

TEAM PACIFIC



Team Pacific



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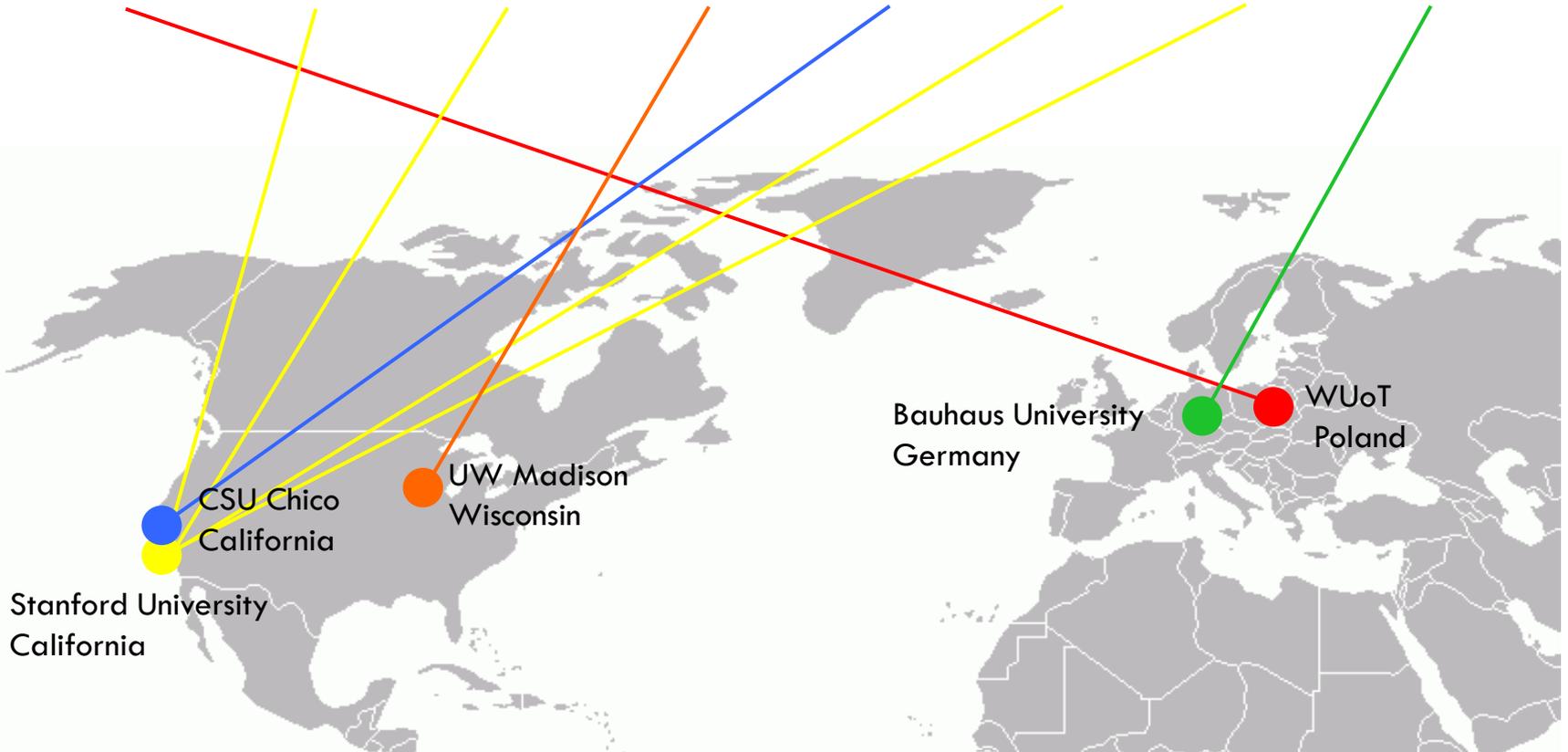
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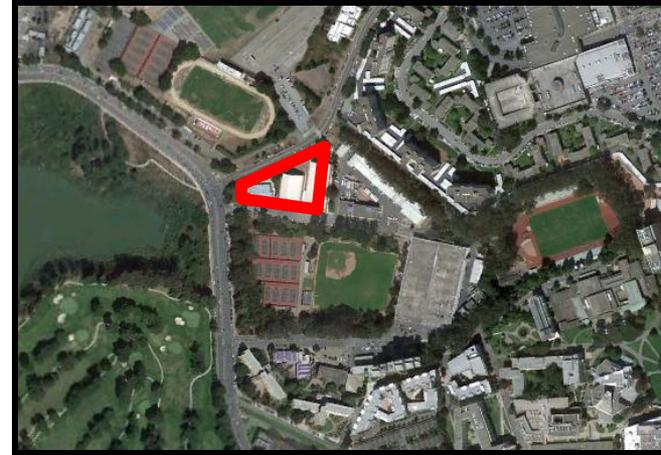
LCFM



Site- San Francisco State University



Lake View



San Francisco State Campus



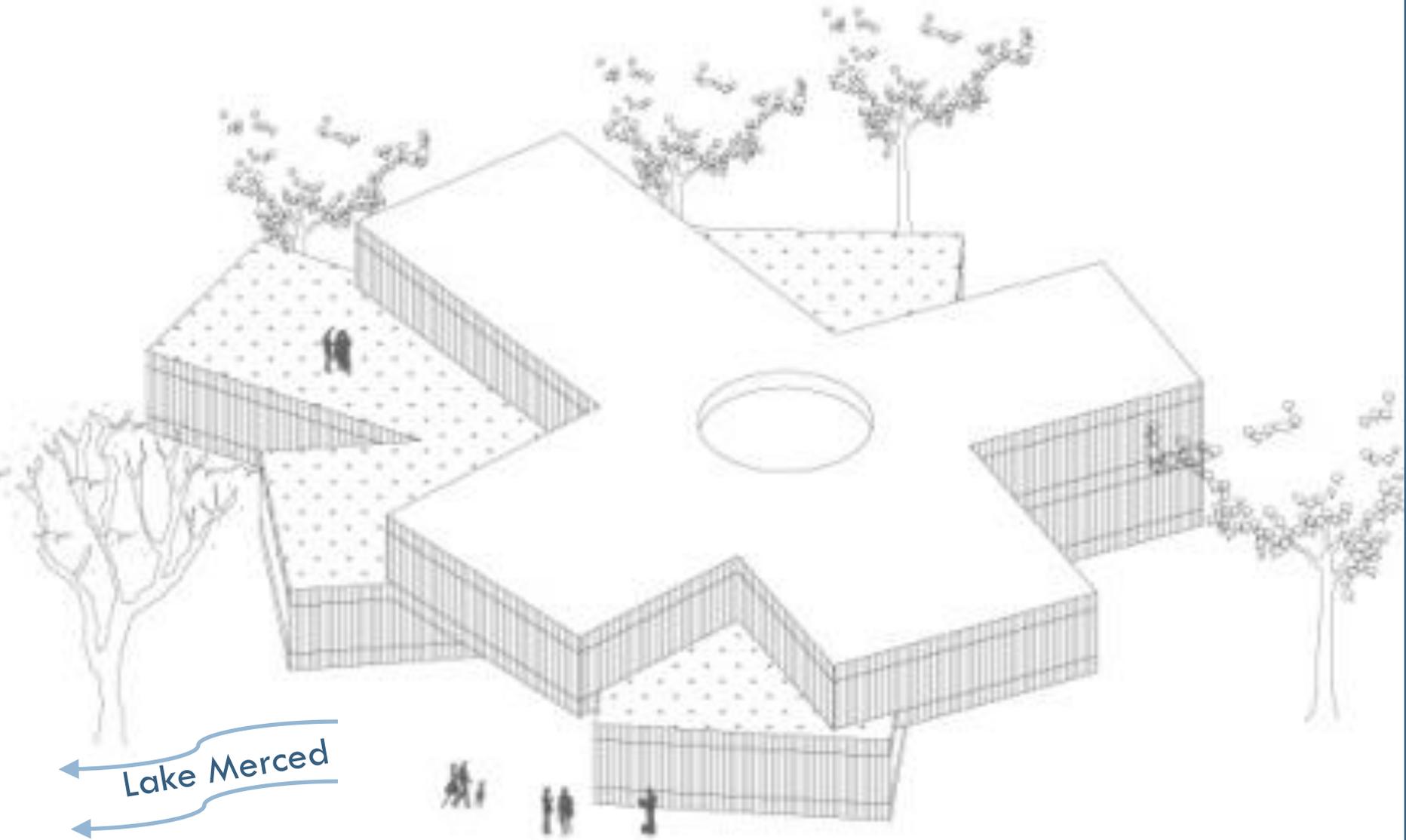
Our Site



Seismic Challenge



Clockwork



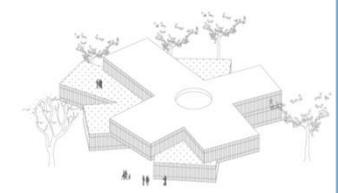
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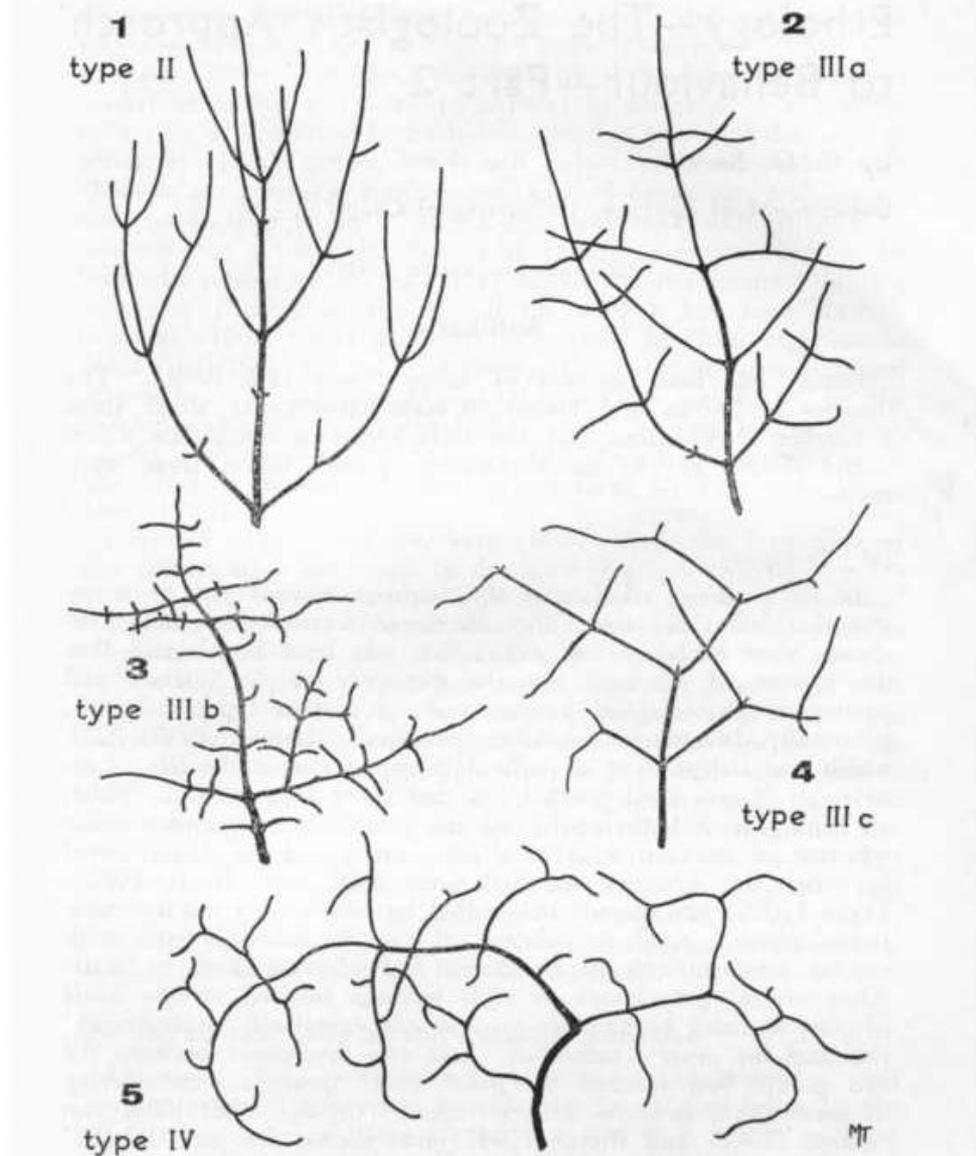
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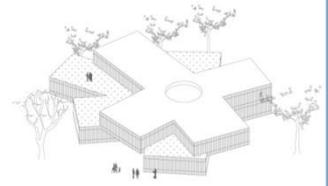
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Branching Patterns





Site Location



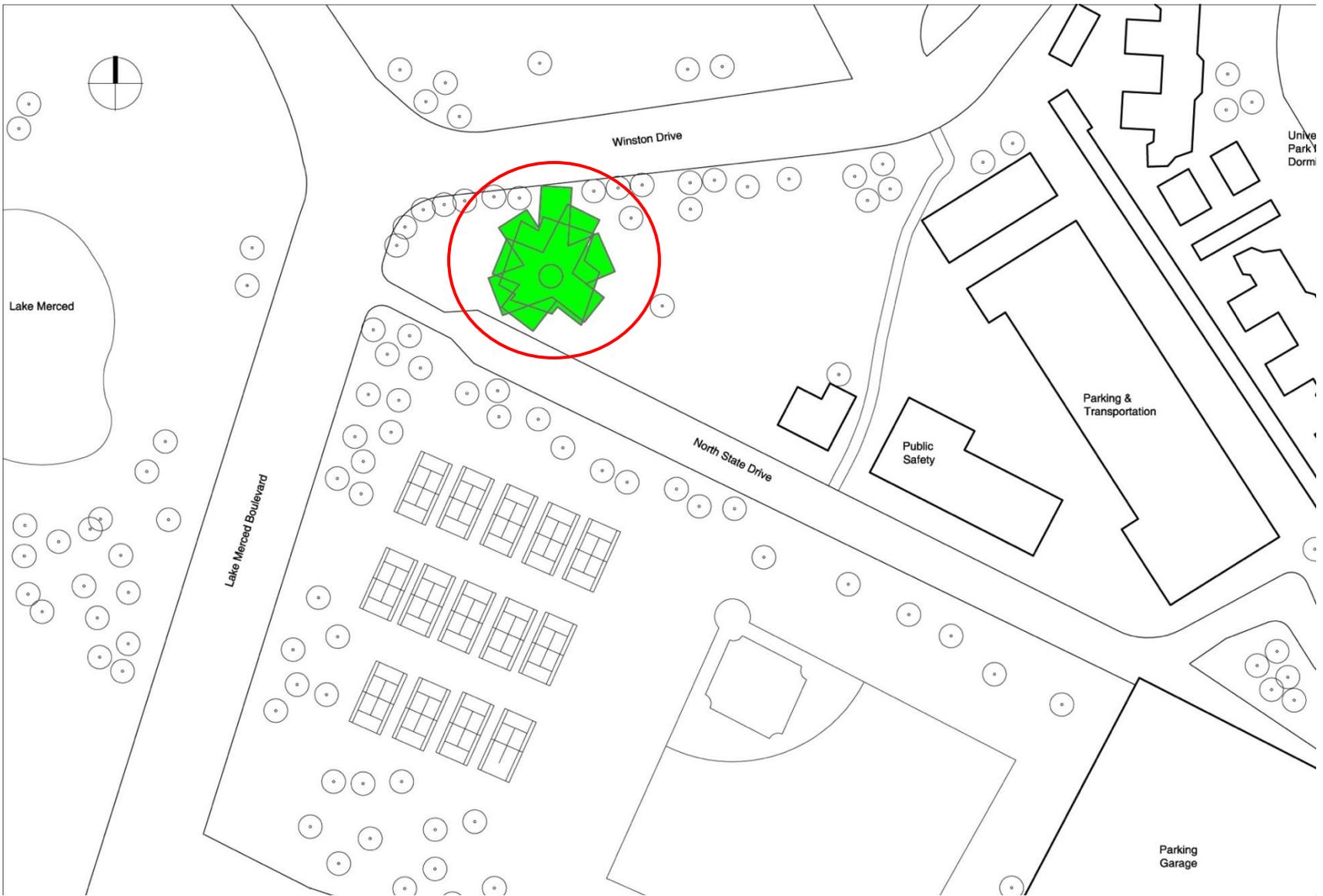
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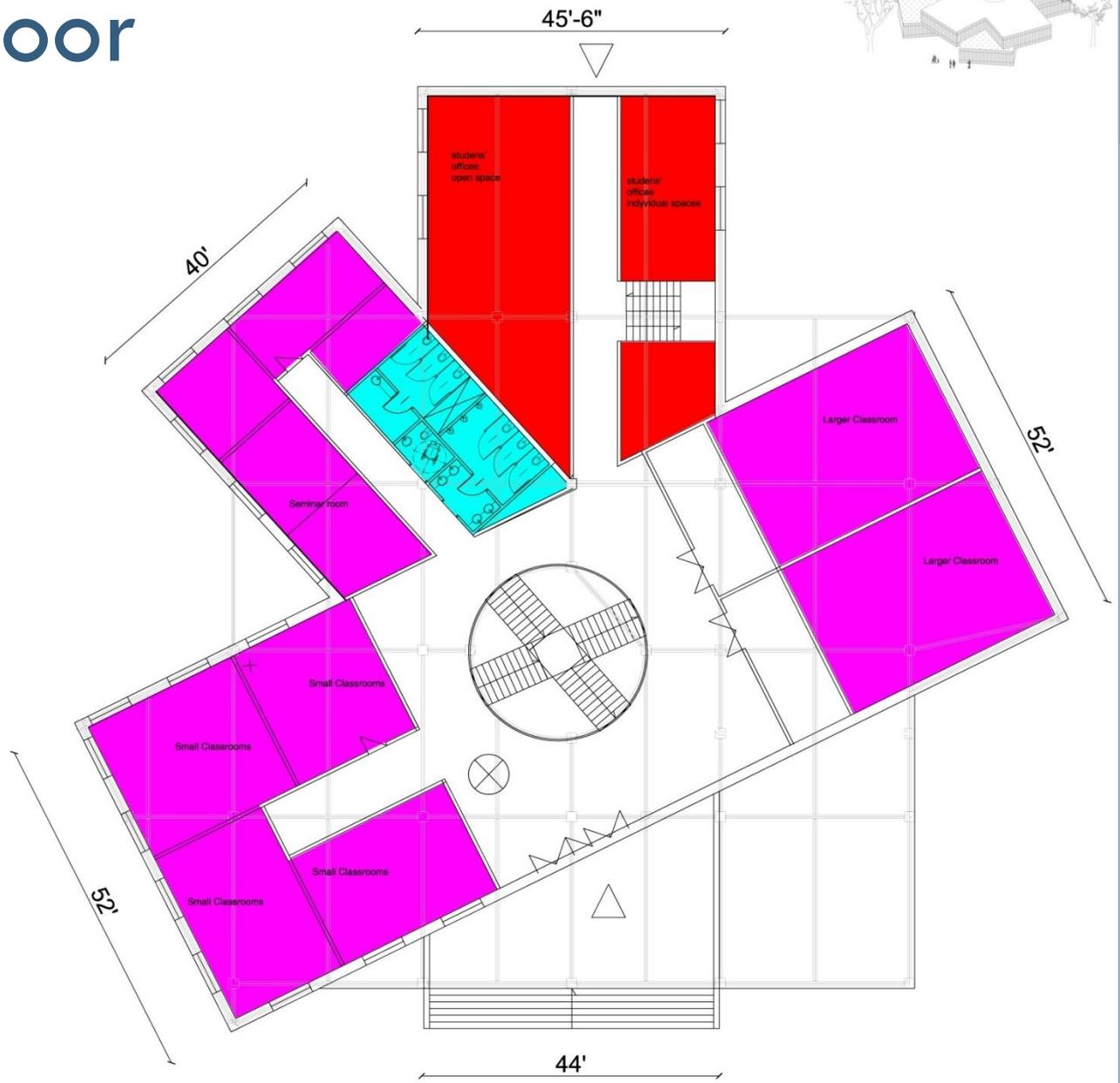
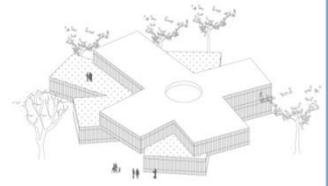
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Second Floor



-  Instructional Labs
-  Classes and Seminar Rooms
-  Toilets

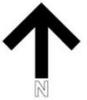
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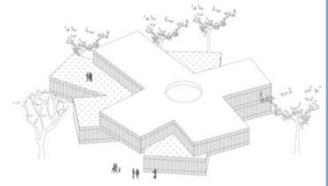
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First Floor



-  Instructional Labs
-  Lobby
-  Auditorium
-  Server Room
-  Toilets



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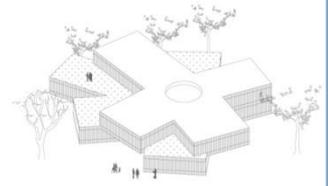
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Third Floor



-  Faculty Offices
-  Faculty Lounge
-  Terrace
-  Toilets

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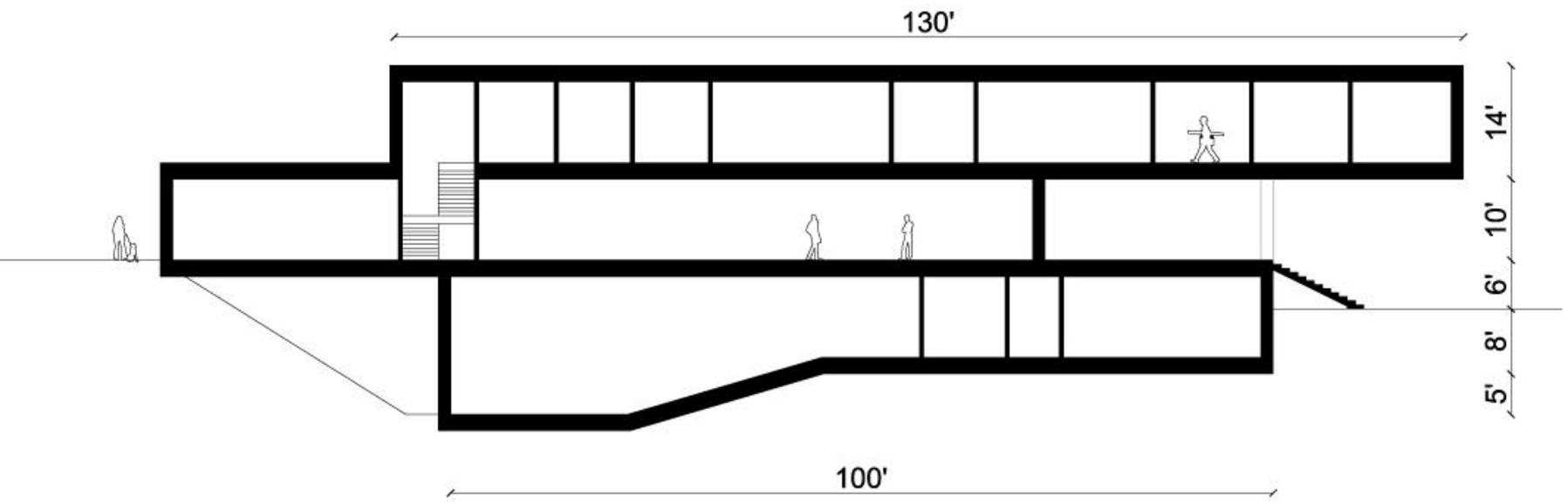
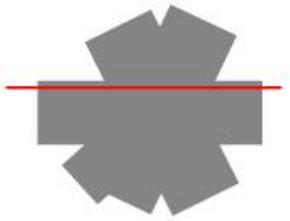
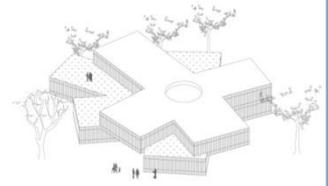
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Section



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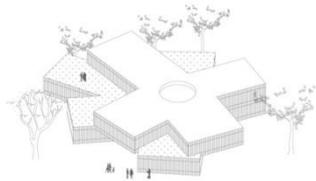
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Loads & Soil Profile



