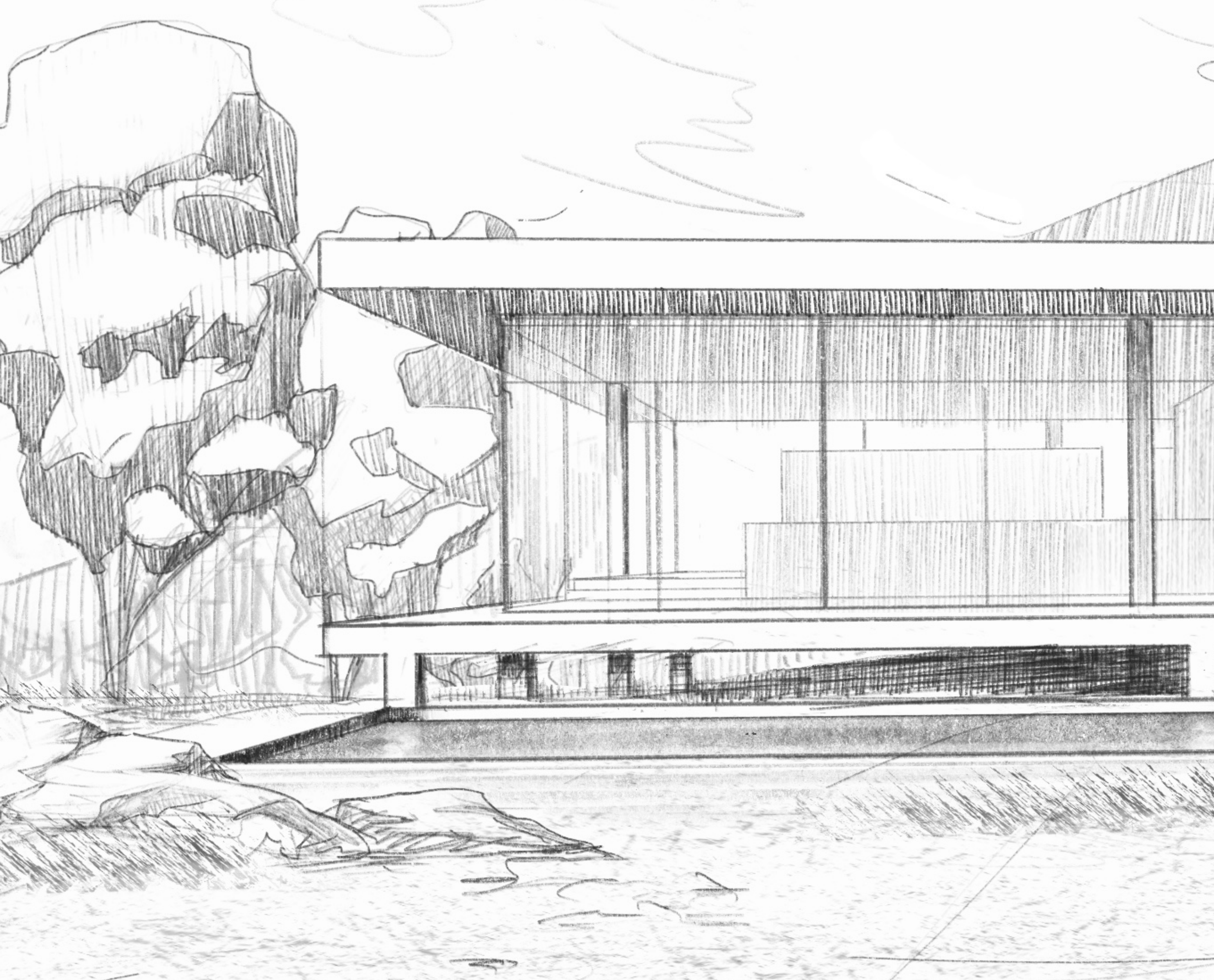
RECONCEPTUALIZING MIES' GLASS HOUSE

Augusta Orlauskaite | Alejo Favero | Araceli Avelar | Armando Castaneda Jr | Ella Gleason | Ignatius Mallari | Madison Lam



Studio Saliklis & Sattler | ARCE 415 & ARCH 453 | June 2021

TEAM MEMBERS

Augusta Orlauskaite
ARCH | Vilnius, Lithuania

Alejo Favero
ARCH | San Diego, CA

Araceli Avelar
ARCE | Tulare, CA

Armando Castaneda Jr
ARCE | Woodland, CA

Ella Gleason
ARCH | Portland, OR

Ignatius Mallari
ARCE | Redding, CA

Madison Lam
ARCE | Houston, TX

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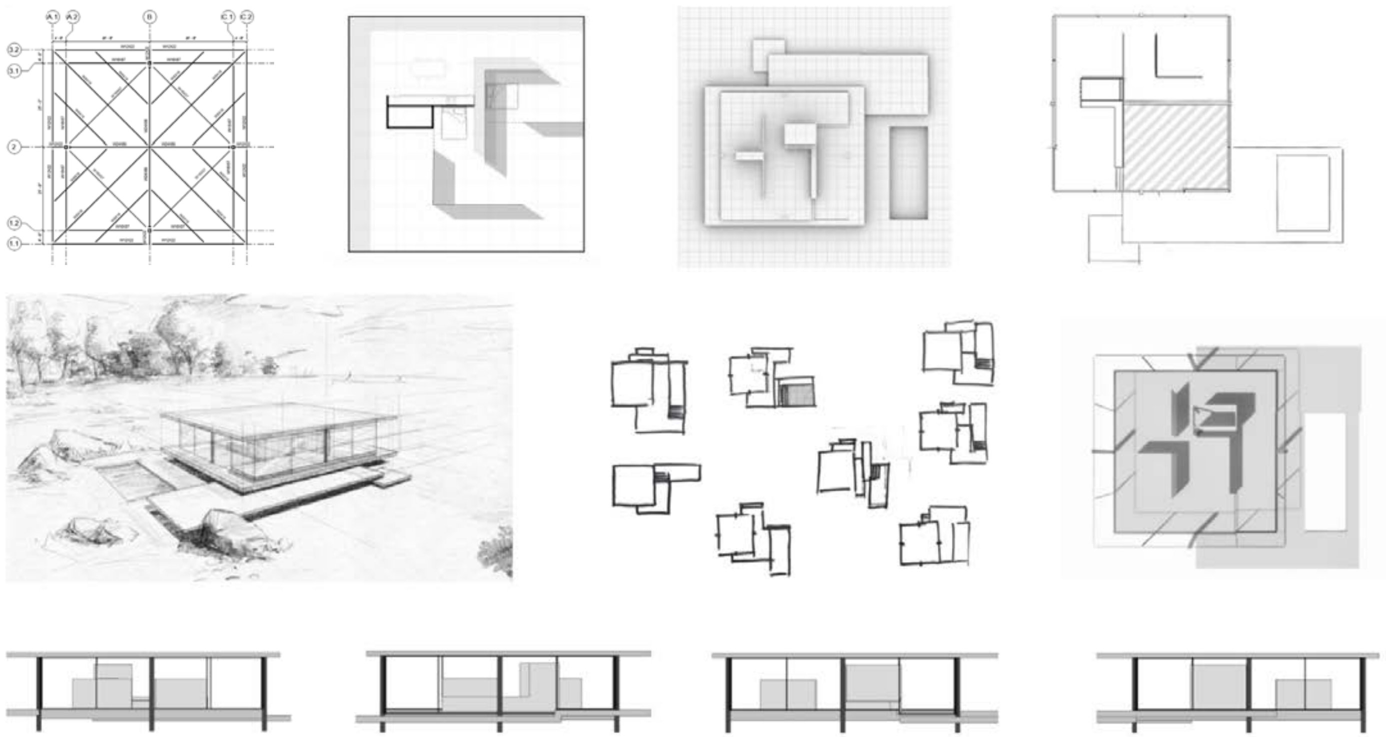
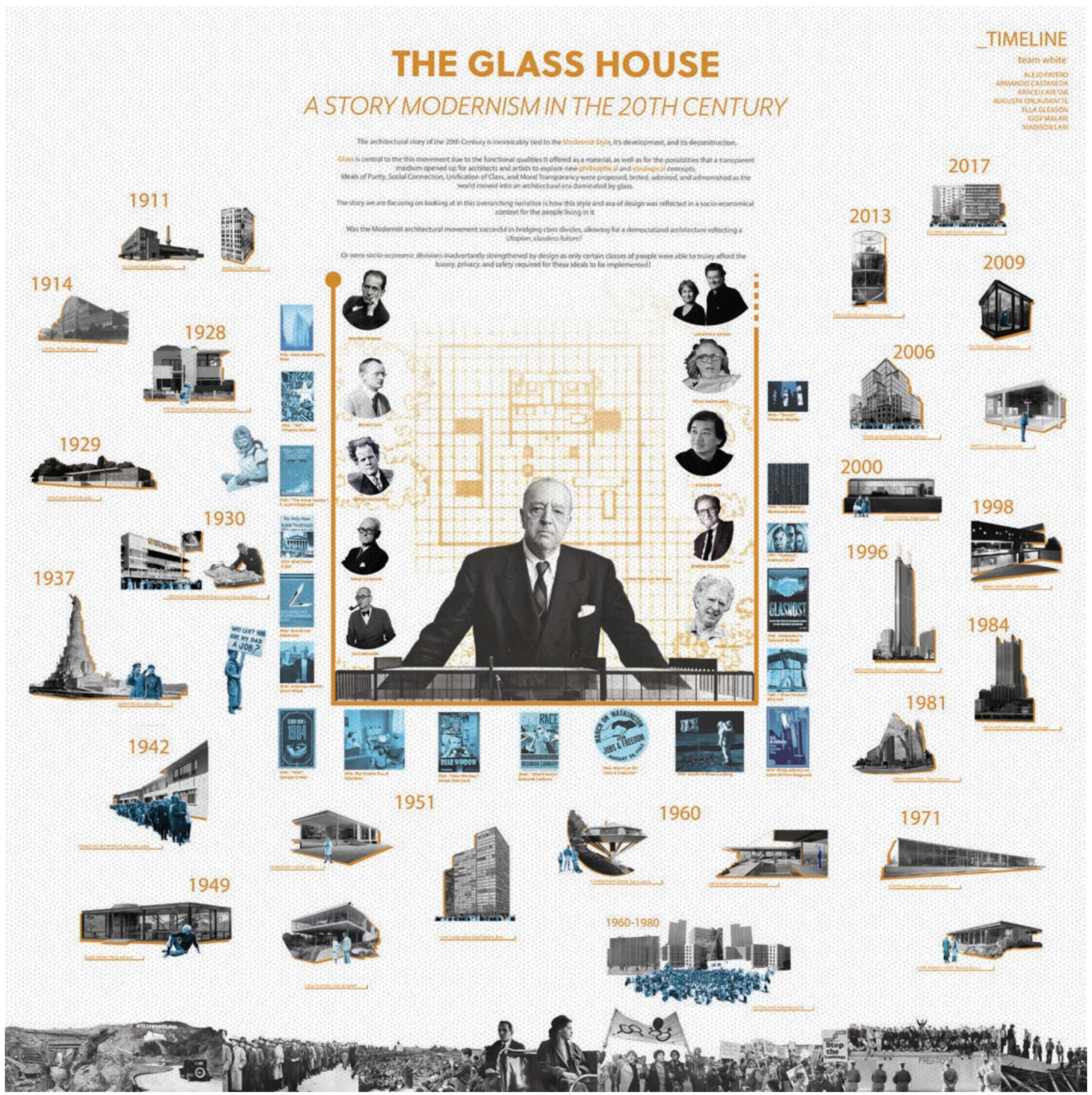


“Gravity is a Force to be Reckoned With”
Installation by Iñigo Manglano-Ovalle at MASS MoCA.
Photo by Sébastien Barré.

“To better understand the Glass House and what the home represents, the team researched the history and theory of glass structure. By studying this complex history, additional exploration into social and symbolic movements related to glazed architectures and surveillance was also conducted; most prominent concept critiqued was the double-edged sword of utopic - dystopic high modernist social engineering born from the class divisions of glass architecture.”



THE HISTORY OF GLASS

1942_Pueblo Del Rio Projects
Paul Williams

1949_Glass House
Phillip Johnson

1951_Farnsworth House
Mies Van Der Rohe

1960-1980_Section 8 Housing Projects

The architectural story of the 20th Century is inextricably tied to the Modernist Style, it's development, and its deconstruction. Glass is central to the this movement due to the functional qualities it offered as a material, as well as for the possibilities that a transparent medium opened up for architects and artists to explore new philosophical and idealogical concepts. Ideals of Purity, Social Connection, Unification of Class, and Moral Transparency were proposed, tested, admired, and admonished as the world moved into an architectural era dominated by glass.

The story we are focusing on looking at in this overarching narrative is how this style and era of design was reflected in a socio-economical context for the people living in it. Was the Modernist architectural movement successful in bridging class divides, allowing for a democratized architecture reflecting a Utopian, classless future? Or were socio-economic divisions inadvertently strengthened by design as only certain classes of people were able to truly afford the luxury, privacy, and safety required for these ideals to be implemented?

“By reimagining Mies van der Rohe’s unbuilt 50‘x50‘ glass house, this studio explored the interconnections of Design and Analysis, Theory and Practice, Art and Science, through a phased design approach. After studying the history of the house itself and the symbolic ideologies associated with glass structures, the team then began to design an entirely glass-walled Mies-inspired 50‘x50‘ structure, tackling the relationship between its tenuous structural system and design intent: a visually lightweight, transparent box for living and viewing.”

“The Glass House aims to preserve Mies’ primary design approach while reenvisioning this project. In doing so, some unbreakable rules were laid out: (1) No diagonals from the roof down to the ground as a Lateral Force Resisting System (LFRS) and no core touching the roof; (2) Minimal exposed structure, complimenting the architecturally expressed in alignment with Mies and Myrons’ Modernist principles; (3) Opening up to a free plan spatial design; and (4) Preservation of geometries and proportions that further a sense of transparency.”

THE GLASS HOUSE

CLIENT & SITE

Client: Mr. and Mrs. Meyer
[a wealthy couple, money comes from tech]

We would like to commission a house to be built at the Presley Estate, in Palm Springs. This house is meant to be a vacation home for our family, but chiefly for our two children so they have a place where they can go and unwind. This is our gift to them for finishing University and we want this to be a place they can return to and enjoy in the Summer months as they continue their lives. We would offer them our own vacation estate but ever since they made a mess of it in Summer of ‘19 we have been reluctant to open it back up to them. That being the case, we decided that giving them their own place would be most suitable. All this being said, we have several requirements for the house:

1. It is to be a glass house.
Not only are my husband and I great admirers of the Miesan aesthetic, having our own home built after it as well, we also think this would be a good way to ensure that the children behave in their leisure. After all, if they are surrounded by glass will they not conduct themselves accordingly?

2. The children are to each have their own room.
This should be self-explanatory.

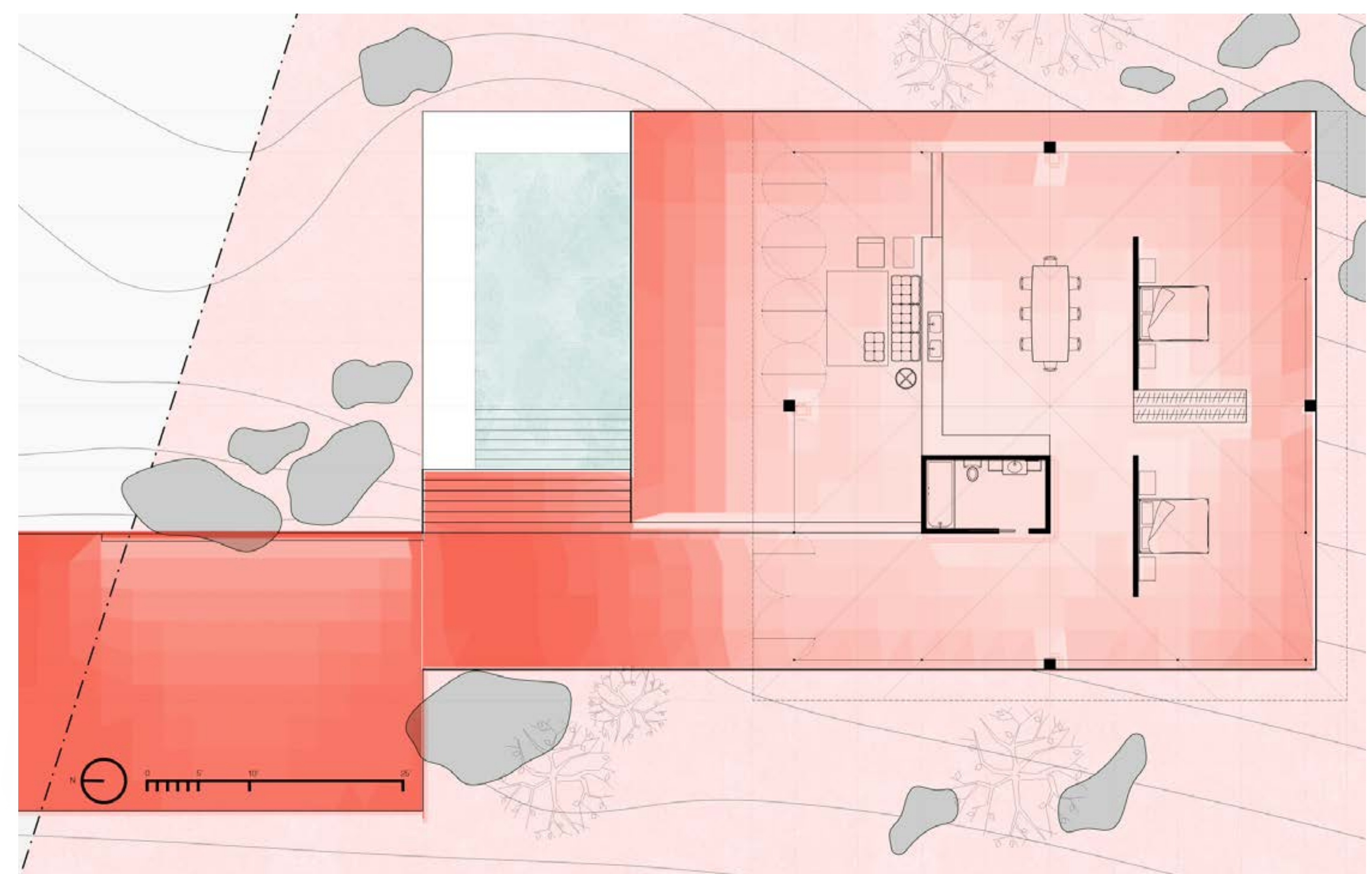
3. There will be a pool.
What good is a summer house without a pool? This is meant to be a place of leisure after all, and it will encourage them to be outside more.

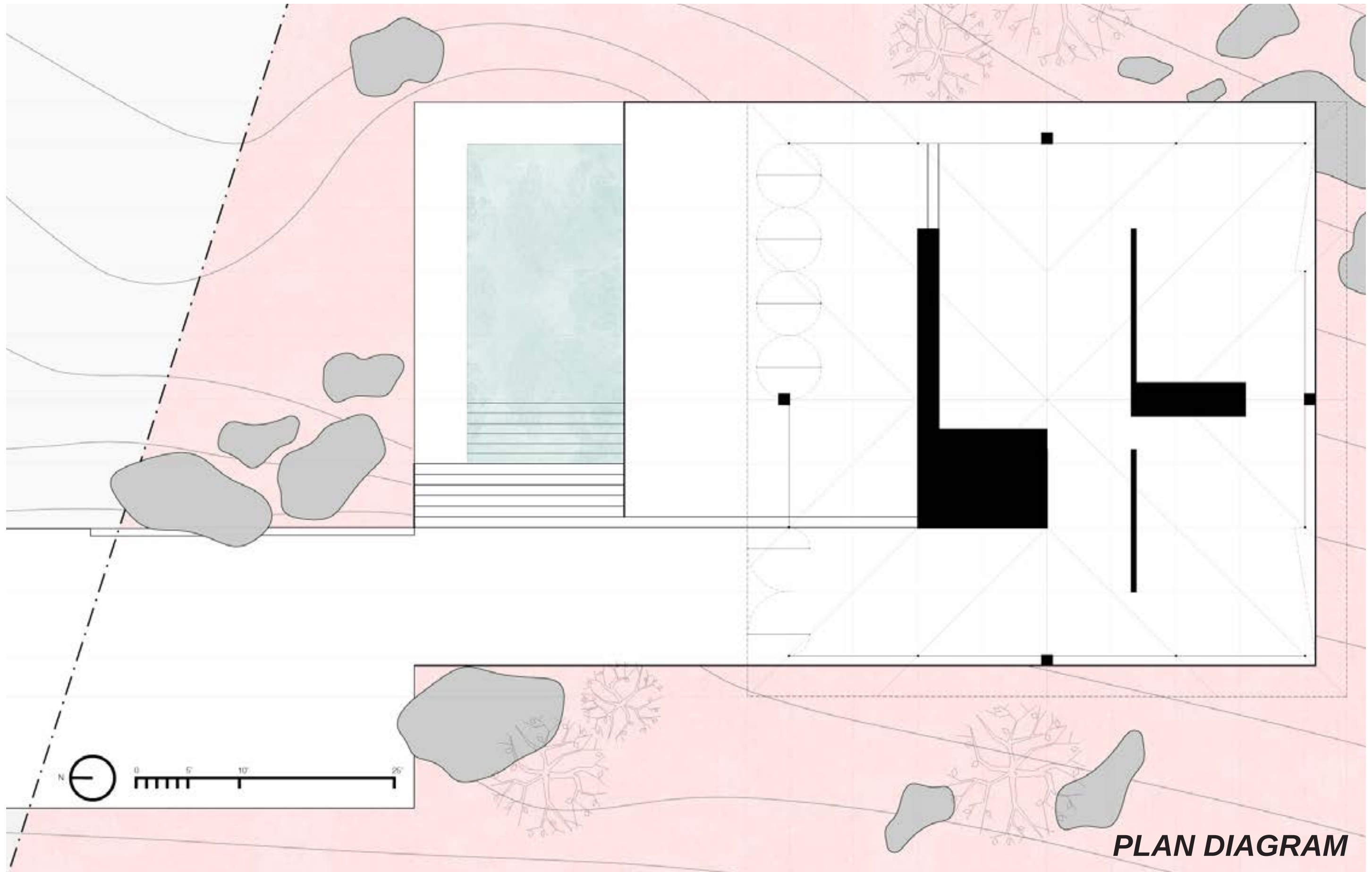
Aside from these things of course make the house beautiful. Our names will be attached to this house after all, and we cannot afford blemishes to the image of our estate. We anticipate seeing what you have to present to us.

