A // paolagonzalez + chewysparra

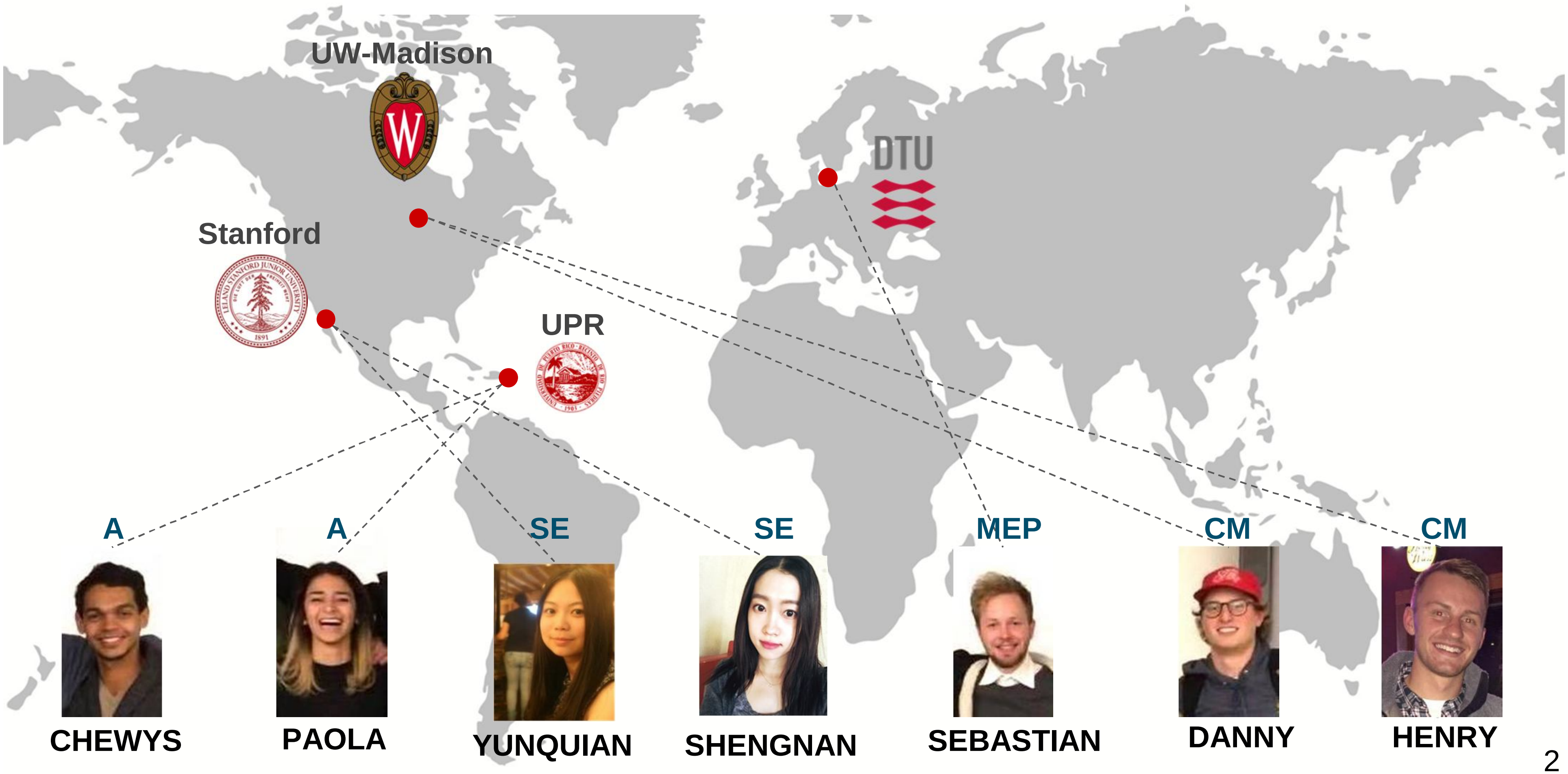
shengnanzhao + yunqiancai // SE

ISLAND17

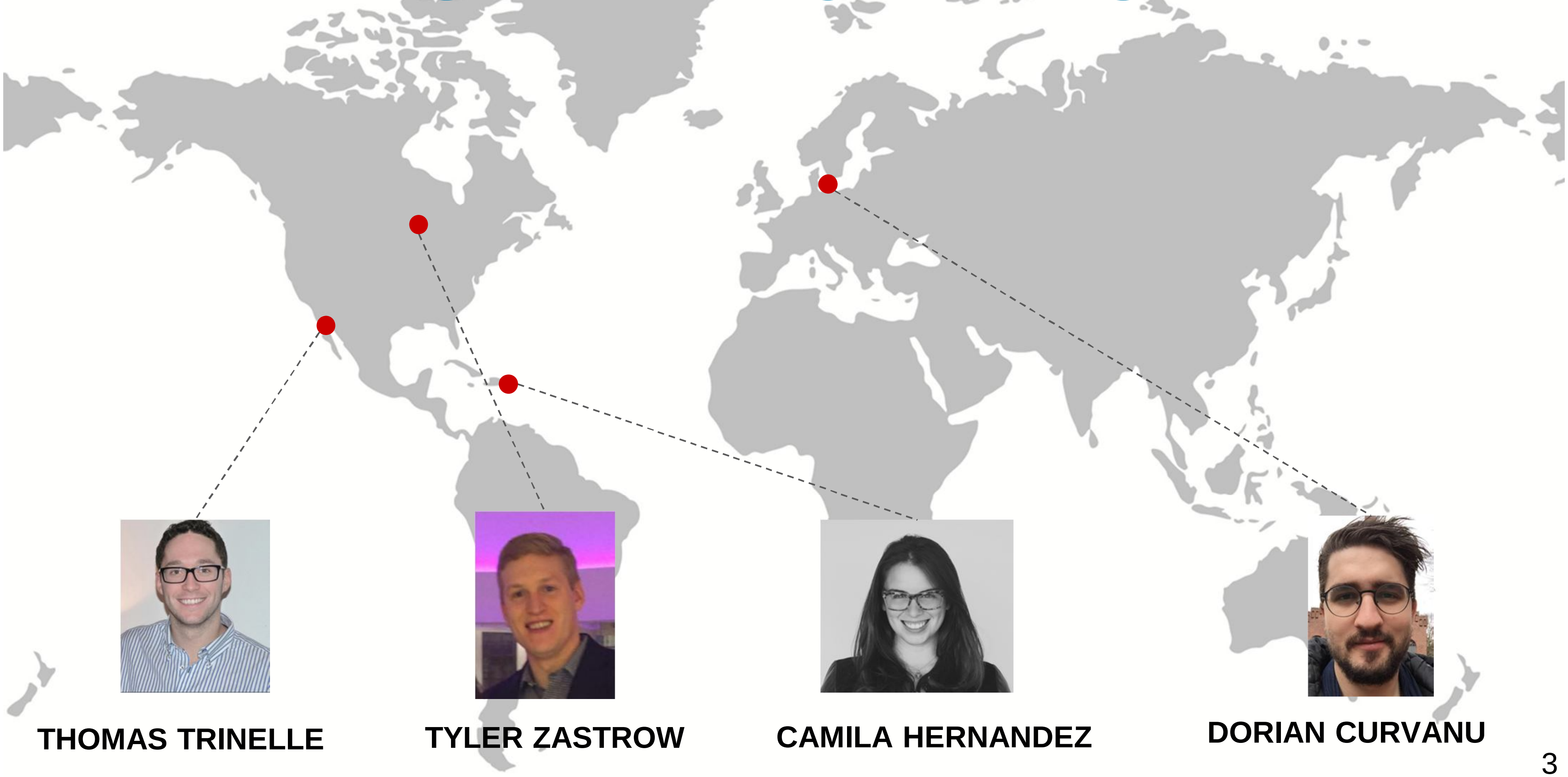
MEP / sebastianglæsel

henrynuckles + dannyradermacher // CM

ISLAND17 TEAM



ISLAND17 OWNERS



ISLAND17 **COMMUNICATION**

Started with FaceBook messenger but it was not an organized chat

slack

TEAM MEETINGS

TERF

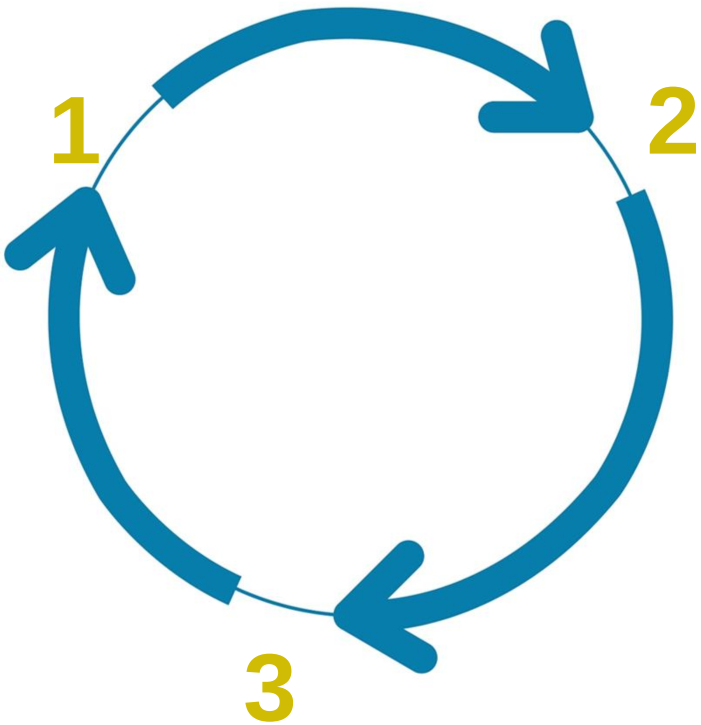
GoToMeeting

FILE SHARING

Google Drive

A // SE // MEP / CM //

ISLAND17 DECISION PROCESS



1 "Guys, we got a problem..."

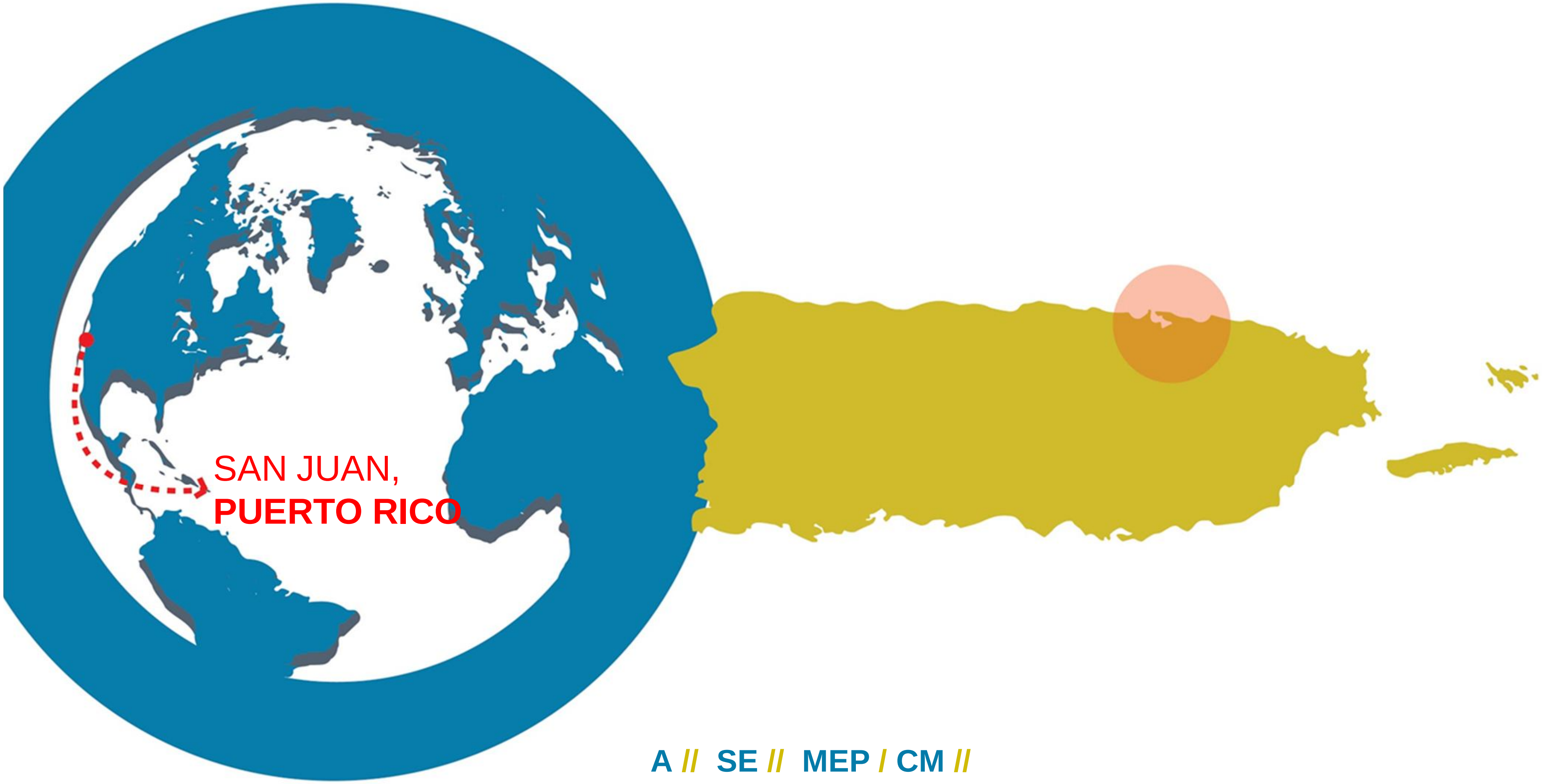
2 "Okay. Don't panic, it's just a column clashing with a duct making clear height 6' and damage costs more than 7 years of tuition…"

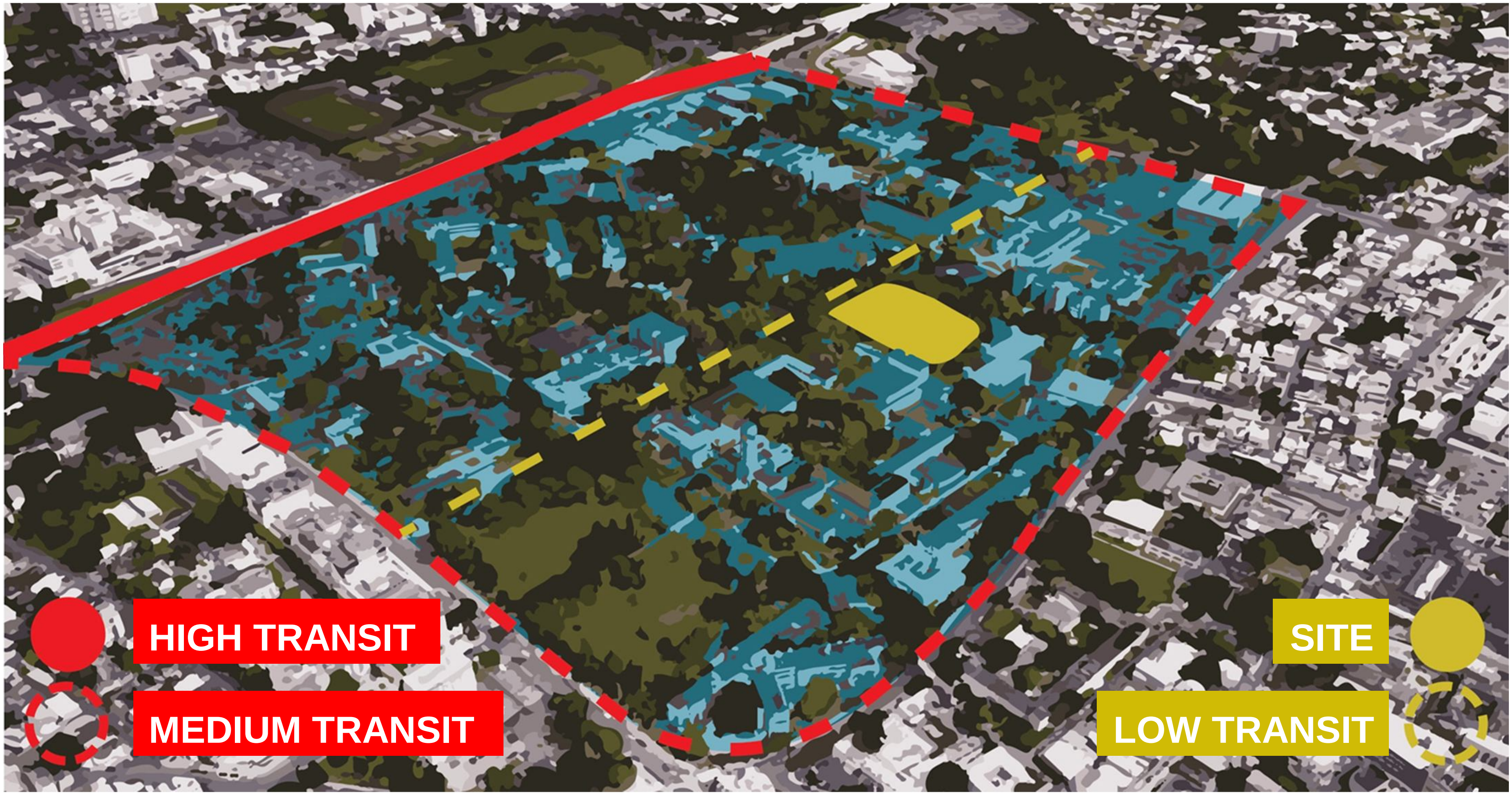
2.1 "Oh…"
(6 seconds later)
"We have to talk."

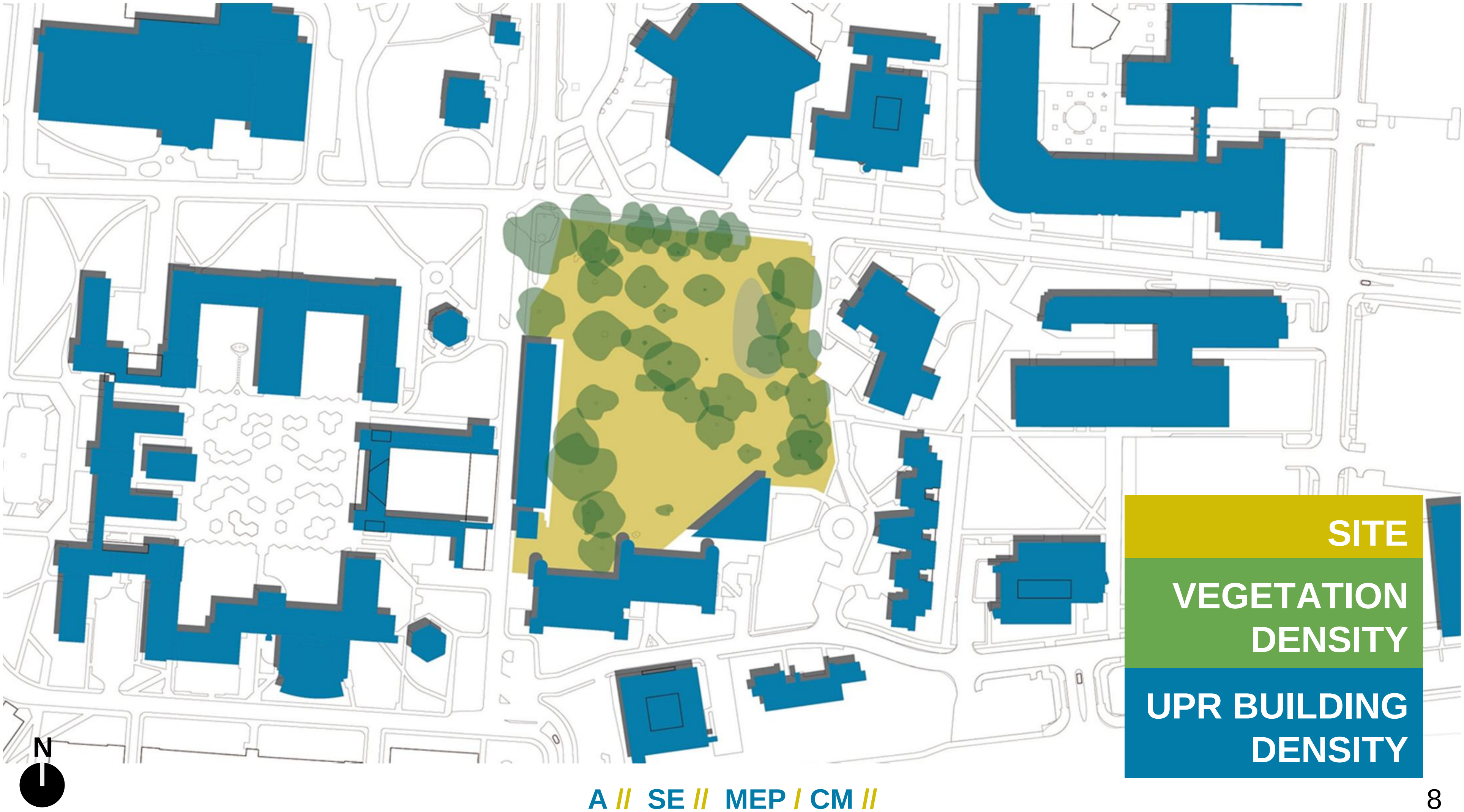
3 And after long discussions and and lots of work, Island17 have solved it!

3.1 "Guys, we got another one..."

OUR LOCATION



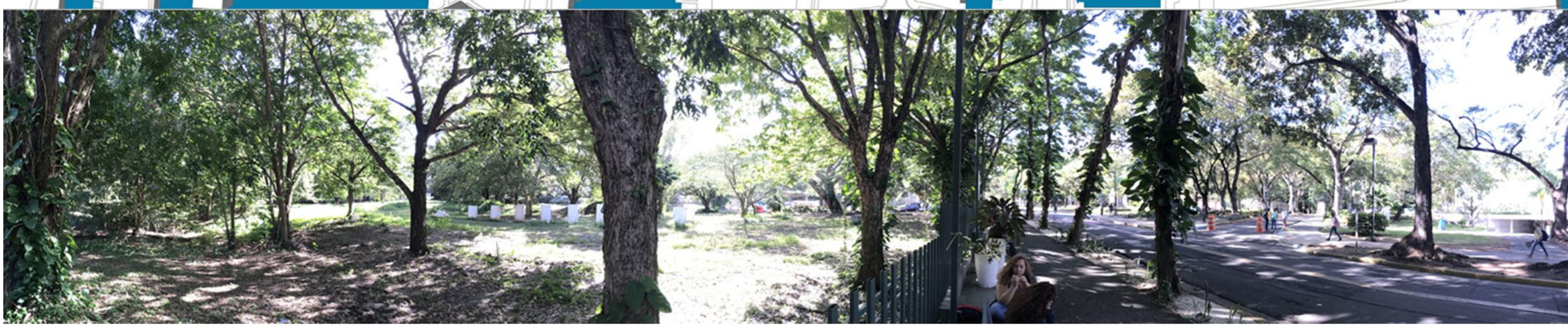

HIGH TRANSIT
MEDIUM TRANSIT
SITE
LOW TRANSIT

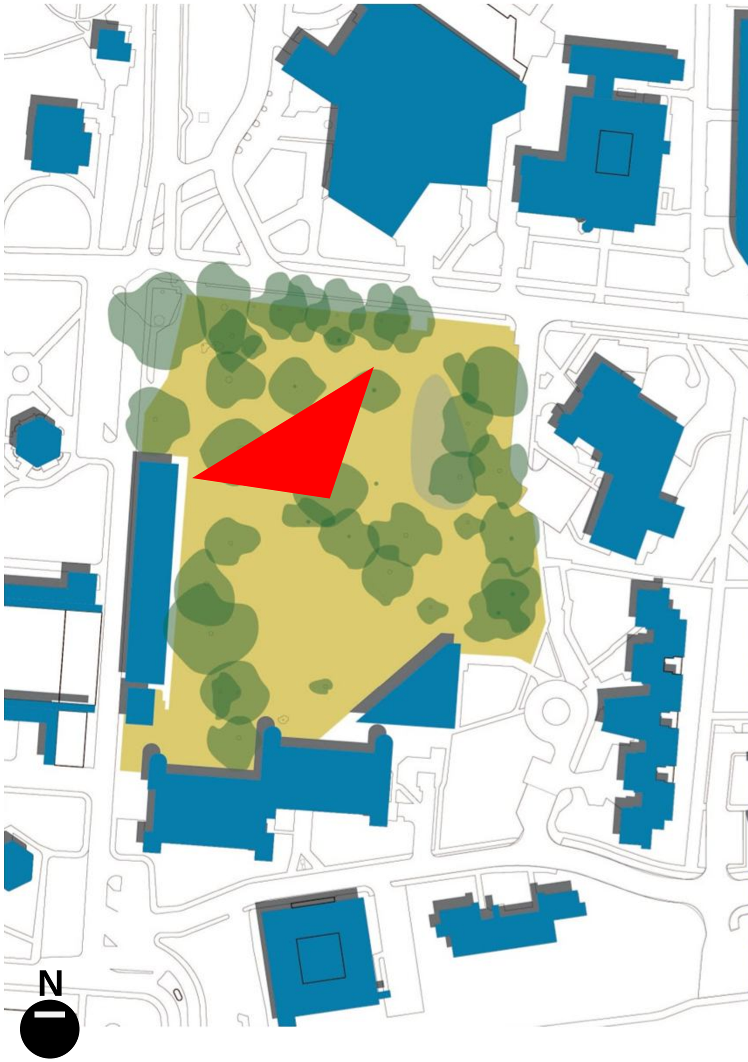


N
SITE
VEGETATION DENSITY
UPR BUILDING DENSITY

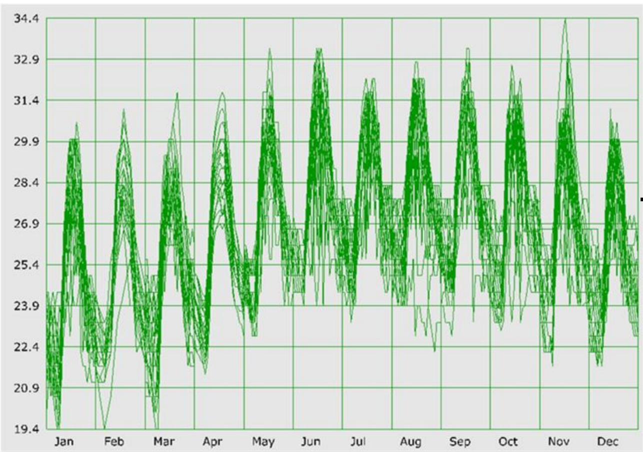

HIGH TRANSIT
MEDIUM TRANSIT
LOW TRANSIT
N


N

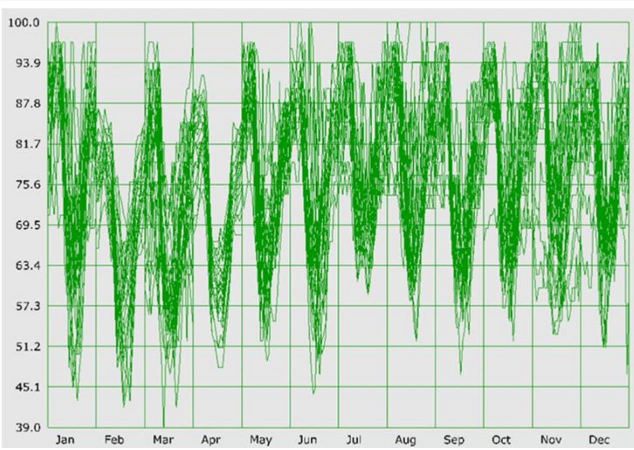



N

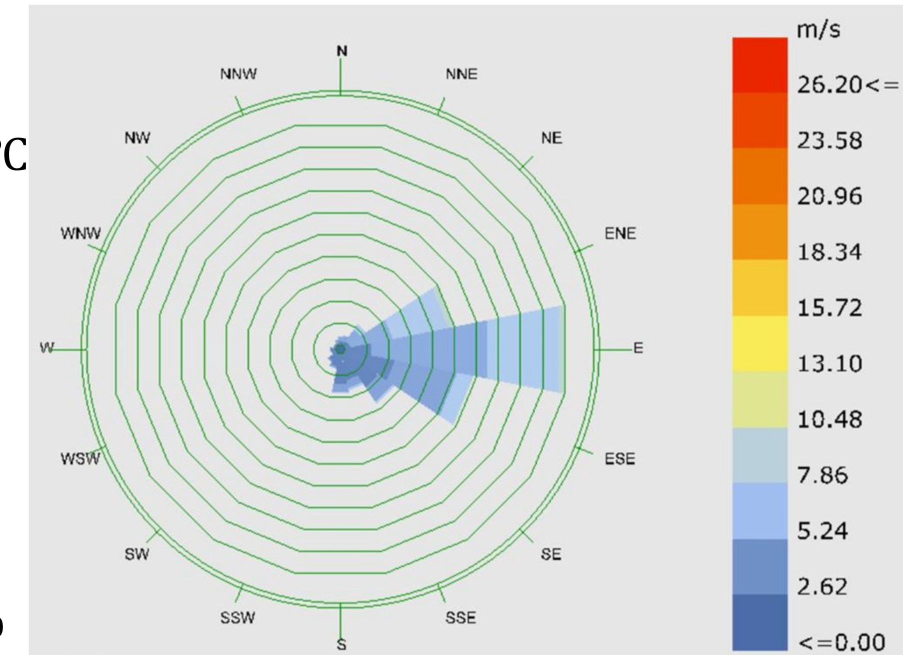
COMFORT PARAMETERS



Dry Bulb Temp.
19,4 - 34,4 ℃



Relative Humidity
39 - 100 %

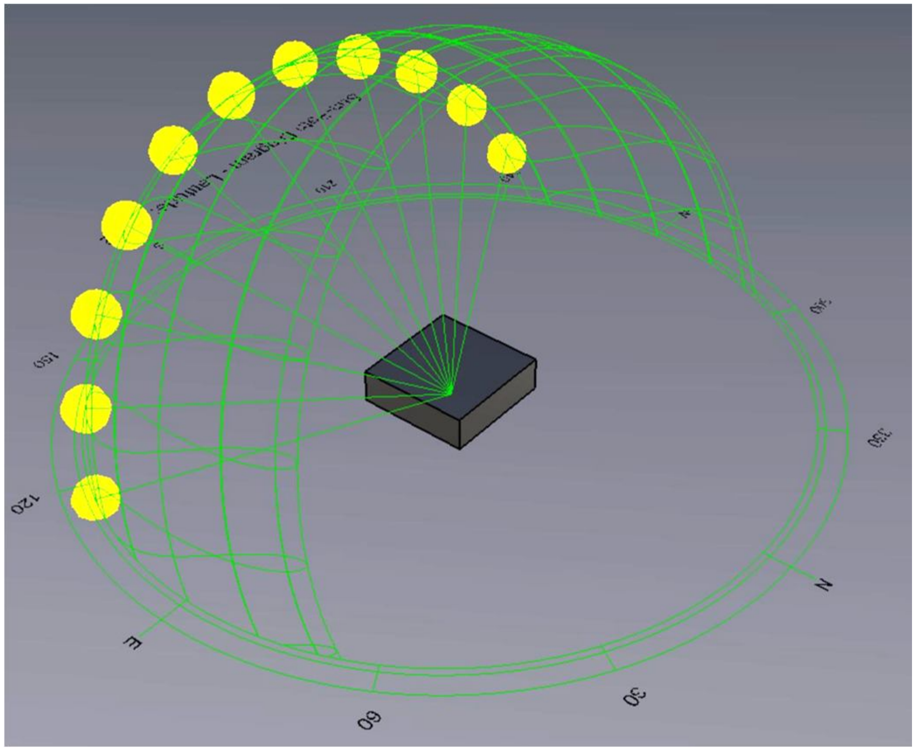


Wind Rose

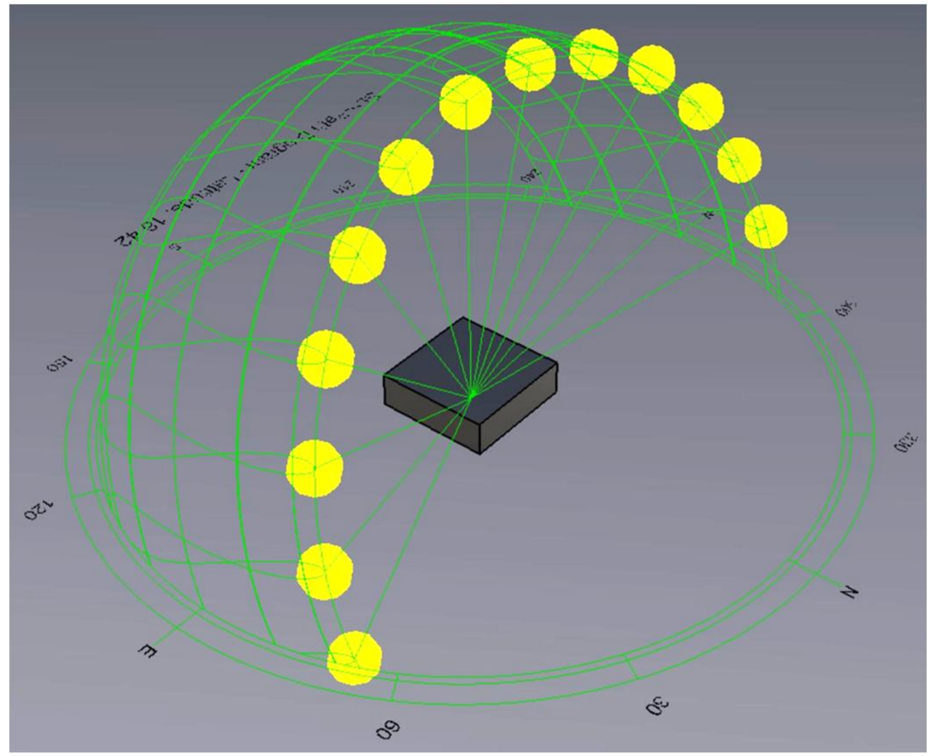
CLIMATE IMPACTS ON MEP

Challenges	Primary system	Secondary system
High temperature	No heating system Reduce heat gain from sun	Focus on thermal comfort rather than air quality
High humidity	Use efficient dehumidification	Maintain positive pressure Avoid still air Avoid exposed, cool elements

BUILDING ORIENTATION



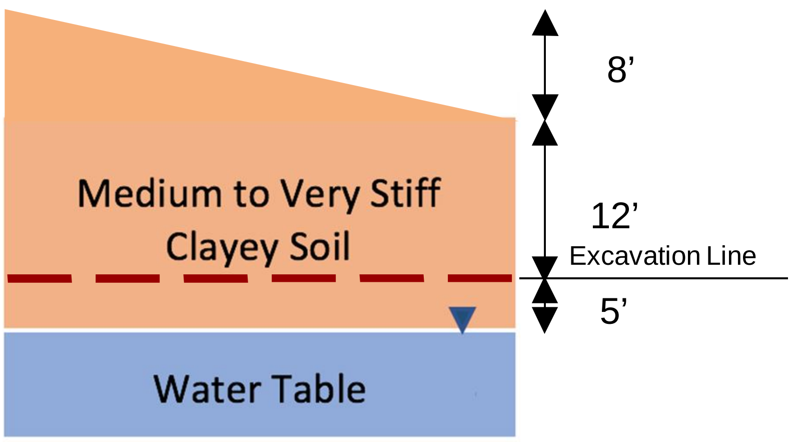
Winter, December



Summer, June

SOIL CONDITION AND CHALLENGES

Soil Profile



Bearing Capacity: 5000 psf

Historical Earthquakes

0.2s SRA = 1.0g
1.0s SRA = 0.4g
Critical Damping = 5%

Historical Hurricanes

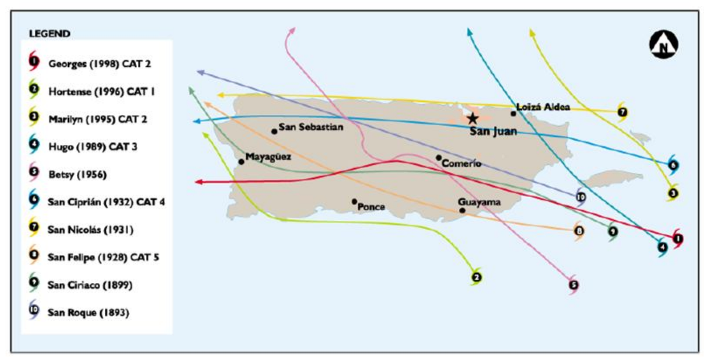


FIGURE 2-1 History of hurricanes in Puerto Rico.
Source: Huracanes en Puerto Rico: Guía de Mitigación de Daños.

Wind Speed:
High wind from SE
160-170 mph

Source from USGS

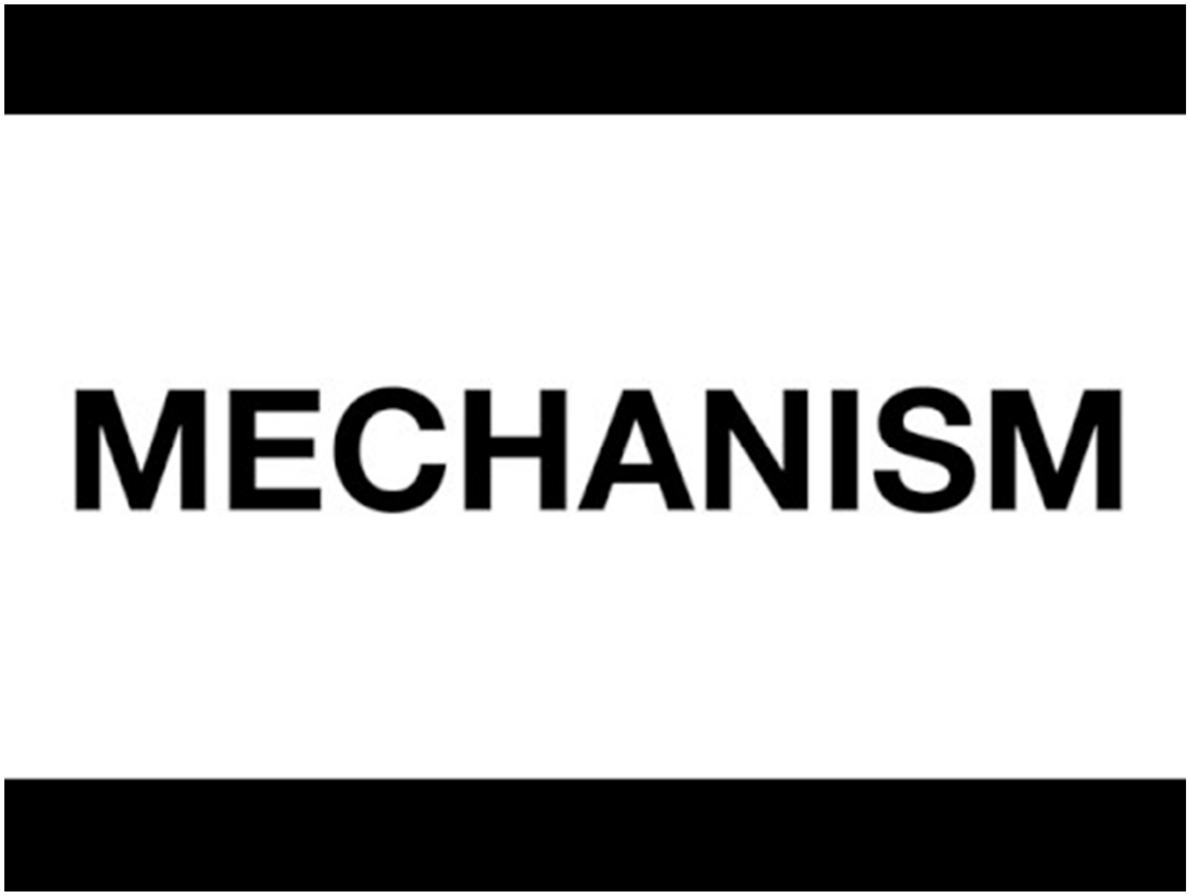
1 Here are some site conditions in Puerto Rico. The soil in our site is majorly medium to very stiff clayey soil, with a bearing capacity of 5000 psf. Water table is 17 ft below ground, and the excavation line is 5 ft above the water table. our site has an 8 ft slope along the entire footprint.