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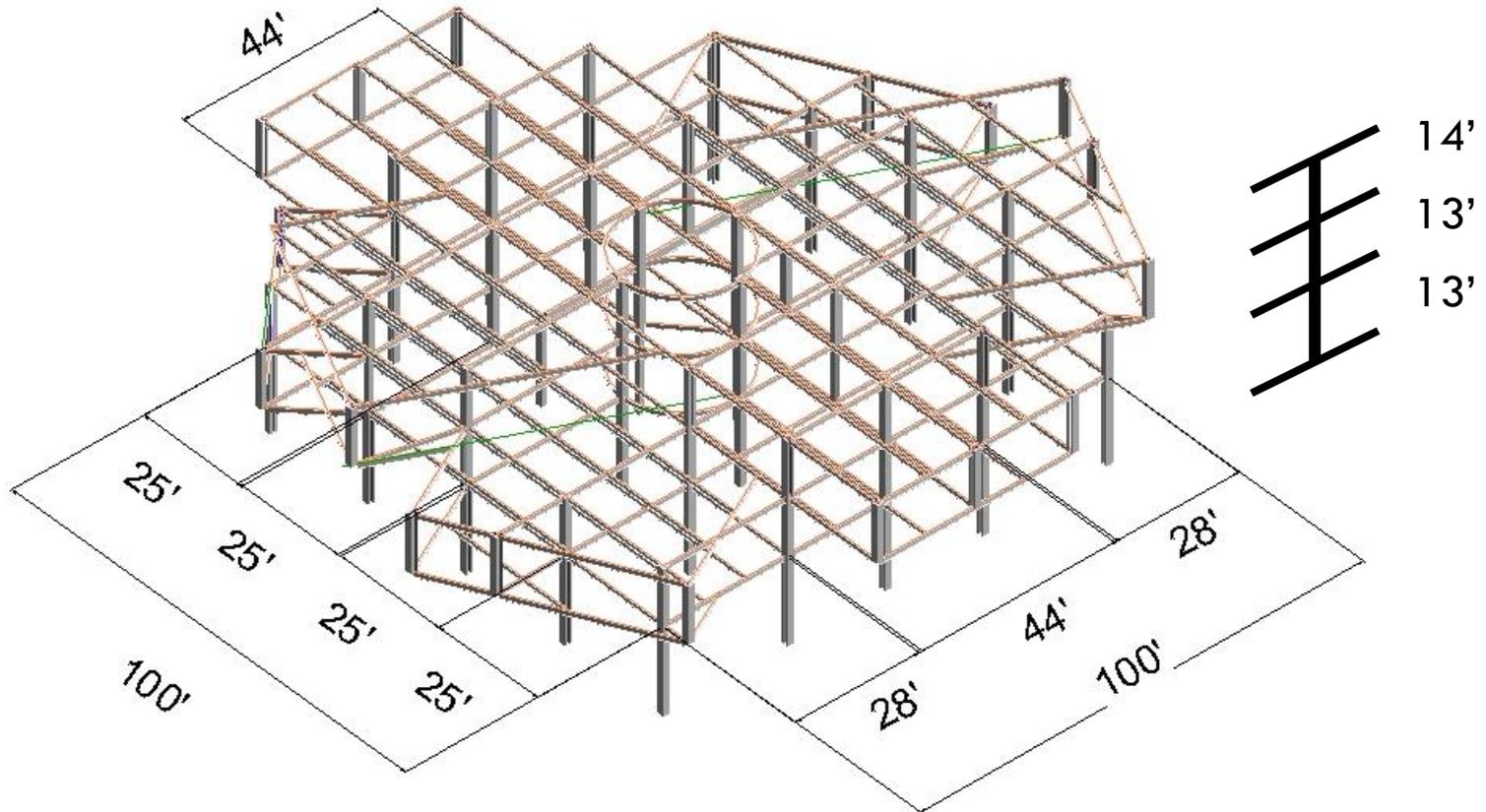
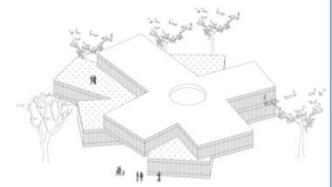
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Live Load	psf
Office	50
Classroom	40
Storage (light)	125
Large Classroom	60
Lobby	100
Construction	20
Corridors	80

Soil Conditions
Well sorted fine to medium sand
Bearing Capacity: 3500psf
Not in Liquefaction Zone
Water Table: 14ft below grade

Seismic Loads	
$S_{ds} = 1.349$	Site Class D
$S_{d1} = 1.085$	
Seismic controls over wind	

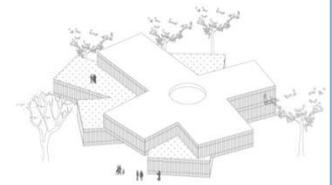
Clockwork



Challenges:

- Irregular floors
- Lack of continuous frames or walls for lateral system
- Spanning Auditorium

Clockwork



	ConXtech Moment Frame	Reinforced Concrete
Gravity System	Steel	Concrete
Lateral System	ConXtech Steel Moment Frame	Concrete Special Moment Frame
Floor System	Concrete Metal Deck	Flat Slab

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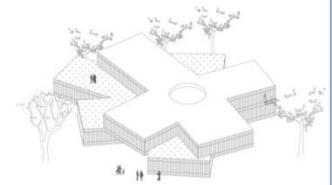
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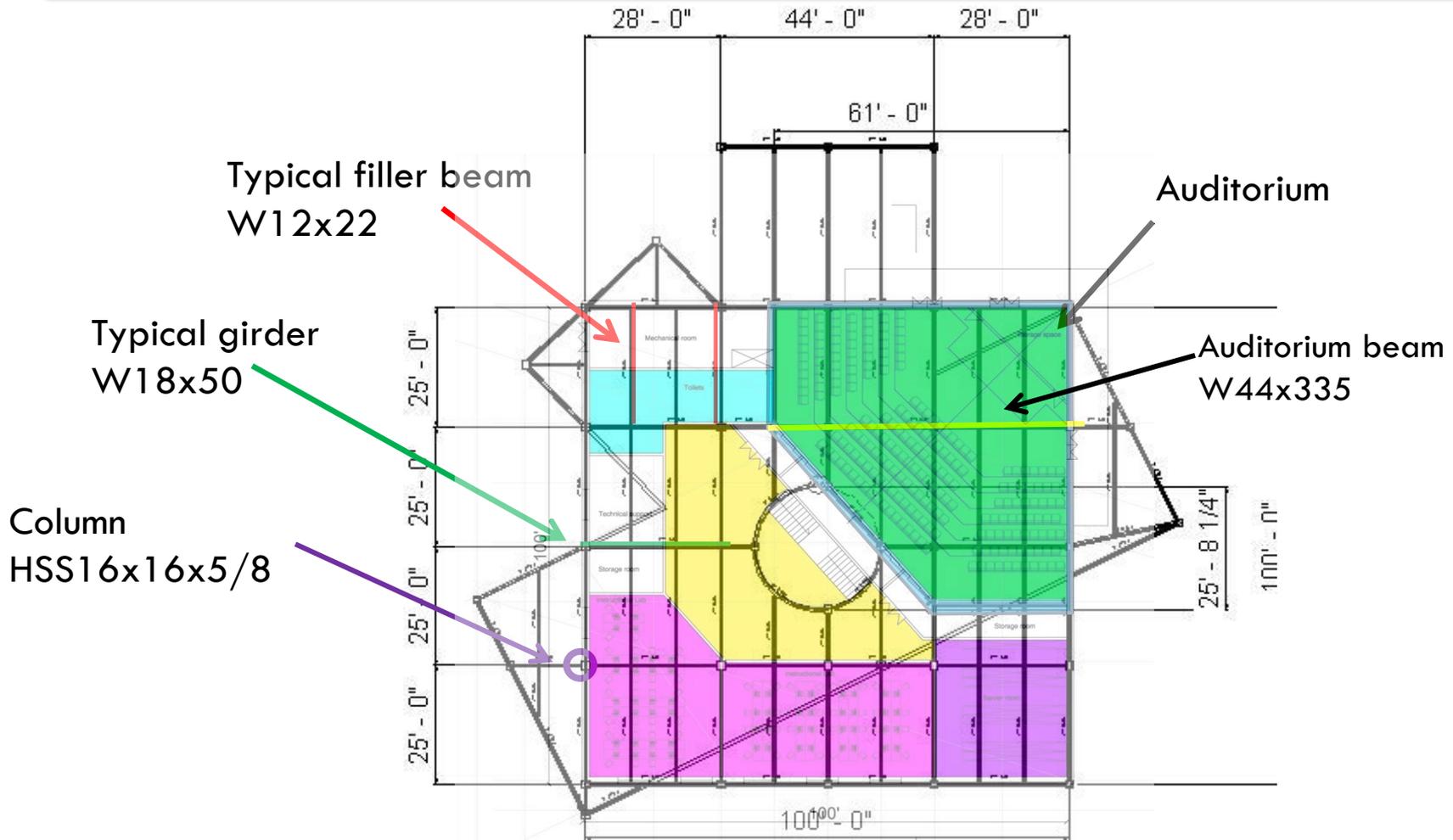
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System 1 – ConXtech Frame

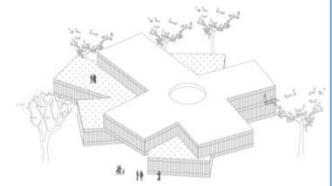
Floor 1



Challenge: Create simple floor system for irregular floor plan

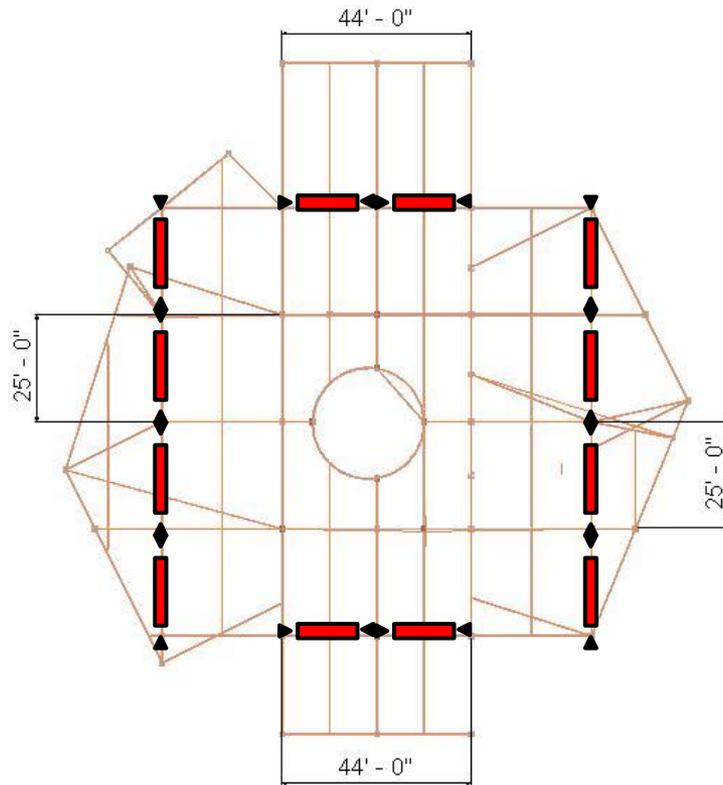


System 1 – ConXtech Frame Lateral System



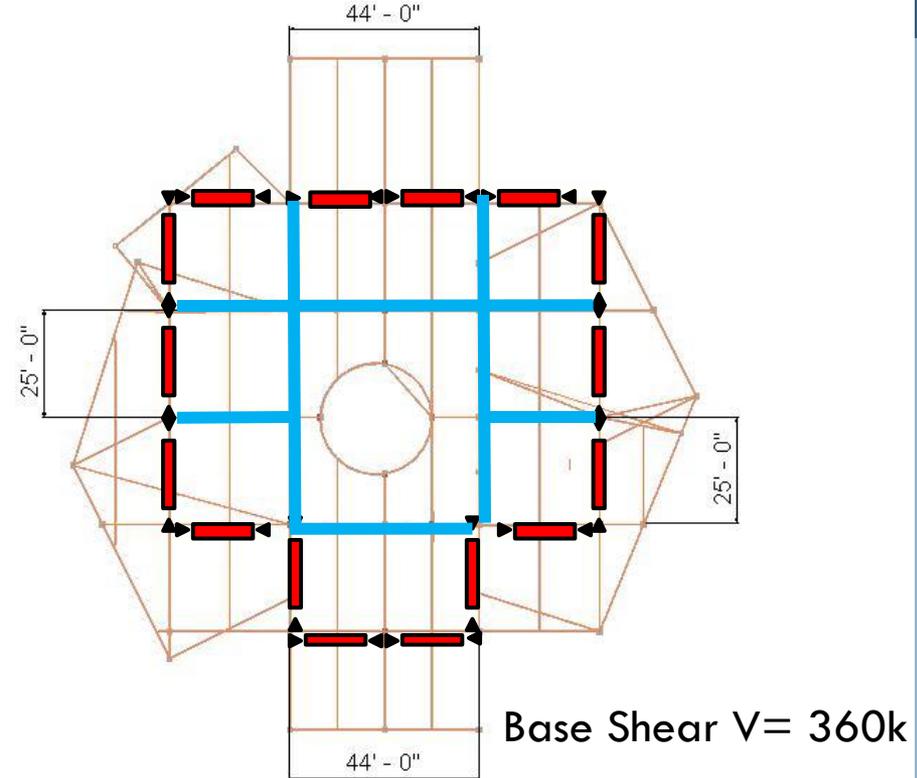
Challenge: Place lateral system with few continuous frames

Traditional Moment Frame



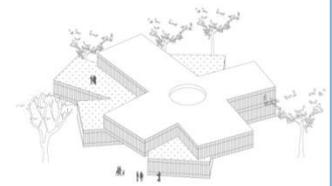
Short Frames in East-West Direction

ConXtech



More frames are possible

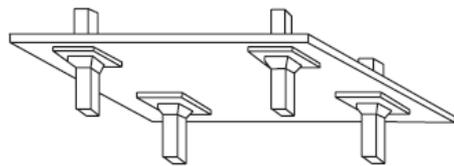
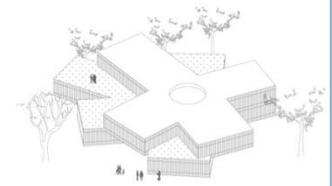
ConXtech frame



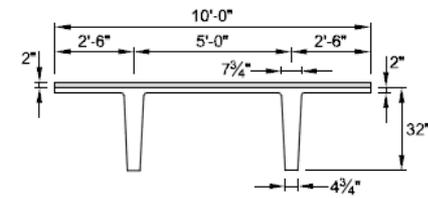
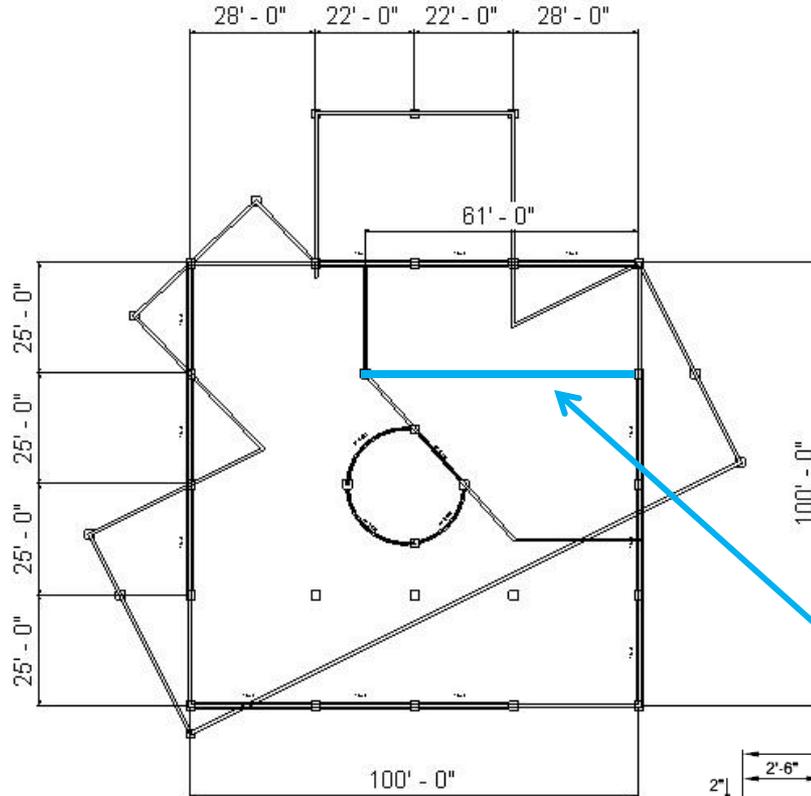
Pros	Cons
<ul style="list-style-type: none">• Simplified Moment Connections	<ul style="list-style-type: none">• Irregular Floor Plan
<ul style="list-style-type: none">• Less Welding	<ul style="list-style-type: none">• Drift
<ul style="list-style-type: none">• Faster Erection Time	<ul style="list-style-type: none">• Large Auditorium Span
<ul style="list-style-type: none">• Allows For Open Floor Plans	<ul style="list-style-type: none">• Lack of Continuous Columns
<ul style="list-style-type: none">• Center Has Regular Floor Plan	
<ul style="list-style-type: none">• Short Cantilevers	

System 2 – Concrete

Floor 1



Flat Slab

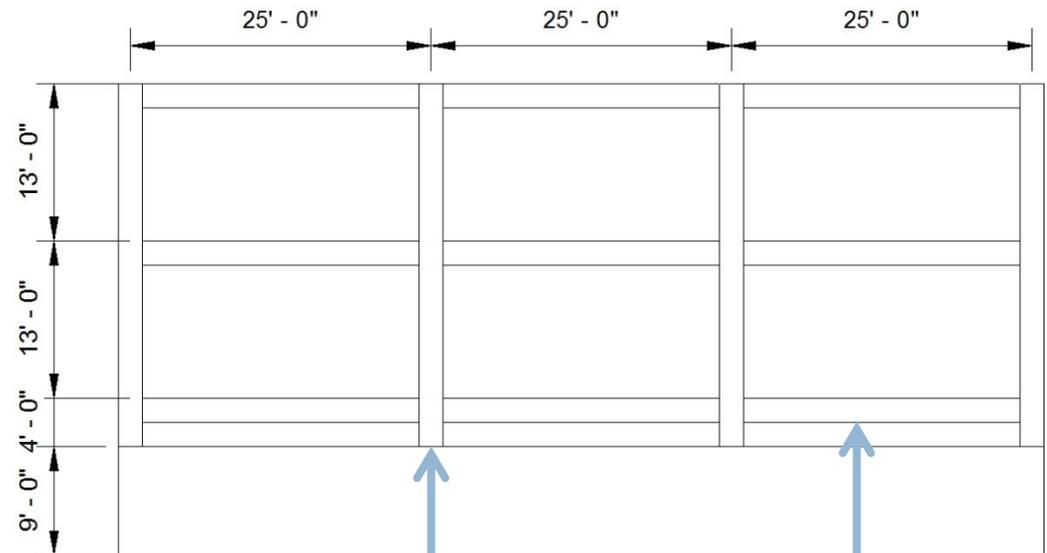
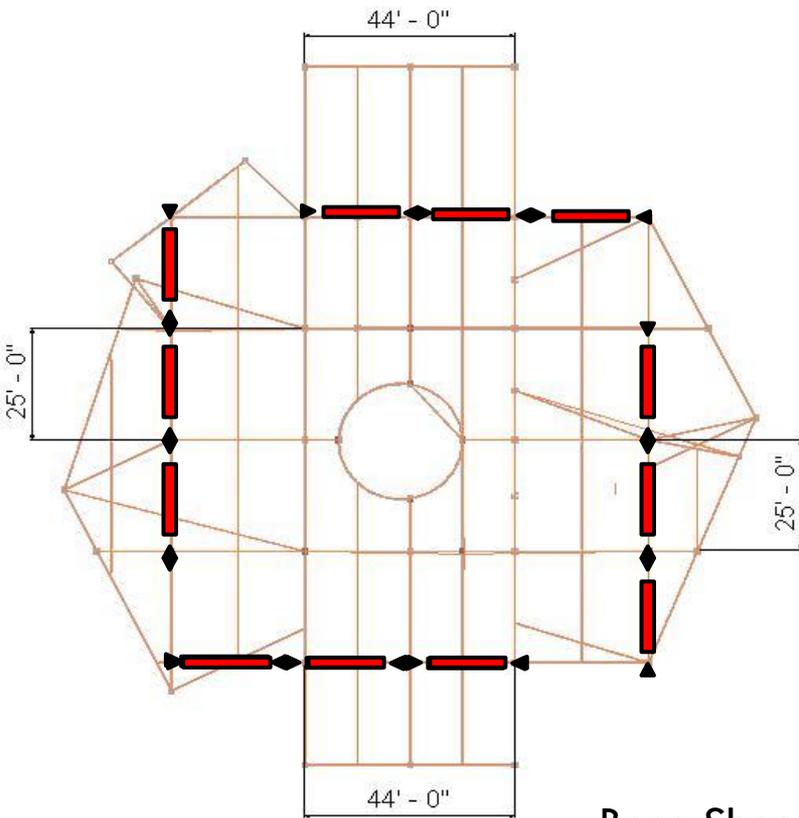
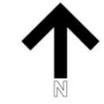
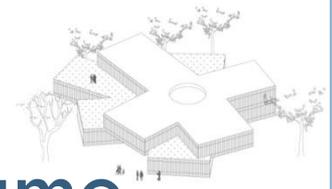


8" slab required. 16" x 16" typical columns

10DT32 with 128-S Strand Pattern

System 2 – Concrete

Lateral System Concrete Moment Frame

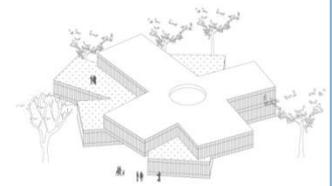


Column:
24" x 24"

Beam:
18" x 24"

Base Shear $V = 465k$

System 2 – Concrete



Pros	Cons
<ul style="list-style-type: none">Cheaper material	<ul style="list-style-type: none">Large auditorium span
	<ul style="list-style-type: none">Constructability
	<ul style="list-style-type: none">Performance
	<ul style="list-style-type: none">Poor repairability after earthquake
	<ul style="list-style-type: none">Column transfer over auditorium