Sincerely,

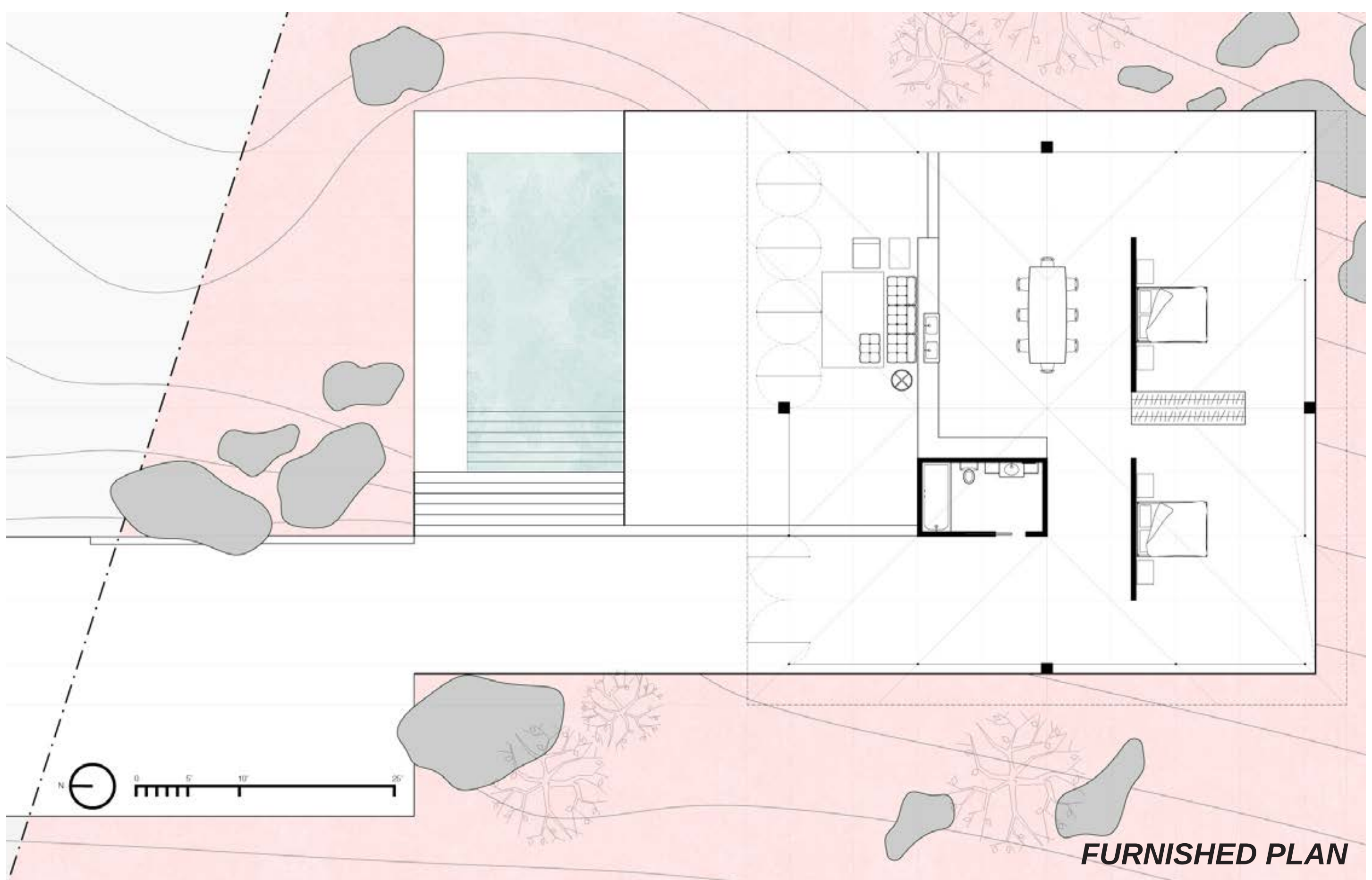
Mr. and Mrs. Meyer

The site is in the neighborhood of Presley Estates in Palm Springs, CA and the Kaufman Desert House. The greenery on the exterior to prevent total exposure and allow some privacy for the clients, allowing there to have some balance of privacy and surveillance.