Puerto Rico suffered a lot from earthquakes. Historically, some earthquakes with magnitude of seven hit Puerto Rico and caused some damages. the critical damping in Puerto Rico is about 5%.

In addition to earthquakes, hurricane is also a major concern. in hurricane seasons, wind speed is typically 160 to 170 miles per hour from the southeast direction.

Yunqian Cai, 3/17/2017

CONCEPT VIDEO



CONCEPT BRIEF

LIVING

morphology | understanding

MECHANISM

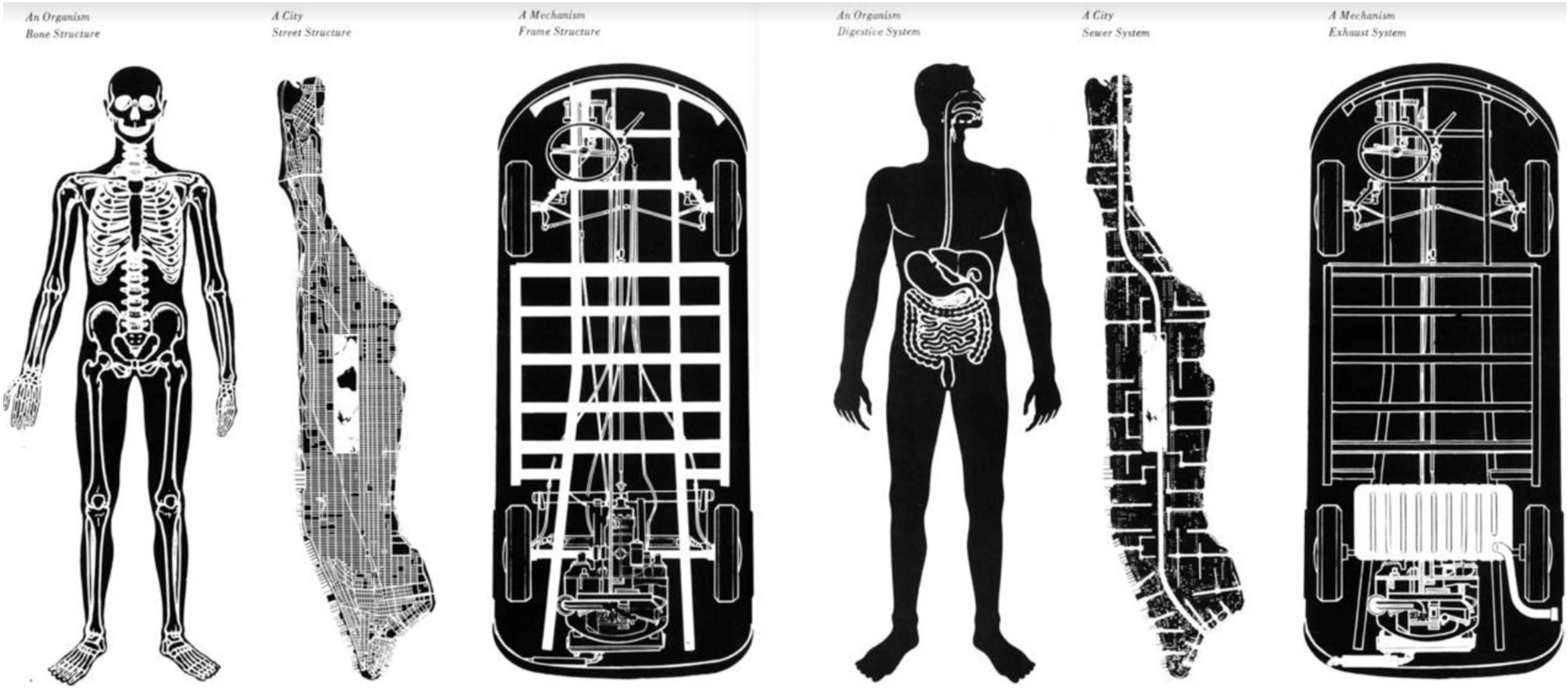
mechanism : *movement*

We propose a building capable of **adapting across time through movement**. Spaces may re-arrange, react, depending on it needs. We unde-stand how its movement works, through interacting with its mech-anism.

X-RAY

x-ray : *components*

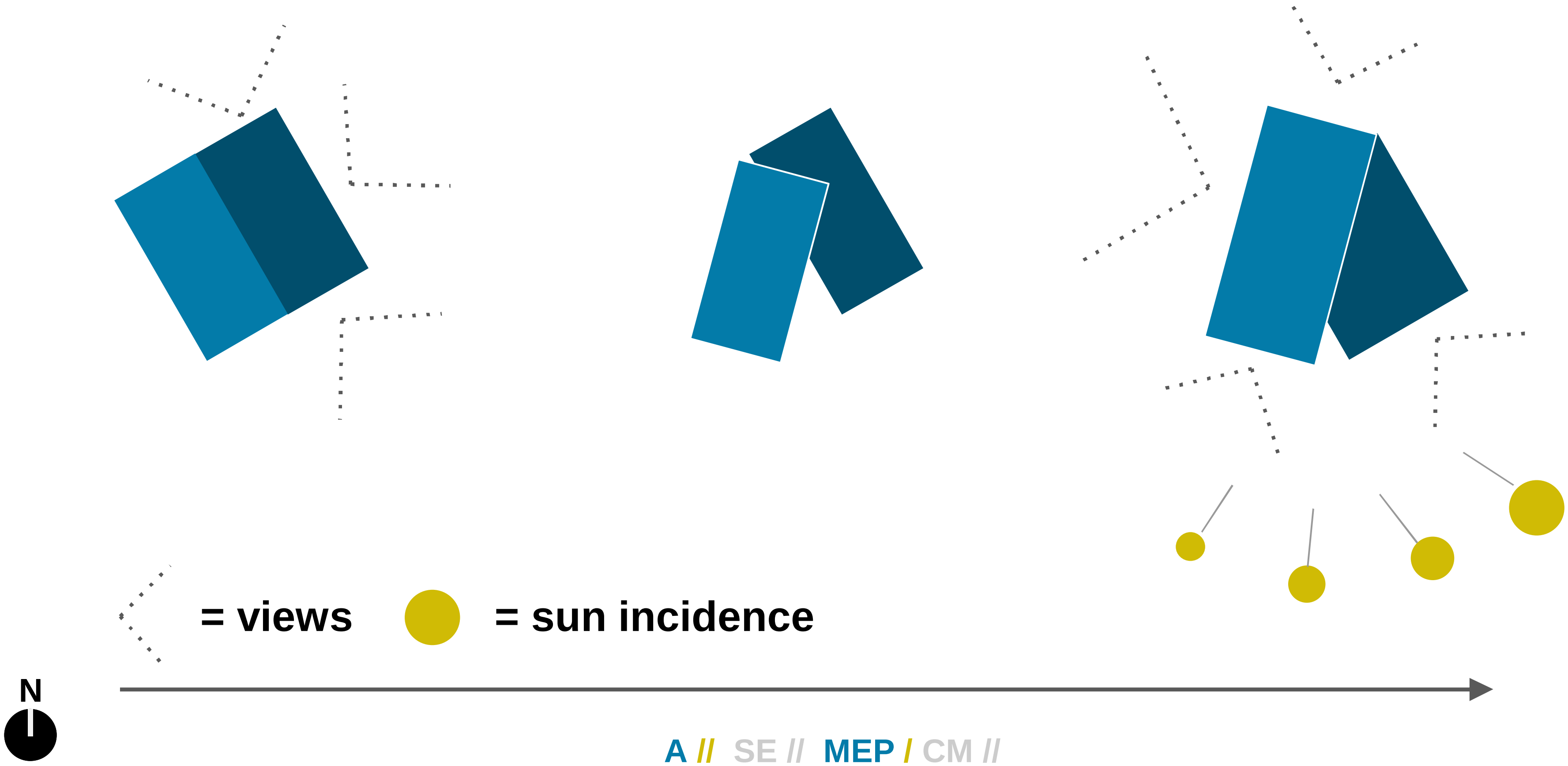
We propose a building capable of **changing perception across space, through exposure**. Spaces may pro-vide visual opacities, building's data, depending on its needs. We undestand how its com-ponets work, through interacting with its "x-ray".



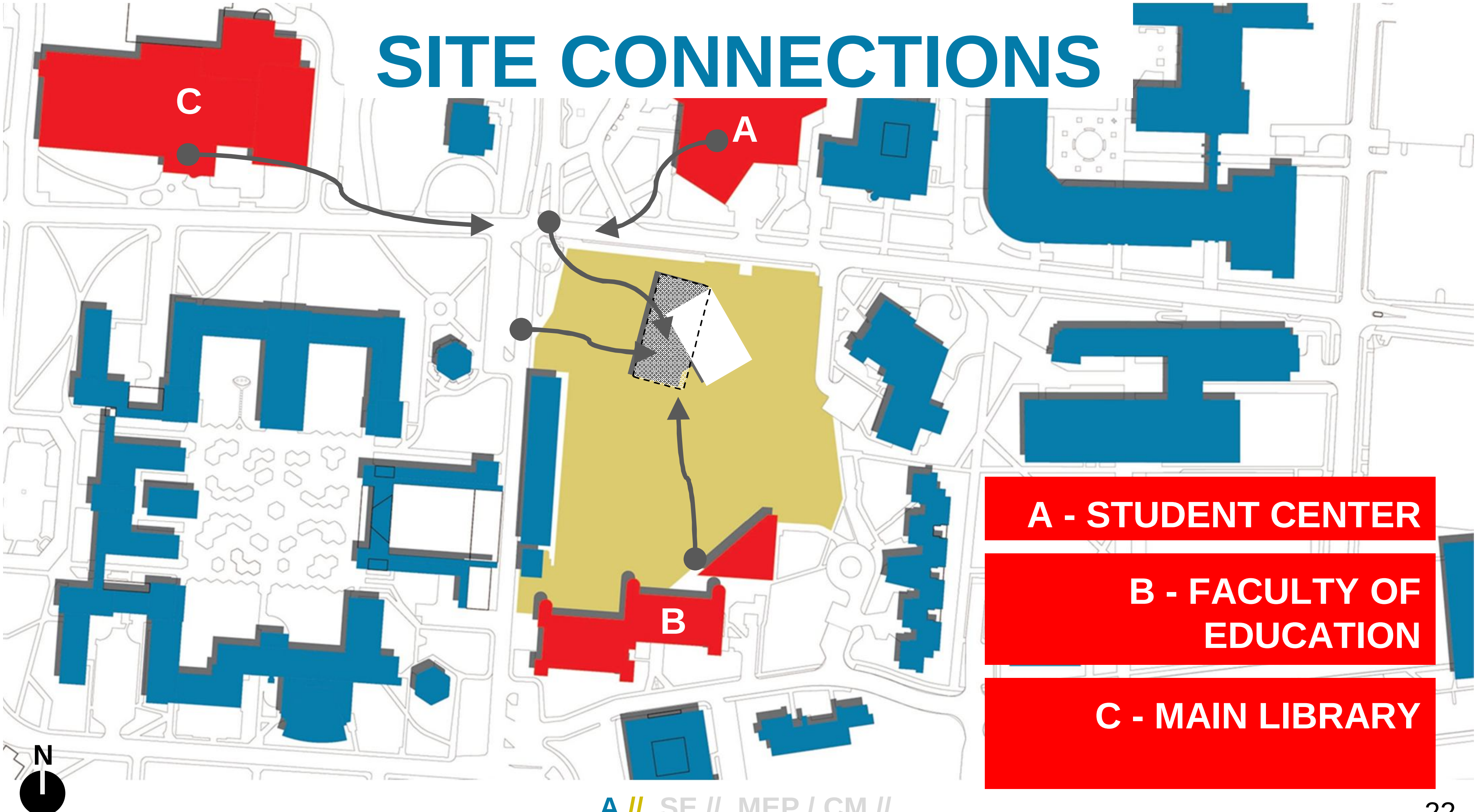
O. M Ungers, morphology: City, metaphors, Walther King Cologne, 2011

MECHANISM

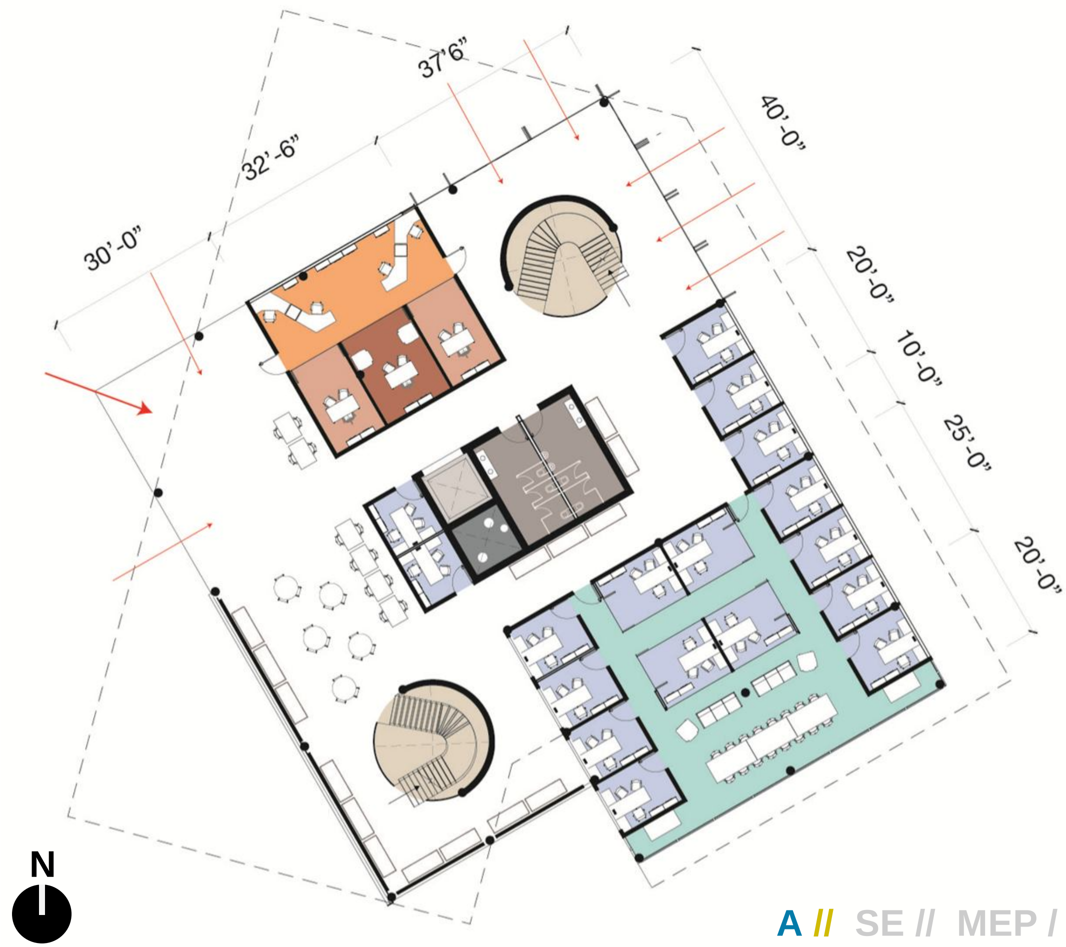
FORM TRANSFORMATION



SITE CONNECTIONS

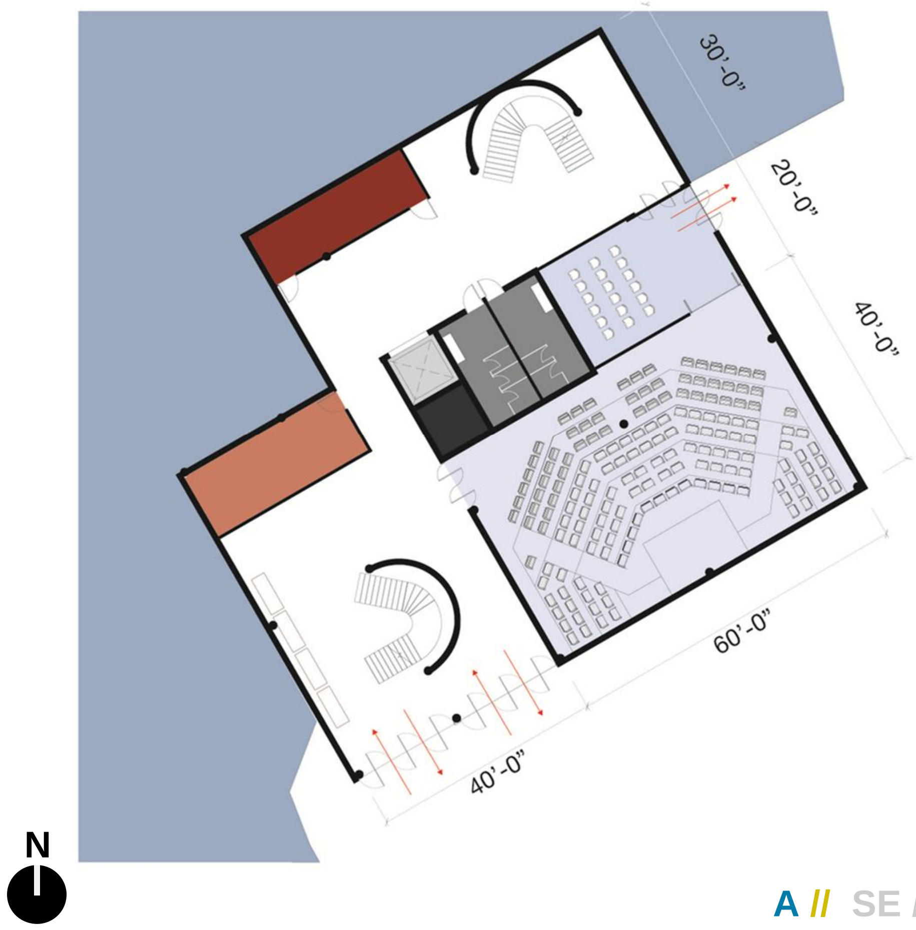


GROUND LEVEL



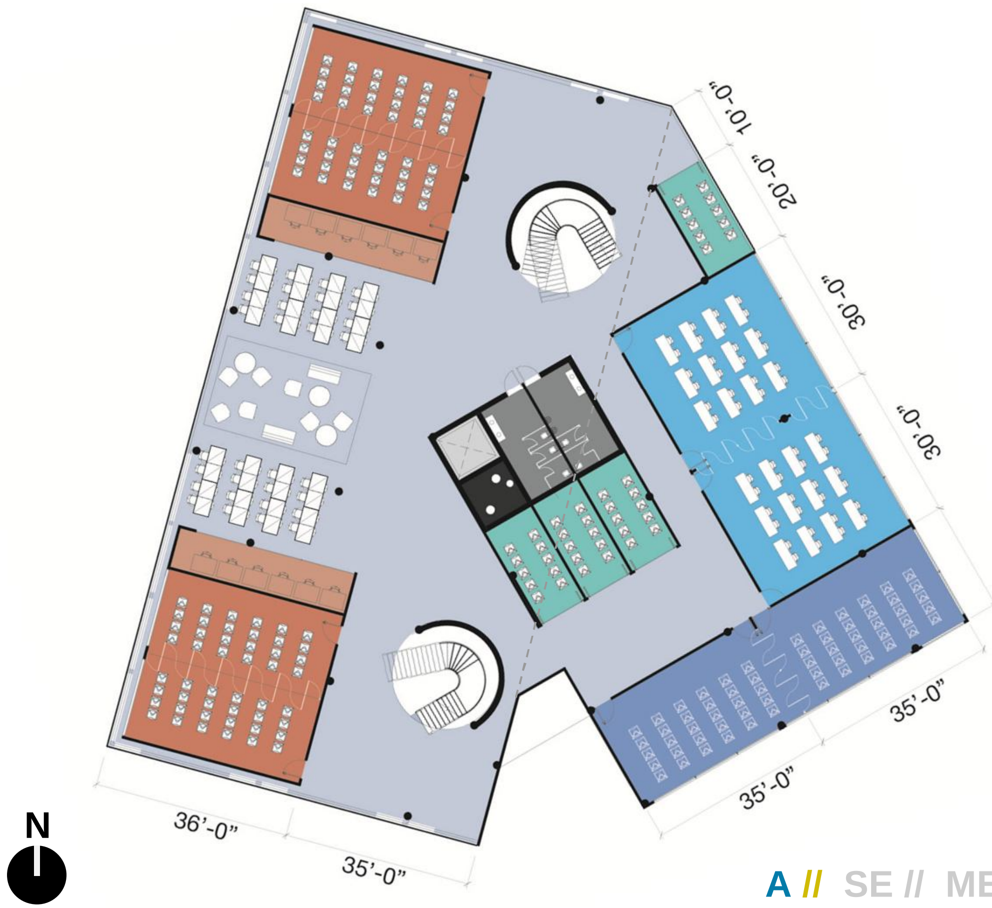
- Administrative Assistant Offices
- Senior Administrative Offices
- Department's Chair Office
- Elevator
- Bathrooms
- Mechanical Shaft
- Faculty Lounge
- Faculty Offices

BASEMENT



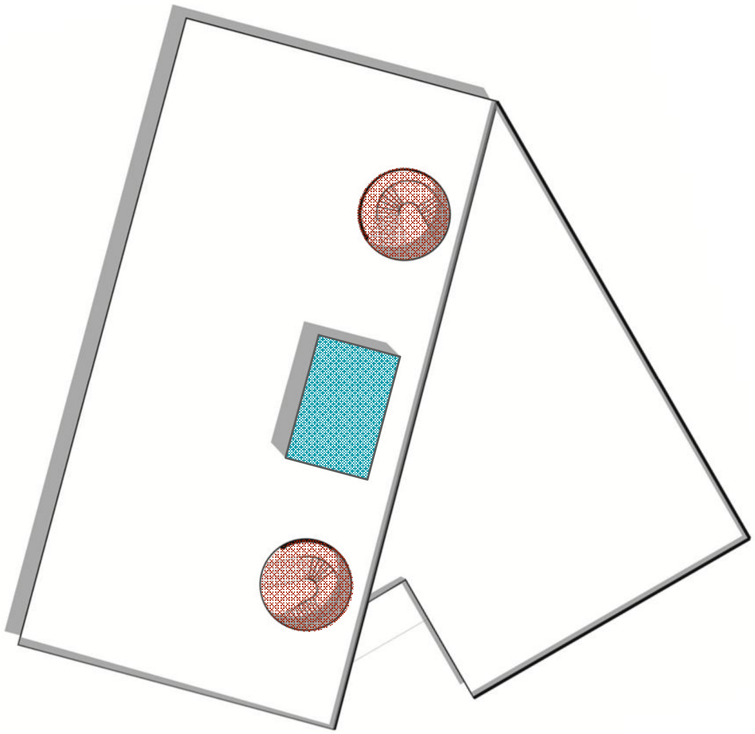
- Food Rental
- Storage
- Elevator
- Bathrooms
- Mechanical Shaft
- Auditorium

1ST LEVEL



- Small Classrooms
- Individual Student Offices
- Elevator
- Bathrooms
- Mechanical Shaft
- Seminar Rooms
- Instructional Labs
- Common Areas + Student Collaboration Offices
- Large Classrooms

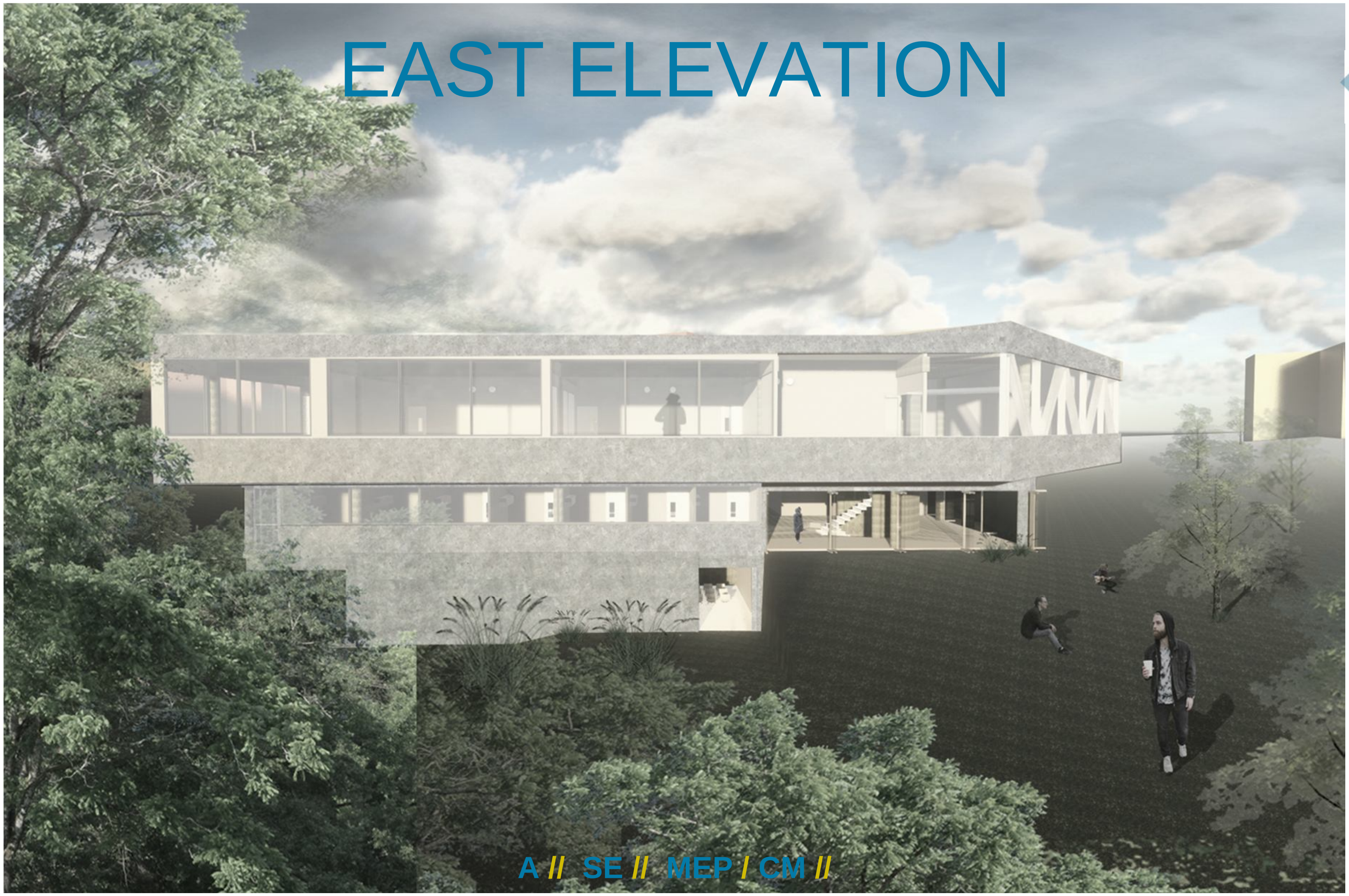
ROOF PLAN



Mechanical Room

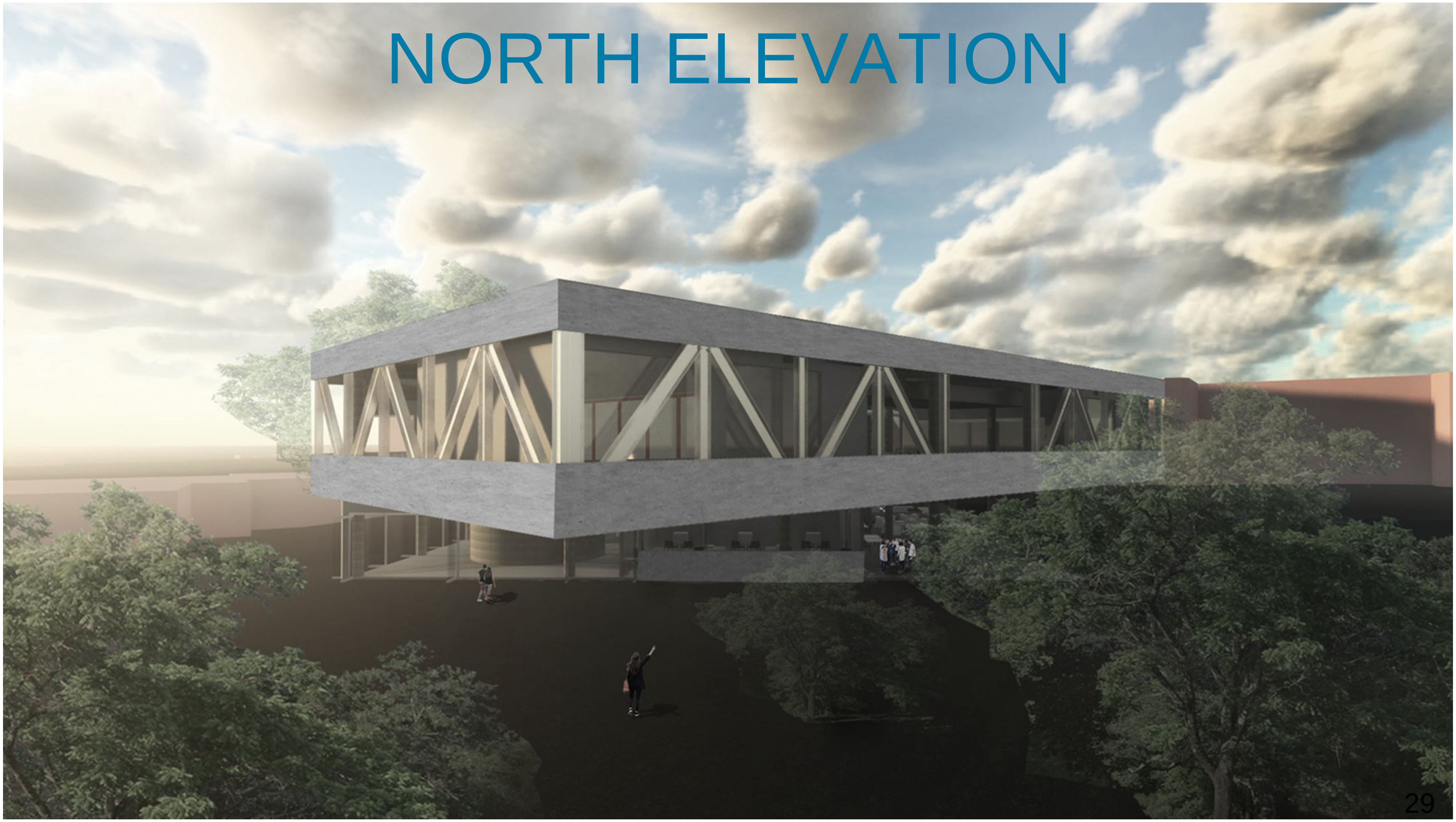
Vertical Circulation

EAST ELEVATION

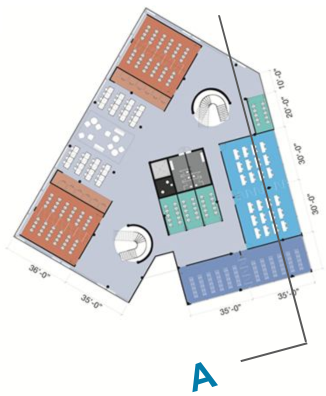


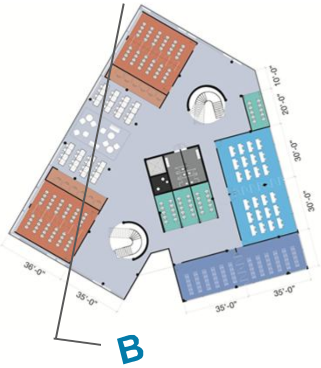
SOUTH WEST ELEVATION

NORTH ELEVATION



SECTION A

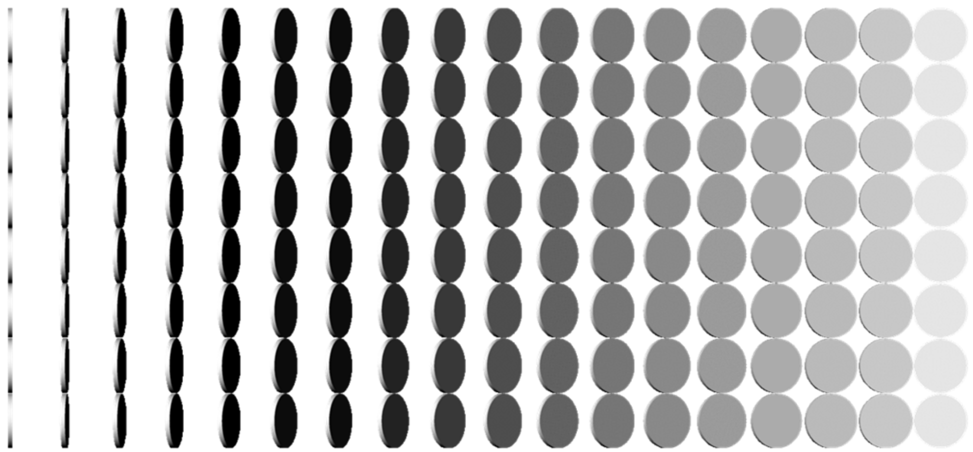




SECTION B

NOT TO SCALE

FACADE SYSTEM DEVELOPMENT



Rotation by reaction of sun and wind.

Sun protection; cross ventilation direction control.

FACADE DEVELOPMENT

BUILDING LOADS

Gravity Loads

Occupancy or Use	Uniform Load [psf]
Classrooms	40
Offices	50
Lobbies, Stairs, Corridors	100
Labs	200
Auditorium	100
Roof (Rooftop Garden)	30
Storage	250

From ASCE 7-10

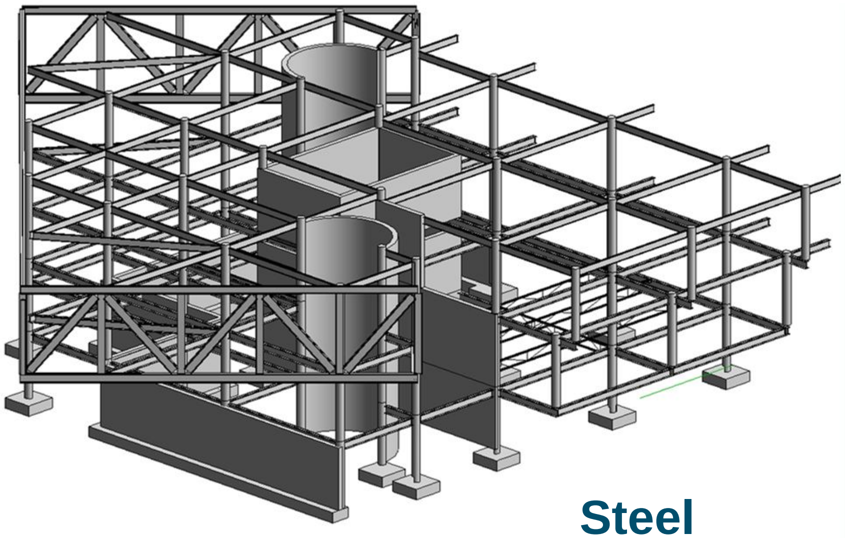
Lateral Loads

Wind Base Shear: 120 kips

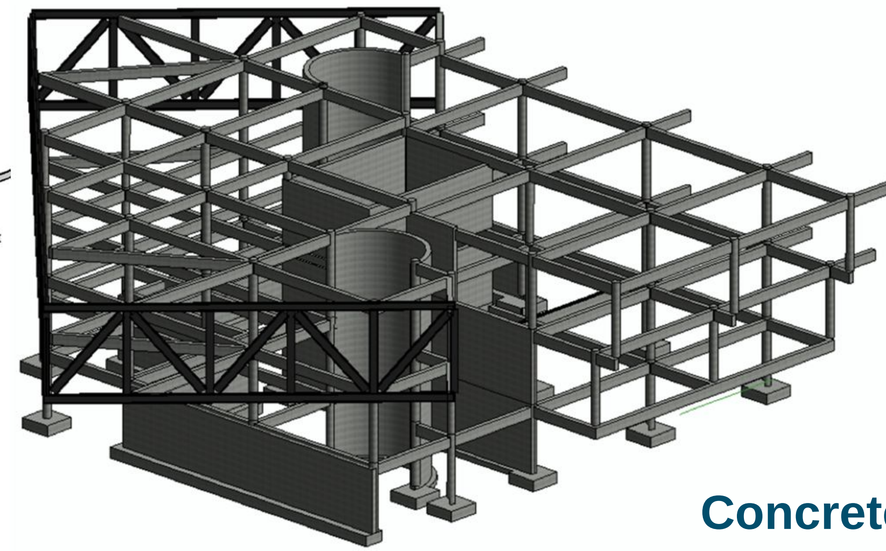
Seismic Base Shear: 460 kips

2 Here shows the building loads that we need to consider for our site.
All the gravity loads are from ASCE 7-10.
For the lateral loads, the wind base shear is 120 kips, and the seismic base shear is 460 kips.
Yunqian Cai, 3/15/2017

MECHANISM STRUCTURAL OPTIONS



Steel



Concrete

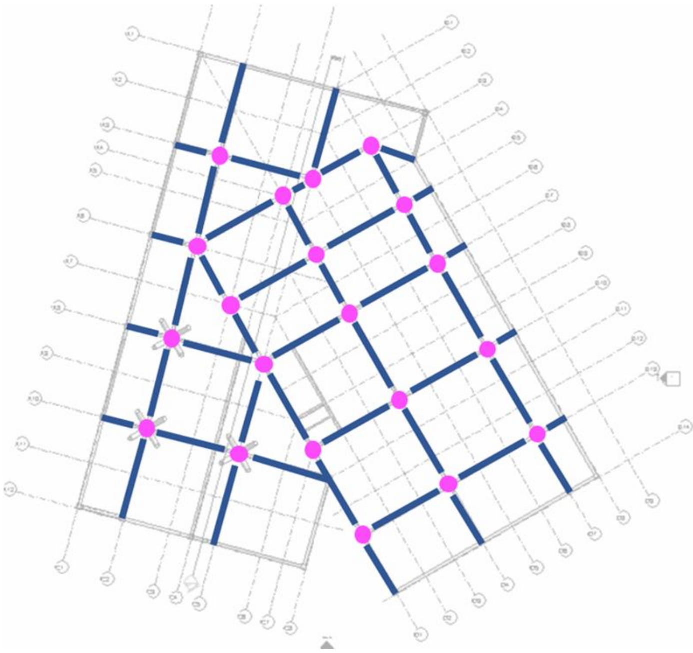
	Steel	Concrete
Lateral Resisting System	Shear wall core + super truss	Shear wall core + super truss
Cantilever Solution	Super truss + Steel beams	Super truss + PT Slab

Slide 35

3 In this slide we are showing the 3D view of the 2 structural design options for the Mechanism building. For this building, our major challenges include protecting the building from natural disasters like earthquakes and hurricanes, and also, we need to find a best solution to anchor the large cantilever on the upper floor. For both the steel and concrete design options, the lateral resisting system to resist wind load and seismic load is shear wall core, circular shear walls and super truss. To solve the cantilever problem, in the steel design we used super truss and steel beams. and in the concrete design we use post-tension slab to provide extra support.