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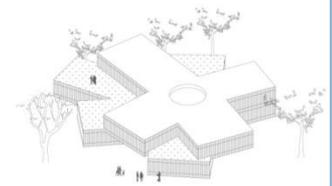
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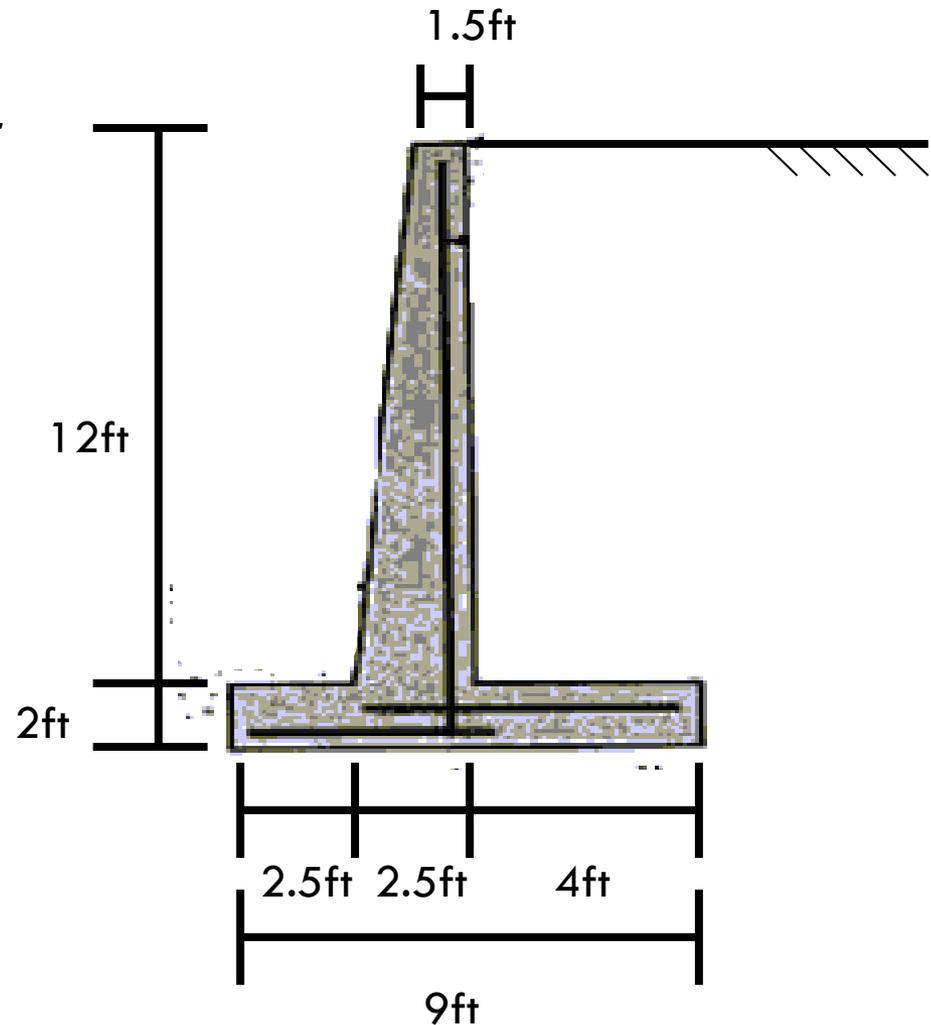
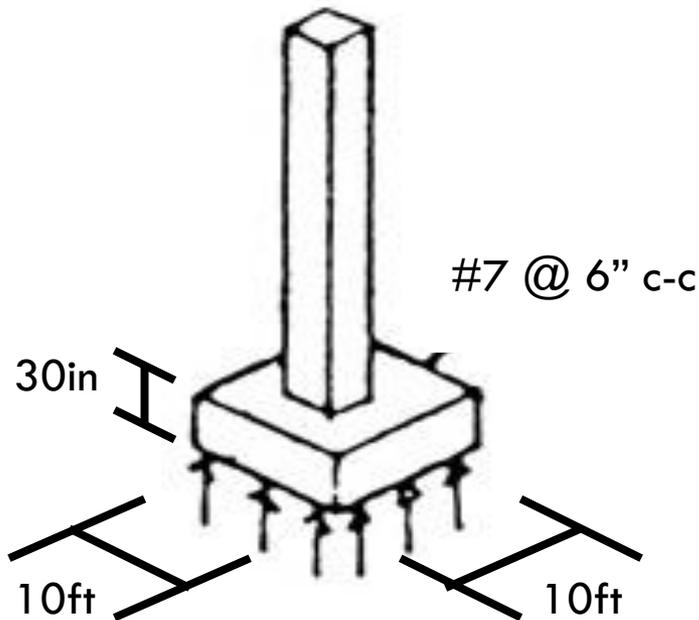
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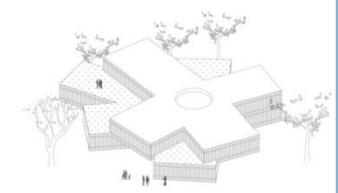
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Foundation Solutions



- Retaining Wall
- Strip Footings along Exterior
- Spread Footings for Interior Columns





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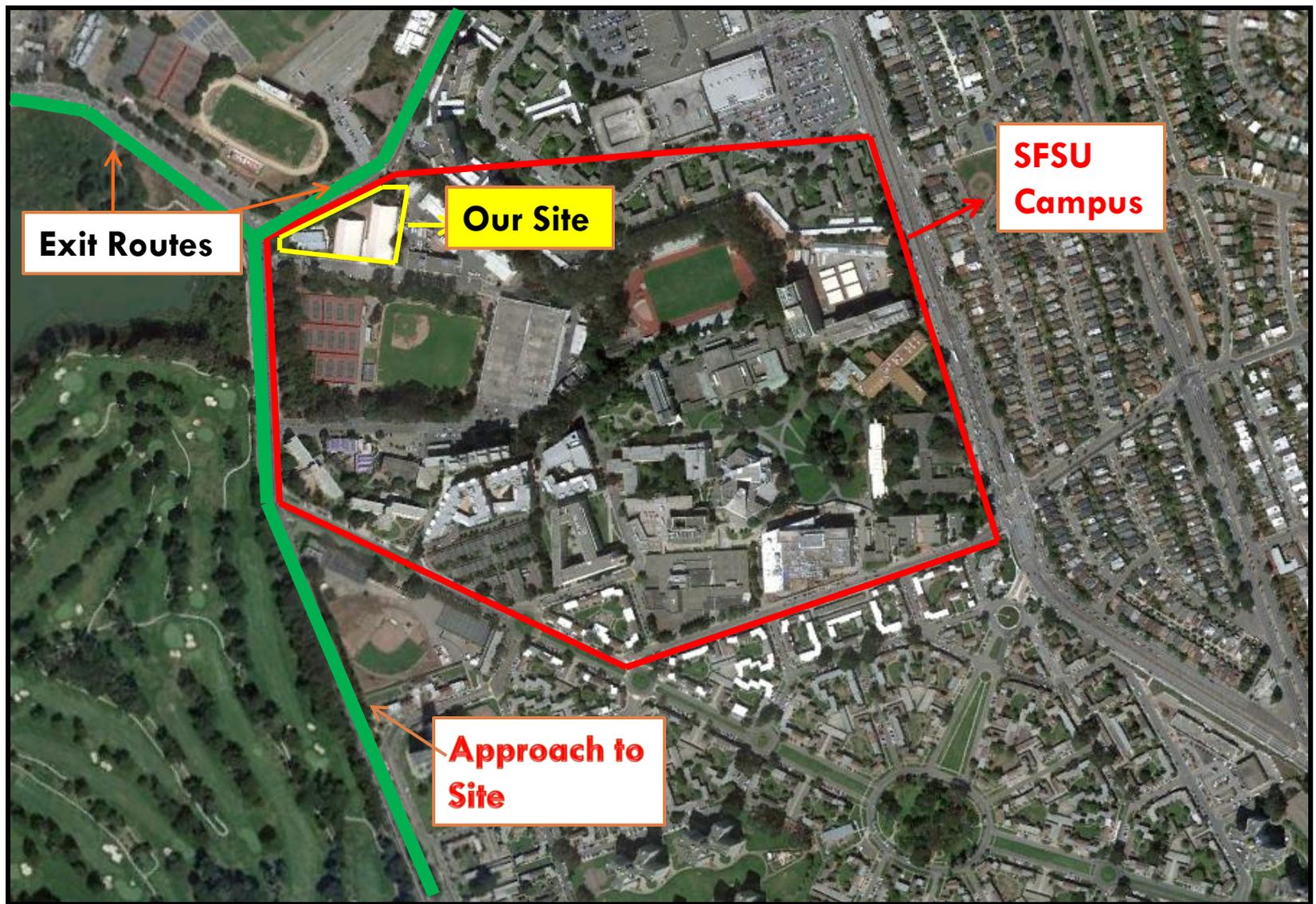
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Site Access



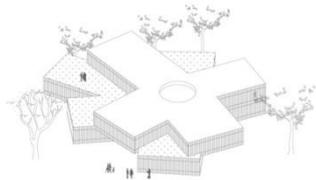
Exit Routes

Our Site

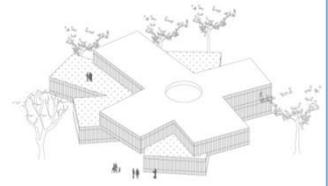
**SFSU
Campus**

**Approach to
Site**

Site Logistics



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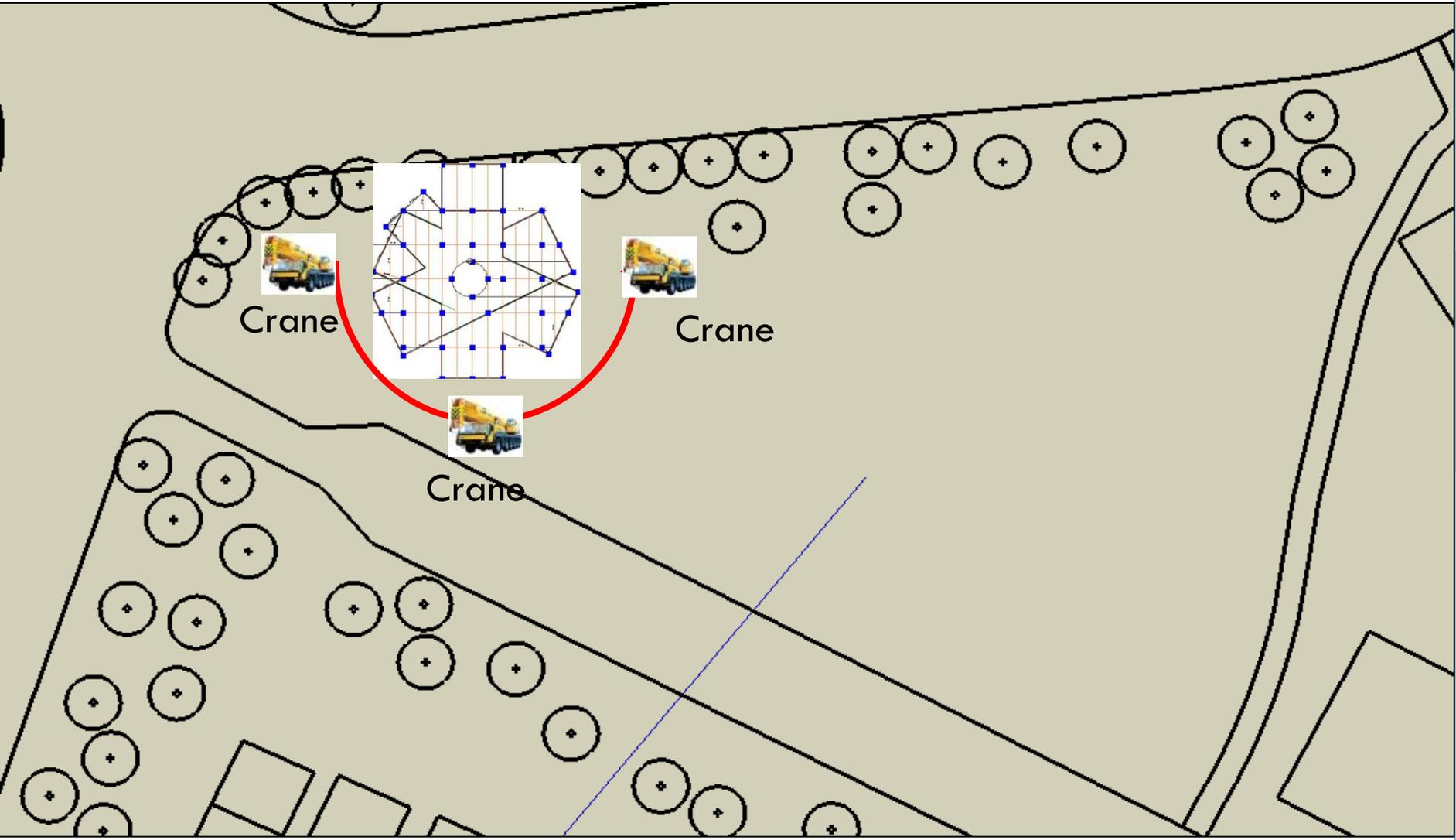
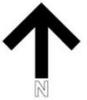
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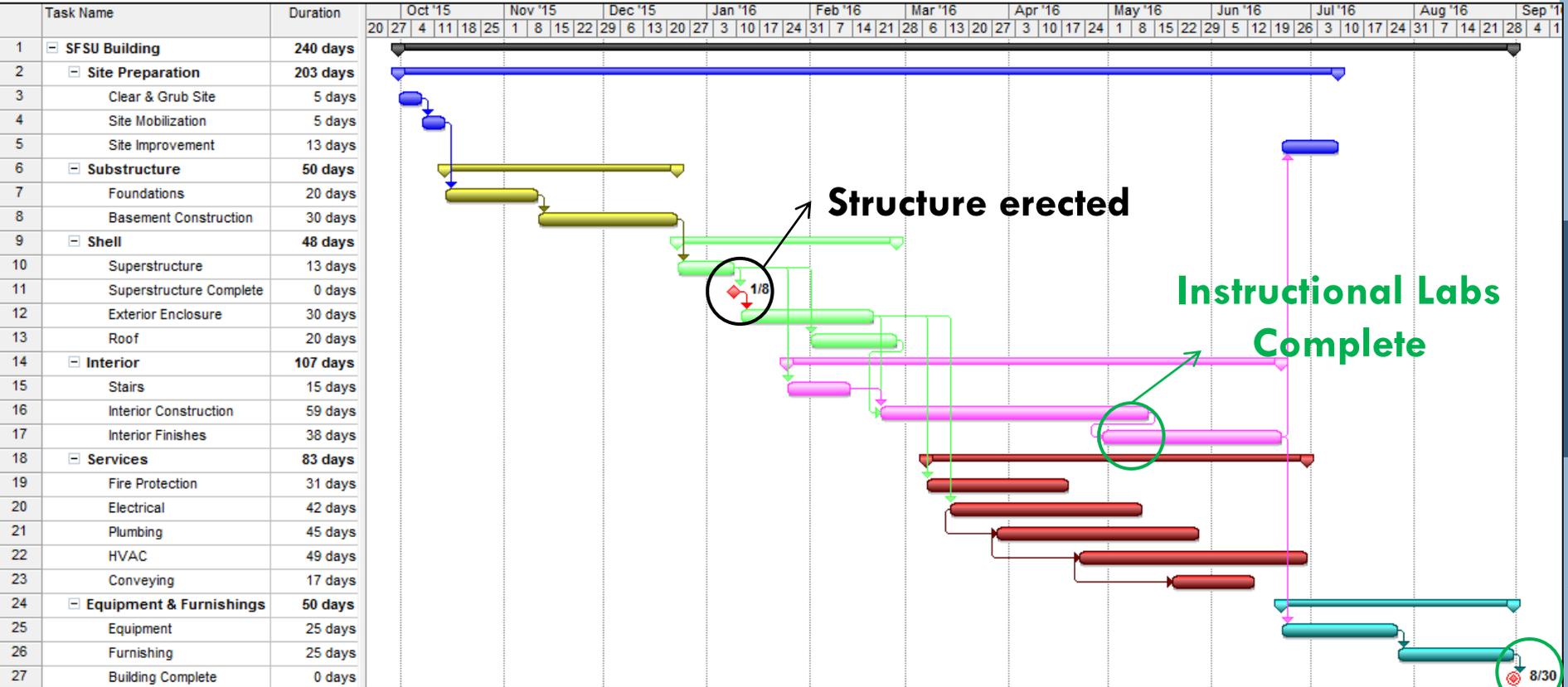
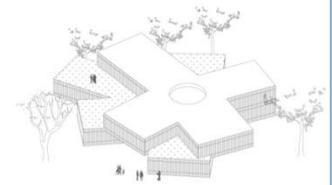
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Sequence ConXtech



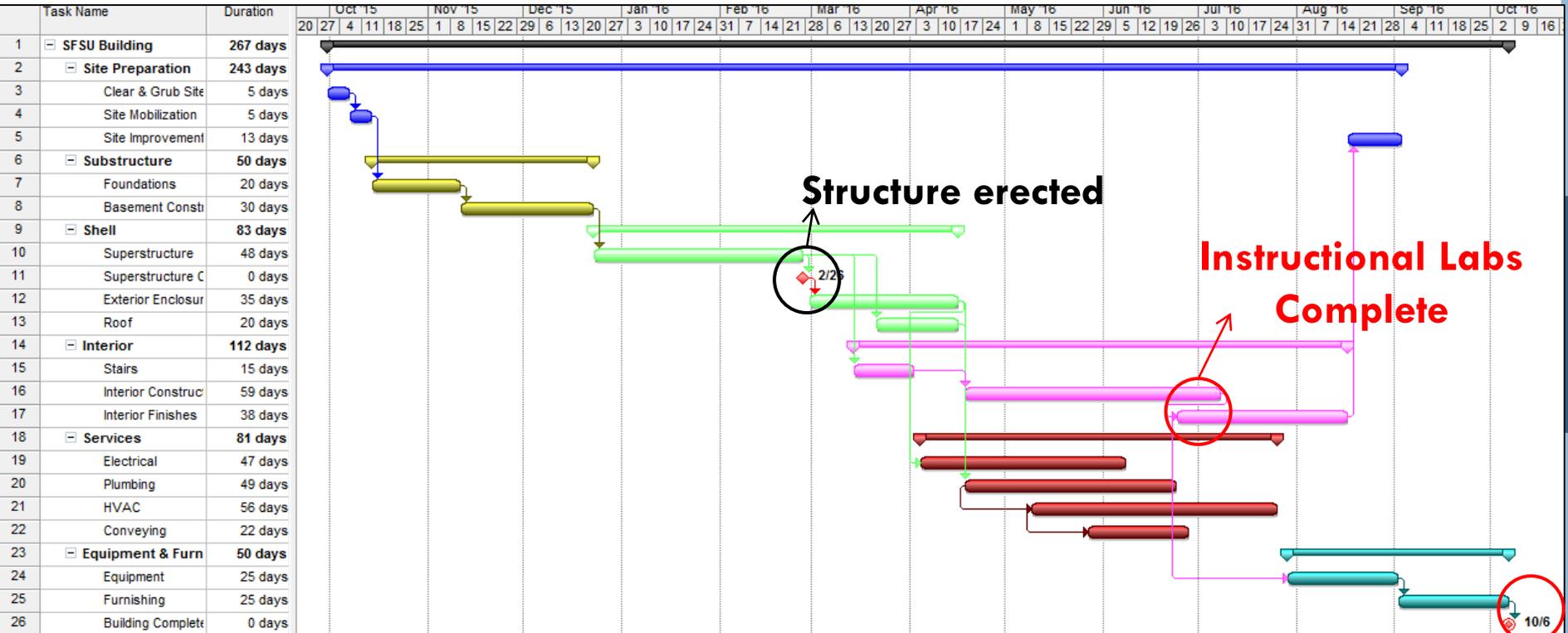
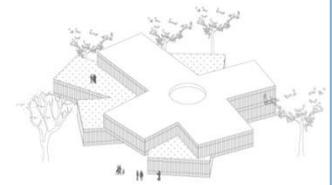
Schedule ConXtech



Duration : 240 days
Completion Date : 8/30/16

Project Complete

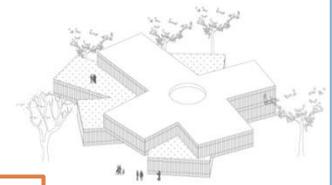
Schedule RC



Duration : 267 days
Completion Date: 10/6/16

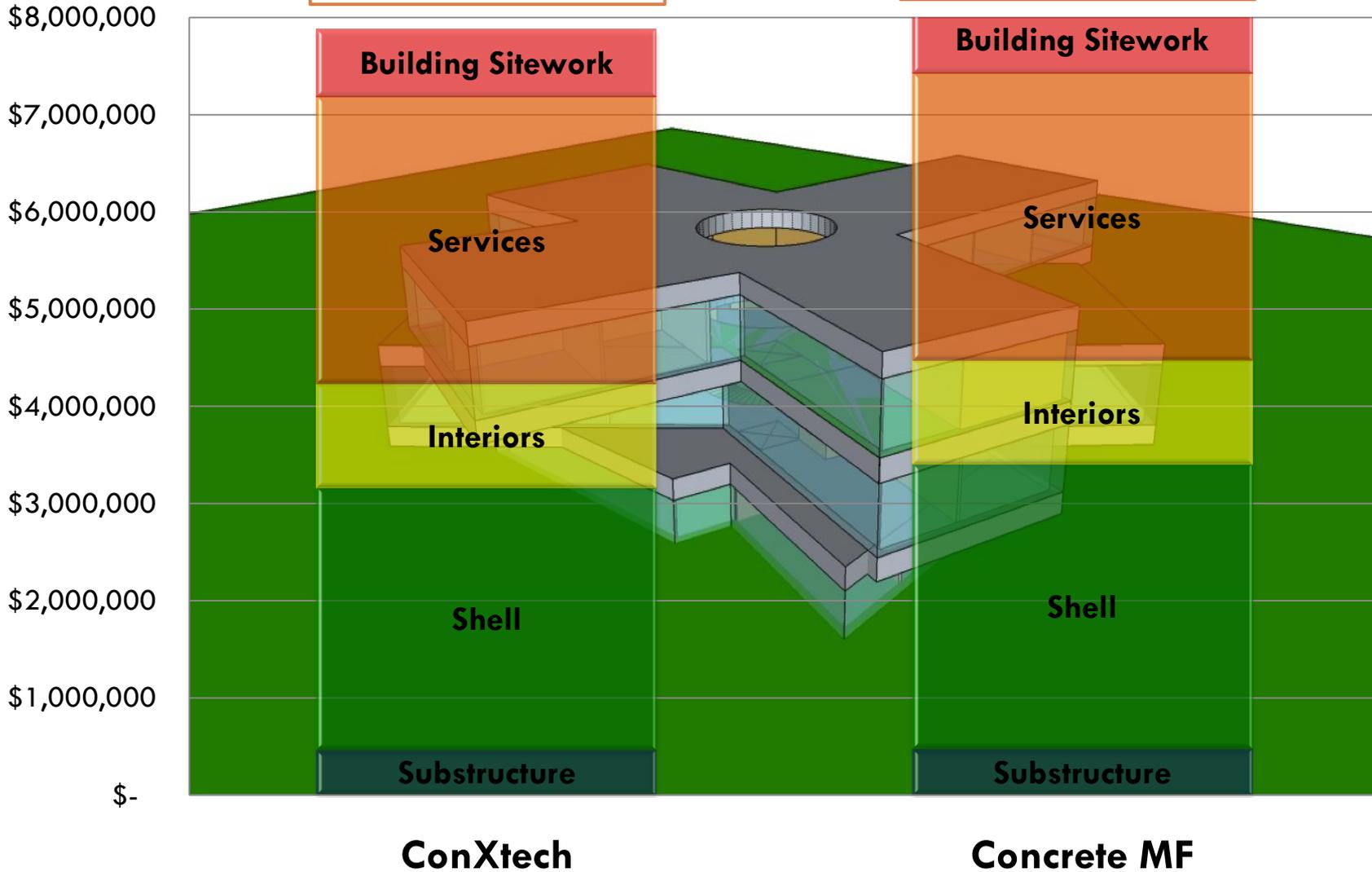
Project Complete

Estimates



\$7,870,000

\$8,110,000



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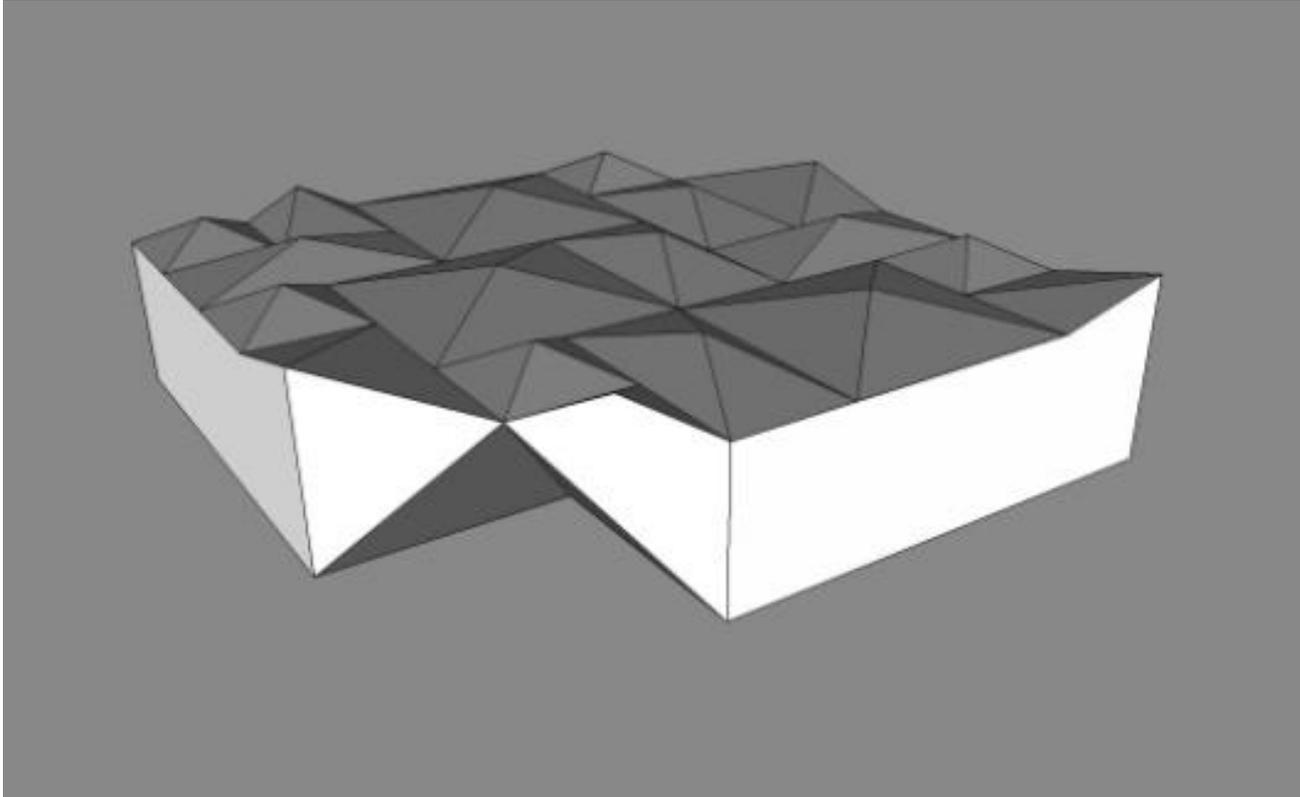
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↑ Houses