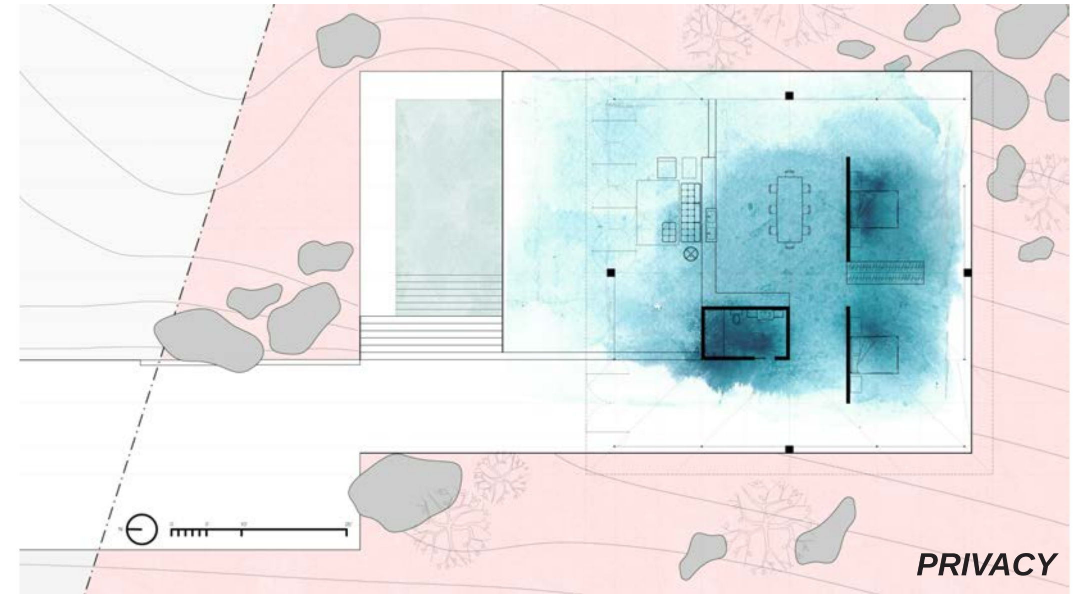




PLAN DIAGRAM

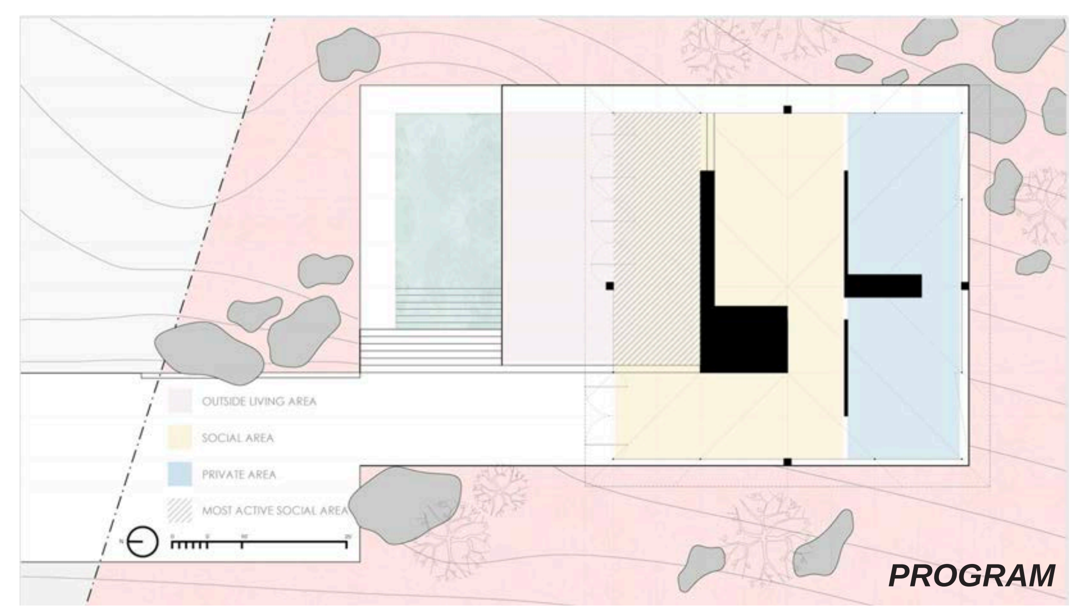


FURNISHED PLAN

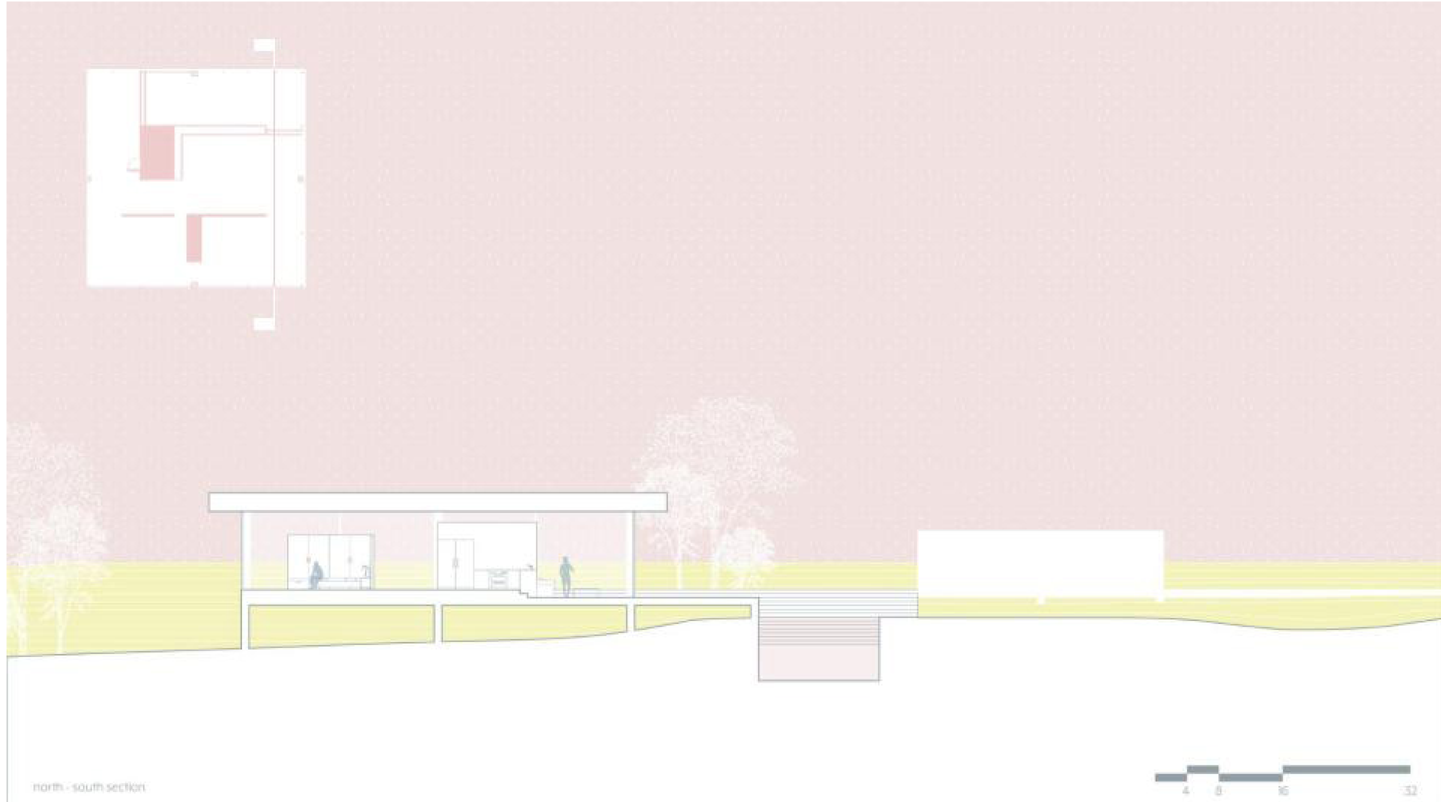


PRIVACY

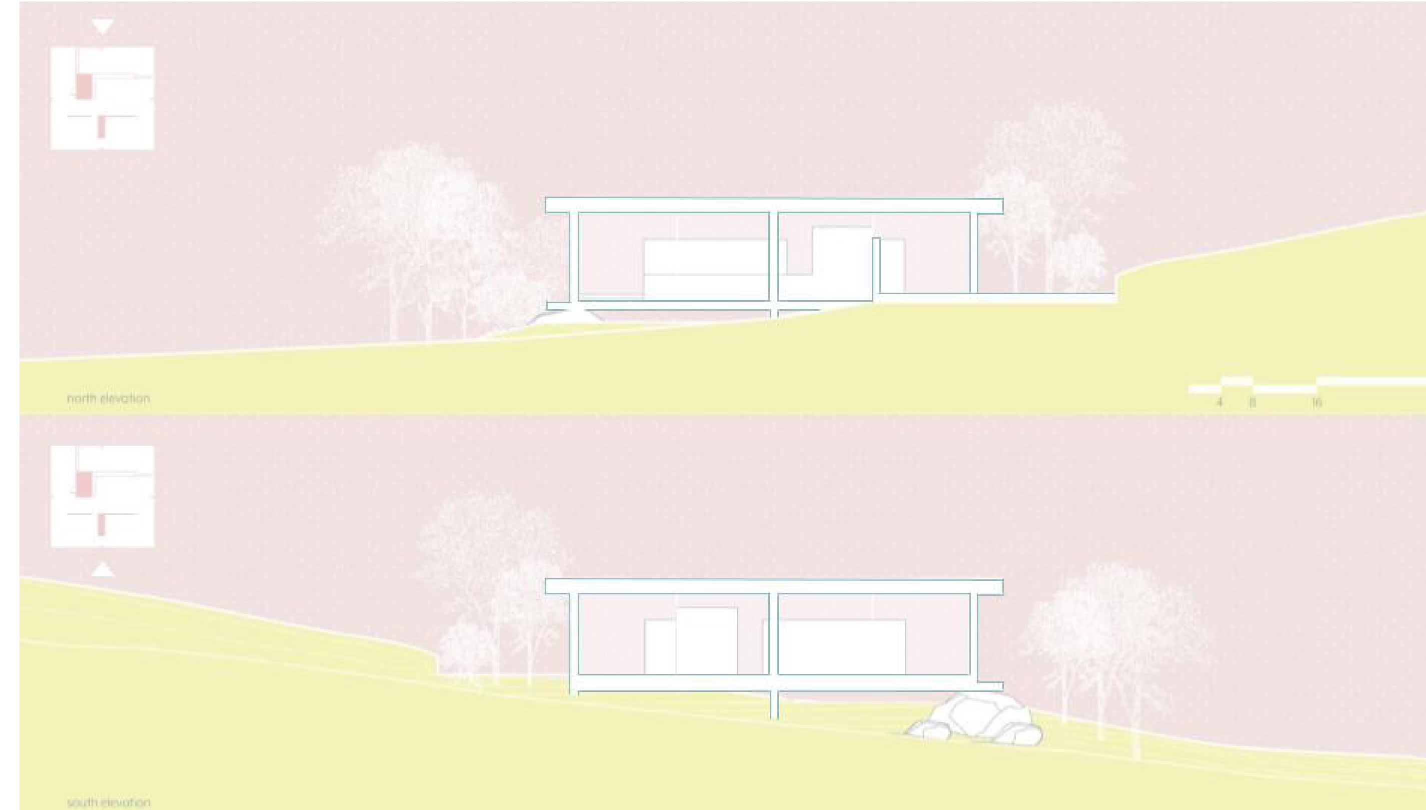
CIRCULATION



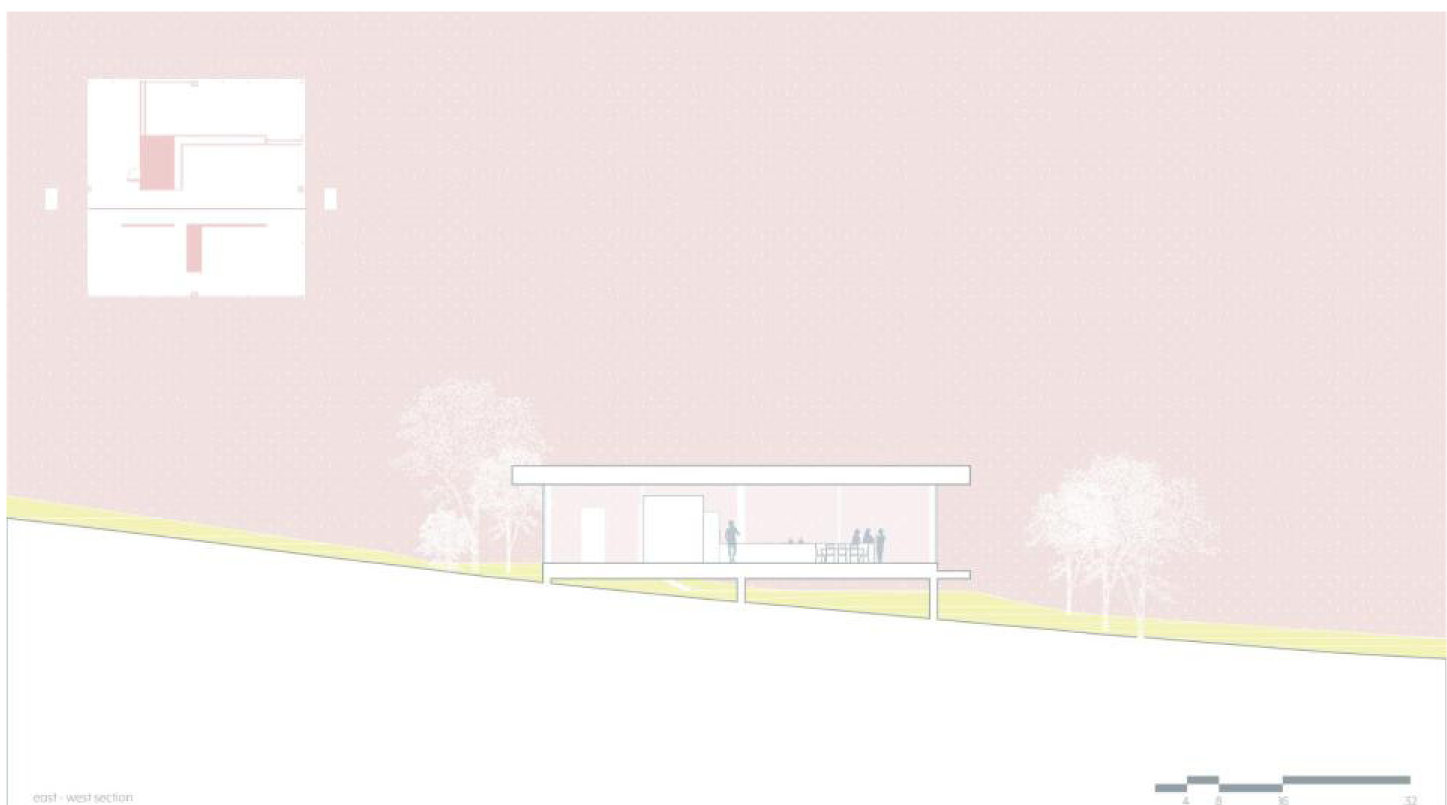
PROGRAM



N/S SECTION

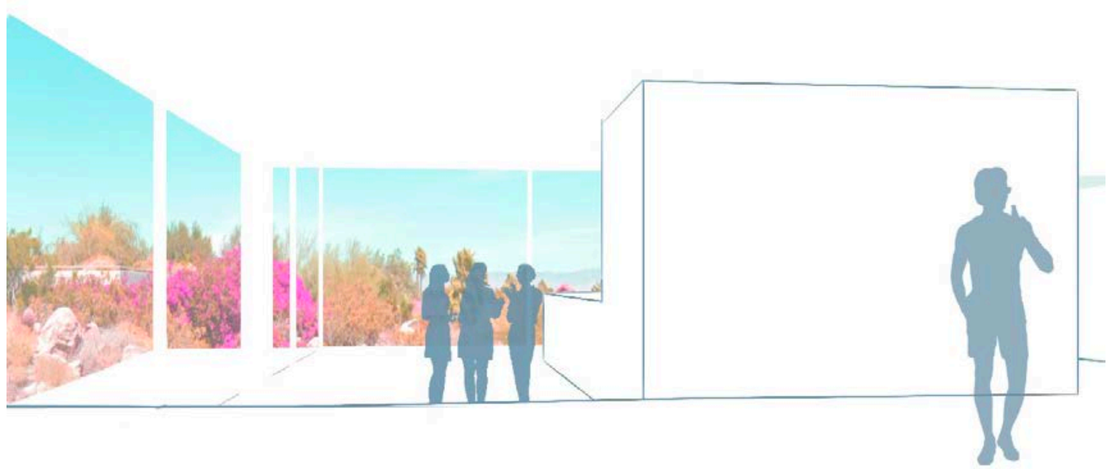


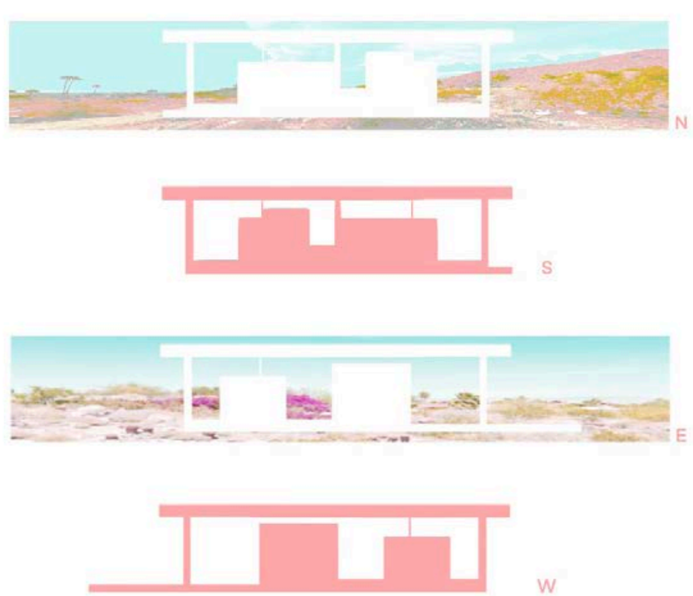
N/S ELEVATIONS



E/W SECTION

E/W ELEVATIONS

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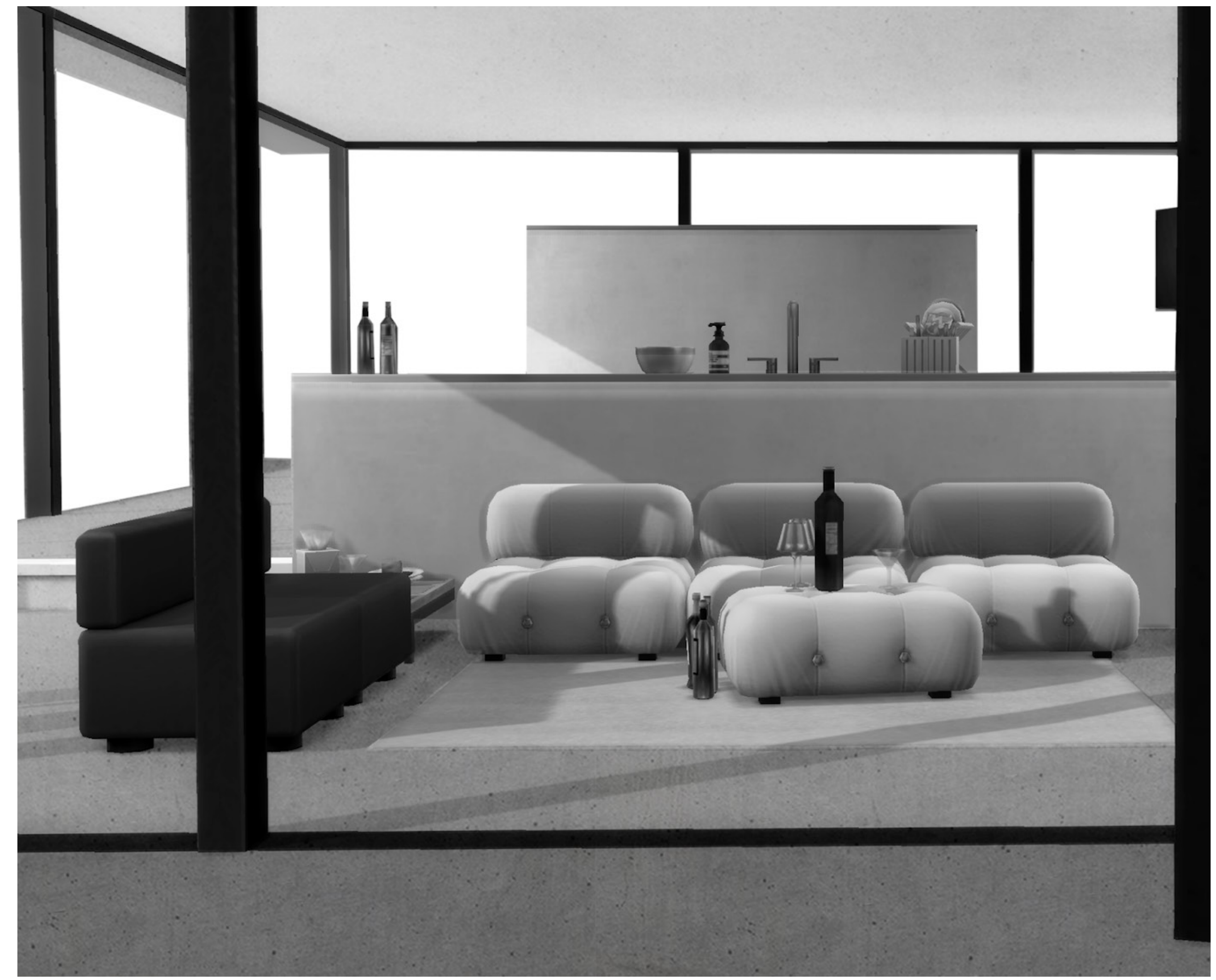
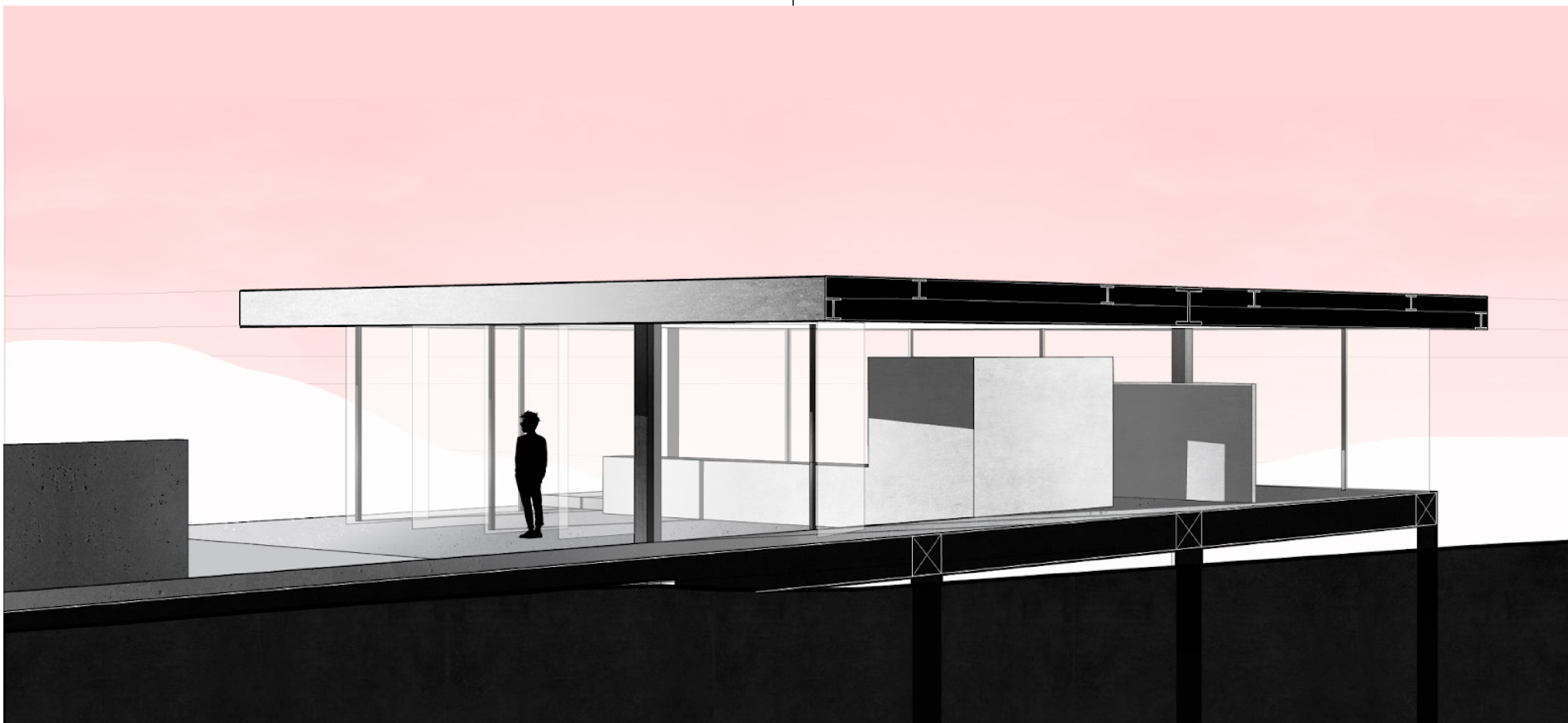
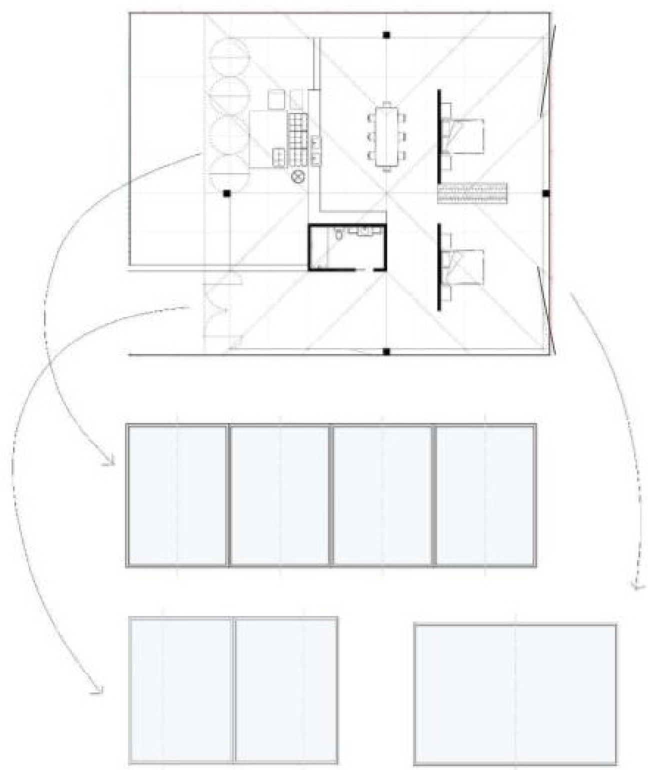
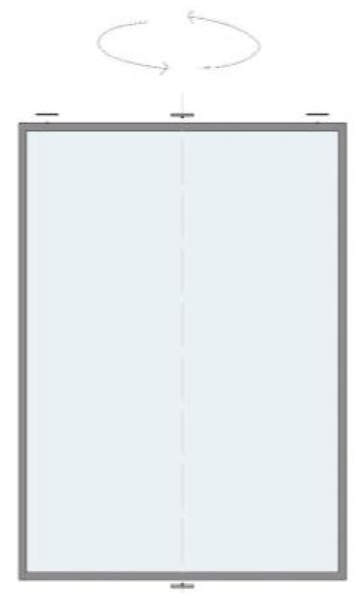


