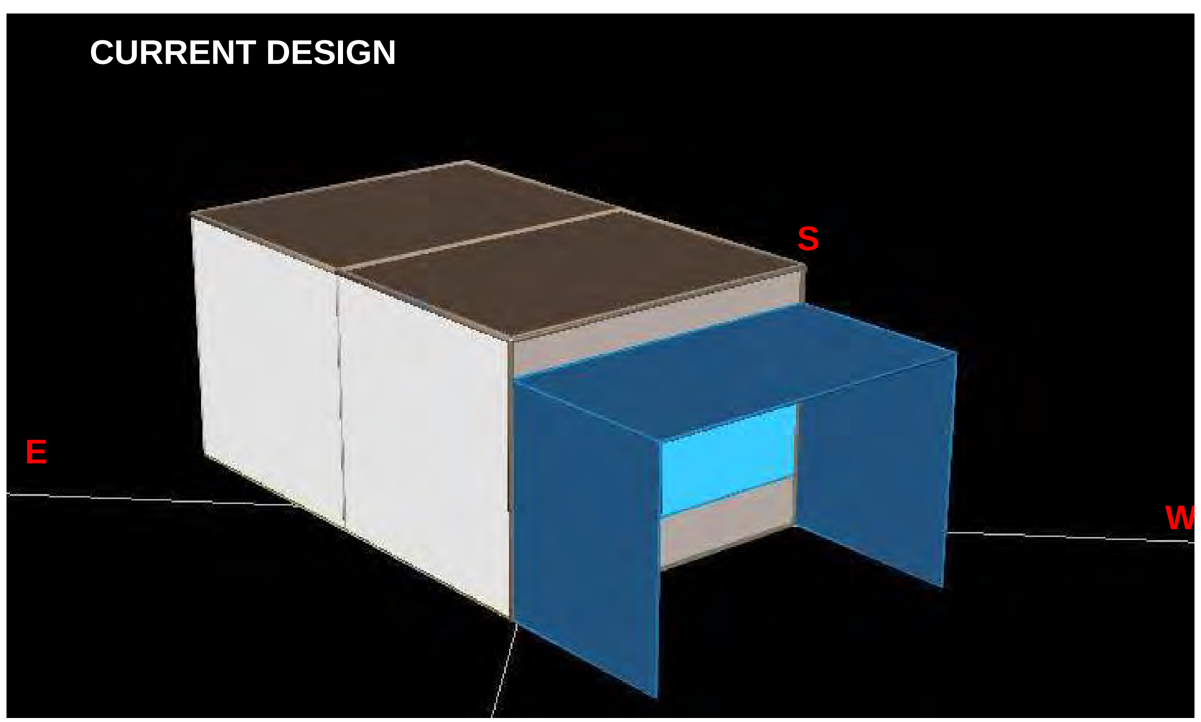
AVERAGE	IL predicted	=	IL Standard		*	DF	*	VT glass	*	M glass	=		
		=	1386	fc	*	3.93%	*	0.64	*	0.85	=	29.6	fc
	Point 1	=	1386	fc	*	2.61%	*	0.64	*	0.85	=	19.7	fc
	Point 2	=	1386	fc	*	4.02%	*	0.64	*	0.85	=	30.3	fc
	Point 3	=	1386	fc	*	4.70%	*	0.64	*	0.85	=	35.4	fc
	Point 4	=	1386	fc	*	4.53%	*	0.64	*	0.85	=	34.2	fc
	Point 5	=	1386	fc	*	4.27%	*	0.64	*	0.85	=	32.2	fc
	Point 6	=	1386	fc	*	3.94%	*	0.64	*	0.85	=	29.7	fc
	Point 7	=	1386	fc	*	3.77%	*	0.64	*	0.85	=	28.4	fc
	Point 8	=	1386	fc	*	3.62%	*	0.64	*	0.85	=	27.3	fc



DAYLIGHTING CALCS

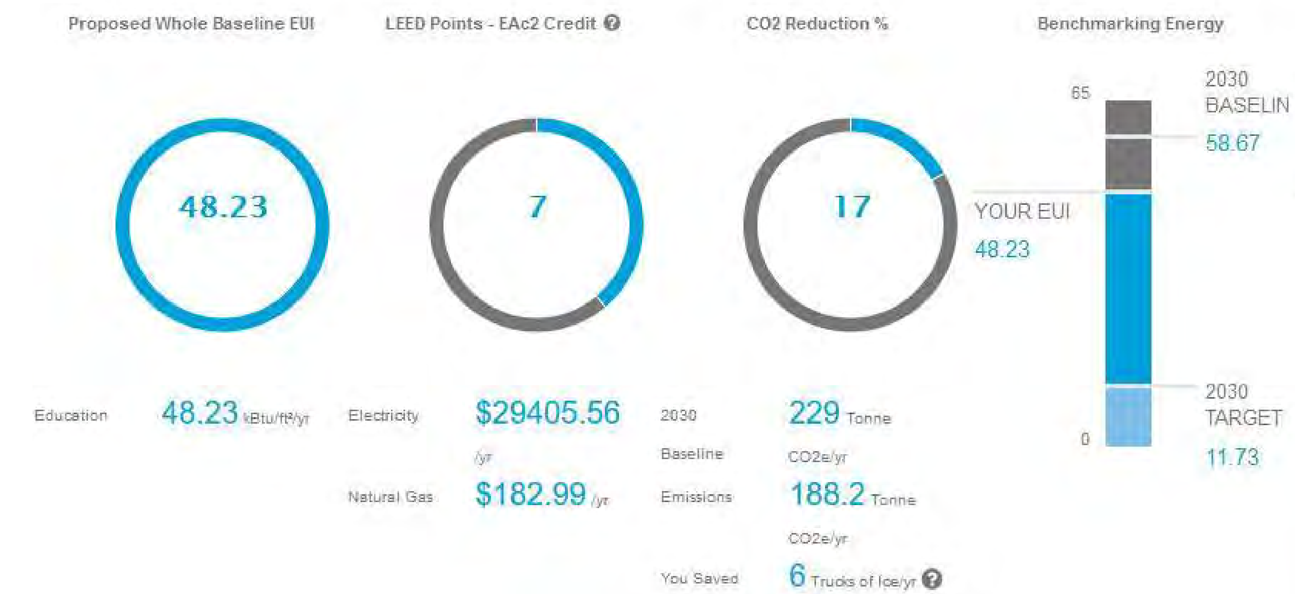






MODEL A: BASELINE FOR ENERGY REQUIREMENTS - 30% GLASS

MODEL B: IMPROVED DESIGN



MODEL C: CURRENT DESIGN - UPDATED DESIGN AND MEP EQUIPMENT

ENERGY SAVINGS ABOVE BASELINE: 33%

COVE TOOL ENERGY ANALYSIS

ANOTHER KEY COMPONENT OF DD WAS DEVELOPING THE STRUCTURE. ALONGSIDE OUR ARCHITECTURAL AND SYSTEMS DEVELOPMENTS, THE ENGINEERING STUDENTS WERE DEVELOPING THEIR STRUCTURE THROUGH RESEARCH, HAND CALCULATIONS, AND CREATING OF A REVIT MODEL AND RISA3D ANALYTICAL MODEL. BY THE END OF THE SEMESTER, ENGINEERING STUDENTS HAD DESIGNED THEIR WHOLE STRUCTURE, INCLUDING LOADING CALCS (WIND, SNOW, SEISMIC), HAND CALCS FOR JOISTS, COMPOSITE MEMBERS, SLABS, AND FOUNDATIONS, BUILDING AND RUNNING THE ANALYTICAL MODEL FOR SERVICE AND STRENGTH LOAD COMBINATIONS, AND UPADATING A FULL SET OF CONSTRUCTION DOCUMENTS (INCLUDING A MINIMUM OF 16 DETAILS). A SELECTION OF THESE CALUCATIONS AND DRAWINGS FOLLOW THIS PAGE.

RESEARCH II:
STRUCTURAL SYSTEM RESEARCH SUMMARY
Sp. 2022 Comprehensive Design Studio
Due 02.28.22
Charlie Guyer

This STEAM Engine Education Center is a 24,000 square feet, two-story structure in Edmond, OK. The Center features a double-volume core gathering space (70 ft wall-to-wall, 50 ft max clear-span, 35 ft max clear height), six studio rooms along the first-floor corridor, and administrative space on the second floor. A total of three structural systems were explored. The first two systems – concrete shear walls with steel roof framing and concrete shear walls with timber roof framing – were both ruled out due to the lack of walls without openings, especially in the core gathering space. Ultimately, an entirely steal structural system was selected to allow for maximum openings within walls and to allow for the aesthetic opportunities of exposed framing.

The selected system uses 1.5” metal roof deck, open-web steel roof joists, composite wide-flange floor beams, wide-flange girders, HSS columns, and HSS braced frames and wind girts. The foundation consists of 5” concrete slab on grade and spread/continuous footings, as recommended by the geotechnical report (Figure 1). This selected system has many notable characteristics that are categorized into aesthetic qualities and technical attributes, both of which are explored below.

AESTHETIC QUALITIES

FLEXIBILITY – Steel structures are, above all else, flexible. This applies to the physical ductility of the structure as well as its architectural adaptability. Steel framing can efficiently manage medium to long spans, especially through the use of long-span steel roof joists. Specifically in this project, the long-span capabilities of deep long-span joists are used in the 50 ft wide gathering space to reduce the number of columns. Considering lateral systems, steel moment frames and steel braced frames are the most flexible systems from an architectural standpoint. These lateral systems allow for punctures through the frame which maximizes spatial versatility and permits future renovations. In this project, steel braced frames are used to maximize openings within the gathering space and between studios.

EXPOSURE – When adequately designed, exposed steel structures can be a great architectural addition to both interior and exterior spaces. The steel can be camouflaged with paint so that it is unified into the overall space, or painted specially to accentuate its addition to the space (Figs. 2 & 3). A drawback to Architecturally Exposed Structural Steel (AESS) is its expense due to the required detailing and fireproofing considerations. Specifically in this project, we want to encourage kids to get curious about the world around them and to think critically about how things are put together. Exposing the structure, specifically exposing the steel framing and braced-frames, invites children to ask questions about building components, physics, construction, etc.

SCALE/WEIGHT – Because of the material efficiency of structural steel and its commonly manufactured shapes (joists, wide-flanges, etc.), the least amount of material can be used in the structure, making it look and feel lightweight. This is especially apparent in tension members that maximize the tension strength of steel – such as steel tension cables and open-web joists. Where lightweight structures are especially exposed, the building feels technologically progressive, contrasting heavy loadbearing structures from decades past. This concept is applied to this project to make the building feel futuristic, innovative, and encouraging for its young users.

TECHNICAL ATTRIBUTES

WEIGHT – From a technical point of view, steel is lightweight compared to concrete and masonry. This is especially important when considering large-scale buildings, because heavy structures have seismic considerations and require greater foundations. This building is a maximum of two stories, so there wouldn’t be a significant difference in weight between material systems. However, there really is no need for a heavy structure for such a small-scale building.

CONSTRUCTABILITY – Depends greatly on level of detailing (specifically the connections). Welded situations require skilled labor, resulting in greater time and cost. Other constructability considerations are erection stability (as the structure is not self-supporting until the members are plumb and connections are in place) and member availability (currently, due to the world-wide supply chain shortage, prefabricated items like steel joists are backordered by over 8 months. This issue is not typically felt by concrete and masonry).

DURABILITY – Most modern structural materials are considered durable, with the exception of timbers. For this context, a steel-framed building is plenty durable.

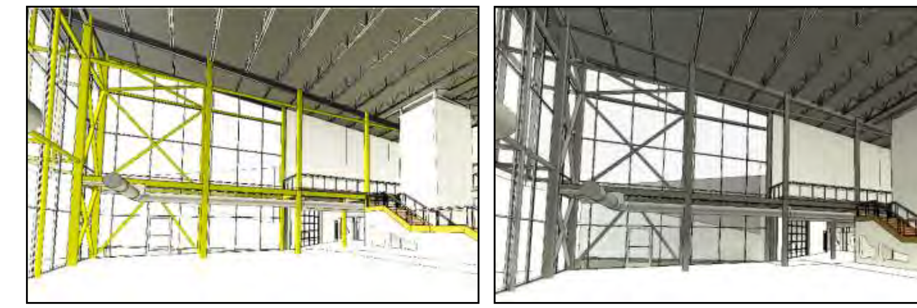
EXPANSION JOINT – This building is quite long, and thus requires an expansion joint. The expansion joint for this building is on the south side of the central core, where the wing intersects the core. Steel framing makes expansion joints easy, because a double column situation can be used to effectively separate the building halves.

COST – Considering the amount of material used for the same loading conditions, a steel building requires less material and is lighter than a concrete structure. This, and considering that steel has virtually no maintenance concerns, means that steel is often cheaper than concrete. Considering this project, lower structural cost is especially true for short buildings.

FIRE RATING – Structural steel is not inherently fireproof. There are three types of fireproofing: fire protecting boards and blankets, intumescent coating, and sprayed cementitious or gyp-based coatings. Cementitious coating is universally unattractive (figure 4). Intumescent coating and fireproof boards are more aesthetically pleasing but are labor intensive and costly (figure 5). Specifically in this project, the joists *could* be fireproofed with cementitious or gyp-based coatings, but that is unattractive and better used where it will not be seen. Thus, exposed open-web steel joists should only be used where fireproofing is not a concern

MAINTENANCE – Very little, especially for a short building.

ENVIRONMENTAL IMPACT – Process of making steel is not great for the environment, but structural steel can be recycled and has a long life cycle.



Figures 2 & 3: Effect of colored AESS on the gathering space, accentuating (left) and hiding (right).

Figure 4: Cementitious fireproofing coating on steel roof joists

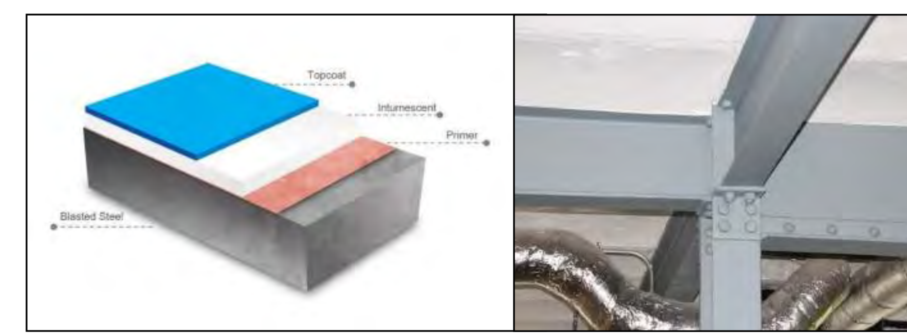


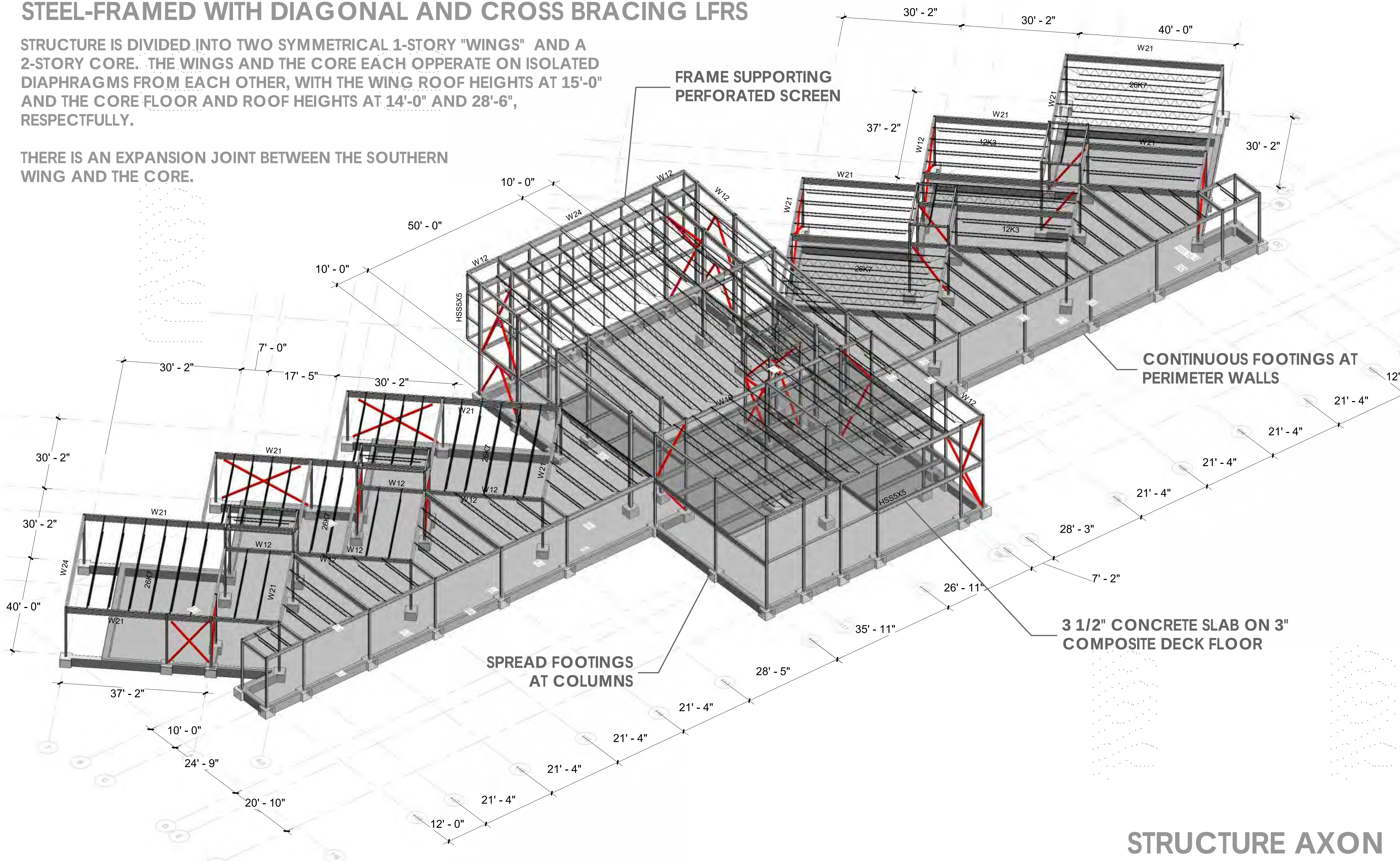
Figure 5: Intumescent fireproofing coating on steel members