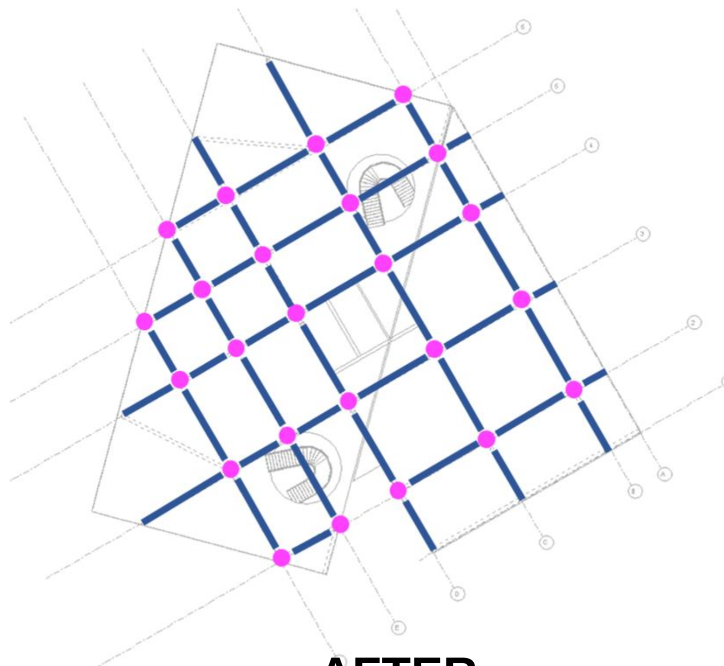
Yunqian Cai, 3/17/2017

EVOLUTION OF GRIDS



BEFORE

Beams oriented based on building shape



AFTER

Beams oriented in one direction

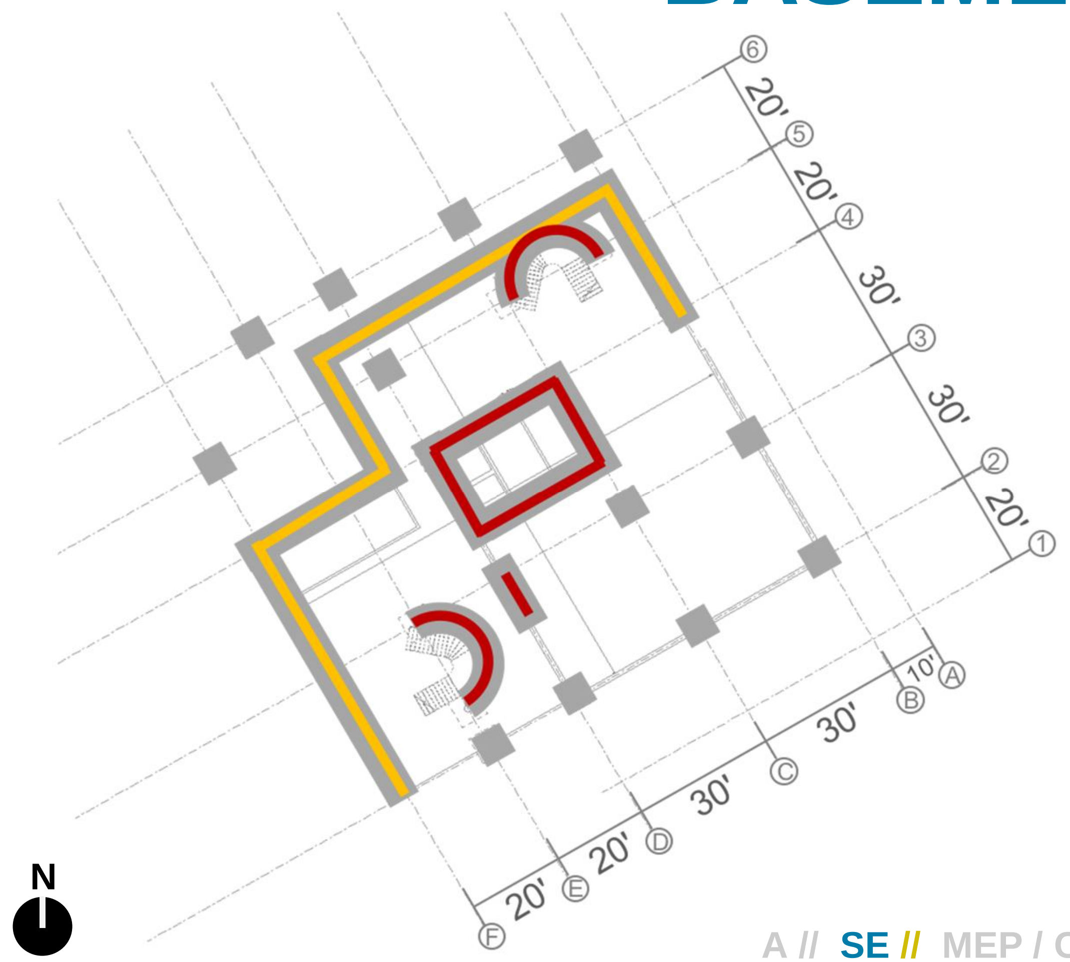
N

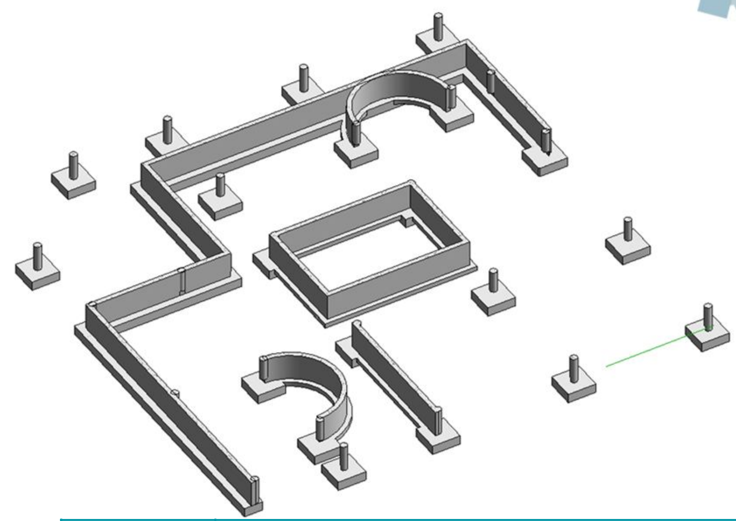
Slide 36

4 In our preliminary design, we decided to orient the beams to fit the orientation of the building. however, when we proceed the design, we found that this strategy caused a lot of problems in column placement and connections. it also makes the load path more complicated. therefore, we decided to rearrange the grid, and make all the beams in one direction, and in this way, we can place the columns continuously, and make the loads smoothly transfered to the ground.

Yunqian Cai, 3/17/2017

BASEMENT



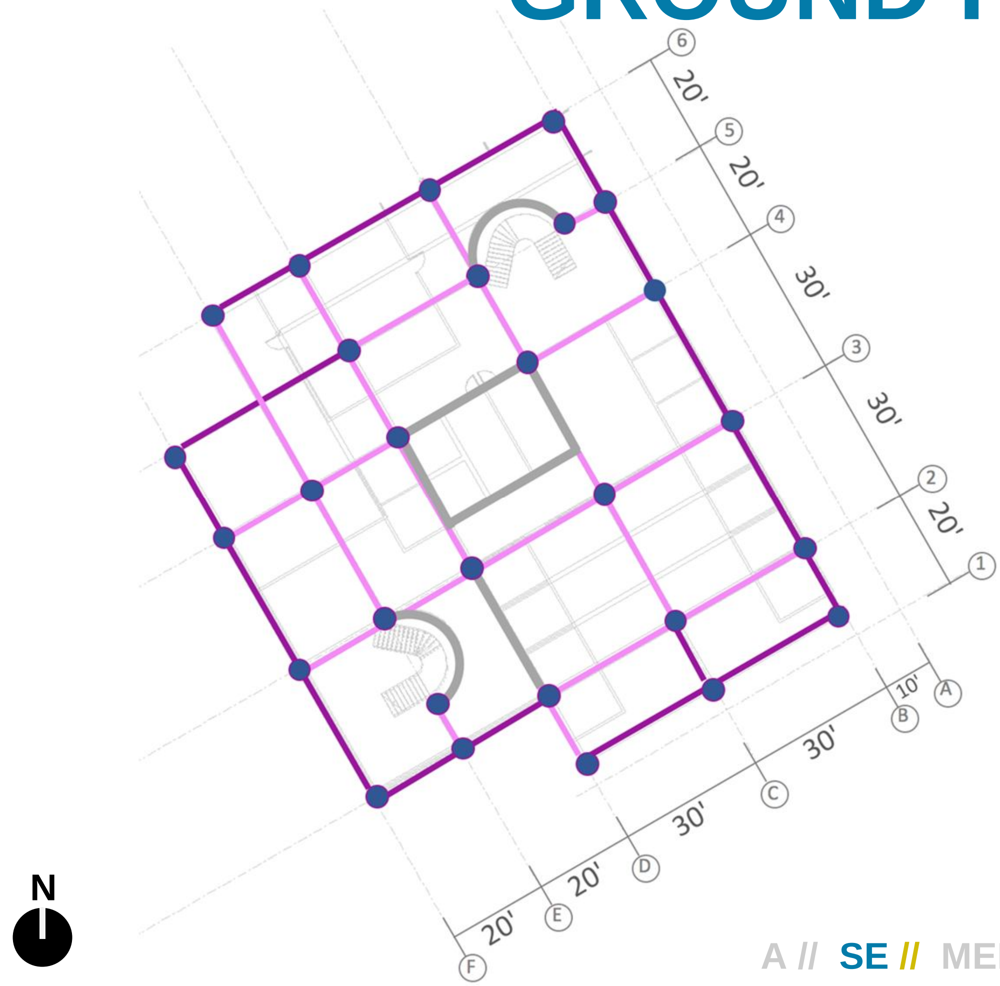


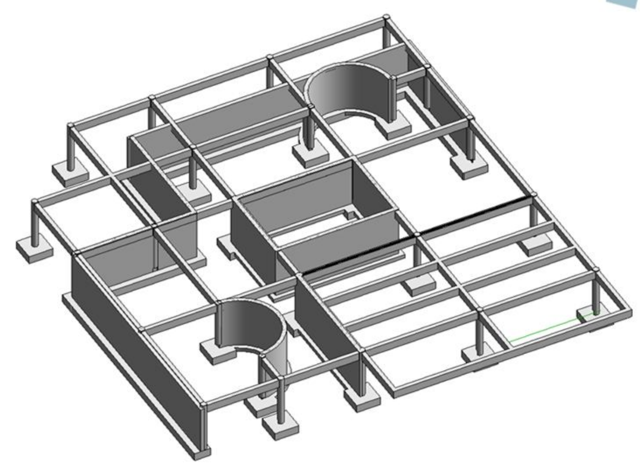
	Both Steel & Concrete Option
	Foundation System
	12” Retaining Wall
	12” Shear Wall

Slide 37

5 This is the floor plan for the basement of the mechanism. the basement design are the same for both concrete and steel options. the foundation system, retaining walls and shear walls are shown in the floor plan in different colors.
Yunqian Cai, 3/17/2017

GROUND FLOOR





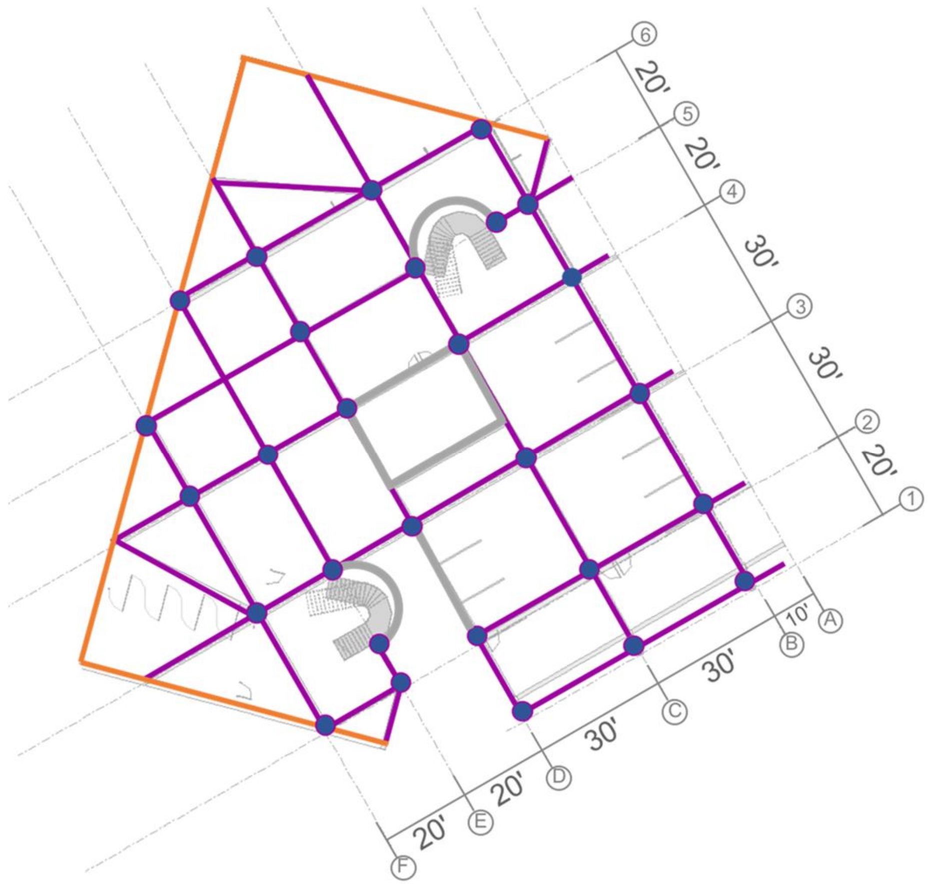
	Steel	Concrete
●	Concrete Round Column, ϕ = 18”	
(dark purple line)	W16 x 67	12x24 Concrete Beam
(pink line)	W16 x 77	12x24 Concrete Beam
(grey bar)	Shear Wall	

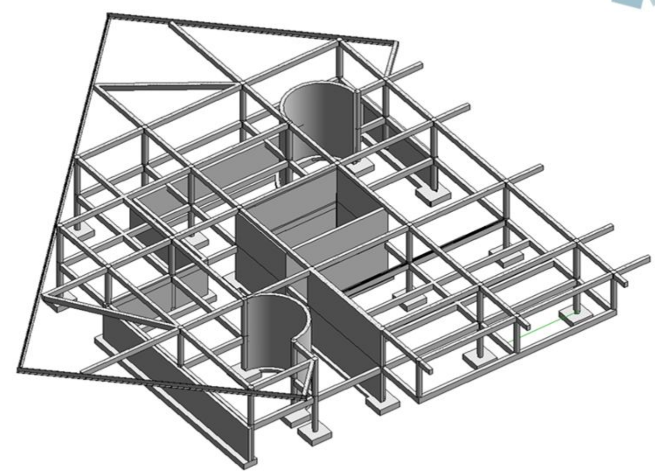
Slide 38

6 For the ground floor, in both concrete and steel options, we are using 18" diameter concrete columns. In the steel option, the exterior girders are W16x67 and the interior girders are W16x77 sections. in the concrete option, we are using 12x20 and 12x24 concrete beams.

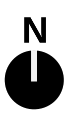
Yunqian Cai, 3/17/2017

FIRST FLOOR & ROOF





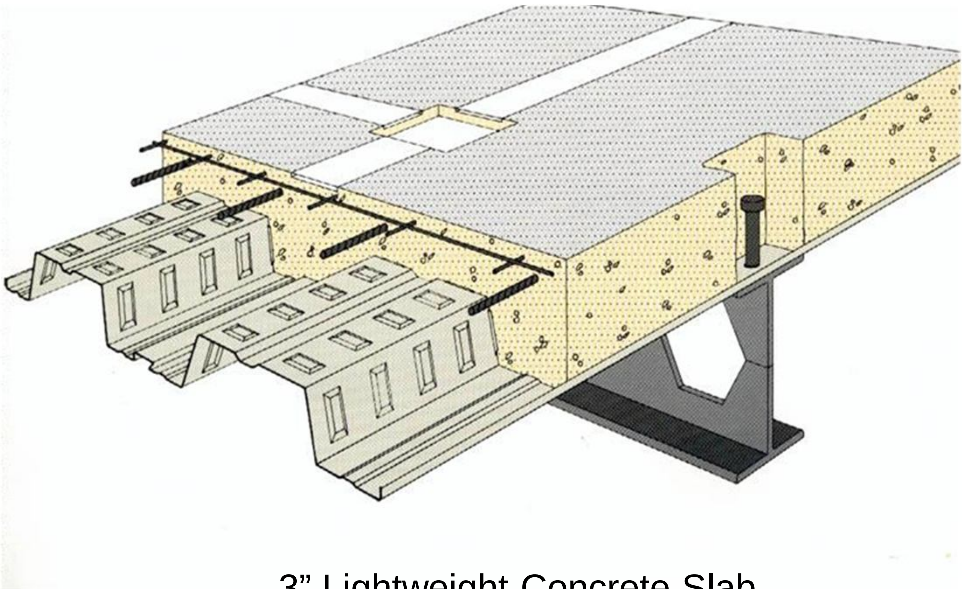
	Steel	Concrete
	Concrete Round Column, ϕ = 18”	
	Super Truss	
	W16 x 67	12x24 Concrete Beam
	Shear Wall	



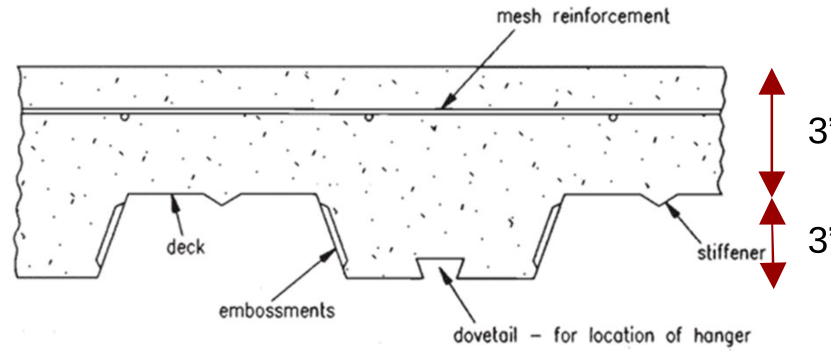
7 For the 1st floor and roof, we are using story height supper trusses to support the large cantilevers on the left part. in the steel option, the girders are W16x67 sections, and in the concrete design, the beams are 12x24 inches

Yunqian Cai, 3/15/2017

SLAB DESIGN - STEEL



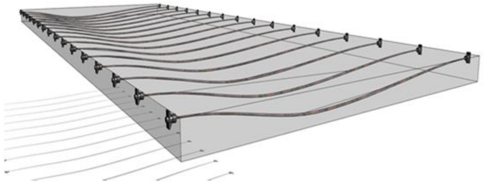
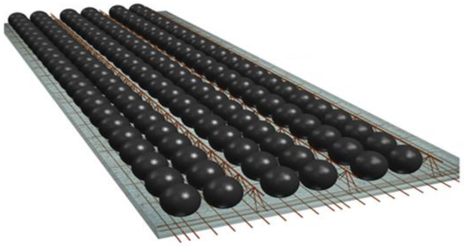
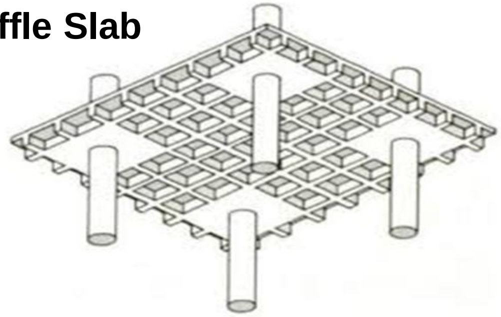
3” Lightweight Concrete Slab
3” steel deck



Slide 40

8 The floor system for the steel design is a composite floor with 3" lightweight concrete slab on 3" steel deck. this composite deck provide s adequate support and also have a good control in fire rating.
Yunqian Cai, 3/17/2017

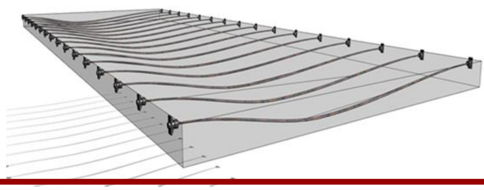
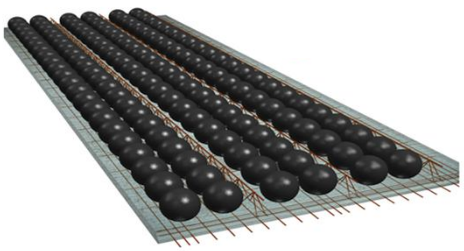
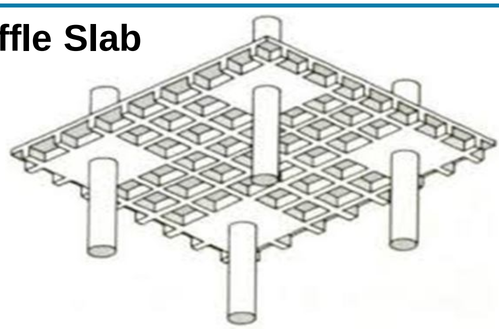
SLAB DESIGN - CONCRETE

	Pros	Cons
Post-Tension Slab 	• Great in supporting cantilever • Resists cracking & heaving • Extremely durable • Lower maintenance costs	• Require more resources of materials and labor
Air-Bubble Slab 	• Lighter weight • Less deflection for long spans	• May need larger slab thickness
Waffle Slab 	• Savings on weight and materials • Less deflection for long spans	• May control the fire rating • Requires special or proprietary formwork • Greater floor height

9 for the concrete design option, we compared different floor systems: post-tension slab, air-bubble slab, and waffle slab. All the three types of slabs have great performance in long span, which is good to support the auditorium floor and the cantilevers. however, each type of slabs has its own weaknesses.

Yunqian Cai, 3/17/2017

SLAB DESIGN - CONCRETE

	Pros	Cons
Post-Tension Slab 	• Longer life expectancy • Resists cracking & heaving • Extremely durable • Lower maintenance costs	• Require more resources of materials and labor WINNER!
Air-Bubble Slab 	• Lighter weight • Less deflection for long spans	• May need larger slab thickness
Waffle Slab 	• Savings on weight and materials • Long spans	• May control the fire rating • Requires special or proprietary formwork • Greater floor height

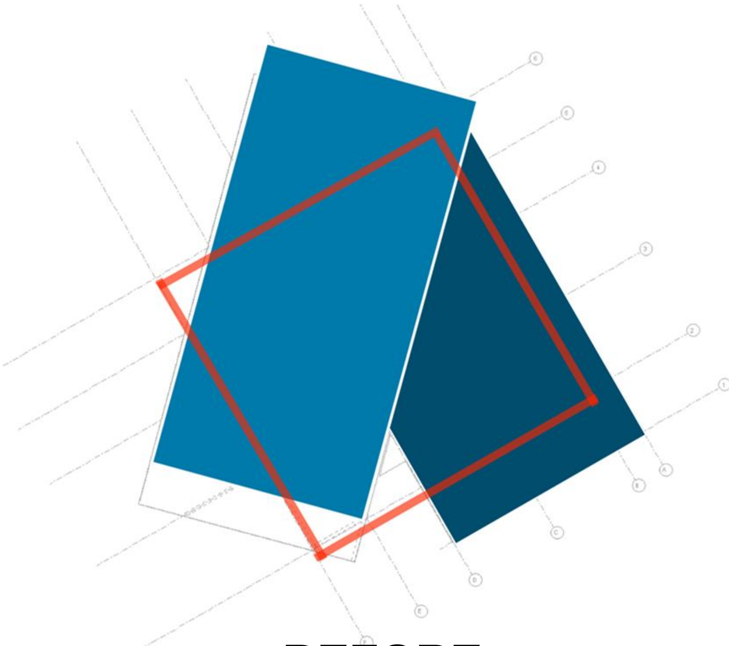
11 _Marked as resolved_
Yunqian Cai, 3/17/2017

12 _Re-opened_
Yunqian Cai, 3/17/2017

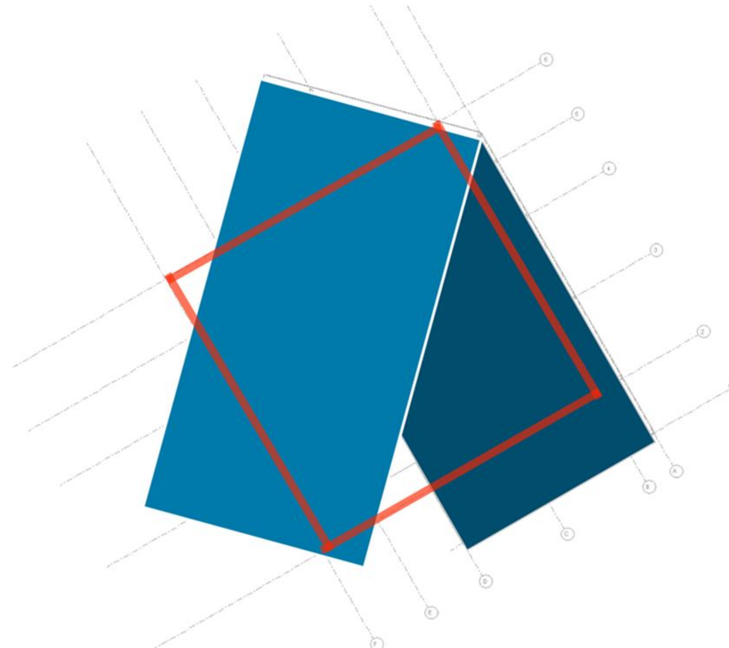
10 Therefore, to consider all the advantages and disadvantages of these 3 types of slab, we determined to use post-tension slab for our concrete design option because we want to provide more reinforcement to our cantilevers. And post-tension slab served as a good floor system to control the deflections and cracking in longer spans.
Yunqian Cai, 3/17/2017

ARCHITECTURAL CHANGE

Triggered by Structural Engineers



BEFORE



AFTER

N

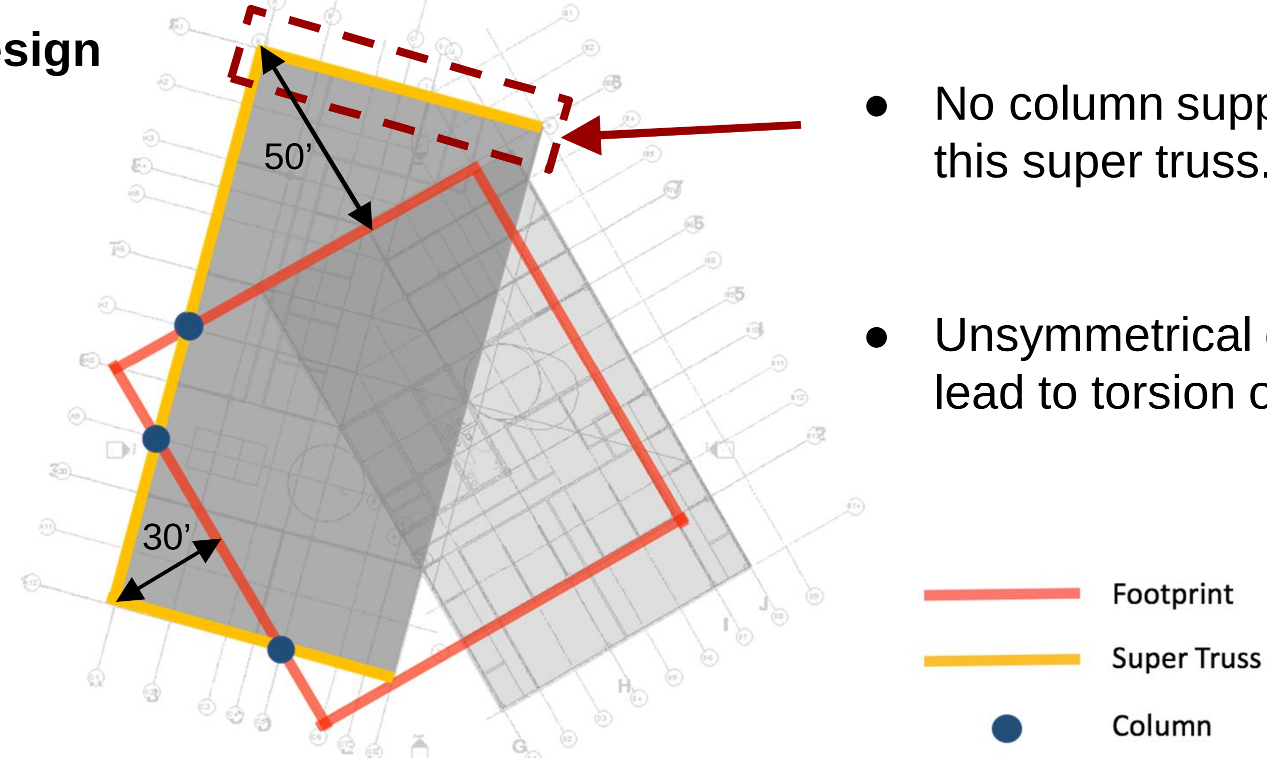
Slide 43

13 in the concept development process, the architects and the structural engineers worked closely and we affected the designs of each other. here is an example of the architectural design change triggered by structural engineers.
we can see the before and after of the building shape. the entire left portion of the building was shifted lower a little bit, to make the cantilevers balanced and all sitting on columns. we can have a closer look on the next slide.
Yunqian Cai, 3/17/2017

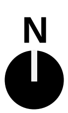
ARCHITECTURAL CHANGE

Triggered by Structural Engineers

Original Design



- No column support for this super truss.
- Unsymmetrical cantilevers lead to torsion of the building.

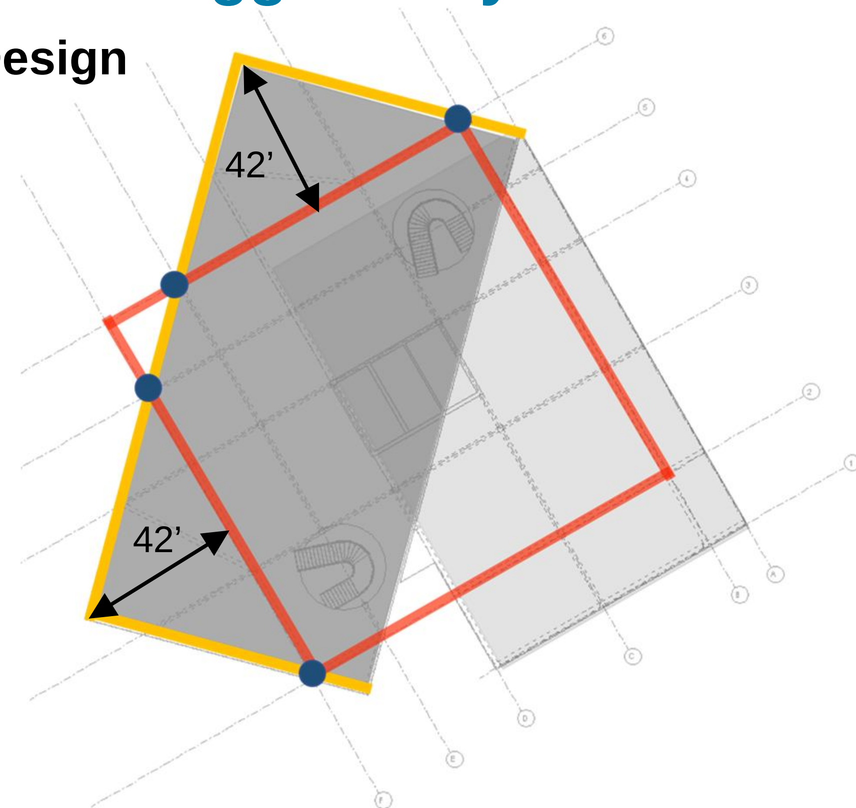


14 in the original design, we have 2 unbalanced triangular cantilevers on the left portion of the first floor, one is 50 ft long, and the other is 30 ft. We first determined that we are going to use super trusses to support the entire cantilever. However, this unsymmetrical cantilever design will lead to unbalanced gravity loads on both side, which will lead to torsion of the building.
Additionally, one serious problem is that there is no column support on one side of the cantilever, as pointed by the arrow. which makes the cantilever portion too long to control.
Yunqian Cai, 3/17/2017

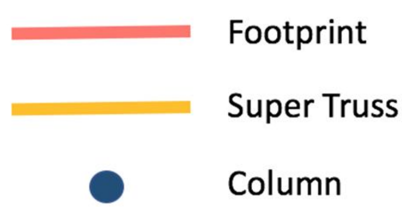
ARCHITECTURAL CHANGE

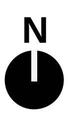
Triggered by Structural Engineers

Revised Design



- All super trusses are column-supported.
- Symmetrical cantilevers give a balanced gravity load.



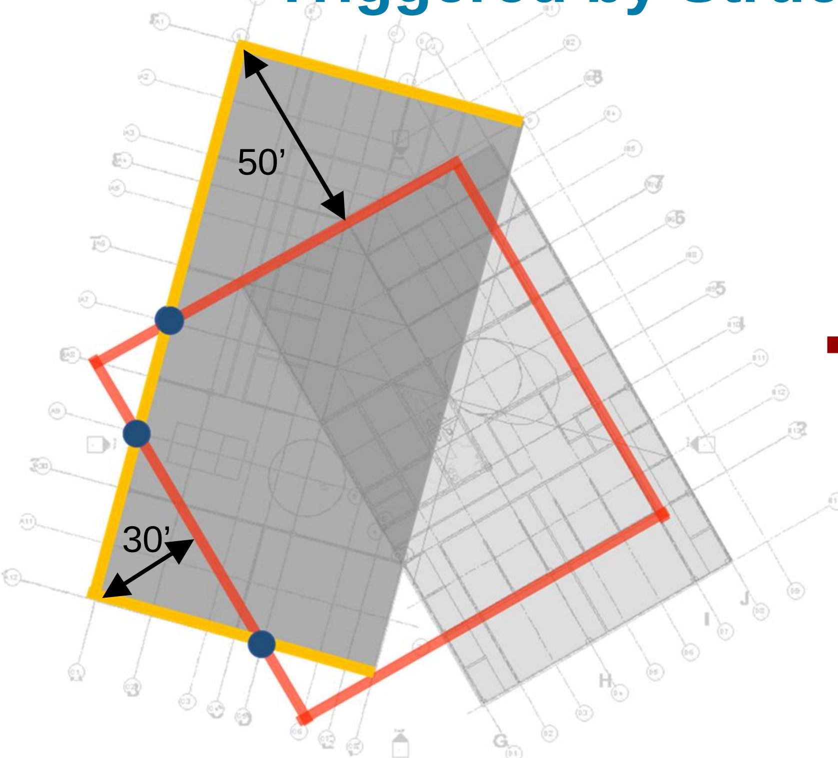


15 Therefore, the architects and the structural engineers sit together, and came up with a revised design. in this new design, the left cantilever portion was shifted downward to make sure that all the three sides are sitting on columns. and also it created a symmetrical double cantilever, which has 42 ft long on both side. the symmetrical shape helps the gravity load to be balanced, and the 4 columns shown in blue dots will help support the cantilevers.

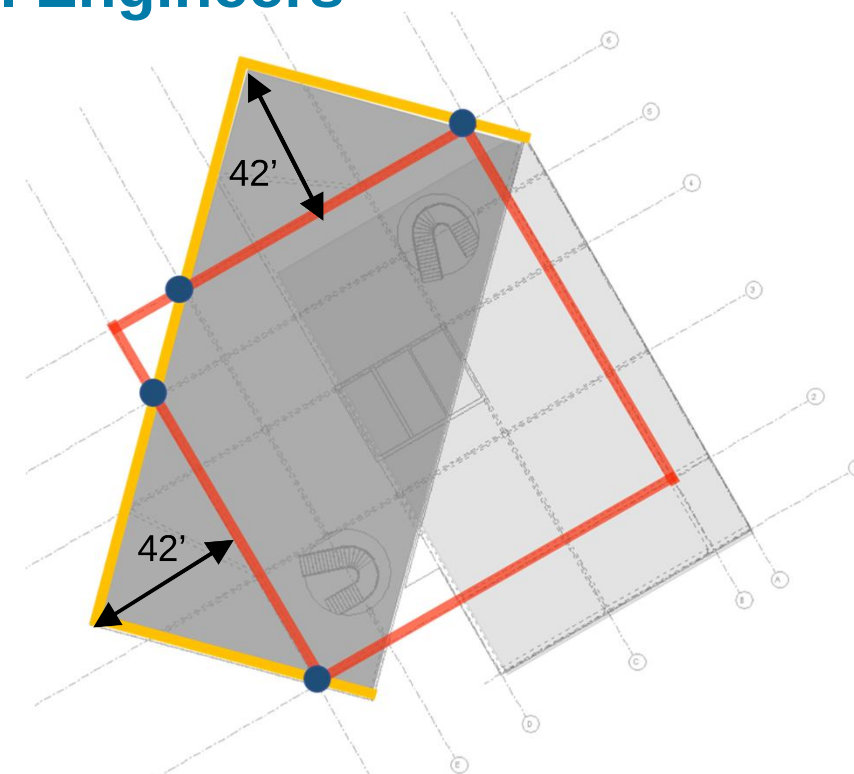
Yunqian Cai, 3/17/2017

ARCHITECTURAL CHANGE

Triggered by Structural Engineers



BEFORE



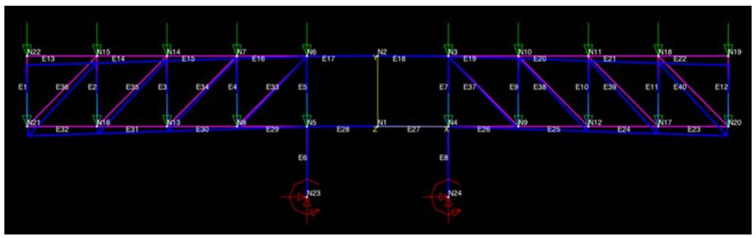
AFTER

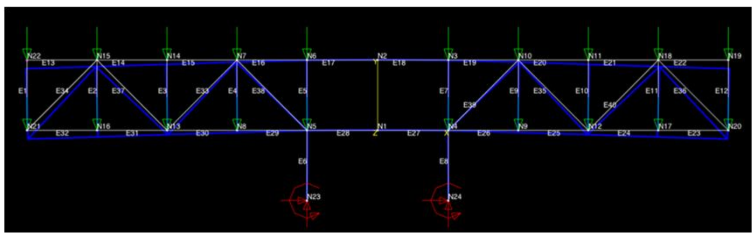
N

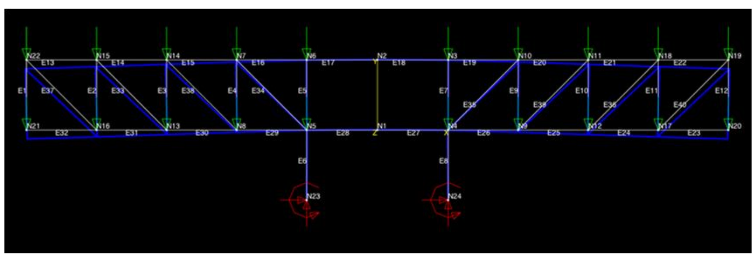
Slide 46

16 here is a comparison between the before and after of the cantilever design.
Yunqian Cai, 3/17/2017

SELECTION OF TRUSS DIAGONAL







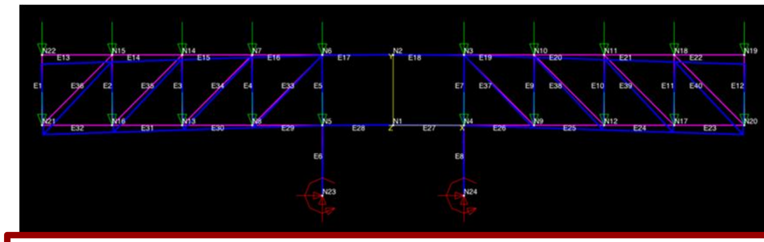
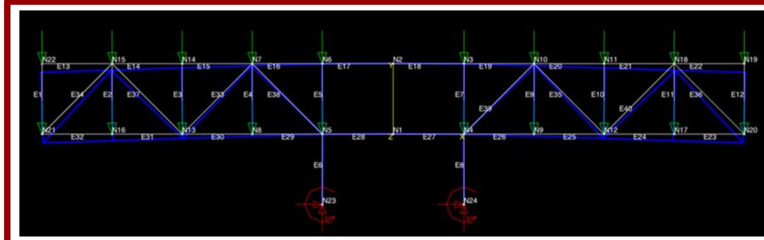
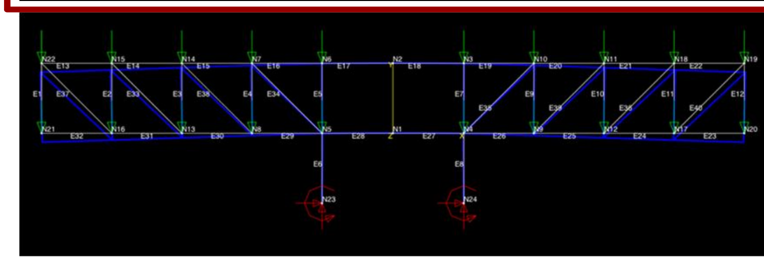
Pros	Cons
Steel has better performance in tension	Will lead to larger deflection
More architecturally aesthetic	
Compressive steel bracing: Better control of deflection	Steel may buckle in large compression, therefore may need larger section

Slide 47

17 After we determined our shape for the cantilever, we had a detailed design for the super truss selection. We created three diagonal orientations for the super truss and we built models to compare their performances under gravity load.