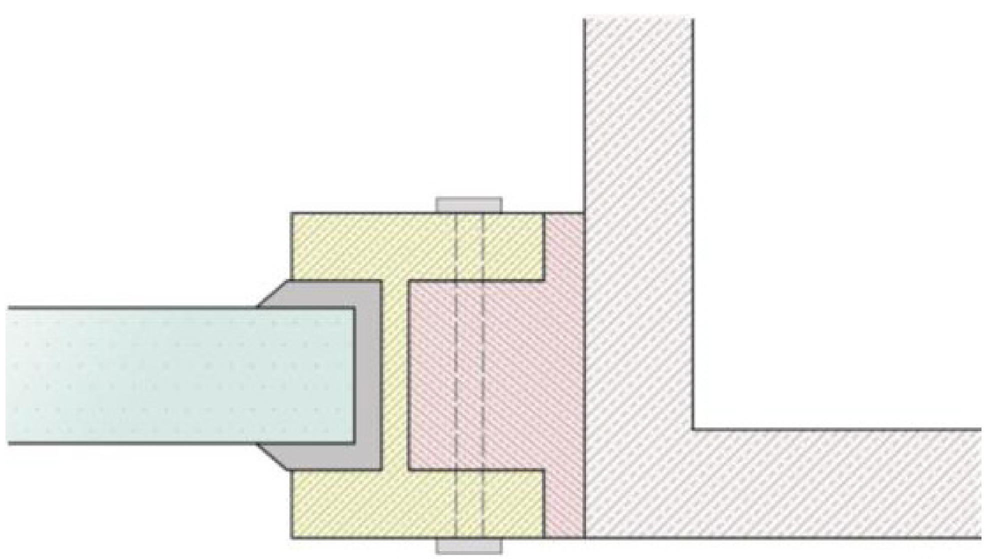


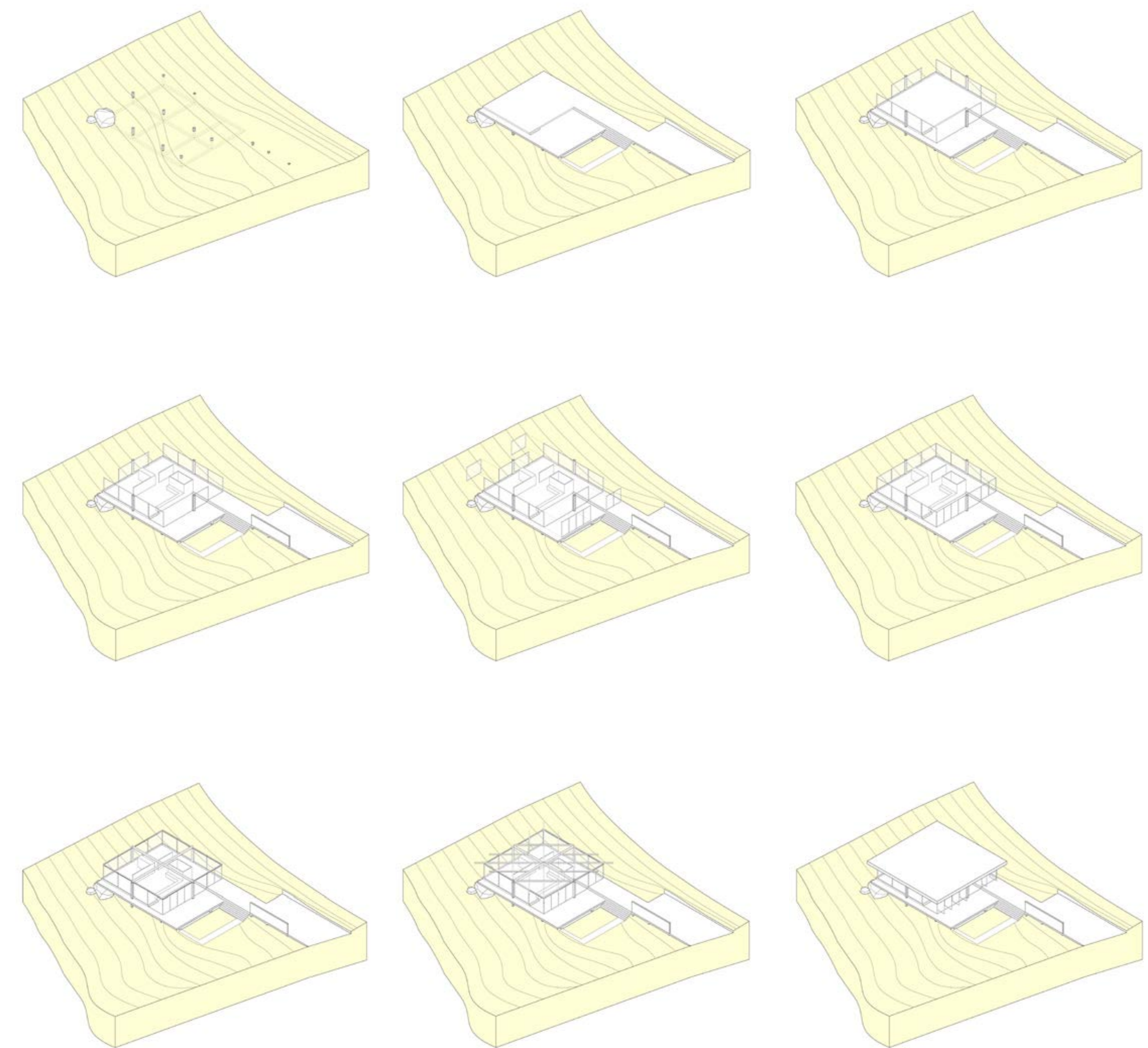
GLASS DETAILS

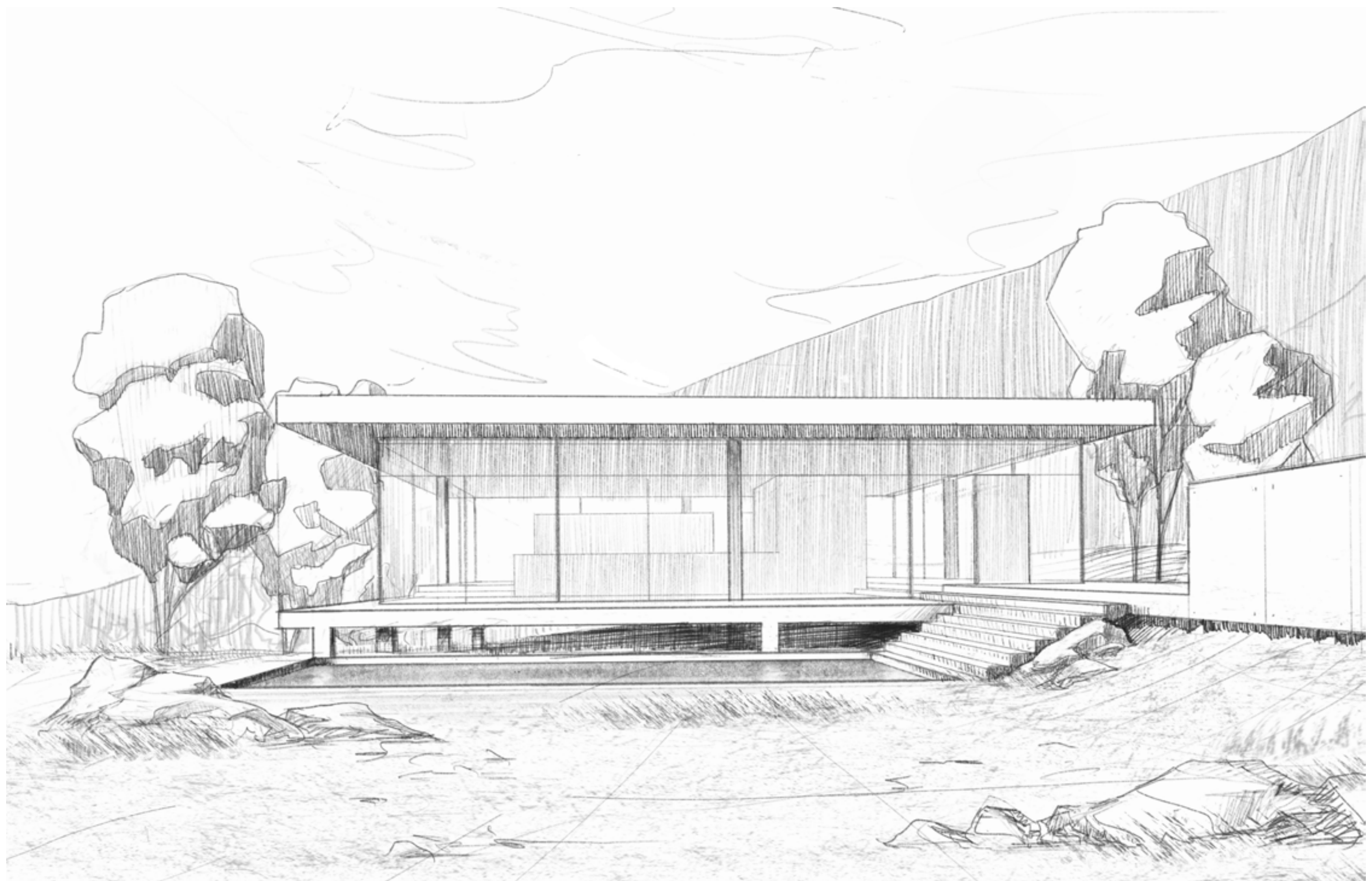


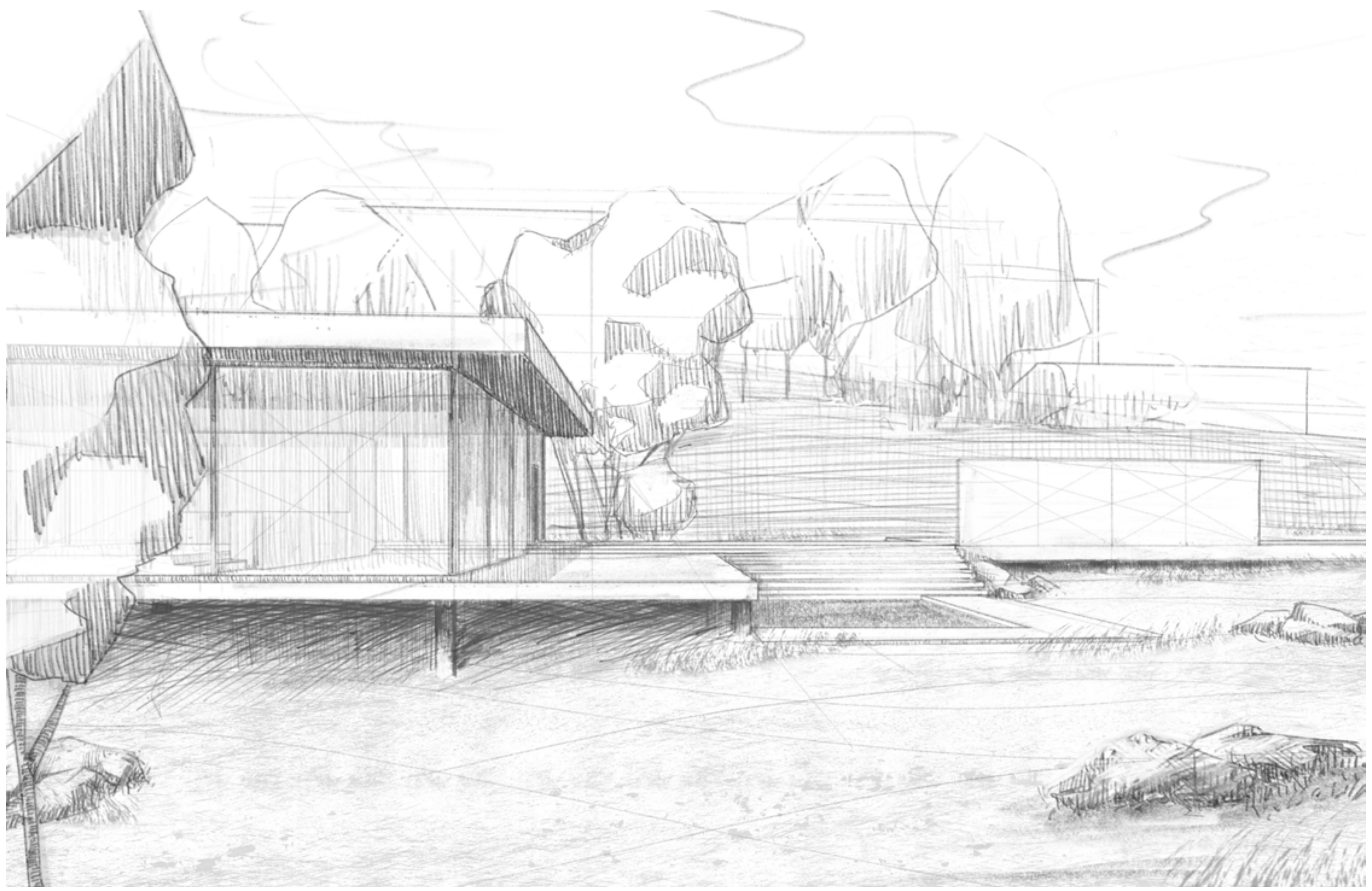


Pivoting door connection







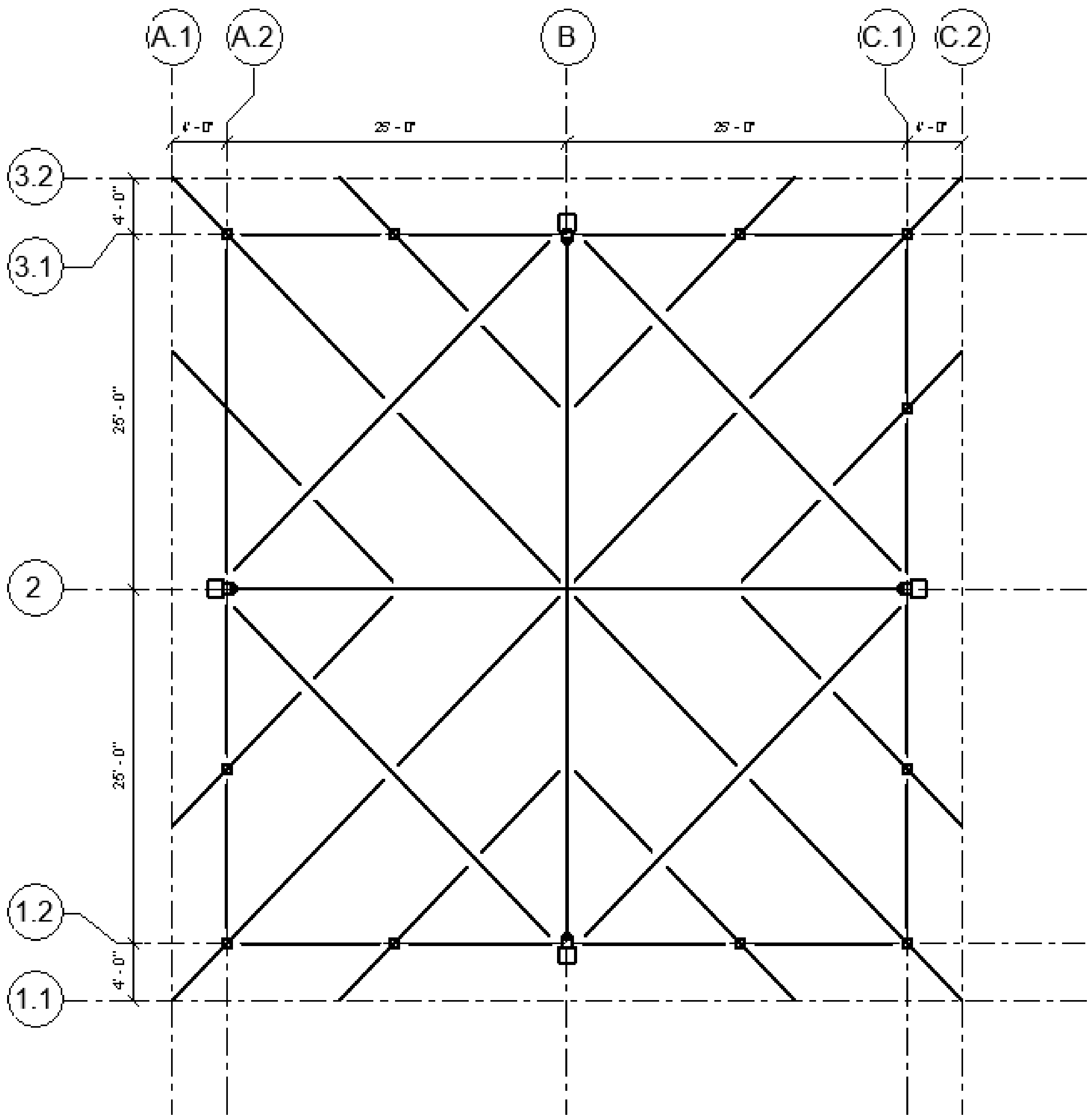


GRAVITY LOADS

Working with the architects, the engineers were challenged with designing the gravity and lateral systems of the glass home. In order to appropriately estimate the member sizes, unit load take-offs were first created and were then simplified to an overall roof & floor load. Due to the plinths that elevate the floor from the grade, both level take offs were need to later help understand the lateral loads on the diaphragms.

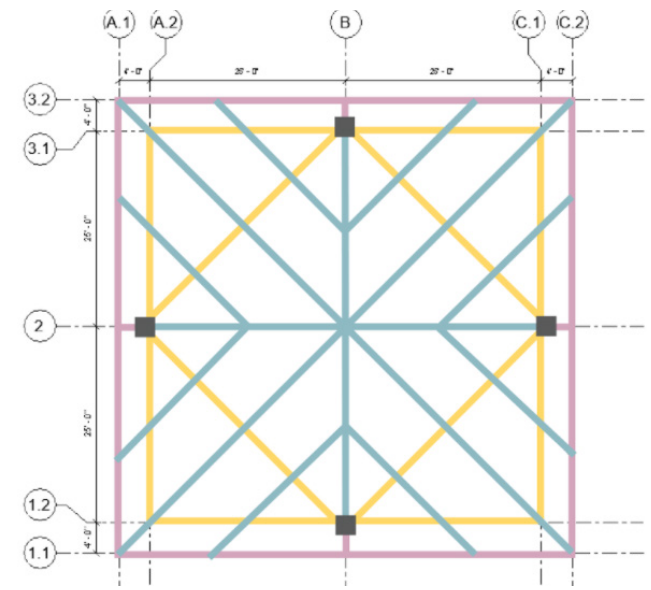
Roof Unit Load Take-Off					
Dead Loads					
Item	**to Joist**	**to Girder**	**to MF**	**to Column**	**Lateral**
Roof Exterior Finish	1 psf	1 psf	1 psf	1 psf	1 psf
Corregated Metal Deck (22 Ga.)	2 psf	2 psf	2 psf	2 psf	2 psf
Joists	2 psf	2 psf	2 psf	2 psf	2 psf
Girders		2 psf		2 psf	2 psf
Moment Frame			2 psf	2 psf	2 psf
Columns				3 psf	3 psf
Fireproofing	1 psf	1 psf	1 psf	1 psf	1 psf
Insulation	1 psf	1 psf	1 psf	1 psf	1 psf
Gypsum Suspended Ceiling	10 psf	10 psf	10 psf	10 psf	10 psf
MEP	5 psf	5 psf	5 psf	5 psf	5 psf
Misc	1 psf	1 psf	1 psf	1 psf	1 psf
TOTAL =	**23 psf**	**25 psf**	**25 psf**	**30 psf**	**30 psf**
DESIGN LOADS USED =	**25 psf**	**25 psf**	**25 psf**	**30 psf**	**30 psf**
Live Loads					
Item	**to Joist**	**to Girder**	**to MF**	**to Column**	**Lateral**
Live	20 psf	20 psf	20 psf	20 psf	20 psf
TOTAL =	**20 psf**	**20 psf**	**20 psf**	**20 psf**	**20 psf**
DESIGN LOADS USED =	**20 psf**	**20 psf**	**20 psf**	**20 psf**	**20 psf**

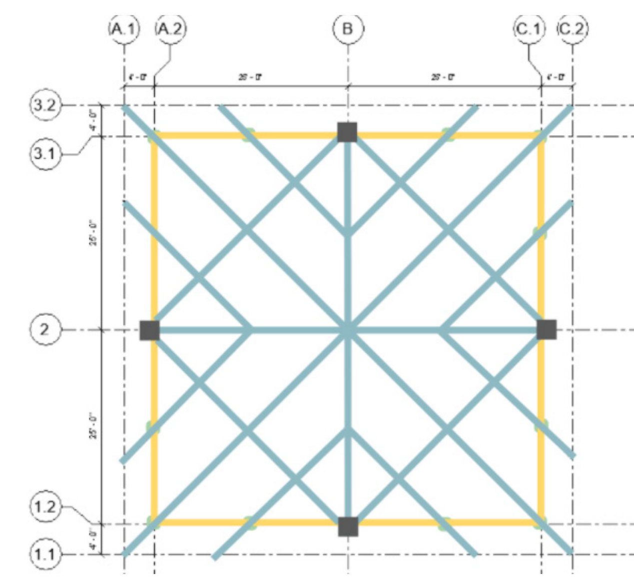
Floor Load Unit-Load Take-Off			
Dead Loads			
Item	**to Slab**	**to Column**	**Lateral**
Slab (8" thick)	75 psf	75 psf	75 psf
Concrete Column (12"x12")		1 psf	1 psf
Insulation	1 psf	1 psf	1 psf
Cement Floor Finish	6 psf	6 psf	6 psf
MEP	12 psf	12 psf	12 psf
Mullions			1 psf
Glass Wall			2 psf
Misc	5 psf	5 psf	5 psf
TOTAL =	**99 psf**	**100 psf**	**103 psf**
DESIGN LOADS USED =	**100 psf**	**100 psf**	**105 psf**
Live Loads			
Item	**to Slab**	**to Column**	**Lateral**
Live	40 psf	40 psf	40 psf
TOTAL =	**40 psf**	**40 psf**	**40 psf**
DESIGN LOADS USED =	**40 psf**	**40 psf**	**40 psf**

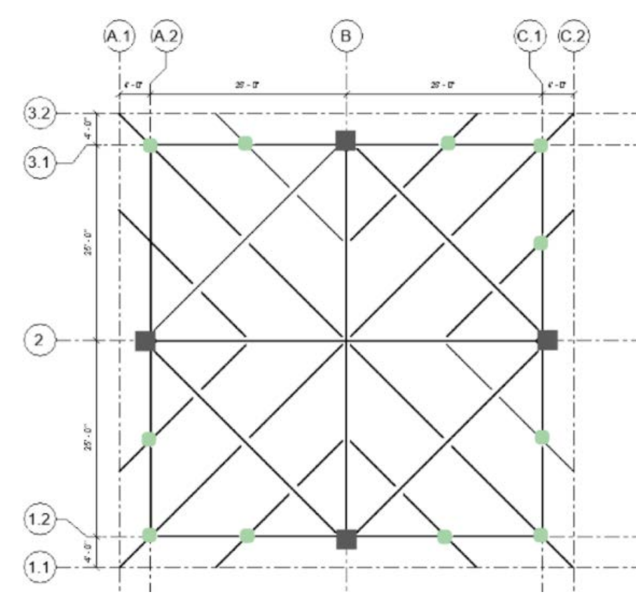


ROOF FRAMING PLAN

FRAMING ITERATIONS

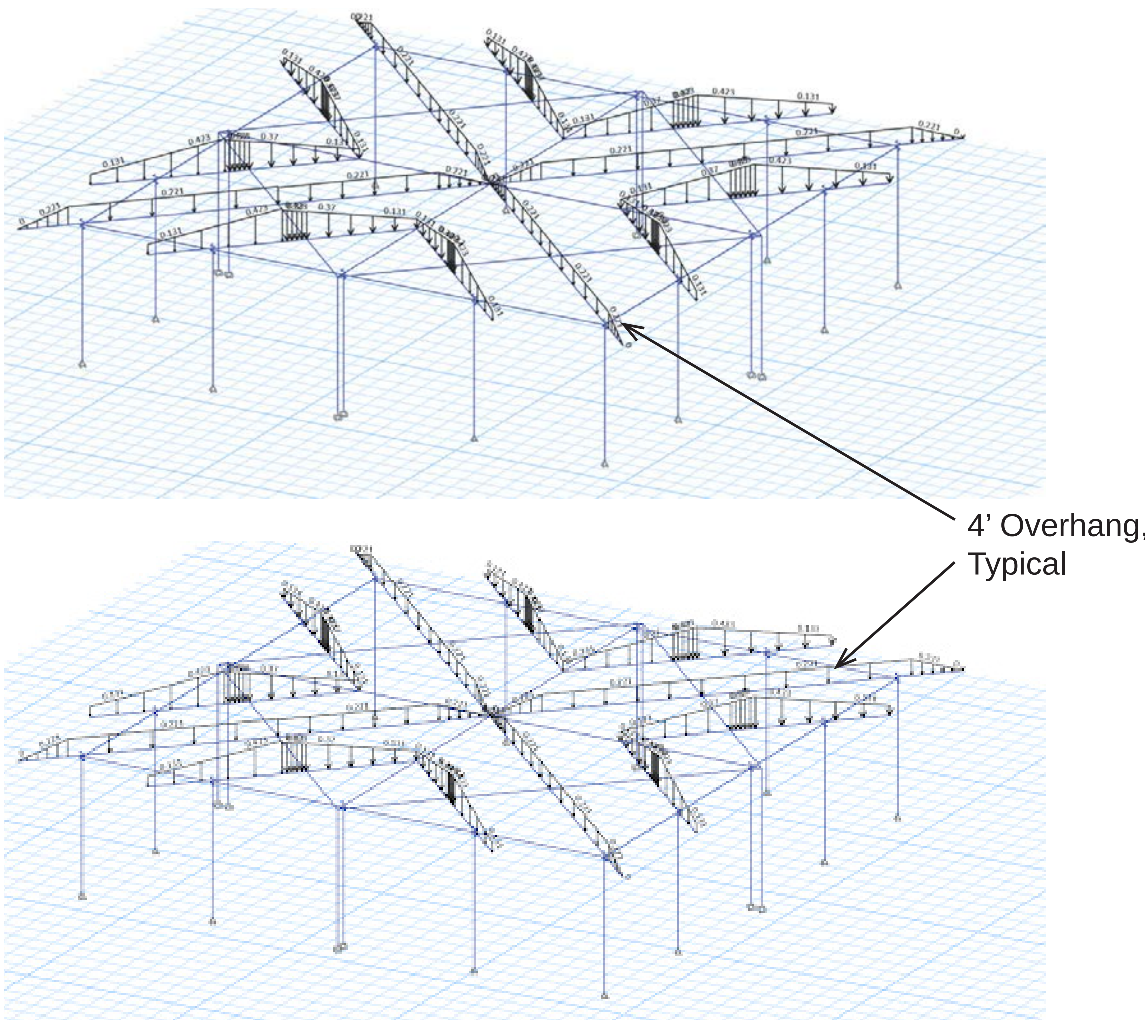






The first image was our framing design for mid review. The members in blue were stacked over the members in yellow and pink. We were trying to limit deflection at the corners which is why we had a second set of pink girders at the edge of the overhang. We decided it was too much steel and it was counterproductive. Our design was revised and that second set of girders was removed. All the members in blue are flush with each other and stacked above the girders in yellow which can be seen in the second image. To help with the deflection of the joists we added structural mullions in the locations of the green dots on the last image. Between grid lines 2 and 3.1 we do not have structural mullions because of the glass doors in that area.

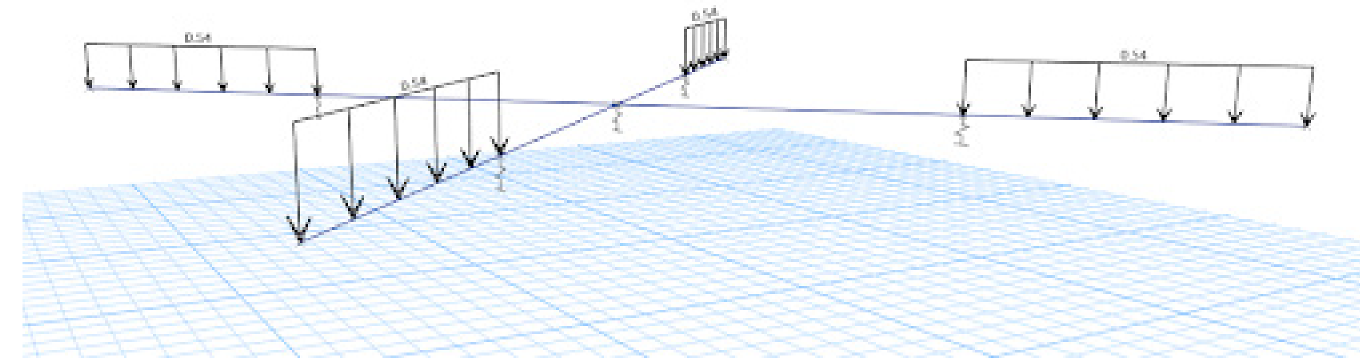
GRAVITY LOADING MODEL



SIMILAR GRAVITY LOADING FOR DEAD (TOP) AND LIVE (BOTTOM)

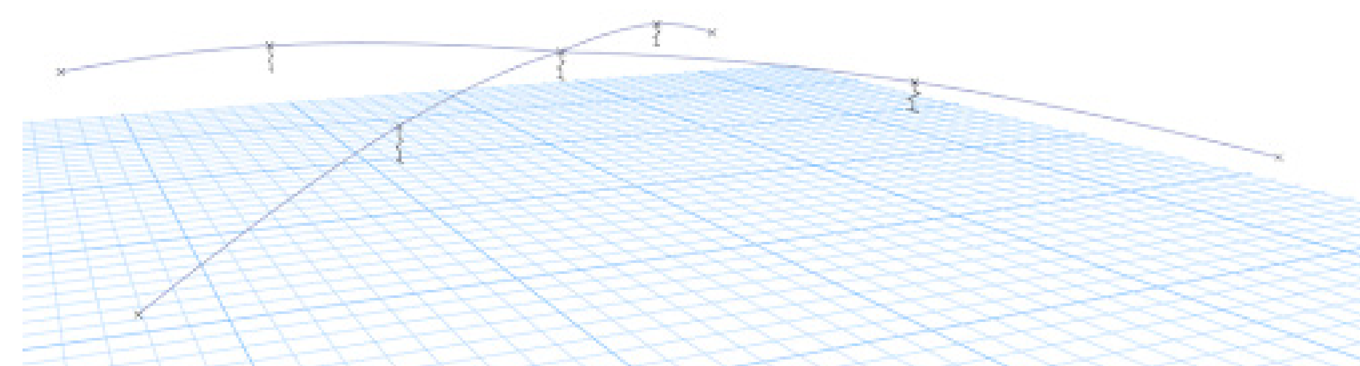
The framing schemes and gravity load calculations were modeled in ETABS to preliminary size our members. The total weight of the roof (including estimated member sizes) were concentrated over the beams as a conservative assumption. Given diagonal orientation of joists with respects to girders, loading was modeled as trapezoidal as that tributary areas were not typically symmetric.