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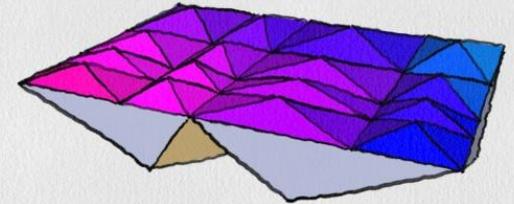
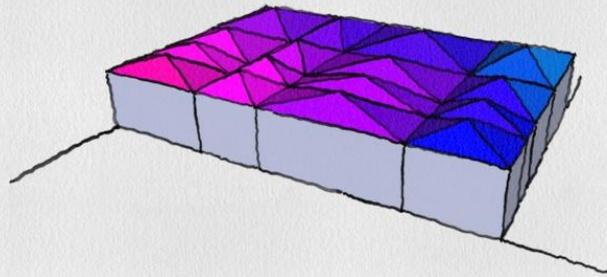
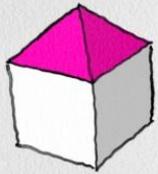
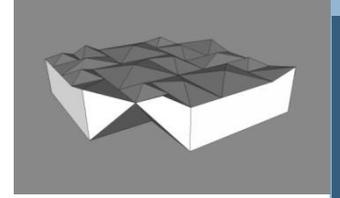
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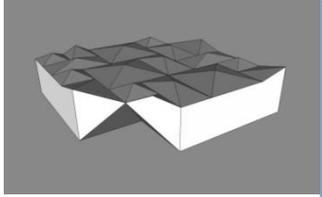
Houses



San Francisco
House

San Francisco
Quarter

San Francisco
School of
Engineering



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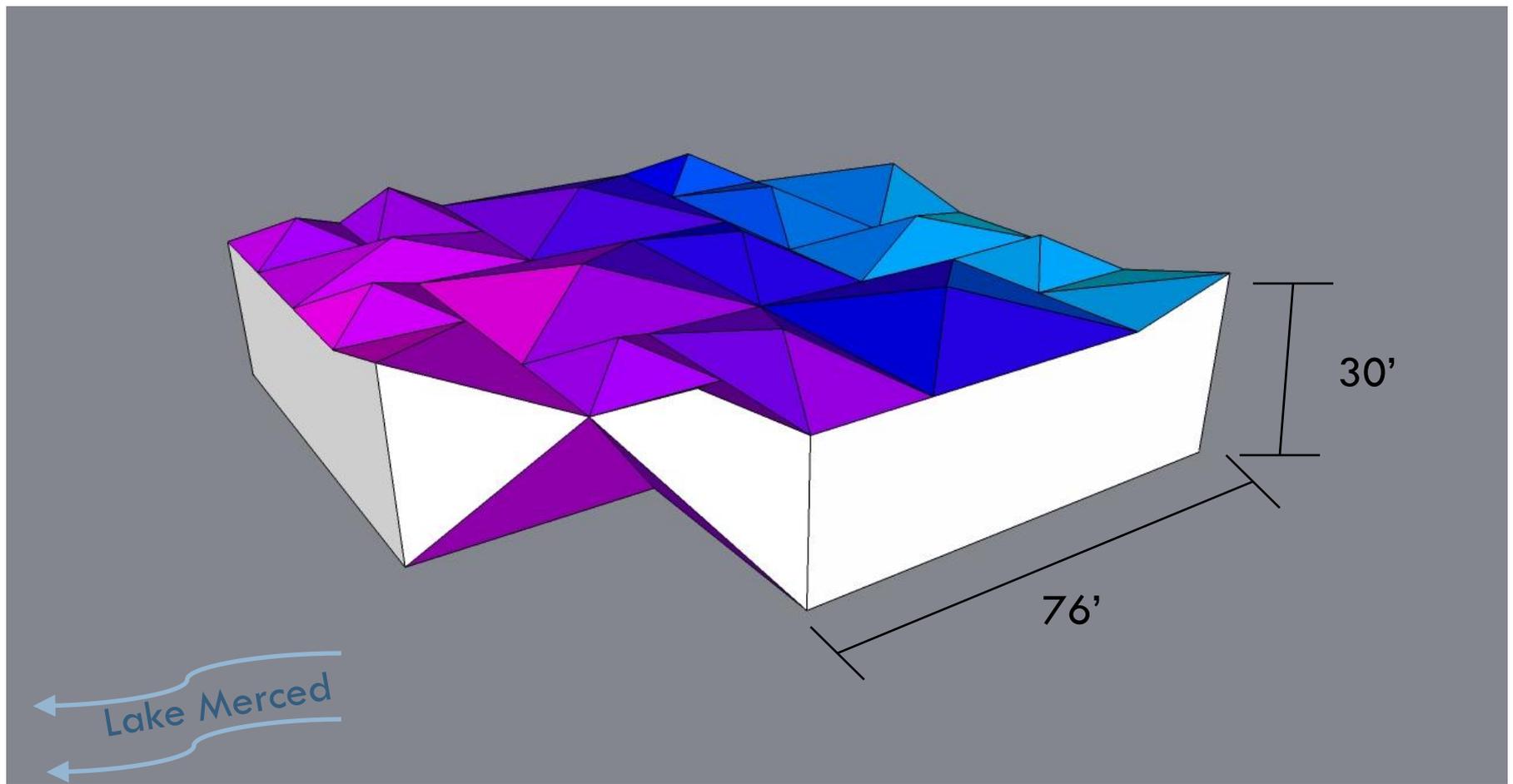
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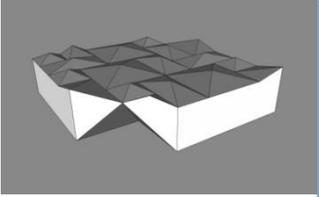
↑ Sketch-Up Model



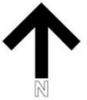
30'

76'

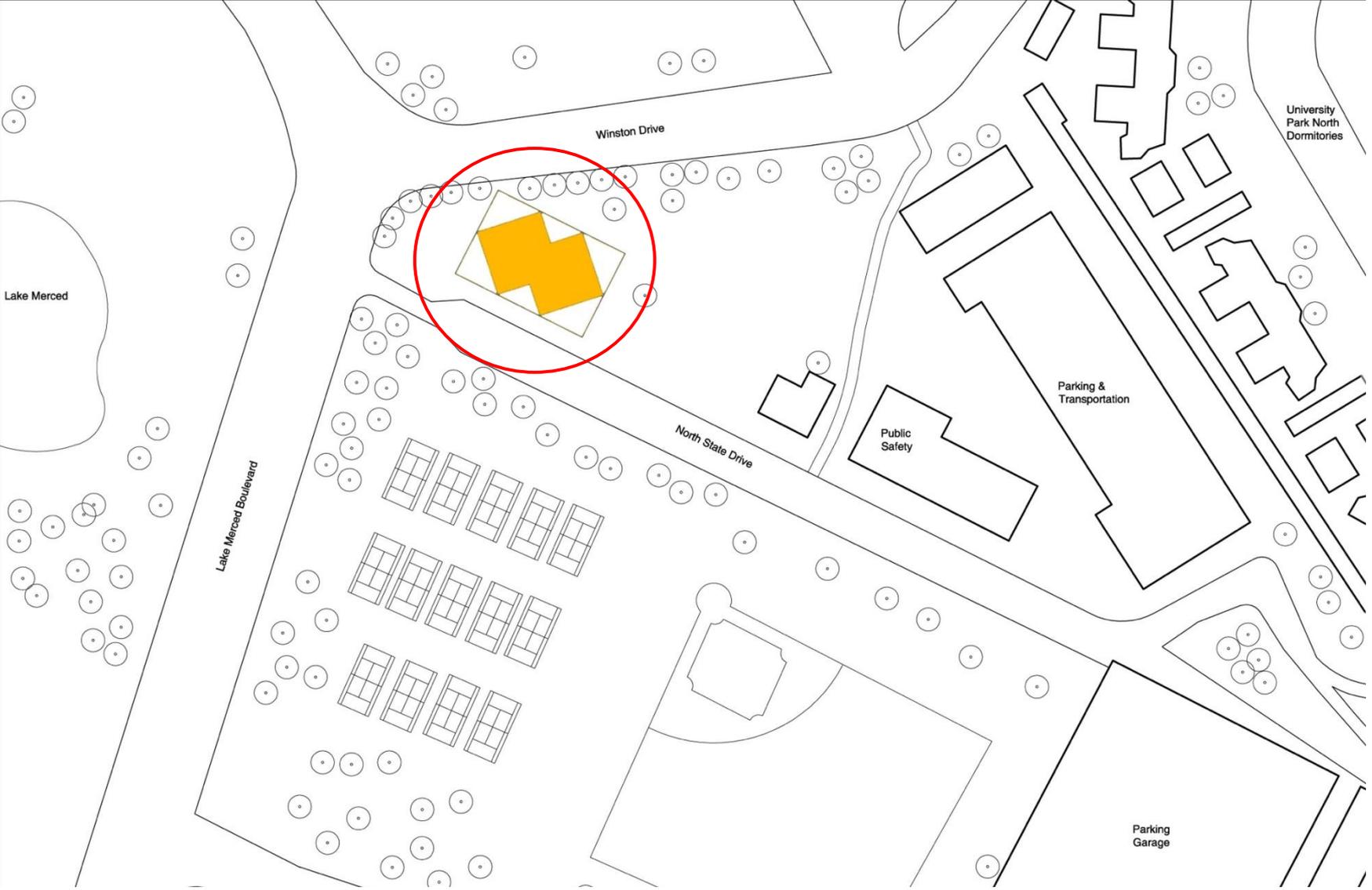
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Site Location

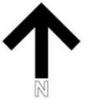


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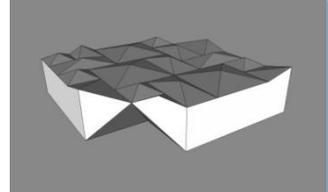
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Second Floor



-  Large Classrooms
-  Faculty Offices
-  Auditorium
-  Toilets

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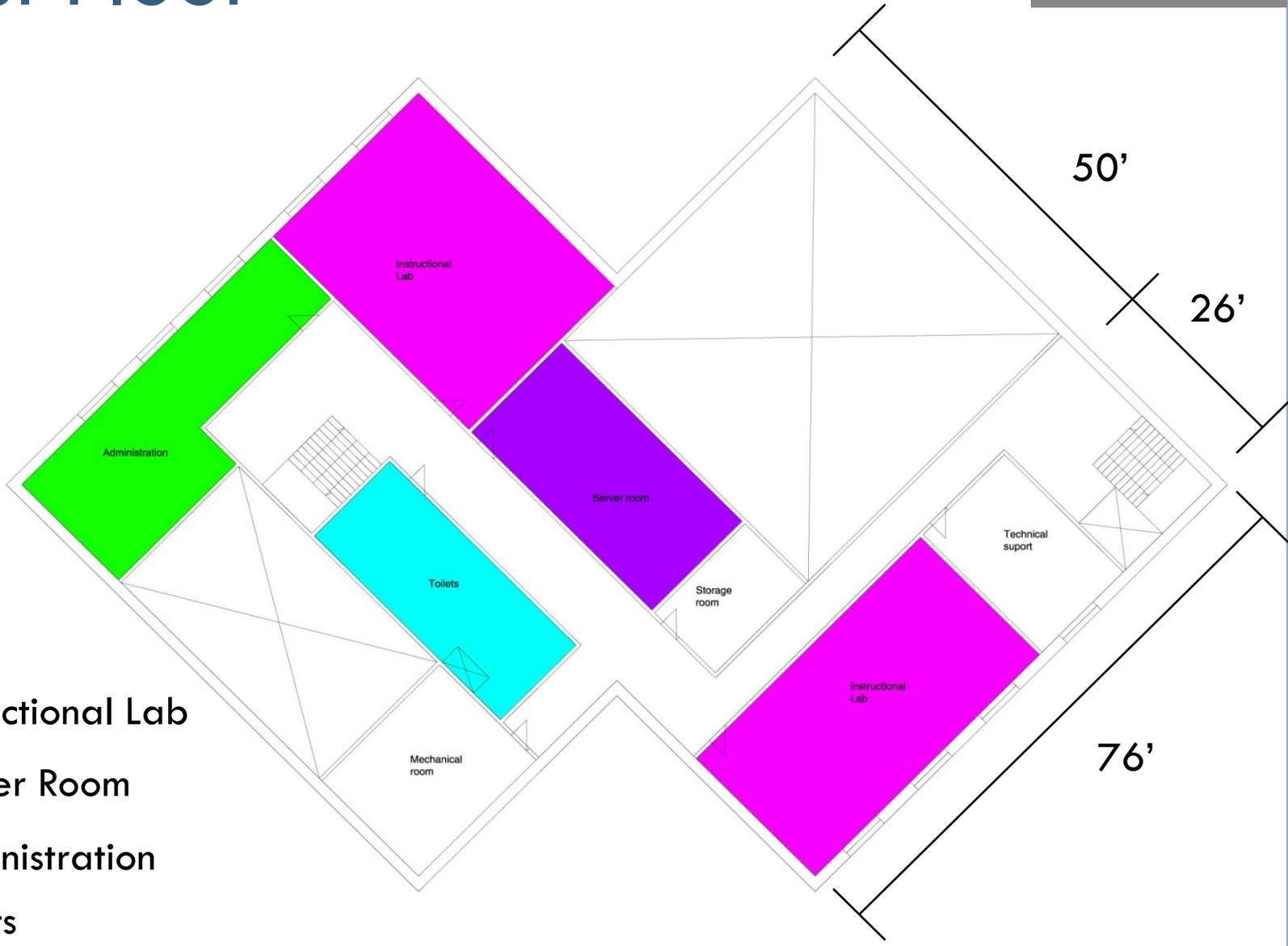
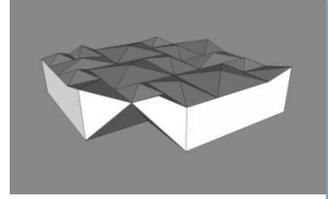
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First Floor



-  Instructional Lab
-  Server Room
-  Administration
-  Toilets

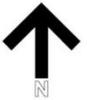
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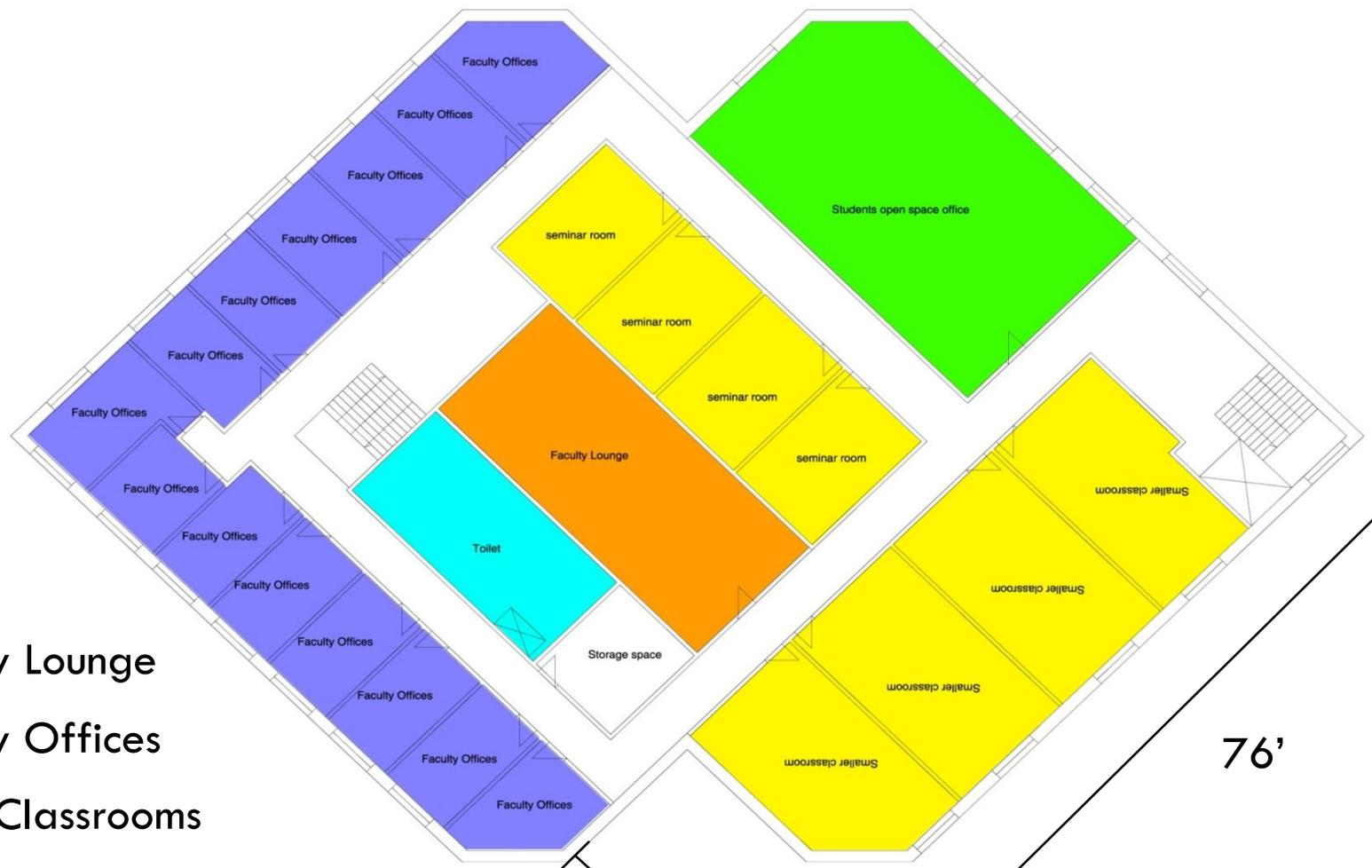
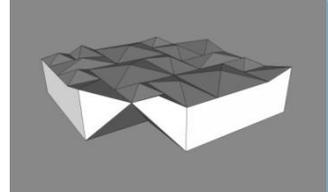
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Third Floor



-  Faculty Lounge
-  Faculty Offices
-  Small Classrooms
-  Toilets
-  Student Open Space Office

21'-10"

8'-1"

76'

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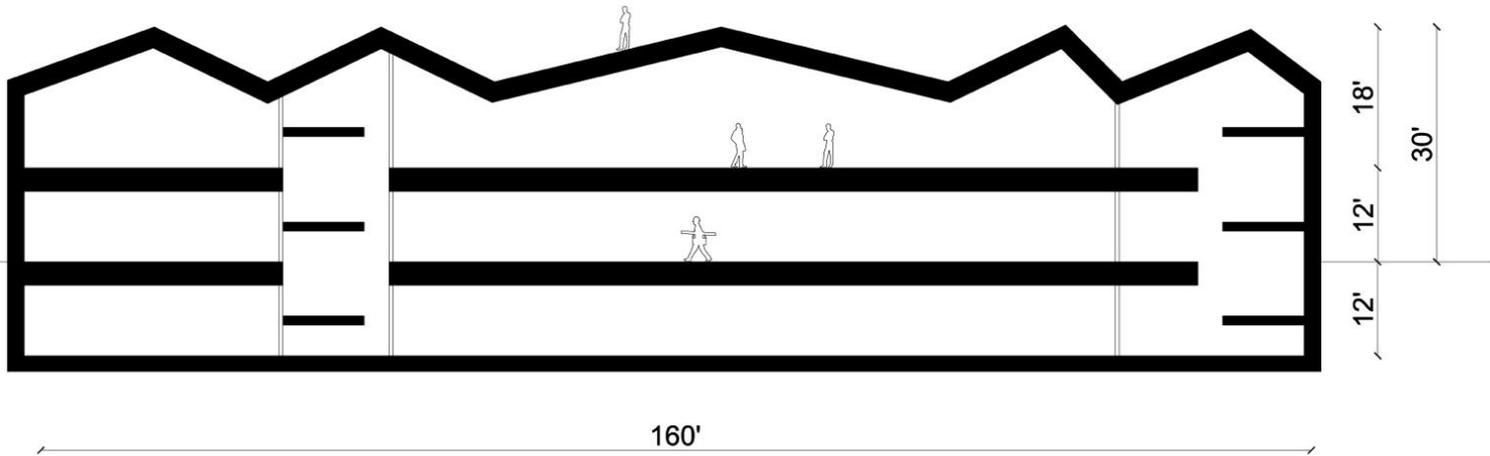
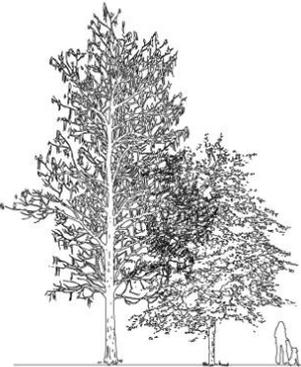
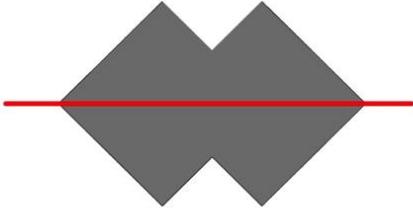
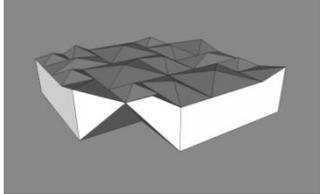
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Section a-a



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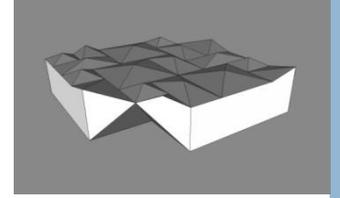
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Houses



	Steel Moment Frame	Eccentrically Braced Frame
Gravity System	Steel	Steel
Lateral System	Steel Moment Frame	EBF
Floor System	Concrete Metal Deck	Concrete Metal Deck