Yunqian Cai, 3/17/2017

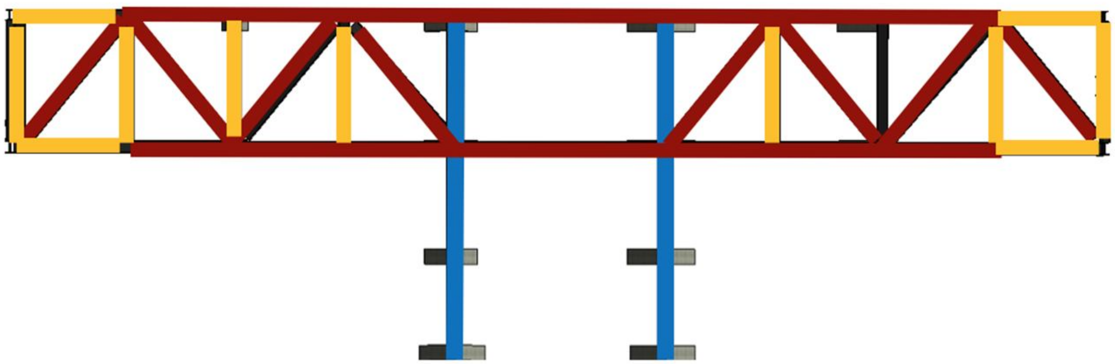
SELECTION OF TRUSS DIAGONAL

	Pros	Cons
	Steel has better performance in tension	Will lead to larger deflection
	More architecturally aesthetic	WINNER!
	Compressive steel bracing: Better control of deflection	Steel may buckle in large compression, therefore may need larger section

18 We checked the members' bending moment, axial load and deflections for these three orientations, and compared the results. since the cantilever is deflection controlled, and after talking with the architects, we chose the second design for the super truss because it is more architecturally aesthetic.

Yunqian Cai, 3/17/2017

DETAILED DESIGN OF TRUSS

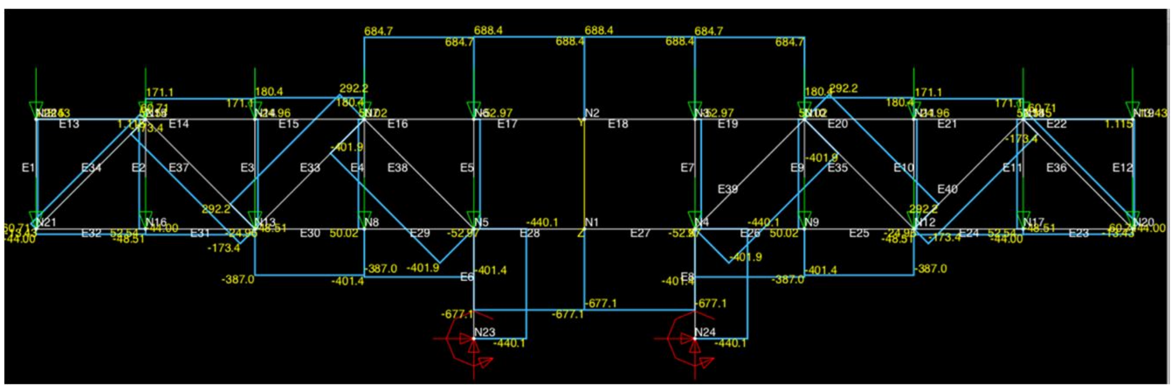


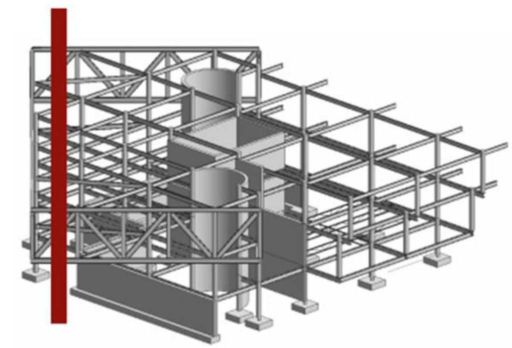
W18x60

W18x130

Concrete Round Column, d = 18"

MASTAN: Axial Load Diagram

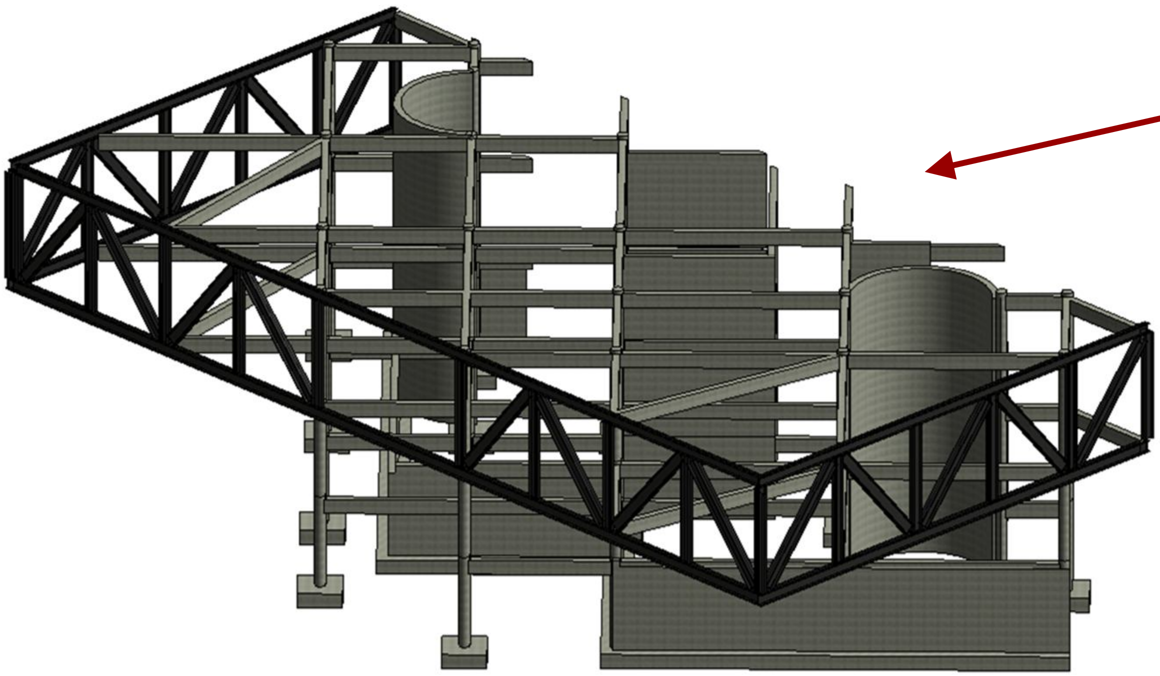


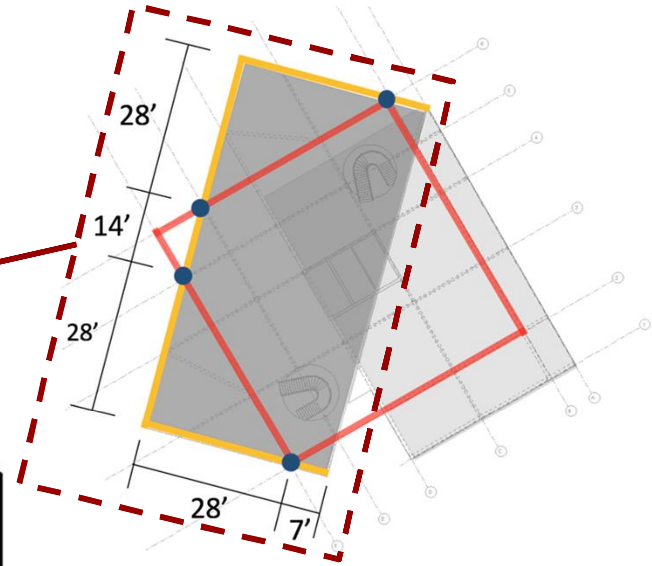


19 To determine the specific sizes of each members, we ran a MASTAN model to find the strength and serviceability of each member. We selected the member sizes shown in the color coding diagram.

Yunqian Cai, 3/17/2017

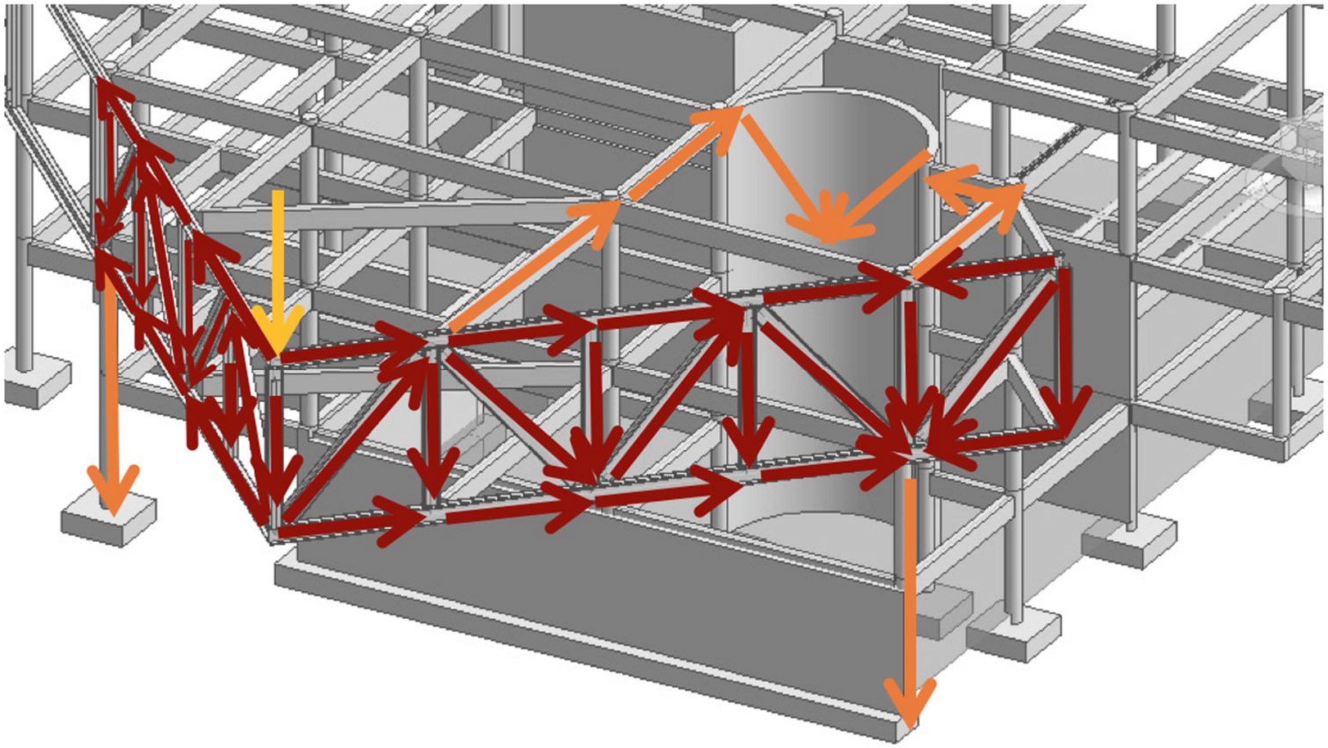
3D VIEW OF CANTILEVER





20 This is an entire 3D view of the cantilever super truss.
Yunqian Cai, 3/17/2017

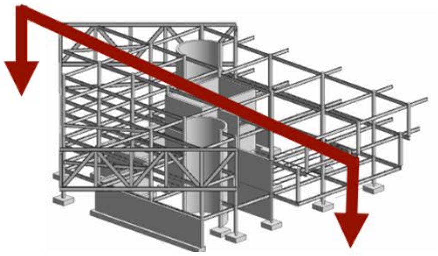
CANTILEVER LOAD PATH

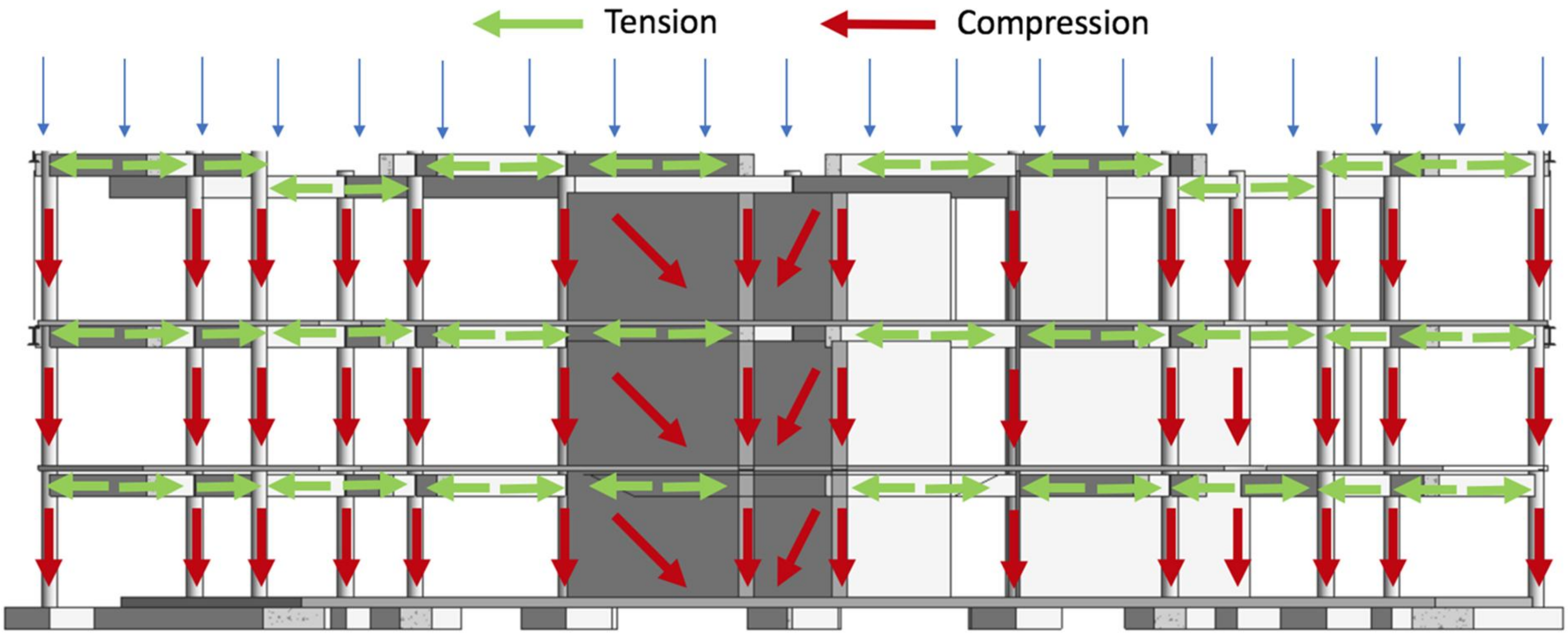


21 This is a load path for a force acting on the tip of the cantilever. Some of the loads will travel through the super truss and finally go to ground through the columns on both sides, and other loads will travel thru the beams to go to the shear wall.

Yunqian Cai, 3/17/2017

GRAVITY LOAD PATH



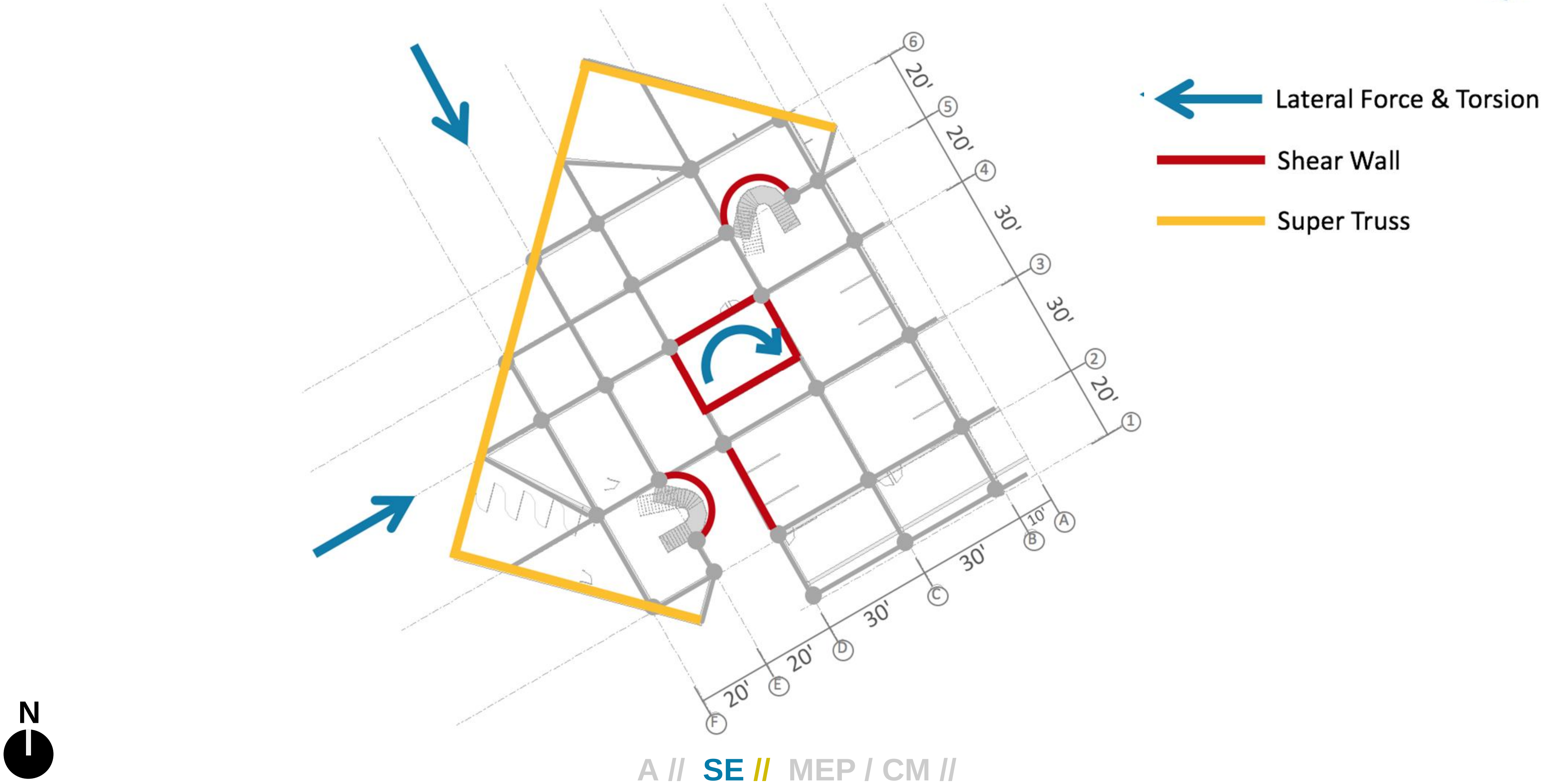


Slide 52

22 This shows the gravity load path of the building. gravity loads travel thru the floors to the beams, columns and shear walls and eventually go to ground.

Yunqian Cai, 3/17/2017

LATERAL RESISTING SYSTEM



Slide 53

23 One of our biggest structural challenge is earthquake. therefore, the major lateral resisting system for this building is shear walls and the super trusses. from this diagram we can see that the lateral loads and torsion can be resisted by the shear wall core, the circular shear wall, and the perimeter shear wall. The super truss also helps the lateral load resisting.

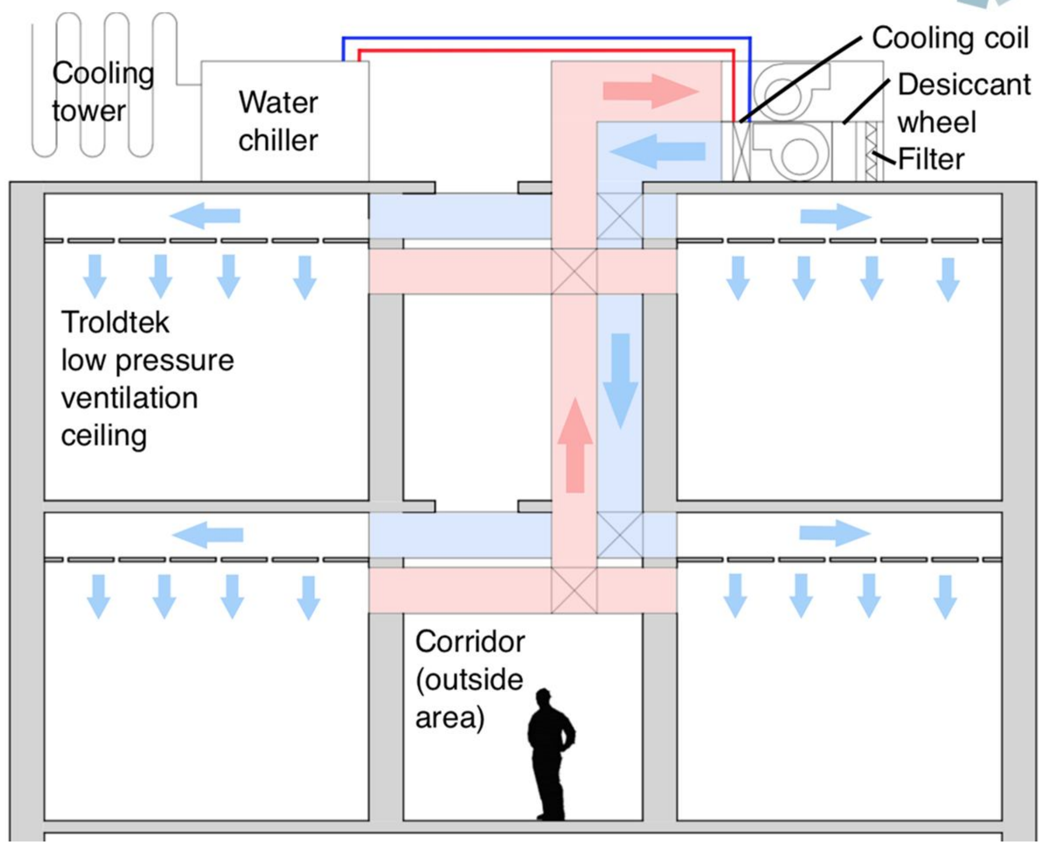
Yunqian Cai, 3/17/2017

PREVIOUS CONSIDERATIONS

MEP system	**Cons**
TABS	condensation, cooling capacity 40-50 W/m^2
Displacement Ventilation	3,5 m free height recommended, cooling capacity 30-40 W/m^2 due to temp. limitations
Geothermal	ground temp. is too high
Boiler	no heating system necessary
Chilled Beams	condensation
VRF	high pressure loss, limited cooling capacity
Mech. room basement	risk of flooding

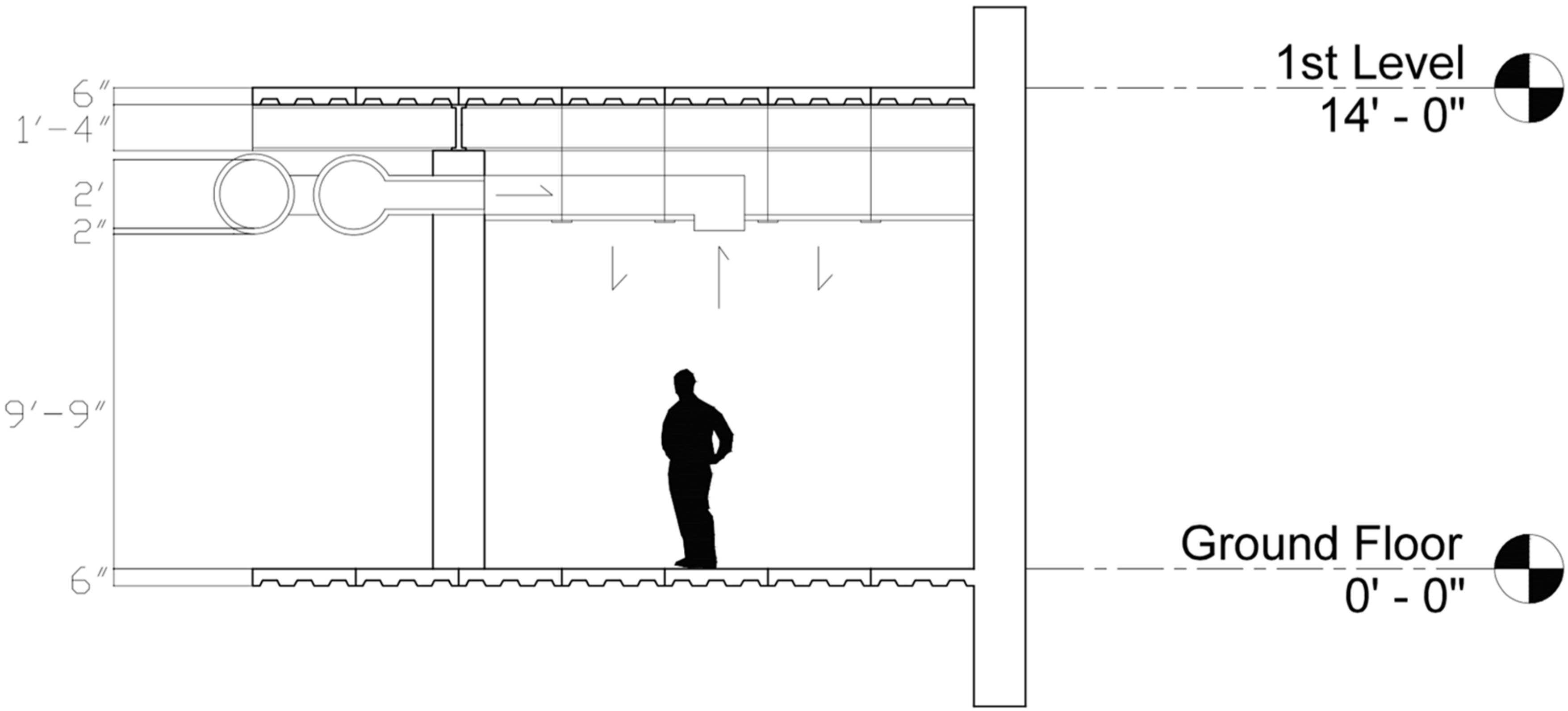
AHU AND WATER CHILLER

Primary system	Two AHU w. desiccant wheels Water chiller system w. cooling tower
Secondary system	Mechanical ventilation
Structural system	Steel

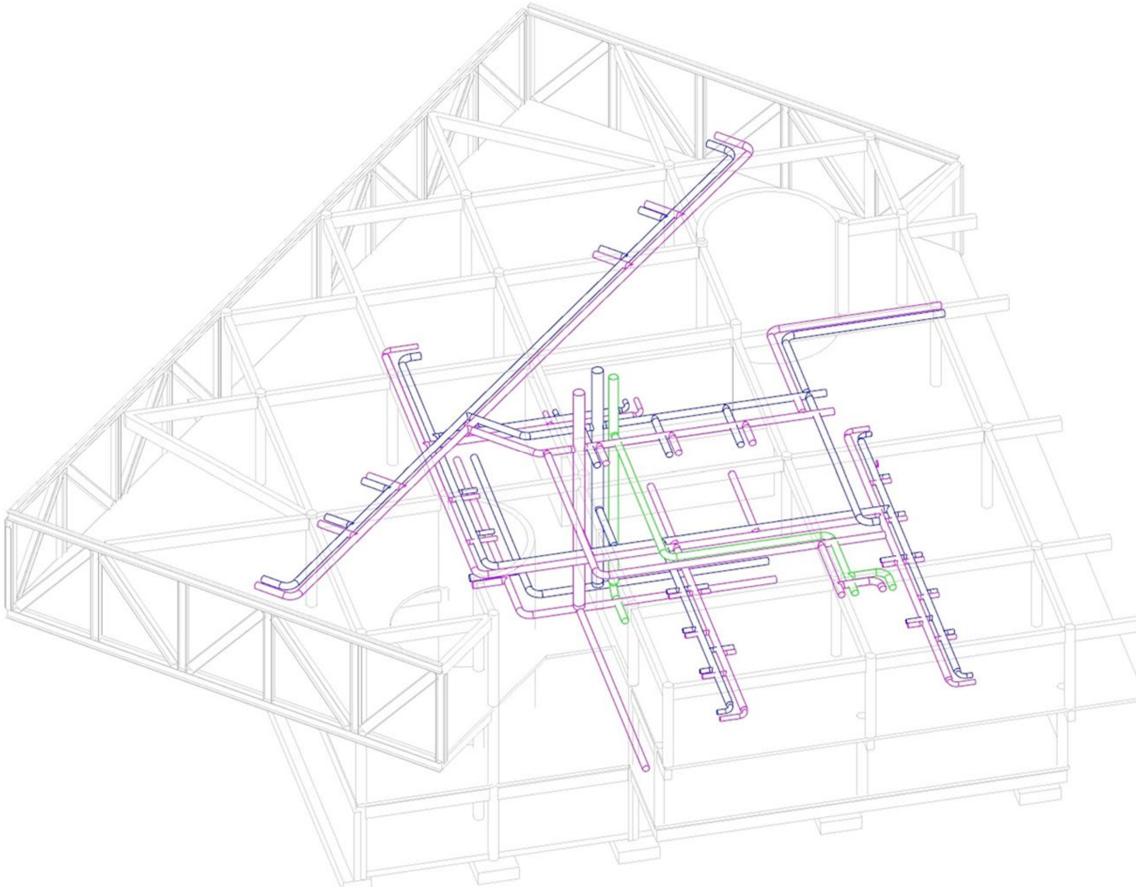


GROUND FLOOR

FLOOR SANDWICH

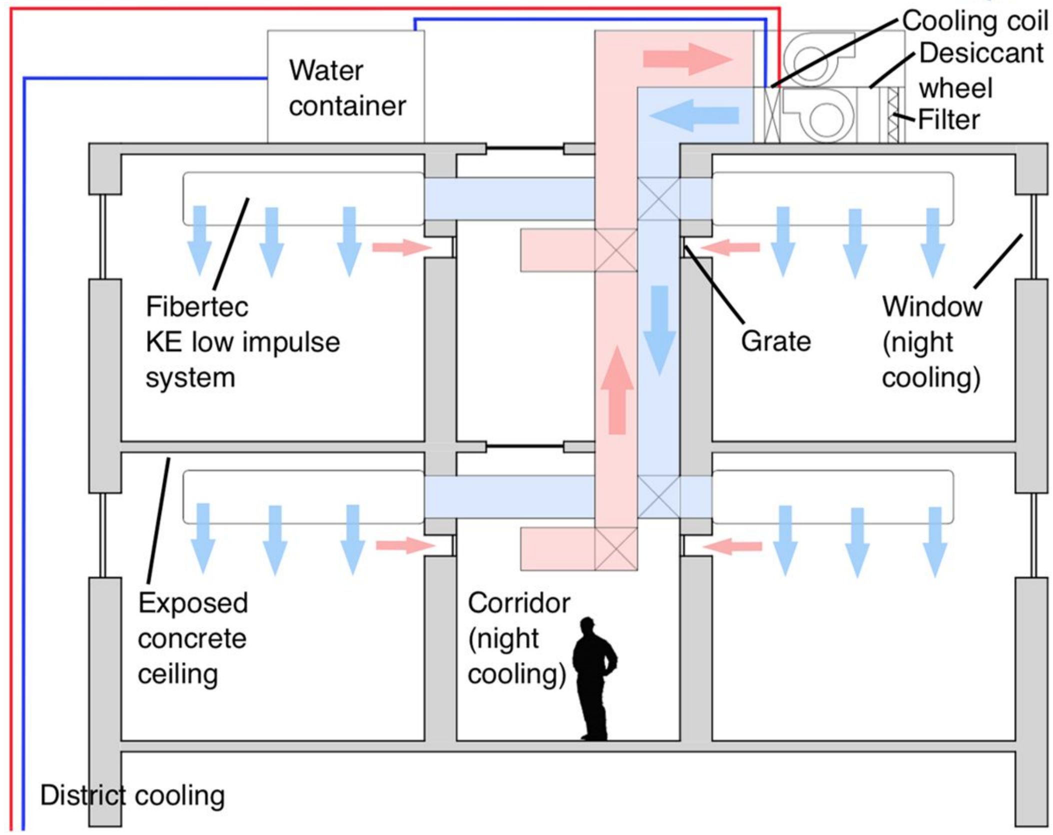


DISTRIBUTION TREE

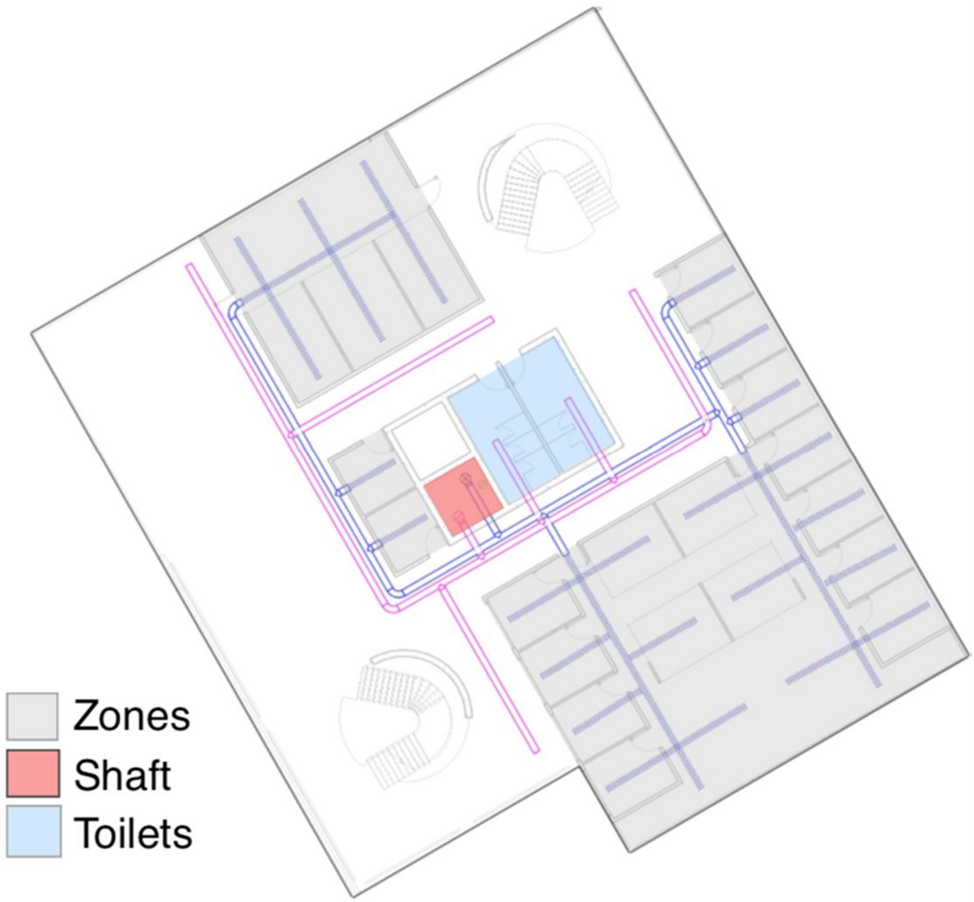


AHU AND DISTRICT COOLING

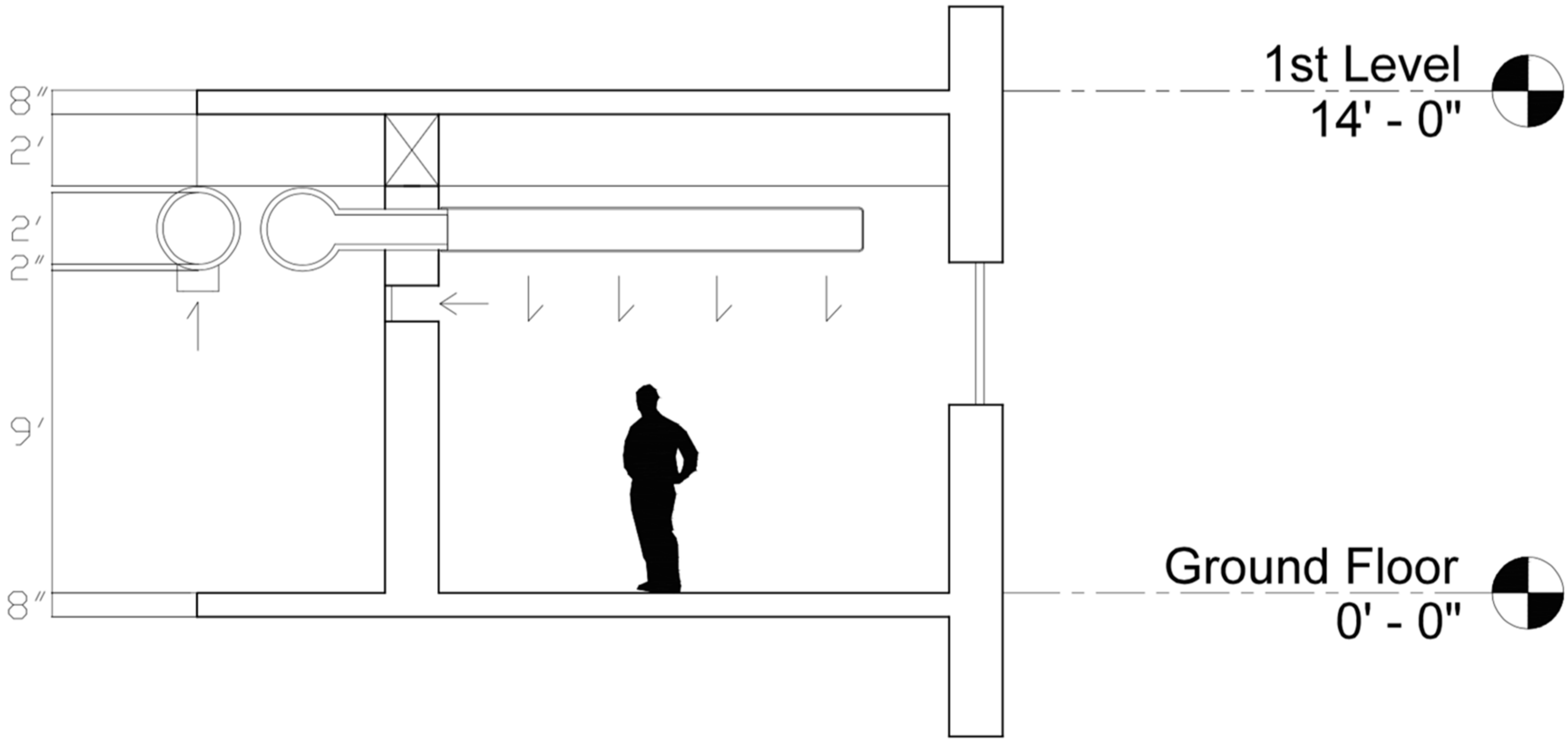
Primary system	Two AHU w. desiccant wheels District cooling w. water container
Secondary system	Hybrid ventilation
Structural system	Concrete