ASYMMETRIC LIVE LOADING



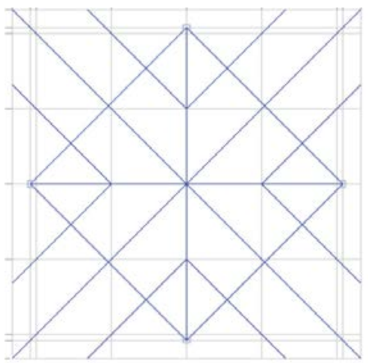
ASYMMETRIC LOADING FOR LIVE LOADING (DEAD LOADING OMITTED FOR CLARITY)

We also looked at asymmetric loading on what we would consider the worst case scenario in live patterned loading. Ultimately, we decided that this type of loading was unlikely since there is no roof access. But more convincingly, we considered our gravity loading as carefully overly conservative, and we found it difficult giving substance to compounding conservatism. In terms of computer modeling, ETABS also includes a Pattern Live Load Factor that also is considered in the design. The model that is shown is a detached portion of the actual over all model. The actual model uses rigid links to show the connection between members that are stacked.

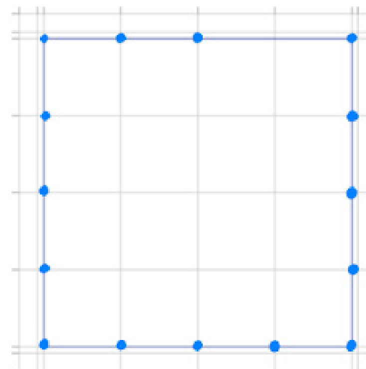


DEFLECTION DUE TO ASYMMETRIC LOADING

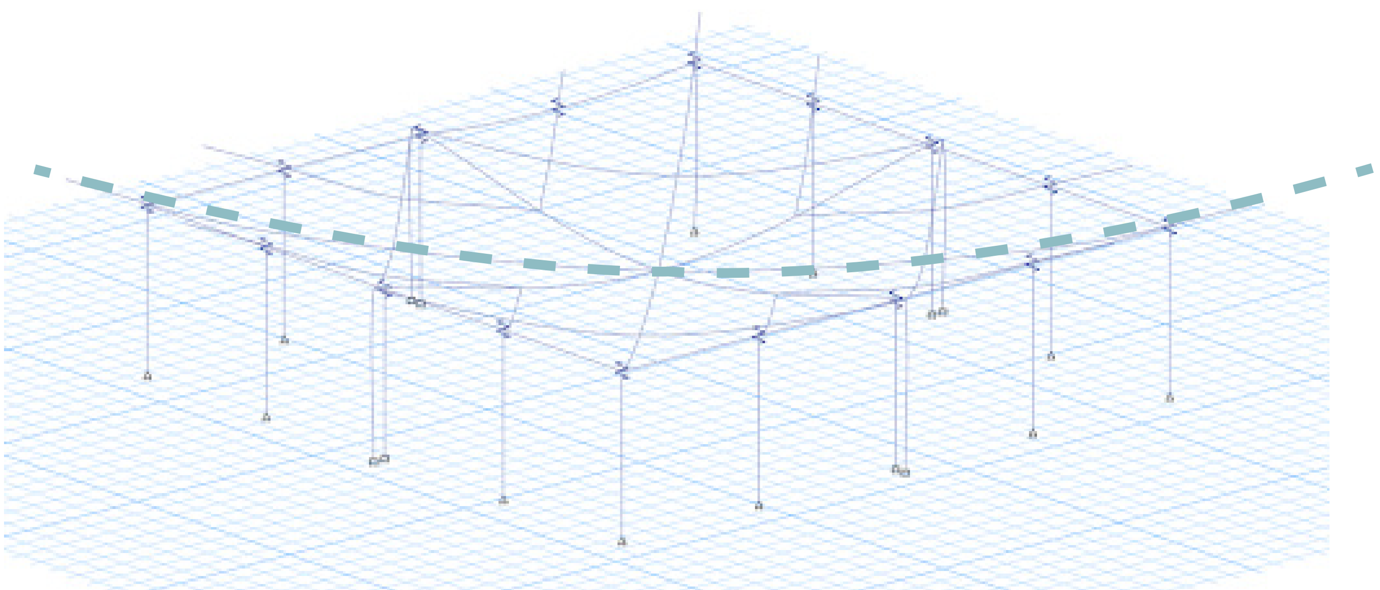
DEFLECTIONS DUE TO GRAVITY



Roof Framing



Mullions

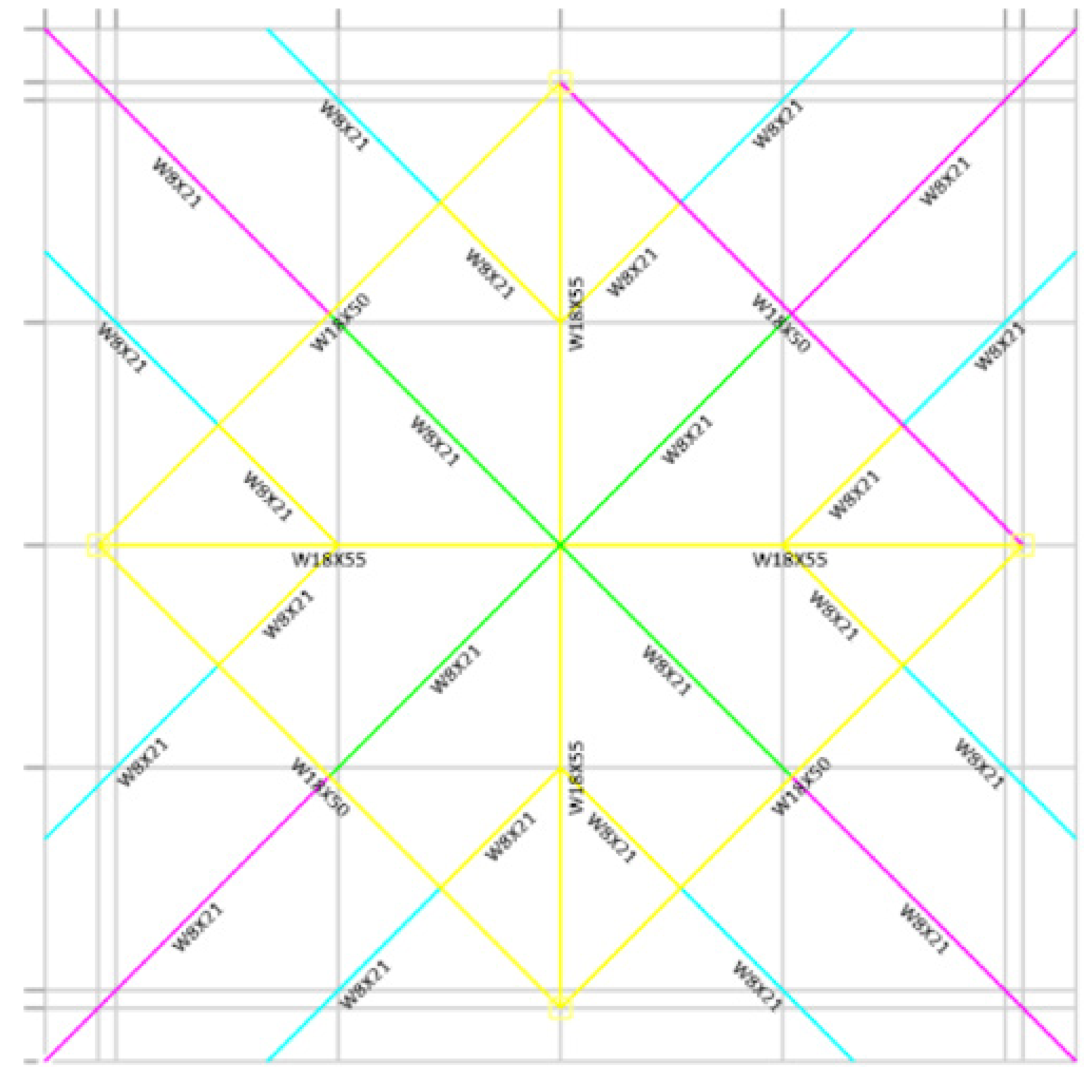


Corner deflection: 0.643 in

Center deflection: -1.636 in

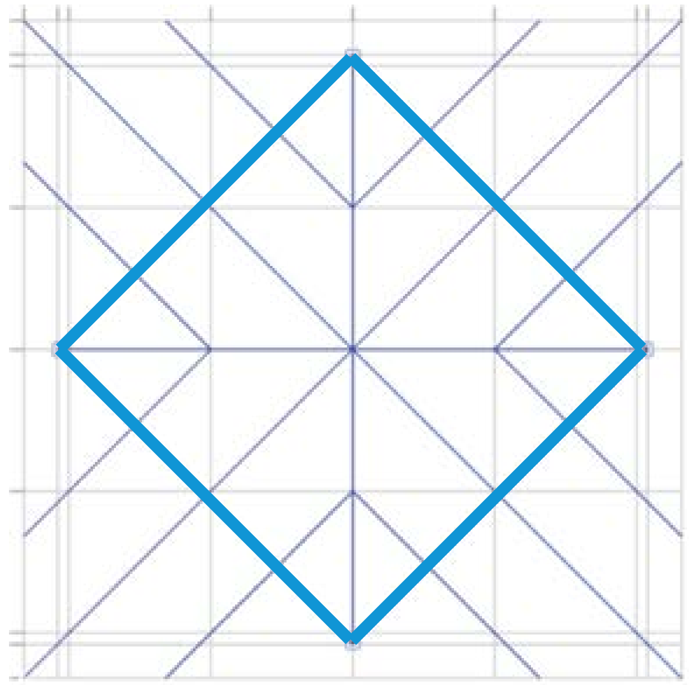
Given the long spans and heavy members we needed for the moment frame members, we knew member deflection would be a controlling factor in our member sizing. Load on cantilever overhang and the diagonal that goes across the entire length of the house mostly only experiences single bending due to moment distributions over support. Additionally, due to a missing structural mullion on one side of the building for door openings, and the asymmetrical columns supports, there was a slight twisting of the building under gravity loads.

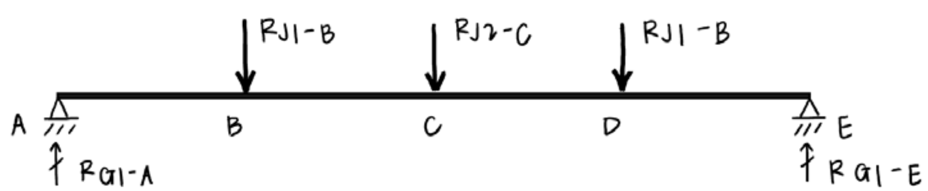
ETABS GRAVITY DESIGN



ETABS MEMBER DESIGN OUTPUT

The ETABS model chose members based on our desired framing schematic. But, we re-modeled this framing with our own member sizes to fit the additional architectural limitations of having a thinner total roof depth. By running this secondary model, we were able to verify that the members were adequate to sustain the applied gravity loads.





G1 FREE BODY DIAGRAM

The ETABS model chose members based on our desired framing schematic. But, we re-modeled this framing with our own member sizes to fit the additional architectural limitations of having a thinner total roof depth. By running this secondary model, we were able to verify that the members were adequate to sustain the applied gravity loads. We did a series of Excel hand calculations to further verify the ETABS outputs. Shown, is the calculations done for girder G1, in which axial, shear, flexural, and combined stresses were analyzed in order to size and design the member.

GIRDER (G1) VERIFICATION

Girder 1 (G1 TYP) Demands			
Shear Demands			
Vu - =	5.78	k	
Vu + =	8.32	k	
Flexural Demands (from ETABS)			
Mux - =	0.00	k-ft	*at ends*
Mux + =	131.69	k-ft	*at midspan*
Muy - =	0.01	k-ft	*at midspan*
Muy + =	0.02	k-ft	*at J1 connection*
Axial Demands (from ETABS)			
Pu =	2.89	k	
Deflection Demands (from ETABS)			
Δtotal (D+L) =	1.245	in	*at midspan*

Girder 1 (G1 TYP) Member Sizing			
Variable	**Value**		**Reference**
Size	**W18x50**		*AISC T.3-10*
ΦMp =	379	k-ft	
ΦBF =	13.2	k	
Lp =	5.83	ft	
Lr =	16.9	ft	*AISC T.3-2*
Ix =	800	in4	
ΦVn =	192	k	
Cb =	1		

Girder 1 (G1 TYP) Member Capacity Checks					
	Value		**Checks**		**Notes**
Flexural (Major)					
Mux - =	0.00	k-ft	8.84	ft	*= LB (braced by joists)*
Mux + =	131.69	k-ft	8.84	ft	*= LB (braced by joists)*
ΦMnx =	339.28	k-ft	OK		*= Cb[ΦMp-ΦBF(Lb-Lp)]*
D/C Ratio =	0.39		OK		
Flexural (Minor)					
Muy - =	0.01	k-ft	8.84	ft	*= LB (braced by joists)*
Muy + =	0.02	k-ft	8.84	ft	*= LB (braced by joists)*
ΦMnx =	339.28	k-ft	OK		*= Cb[ΦMp-ΦBF(Lb-Lp)]*
D/C Ratio =	0.00		OK		
Shear					
Vu - =	5.78	k			
Vu + =	8.32	k			
ΦVn =	192	k	OK		
D/C Ratio =	0.04		OK		
Axial					
Pu =	2.89	k			
ΦPn =	43.40	k	OK		*AISC T.6-2*
D/C Ratio =	0.07		OK		
Combined (Flexural & Axial)					
Pr/Pc ratio =	0.07	< .2			*use eqn H1-1b*
D/C Ratio =	0.42		OK		
Deflection					
span =	35.36	ft			*nonplaster ceiling*
ΔD+L =	1.245	in			
Δ IBC Limit =	2.357	in	OK		*l/180*

** verified with ETABS member selection*

FRAMING MEMBERS

Most of the member sizes are typical, but in the northern corner, unique members sizes were needed to account for the missing mullion. All of the typical joist's sizes were governed by the longest spanning diagonals J2 joists.

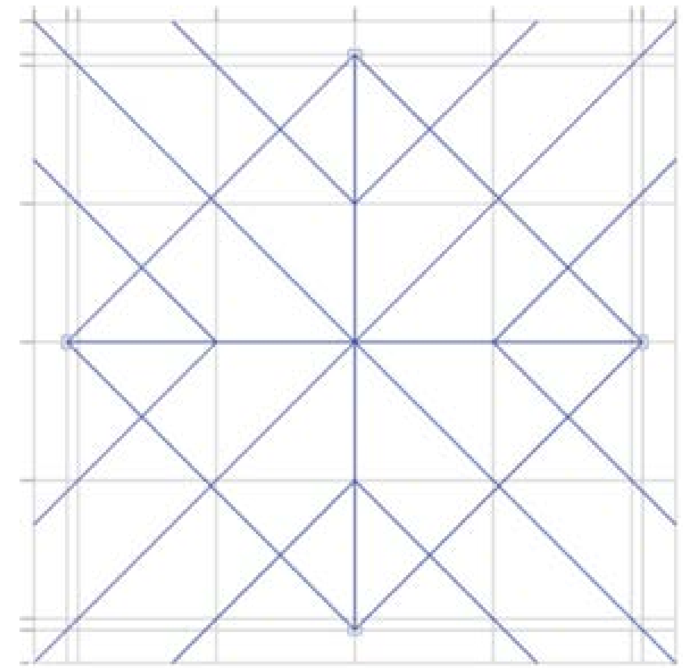
The G1 girders were our most critical members due to the multiple point loads carried from the intersecting joists. Reflecting this increased additional load, these girders needed to be sized up.

To maintain a thinner roof profile, we made the conscious decision to have slightly heavier members that had smaller overall depths.

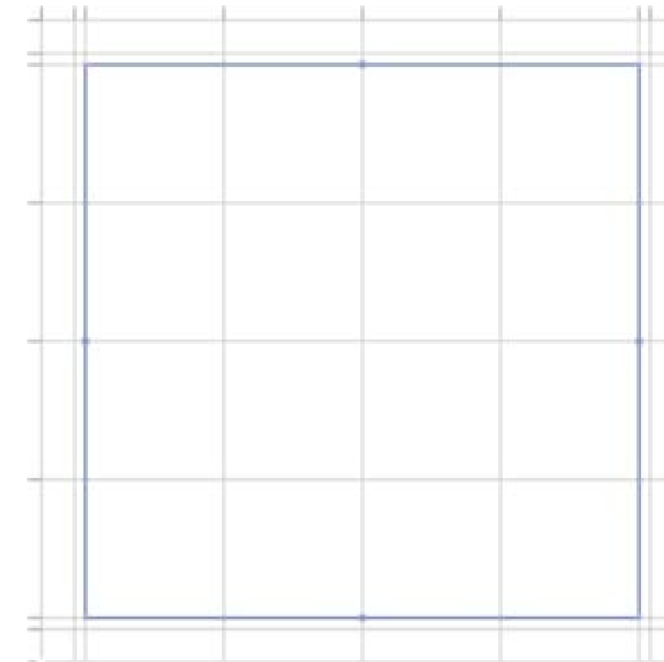
The moment frames were designed with the applied gravity load, but later rechecked in ETABS with the additional lateral loads applied.

The G2 girder members were not carrying much load (mainly taking only its own self weight), but was included in the roof framing to add additional stiffness to the roof diaphragm. Without them, the deflections were getting too large. Because of this, these perimeter girders were able to be kept as smaller sizes.

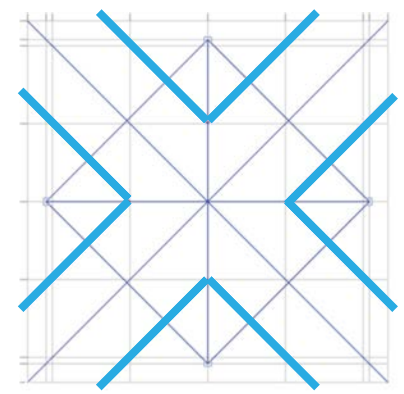
Both the moment frame columns and structural mullions were chosen to be HSS to help with the glass-to-steel architectural connections and the overall exterior aesthetic.