DD STRUCTURE & INTITIAL RESEARCH

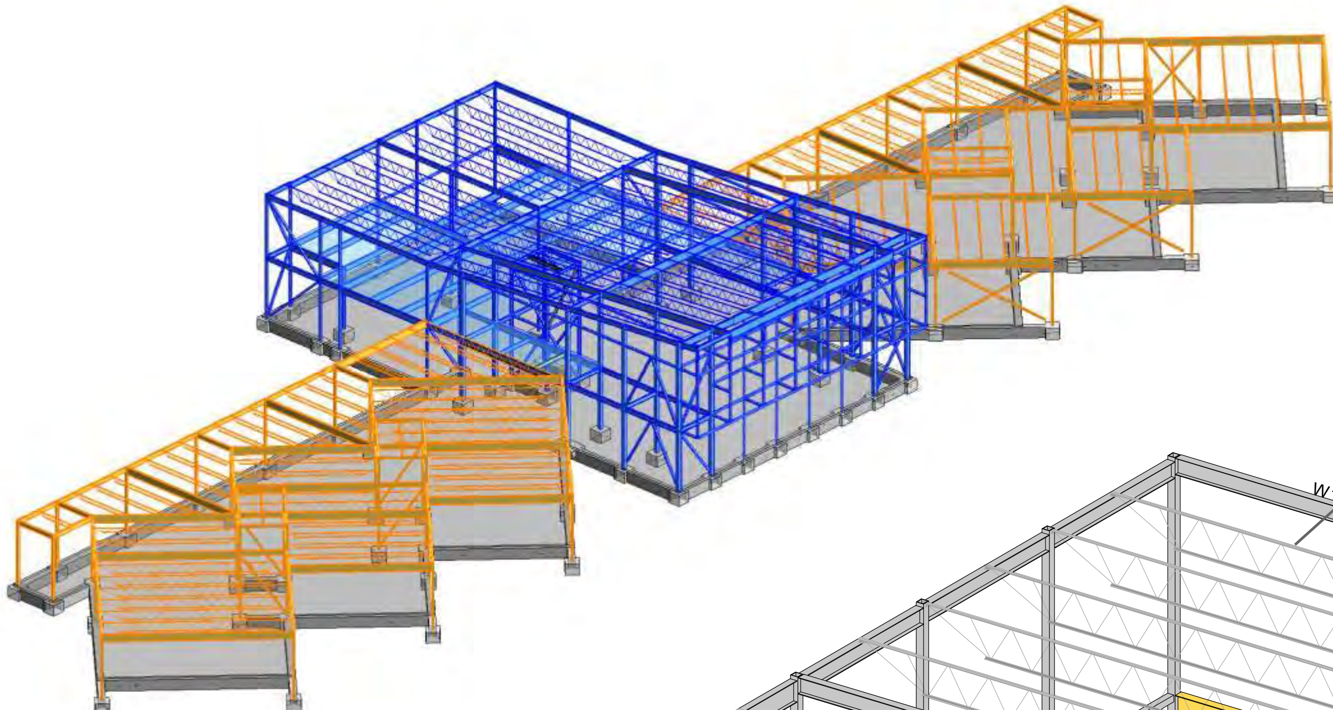
STEEL-FRAMED WITH DIAGONAL AND CROSS BRACING LFRS

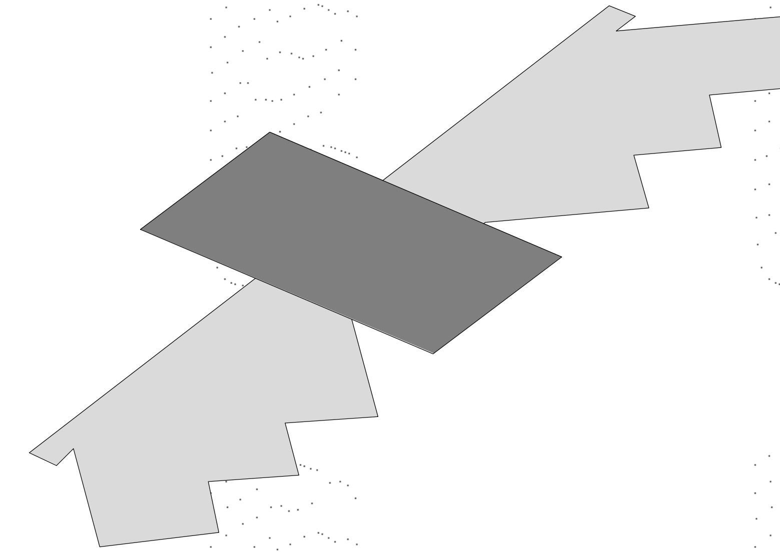
STRUCTURE IS DIVIDED INTO TWO SYMMETRICAL 1-STORY "WINGS" AND A 2-STORY CORE. THE WINGS AND THE CORE EACH OPPERATE ON ISOLATED DIAPHRAGMS FROM EACH OTHER, WITH THE WING ROOF HEIGHTS AT 15'-0" AND THE CORE FLOOR AND ROOF HEIGHTS AT 14'-0" AND 28'-6", RESPECTFULLY.

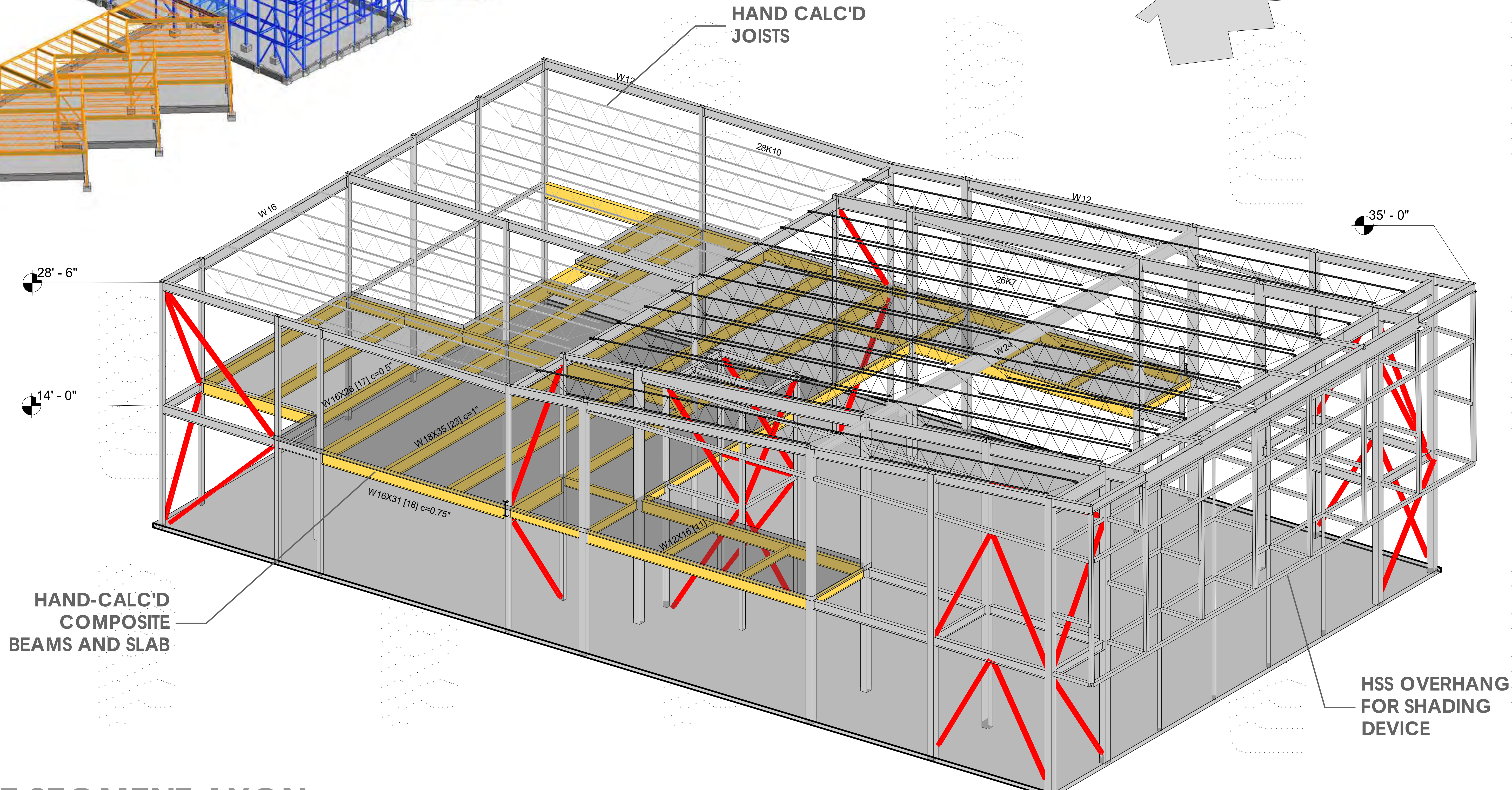
THERE IS AN EXPANSION JOINT BETWEEN THE SOUTHERN WING AND THE CORE.