A

E

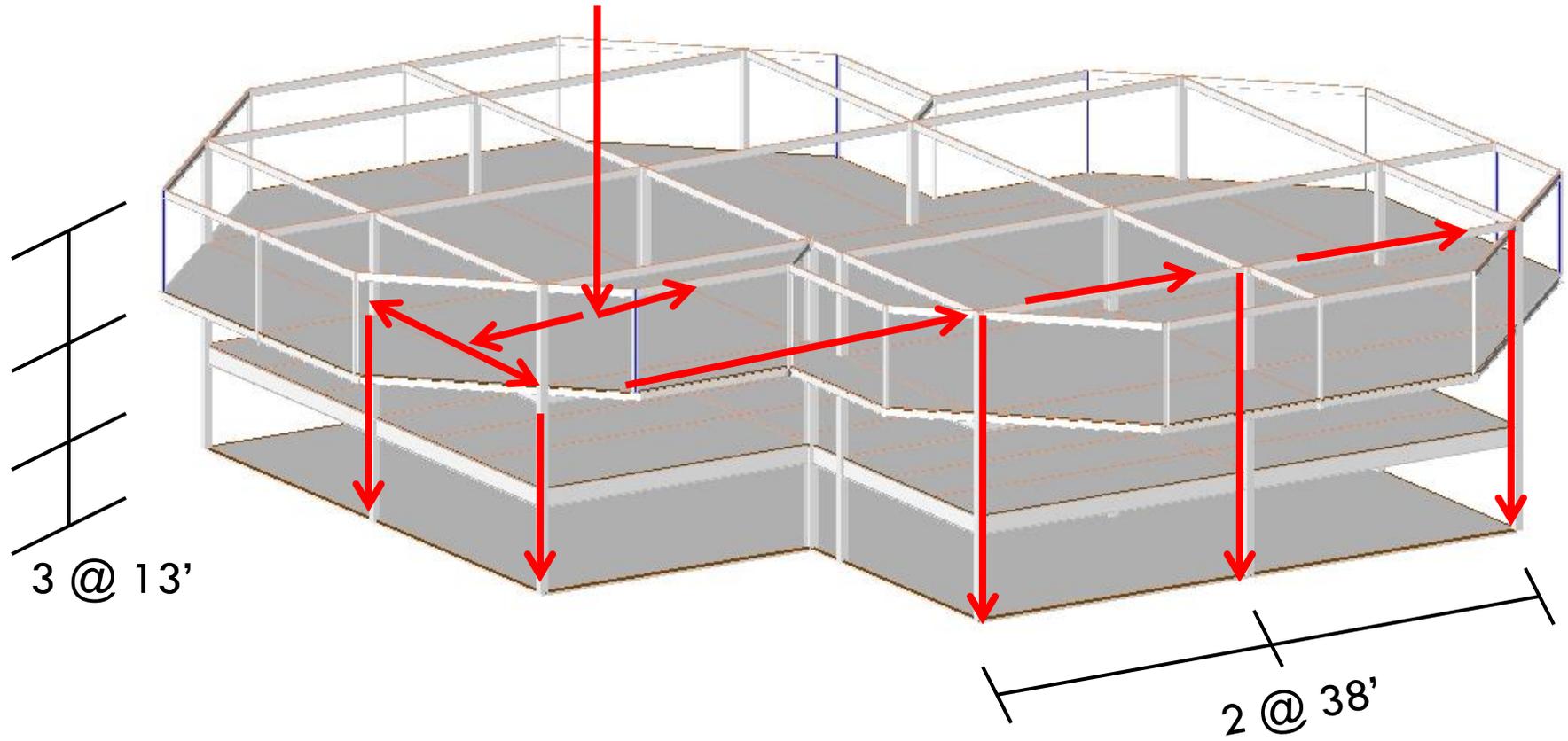
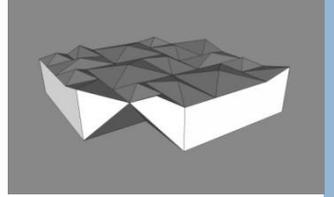
C

M

L

System 1

Steel Moment Frame



A

E

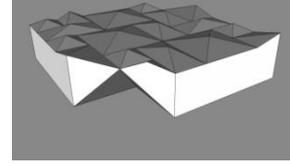
C

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L

System 1

Floor 1



A

E

C

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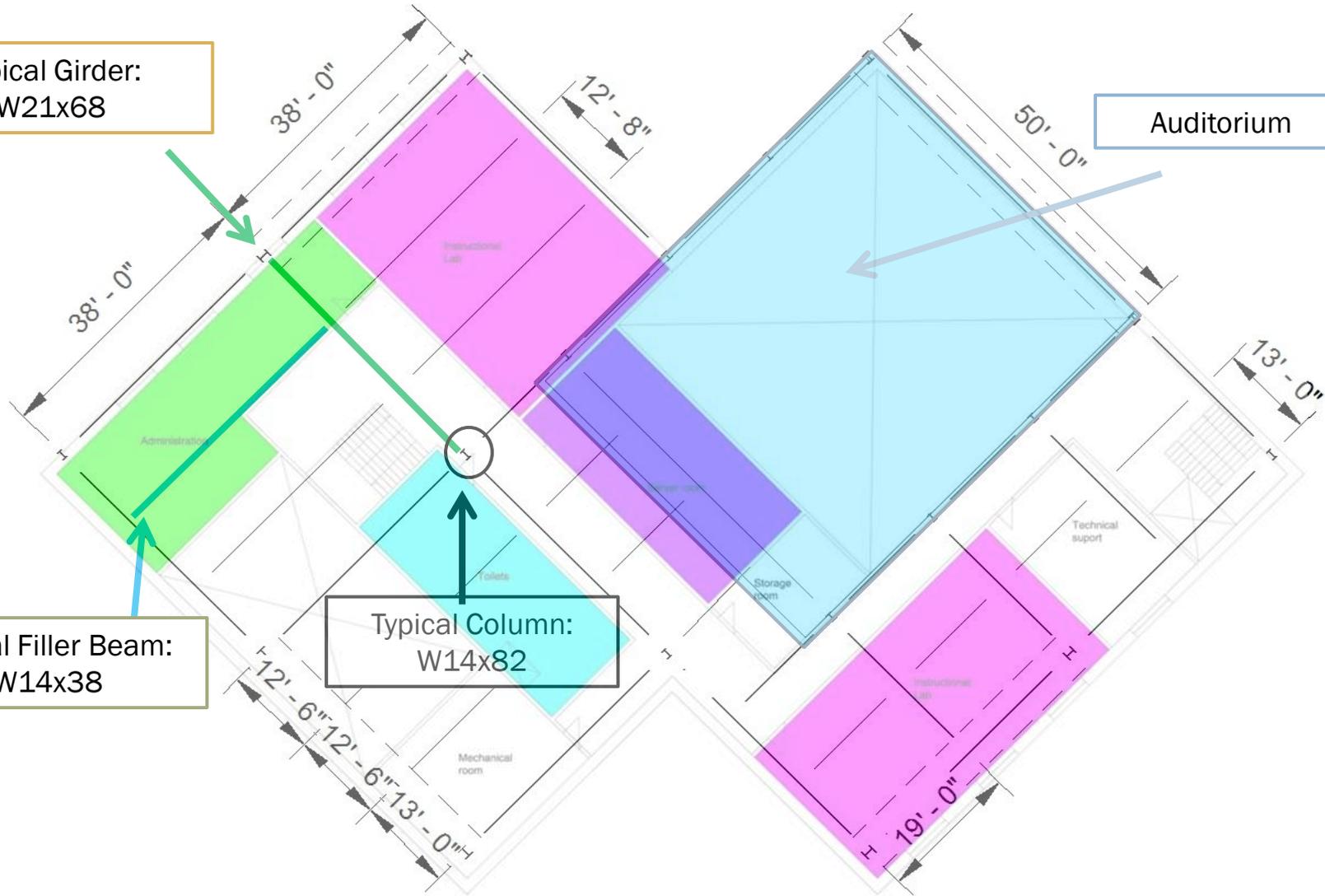
L

Typical Girder:
W21x68

Auditorium

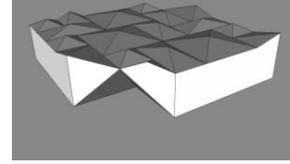
Typical Filler Beam:
W14x38

Typical Column:
W14x82



System 1

Floor 2

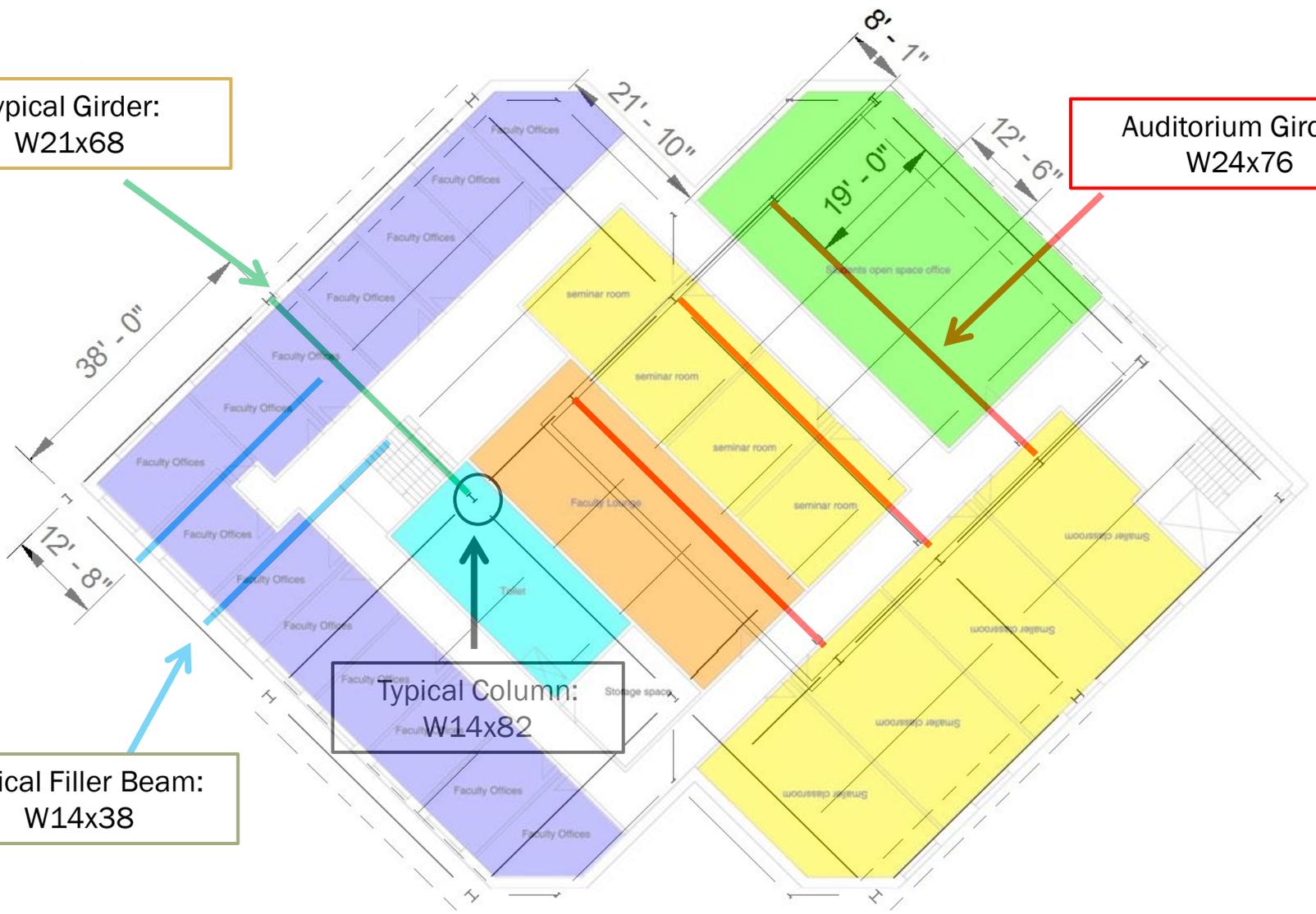


Typical Girder:
W21x68

Auditorium Girder:
W24x76

Typical Filler Beam:
W14x38

Typical Column:
W14x82



A

E

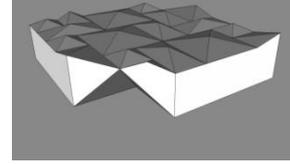
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System 1

Steel Moment Frame



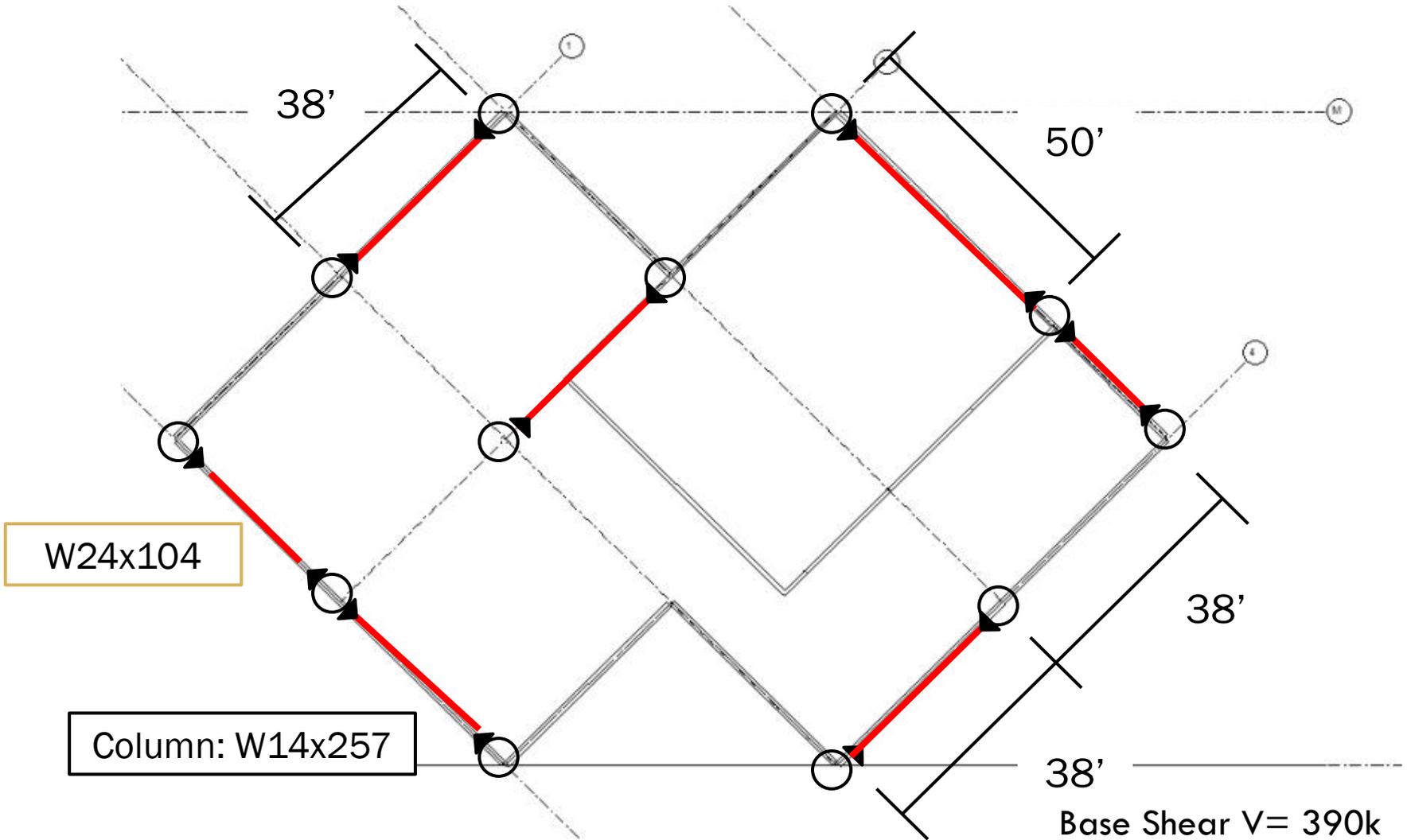
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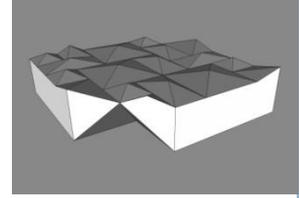
M

L



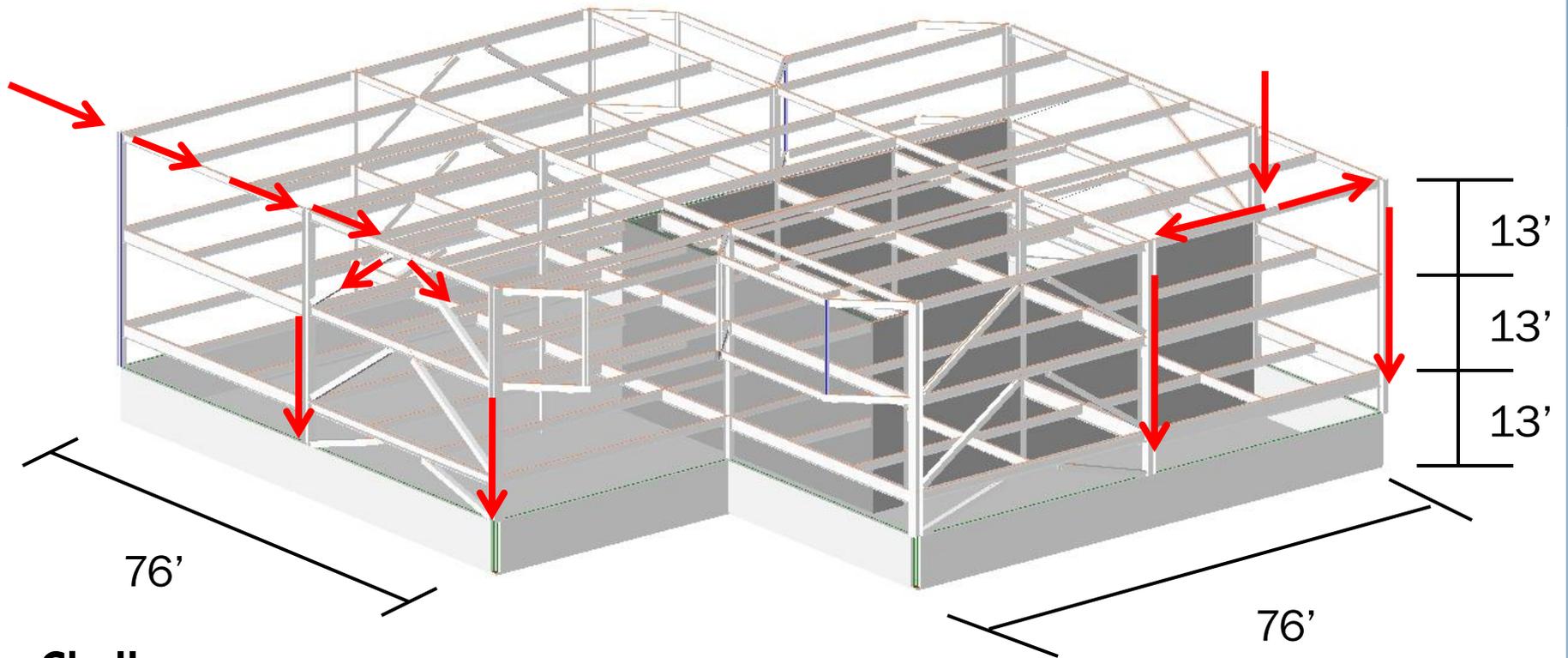
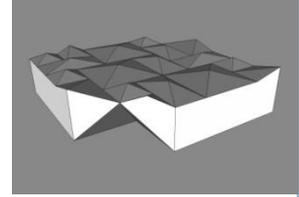
System 1

Steel Moment Frame



Pros	Cons
<ul style="list-style-type: none">• Regular Shape	<ul style="list-style-type: none">• Auditorium Span 50ft
<ul style="list-style-type: none">• Short Cantilevers	<ul style="list-style-type: none">• Drift
<ul style="list-style-type: none">• Open Bays For Windows	<ul style="list-style-type: none">• Long Typical Spans: 38ft

System 2 – Eccentrically Braced Frame

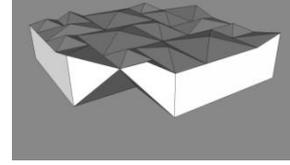


Challenges:

- **Spanning Auditorium**
- **Placing Lateral System**

System 2

Floor 1



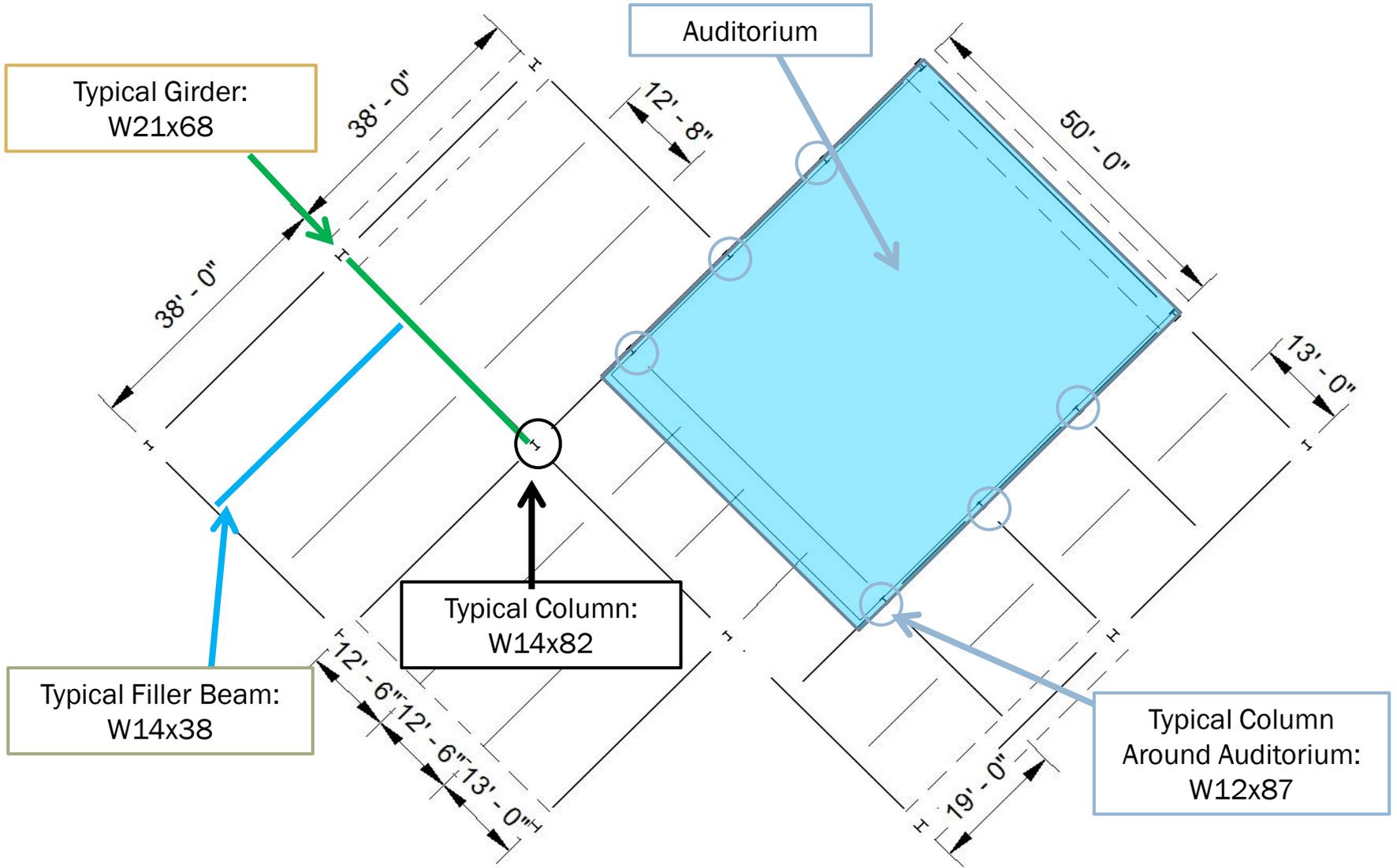
A

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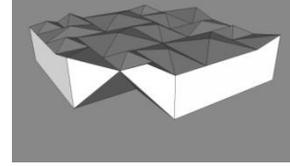
M