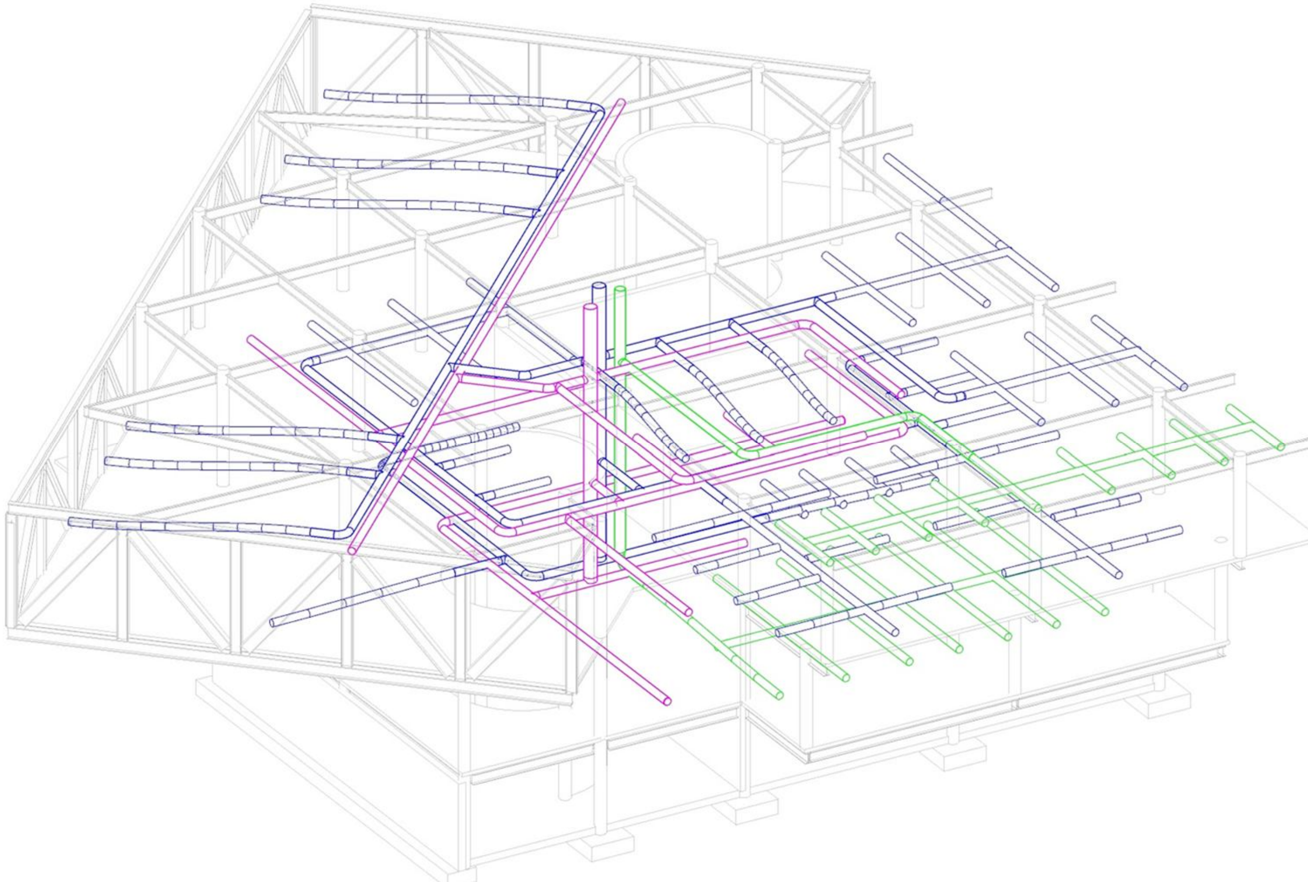
GROUND FLOOR



FLOOR SANDWICH



DISTRIBUTION TREE



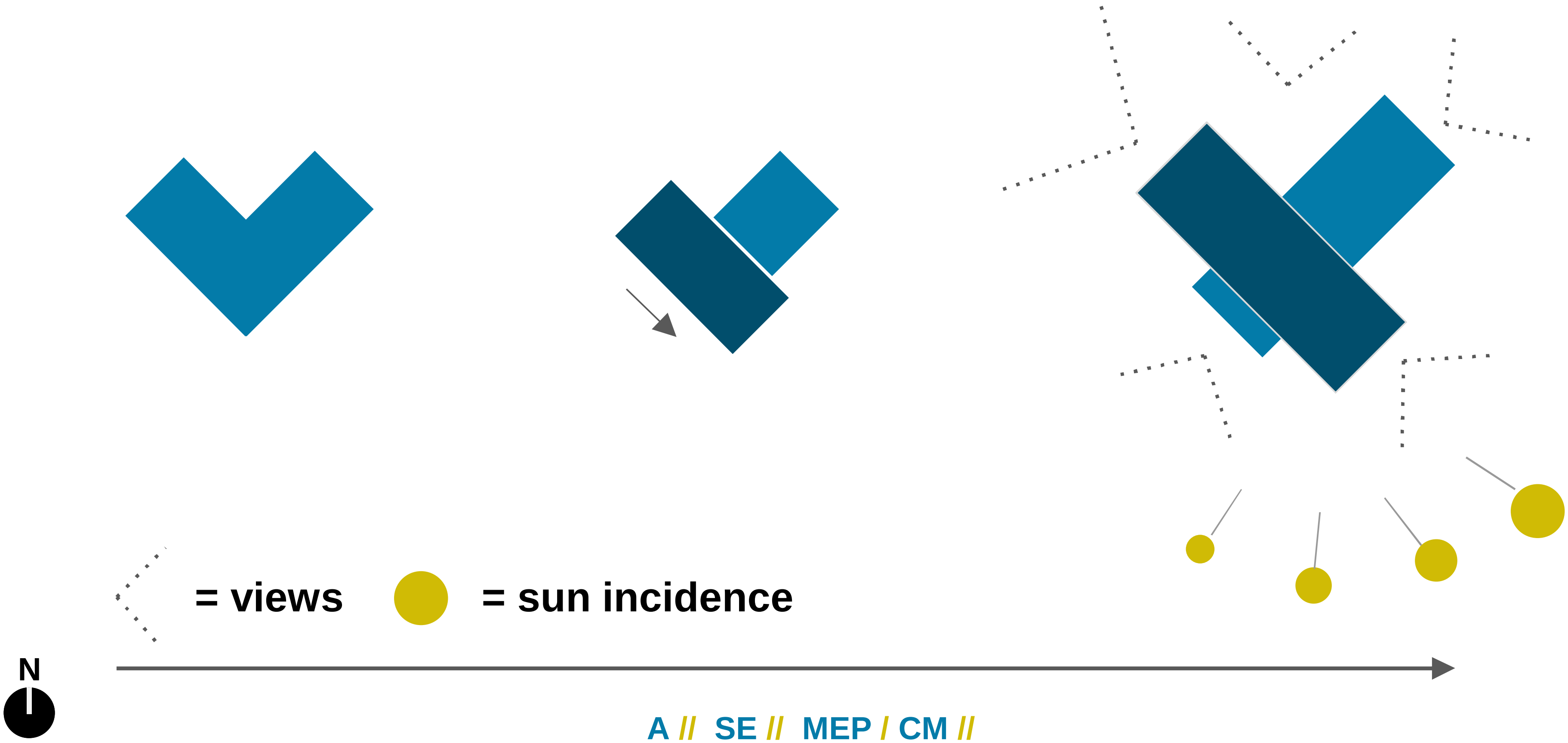
DECISION MATRIX

	AHU and Water Chiller	AHU and District Cooling
Cost	Higher initial cost Electricity during user phase	Low initial cost Fee to local plant Savings on Fibertec
Sustainability	Wind	District cooling
Comfort	Diffuse ceiling	Low impulse system
Big Idea	Fewer ducts	Easy to install

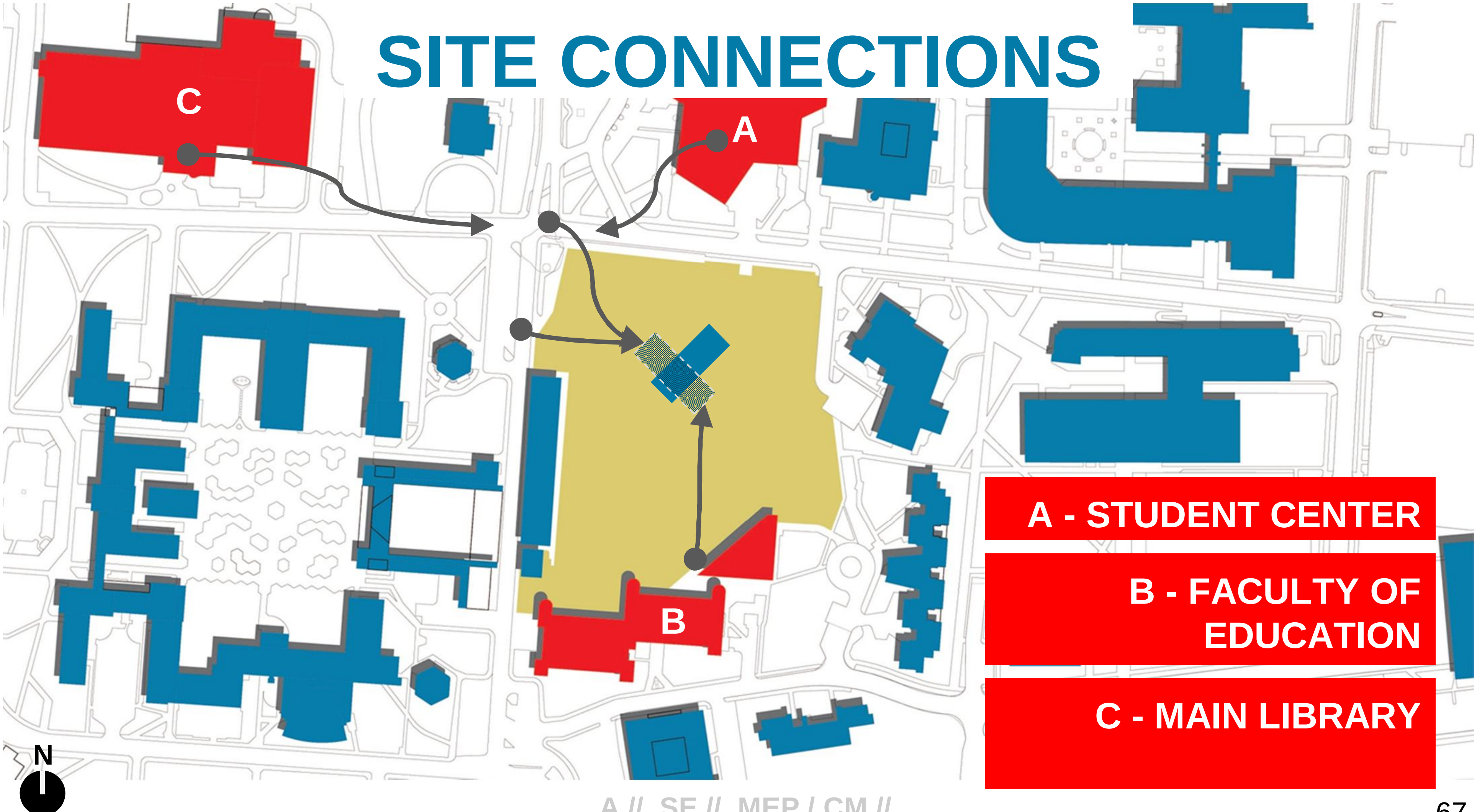
X-RAY


N

FORM TRANSFORMATION



SITE CONNECTIONS

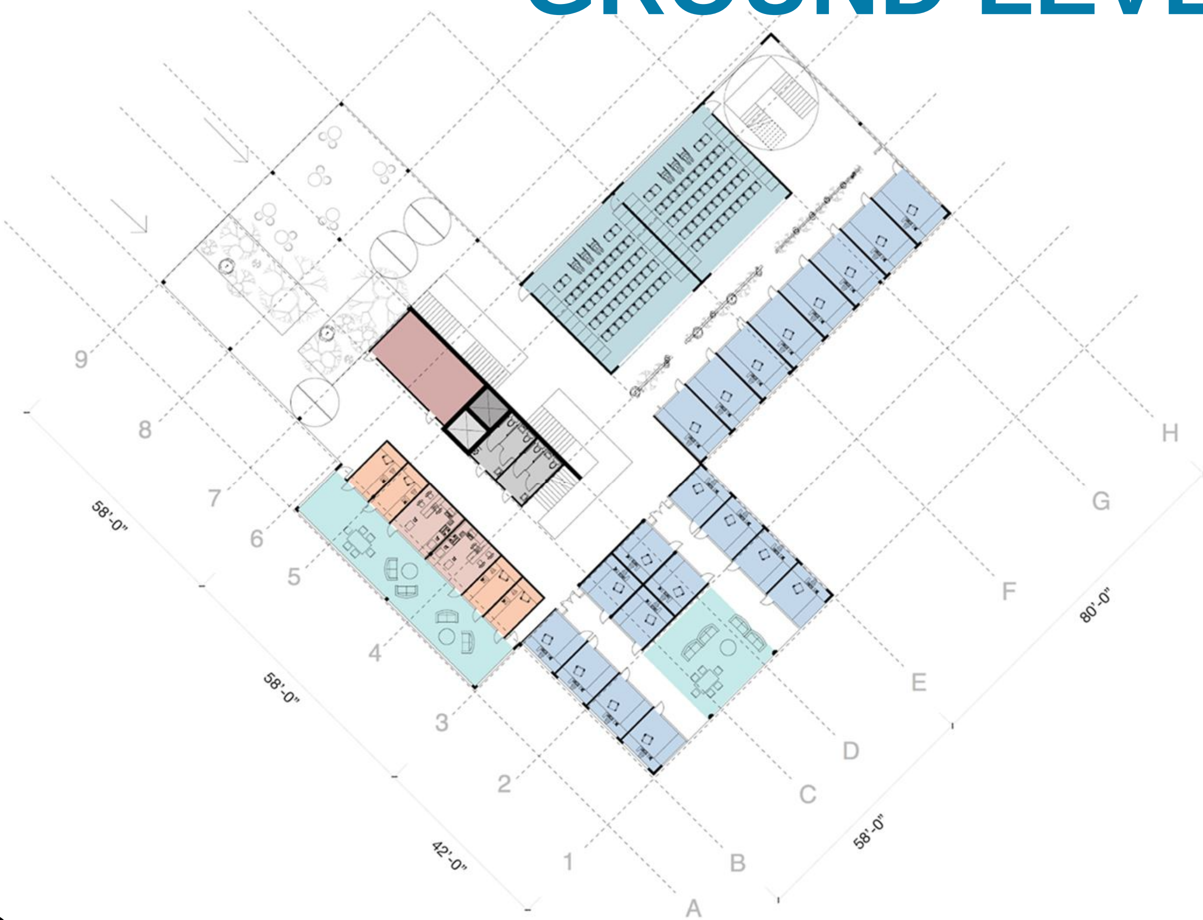


A - STUDENT CENTER

B - FACULTY OF EDUCATION

C - MAIN LIBRARY

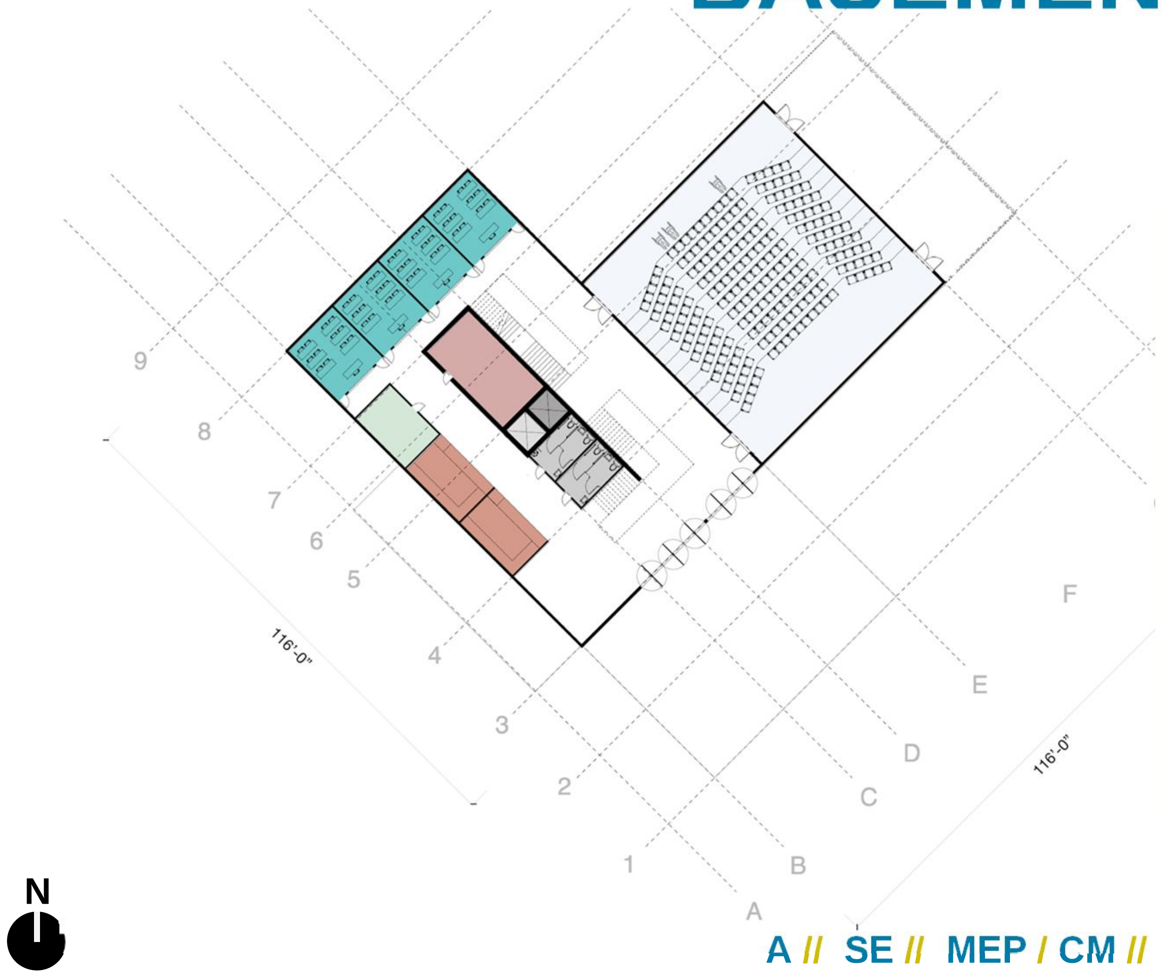
GROUND LEVEL



- Administrative Assistant Offices
- Senior Administrative Offices
- Department's Chair Office
- Elevator
- Bathrooms
- Mechanical Shaft
- Faculty Lounge
- Faculty Offices
- Large Classrooms

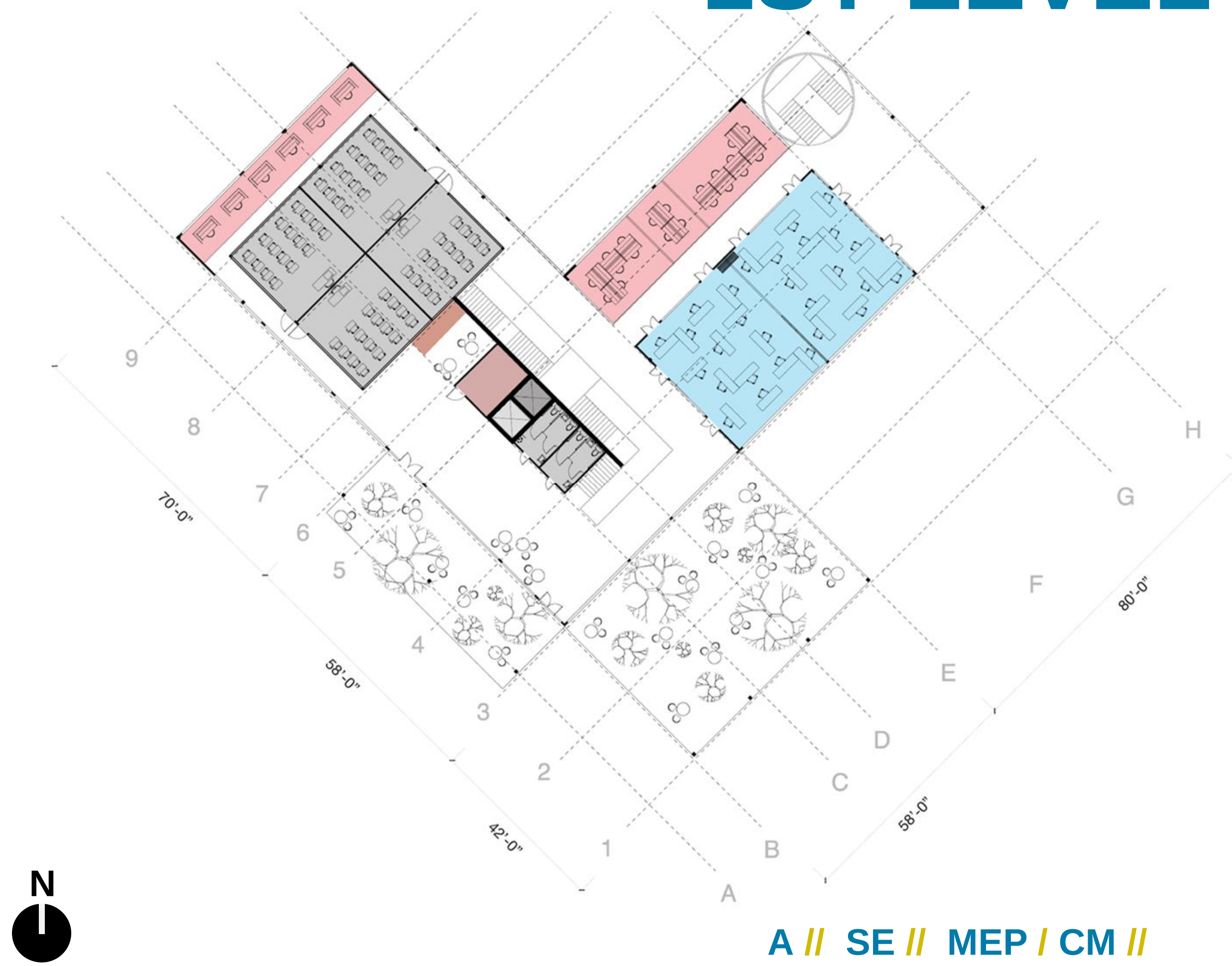
N

BASEMENT



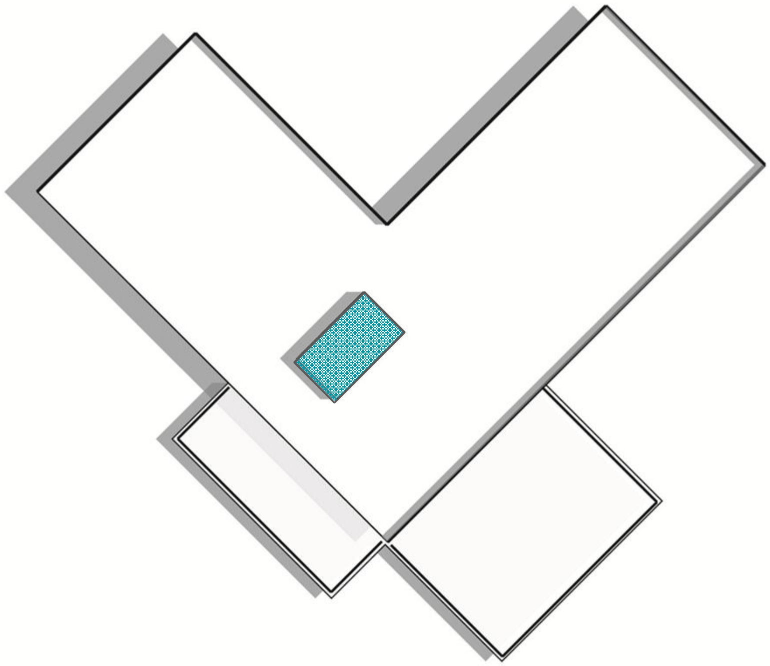
- Food Rental
- Storage
- Elevator
- Bathrooms
- Mechanical Shaft
- Auditorium
- Seminar Rooms

1ST LEVEL

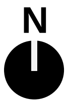


- Small Classrooms
- Student Offices
- Elevator
- Bathrooms
- Mechanical Shaft
- Instructional Labs