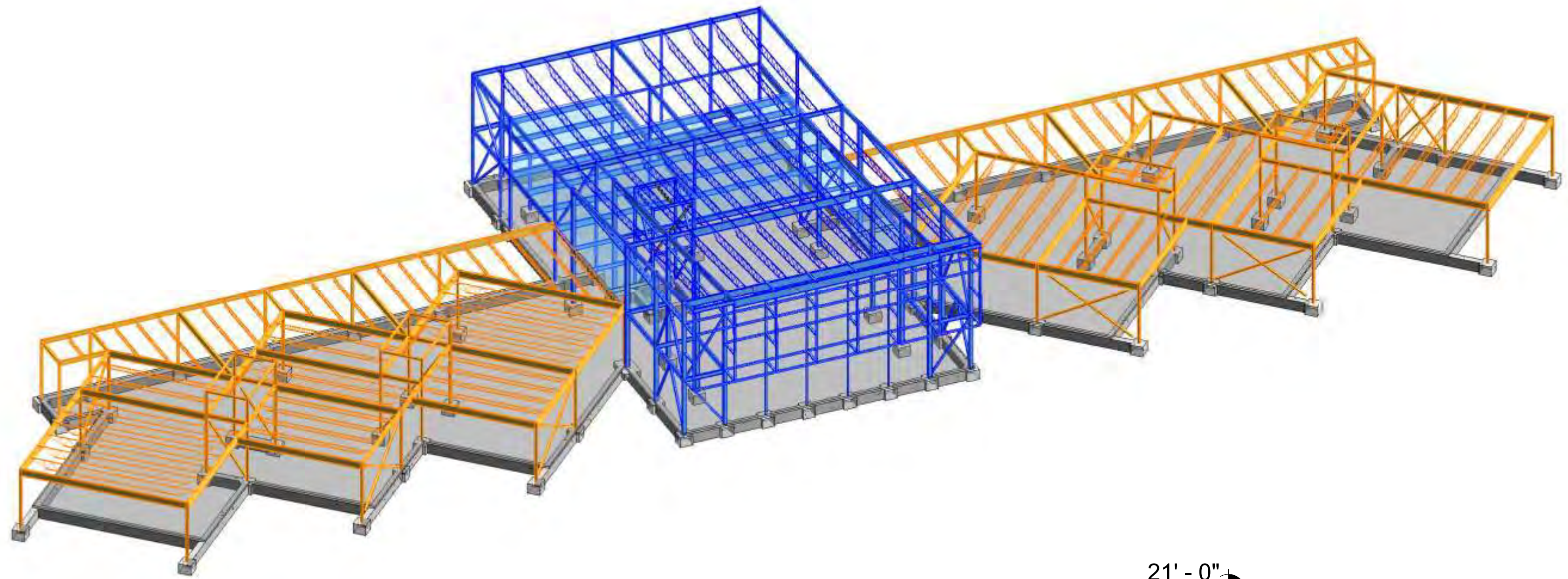
STRUCTURE AXON

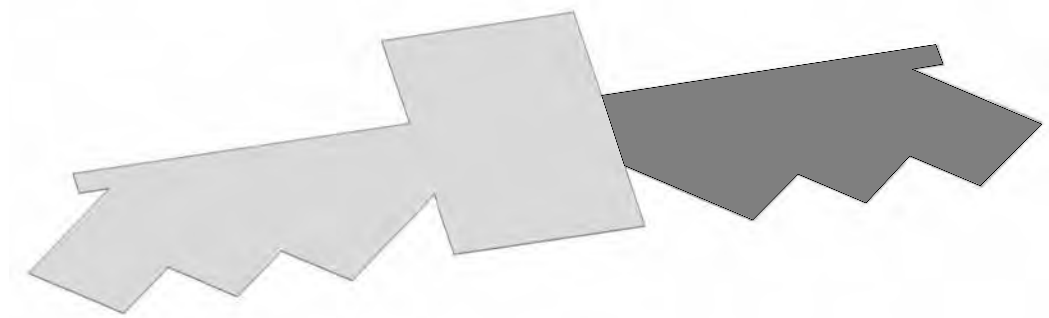


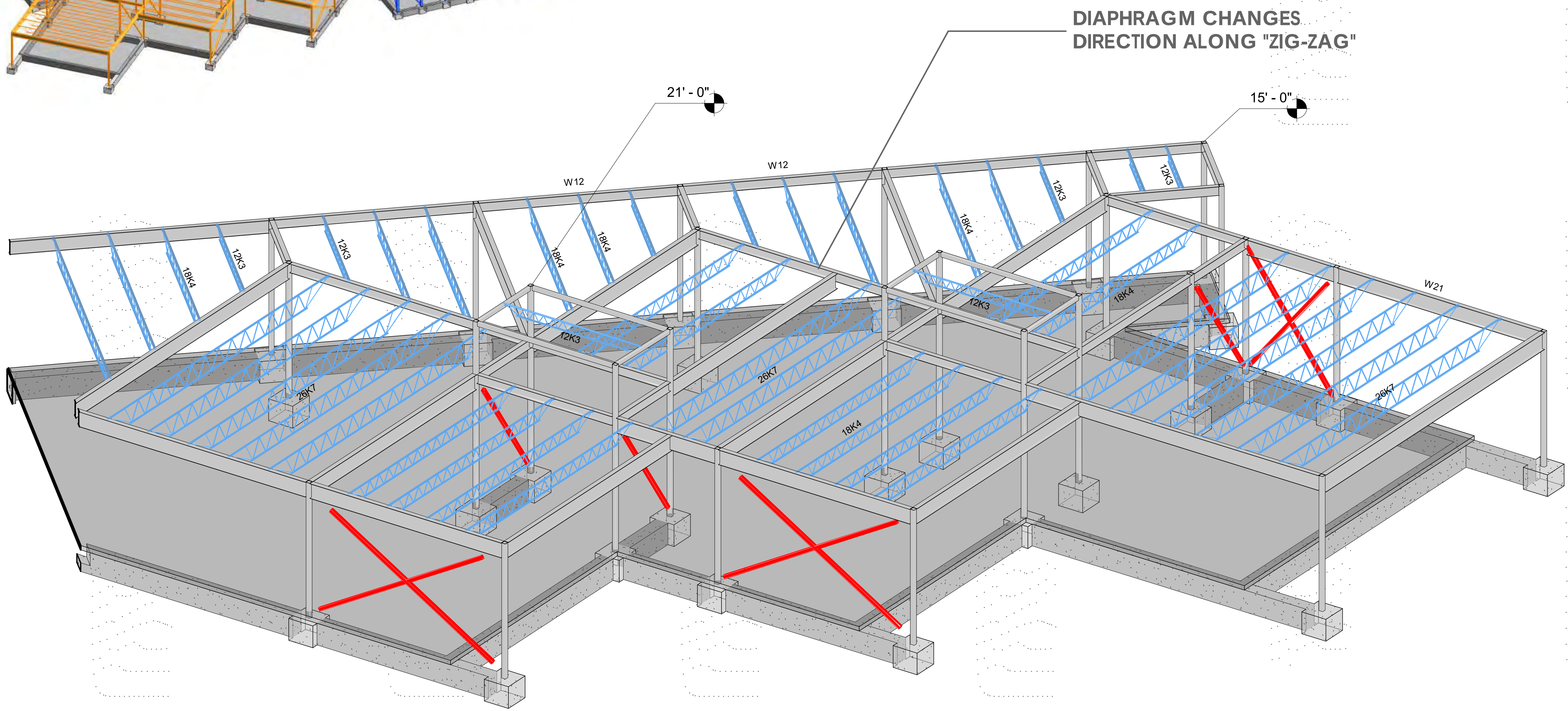




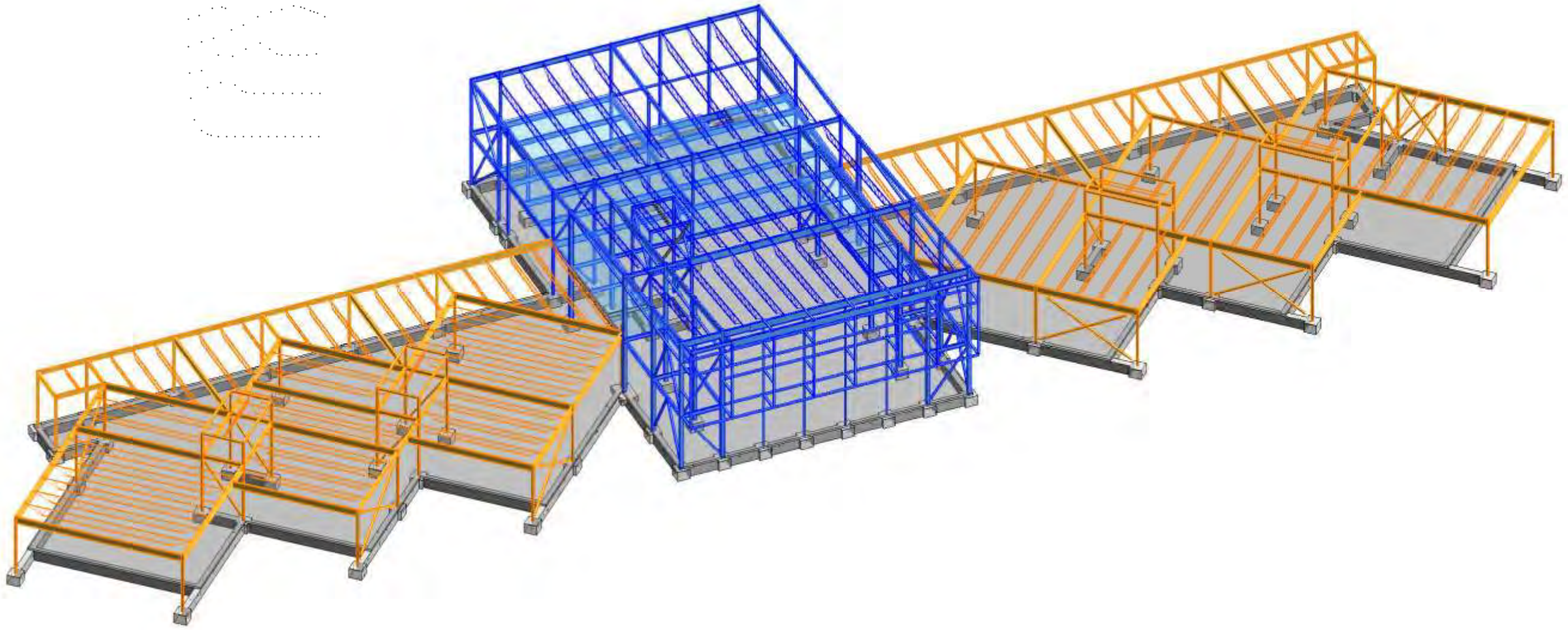
CORE SEGMENT AXON

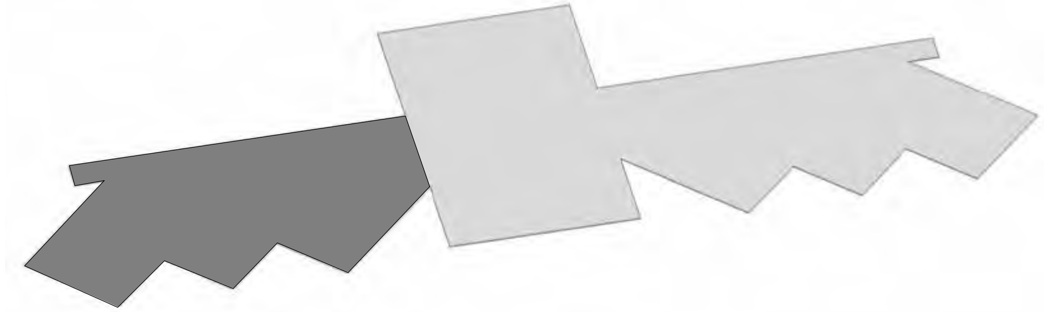


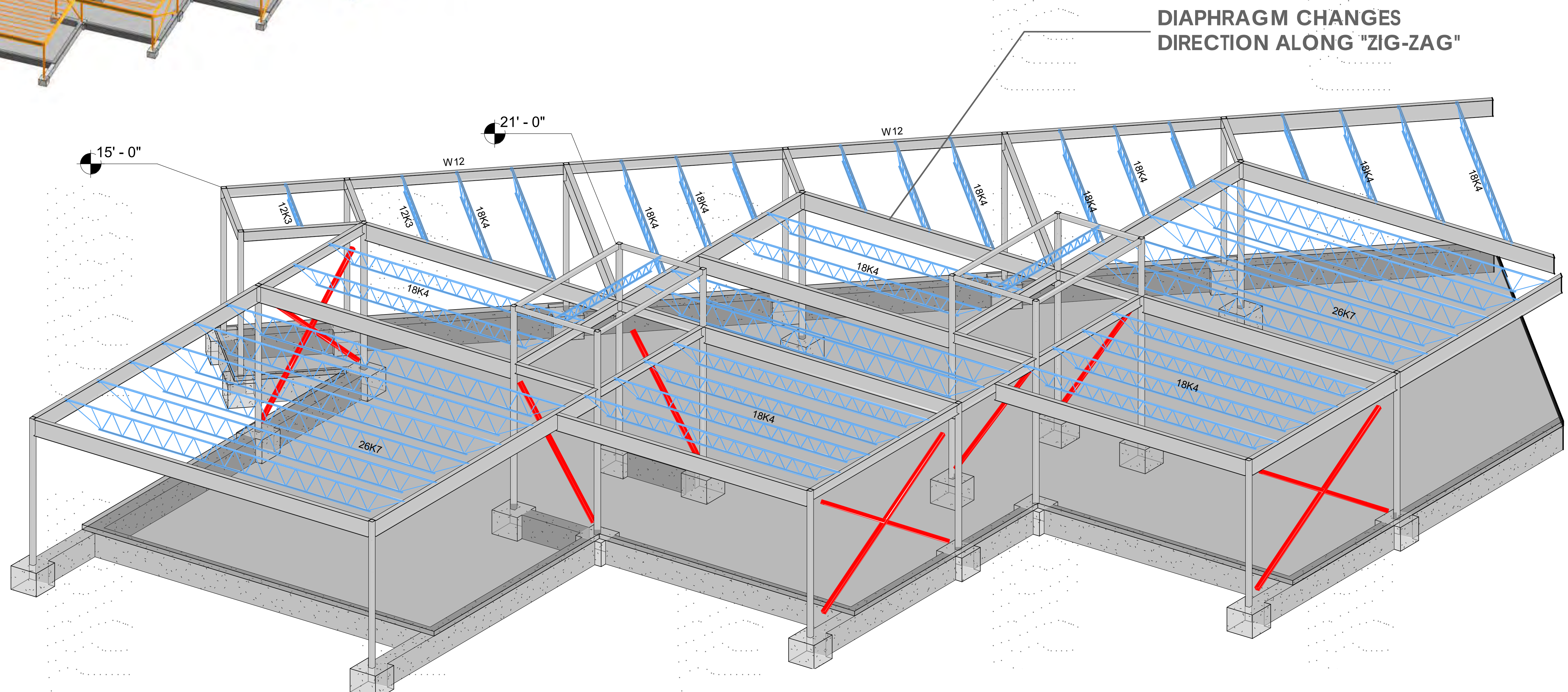




SOUTH WING AXON



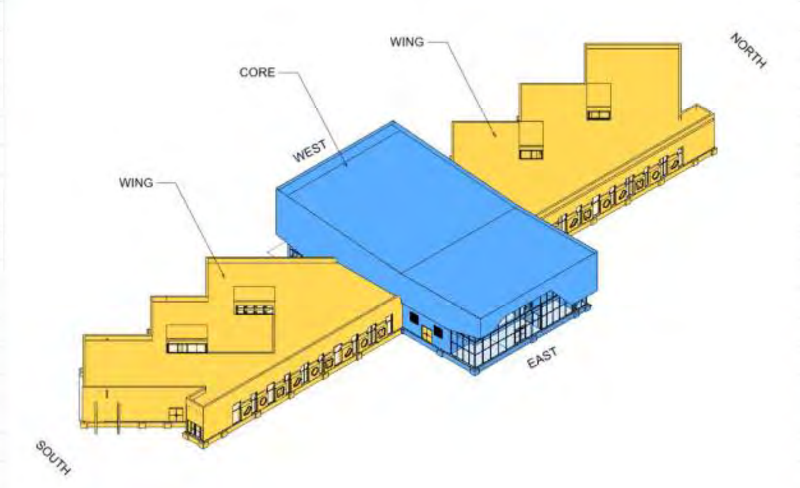




NORTH WING AXON

WIND CALCULATIONS
C. GUYER
04.07.2022

Building: Education/Vocation Building
Location: Edmond, OK
Partially Exposed, Suburban (exposure B)
Risk Category: III
Flat Roof
Size: 375' x 123'
Wing Roof Height: 15ft + 3.5ft parapet
Core East-Side Height: 28.5ft + 3.5ft parapet
Core West-Side Height: 36.2ft + 3.5ft parapet (1:12 slope)
6ft protrusions on north and south wings that act as penthouses @ h=21ft



Eqn 27.3-1: p=q GCp - qi(CGpi)

q=0.00256 kz * kzt * kd * ke * V^2

Table 1.5-2 - Risk Cat III: $I_w := 1.00$

basic wind speed for Edmond, OK: (Figure 26.5-1B) $v := 116\ mph$

Table 26.6-1 - Wind directionality factor for MWFRS: $k_d := .85$

Fig 26.8-1 - topographic factor: Flat terrain $k_{zt} := 1.0$

Section 26.9 - ground elevation factor $k_e := 1.0$

Section 26.13 Internal pressure coefficient (enclosed building) $GC_{pi} := 0.18$ Enclosed Building

$GC_{pi}' := -0.18$

Section 26.11 - gust effect factor for rigid building $G := .85$

Figure 27.3-1 External pressure coefficients

For windward wall: $C_{pww} := 0.8$

direction 1 is North-South $L_1 := 375\ ft$ $B_1 := 123\ ft$ $\frac{L_1}{B_1} = 3.049$

direction 2 is East-West $L_2 := 123\ ft$ $B_2 := 375\ ft$ $\frac{L_2}{B_2} = 0.328$

For leeward wall:

$$C_{p1} := \begin{cases} \text{if } \frac{L_1}{B_1} \le 1 & -0.5 \\ \text{else if } \frac{L_1}{B_1} \ge 4 & -0.2 \\ \text{else if } 1 < \frac{L_1}{B_1} \le 2 & \left(\frac{\left(\frac{L_1}{B_1}\right)-1}{2-1}\right)\cdot((-.3)-(-.5))+(-.5) \\ \text{else} & \left(\frac{\left(\frac{L_1}{B_1}\right)-2}{4-2}\right)\cdot((-0.2)-(-0.3))+(-0.3) \end{cases} = -0.248$$

$$C_{p2} := \begin{cases} \text{if } \frac{L_2}{B_2} \le 1 & -0.5 \\ \text{else if } \frac{L_2}{B_2} \ge 4 & -0.2 \\ \text{else if } 1 < \frac{L_2}{B_2} \le 2 & \left(\frac{\left(\frac{L_2}{B_2}\right)-1}{2-1}\right)\cdot((-.3)-(-.5))+(-.5) \\ \text{else} & \left(\frac{\left(\frac{L_2}{B_2}\right)-2}{4-2}\right)\cdot((-0.2)-(-0.3))+(-0.3) \end{cases} = -0.5$$

direction 1 is North-South $C_{p1} = -0.248$

direction 2 is East-West $C_{p2} = -0.5$

mean roof height@ core: $h_{core} := 36.2\ ft$

mean roof height@ wings: $h_{wing} := 15\ ft$

SOLVING FOR qz
ALL WINDWARD

Location	Height (z)	Kz
wing roof	15	0.57
wing parapet	18.5	0.605
wing "penthouse"	21	0.628
east core roof	28.5	0.688
west core roof	36.2	0.737
west core roof parapet	39.7	0.758

$$z := \begin{bmatrix} 15 \\ 18.5 \\ 21 \\ 28.5 \\ 36.2 \\ 39.7 \end{bmatrix} ft \qquad k_z := \begin{bmatrix} 0.57 \\ \left(\frac{18.5-15}{5}\right)\cdot(0.62-0.57)+.57 \\ \left(\frac{21-20}{5}\right)\cdot(0.66-0.62)+0.62 \\ \left(\frac{28.5-25}{5}\right)\cdot(0.7-0.66)+.66 \\ \left(\frac{36.2-30}{10}\right)\cdot(0.76-0.7)+0.7 \\ \left(\frac{39.7-30}{10}\right)\cdot(0.76-0.7)+0.7 \end{bmatrix} = \begin{bmatrix} 0.57 \\ 0.605 \\ 0.628 \\ 0.688 \\ 0.737 \\ 0.758 \end{bmatrix}$$

$$q_{ww} := 0.00256 \cdot \left(\frac{1}{mph}\right)^2 psf \cdot k_z \cdot k_{zt} \cdot k_d \cdot k_e \cdot v^2 = \begin{bmatrix} 16.69 \\ 17.715 \\ 18.388 \\ 20.145 \\ 21.585 \\ 22.2 \end{bmatrix} psf$$

Windward Pressures:

$$p_{ww} := q_{ww} \cdot G \cdot C_{pww} = \begin{bmatrix} 11.349 \\ 12.046 \\ 12.504 \\ 13.698 \\ 14.678 \\ 15.096 \end{bmatrix} psf$$

wing roof
wing parapet
wing "penthouse"
east core roof
west core roof
west core roof parapet

PARAPETS
Eqn 27.3-3

$GC_{pnWW} := 1.5$ $GC_{pnLW} := -1.0$

Wing parapet height $z_{pwing} := 18.5\ ft$

$q_{pwing} := q_{ww_1} = 17.715\ psf$

core parapet height $z_{pcore} := 39.7\ ft$

$q_{pcore} := q_{ww_5} = 22.2\ psf$

Wing Windward Parapet $P_{pww} := q_{pwing} \cdot GC_{pnWW} = 26.572\ psf$

Wing Leeward Parapet $P_{plw} := q_{pwing} \cdot GC_{pnLW} = -17.715\ psf$

Core Windward Parapet $P_{pww} := q_{pcore} \cdot GC_{pnWW} = 33.3\ psf$

Core Leeward Parapet $P_{plw} := q_{pcore} \cdot GC_{pnLW} = -22.2\ psf$

Roof Uplift:
Figure 27.3-1 (interpolate for Cp values)

Wing Roof height: $z_{rwing} := 15\ ft$

Wing North-South $\frac{z_{rwing}}{L_1} = 0.04$ $C_{pr1} := -0.9$

East-West $\frac{z_{rwing}}{L_2} = 0.122$ $C_{pr2} := -0.9$

$C_{pr} := min(C_{pr1}, C_{pr2}) = -0.9$

$P_{up2} := q_{rwing} \cdot G \cdot C_{pr} - q_{rwing} \cdot GC_{pi} = -15.772\ psf$

Core Roof height: $z_{rcore} := 36.2\ ft$

Wing North-South $\frac{z_{rcore}}{L_1} = 0.097$ $C_{pr1} := -0.9$

East-West $\frac{z_{rcore}}{L_2} = 0.294$ $C_{pr2} := -0.9$

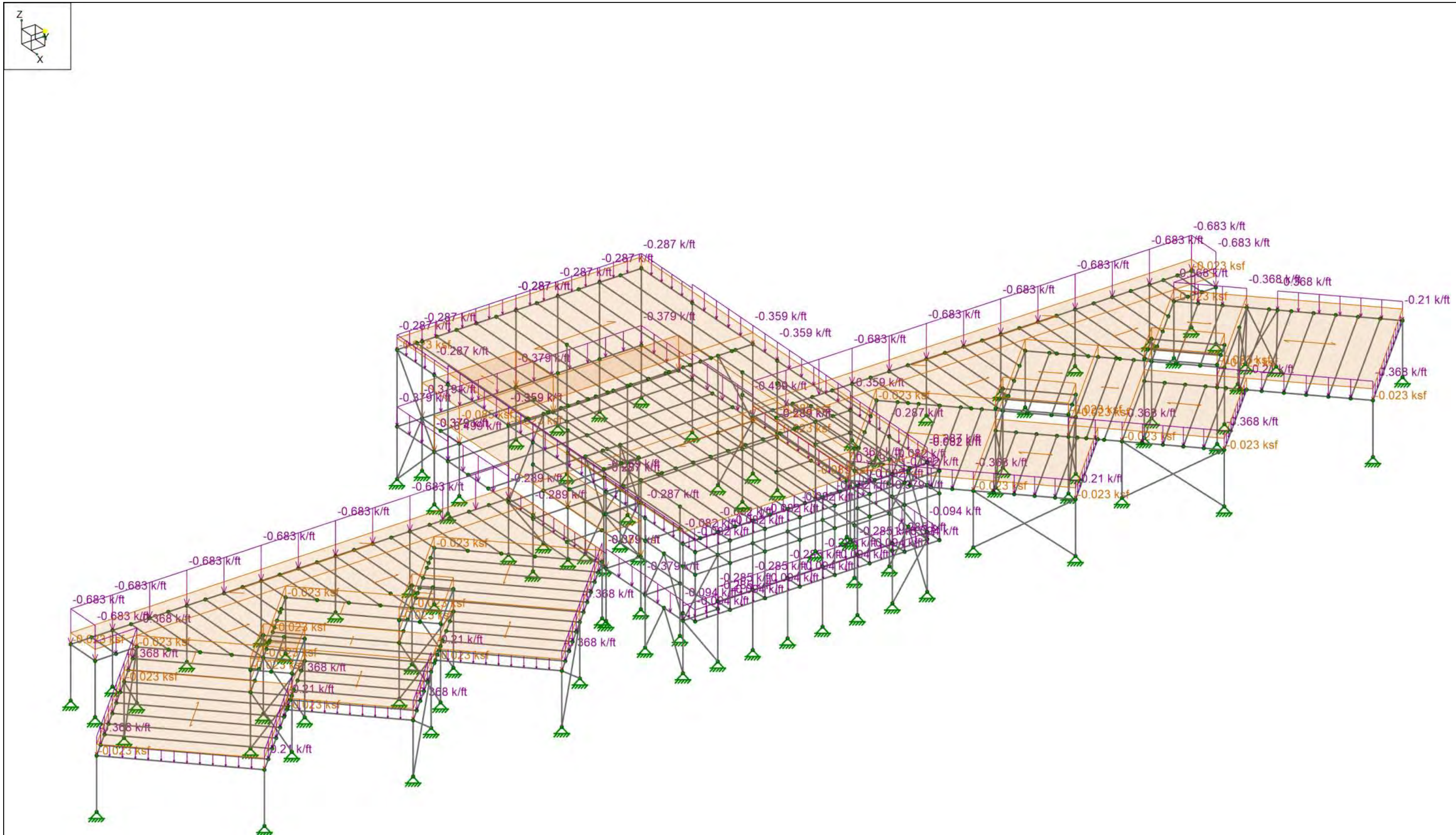
$C_{pr} := min(C_{pr1}, C_{pr2}) = -0.9$

$P_{up2} := q_{rcore} \cdot G \cdot C_{pr} - q_{rcore} \cdot GC_{pi} = -20.398\ psf$

Roof Overhang:
27.3.3

$C_{pOH} := 0.8$ $P_{upOH} := q_{rwing} \cdot G \cdot C_{pOH} - q_{rwing} \cdot GC_{pi} = 8.345\ psf$