L



System 2

Floor 2



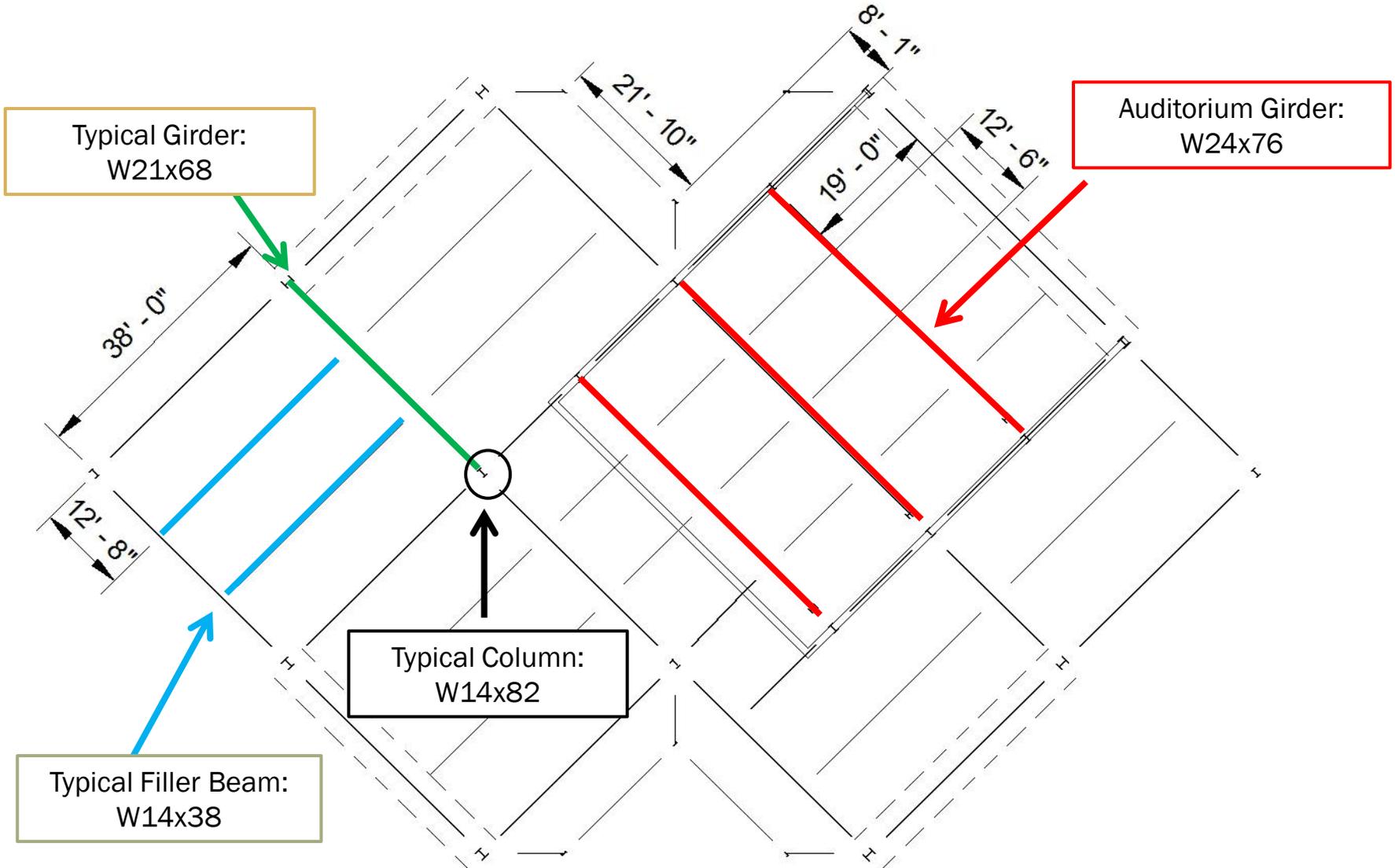
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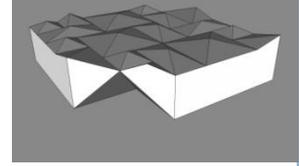
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A

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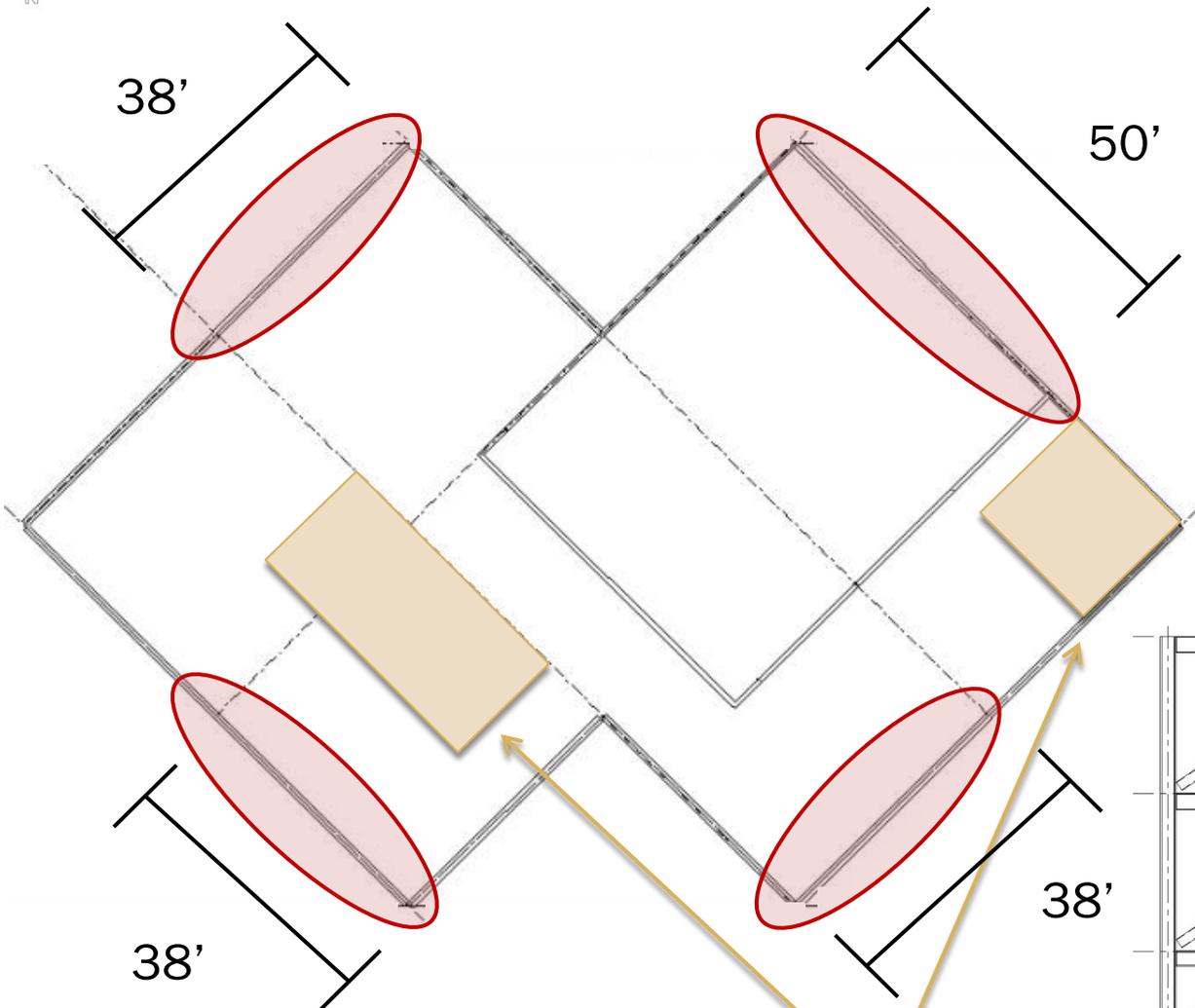
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EBFs



Initial Sizing:

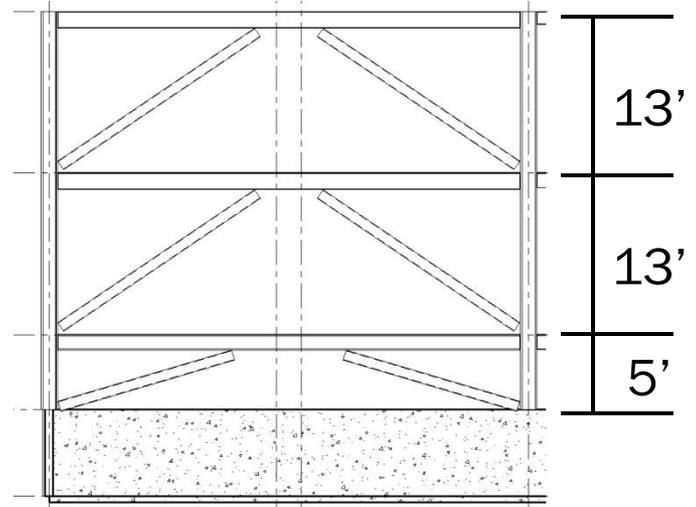
Columns: W14x193

Beams: W14x132

Roof: W14x68

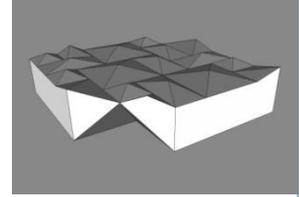
Brace: HSS10x10x5/8

Possible Locations for Additional Frames if Necessary



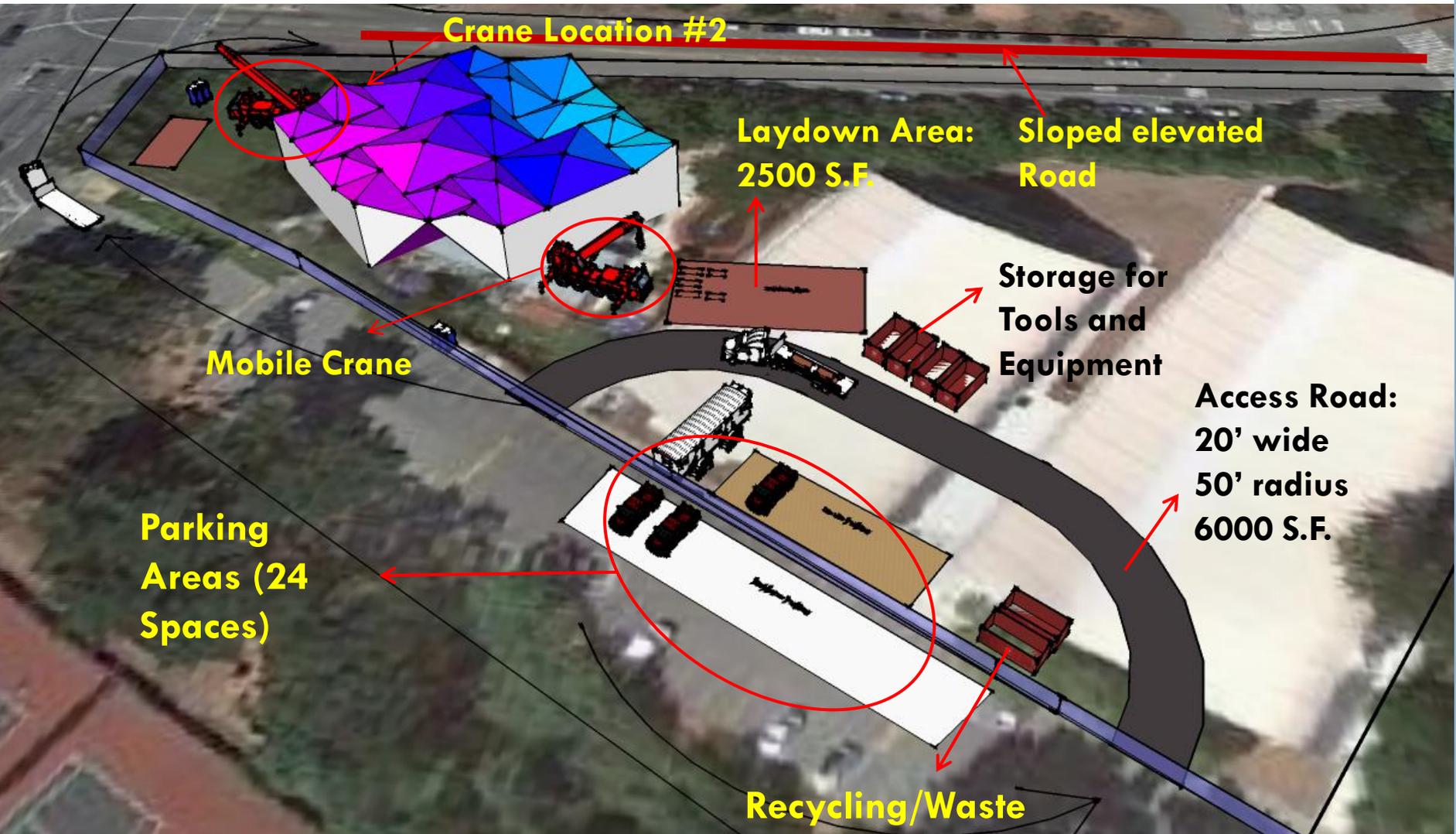
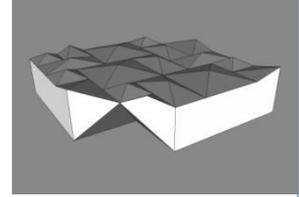
Base Shear $V = 390k$

System 2 – EBF



Pros	Cons
<ul style="list-style-type: none">• Regular Shape	<ul style="list-style-type: none">• Auditorium Span 50ft
<ul style="list-style-type: none">• Short Cantilevers	<ul style="list-style-type: none">• EBF Along Auditorium
<ul style="list-style-type: none">• Brace Along Exterior	<ul style="list-style-type: none">• EBFs Block Windows
<ul style="list-style-type: none">• Regular Frames of 38ft	

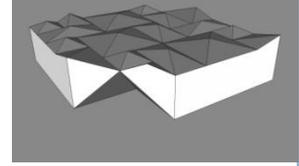
Site Logistics



A
E
C
M
L

Sequence

Moment Frame & EBF



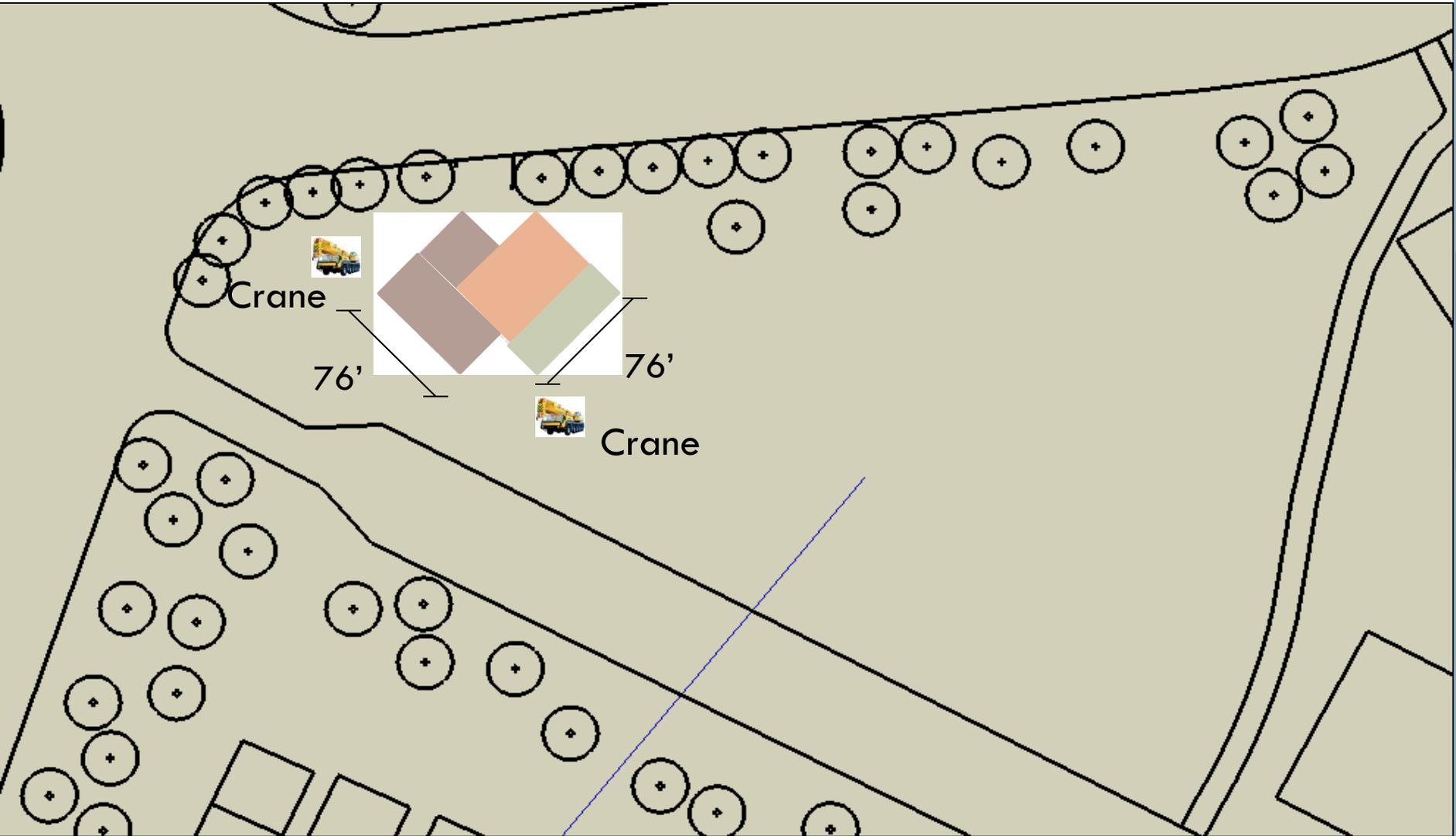
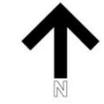
A

E

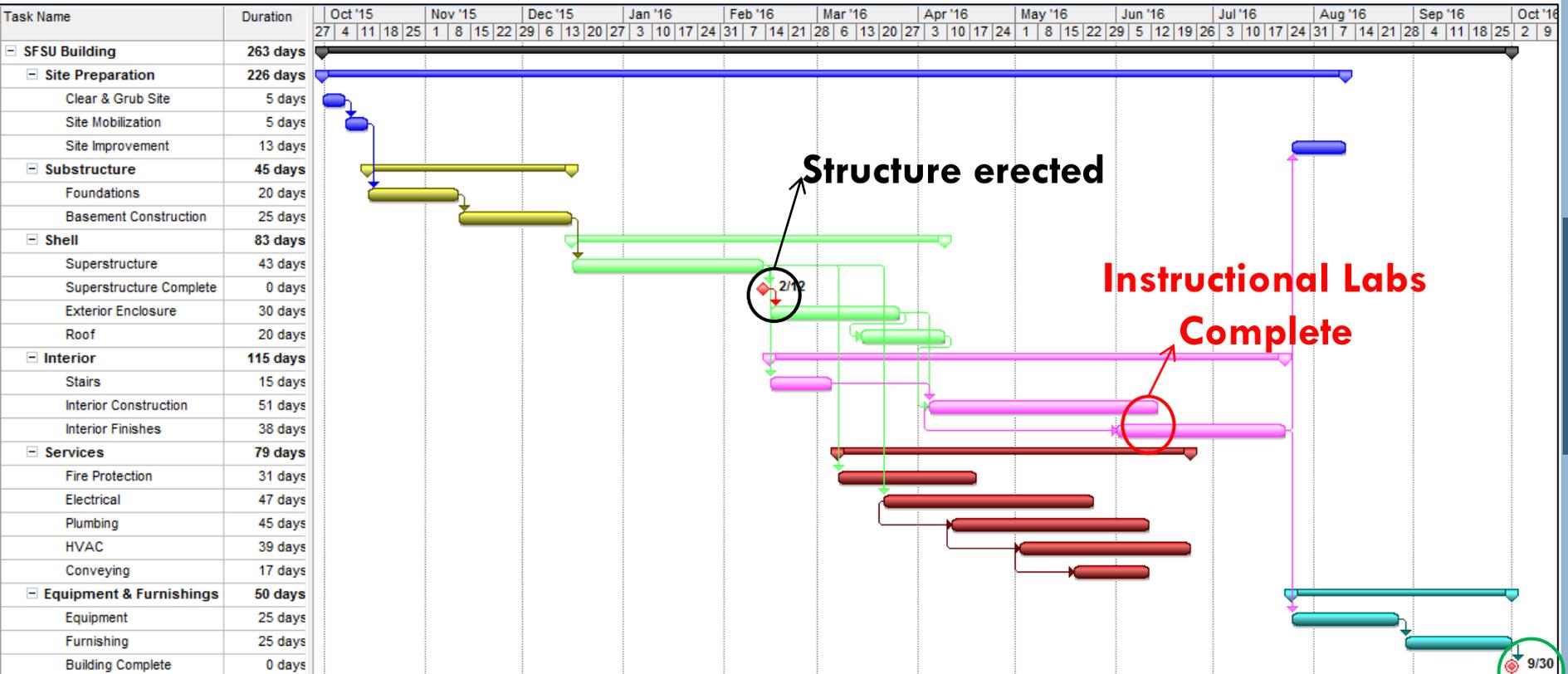
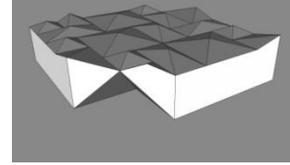
C

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Schedule Moment Frame

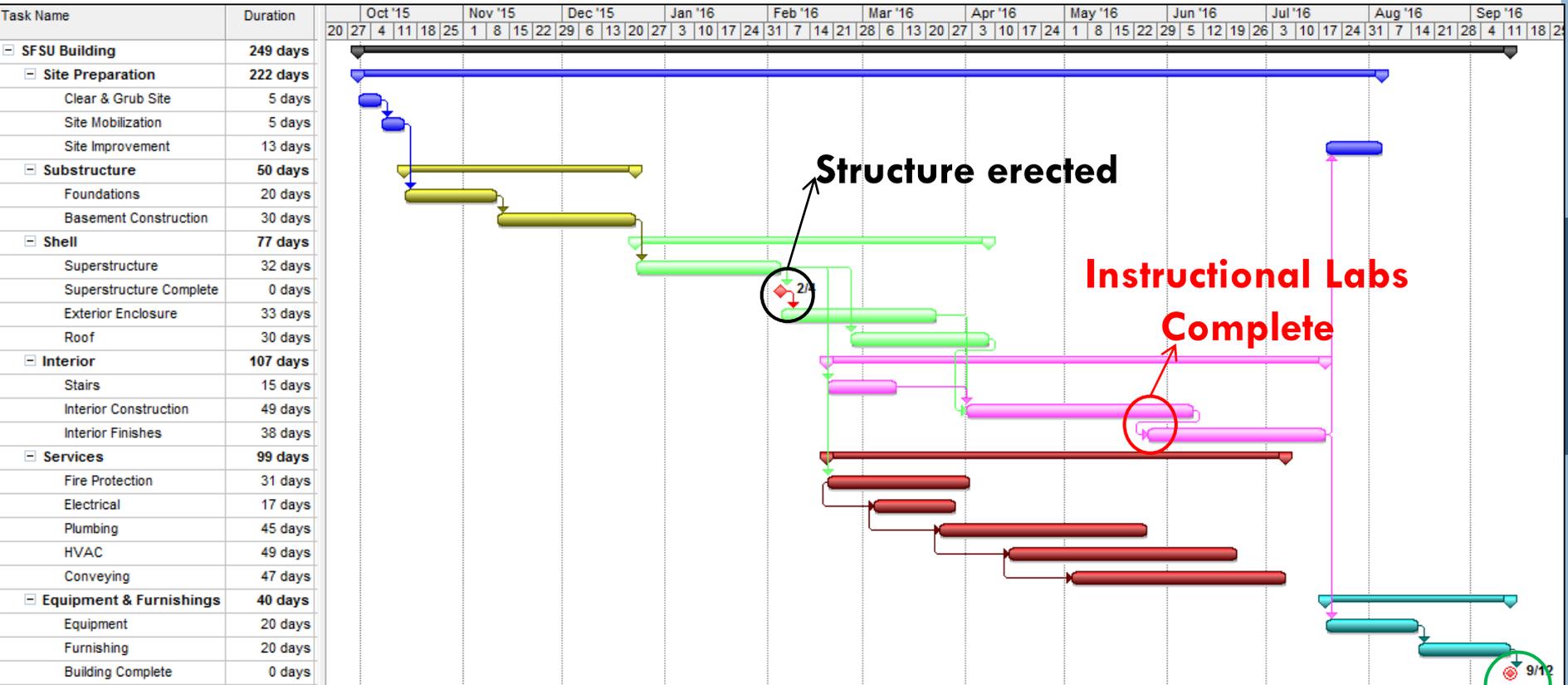
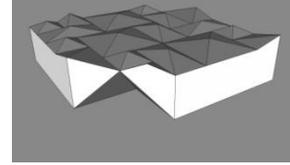