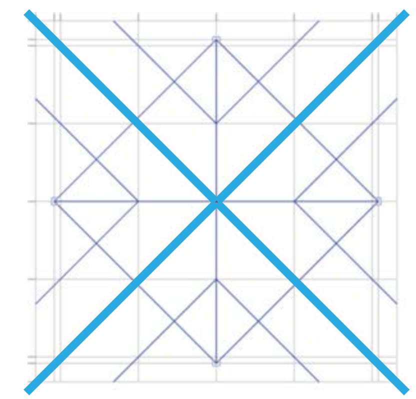
Upper Level Framing
(J1, J2, G1, MF)



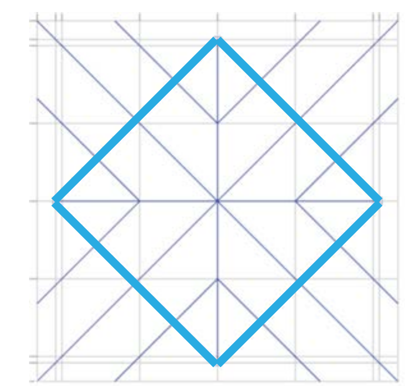
Lower Level Framing
(G2, mullions)



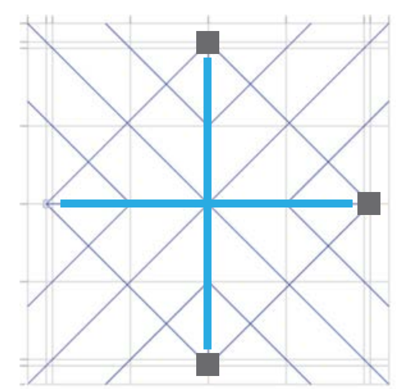
Joist (J1)
W8x21



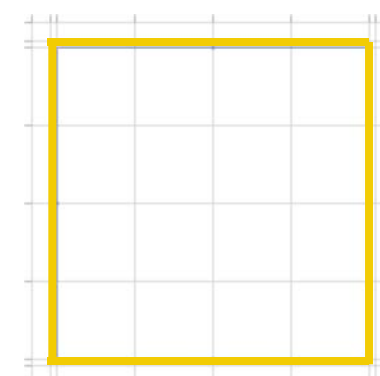
Joist (J2)
W8x21



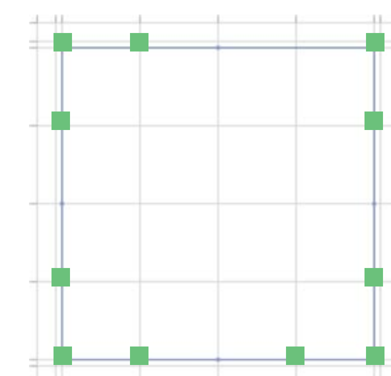
Girder (G1)
W18x50



Moment Frame (MF)
W18x55
HSS 14x14x5/16 (col)

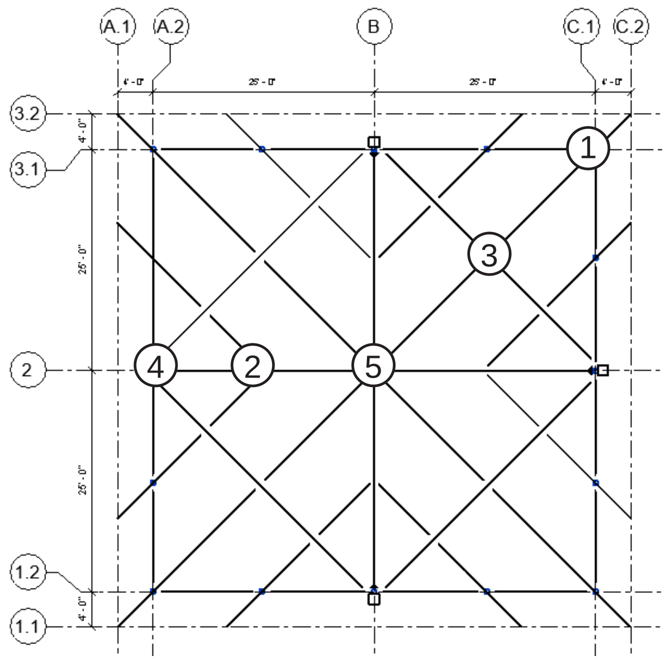


Girder (G2)
W6x20



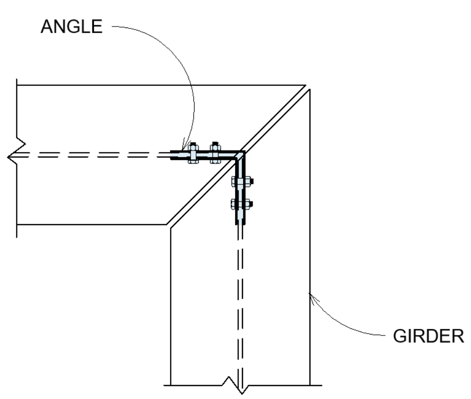
Mullions
HSS 3x3x5/16

FRAMING CONNECTIONS

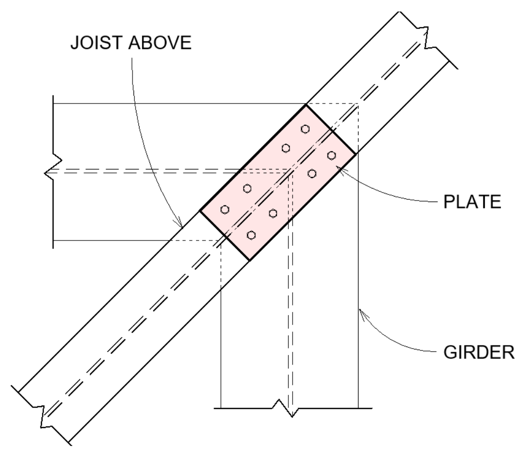


KEY PLAN

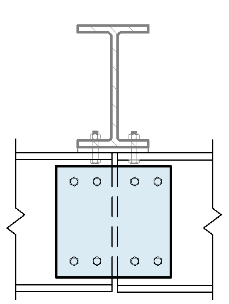
(1a) GIRDER TO GIRDER CORNER
(1b) JOIST TO GIRDERS
(2) JOIST TO MOMENT FRAME
(3) JOIST TO GIRDER INTERSECTION
(4) BEAM TO COLUMN MOMENT CONNECTION
(5) CENTER CUSTOM PLATE CONNECTION



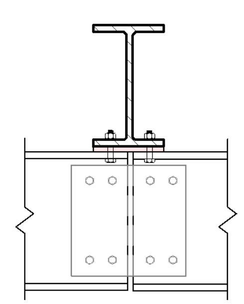
(1a) GIRDER TO GIRDER CORNER
Plan



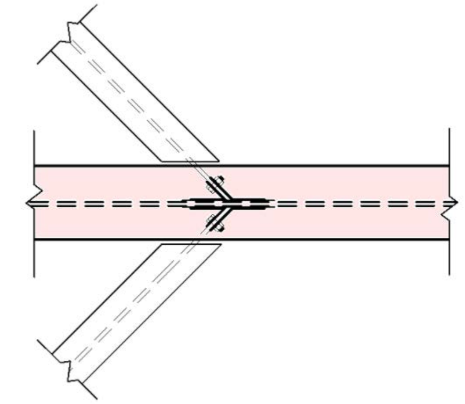
(1b) JOIST TO GIRDERS
Plan



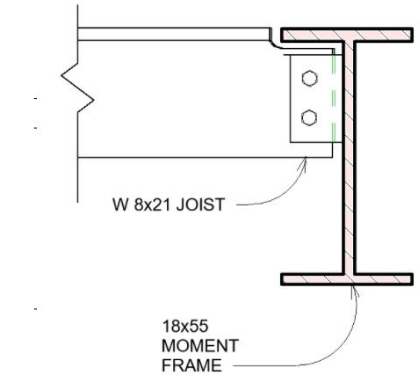
(1a) GIRDER TO GIRDER CORNER
Elevation



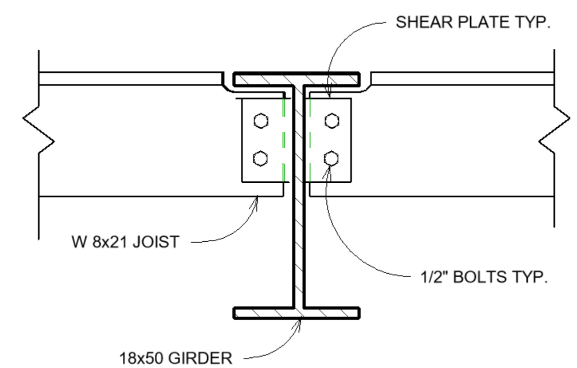
(1b) JOIST TO GIRDERS
Elevation



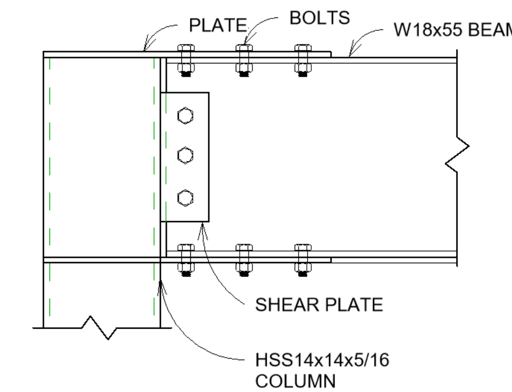
(2) JOIST TO MOMENT FRAME
Plan



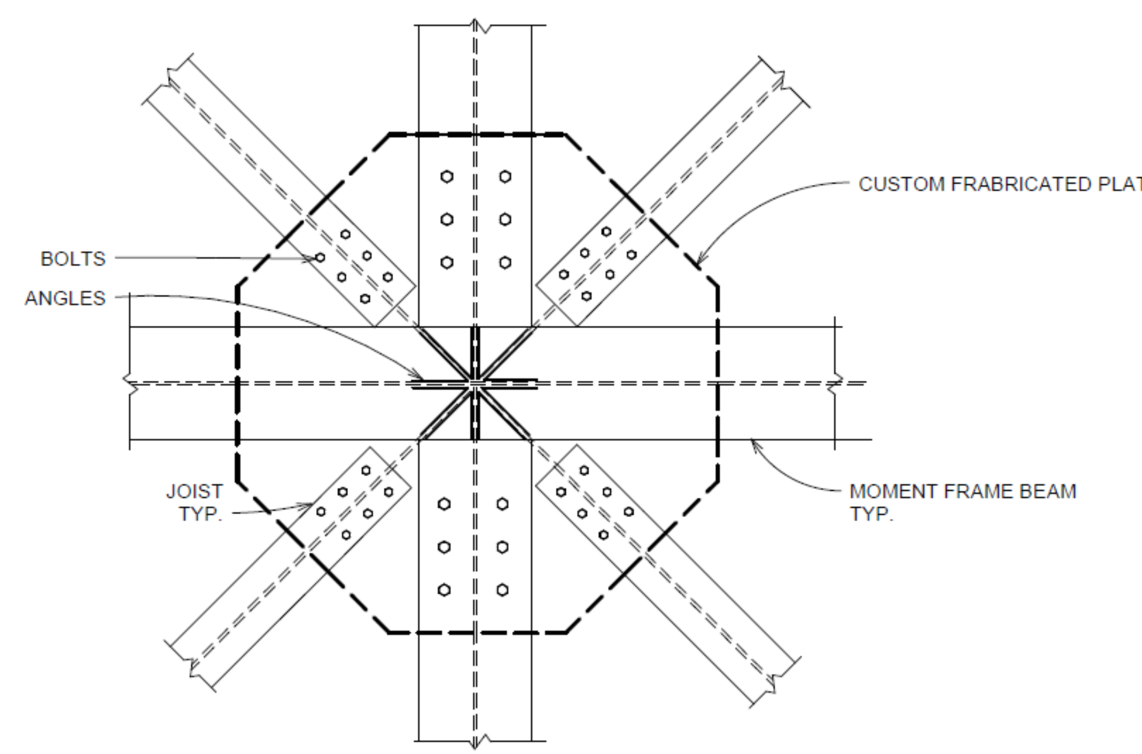
(2) JOIST TO MOMENT FRAME
Elevation



(3) JOIST TO GIRDER
INTERSECTION



(4) BEAM TO COLUMN
MOMENT FRAME



(5) CENTER CUSTOM PLATE CONNECTION

WIND LATERAL LOADS

Once the schematic design of the gravity system was completed, the engineers then began the lateral analysis of the structure. A quick wind analysis (using the ASCE 7-16 simplified design method) was conducted, but concluded to not govern over the seismic lateral analysis.

Site & Building Conditions		
Occupancy	Residential	
Risk Category	II	
Building Class	1	
Exposure	C - Common Exposure	
Topografic Factor	1.0	
Site Wind Speed	**97 mph**	ACSE 2-16 Hazard Maps

Site Wind Pressures (ASCE 7-16 §27)

Description	Variable	Value	Reference
Roof Height	h =	12 ft	
Diaphragm Length	L =	54 ft	
Diaphragm Width	B =	54 ft	
Diaphragm Ratio	L/B =	1	ASCE 7-16 T.27.5-1
Upper Wall Pressure	ph =	16.7 psf	
Lower Wall Pressure	p0 =	16.7 psf	

Re-Scale Wind Pressures (ASCE 7-16 §27)

Description	Variable	Value	Reference
ASCE Wind Speed	V =	110 mph	ASCE 7-16 T.27.5-1
Scaled Upper Wall Pressure	ph =	14.7 psf	
Scaled Lower Wall Pressure	p0 =	14.7 psf	

Base Shear (ASCE 7-16 §27)

Description	Variable	Value	Reference
Average Wall Pressure	pavg =	14.7 psf	
Wall Area	A =	648 ft2	
Base Shear	**V =**	**9.54 k**	ASCE 7-16 27.5-1

SEISMIC LATERAL LOADS

SEAOC Seimic Maps Site Report

Description	Variable	Value	Reference
Mapped Spectral Accelerations (%g) at Site Class C	Ss=	1.839	SEAOC Seismic Design Maps
	S1=	0.766	
Site Coefficients (%g)	Design Site Class	D - Default Soil	SEAOC Seismic Design Maps

Site Amplification Factors

Description	Variable	Value	Reference
Site Coefficients (%g)	Fa =	1.2	ASCE 7-16 T.11.4-1
	Fv =	1.7	ASCE 7-16 T.11.4-2
Site Modified Design Spectral Acceleration (%g)	SMS =	2.207	
	SM1 =	1.3022	(null)
	SDS =	**1.471**	
	SD1 =	**0.868**	(null)

Lateral Structural System

Description	Variable	Value	Reference
Response Modification Coefficient	R (for Special Moment Frame) =	8	ASCE 7-16 12.2-1
System Overstrength Factor	Ω0 =	3	
Deflection Amplification Factor	Cd =	5.5	
System Limitations	Hn =	NL	

Seismic Design Category (ASCE 7-16 §11.6)

Risk Category	Risk II		
Design Category based on S1	S1 = 0.766	1.7*	
Design Category based on SDS	0.5 < (SDS= 1.471)	D	ASCE 7-16 T.11.6-1
Design Category based on SD1	n/a	n/a	AISC 7-16 T.11.6-2
Design Seismic Design Category		**D**	

Seismic Response Coefficient (ASCE7-16 §12.8.1)

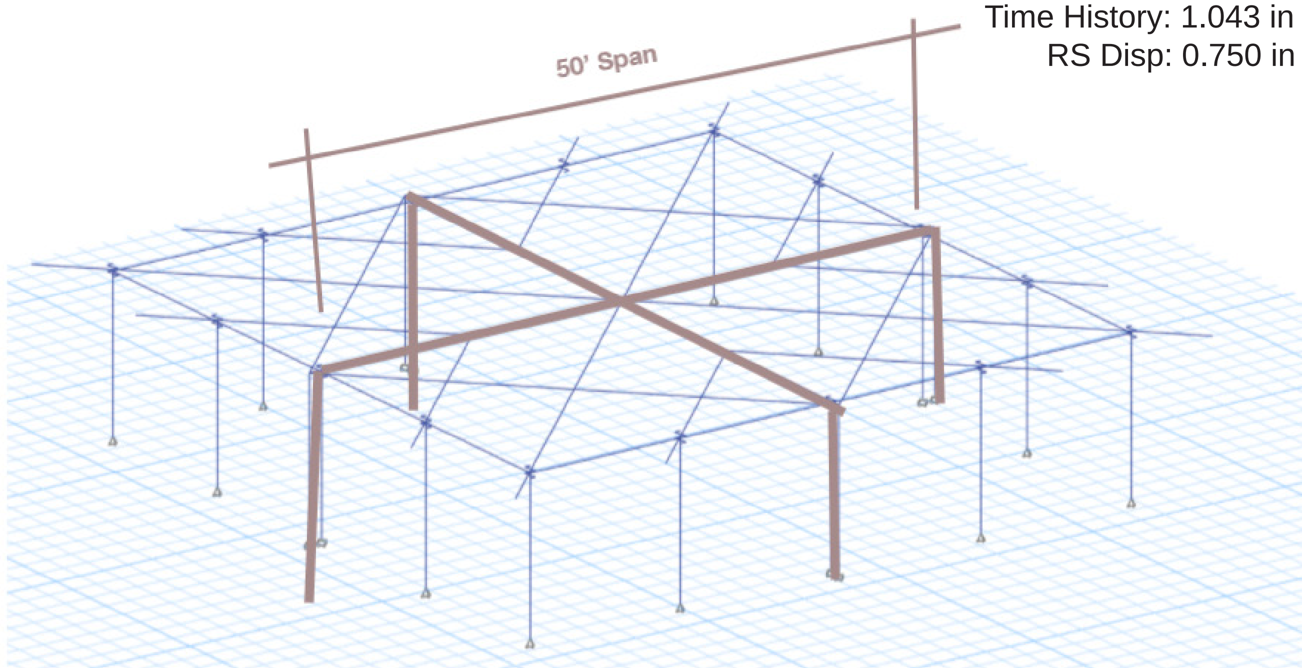
Variable	Calculation Notes	Value	Reference
ρ =		1	ASCE 7-16 §12.3.4.2
Cs =	SDS/(R/Ie)	0.184	EQN 12.8-2
Cs.max =	SD1/(T*R/I) [For T<=TL]	0.384	EQN 12.8-3
Cs.max =	SD1*TL/(T^2*R/I) [For T>TL]	10.860	EQN 12.8-4
Cs.min =	0.044*SDS*Ie	0.065	EQN 12.8-5
Cs.min =	0.5*S1/(R/I) [For S1>=0.6g]	0.048	EQN 12.8-6
V =	**ρ *Cs*W**	**93.094**	EQN 12.8-1

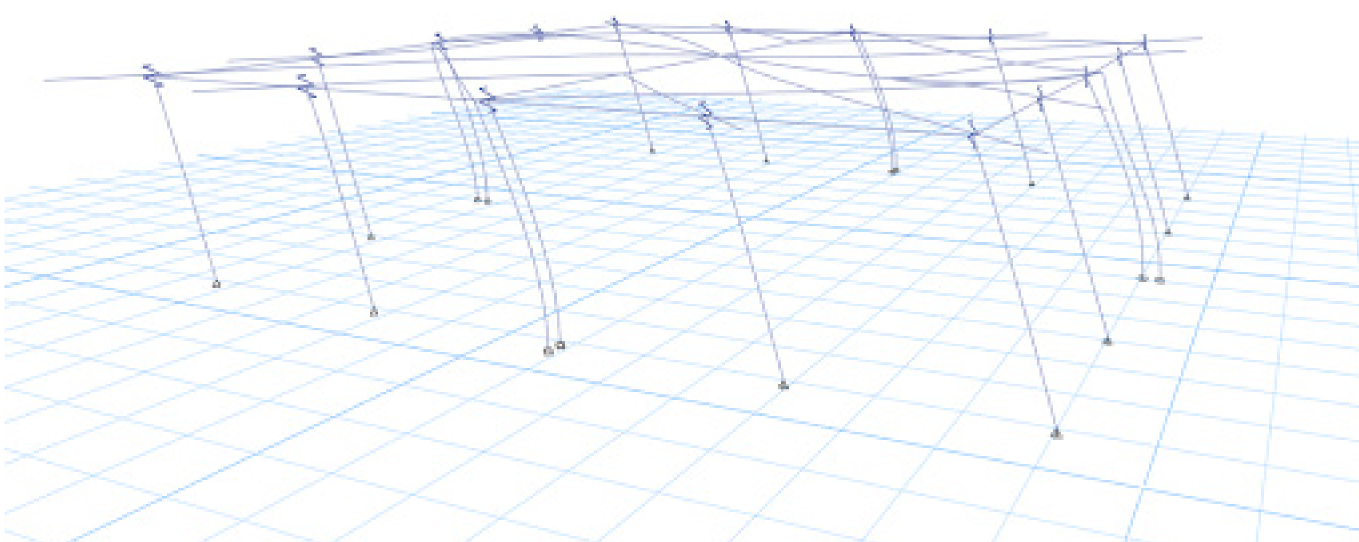
Vertical Distribution of Seismic Forces (ASCE7-16 §12.8.3)

Force Level: STRENGTH k= 1

Level	wx (k)	hx (ft)	wxhx^k	Cvx = wxhx^k/Σwxhx^k	Fx = Cvx*V
Roof	100.92	18.0	1817	0.428	**39.8**
Floor	405.3	6.0	2432	0.572	**53.3**
Σ=	**506.22**		**4248**	**1.000**	**93.1**

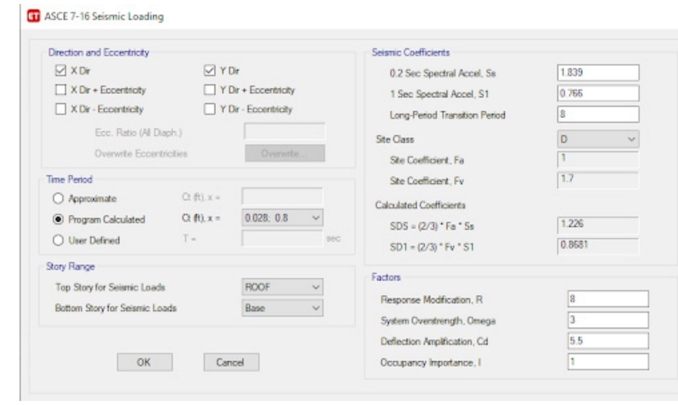
Roof Drift:
ASCE 7-16: 0.137 in
Time History: 1.043 in
RS Disp: 0.750 in



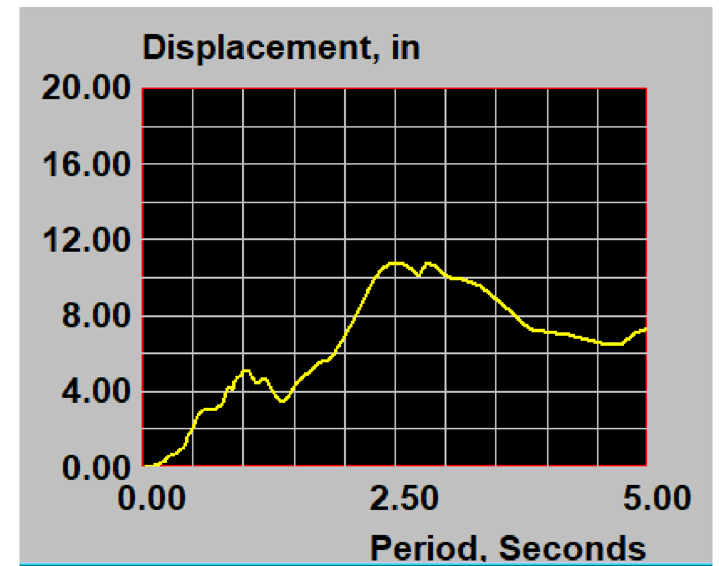


MOMENT FRAME OUTLINE IN ETABS

SEISMIC LOADING MODEL

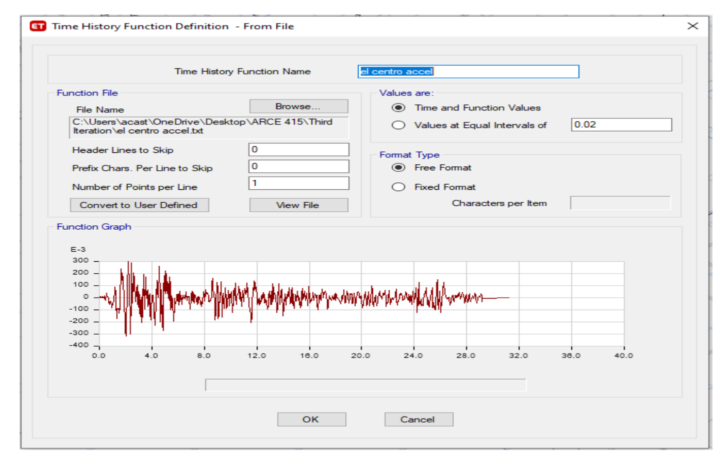


Testing the model in EtABS, we got a maximum drift of about an eighth of an inch using the ASCE 7-16 dictation tool in ETABS. Running the seismic response history of the El Centro earthquake through the model outputs a maximum deflection of about an inch. For analysis purposes we used the values required by code.