ROOF PLAN

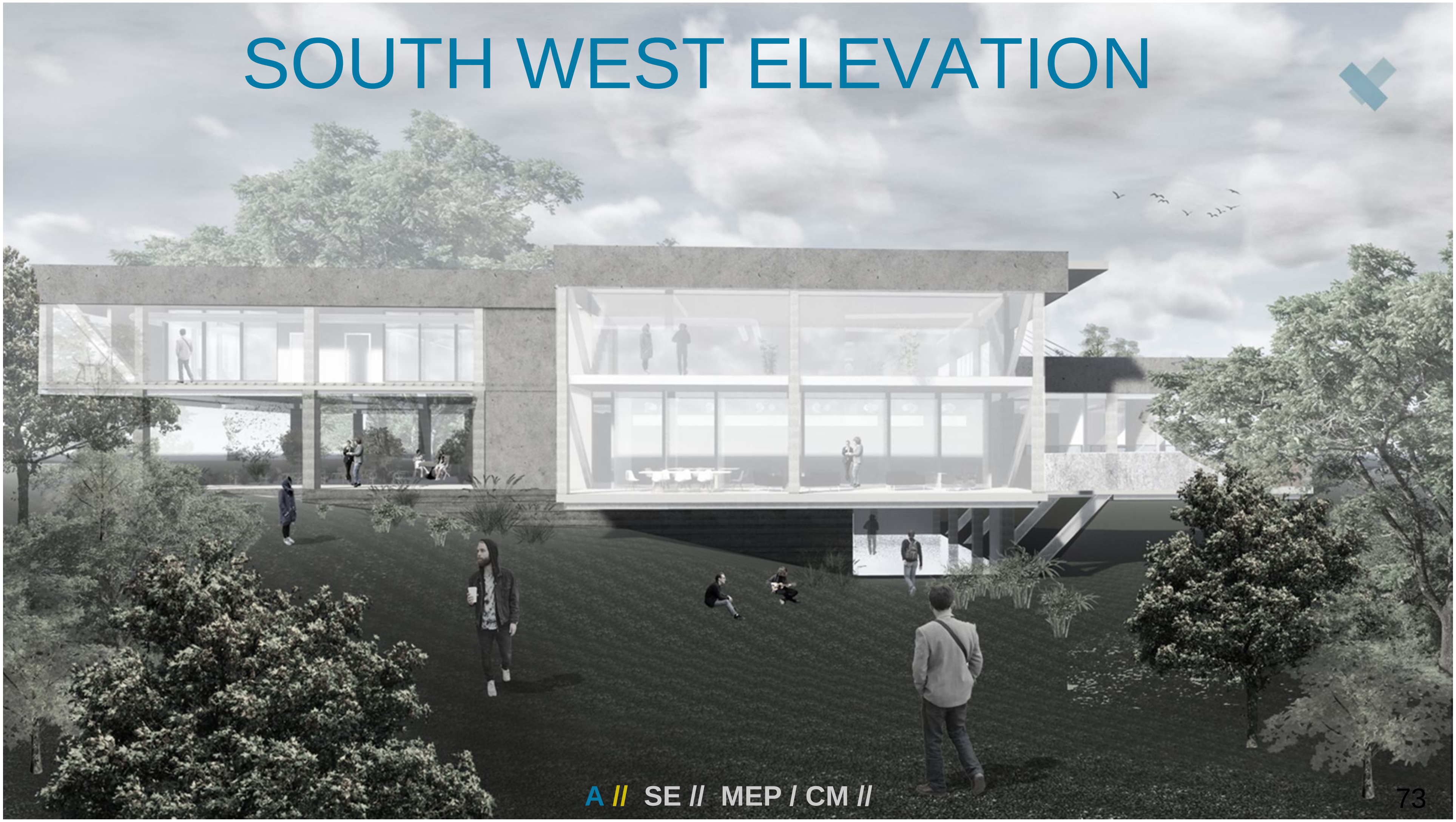


Mechanical Room

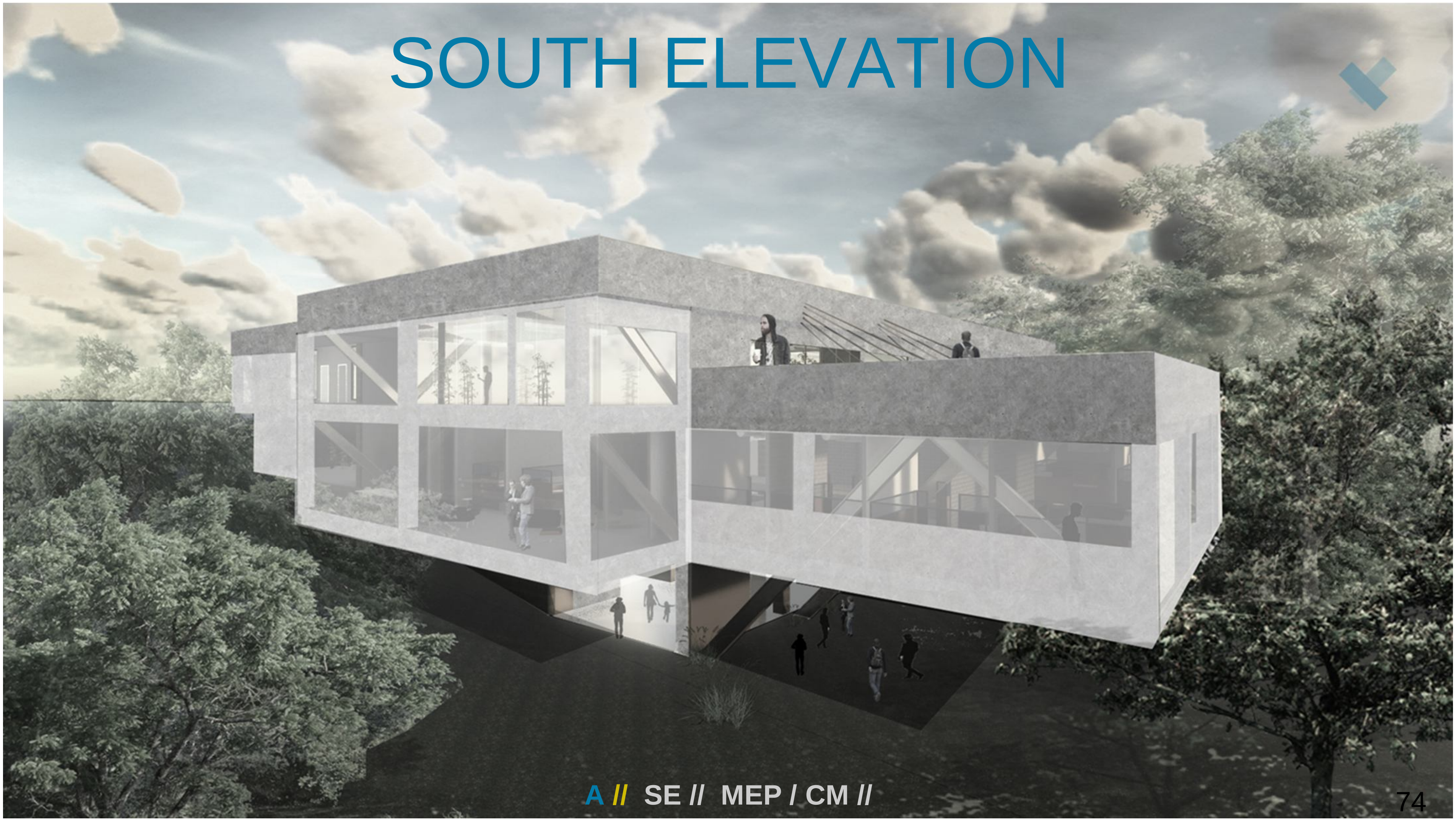


WEST ELEVATION

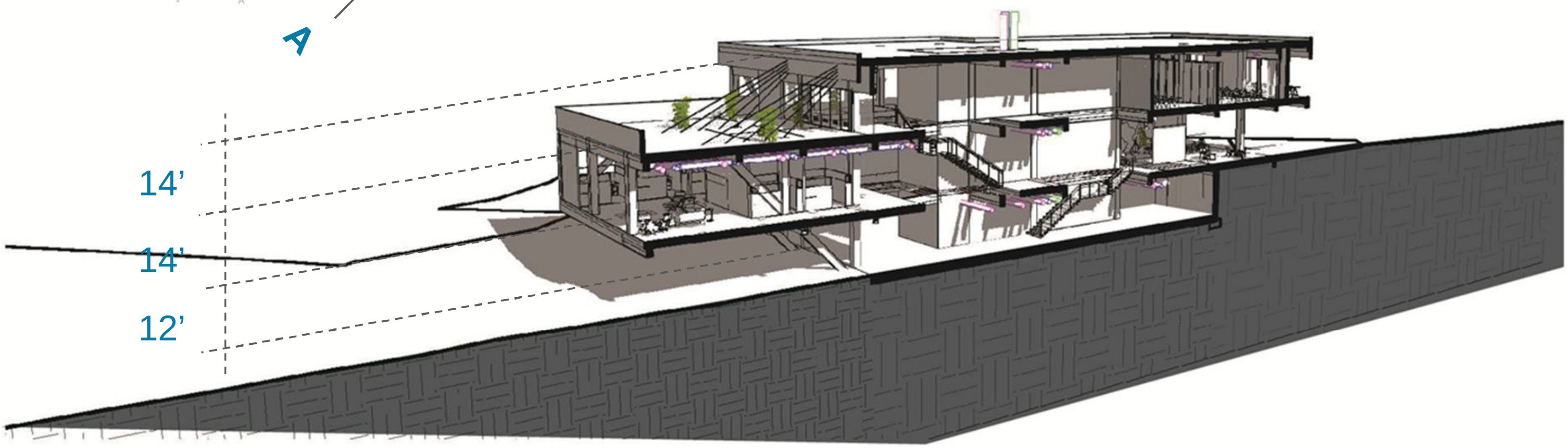
SOUTH WEST ELEVATION



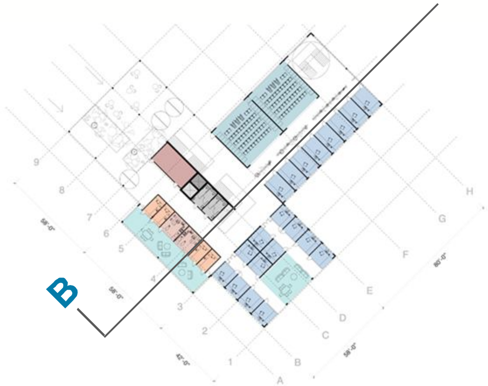
SOUTH ELEVATION

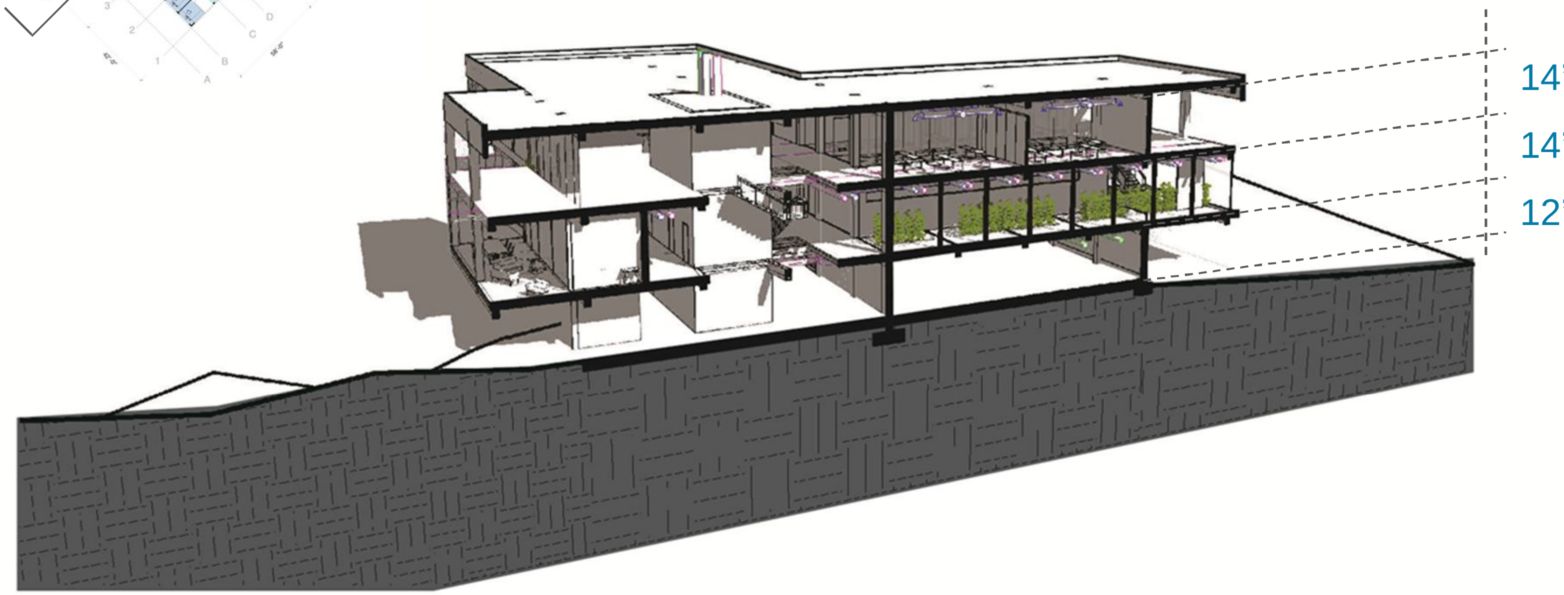


SECTION A

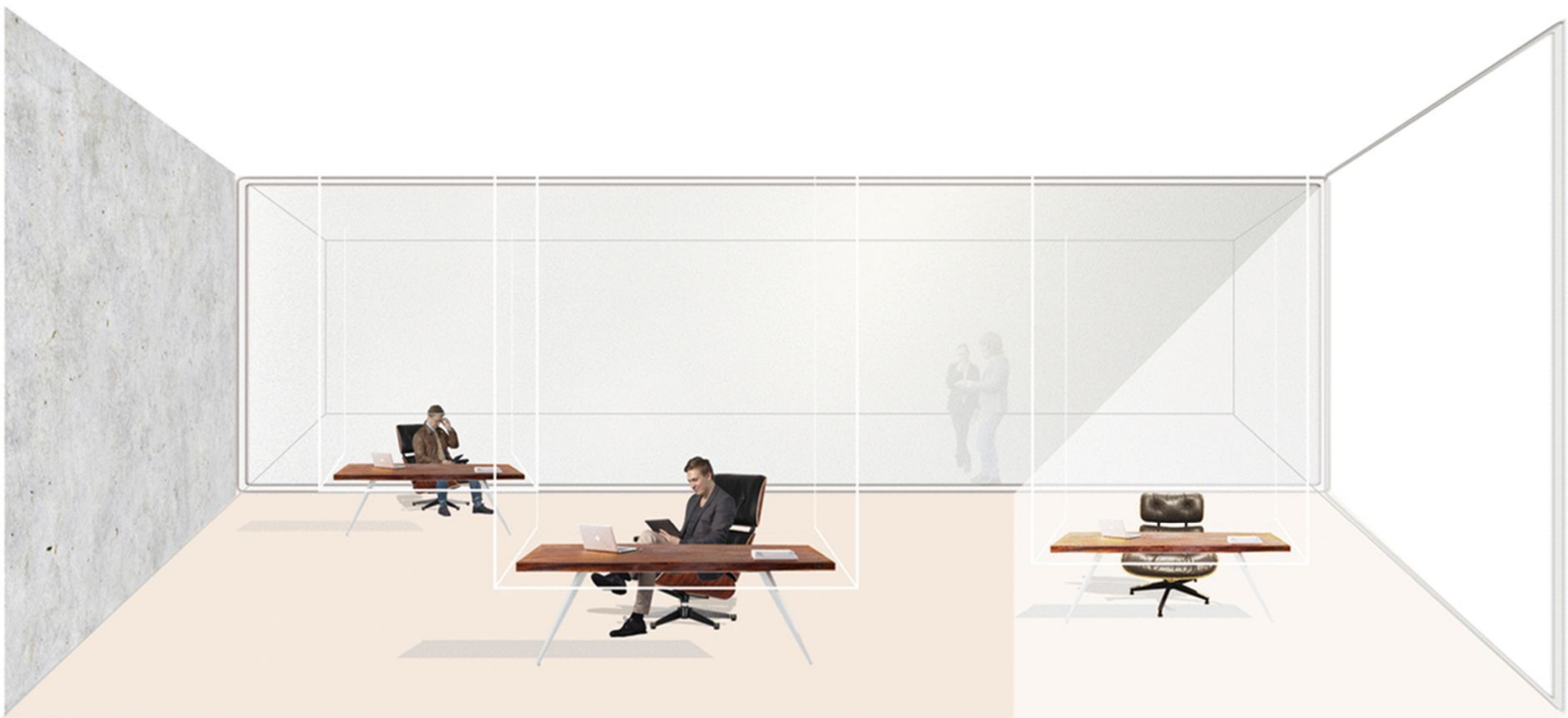


SECTION B

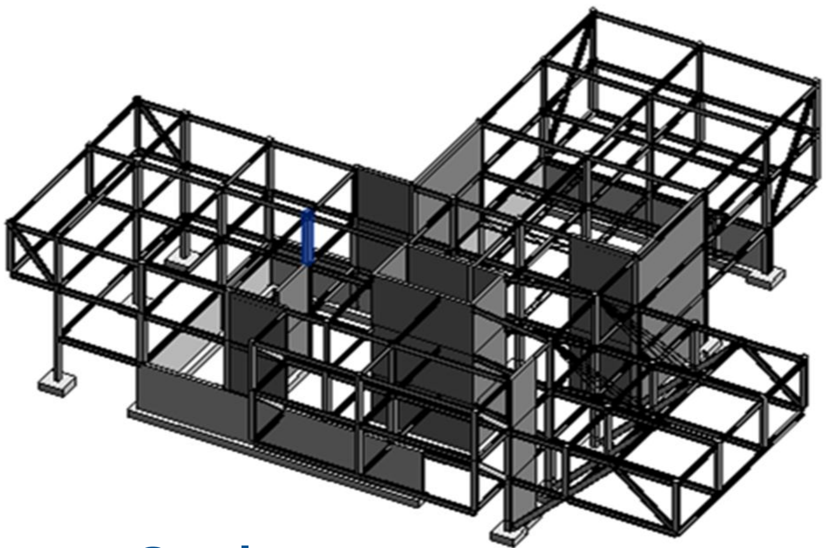


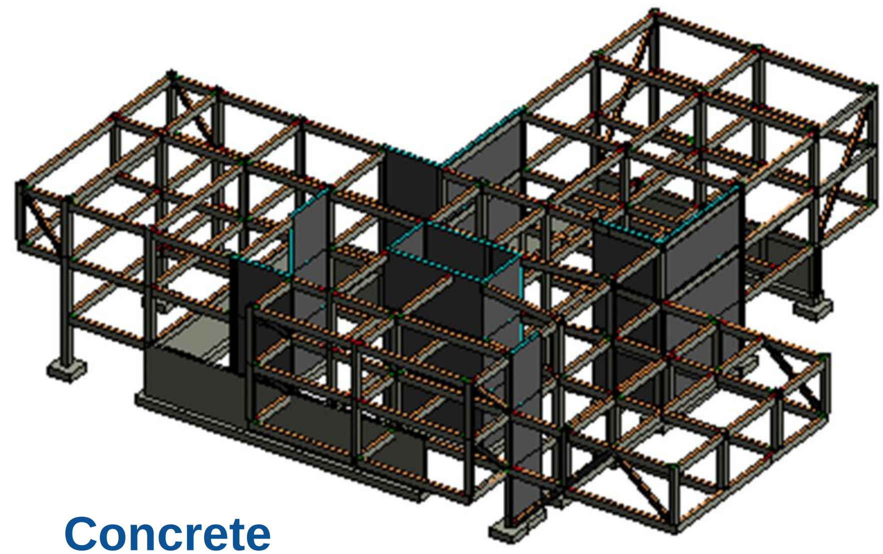


X-RAY



X-RAY STRUCTURAL OPTIONS





Steel
Composite Slab
Steel Beam
Concrete Columns
Steel Bracing & Cable Stayed Cantilever
Tapered Steel Joist Supporting Auditorium

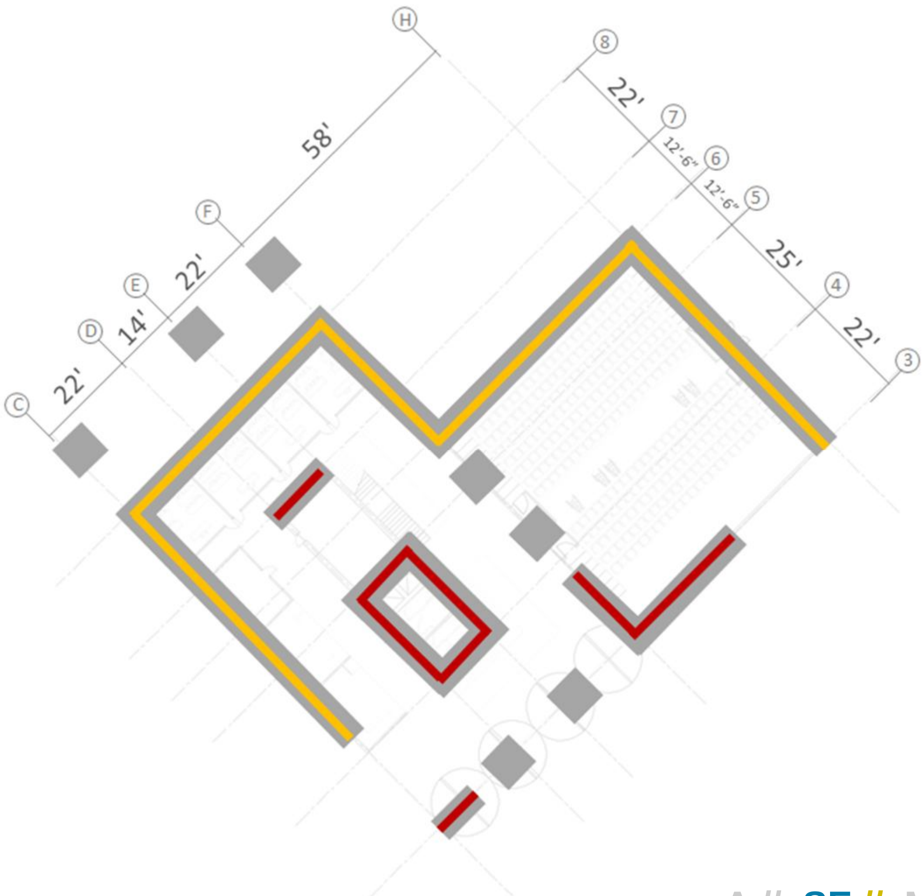
Concrete
PT Slab
Concrete Beam
Concrete Columns
Steel Braces, PT Slab Supporting Cantilever
PT Slab, PT Beam & PT Column for Auditorium

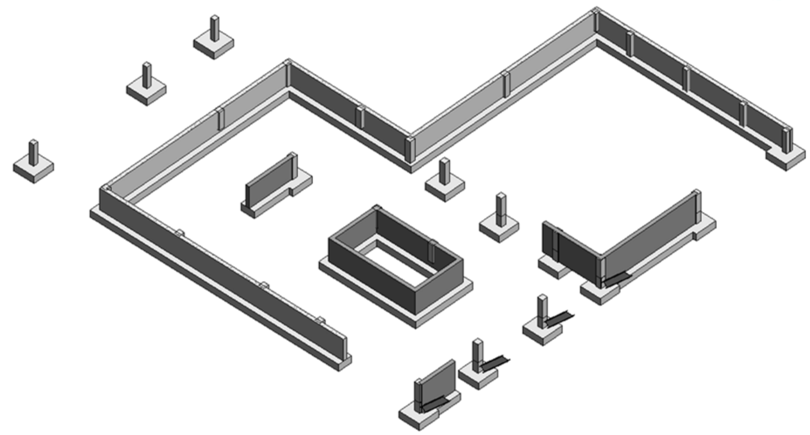
Slide 78

24 Same as the mechanism building, we proposed two structural design options. One in steel one in concrete. Listed at the bottom, are the structural system we chose.
Yunqian Cai, 3/15/2017

1 Next, I will talk about the structural design for the X-Ray building. Same as the mechanism building, we proposed two structural design options. One in steel the other one in concrete. Listed at the bottom, are the structural system we chose. In both design options, we use concrete columns. But in the steel option, we propose composite slab and steel beams; in the concrete option, we are gonna use PT slab and concrete beam. For the cantilever design, we use compression steel bracing for both options. In addition to that, for the steel option we add some tension cable to help secure the cantilever. For the auditorium at the basement, in order to have a large open space without columns, we will use tapered steel joist for the steel option, and PT slab, PT beam and columns for the concrete option. The big idea for this building is X-RAY, so we are gonna expose all of our structural system for the students to see and explore. Also, in order to implement our X-RAY big idea, we try to design our structural elements as architectural features. We try to make them aesthetic and fit with the architectural design of the building. The challenges for our structural design are hurricane, earthquake and long cantilevers, we will talk about how we address these challenges in the following slides.
Shengnan Zhao, 3/17/2017

BASEMENT





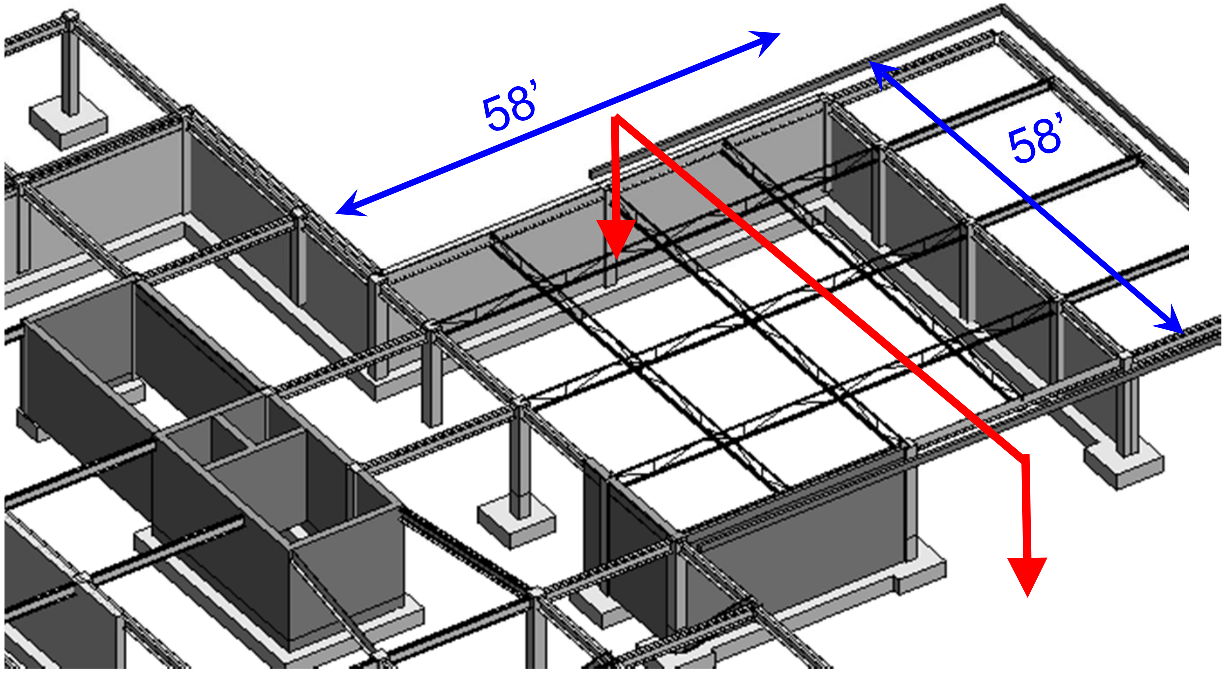
	Both Steel & Concrete Option
■	Foundation System
yellow line	12” Retaining Wall
red line	12” Shear Wall

Slide 79

2 This slide shows our structural design for the foundation system. It is color coded and summarized in the table at the bottom, The design is the same for both steel and concrete option. We plan to use 12" retaining wall and 12" Shear Wall. We designed shear wall core and some premier shear walls to resist the wind load and earthquake load. We looked at several lateral systems such as damper bracing device and base isolation. But we decided that for a small low rise building, shear wall is sufficient   and the most economical choice.

Shengnan Zhao, 3/17/2017

AUDITORIUM DESIGN



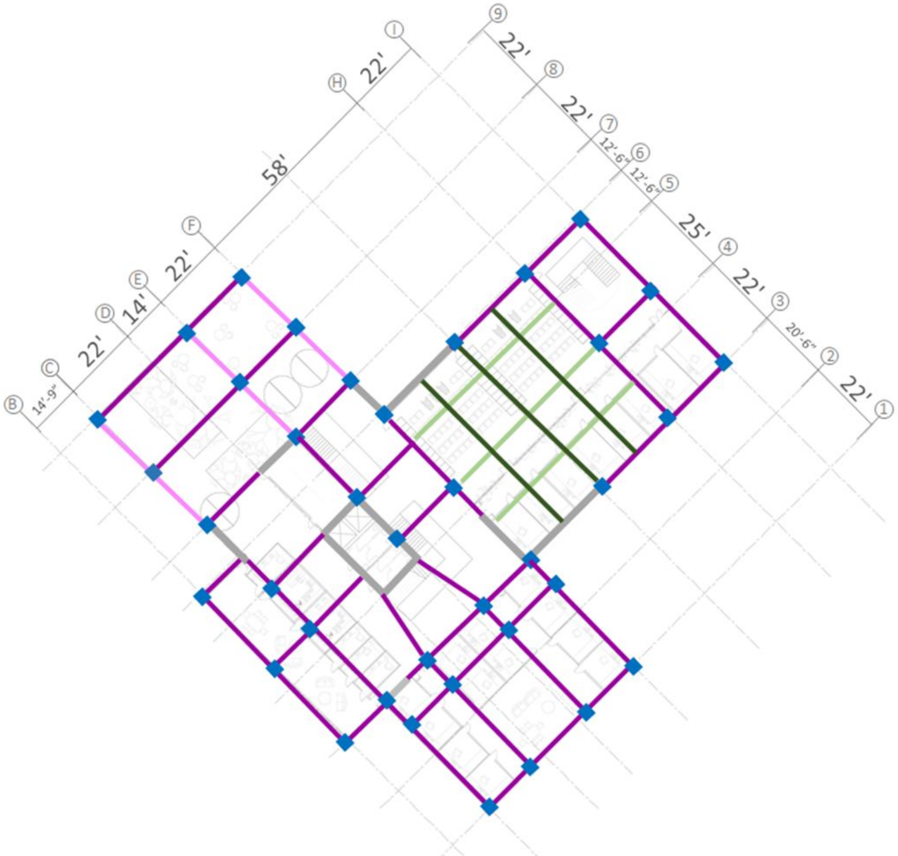
SW-NE Direction
2' Deep Steel Joist
NW-SE Direction
Tapered Steel Joist

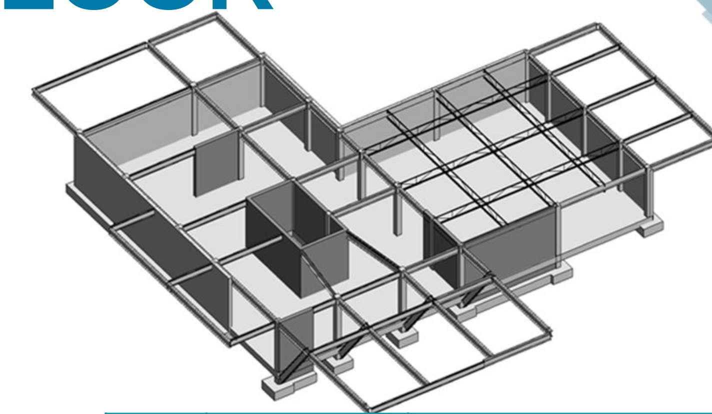
Slide 80

3 Our auditorium at the basement is 58' by 58'. In order to have a large open space without columns, we decide to design steel joists. And we run the steel joists in both directions to get more clear height. In the SW- NE direction the steel joists are 2' deep. And to take advantage of our sloped site, we designed the steel joists to be tapered from 2'-5' deep in the NW-SE direction. You can see a blow up view at the top right corner.

Shengnan Zhao, 3/16/2017

GROUND FLOOR





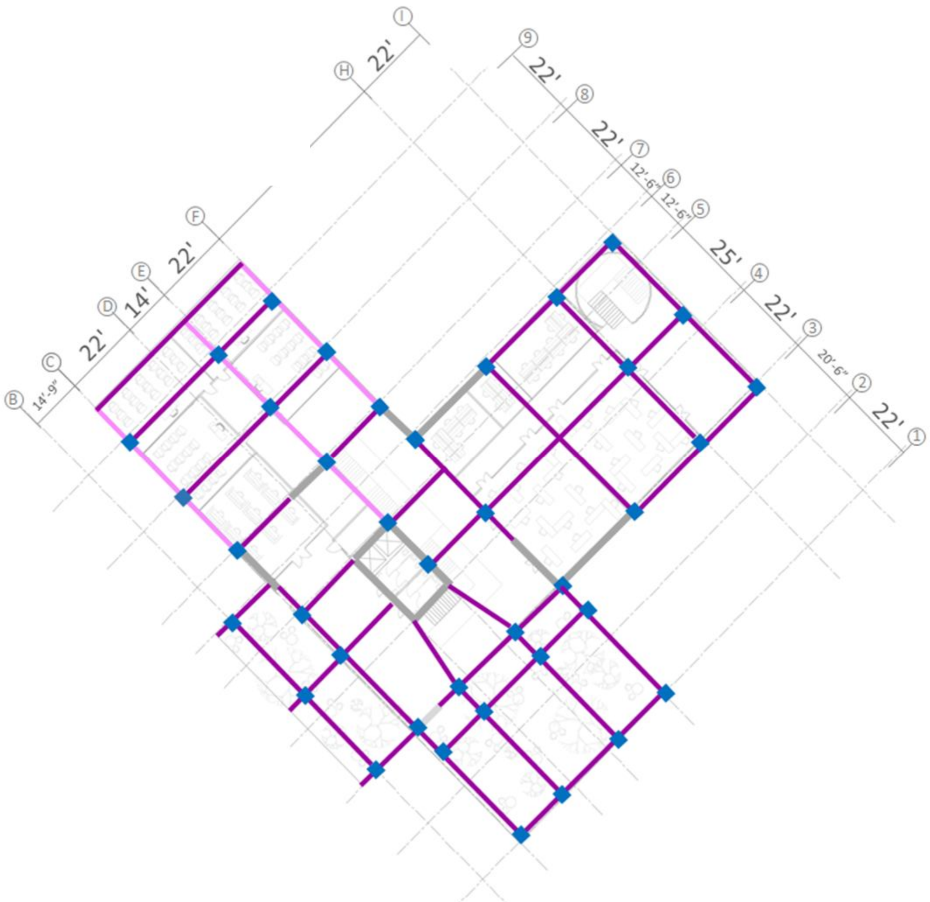
	Steel	Concrete
(blue square)	Concrete Column, 18x18, 15x15	
(light green line)	Steel Joist	
(dark green line)	Tapered Steel Joist	
(pink line)	W16 x 50	12x20 Concrete Beam
(purple line)	W16 x 67	12x24 Concrete Beam
(grey bar)	Shear Wall	

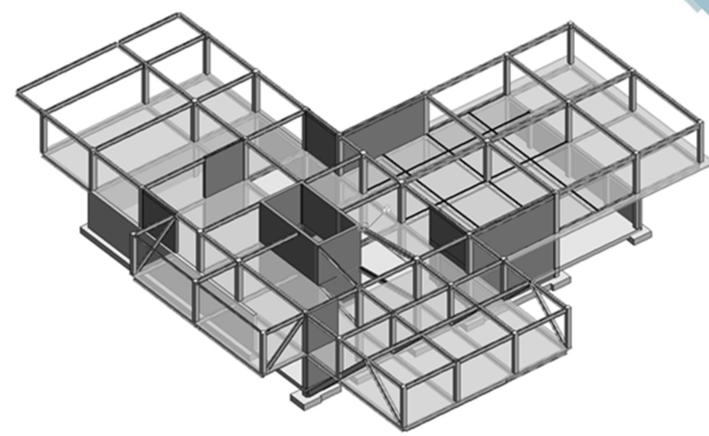
Slide 81

4 This slide shows the lay out of our columns and beams for ground floor. We use 18x18 or 15x15 concrete columns base on the tributary area. The different sizes of the beams we chose for steel or concrete option are color coded and clearly shown in the graph. The grey lines show the shear wall placement. You can also see the steel joist placement for the auditorium.

Shengnan Zhao, 3/16/2017

1ST FLOOR





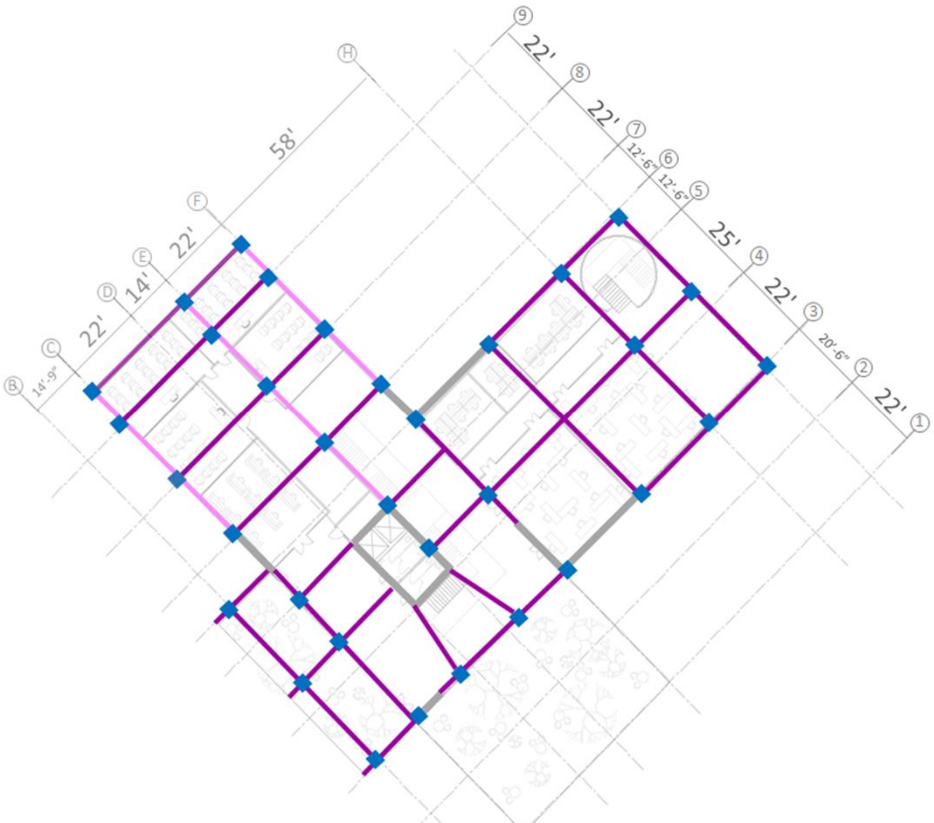
	Steel	Concrete
■	Concrete Column, 18x18, 15x15	
(pink line)	W16 x 50	12x20 Concrete Beam
(purple line)	W16 x 67	12x24 Concrete Beam
(grey bar)	Shear Wall	

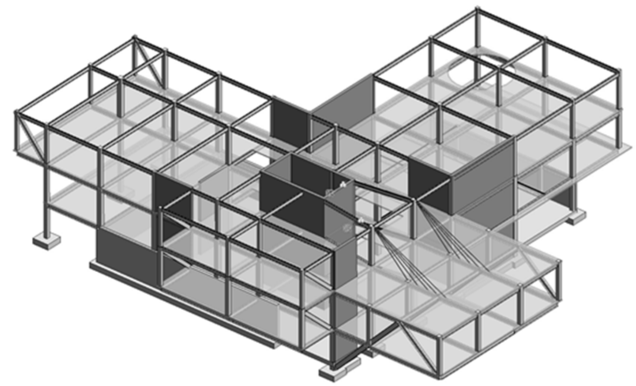
6 _Marked as resolved_
Shengnan Zhao, 3/17/2017

5 Same as last slide, this one shows the structural system for 1st floor. The size of column and beams we chose are the same as the ground floor.
Shengnan Zhao, 3/17/2017

7 _Re-opened_
Shengnan Zhao, 3/17/2017

ROOF





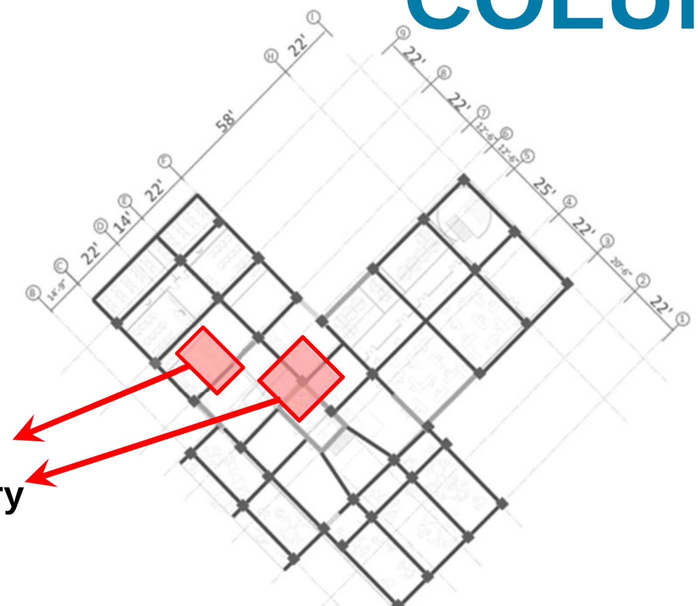
	Steel	Concrete
	Concrete Column, 15x15, 12x12	
	W16 x 31	12x20 Concrete Beam
	W16 x 50	12x24 Concrete Beam
	Shear Wall	

Slide 83

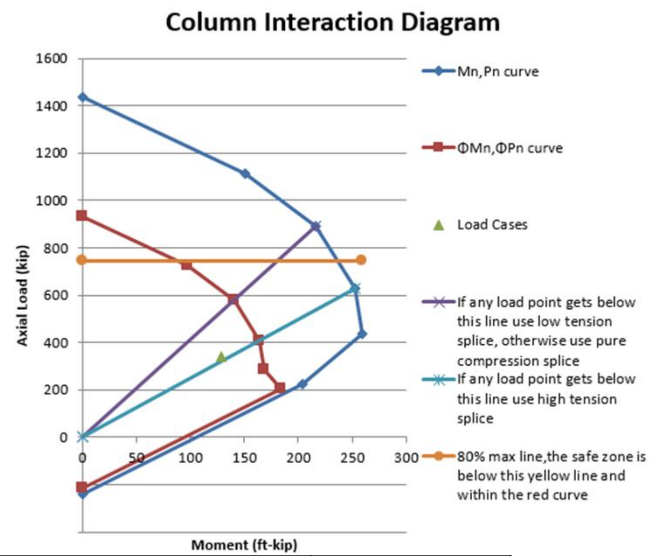
8 This slide shows the structural system for the roof level. In here because the gravity load is much smaller, we are using smaller columns and beams. The sizes are chosen base on hand calculation and Mastan analysis.

Shengnan Zhao, 3/16/2017

COLUMN SIZING



Tributary Area

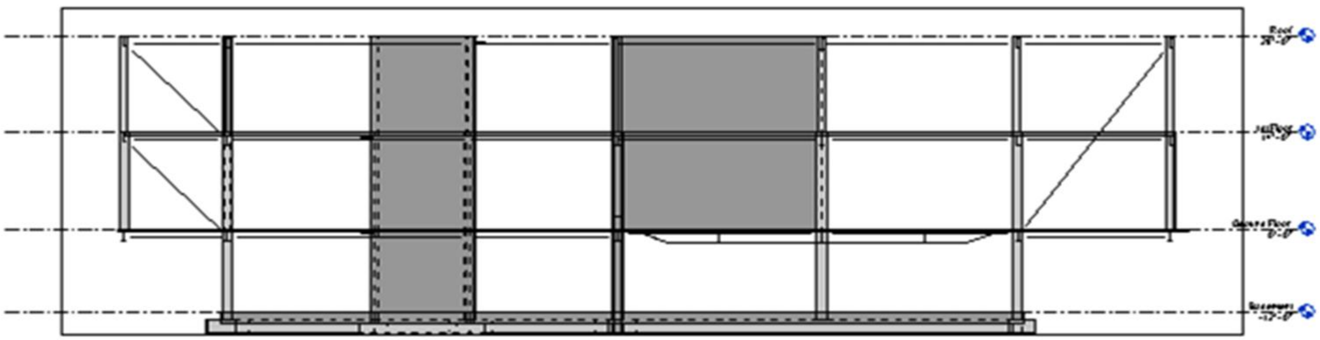


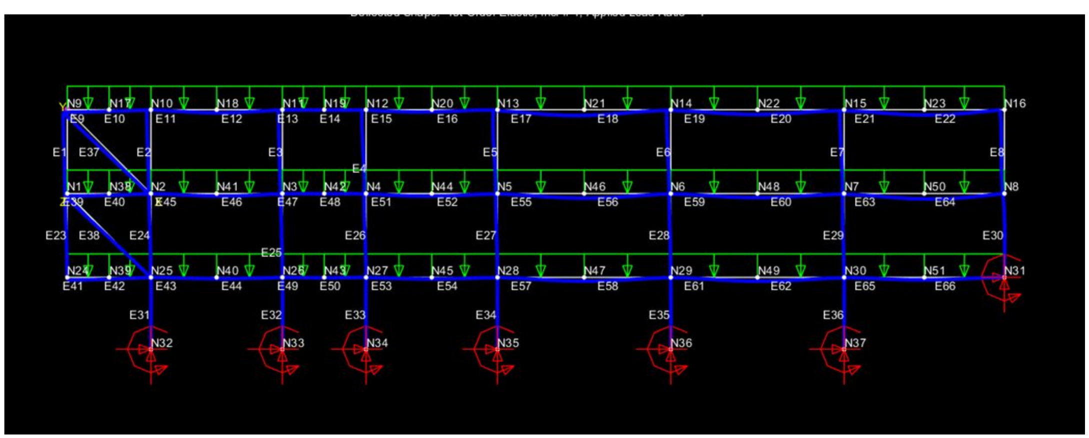
	Tributary Area	Load on lower floor	Load on upper floor	Chosen Size	
	ft^2	kips		Basement & Ground Floor	1st Floor
Edge Column	285	116.28	63.84	15x15	12x12
Interior Column	360	146.88	80.64	15x15	12x12
Largest Interior Column	840	342.72	188.16	18x18	15x15

Slide 84

9 We summarize our column sizing procedure in here. We first determined the tributary area of each column and calculated the load applied to it. Then, by using a excel spread sheet we developed, we decide to use 15x15 or 18x18 columns in the basement and ground floor. And we will use 12x12 or 15x15 columns in the 1st floor.
Shengnan Zhao, 3/16/2017

BEAM SIZING



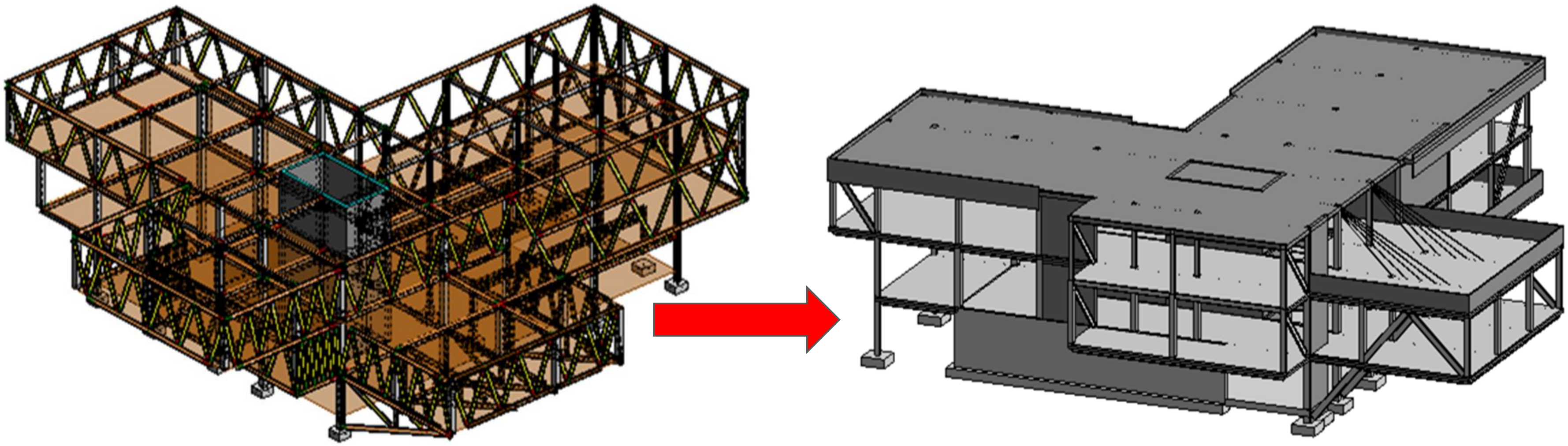


	Steel Option	Concrete Option
1st Floor	W16x31, W16x50	12x20 12x24
Ground Floor & Basement	W16x50, W16x67	12x20 12x24
Bracing	W16x 67	W16x 67

10 To determine the beam size and bracing size, we run mastan analysis. The design is deflection controlled, so we determined the beam and bracing size base on trial and error to make sure our design meets the serviceability requirement. We use W16x67 steel bracing to support the cantilever in both concrete and steel option, because diagonal concrete bracing is hard to construct. Also we can use smaller size of bracing if we use steel.