Duration : 263 days
Completion Date : 9/30/16

Project Complete

Schedule

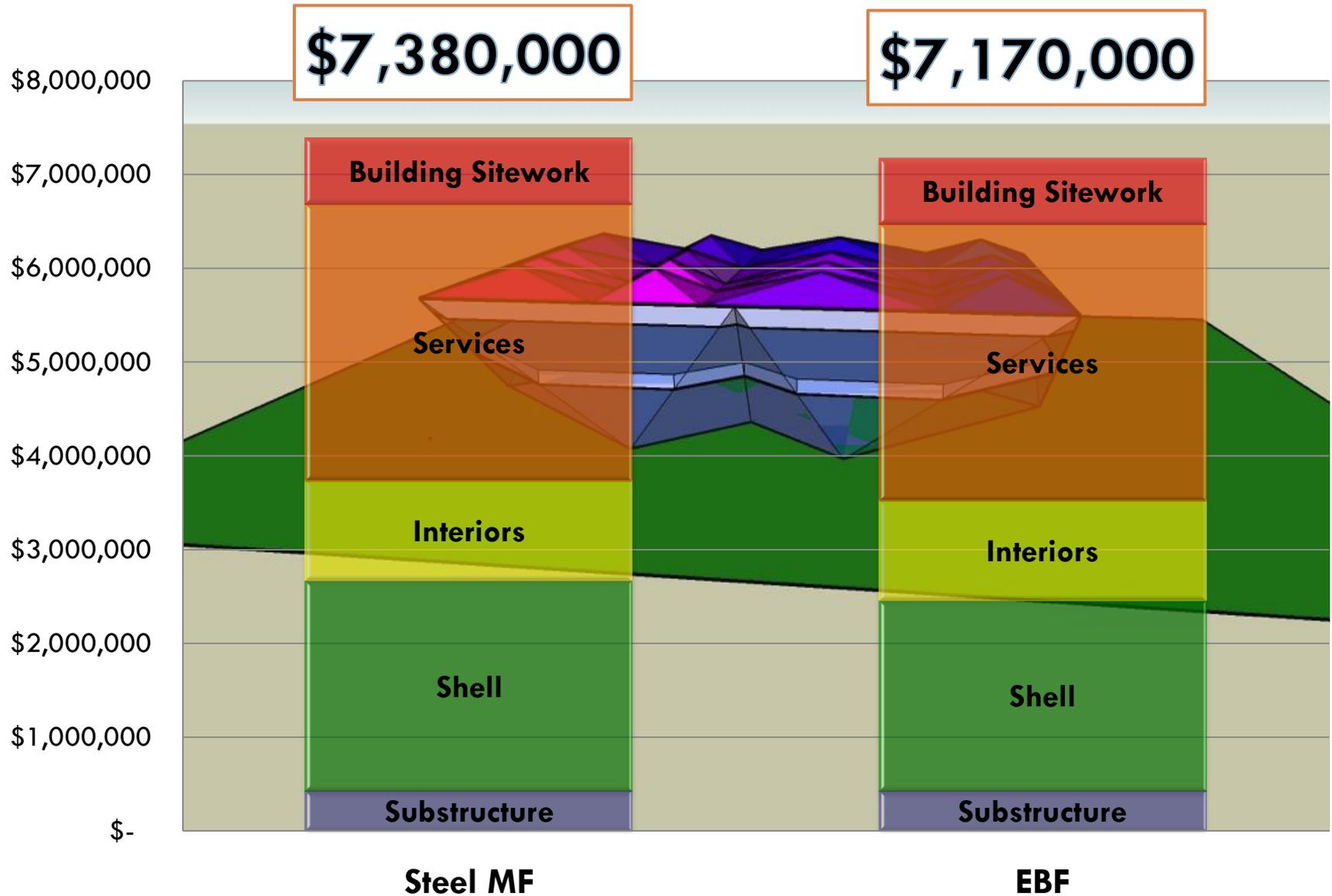
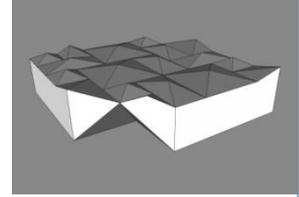
EBF



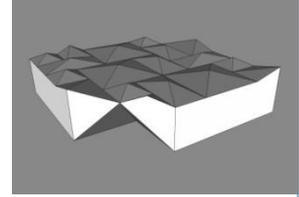
Duration : 249 days
Completion Date : 9/12/16

Project Complete

Estimates



Equipment



Wheel Loader:
JCB 426 HT
2.5 CY Bucket



Excavator:
JCB JS 260
1.5 CY Bucket



Mobile Crane:
Grove TM 8690

Other Equipment

Aerial Lifts

Forklift

Trucks

A

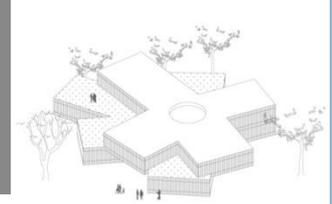
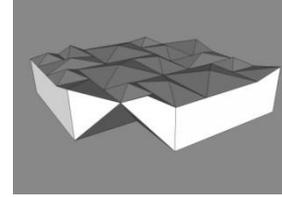
E

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MEP Inspiration



A

E

C

M

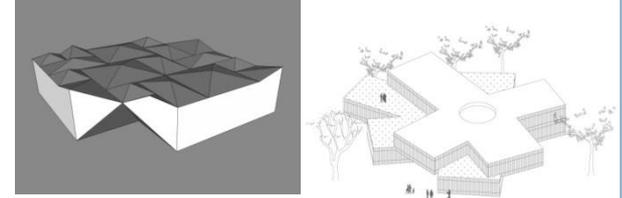
L

San Francisco Federal Building

- Natural Ventilation
 - ▣ Mechanical Backup
- Daylight
 - ▣ Reduce Heating



Smart Windows



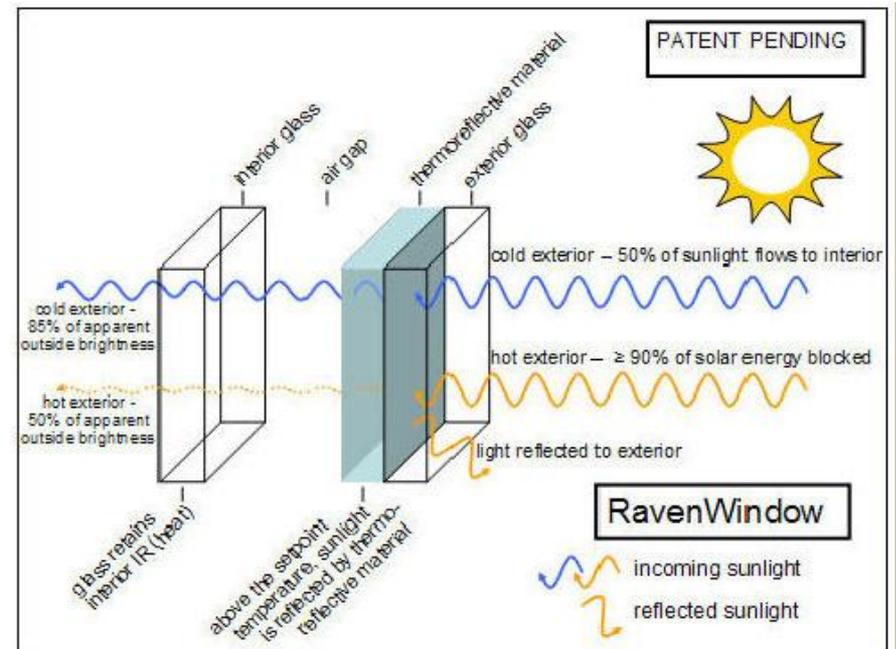
- Architect: “no shading devices”
- Hot Days: (tinted) reflect solar Heat away from Building
- Cold Days: (transparent) allow solar Heat into Building
- Reduce Energy Bills by 30%



Cold Days

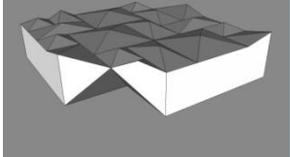


Hot Days

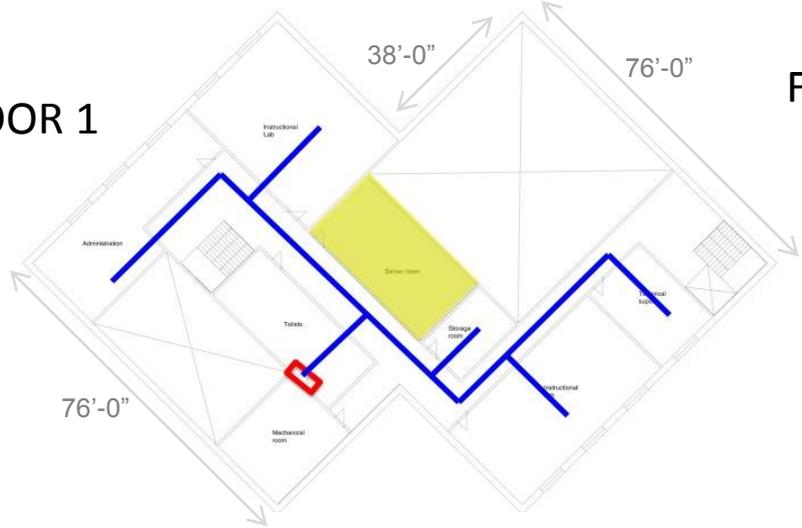




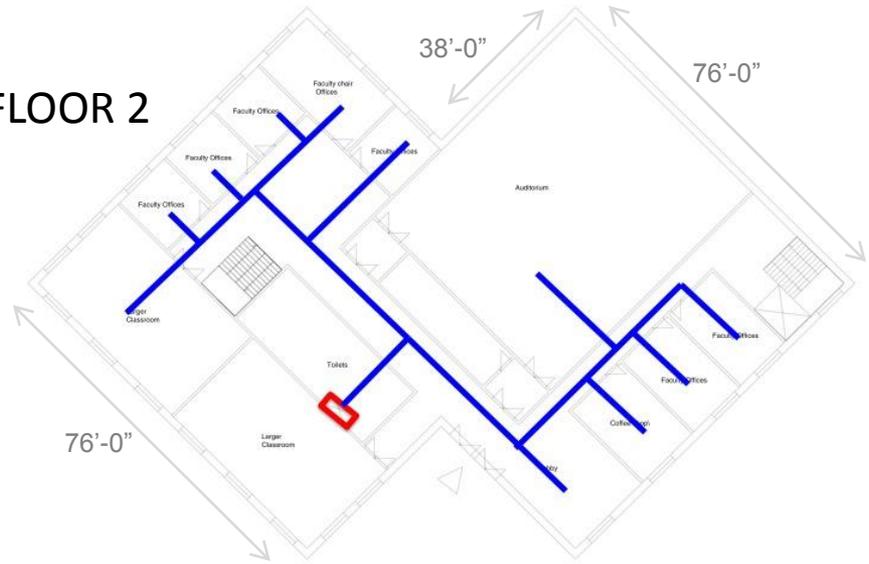
Mechanical System Distribution Houses



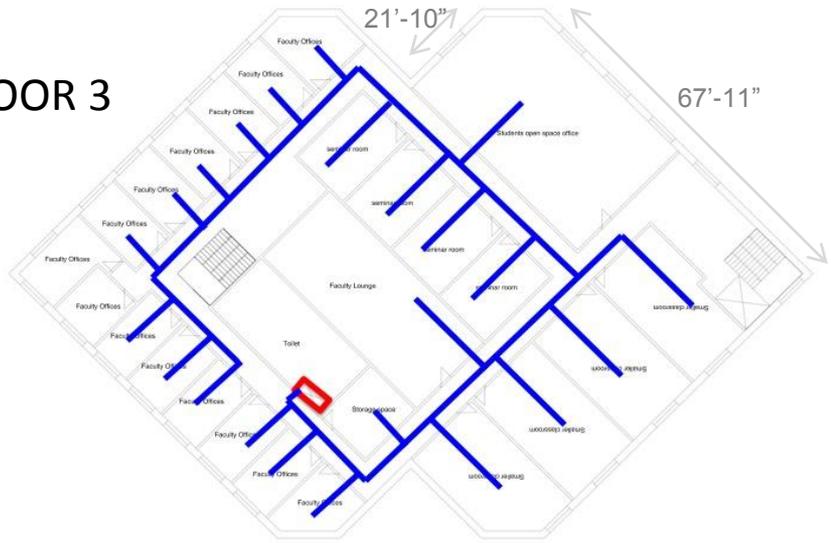
FLOOR 1



FLOOR 2



FLOOR 3




 Server Room
 Portable A/C
 Unit



Active
 Chilled
 Beams



A

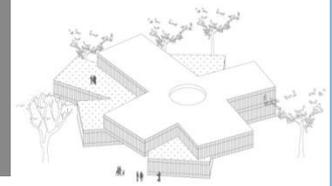
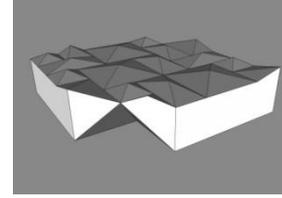
E

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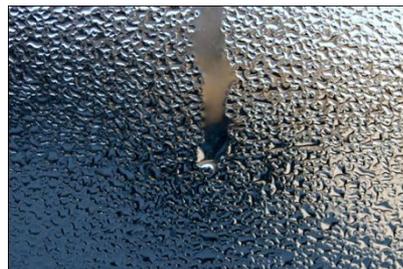
Details on Chilled Beams



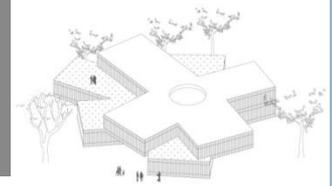
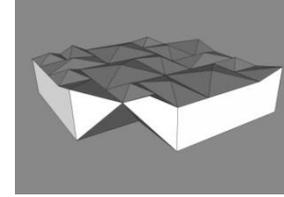
- Thermostats (individual Control)



- Sensor on each Chilled Beam
 - Provide only the required Heating/Cooling
 - Linked to Thermostats
 - Dewpoint Temperature Control



MEP Options & Decisions



	Forced-Air Heat Pump	Hybrid System	Active Chilled Beams
Sandwich Height	3 ft	3 ft	1.5 ft
Lifetime	20 years	> 18 years	20 years
Cost	High Installation	High Installation	Reduced Installation
Maintenance	Low	High	Very Low (if any)
Energy Efficiency	Baseline	> Baseline < Chilled Beams	> Hybrid

A

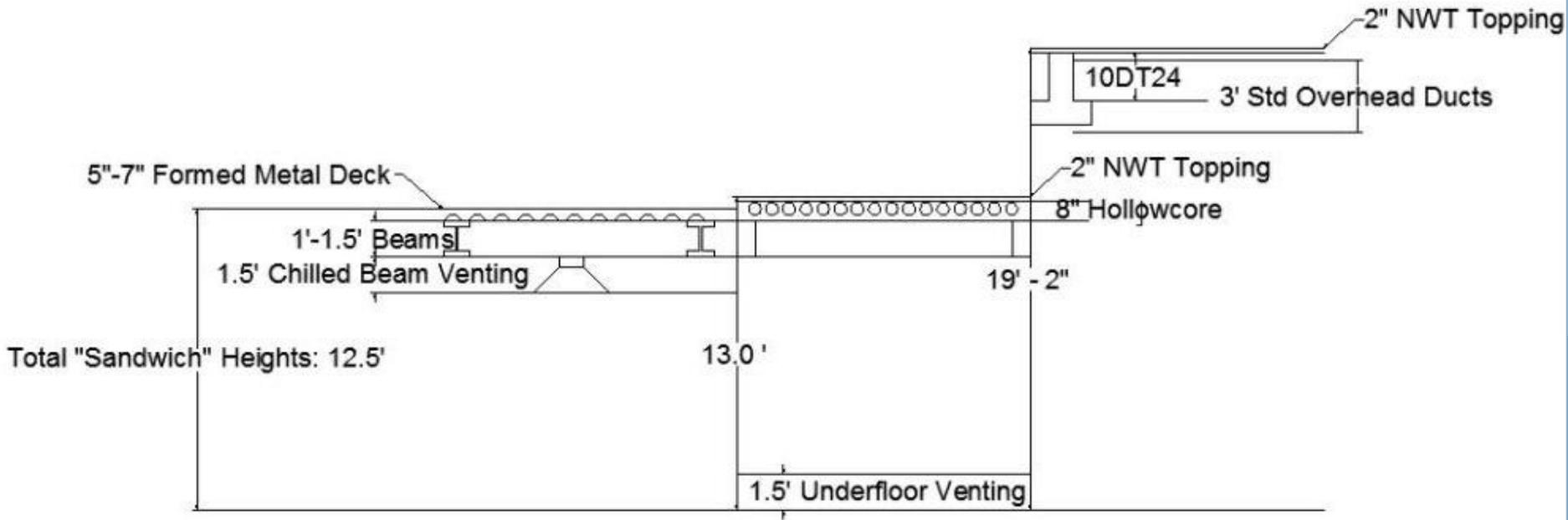
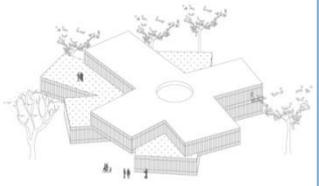
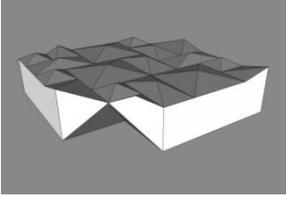
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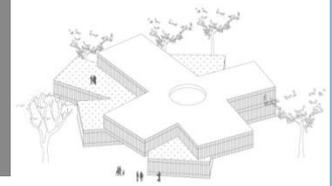
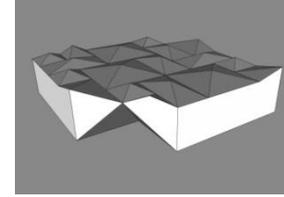
M

L

MEP Options & Decisions



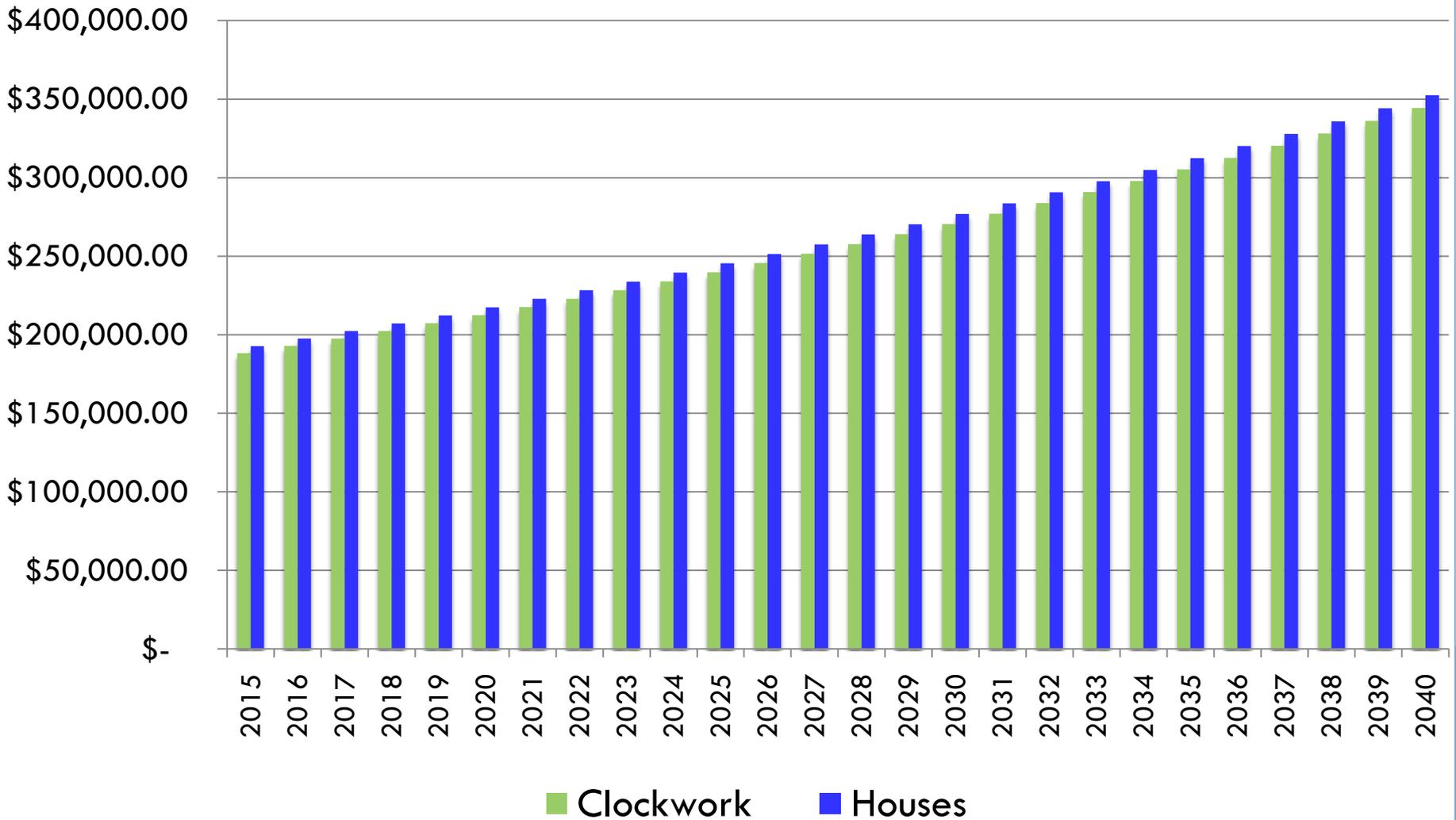
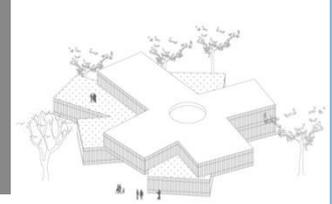
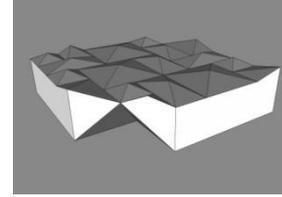
MEP Options & Decisions



	Forced-Air Heat Pump	Hybrid System	Active Chilled Beams
Sandwich Height	3 ft	3 ft	1.5 ft
Lifetime	20 years	> 18 years	20 years
Cost	High Installation	High Installation	Reduced Installation
Maintenance	Low	High	Very Low (if any)
Energy Efficiency	Baseline	> Baseline < Chilled Beams	> Hybrid

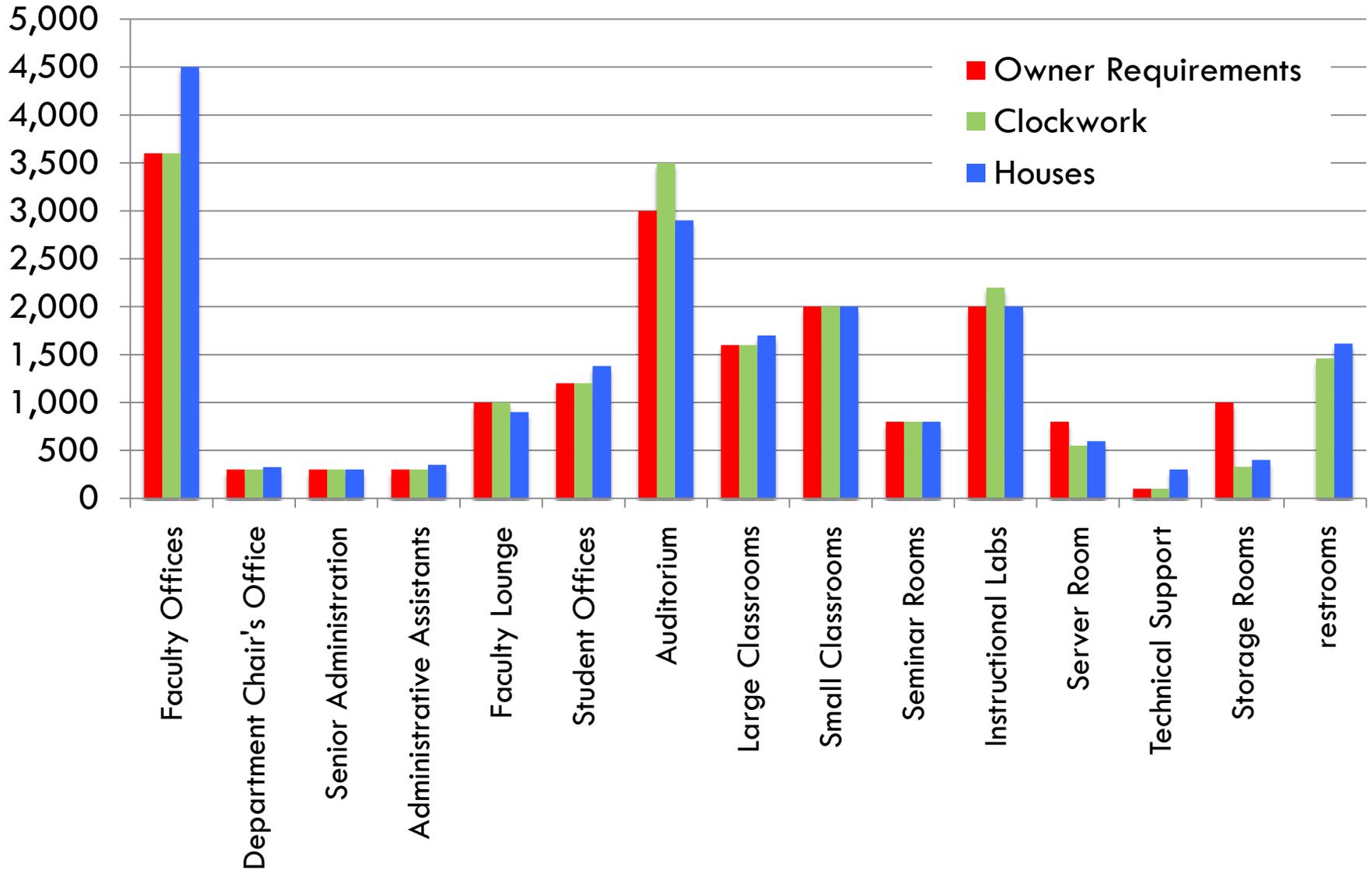
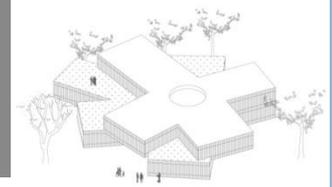
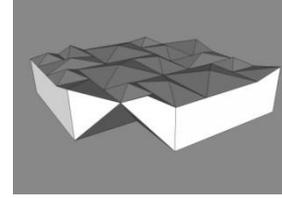
A
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O&M Costs