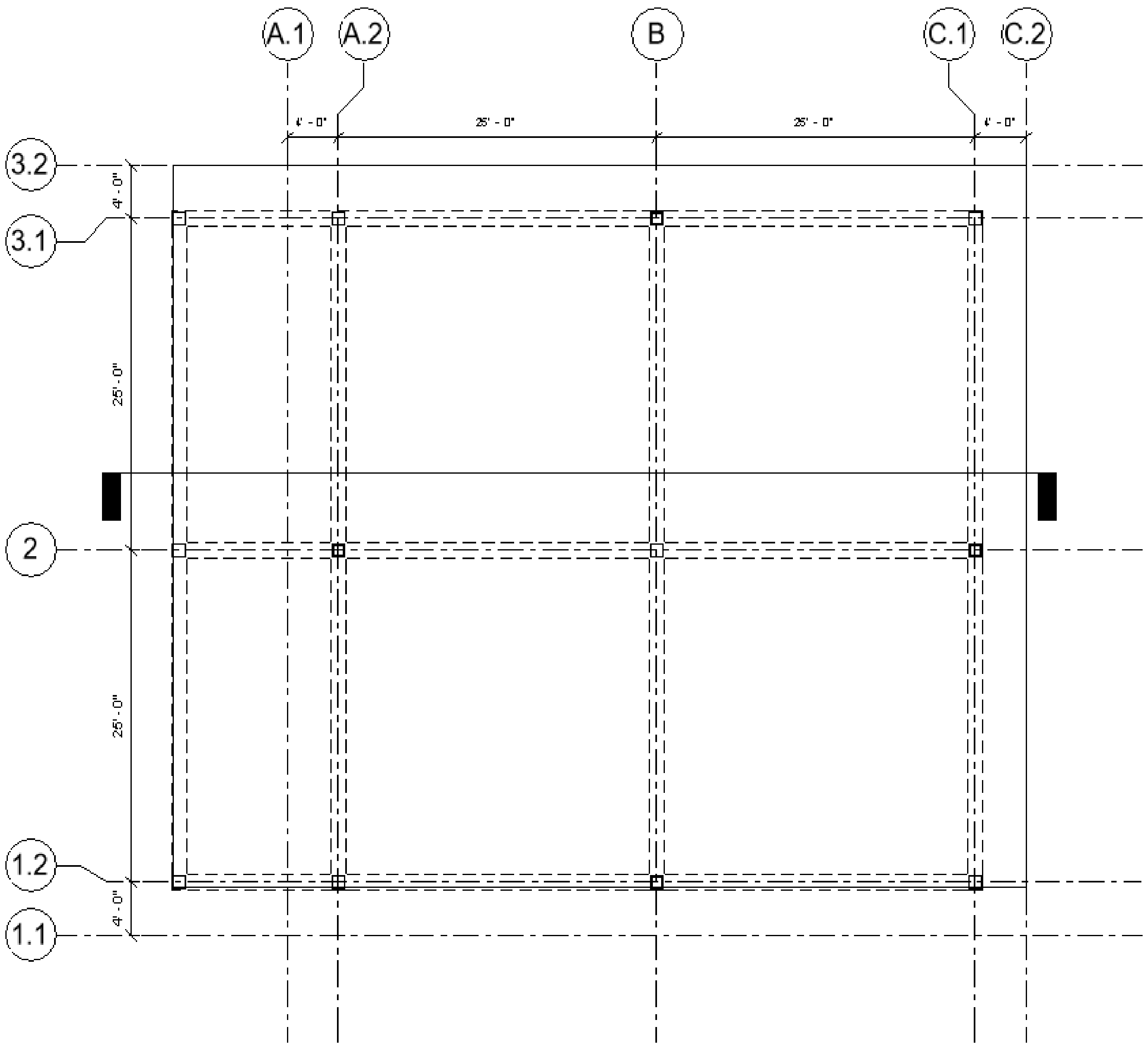


The Spectral Response Displacement for El Centro predicted a displacement of about .75 inches for the first mode, so this may indicate that our assumption of 90% modal participation is not a working assumption, but given the fact that this is a one story building with little building irregularities, we can still safely assume that per the code.

The ETABS testing and design did result in an increase in size in some of the members with the additional input of the lateral loading, particularly in the moment frame. When analyzing the roof diaphragm, we assumed collector and chord action took place in the diagonal joist and girder members. The members that ETABS designed for us helped in selecting preliminary member sizes.

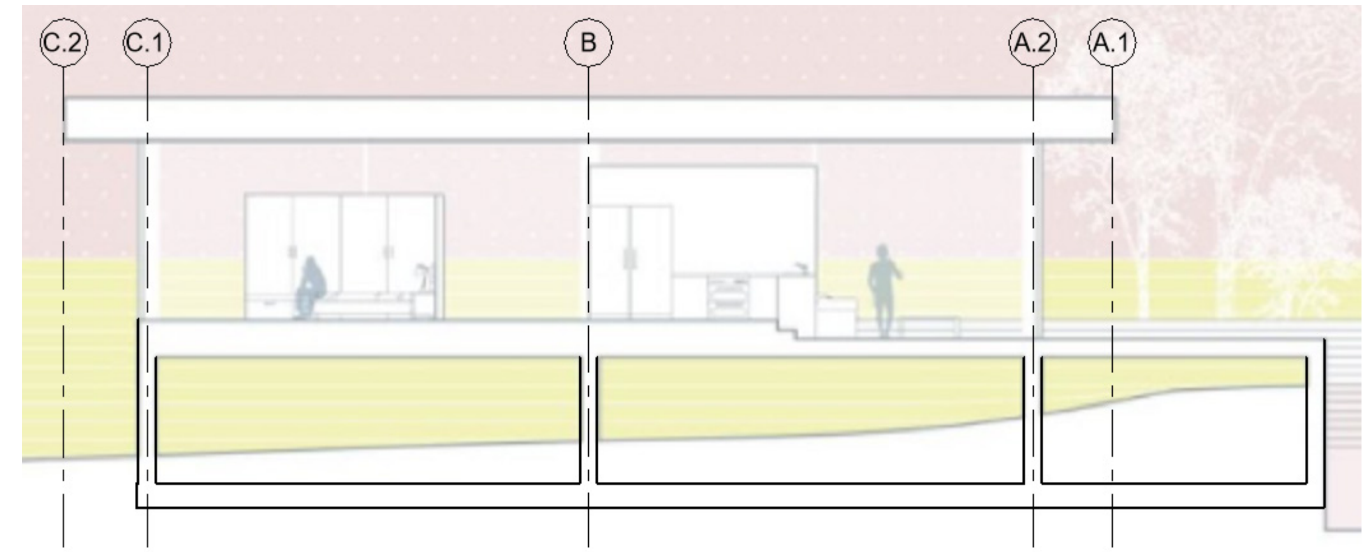


Ultimately, special moment frames were selected to resist lateral earthquake loads. This was dictated by architectural constraints on the interior areas since the client wanted a lot of usable space. For that moment frame,our modeling assumed moment carrying connections at the beams and at the floor, and assumed the floor acted rigidly.



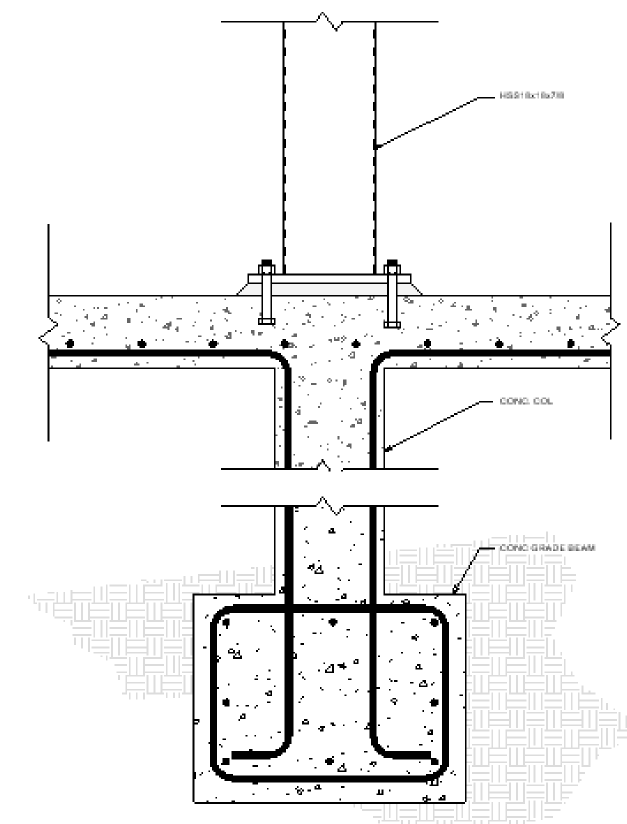
FOUNDATION PLAN

FOUNDATIONS



SECTION

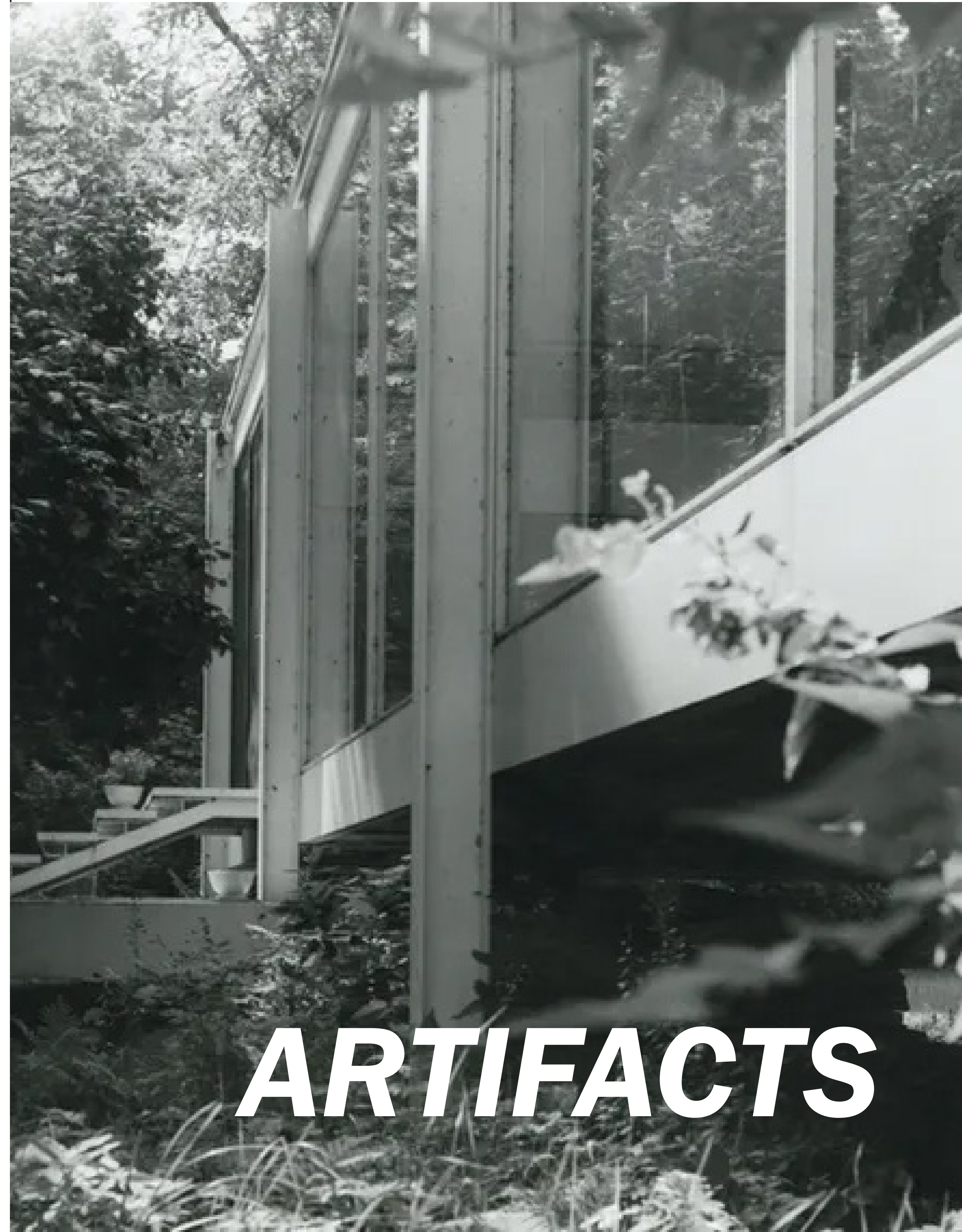
Our last consideration for our glass house was our foundations. This is a conceptual design so no calculations were performed. Our slab will be a post-tensioned two way slab which is sitting on concrete columns. The concrete columns have footings and a system of grade beams which is a more clear on the section drawing. We also have a foundation detail cut through the slab, column and grade beam to show what the rebar might look like if calculations were performed. If we were to move forward with this design, we would add a shear key to prevent the house from sliding down the grade. Grade beams were also considered to make sure that foundation footings were anchored together, and to ensure frame action in the moment frames. Collectively, the structural analysis and design heavily considered the architectural constraints given by the architect and the client.



FOUNDATION DETAIL

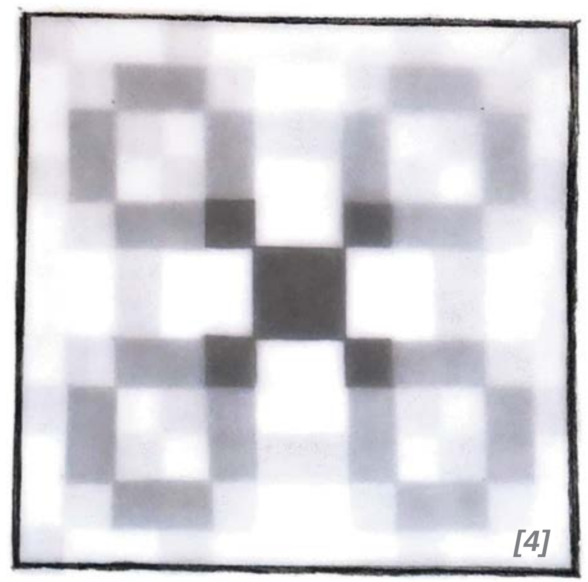
Farnsworth House, south façade and terrace.
Photo by Gorman's Child Photography.

"A convincing historical artifact is one that transcends its time and place. Many are very personal and intended for the creator, all speaking to and about our dreams, inspirations, and/or desires of its maker. Through the process of making our own, artifacts help us to access our motivations and visions through deep processes of creation. To create an Artifact - in the form of painting, musical score, poem, film, etc. - that addresses your thoughts, inspirations, and/or desires, related to Glass Houses and the myriad of theoretical and material content we've examined, and designed, thus far in the studio. From this, deep cultivation of our personal positions and critiques on transparency in architecture and engineering are born and a better view of the overall story of glass can be understood."



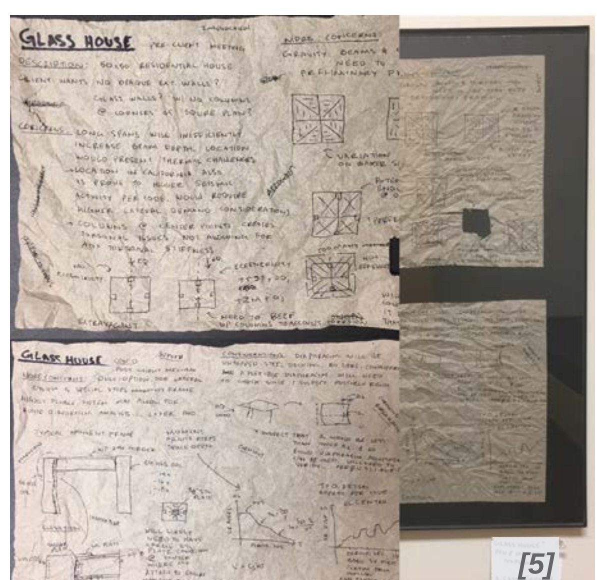
[1]

[3]



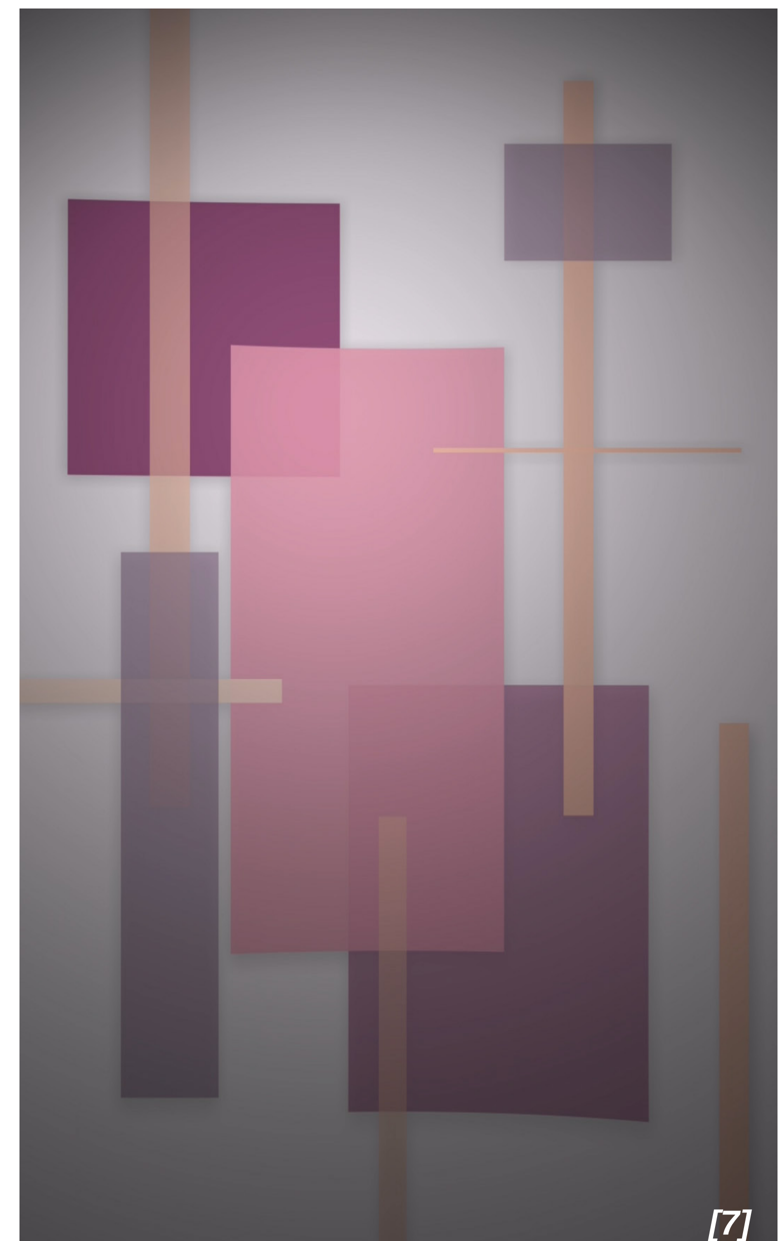
[4]