Shengnan Zhao, 3/16/2017

EVOLUTION OF CANTILEVER

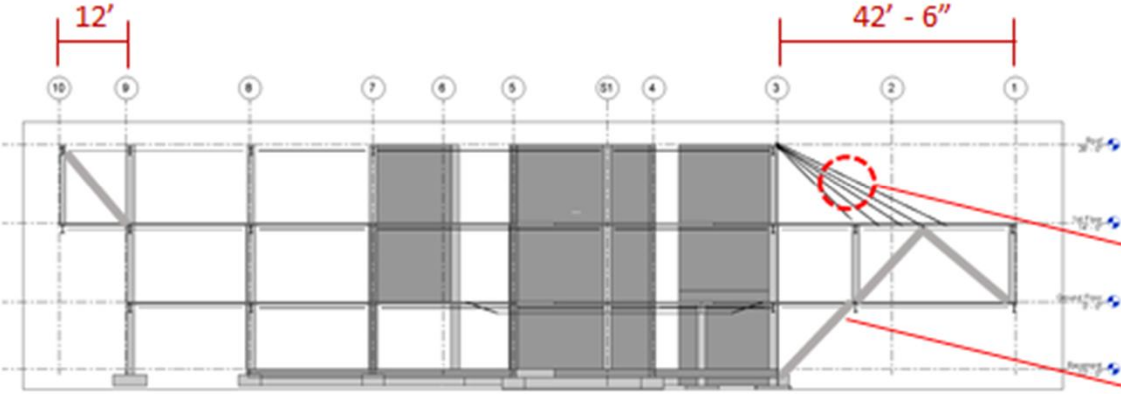


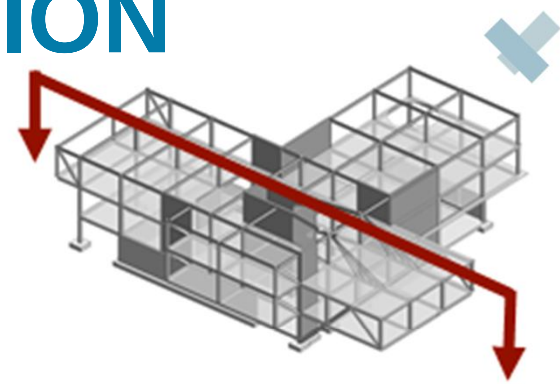
Optimize Bracing System

11 This slide shows the evolution of our structural design for the cantilever. At first we had bracing all around the building, it was over designed, waste a lot of material and made the building cage like. So after we consult with the structural engineer mentors, we determined the best locations and orientation to place the bracing, and also to integrate with the architectural design make the bracing placement aesthetic.
Shengnan Zhao, 3/16/2017

CANTILEVER SOLUTION

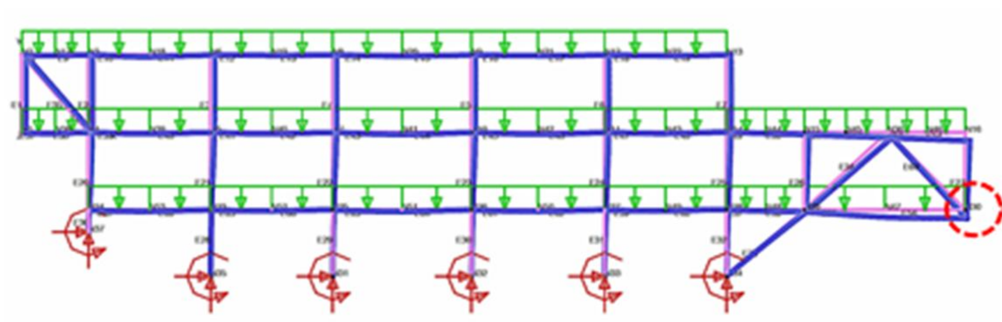
Steel Option Cantilever Solution: Compressive Bracing + Tensile Cables





Use Cable to secure the cantilever from the top

W16x67 Bracings in compression



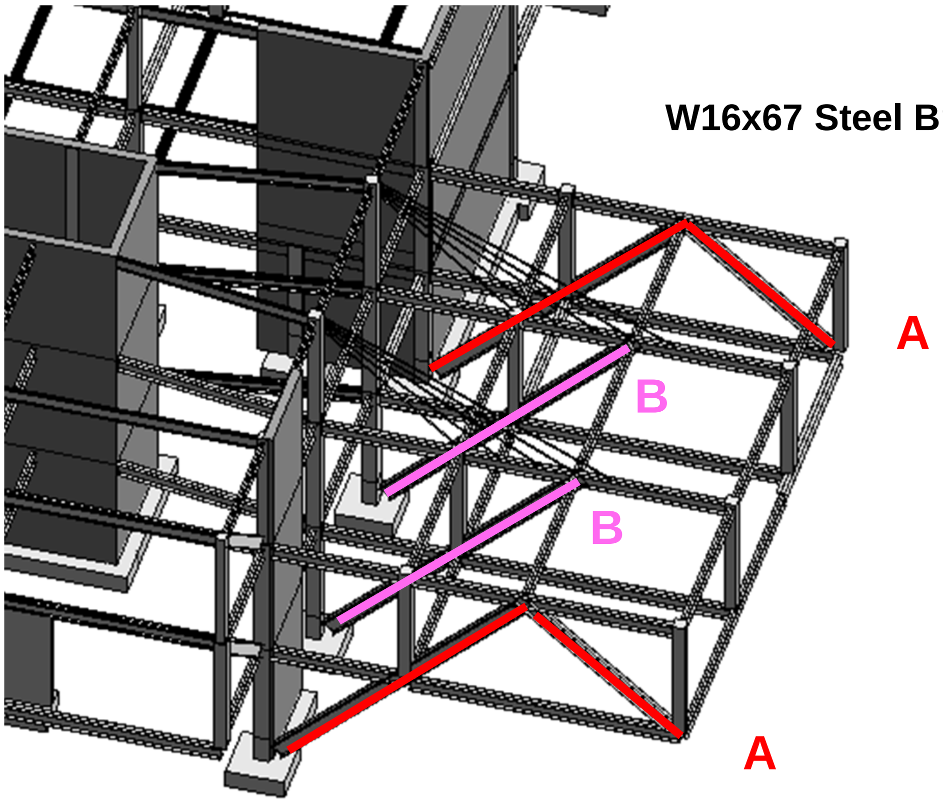
Check serviceability:
Max deflection< L/360

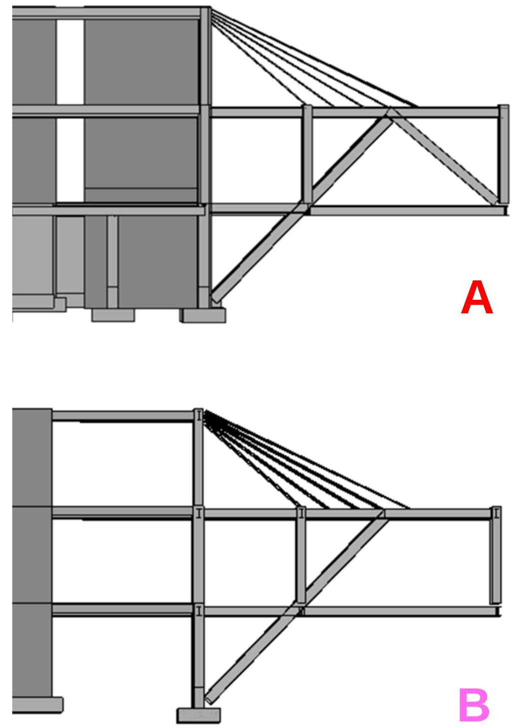
12 We have cantilevers on all four sides of our building. But three of them are small, less that 20' long. We only have one large cantilever that is 42' 6" long. To support this cantilever we designed four sets of W16x67 bracings, two on the exterior of building and two in the interior. In the concrete design, the PT slab will help us support the cantilever, but int the steel design, we are using composite slab, So in the steel design, in addition to the steel braces, we propose steel cables on top of the cantilever to tie it back to the back span. We determined the size of the steel braces using mastan analysis and we made sure it meets the serviceability requirement by the code.

Shengnan Zhao, 3/17/2017

CANTILEVER SOLUTION

W16x67 Steel Bracings



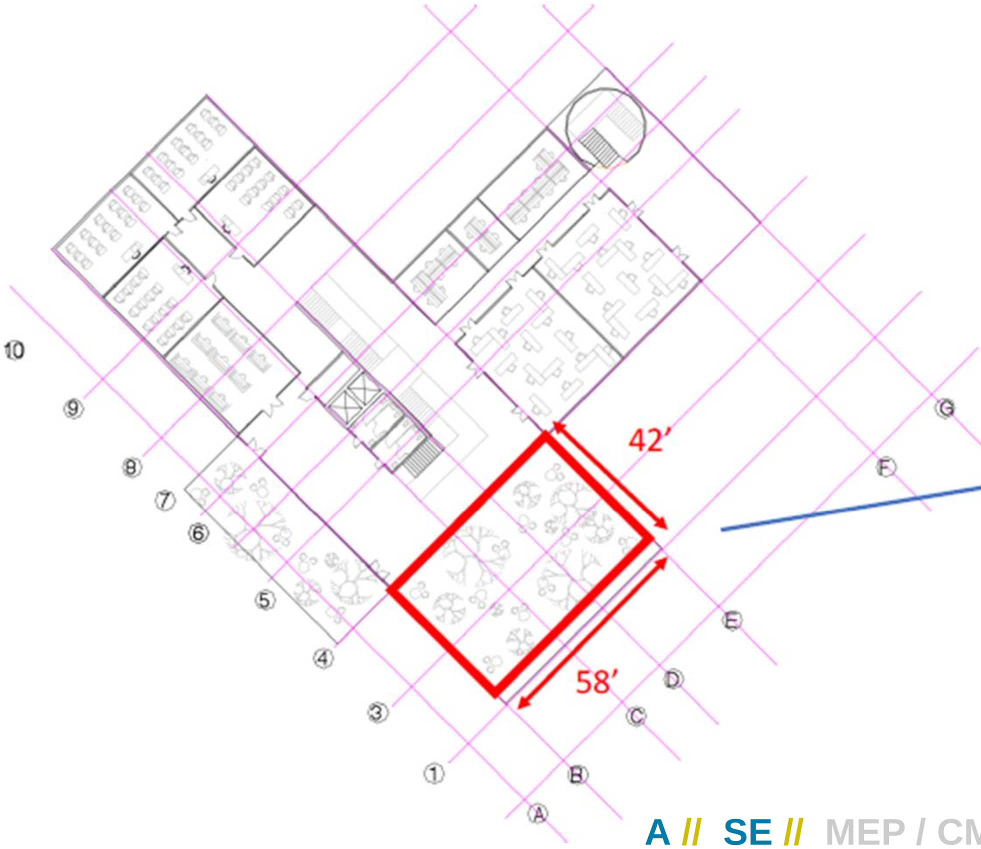


13 These section views clearly show the bracing placement. In the exterior, we have steel bracing going up from basement to 1st level and another one going from 1st level down to the ground floor. That is section A. In section B which is inside the building, we only have bracing going up from basement to 1st level. So that the braces won't hinder with the circulation for people in the building.

Shengnan Zhao, 3/17/2017

CANTILEVER SOLUTION

Architectural Floor Plan - 1st Floor



On the top floor, it is an opened rooftop garden.

Slide 89

14 On top of our cantilever is an opened rooftop garden. The size of the cantilever is 42' by 58'. The bracing help us manage the deflection in the 42' direction but we are still worried about the deflection in the 58' direction. In the concrete design, we can use PT slab help supporting the cantilever. In the steel design, we thought about adding some structural elements on top of the cantilever to control the deflection.

Shengnan Zhao, 3/17/2017

CANTILEVER SOLUTION

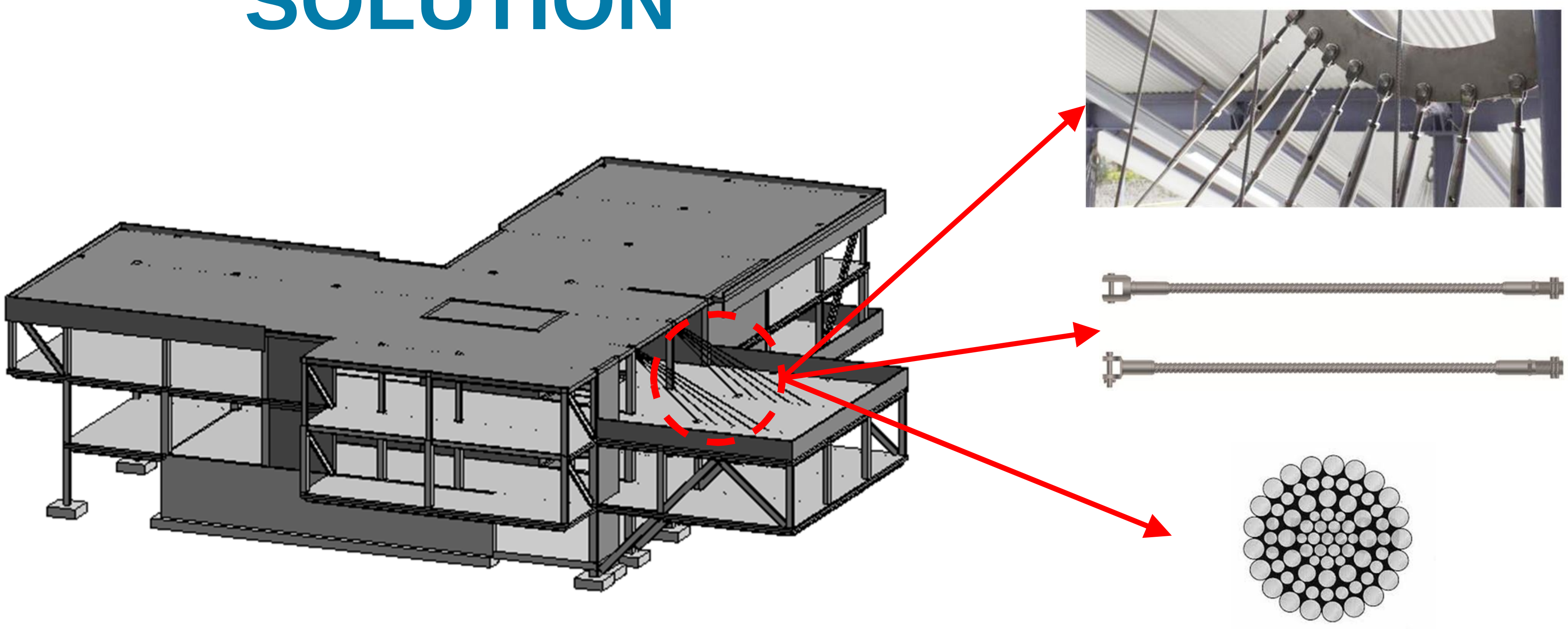
Reference: Sundial Bridge

Slide 90

15 We got our design inspiration from the cable stayed bridges. This is a picture of Sundial Bridge. We think that tension cables will help limit deflection of our cantilever, It is both structural element and also aesthetic architectural feature. So we decide to experiment with it and implement it into our design.

Shengnan Zhao, 3/17/2017

CANTILEVER SOLUTION



Slide 91

16 This picture shows the placement of the tension cable. We collaborated with our architects to make sure it will integrate with the roof garden design. The blow up view shows the kind of cable, and connection we want to use and cross section of the cable. The detailed sizing will be done next semester if we decide to use this structural system.

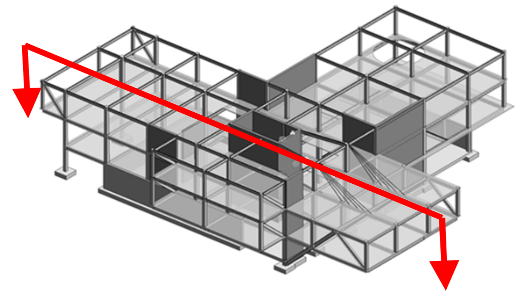
Shengnan Zhao, 3/17/2017

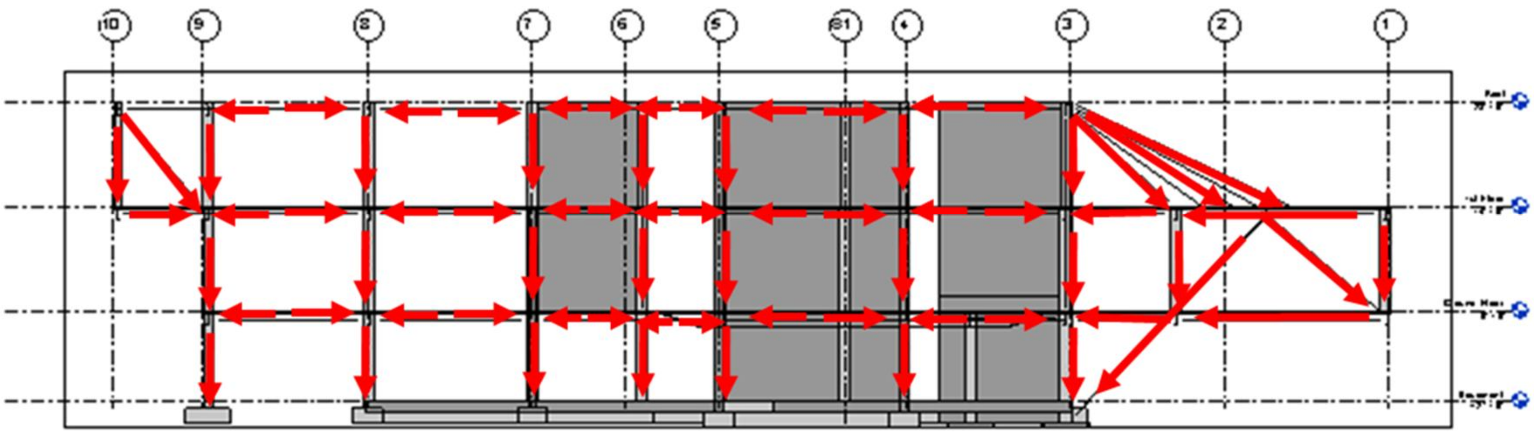

A // SE // MEP / CM //

Slide 92

17 This slide is a rendering picture of our roof garden with the tension cables.
Shengnan Zhao, 3/17/2017

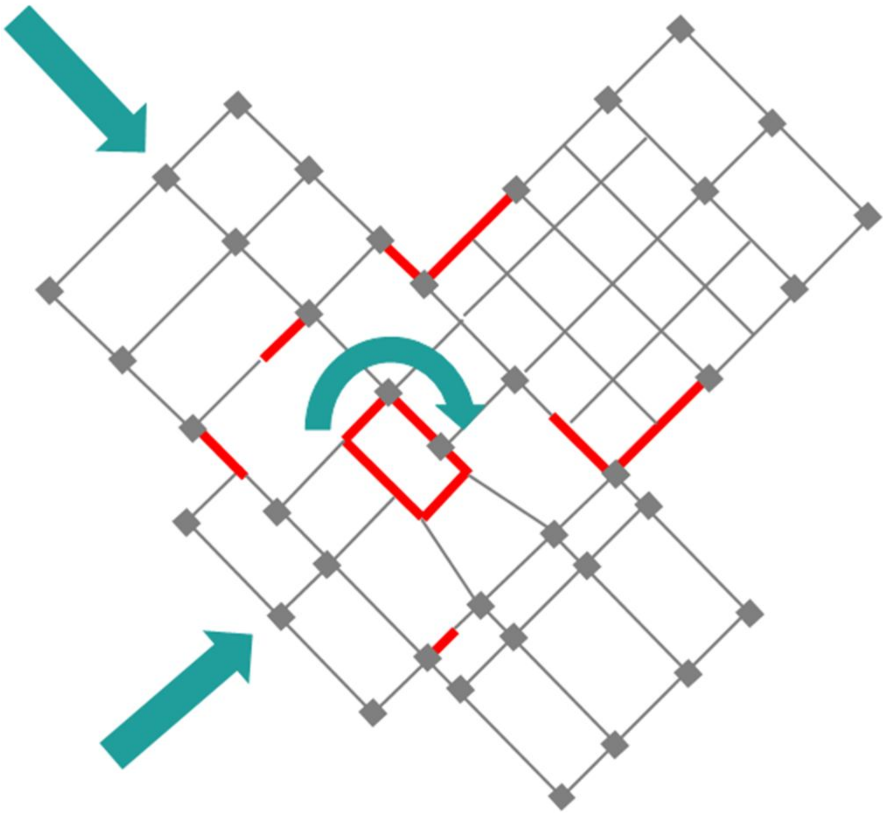
GRAVITY LOAD PATH

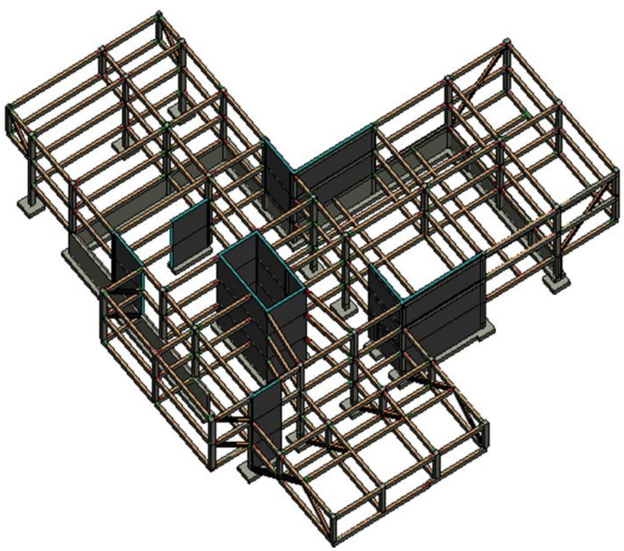




18 This slide is a section view of our building and it shows the gravity load path. The loads are transferred from beams, girders and bracings to the columns and finally transferred into the foundation.
Shengnan Zhao, 3/17/2017

LATERAL SYSTEM





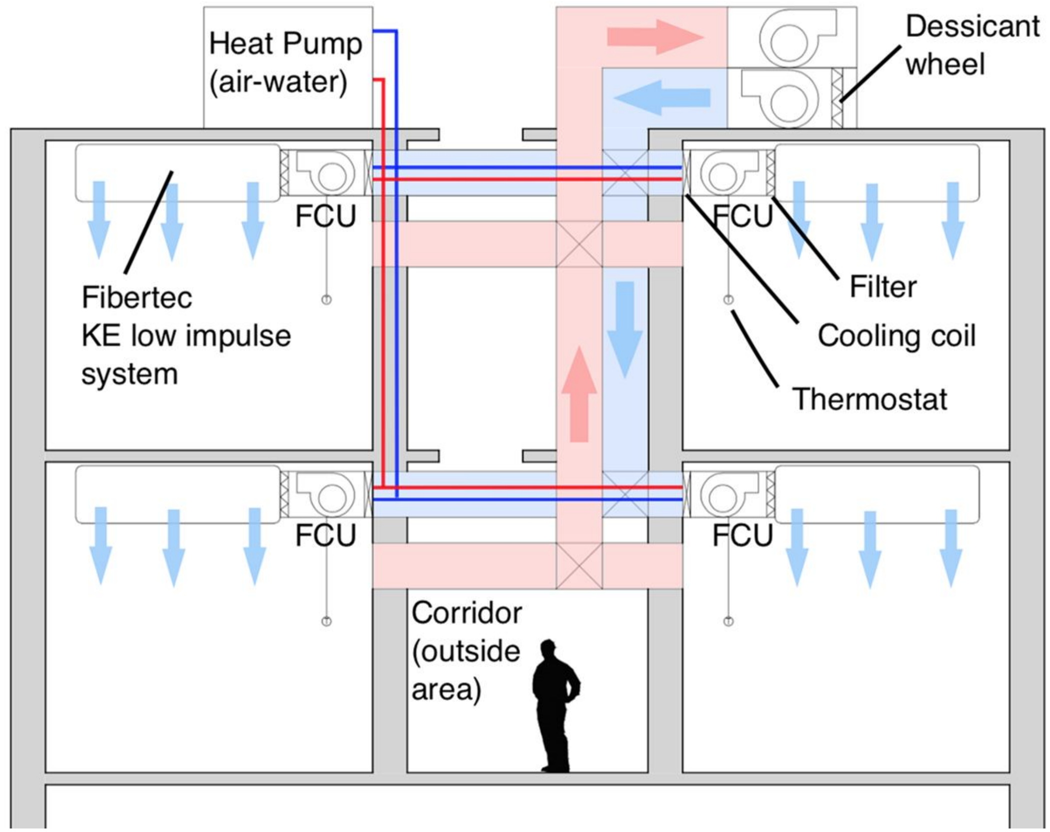
Slide 94

19 This slide shows the lateral system, we use shear wall core and perimeter shear walls to resist torsion caused by wind load and earthquake.

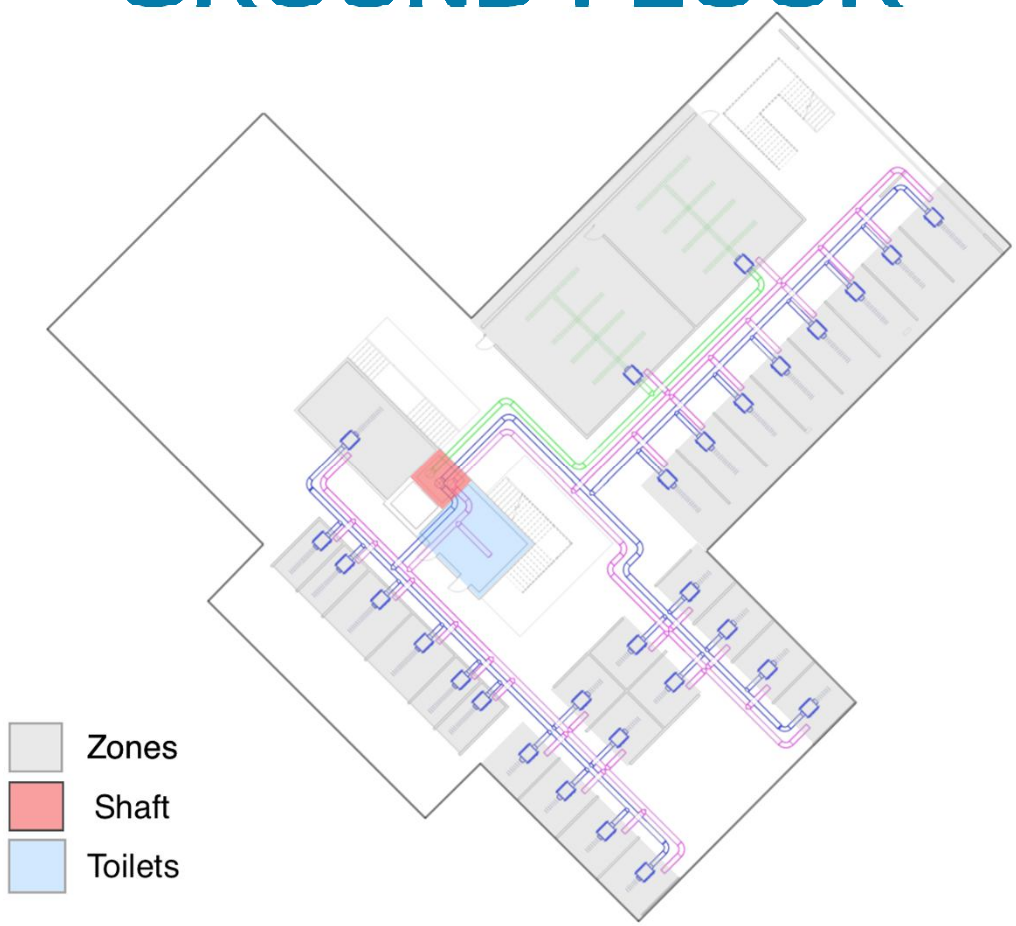
Shengnan Zhao, 3/17/2017

AHU AND HEAT PUMP

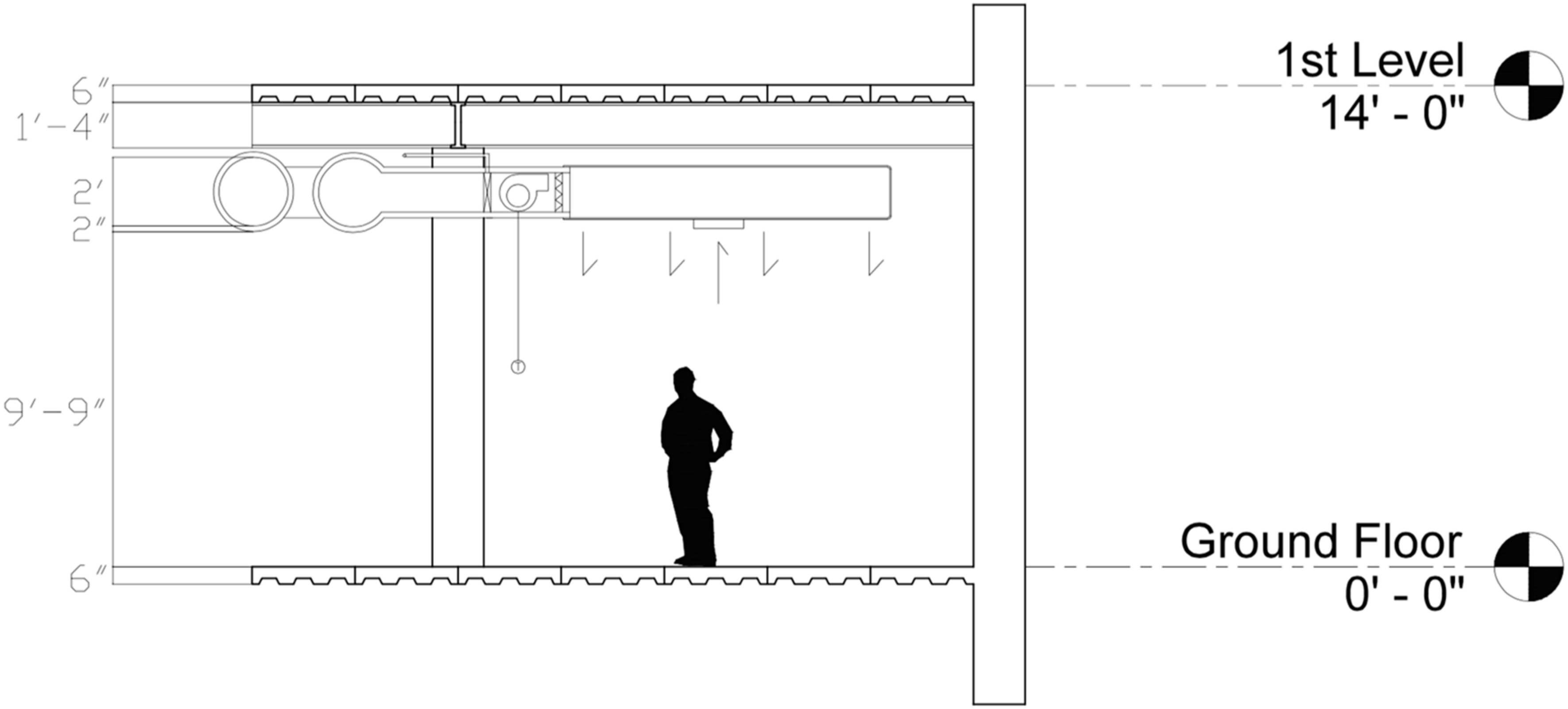
Primary system	Two AHU w. desiccant wheels Heat pump
Secondary system	Mechanical ventilation
Structural system	Steel



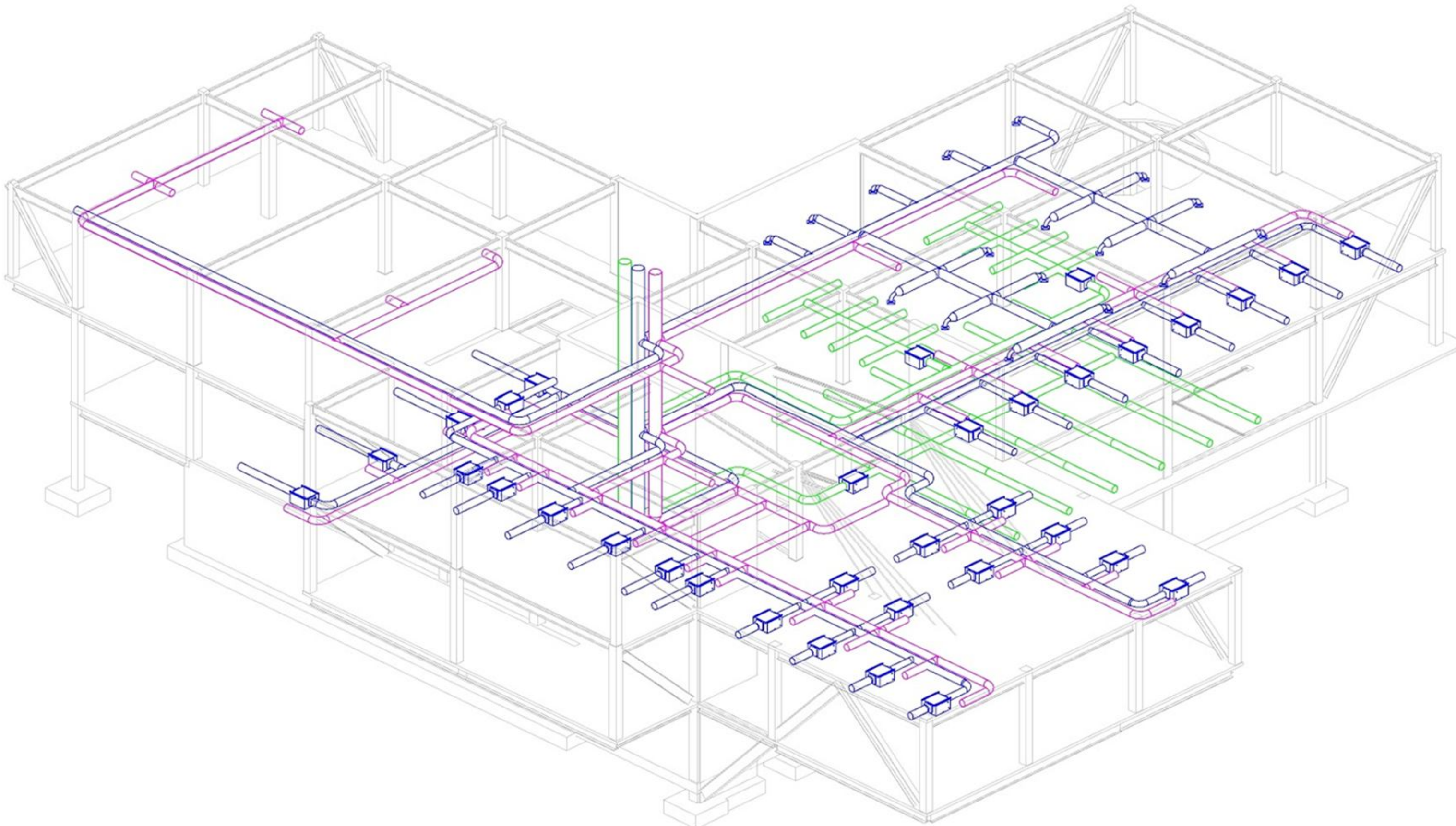
GROUND FLOOR



FLOOR SANDWICH

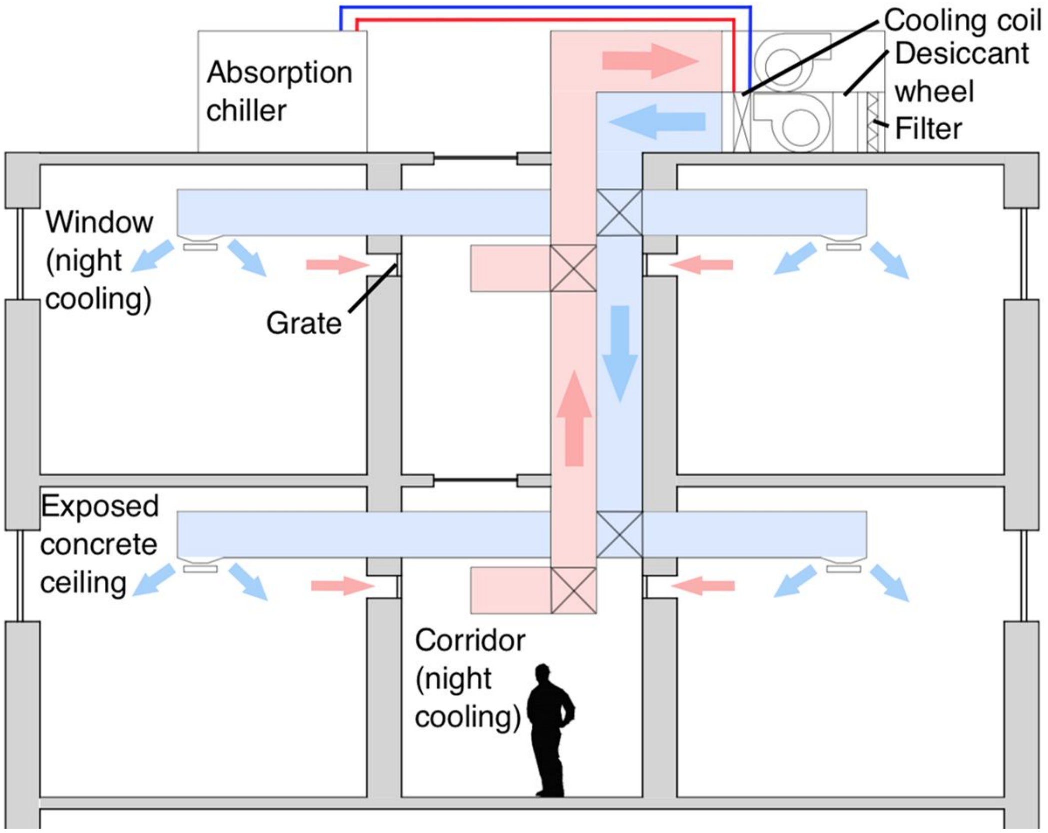


DISTRIBUTION TREE



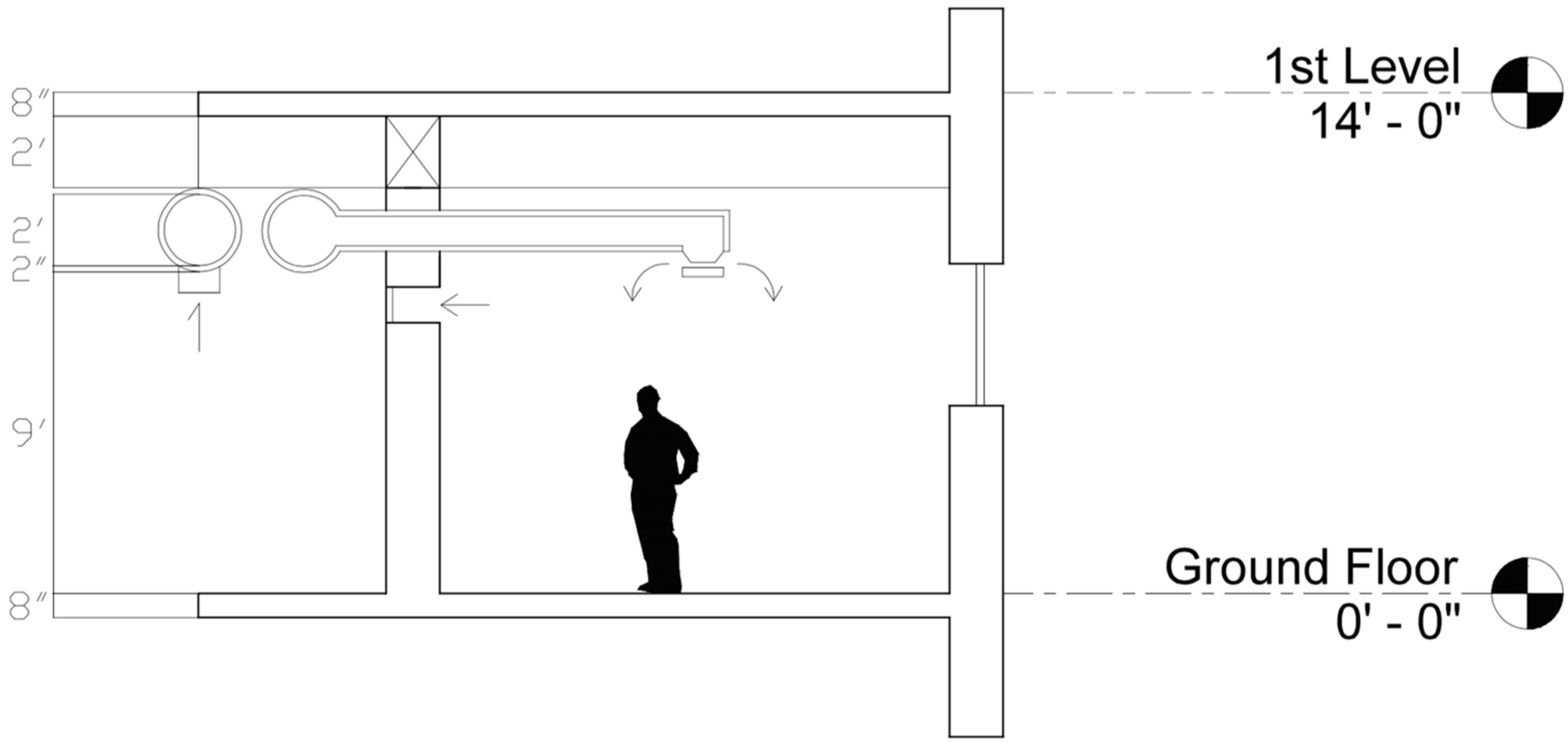
AHU AND ABSORPTION CHILLER

Primary system	Two AHU w. desiccant wheels Absorption chiller
Secondary system	Hybrid ventilation
Structural system	Concrete