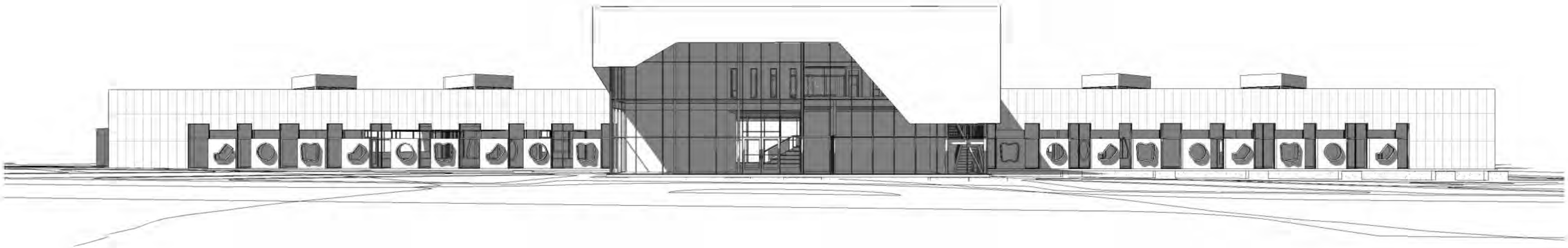
SELECTED HAND CALCS



Loads: BLC 1, DL
Envelope Only Solution

RISA3D ANALYTICAL MODEL

STEAM ENGINE CENTER - OKC



SD ARCHITECTS:
R. CORTEZ, C. GUYER, H. VO

STRUCTURAL ENGINEER
C. GUYER OF GUYER STRUCTURES

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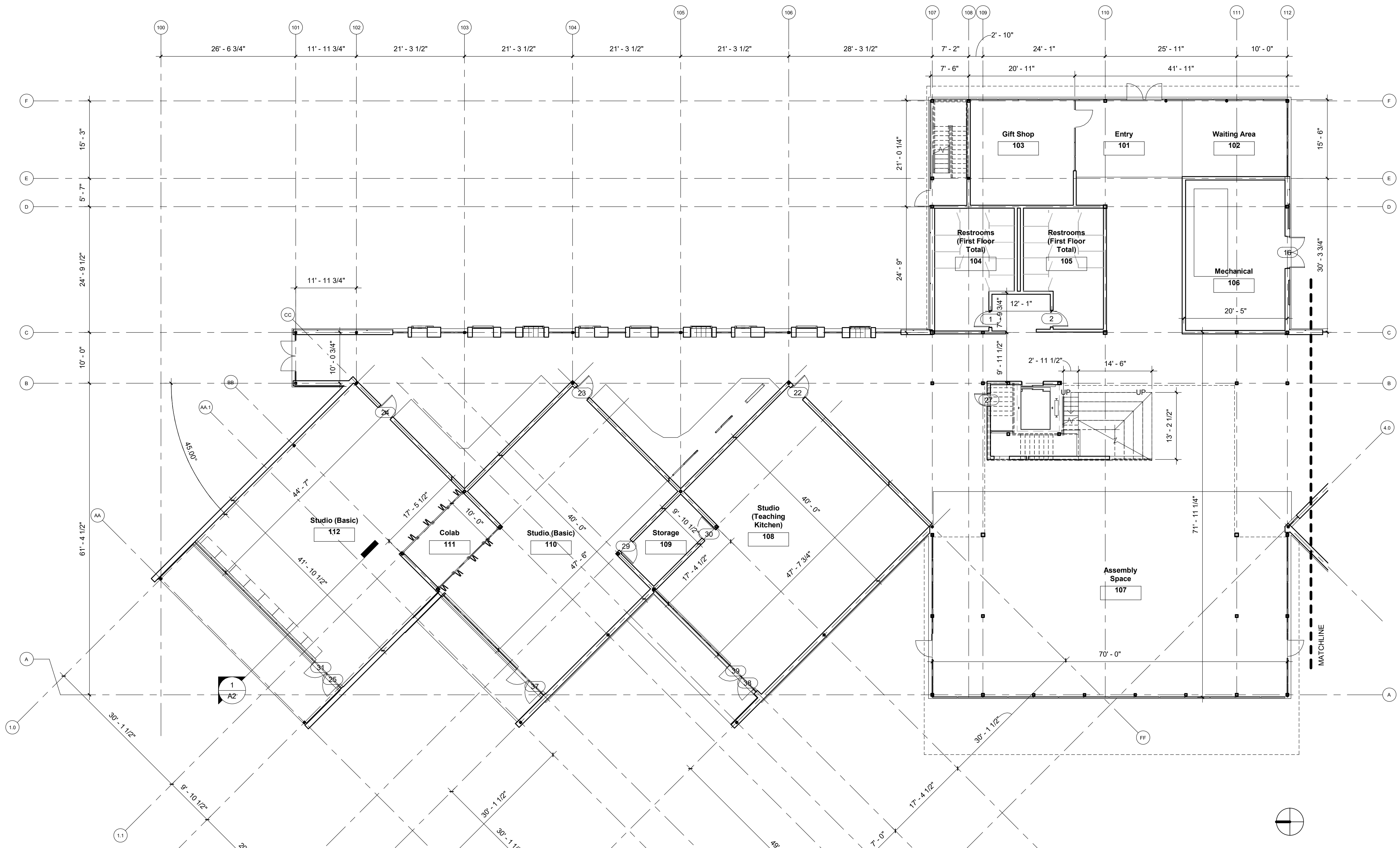
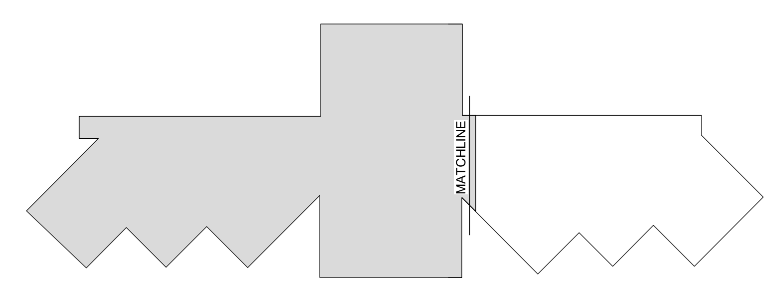


1 GROUND FLOOR PLAN - AREA 1
3/32" = 1'-0"



2 MATCHLINE A1.1
1" = 50'-0"

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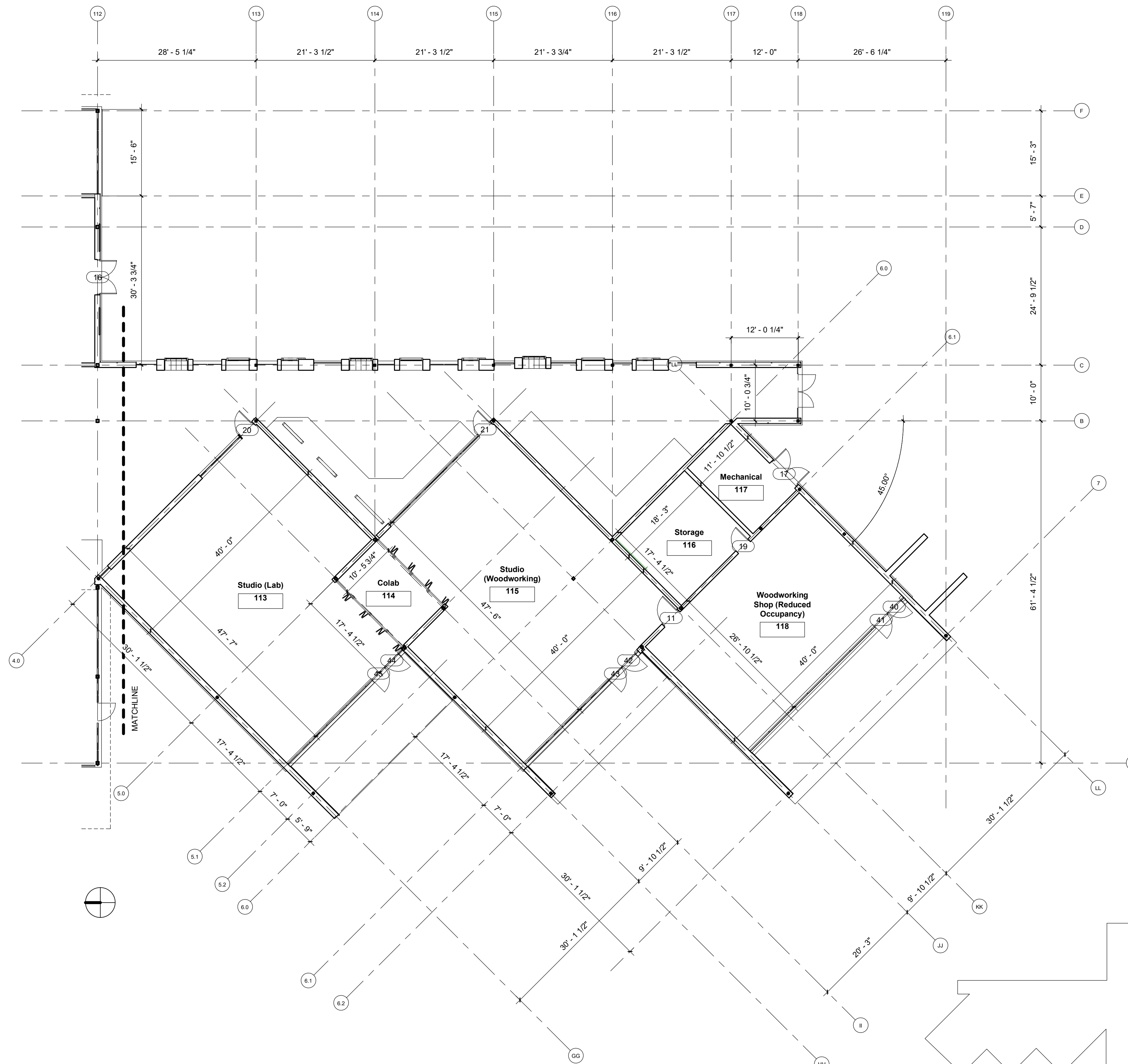
GROUND FLOOR PLAN AREA 1



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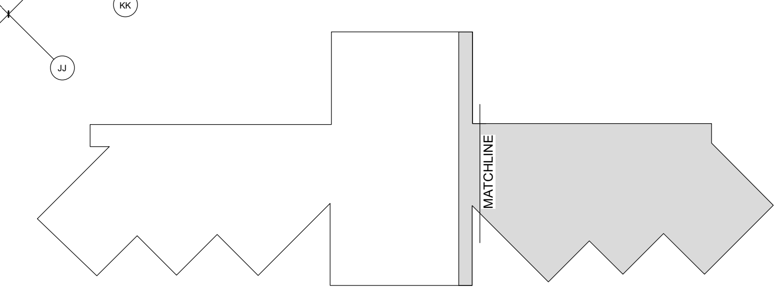
3/32" = 1'-0"



2 MATCHLINE A1.2
1" = 50'-0"

Guyer Structures

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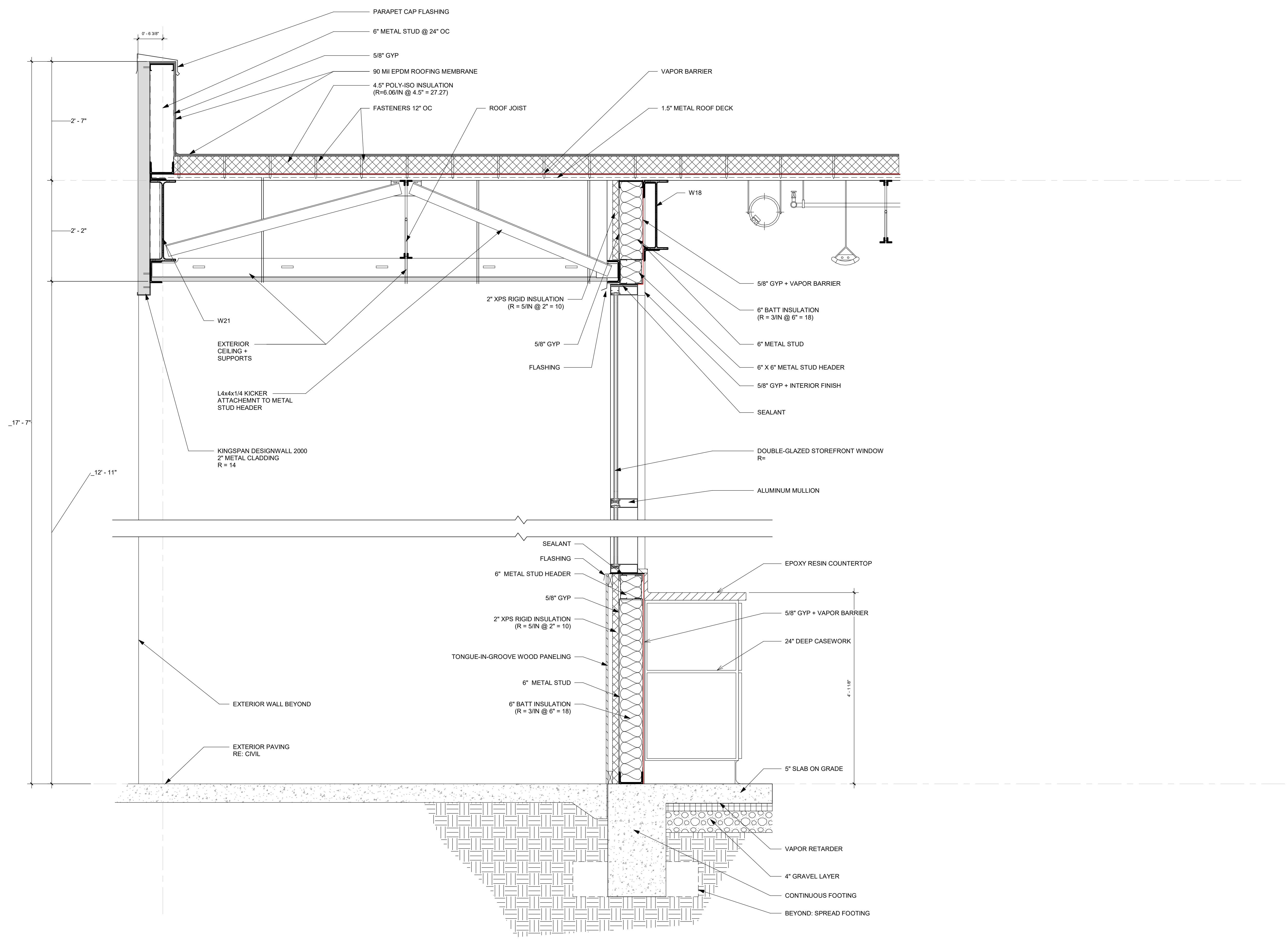
A1.2
GROUND FLOOR PLAN AREA 2



1 *FOCUS SPACE SECTION NEW Copy 1
1" = 1'-0"

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A2
WALL SECTION 1

SECTION 1: GENERAL INFORMATION AND DESIGN CRITERIA

SECTION 1.1 - DOCUMENTS

1.1.1 Structural Construction Documents consist of Project Specifications and Structural Drawings. Structural drawings include General Notes and Typical details in addition to plans, sections and details.

1.1.2 General Notes and Typical Details describe general criteria that apply to all similar conditions throughout the project regardless of whether or not they are specifically referenced in the plans or details.

1.1.3 Do not scale plans, details and sections for quantity, length or fit of materials.

1.1.4 The structural documents are protected by U.S.A. Copyright Laws. They shall not be used for any purpose other than construction of the structure shown on the site indicated on the Architectural Drawings.

1.1.5 The design represented by these documents is valid only for the building site and the purposes shown on the Architectural Drawings.

1.1.6 The GEOTECHNICAL REPORT is a separate document (not part of contract documents) furnished by the project owner. The contractor is urged to obtain a copy of the report for reference as it describes sub-surface conditions that may be encountered during installation of foundations and contains other information pertinent to construction of the project.

1.1.7 The contractor must coordinate Structural Documents with other trades and disciplines including; architectural, mechanical, electrical, HVAC and fire protection. Every attempt is made to coordinate drawings prior to issue, however, some requirements are not known prior to issue, and change may occur during construction as layout and fabrication drawings are developed.

1.1.8 Promptly report deviations and interferences with structural components for resolution by the Engineer.

1.1.9 Verify dimensional location and depth of slab recesses and offsets with Architectural Drawings.

1.1.10 Verify weights, location and details of structurally supported mechanical equipment prior to construction of the supporting structure. Report deviations from assumed conditions to the Engineer prior to fabricating materials.

1.1.11 Verify the location, size and detail of roof openings and curbs for mechanical equipment prior to fabricating materials. Report deviations from assumed conditions to the Engineer before proceeding with work.

1.1.12 Verify location and size of floor and roof penetrations and sleeves for mechanical and electrical components. Openings in beams, girders, columns and slabs must be submitted for approval.

1.1.13 Verify dimensions, details, plumbness and squareness of existing structures meeting or tieing into new construction.

1.1.14 Heights of floor and roof decks and various framing components are given on the drawings relative to a reference elevation of 100'-0".

SECTION 1.2 - CODES AND STANDARDS

1.2.1 Building Code: 2021 International Building Code (IBC)

1.2.2 Concrete Code: American Concrete Institute ACI 318-14

1.2.3 Steel Code: AISC Steel Construction Manual, 14th edition

SECTION 1.3 - DESIGN LOADS

1.3.1 Live Loads:

Public Stairs	100	psf
Assembly, Lobbies	100	psf
Corridors	100	psf
Light Storage	125	psf
Mechanical Room	150	psf (2)
Offices, Typical Floors	50	psf (1)
Restaurant, Dining Areas	100	psf
Roof, Slope Less than 4:12	20	psf

Notes:
(1) Plus partition loading (see Dead Loads)
(2) Minimum load, or weight of equipment (the heavier)

1.3.2 Dead Loads:

6 1/2" Composite Floor System	62.5	psf
Flooring	2	psf
Typical Ceilings	3	psf
Floor Collateral	9.5	psf (1)
Floor Sprinklers	3	psf (3)
Partition Loading	15	psf (4)
Roof Collateral	3.45	psf (1)
Roof Insulation	3.5	psf
Roof Sprinklers	3	psf (3)
Roofing System	23	psf (2)

Notes:
(1) Collateral loads include; lighting, ductwork, miscellaneous framing.
(2) Roofing system weight is the maximum unit weight of roofing materials and ballast (where applicable) for which the roof structure is designed.
(3) Sprinkler loadings are for distribution lines and heads, exclusive of mains, which are included Separately as concentrated dead loads.
(4) Applied where noted under "Live Loads".