[2]



[5]

[6]



[7]

[1] Madison Lam

[2] Augusta Orlauskaite

[3] Ella Gleason

[4] Araceli Avelar

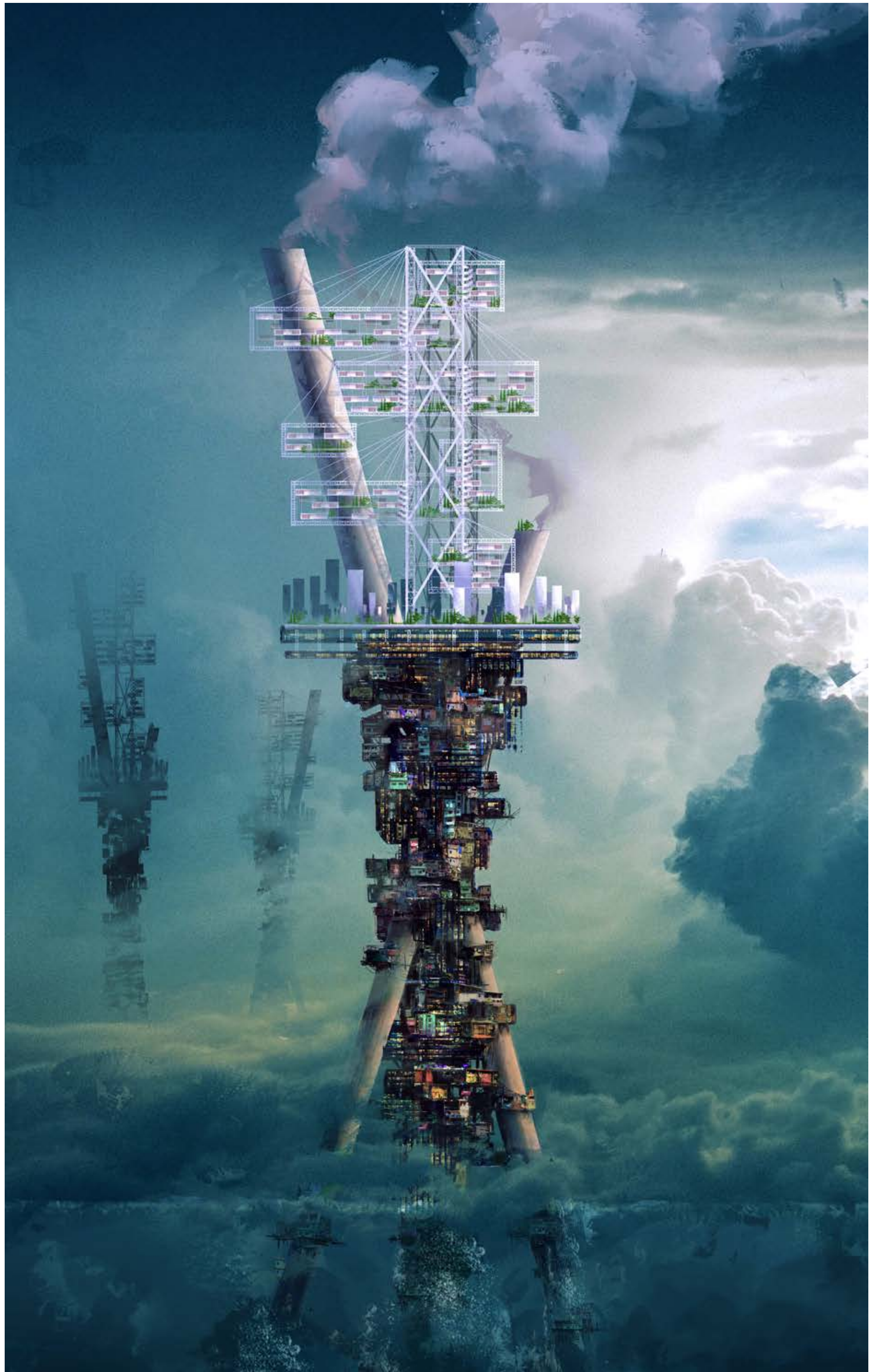
[5] Armando Castaneda Jr

[6] Alejo Favero

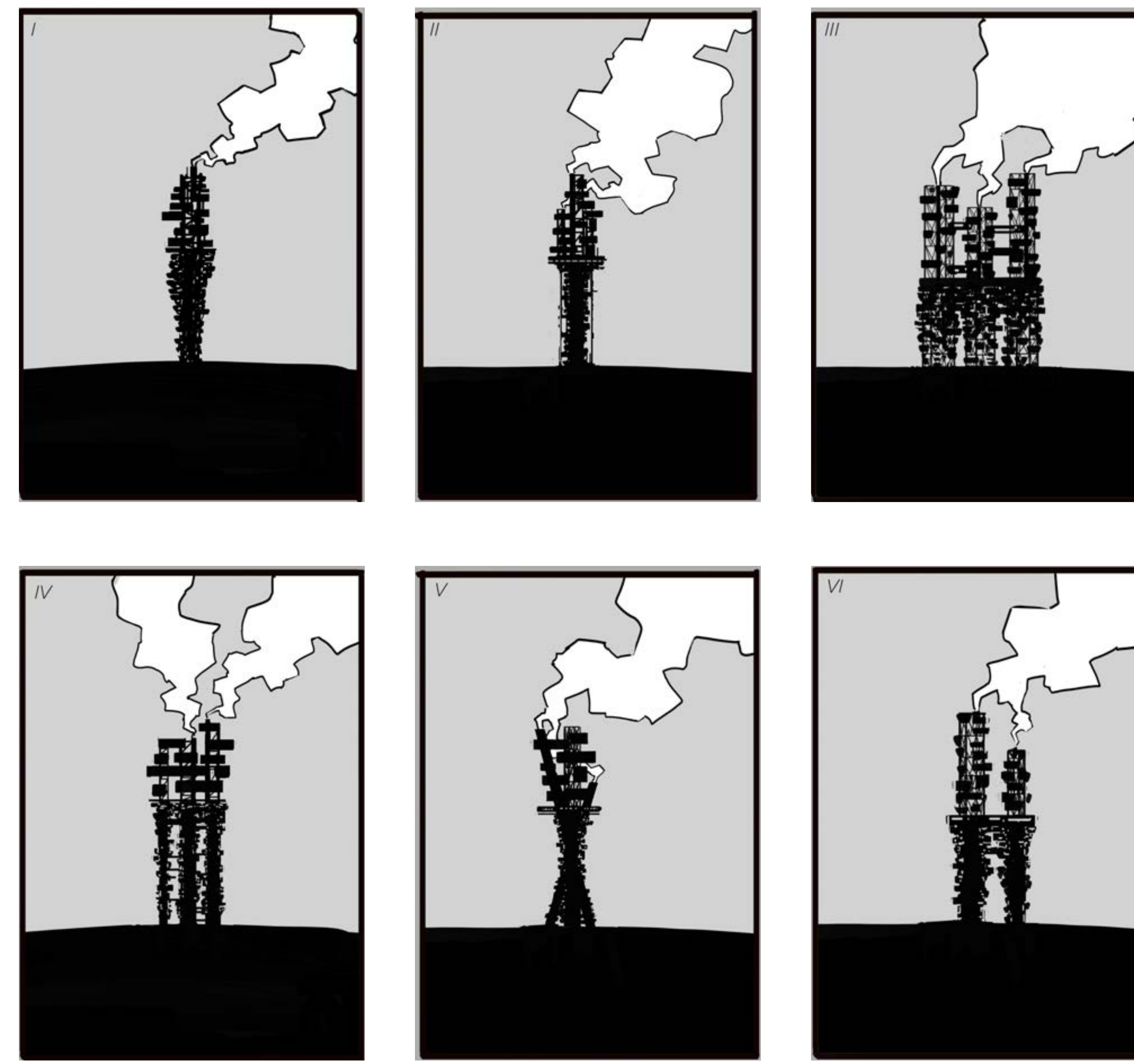
[7] Ignatius Mallari

“Through intense analysis and iteration, the team arrived at the final phase of the studio, where a re-imagined 50’x50’ glass house is developed as one component of a larger part-to-whole structure, a “Final Fantasy,” sited within the Modernist context of Palm Springs. How might this structure be modified to be part of an affordable housing, mass marketing solution? Or how might your re-designed house serve a single family or perhaps a single client? Conversely, how might this structure be part of a dystopian society, one where glass walls are used to control and survey the population? How do these two differing visions - one utopian, one dystopian - intersect to reflect the class stratifications of our society?”

Moving on to our final fantasy project, the team wanted to take this opportunity for a conceptual project and use it to further explore this complicated notion of Utopia, and how it relates to the socioeconomic patterns we were seeing in history. Looking 200 years into the future where rising sea levels quickly forced societies into towering rig cities.



Here the idea of social hierarchy is laid visually bare with a Utopia being built quite literally on the back of the Dystopia below it, where the citizens of the upper levels live in ignorant bliss amongst their glass houses, while the population below struggles to avoid the rising waters. This was our way of conceptualizing and visually representing the idea that there is no Utopia absent of some element of Dystopia supporting it. A reflection of the past and present where the luxuries afforded by a few are built on the work of a larger society beneath them. As the waters rise, the lower population has nowhere to go but up, until eventually there will be a breaking point at the barrier between the two cities, and who is to say what happens after that.



LAST-HOPE PROJECT

Description: Given that the world is accelerating towards a dangerous point involving global warming, the states of the world decided that they must build upward to live in what would be a haphazard attempt to live sustainably. This project attempts to densify population to decrease the amount of arable land that is being ravaged by expanding suburban life and the niceties of golf courses. It was commissioned to build high into the sky and away from whatever dangers might still come from rising sea levels and melting ice caps…

The work is meant to be completed in 4 parts, the initial 2 parts concern the lower 70 percent of the structure where this portion will simply be created to temporarily carry the load of the third part. This third part will be where the luxury units will be held and must be complete in order for those who are able to move in sooner and are able to pay for their helicopter ride to the different towers. The 4th part will consist of going back and completing the lower 70 percent.

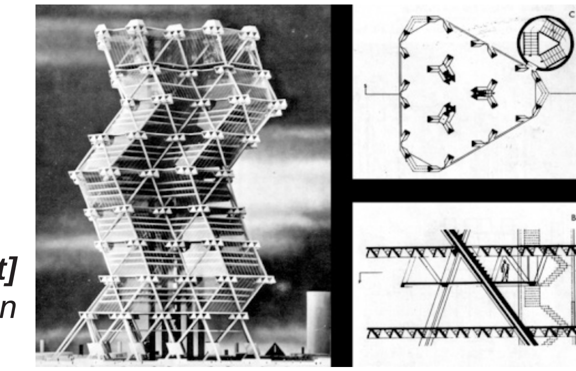
Gravity:
The gravity system will include different elements of the 3 towers being built. Similar to the Burj Khalifa, the Last-Hope towers take advantage of the buttressing action of the wide base. This wide base extends further up in its full width and depth up until the luxury units are reached. The base extending up creates a tube with a 10' thick wall. There will also be a sub-tube structure. The diagonal members will work similarly concerning this super structure. The substructures will be needed to stiffen the four walls and make sure there are interlocking mechanisms throughout the structure. The concrete tube will support concrete slabs at each level. Once the luxury apartments are reached, to keep more open spaces, the structure will transition into steel beams and columns. The towers will be connected via convenient bridges and there will be convenient helicopter pads located throughout the structure.

Lateral:
The lateral system will take advantage of the large gravity system. The concrete tube base will act as a concrete shear wall reinforced with steel reinforcements. The corners will need to be specially reinforced and special care will need to be taken to ensure failures are localized. In the luxury units portion, the moment frame will need to resist relatively smaller demands. Because of this, the moment frames will likely only need to be designed with simple hand calculations. The connections at the base of the luxury units portion will need to be embedded into the concrete below to ensure a moment carrying connection. The sub-towers will be designed similarly.

PRECEDENT

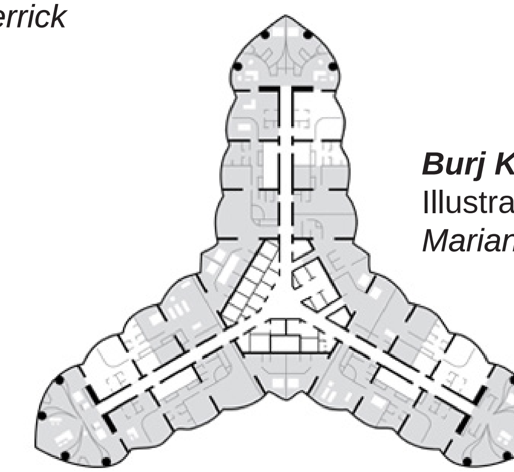
John-Hancock Building
No. 1 Noel

City Center Building [Unbuilt]
Louis I Kahn



Starting off trying to find structural systems that would work for a tall building, we looked at precedents for tall structures. In particular we sought to find systems that would work in conjunction with the sudden vertical change in lateral system from concrete shear walls to steel concentrically braced frames.

Burj Khalifa
Nick Merrick

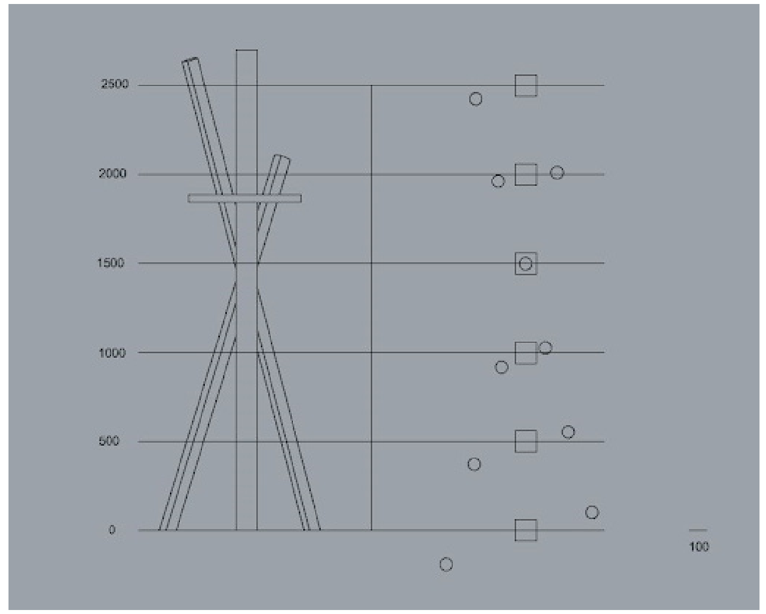


Burj Khalifa Core
Illustration by
Marianne Rom

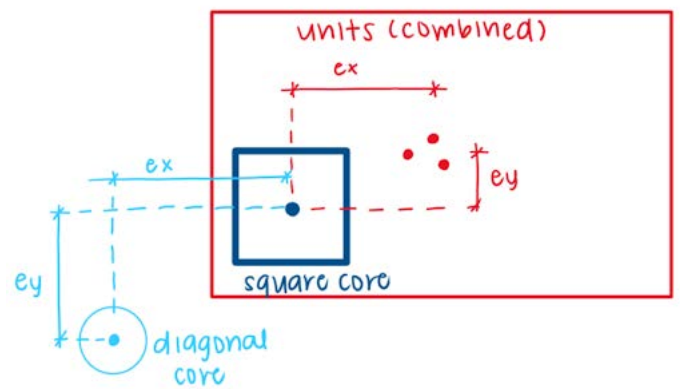
For the concrete shear wall, we looked at the buttressed core system of the Burj Khalifa and thought this same action could be achieved just by the length and the width of the base. We had concerns that steel concentrically braced frames would not work efficiently and so we started to think we may need to use buckling restrained braced frames, but felt more comfortable that demands could be met without this added cost looking at the John Hancock building. Finally, for precedent we also looked at the Center City building by Louis Khan that was never built to try and get an idea about inner tube cores and structuring buildings with irregular architectural living units.

CENTER OF MASS STUDY

For the conceptual engineering of our final fantasy structure,we did a center of masses (COM) study of the combined masses of the housing units added to the main cores of our structure. We also assigned relative member weights to the different cores and units based on their materiality and how much load we believe there were going to add on. This study helped inform the architects moving forward with their placement of the units in relationship to the cores.



COM Relative Effects	
Member	**Factors**
Sq Core (stl)	3
Diag x 2 (conc)	3
Utopia Units	1.5
Sq Core (conc)	5
Diag x 2 (conc)	3
Dystopia Units	2

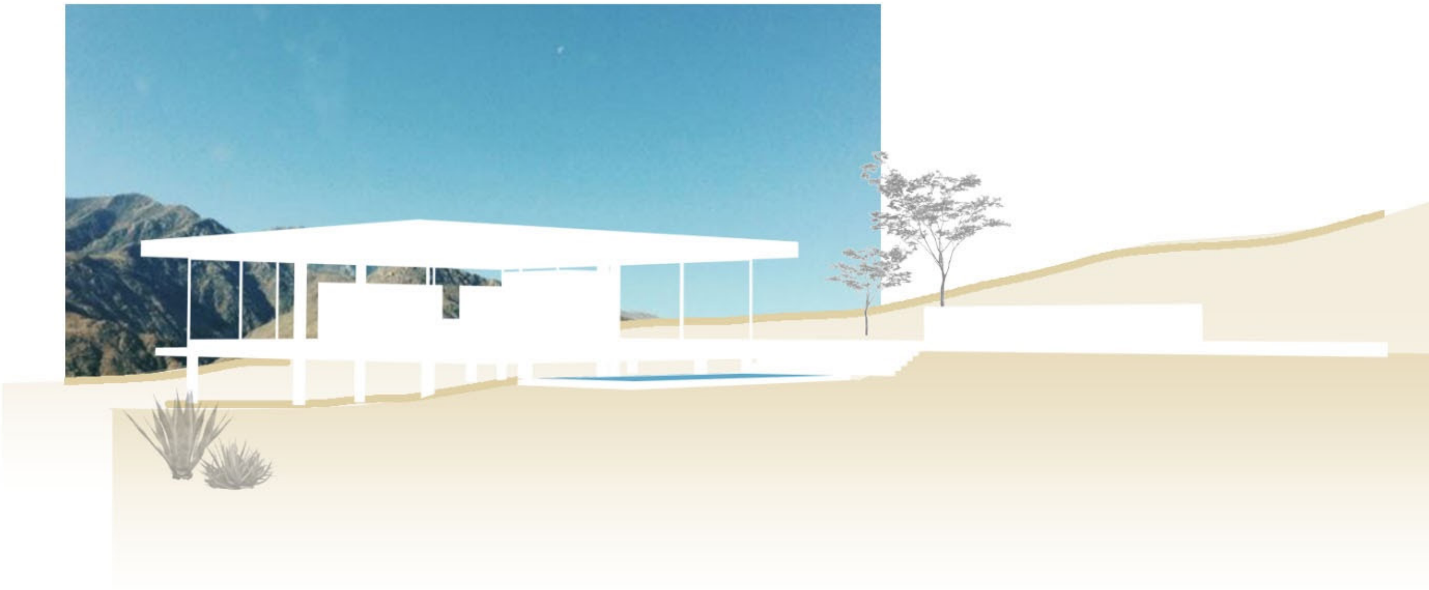


Eccentricities						
	Diag 1		Diag 2		Sq Core	
Elevations	x (ft)	y (ft)	x (ft)	y (ft)	x (ft)	y (ft)
2500	200	425				
2000	340	450	675	500		
1500	500	500	500	500	500	500
1000	625	525	350	600		
500	750	575	200	350		
0	875	600	50	300		

* origin at the lower, left

Residential Unit Overall COM				
	Fixed			500
Elevations	x (ft)	y (ft)	ex (ft)	ey (ft)
2500	1100	650	600	150
2000	470	600	-30	100
1500	500	500	0	0
1000	538	313	38	-188
500	575	613	75	113
0	613	650	113	150

* e relative to centroid of sq core



The team used the glass house studio to explore class stratification, particularly using the glass as a reflection of class dichotomy in our society. The glass and Miesian design approach glorifies the clean cut, picture-perfect utopia only accessible to the wealthy few. But reality proves that there is more to this. As architects and engineers, we should strive to create environments that may uphold our values of equity and diversity and ultimately serve all sectors of society.