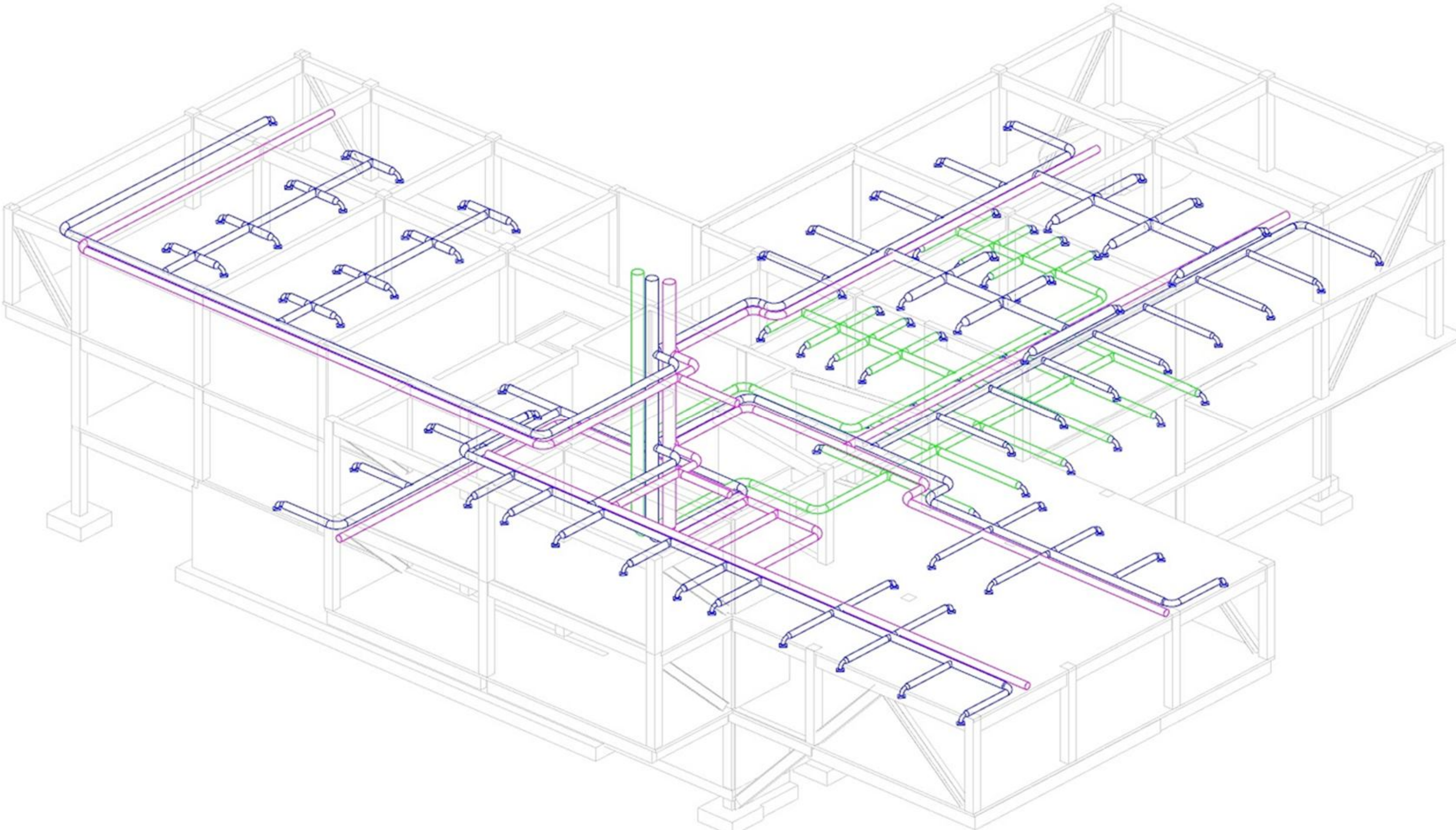


GROUND FLOOR

FLOOR SANDWICH



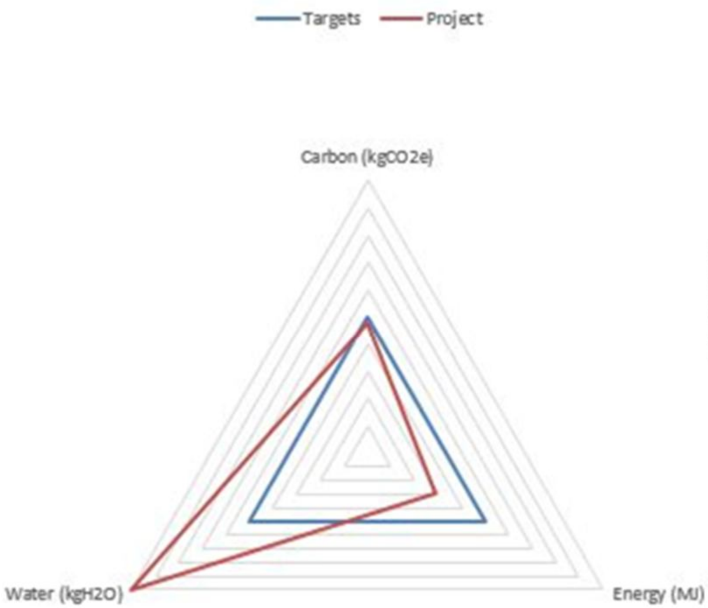
DISTRIBUTION TREE

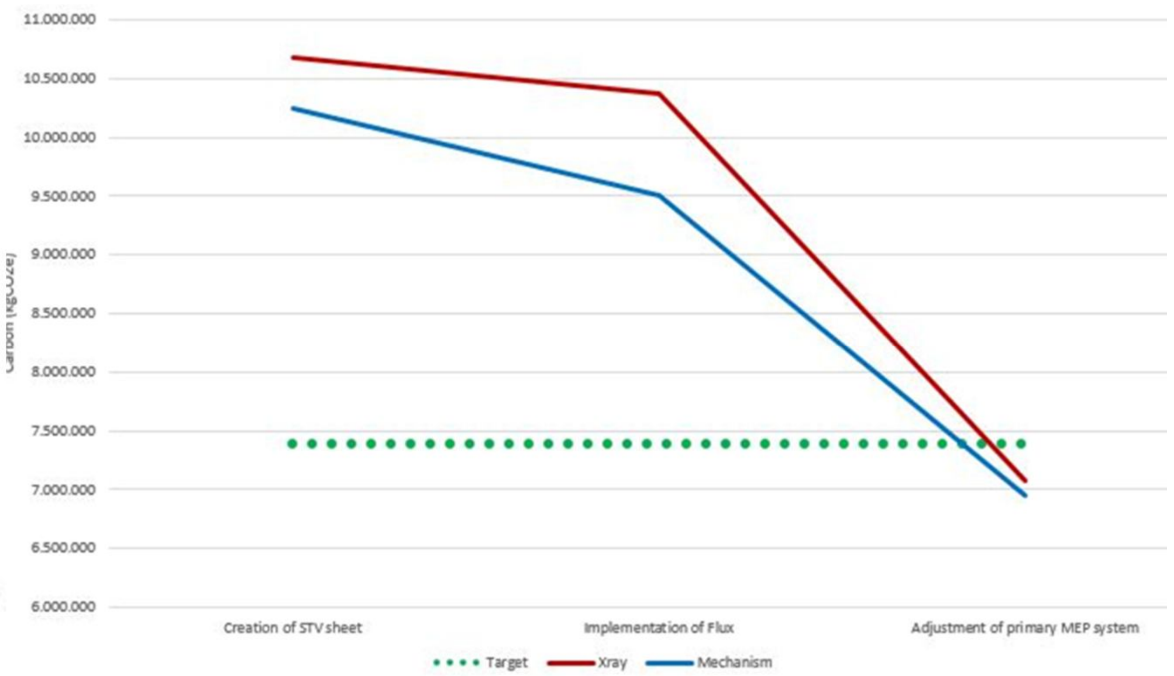


DECISION MATRIX

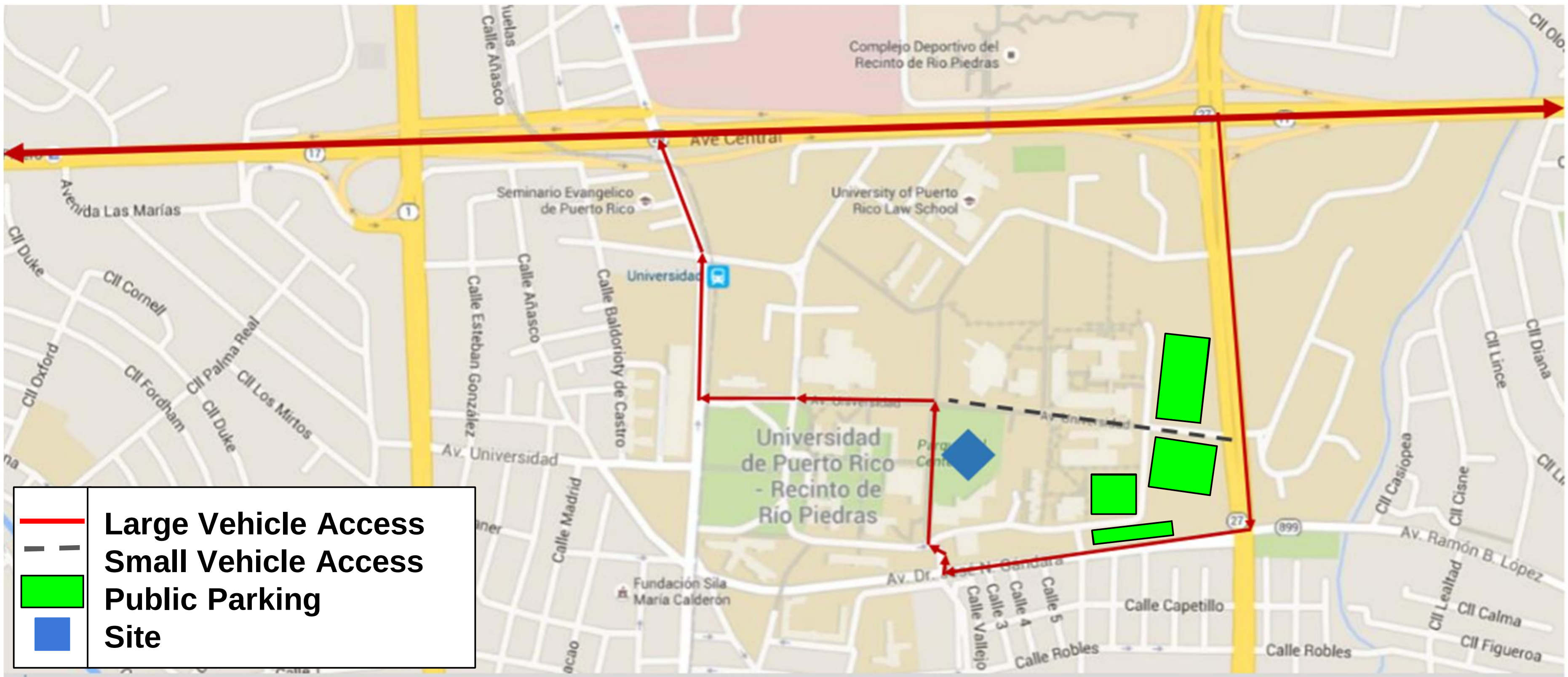
	AHU and Heat Pump	AHU and Absorption Chiller
Cost	High quantity of FCU's	Expensive chiller system
Sustainability	Uses wind	Uses sun
Comfort	Low impulse system Individual control	Supply air diffusers
Big Idea	Visible ducts in colors Individual control	Exposed ducts

IMPACT ON ENVIRONMENT

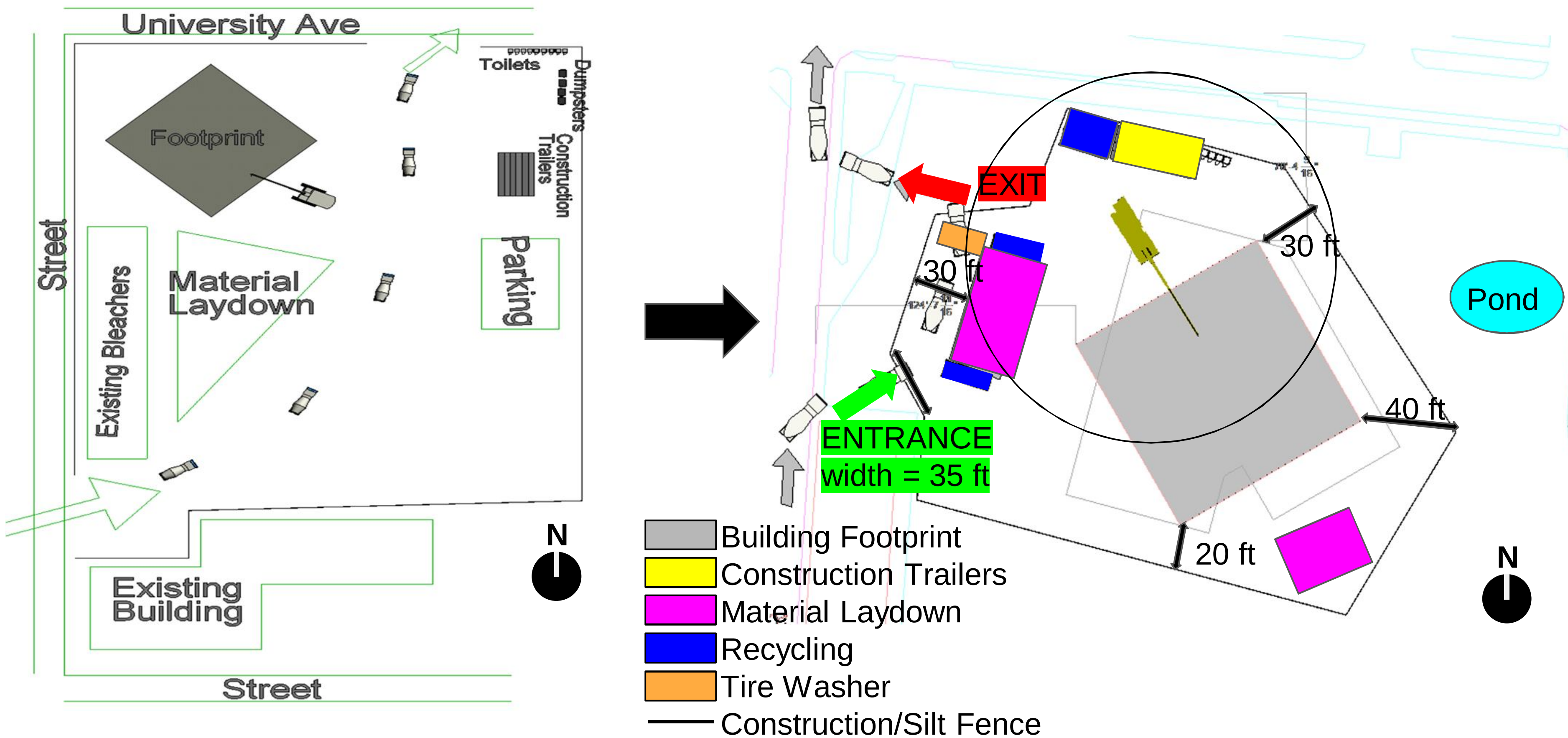




OFF SITE LOGISTICS



ON SITE LOGISTICS



CRANE SELECTION

Largest pick = concrete beam = 10,000lb
Radius = 85’
Boom = 104.5’
Height = 40’

CRANE SELECTION

Largest pick = concrete beam = 10,000lb
Radius = 85'
Boom = 104.5'

Pounds

Feet	42.3'	57.9'	73.4'	88.7'	104.5'	119.6'	134.7'	150.9'	166.4'	181.7'	196.9'
8	*300,000										
9	236,000										
10	217,000	199,000	186,000	143,000							
12	199,000	185,000	173,000	143,000							
15	173,000	165,000	154,000	143,000	110,000						
20	138,500	137,000	132,000	125,000	108,000	84,000	62,000	45,000			
25	108,000	109,500	110,000	109,500	98,000	78,000	62,000	45,000	35,200		
30	87,200	89,250	89,650	89,000	90,000	72,000	61,000	45,000	35,200	25,600	22,000
35		75,400	74,800	75,000	75,750	66,000	56,000	45,000	35,200	25,600	22,000
40		64,050	63,400	65,450	64,450	60,000	51,000	45,000	35,200	25,600	22,000
45		55,100	54,500	56,500	55,550	56,000	47,000	41,400	35,200	25,600	22,000
50			49,000	49,350	48,350	50,200	42,600	38,400	34,800	25,600	22,000
55			43,100	42,700	43,400	43,050	39,200	35,600	32,400	25,600	22,000
60				36,650	38,500	37,050	35,500	32,800	29,800	25,600	22,000
65				32,200	33,650	32,200	31,200	29,800	27,800	25,600	22,000
70				30,000	29,700	28,300	29,400	26,750	25,800	24,400	21,600
75					26,350	25,400	26,250	23,450	23,800	23,000	20,600
80					23,500	24,000	23,400	21,000	21,000	21,400	19,600
85					21,000	22,300	20,950	19,800	18,600	19,250	18,600
90					18,800	20,150	18,850	19,000	16,500	17,150	17,800
95						18,250	17,000	17,550	14,800	15,600	16,150
100						16,550	15,450	15,900	13,600	14,600	14,700
105							13,950	14,550	12,800	13,800	13,250
110							12,600	13,250	12,200	12,900	11,900

SUSTAINABILITY ON SITE

- Exterior walls made from 50-65% post consumer recycled material
- ENERGY STAR windows and doors
- LED lighting
- 8 solar panels
- Rain collecting gutters that produce water for watering plants

SAFETY

Monday morning safety meetings every week

Safety orientation for new crew members

Traffic management plan for walkers, bikers, vehicles.

MATERIAL/EQUIP. PROCUREMENT

Site

Equipment

Esmo Crane Corp.

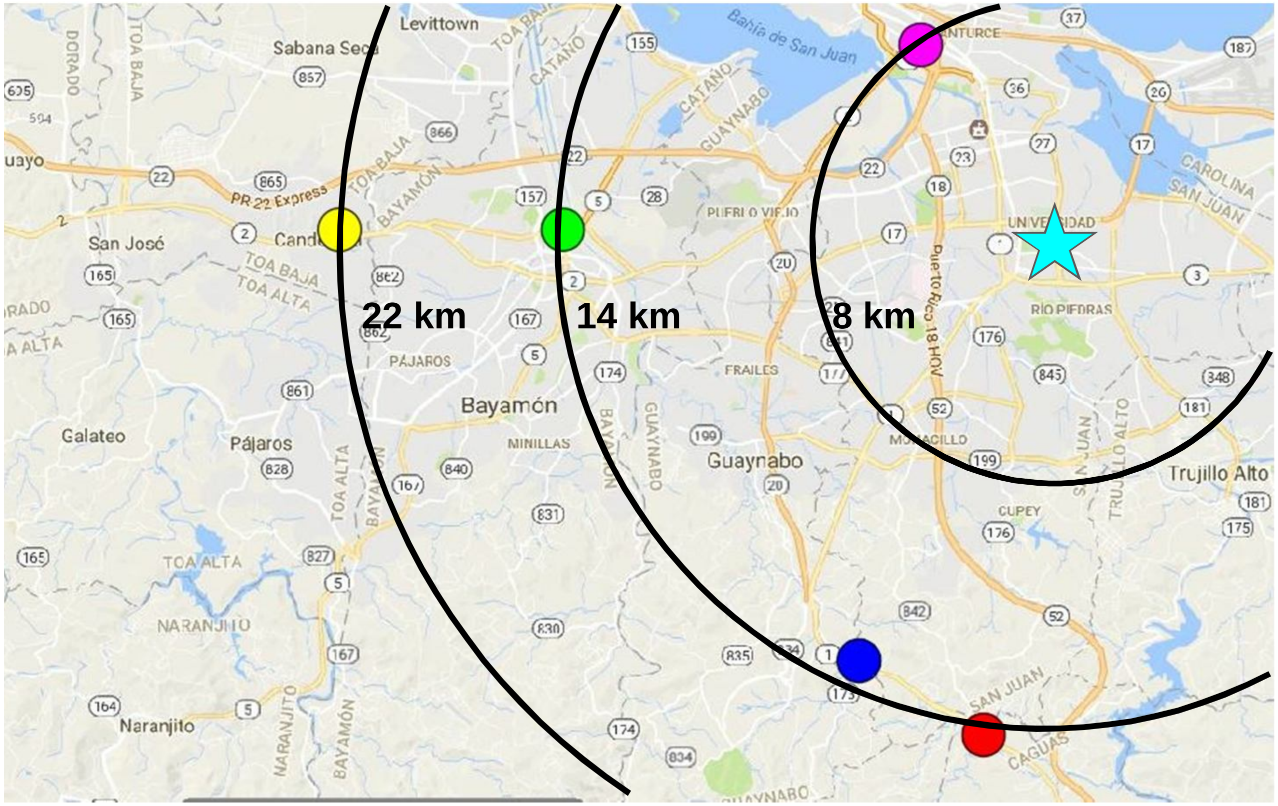
BlueLine Rental

Material

Steel & Pipes Inc.

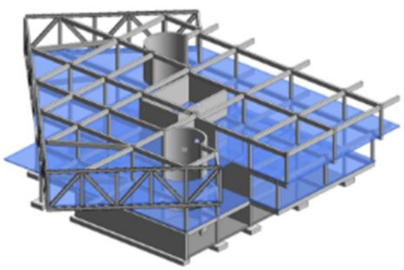
Cemex

United Glass Co.



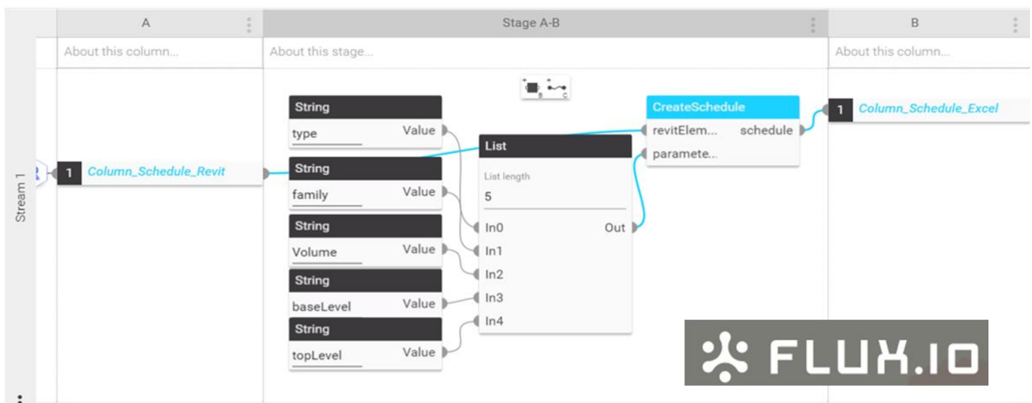
FLUX ENABLED TAKEOFF

AUTODESK
REVIT



Excel

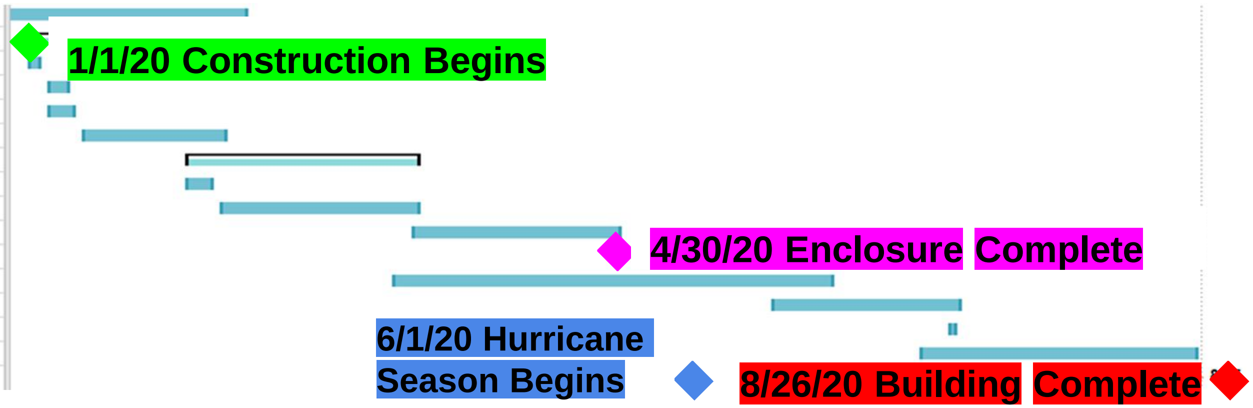
	U	V	W	X	Y
		Beams			
Elemen	Length	Volume	family	type	Weight (lbs)
600698	57	3.627314815	BG Joist Girder	24BG	1755.04
604840	57	3.627314815	BG Joist Girder	24BG	1755.04
604903	56.6875	3.607783565	BG Joist Girder	24BG	1745.59
605049	58	3.689814815	BG Joist Girder	24BG	1785.28
605105	57.984375	3.688838252	BG Joist Girder	24BG	1784.8075
605209	58	3.689814815	BG Joist Girder	24BG	1785.28
556357	35.25	2.097363414	W Shapes	W14X30	1014.7883
556359	21.35075893	1.203176354	W Shapes	W14X30	582.14485
556361	21.75	1.228943541	W Shapes	W14X30	594.61204



SCHEDULE

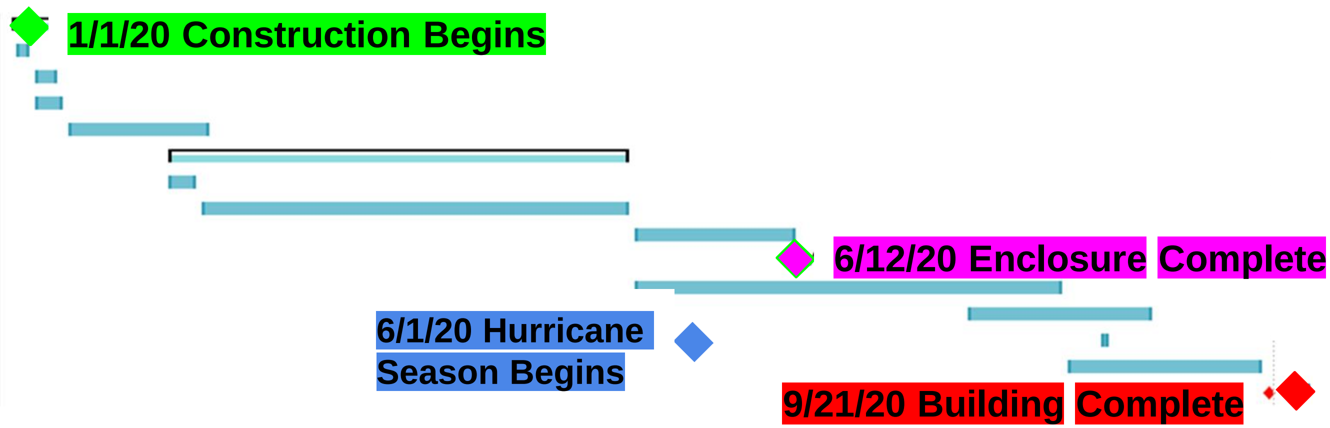
Utilize Prefab

Prefabrication Off Site	55 days	Mon 12/2/19	Fri 2/14/20
Mobilization	**8 days**	**Wed 1/1/20**	**Fri 1/10/20**
Tree Relocation	2 days	Thu 1/2/20	Fri 1/3/20
Fencing and Const. Trailers	4 days	Mon 1/6/20	Thu 1/9/20
Site Utilities	5 days	Mon 1/6/20	Fri 1/10/20
Excavation	21 days	Mon 1/13/20	Mon 2/10/20
Structure Construction	**35 days**	**Mon 2/3/20**	**Fri 3/20/20**
Pour Foundation and Slab	5 days	Mon 2/3/20	Fri 2/7/20
Structure Framing Construction	30 days	Mon 2/10/20	Fri 3/20/20
Building Enclosure	30 days	Fri 3/20/20	Thu 4/30/20
Enclosure Complete	0 days	Thu 4/30/20	Thu 4/30/20
MEP Installation	65 days	Mon 3/16/20	Fri 6/12/20
Interior Finishing	28 days	Mon 6/1/20	Wed 7/8/20
User Move-in	1 day	Tue 7/7/20	Tue 7/7/20
Comissioning/Testing	40 days	Wed 7/1/20	Tue 8/25/20
Building Complete	0 days	Wed 8/26/20	Wed 8/26/20



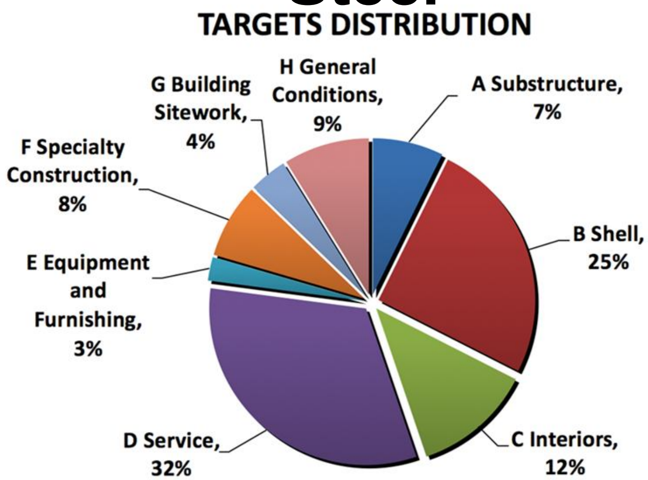
No Prefab

Mobilization	**8 days**	**Wed 1/1/20**	**Fri 1/10/20**
Tree Relocation	2 days	Thu 1/2/20	Fri 1/3/20
Fencing and Const. Trailers	4 days	Mon 1/6/20	Thu 1/9/20
Site Utilities	5 days	Mon 1/6/20	Fri 1/10/20
Excavation	21 days	Mon 1/13/20	Mon 2/10/20
Structure Construction	**70 days**	**Mon 2/3/20**	**Fri 5/8/20**
Pour Foundation and Slab	5 days	Mon 2/3/20	Fri 2/7/20
Structure Framing Construction	65 days	Mon 2/10/20	Fri 5/8/20
Building Enclosure	25 days	Mon 5/11/20	Fri 6/12/20
Enclosure Complete	0 days	Fri 6/12/20	Fri 6/12/20
MEP Installation	65 days	Mon 5/11/20	Fri 8/7/20
Interior Finishing	28 days	Mon 7/20/20	Wed 8/26/20
User Move-in	1 day	Mon 8/17/20	Mon 8/17/20
Comissioning/Testing	30 days	Mon 8/10/20	Fri 9/18/20
Building Complete	0 days	Mon 9/21/20	Mon 9/21/20

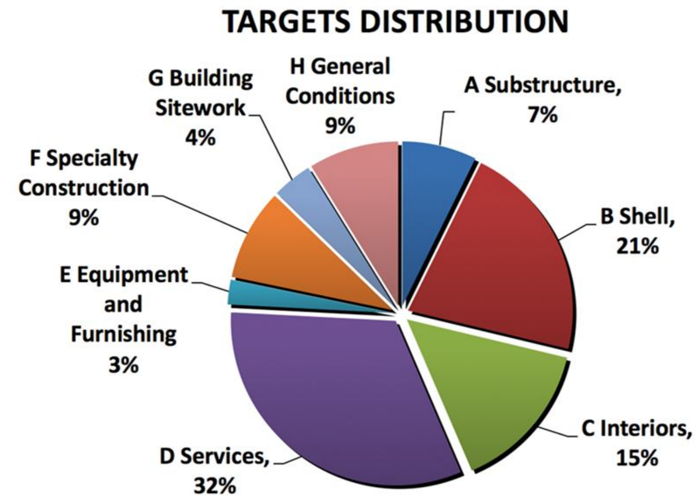


TVD TARGETS

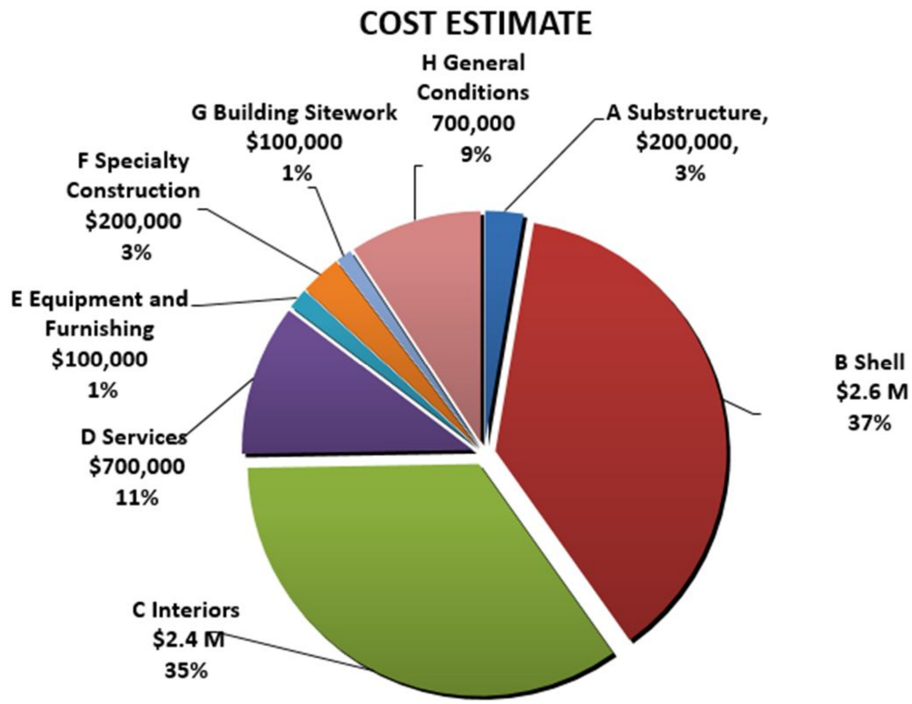
Steel



Concrete



TVD ESTIMATE

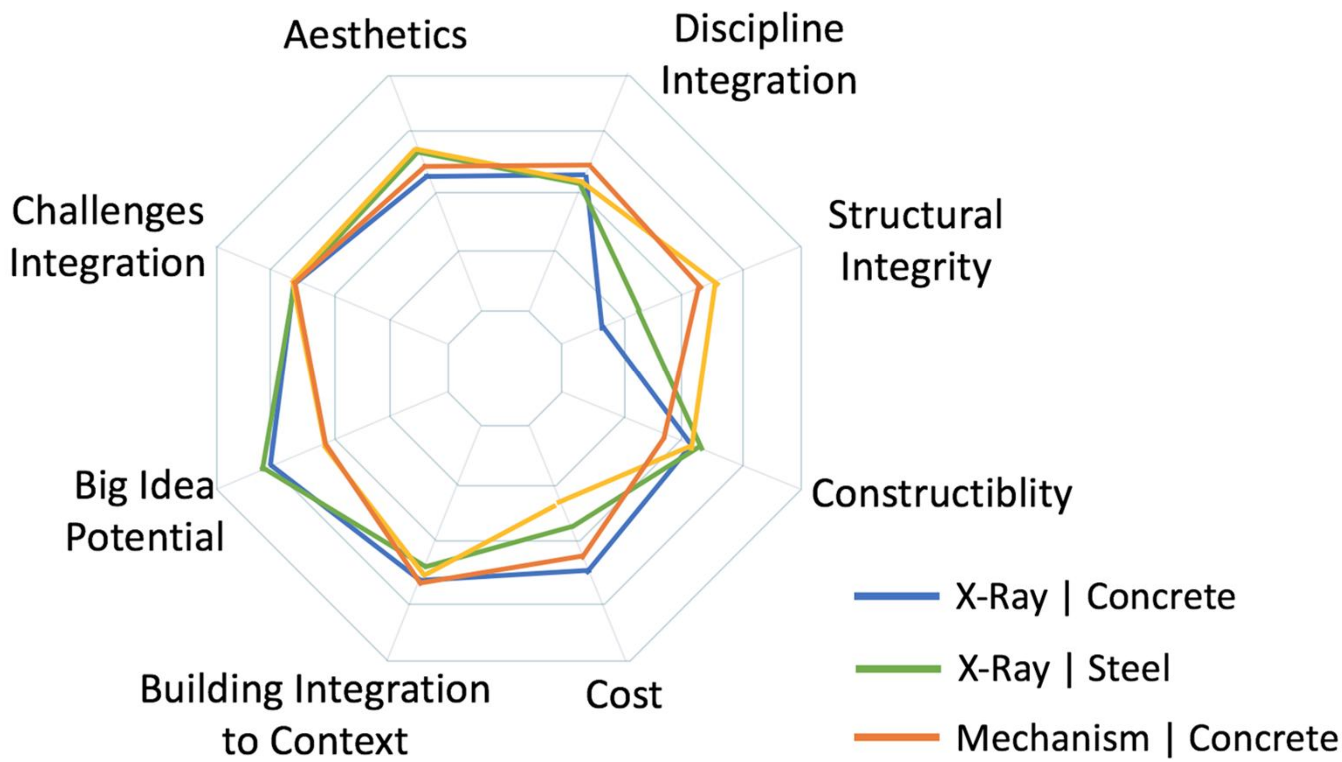


DECISION MATRIX

MECHANISM

VS

X-RAY



DECISION MATRIX

MECHANISM

VS

X-RAY

		X-Ray		Mechanism	
	Weight	**Concrete**	**Steel**	**Concrete**	**Steel**
Aesthetics	8%	6.75	7.25	7.00	7.38
Discipline Integration	15%	6.75	6.125	6.75	6.25
Structural Integrity	20%	3.88	4.63	[redacted]	[redacted]
Constructability	10%	6.13	6.50	5.63	6.38
Cost	5%	7.00	5.50	6.50	4.25
Building Integration to Context	7%	7.25	7.00	7.25	7
Big Idea Potential	25%	[redacted]	[redacted]	6.25	6.25
Challenges Integration	10%	7.25	7.25	7.25	7.25
Total	100%	6.60	6.70	7.72	6.69

WINNER

STRUCTURAL INTEGRITY

MECHANISM CONCRETE

BIG IDEA POTENTIAL

X-RAY

THANK YOU!

MECHANISM

X-RAY

A // SE // MEP / CM //