1.3.3 Wind Loads: MWFRS

Base Mean Wind Velocity	116 mph
Wind Exposure Classification	B
Wind Importance Factor	1.0
Analysis Procedure -	DIRECTIONAL

1.3.4 Seismic Loads:

Mapped Spectral Response Acceleration, Ss	0.279
Mapped Spectral Response Acceleration, S1	0.078
Spectral Response Coefficient, Sds	0.242
Spectral Response Coefficient, Sd1	0.078
Site Class	C
Seismic Importance Factor, Ie	1.25
Seismic Use Group	II
Seismic Design Category, SDC	B
Seismic Response Coefficient, Cs	0.019
Basic Seismic Force Resisting System	SCBF
Response Modification Factor, R	6.0
Design Base Shear	37 K

Analysis Procedure - Equivalent Lateral Force Procedure

SECTION 2: FOUNDATIONS AND RELATED EARTHWORK

GEOTECHNICAL REPORT

2.1 Design of foundations and structural components in contact with soil is based on the recommendations given in the following:

Report by : RED ROCK CONSULTING
Date of Report : SEPT 23, 2019
Report Reference : 19051

2.2 Refer to the geotechnical report for subsoil conditions that may be encountered in the installation of foundations, and other information relevant to foundations and site preparation.

2.3 Design of soil-supported building slabs is based on a range of soil movement of 0 to 1 inch(es), based on the recommendations of Geotechnical Report.

2.4 Refer to Specifications for soil stabilization under soil-supported building slabs.

EARTH RETENTION SYSTEMS

2.5 The design of earth retention systems is not included in Structural Documents. Refer to the Technical Specifications for requirements.

CONCRETE FOOTINGS

2.6 Design Criteria:
Bearing Material: LOW VOLUME CHANGE FILL
Bearing Elevation: 2'-6" BELOW GRADE
(For Bidding Purposes Only)
Spread Footing Bearing Capacity: 2000 psf
Continuous Footing Bearing Capacity: 1600 psf

2.7 Required footing thickness is 12" minimum and shall be adjusted as necessary to achieve required bearing conditions.

2.8 Steel dowels at tops of footings shall extend 30 bar diameters above and shall be hooked 3" above bottom of footing unless noted otherwise.

2.9 Top of footing elevations given are relative to reference elevation 100'-0".

SECTION 3: STRUCTURAL CONCRETE

3.0.1 Composite deck system shall be shored in accordance with manufacturer's requirements. Shoring is to remain in place until concrete has reached 75% of specified compressive strength. In addition, shoring is to remain in place until all levels have been placed and have reached 75% of specified compressive strength.

3.0.2 At support points and edge of deck locations, composite deck shall be attached to load bearing walls and structural steel support beams with Hilti Flex Screws, Type 12-14x7/8 HWH #3, at 12" o.c., UNO.

3.0.3 Deck shall span between supports. No midspan splicing of the deck is permitted. Provide #10 tek screw side fasteners at 24" o.c.

SECTION 3.1 - CONCRETE FORMS

3.1.1 Formed Voids - Provide retained void spaces between bottom of structural members and sub grade as follows:
Grade Beams 6 inches
Structural Slabs 10 inches

3.1.2 Grade Beams - shall be formed both sides unless specifically shown or noted otherwise in the details.

SECTION 3.2 - STEEL REINFORCING

STEEL REINFORCING

3.2.1 All bars shall be deformed in accordance with ASTM A615. Reinforcing indicated to be welded shall conform to ASTM A796.

3.2.2 Strength of bars shall be as follows:

All Bars Grade 60

SPLICING OF REINFORCING BARS

3.2.3 Top bars in beams, slabs or joists shall be spliced at midspan between supports, unless noted otherwise.

3.2.4 Bottom bars in beams, slabs or joists shall be spliced at supports, unless noted otherwise.

3.2.5 Vertical bars in walls shall be spliced at top of concrete above floors, unless noted otherwise.

3.2.6 Column reinforcing shall be spliced at top of concrete above floors, unless noted otherwise.

LAPPED SPLICE LENGTHS

3.2.7 Lap reinforcing 30 bar diameters at splices unless noted or detailed otherwise.

CONCRETE COVER TO REINFORCING

3.2.8 Clearance from face of concrete to face of reinforcing:

Footings	3"
Formed Grade Beams	1-1/2" top, 2" sides, 3" bottom
Columns	1-1/2" interior, 2" exterior exposure
Slabs	3/4"

PLACEMENT OF REINFORCING

3.2.9 Offsets in reinforcing bars shall be bent at a ratio of 1 (normal to bar axis) to 6 (parallel to bar axis).

3.2.10 Provide corner bars at intersections of beams and walls in accordance with Typical Details.

3.2.11 Provide dowels from grade beams or foundation equal in size and spacing to vertical bars in walls or pilasters and extend one splice length above and below joint line, unless noted otherwise.

3.2.12 Start stirrup spacing in beams 2 inches outside of face of supports.

3.2.13 Place first bar of slab reinforcing parallel to side 2 inches from a free edge or half of required bar spacing from face of edge beam.

3.2.14 Single layer reinforcing in walls shall be placed at center of walls unless noted otherwise.

3.2.15 Place welded wire reinforcing in slabs in toppings, or in slabs poured on metal deck at center of slab unless noted otherwise.

SECTION 3.3 - CONCRETE MIX DESIGNS

3.3.1 Concrete Mix Schedule:

a) "HRC" refers to hardrock concrete having air dry unit weight of approximately 145 PCF.
b) "LWC" refers to sand lightweight concrete having dry unit weight not to exceed 120 PCF.
c) Where w/c ratio is not indicated in the Concrete Mix Schedule, it shall be as necessary to meet strength requirements.
d) Where the w/c ratio is shown, it shall be adhered to regardless of strength requirements.
e) "Strength" is required compressive cylinder strength at 28 days.

Conc. Class	Strength psi	Agg. Type	Agg. Size	Slump Inches	Max w/c	Notes
A	3000	HRC	1-1/2"	5-7	---	
B	3000	HRC	1"	3-5	---	
C	3500	HRC	1"	2-4	---	
D	4500	HRC	1"	3-5	---	
E	3000	HRC	3/4"	2-4	---	
F	4000	HRC	1"	3-5	---	

3.3.2 Mix Usage Schedule:

Description of Use	Concrete Class	Air Content
Footings	F	------
Grade Beams	F	4.5-6%
Interior Slab-on-Grade	F	------
Elevator Pit Walls	F	------
Slab on Composite Metal Deck	F	------

SECTION 3.4 - CONCRETE SLABS

3.4.1 Slabs Placed on Grade

Location	Thickness	Reinforcing
All	5 inches	#3 @ 12 EW

a) Reinforcement shall be placed 2 inches from top of slab unless detailed otherwise.
b) Provide construction joints in slabs where indicated on Plans. Allow minimum of 4-day interval between placing adjacent sections of slab.

SECTION 5: STRUCTURAL STEEL

SECTION 5.1 - STRUCTURAL FRAME

5.1.1 Structural Steel Properties:

W-shapes and Tees	ASTM A992
Angles, Channels, Plates, uno	ASTM A36
Pipe Columns	ASTM A53, Grade B
HSS Rectangular	ASTM A500, Grade B
HSS Round	ASTM A500, Grade B
Erection Bolts	ASTM A307
High Strength Bolts	ASTM A325N
Anchor Bolts	ASTM A36 or A307
High Strength Anchor Bolts	ASTM A193 Grade B7
Headed Stud Anchors	ASTM A108

WELDING

5.1.2 Unless otherwise noted, angles, plates, rods, and miscellaneous framing shall be welded at contact joints and supports. Weld sizes shall conform to AWS D1.1 minimum, except where noted otherwise.

5.1.3 Where fillet weld sizes are not indicated on weld symbols, fillet size shall be 1/16th inch smaller than thickness of thinner of materials being joined.

5.1.4 Complete penetration welds are indicated by notation "CP" on weld symbols, partial penetration by "PP".

5.1.5 Edge angles at perimeters of floors and roofs noted as "CHORD MEMBERS" or "CONTINUOUS" on details shall be butt welded at splices to develop full allowable tensile strength of member.

5.1.6 Edge angles supporting floor or roof deck shall be spliced only over supports.

STRUCTURAL BOLTS

5.1.7 Bolts indicated on details shall be ¾" diameter, unless noted otherwise.

5.1.8 Bolts shall be tightened by the AISC "Snug Tight" method unless noted otherwise.

5.1.9 Shelf angles supporting masonry shall have ¼" wide expansion joints spaced not more than 40 feet apart.

SECTION 5.2 - METAL ROOF DECK

5.2.1 Metal Deck Schedule:

Deck Gauge	SDI Deck Type	Deck Depth (In.)	Sheet Width (In.)	Min. Ix (In.4)	Min. Sx(top) (In.3)	Min. Sx(bot) (In.3)
22	WR	1.5	36	0.169	0.192	0.186

5.2.2 Metal Deck Connection Schedule:

Mark	Conn. @ Supports (W/N)	Conn. @ Parallel Edges (In.)	Sidelap Conn. (#/span)	Req'd Shear Capacity (lb/ft)
I	36/5	12	4	287
II	36/7			

5.2.3 Support and parallel edge connections shall be 5/8-inch diameter puddle welds. Sidelap connections shall be #10 hex screws. W/N = sheet width / # connections each sheet.

5.2.4 Roof deck shall be connected as indicated for Mark I unless noted otherwise.

.

SECTION 5.3 – LIGHT GAUGE METAL FRAMING

5.3.1 Metal stud sizes, spacing, gages, details and connections are minimum requirements based on member section properties of Dietrich Industries. Contractor shall provide complete engineered light gage framing system for exterior and interior metal stud framing.

5.3.2 Lightgage Steel Properties:

Mbr	Material	Grade	Fy	Shop Coat
Studs	ASTM A446	C	40 ksi	Galvanize (G-60)
Joists	ASTM A446	C	40 ksi	Galvanize (G-60)
Track	ASTM A446	A	33 ksi	Galvanize (G-60)

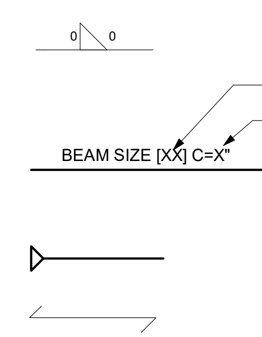
5.3.3 Slide clip capacity and connection shall be adequate to safely brace metal wall studs against design lateral load of 700 pounds for each stud (allowable stress increase permitted by Building Code already taken into account).

5.3.4 Welding of light gage materials indicated on details shall be 1/8th inch fillet welds, unless noted otherwise. Use special welding equipment to prevent blow-out or burning through material.

5.3.5 Do not weld 20 gage or lighter metal framing unless called for on plans or details

SYMBOLS LEGEND

SYMBOL — DESCRIPTION



WELD
SHEAR STUD QUANTITY
CAMBER
MOMENT CONNECTION
DECK SPAN DIRECTION

ABBREVIATIONS

ARCH	ARCHITECTURAL
ASD	ALLOWABLE STRESS DESIGN
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWS	AMERICAN WELDING SOCIETY
BM	BEAM
BP	BASE PLATE
CJ	CONTROL JOINT
CL	CENTER LINE
CLR	CLEAR
COL	COLUMN
CONC	CONCRETE
CONT	CONTINUOUS
DIA	DIAMETER
DL	DEAD LOAD
DN	DOWN
DWLS	DOWELS
EA	EACH
EL	ELEVATION
ELEV	ELEVATION
EQ	EQUAL
EQUIV	EQUIVALENT
EW	EACH WAY
FIN	FINISH
FLR	FLOOR
FND	FOUNDATION
FTG	FOOTING
IN	INCH/INCHES
JST	JOIST
JT	JOINT
LBS	POUNDS
LL	LIVE LOAD
LONG	LONGITUDINAL
LRFD	LOAD AND RESISTANCE FACTOR DESIGN
MAX	MAXIMUM
MIN	MINIMUM
OC	ON CENTER
PL	PLATE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
REINF	REINFORCING
SF	SQUARE FOOT
SIM	SIMILAR
STD	STANDARD
TO	TOP OF
TOS	TOP OF STEEL
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL
W/	WITH
W/O	WITHOUT
WWF	WELDED WIRE FABRIC
WWR	WELDED WIRE REINFORCING

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Sheet No.:
S0.1
GENERAL NOTES

FOUNDATION PLAN NOTES

1. SEE S.0 FOR GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS
2. FINISH FLOOR ELEVATION IS 100'-0" (RELATIVE TO DATUM 100-0)
3. TOP OF CONCRETE SLAB IS FINISH FLOOR UNLESS SHOWN OR NOTED OTHERWISE.
4. TYPICAL CONCRETE SLAB ON GRADE THICKNESS IS 5" NORMAL WEIGHT CONCRETE REINFORCED WITH #3 BARS @12" O.C.E.W PLACED AT MID DEPTH OF SLAB ON LAYER OF CRUSHED STONE WITH VAPOR BARRIER UNLESS NOTED OTHERWISE
5. AT ALL GRID LOCATIONS: SEE COLUMN SCHEDULE FOR COLUMN SIZE AND HEIGHT
6. AT ALL COLUMN LOCATIONS: SEE COLUMN SCHEDULE FOR FOOTING MARK AND SEE FOOTING SCHEDULE FOR FOOTING SIZE, DEPTH, AND REINFORCING
7. SHEET INDEX

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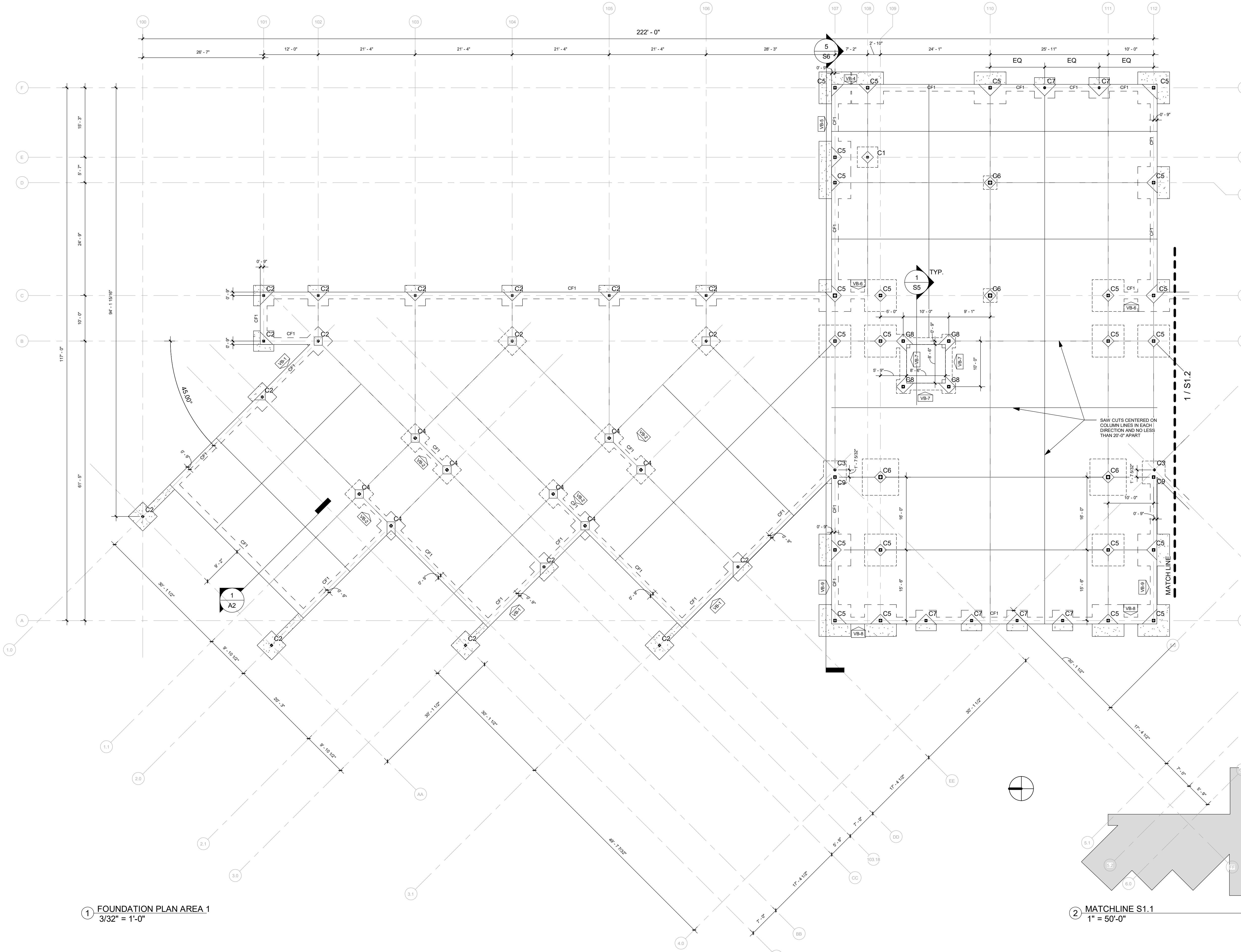
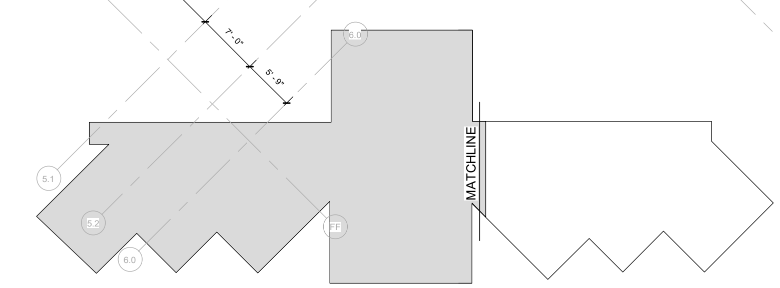
SCHEDULES	S4
TYPICAL DETAILS	S5, S6



1 FOUNDATION PLAN AREA 1
3/32" = 1'-0"



2 MATCHLINE S1.1
1" = 50'-0"

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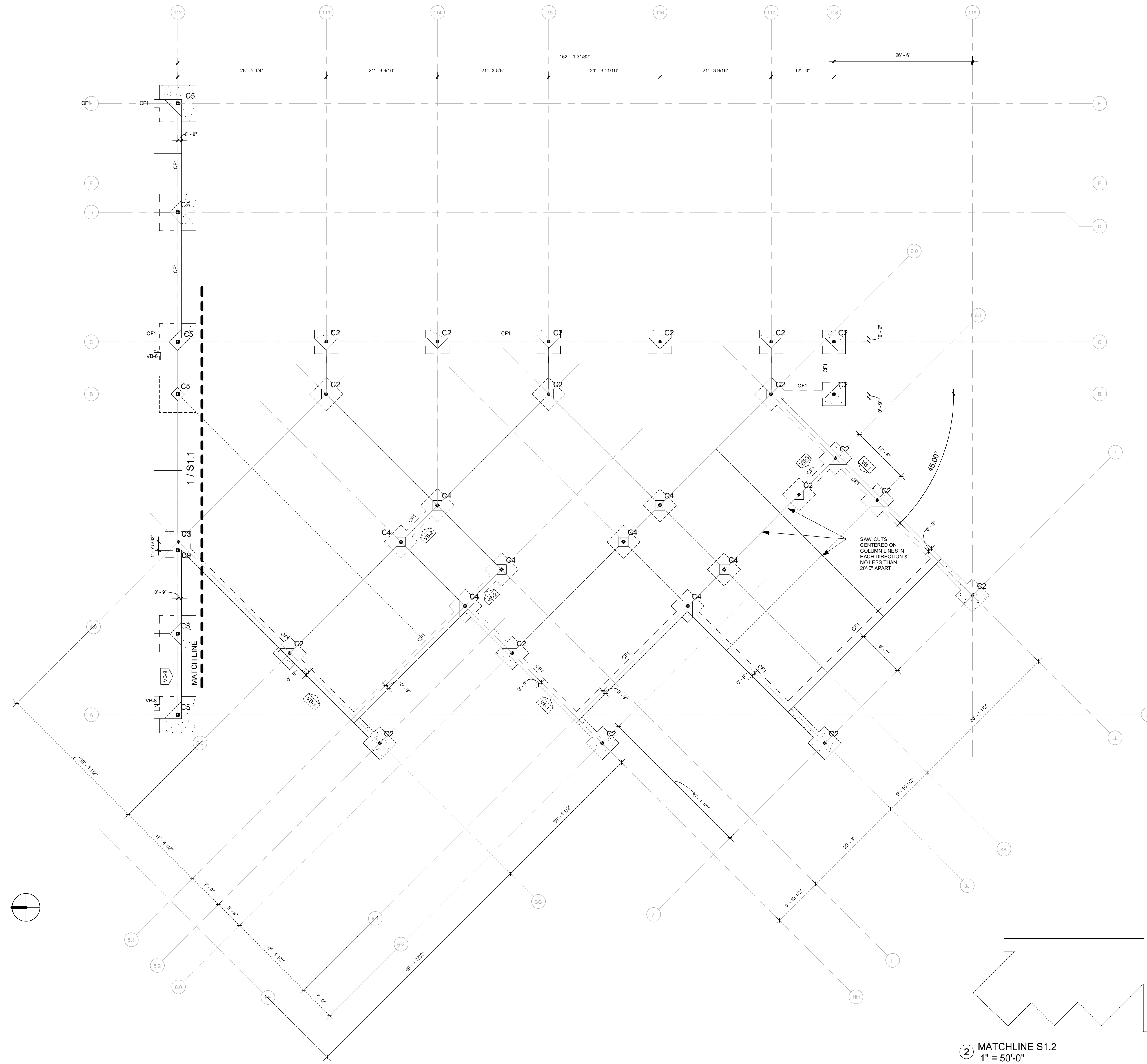
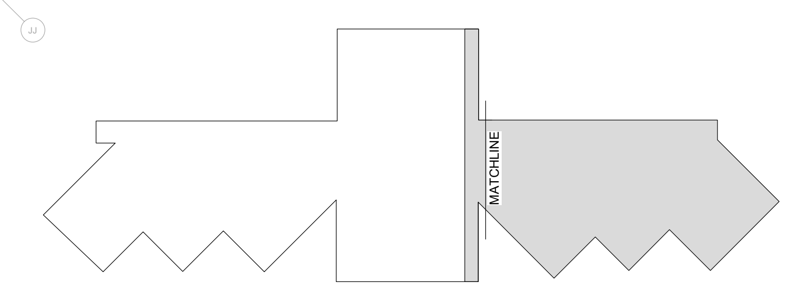
TYPICAL DETAILS	S5, S6



1 FOUNDAITON PLAN AREA 2
3/32" = 1'-0"



2 MATCHLINE S1.2
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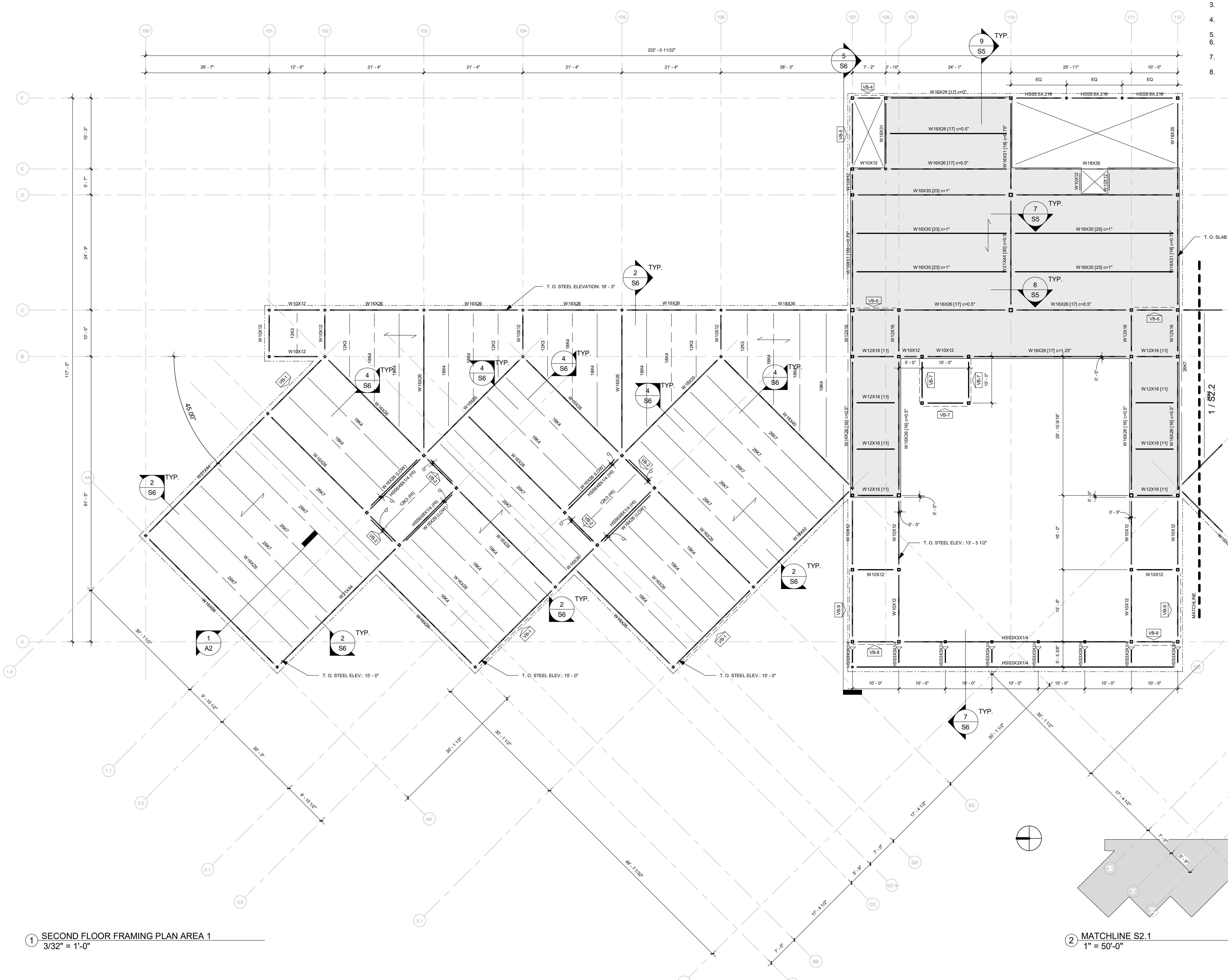
Sheet No.:
S1.2
FOUNDATION PLAN 2

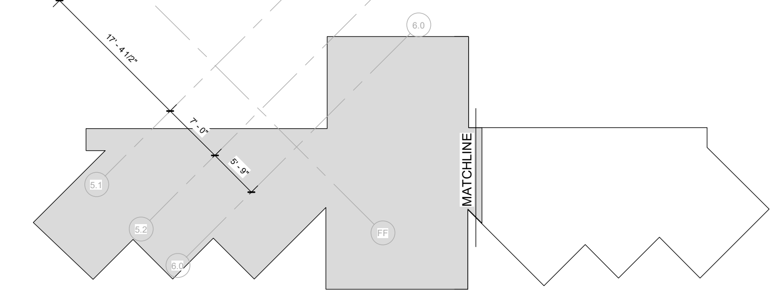
2ND FLOOR FRAMING PLAN NOTES

1. FINISH FLOOR ELEVATION (RELATIVE TO DATUM 100-0) IS 114-0
2. TOP OF ROOF STRUCTURE IS SLOPED FOR DRAINAGE. SEE ELEVATIONS NOTED ON PLAN.
3. TOP OF CONCRETE SLAB IS FINISH FLOOR UNLESS SHOWN OR NOTED OTHERWISE.
4. FLOOR SLAB: 3VL-36 20-GAGE GRADE-50 DECK WITH 3 1/2" NWC SLAB, REINFORCED WITH 6x6-W2.1xW2.1
5. ROOF DECK: 1.5B22 PER GENERAL NOTES
6. UNLESS NOTED OTHERWISE, STEEL JOISTS SHALL BE CENTERED ON AND EQUALLY SPACED BETWEEN COLUMN CENTERLINES.
7. DESIGN STEEL JOISTS FOR A NET UPLIFT OF 30 POUNDS PER SQUARE FOOT (psf) FOR WIND LOADING
8. SHEET INDEX

GENERAL STRUCTURAL NOTES	S0.1
SCHEDULES	S4
TYPICAL DETAILS	S5, S6



① SECOND FLOOR FRAMING PLAN AREA 1
3/32" = 1'-0"



② MATCHLINE S2.1
1" = 50'-0"

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S2.1
SECOND FLOOR FRAMING 1

2ND FLOOR FRAMING PLAN NOTES

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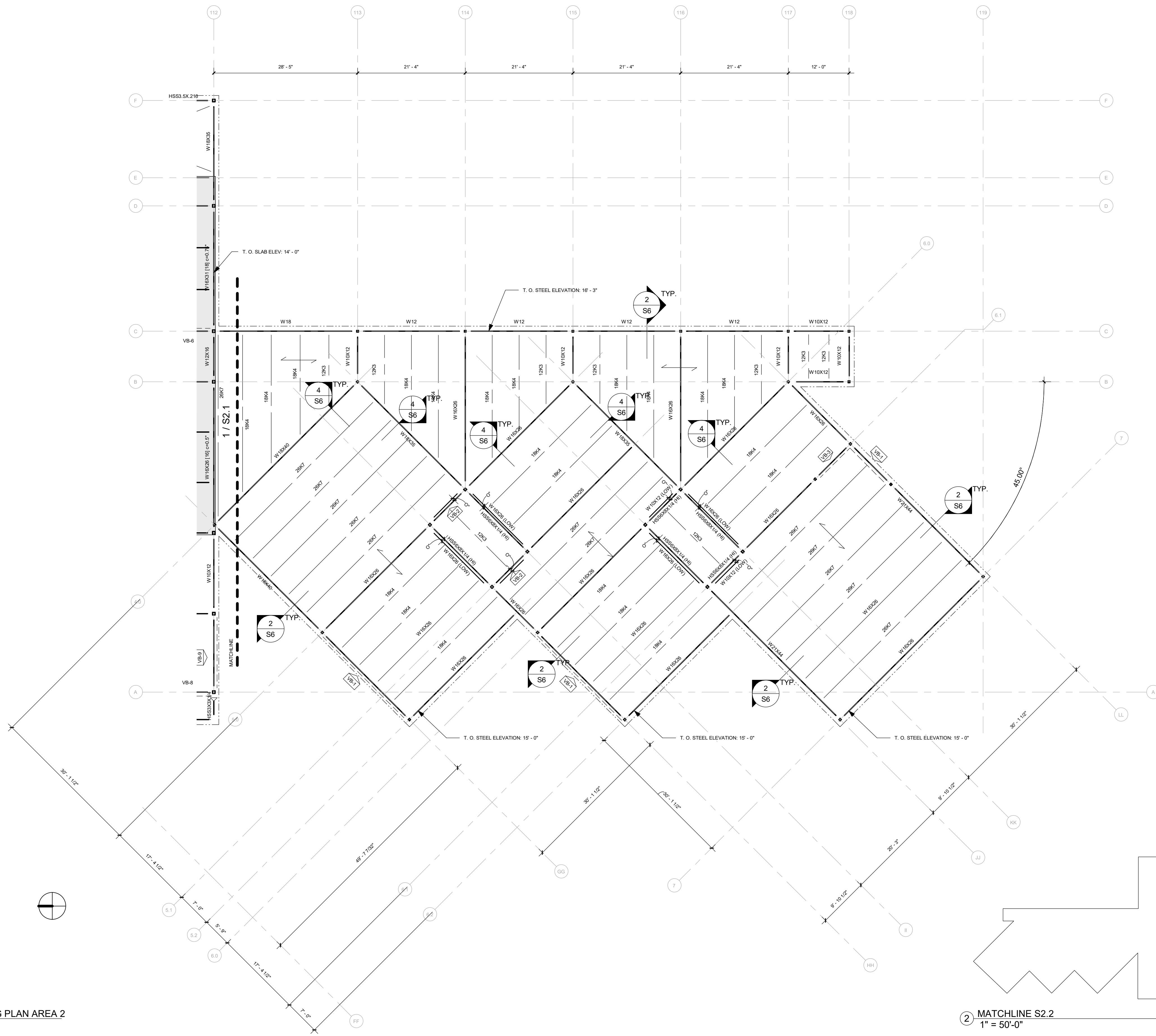
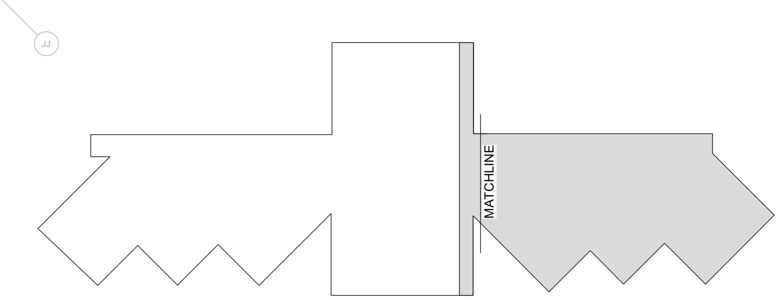
6. UNLESS NOTED OTHERWISE, STEEL JOISTS SHALL BE CENTERED ON AND EQUALLY SPACED BETWEEN COLUMN CENTERLINES.
7. DESIGN STEEL JOISTS FOR A NET UPLIFT OF 30 POUNDS PER SQUARE FOOT (psf) FOR WIND LOADING
8. SHEET INDEX

	GENERAL STRUCTURAL NOTES	S0.1
	SCHEDULES	S4
	TYPICAL DETAILS	S5, S6



1 SECOND FLOOR FRAMING PLAN AREA 2
3/32" = 1'-0"



2 MATCHLINE S2.2
1" = 50'-0"

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S2.2
SECOND FLOOR FRAMING 2

HIGH ROOF FRAMING PLAN NOTES

1. TOP OF ROOF STRUCTURE IS SLOPED FOR DRAINAGE. SEE ELEVATIONS NOTED ON PLAN.
2. ROOF DECK: 1.5B22 PER GENERAL NOTES
3. UNLESS NOTED OTHERWISE, STEEL JOISTS SHALL BE CENTERED ON AND EQUALLY SPACED BETWEEN COLUMN CENTERLINES.
4. DESIGN STEEL JOISTS FOR A NET UPLIFT OF 30 POUNDS PER SQUARE FOOT (psf) FOR WIND LOADING
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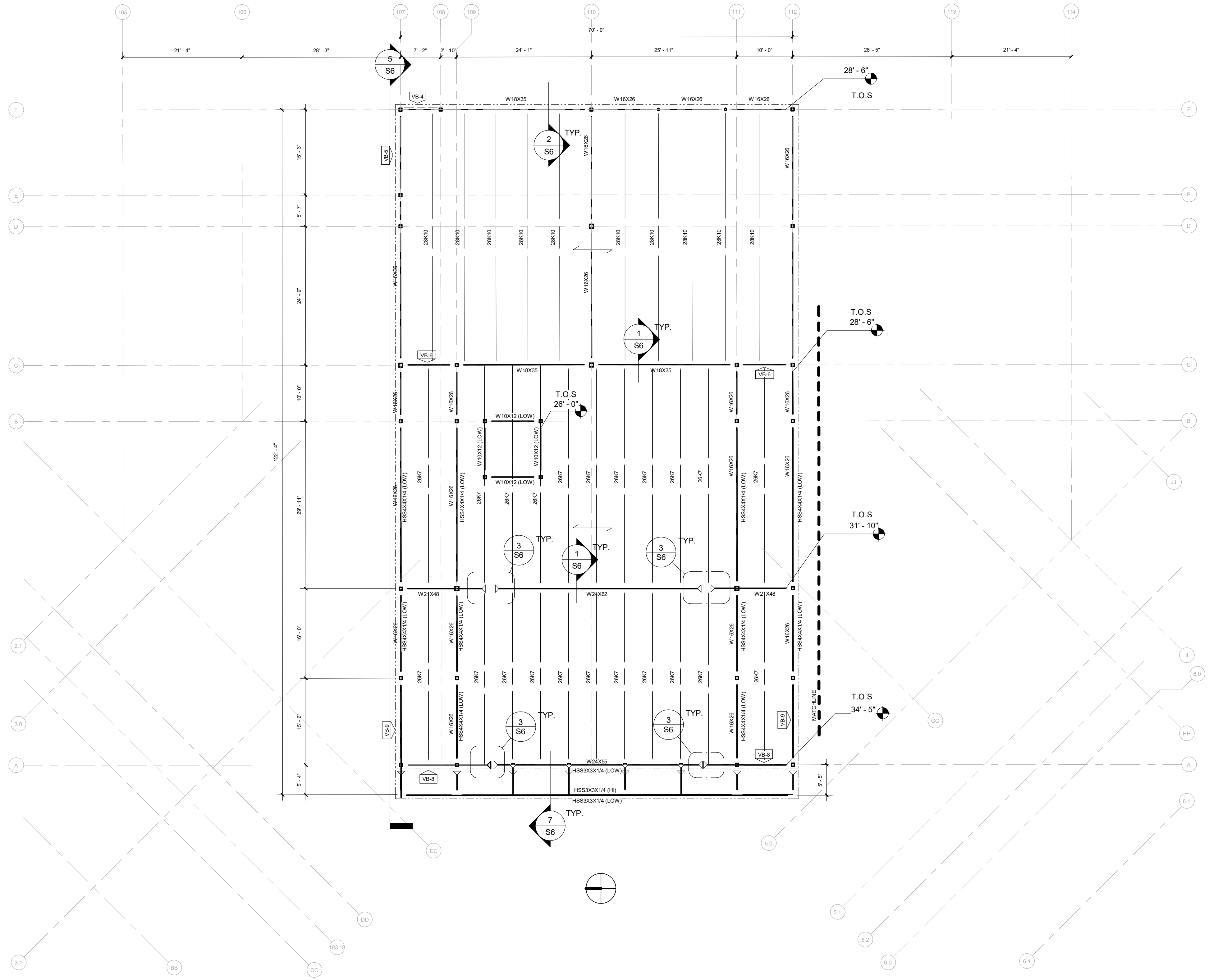
GENERAL STRUCTURAL NOTES	S0.1
SCHEDULES	S4
TYPICAL DETAILS	S5, S6



1 HIGH ROOF FRAMING PLAN
3/32" = 1'-0"

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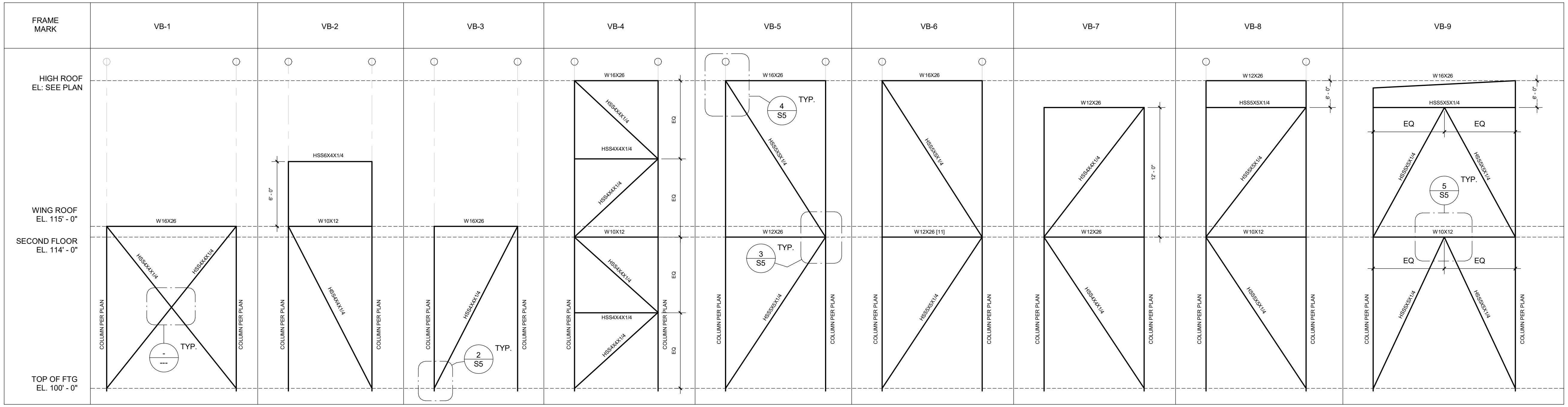
S3

HIGH ROOF FRAMING

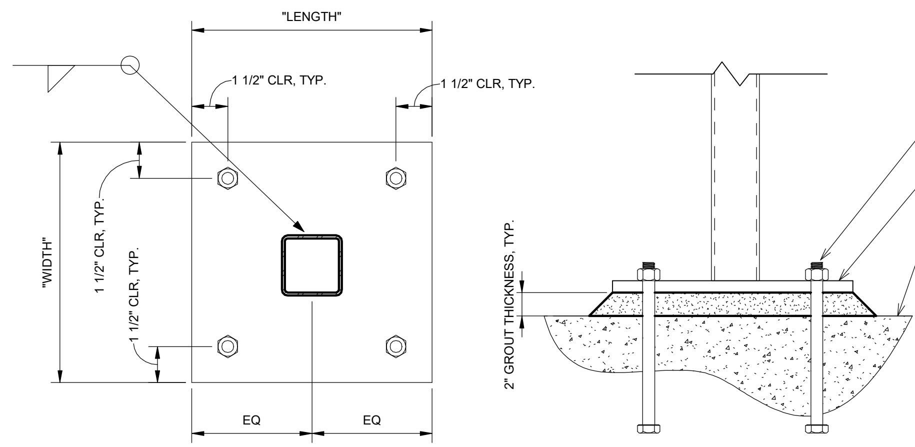


3 VERTICAL BRACE SCHEDULE

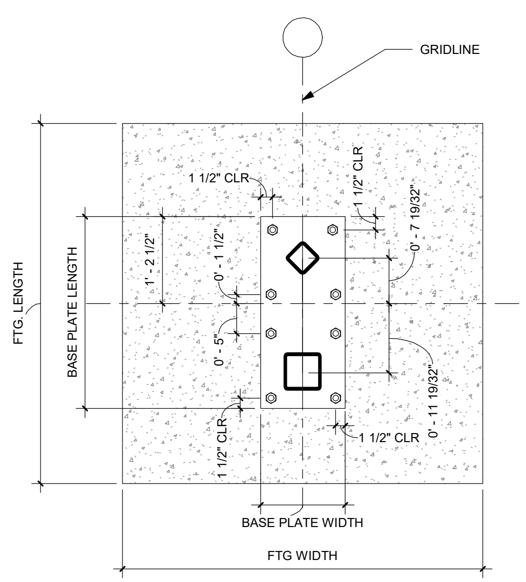
FOOTING MARK[1]	COLUMN BASE PLATE			PEDESTAL WIDTH	FOOTING SIZES		FOOTING THICKNESS	FOOTING DEPTH	STEEL REINFORCING, BOTH DIRECTIONS	STEEL DOWELS
	LENGTH[3]	WIDTH[3]	THICKNESS[3]		LENGTH	WIDTH				
F1	11"	0' - 11"	1/2"	12"	4' - 6"	4' - 6"	12"	3' - 0"	4 #6 BARS	4 #4
F2	12"	1' - 0"	5/8"	12"	7' - 0"	7' - 0"	12"	3' - 0"	6 #6 BARS	4 #4
F3	14"	1' - 2"	5/8"	14"	8' - 0"	8' - 0"	12"	3' - 0"	6 #6 BARS	6 #4
F4[2]	32"	1' - 0"	5/8"	32"	5' - 0"	5' - 0"	24"	3' - 0"	6 #6 BARS	12 #6
F5	11"	0' - 11"	1/2"	SEE ELEVATOR PIT DETAIL						
CF1	N/A			N/A	18"		N/A	3' - 0"	#6 @ 4" O.C.[4]	N/A

NOTES:
1: COLUMNS CENTERED ON FTGS U.N.O.
2: FTG. F4 IS A COMBINED FOOTING. SEE DETAIL FOR COLUMN PLACEMENT
3: @ ALL VERTICAL BRACE LOCATIONS, BASE PLATE DIMENSIONS ARE: 5/8" X 14" X 2' - 0"
4: ONLY IN THE TRANSVERSE DIRECTION OF THE CONTINUOUS FOOTING

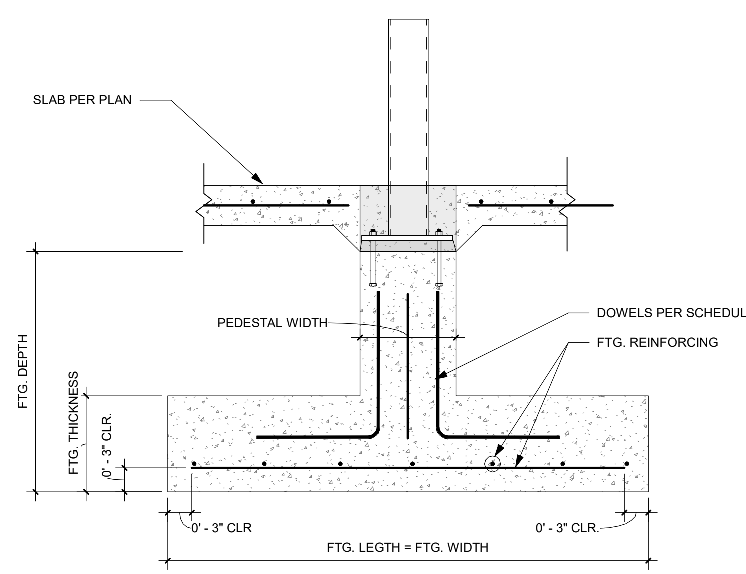
2 FOOTING SCHEDULE



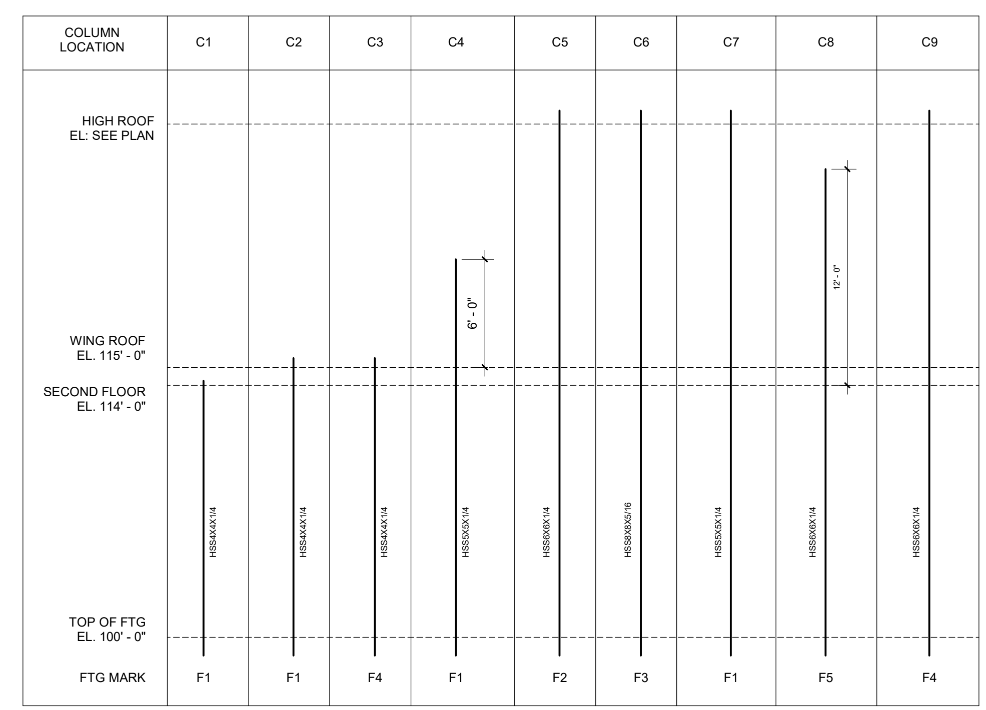
4 BASE PLATE DETAIL, TYP.
1 1/2" = 1'-0"



6 FOOTING F4
3/4" = 1'-0"



5 TYPICAL FOOTING
1" = 1'-0"



1 COLUMN SCHEDULE

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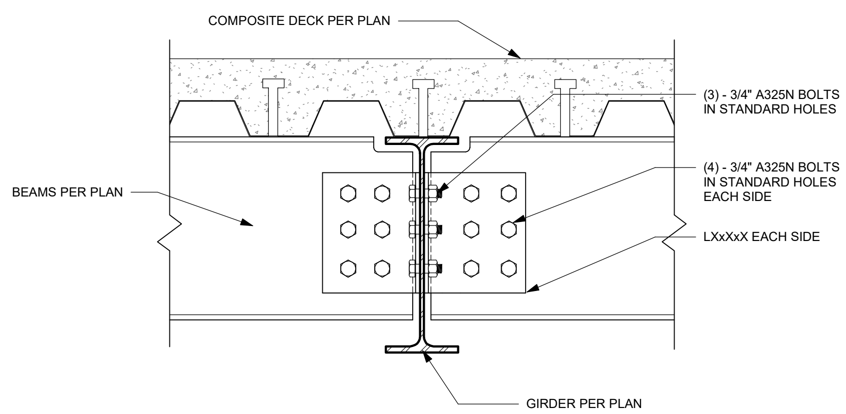
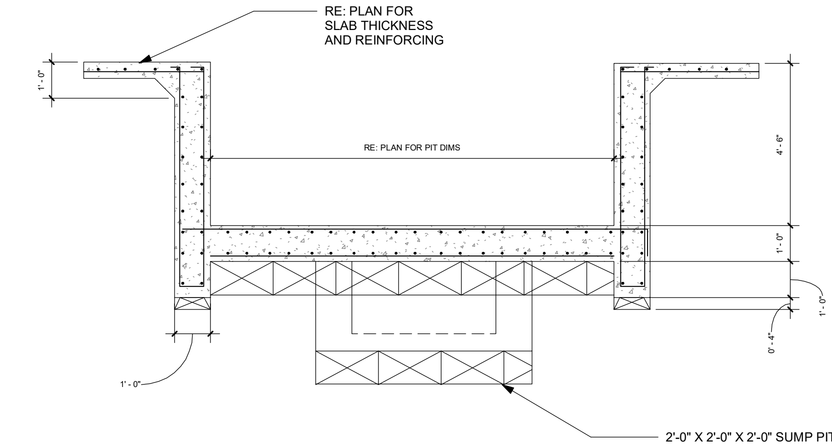
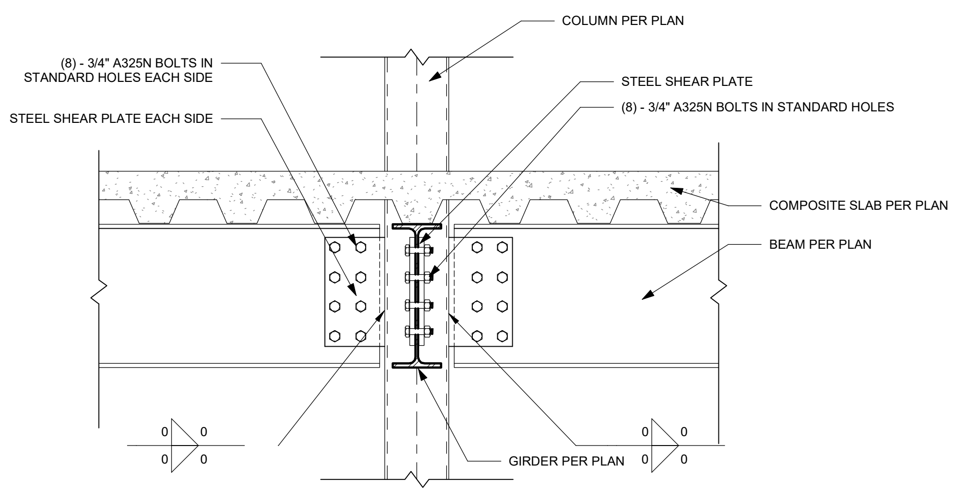
S4
SCHEDULES



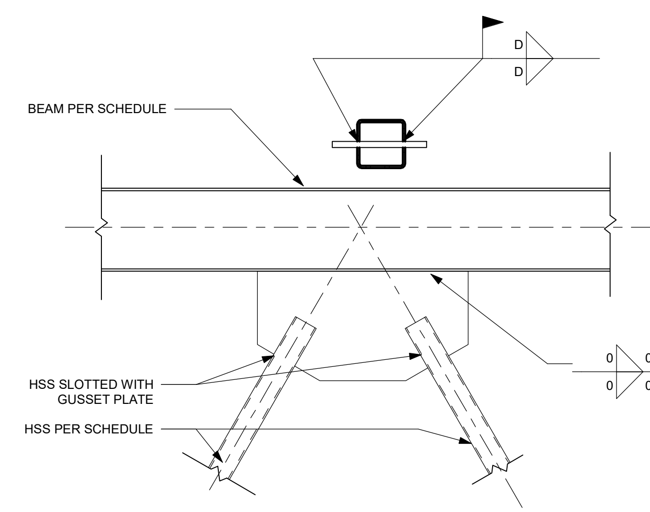
7 FLOOR BM TO GIRDER CONNECTION
1 1/2" = 1'-0"



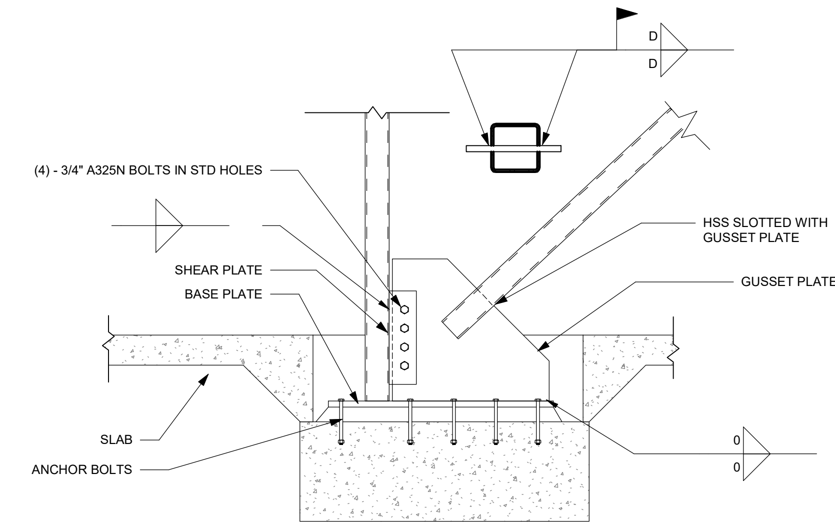
1 ELEVATOR PIT
3/8" = 1'-0"



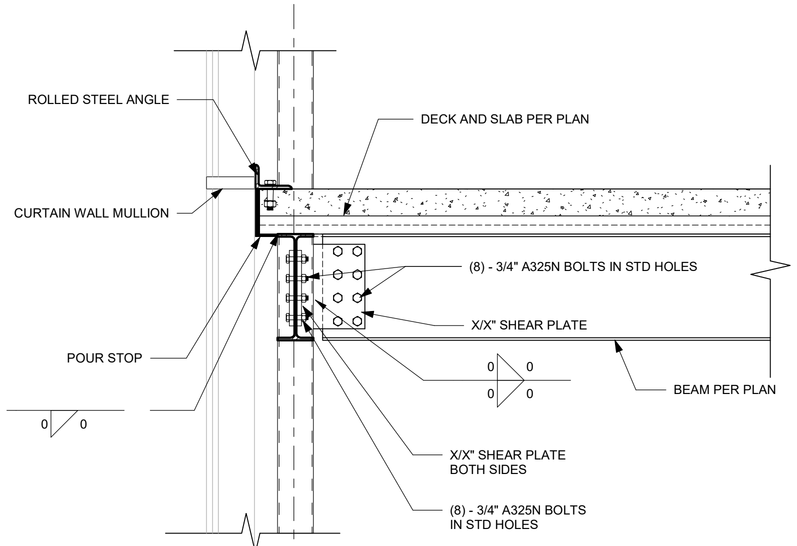
8 FLOOR BEAM TO COLUMN CONNECTIOIN
1" = 1'-0"



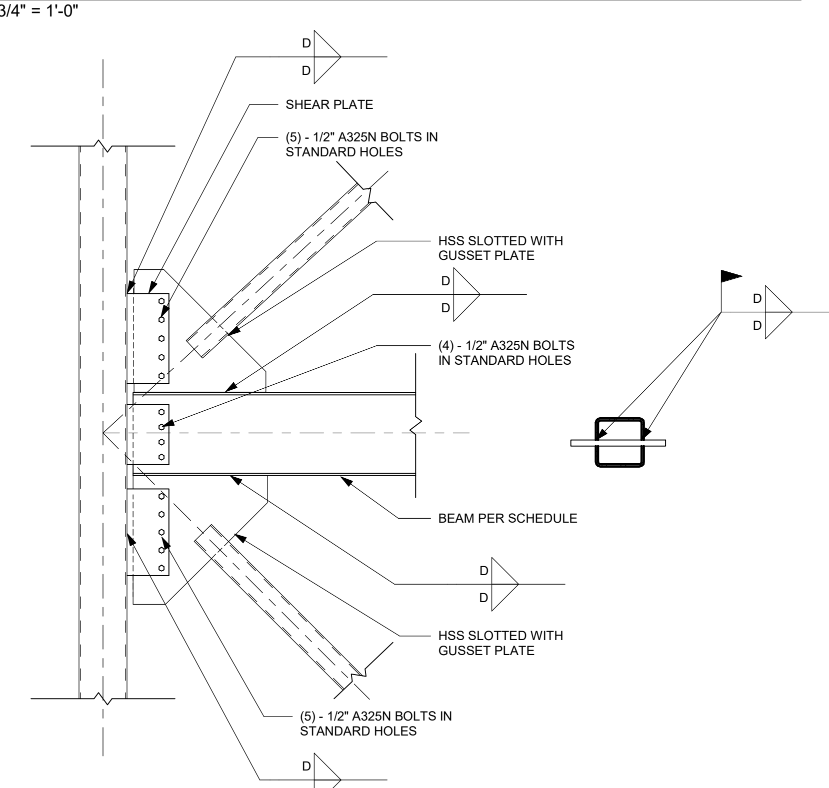
5 CHEVRON BRACE CONNECTION
3/4" = 1'-0"



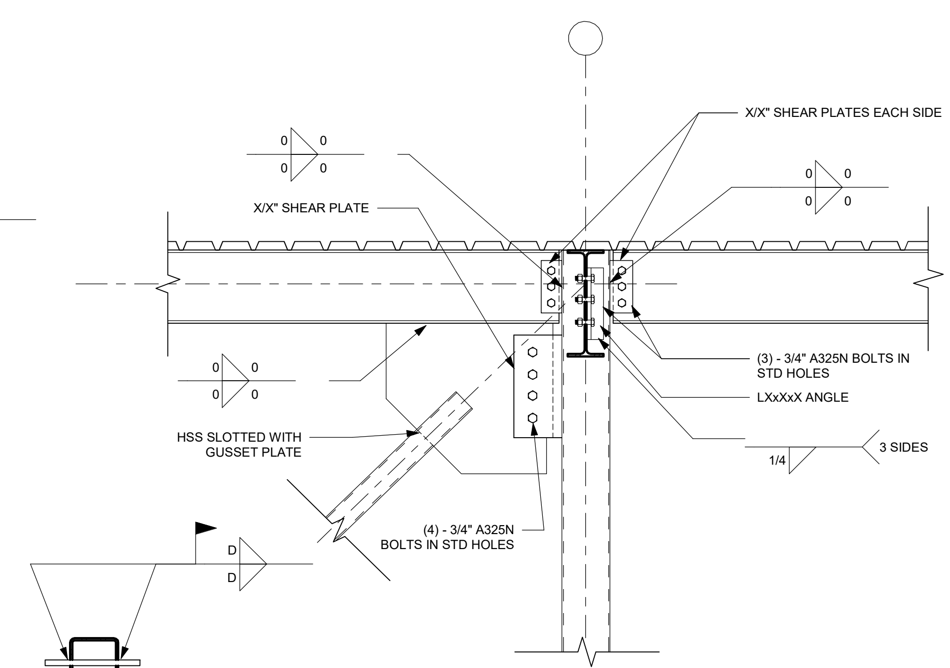
2 VB CONNECTION AT FOUNDATION, TYP.
3/4" = 1'-0"



9 EXTERIOR FLOOR EDGE
3/4" = 1'-0"



3 VB CONNECTION AT FLOOR BEAM
3/4" = 1'-0"



4 VB CONNECTION AT ROOF, TYP.
3/4" = 1'-0"

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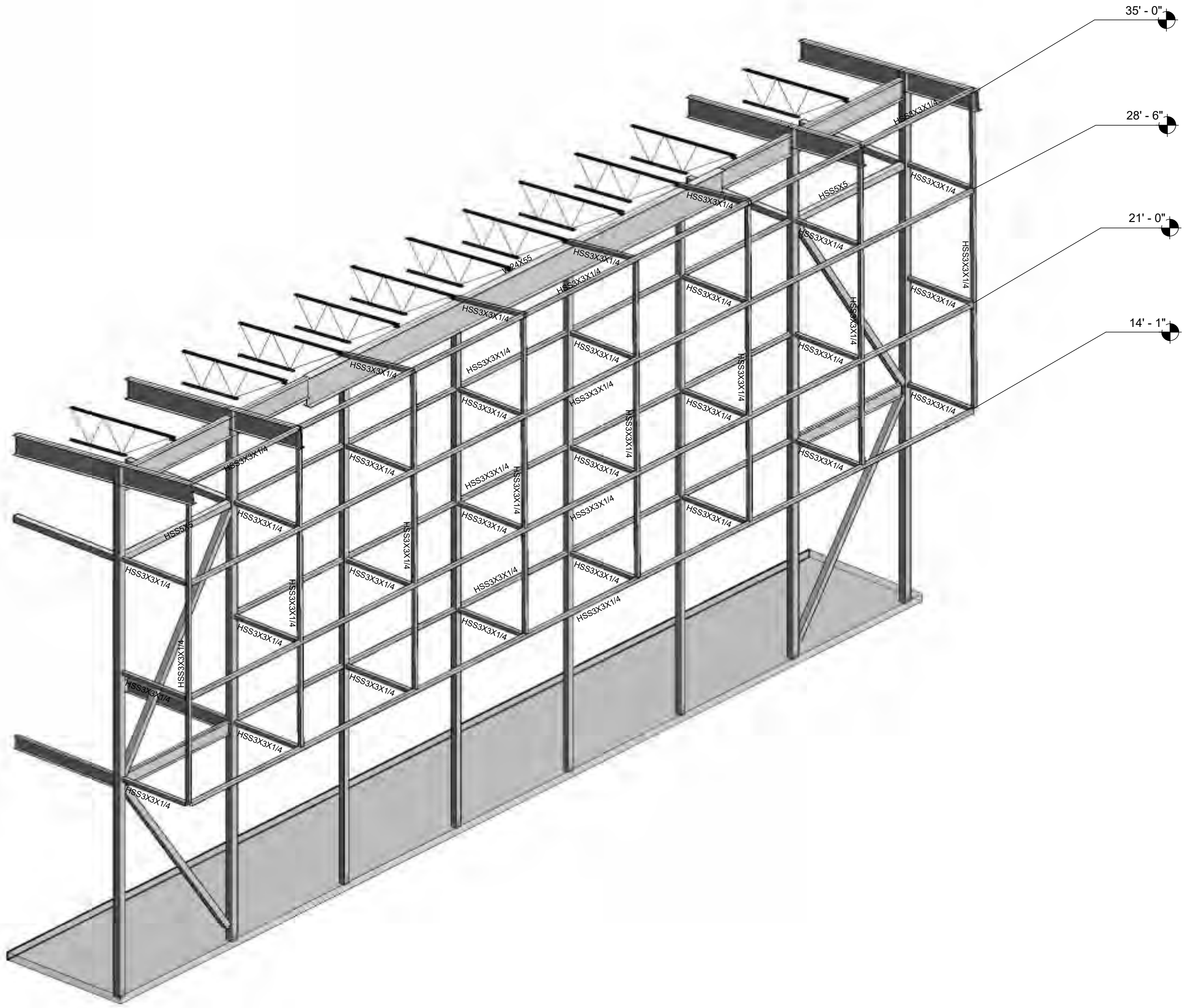
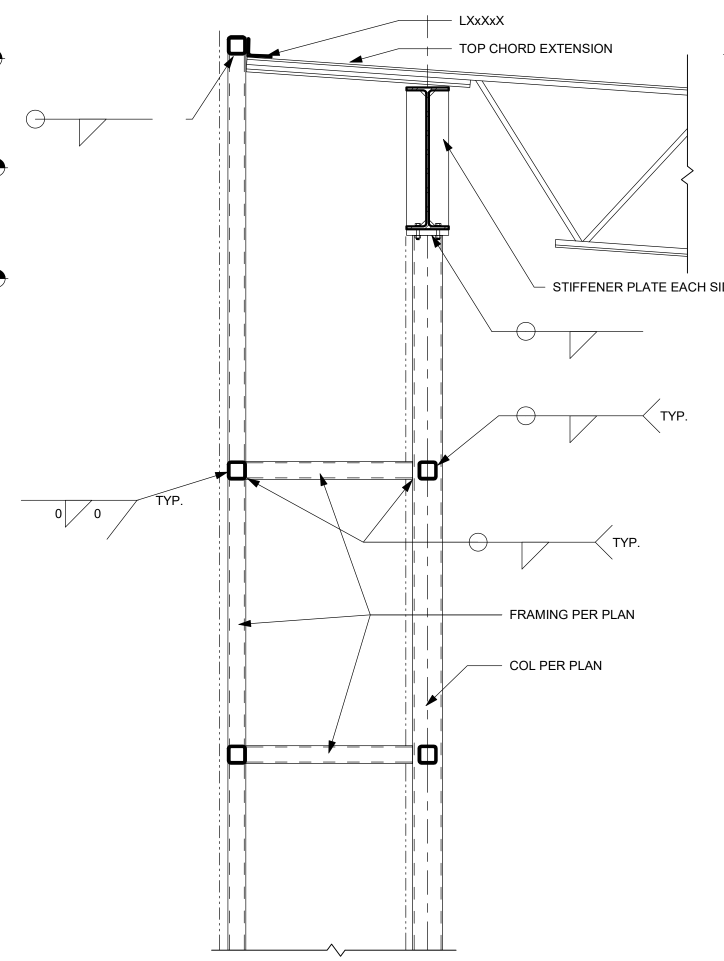
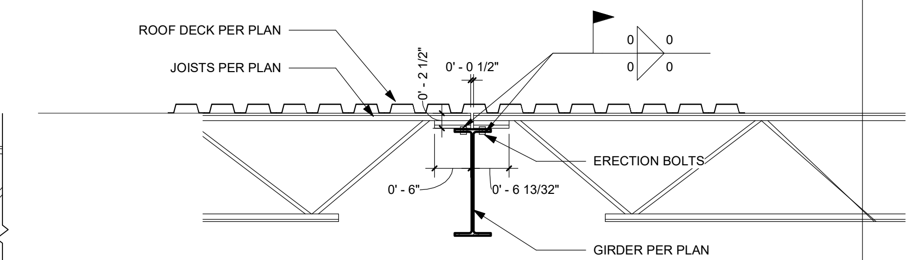
STRUCTURAL DETAILS



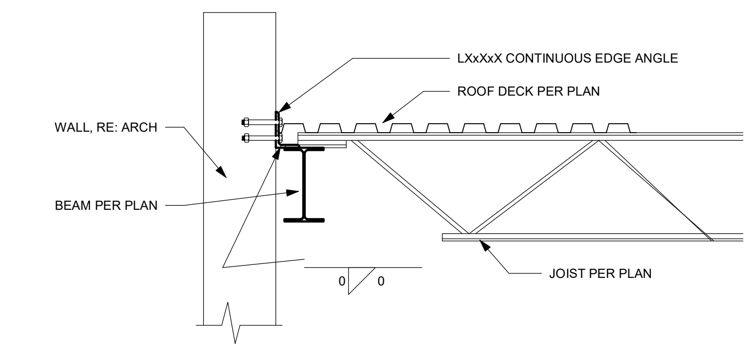
6 WEST OVERHANG AXON



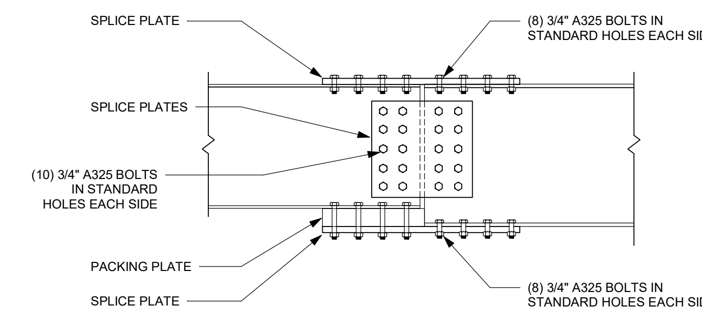
7 OVERHANG DETAIL
3/4" = 1'-0"



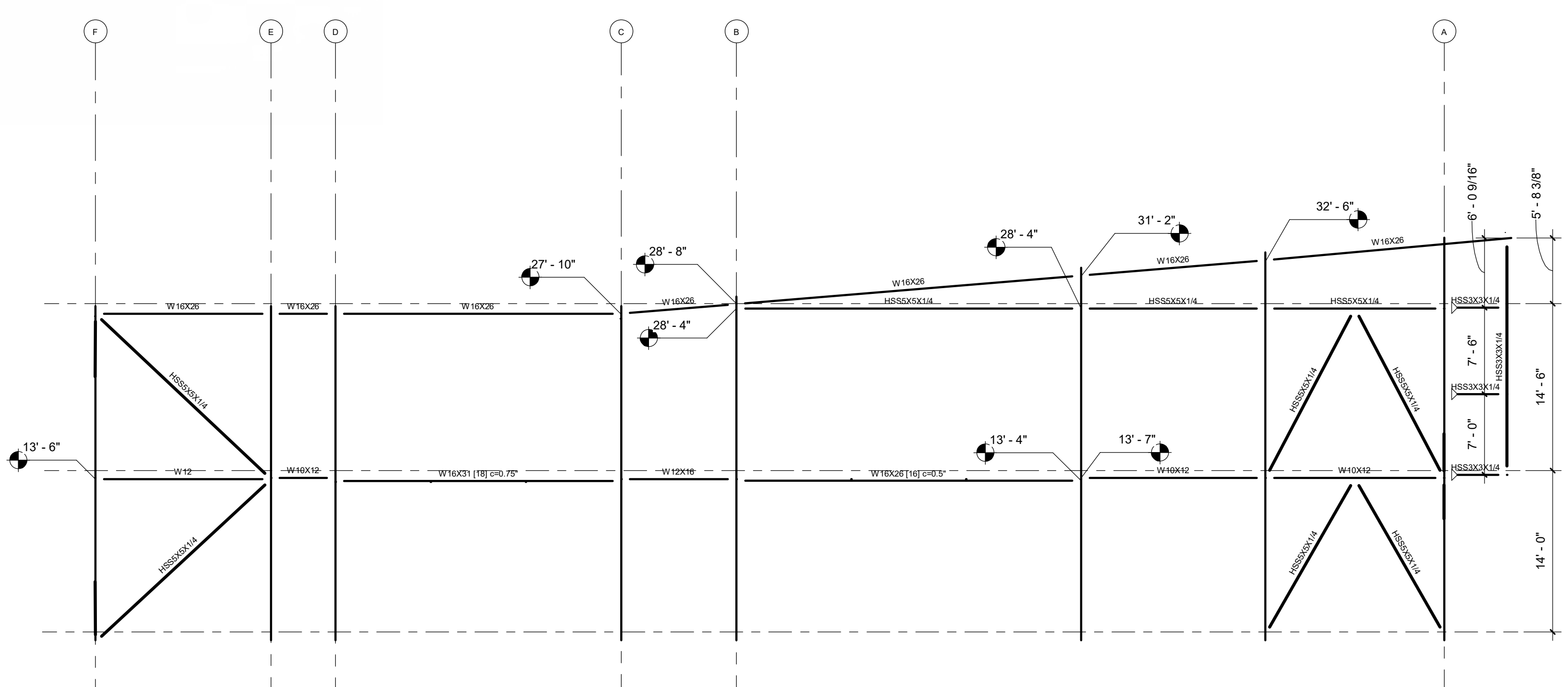
1 ROOF JOIST TO GIRDER FRAMING
3/4" = 1'-0"



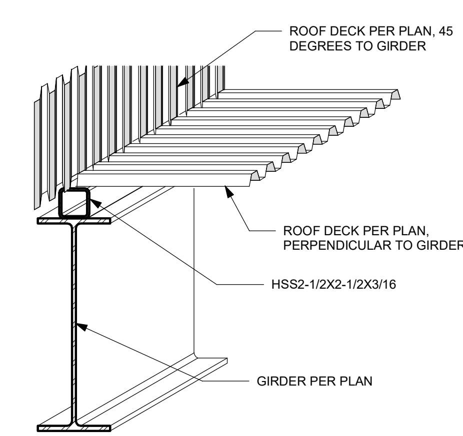
2 ROOF JOIST TO EDGE GIRDER
3/4" = 1'-0"



3 MOMENT SPLICE
3/4" = 1'-0"



5 STRUCT CORE ELEVATION
1/8" = 1'-0"



4 CHANGE IN DECK DIRECTION
1 1/2" = 1'-0"

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