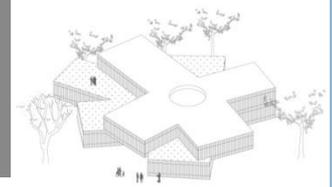
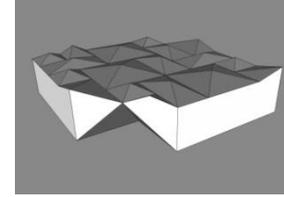


Comparison

Building Program Fit



Life Cycle Benchmarks



Ratio	Clockwork	Houses	Goals
Circulation Area / Usable Floor Area	0.28	0.28	as small as possible
Usable Floor Area / Gross Floor Area	0.84	0.87	> 0.6
Circulation Area / Gross Floor Area	0.23	0.24	as small as possible

A

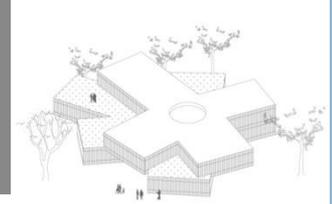
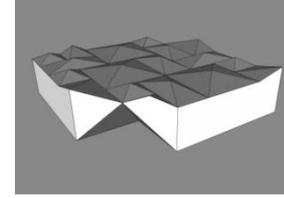
E

C

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L

Risk List



Phase	Risk Name	Description	Affected Aspect	Max. Cost Reduction	Most Likely	Max. Cost Increase
Planning and Construction	Steel Price	Price Changes	Cost of Steel	65%	100%	150%
	Concrete Price	Price Changes	Cost of Concrete	80%	100%	120%
	Soil-Condition	Problems with Excavation and Foundation	Excavation and Foundation Cost	95%	100%	110%
Operation and Maintenance	MEP System Performance	MEP System works better/worse than expected	Heating and Cooling Cost	80%	100%	200%
	Water Price	Price Changes	Water Cost	90%	100%	115%
	Electricity Price	Price Changes	Electricity Price	90%	100%	130%

A

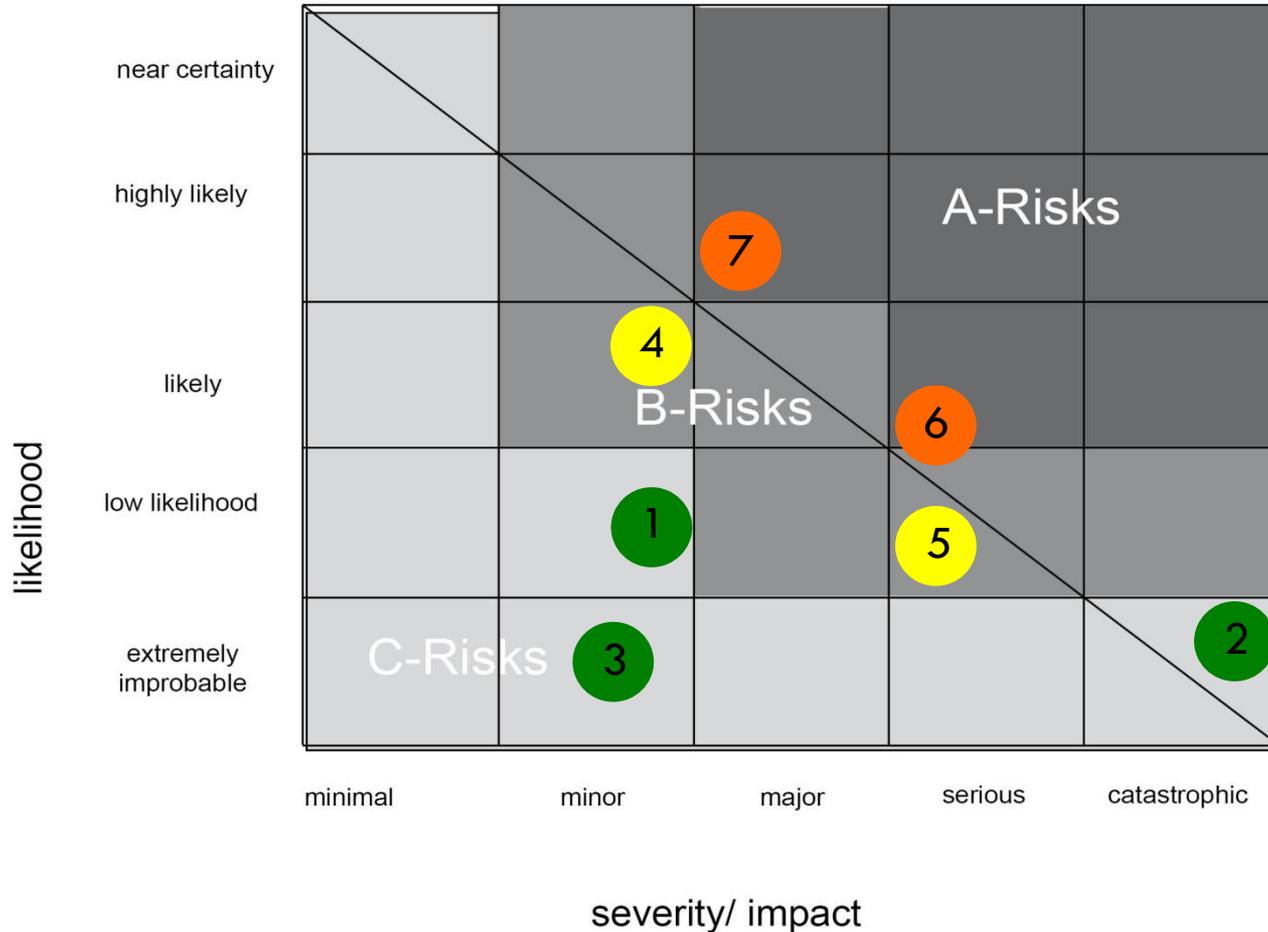
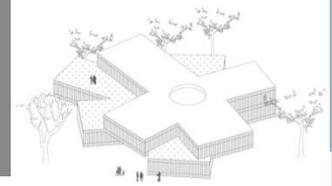
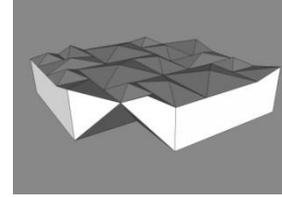
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Risk Matrix



1 Material Quality

4 MEP System

6 Building Costs

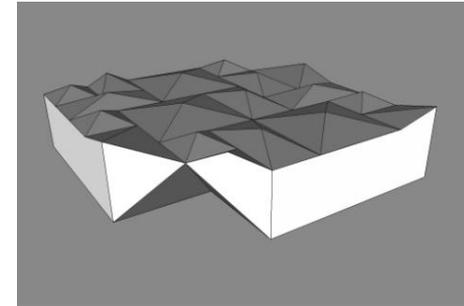
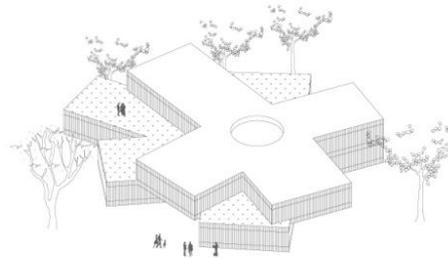
2 Earthquake

3 Concrete Price

5 Electricity Price

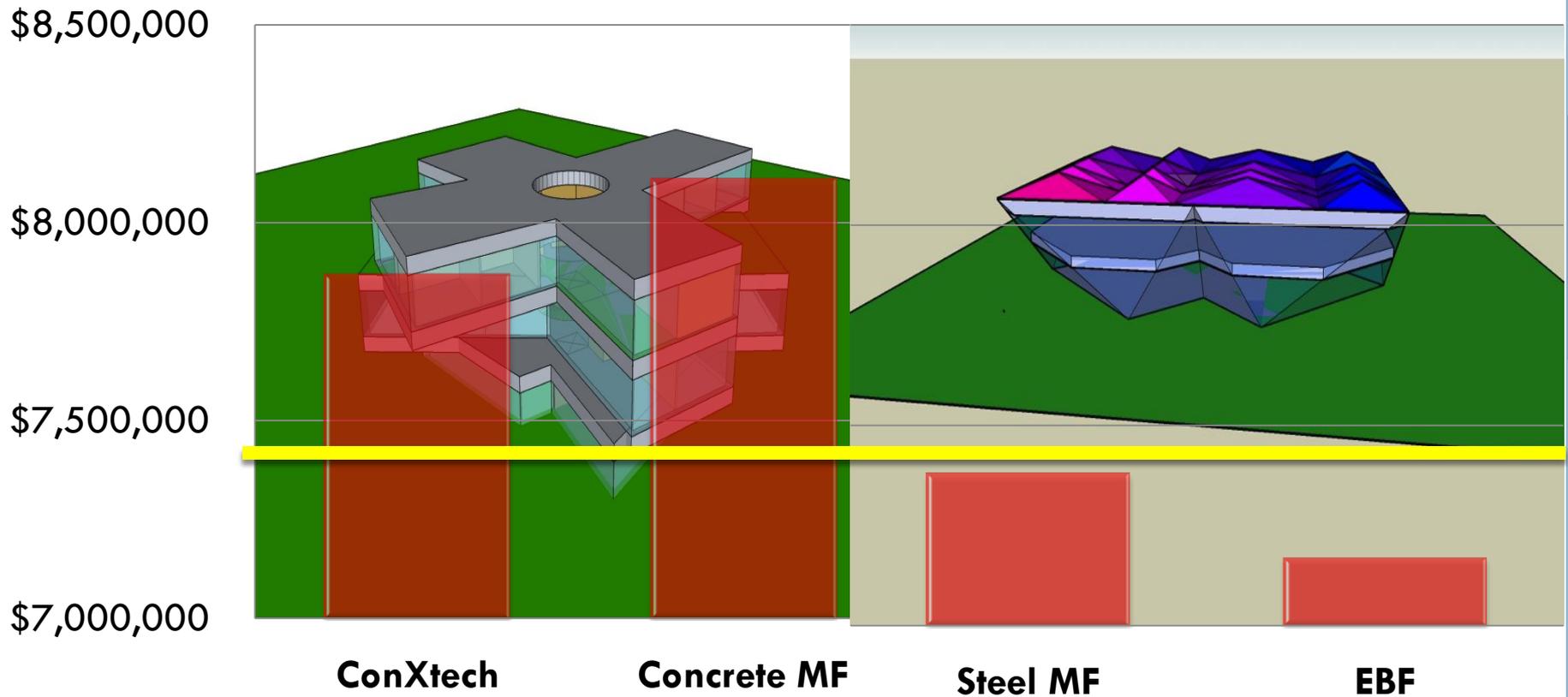
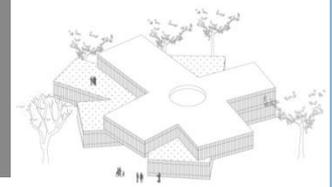
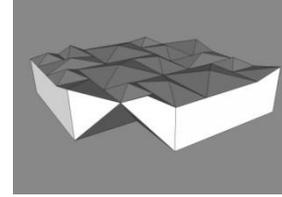
7 Steel Price

Clockwork vs. Houses



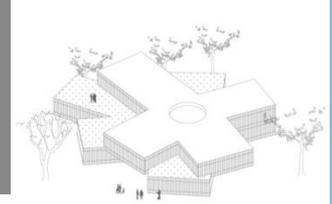
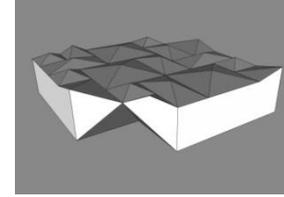
	Clockwork		Houses	
	ConXtech	RC	Steel MF	EBF
Total Cost	\$7,870,000	\$8,110,000	\$7,380,000	\$7,170,000
Construction Duration	240 days	267 days	263 days	249 days
Completion Date	8/30/16	10/6/16	9/30/16	9/12/16

Estimates: Compared



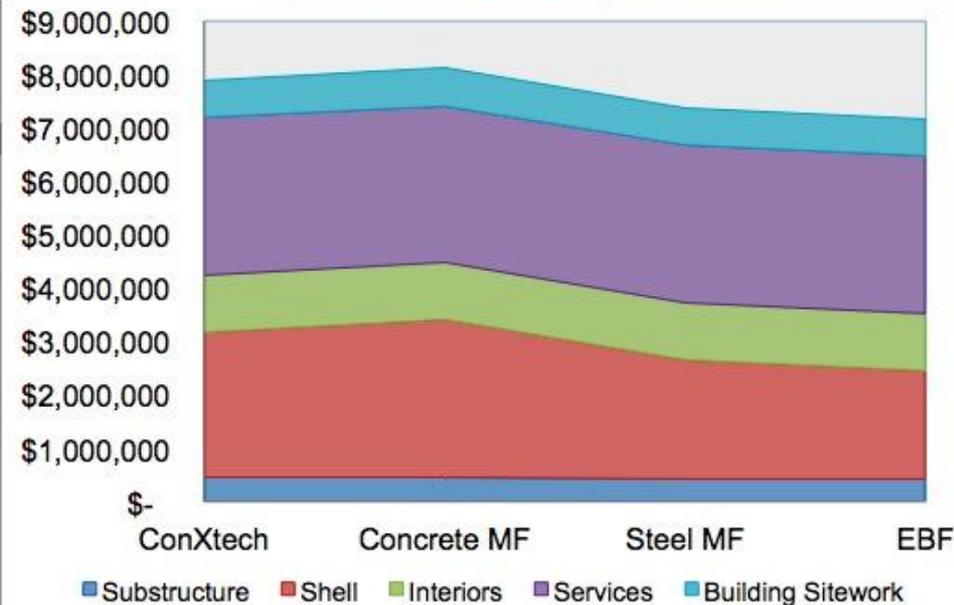
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Total Value Design



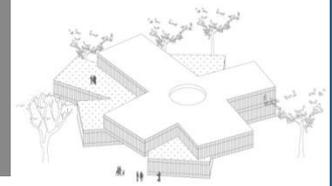
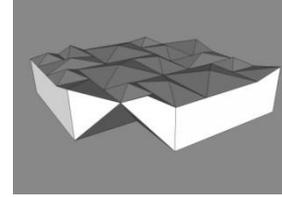
- Goal: Provide valuable Cost Information as Input to Design
- Level 1: General Cost Guidelines
- Level 2: Comparative Assembly Costs
- Level 3: Total Building Value Tracking
 - ▣ Regular Intervals (easily repeatable)
 - ▣ Visual

	Clockworks		Houses	
	ConXtech	Concrete MF	Steel MF	EBF
A Substructure	\$ 460,000	\$ 470,000	\$ 420,000	\$ 420,000
B Shell	\$ 2,700,000	\$ 2,930,000	\$ 2,240,000	\$ 2,030,000
C Interiors	\$ 1,070,000	\$ 1,070,000	\$ 1,070,000	\$ 1,070,000
D Services	\$ 2,950,000	\$ 2,950,000	\$ 2,950,000	\$ 2,950,000
G Building Sitework	\$ 700,000	\$ 700,000	\$ 700,000	\$ 700,000
Total Project Estimate	\$ 7,870,000	\$ 8,110,000	\$ 7,380,000	\$ 7,170,000



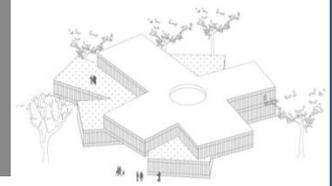
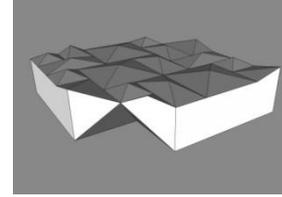
Native Challenge

- Natural Ventilation
- Water Reuse
- Maximum Daylight
- Use of Native Materials for Interior
- Smart Windows
- Looking Ahead:
 - ▣ Heat and Power Unit



LEED Strategies

Sustainable Performance



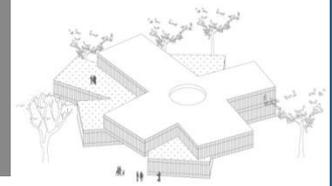
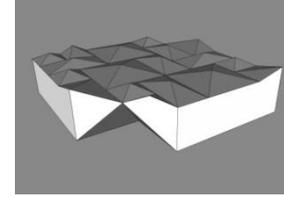
- Natural Ventilation
- Maximum Occupant Comfort
- Smart Windows
- Maximum Daylight
- Minimal Site Disturbance During Construction



- Water Reuse
- Native Materials for Interior
- Bicycle Racks
- Heat and Power Unit
- Vertical Axis Wind Turbine



LEED Certification



LEED Rating Categories	Yes	No	Maybe	Possible Points
Sustainable Site	17	1	8	26
Water Efficiency	3	0	7	10
Energy & Atmosphere	15	5	17	35
Materials & Resources	7	1	6	14
Indoor Environmental Quality	10	1	4	15
Innovation & Design Process	0	0	0	6 bonus
Regional Priority Credits	0	0	0	4 bonus
Silver Accredited	52	8	42	50-59

A

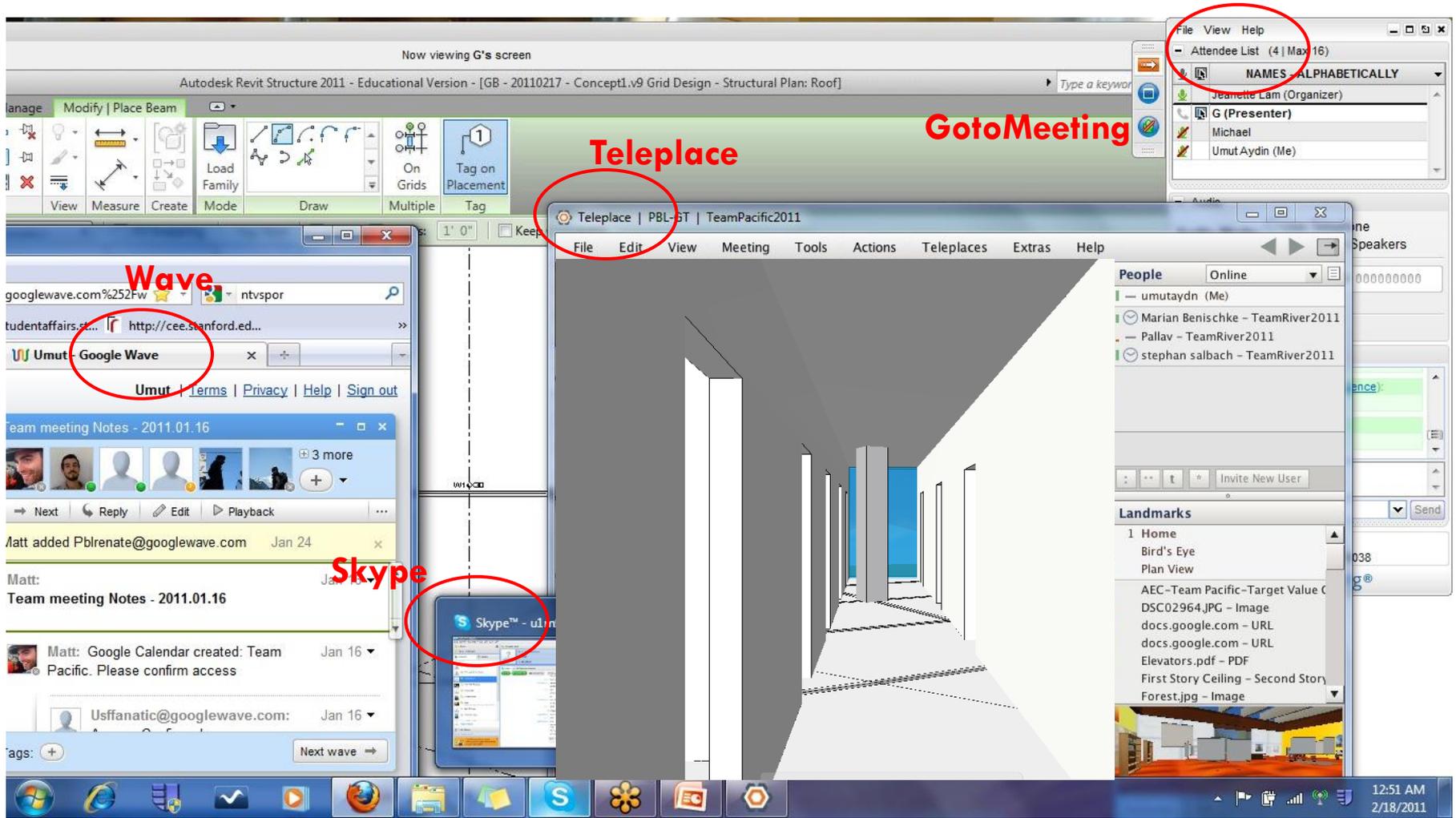
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Team Process - Communications



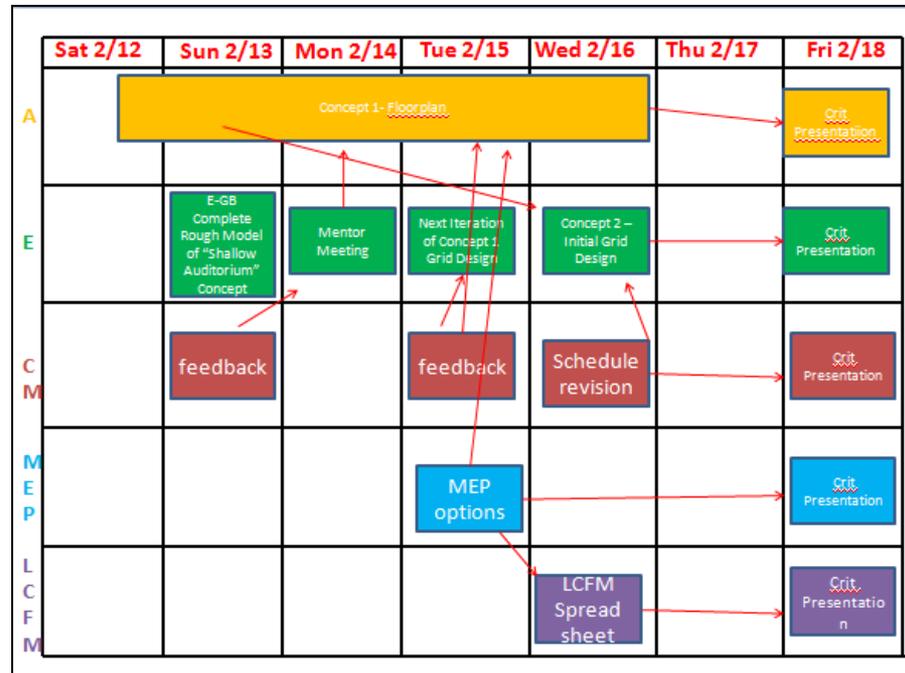
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Team Process - Production

Task List

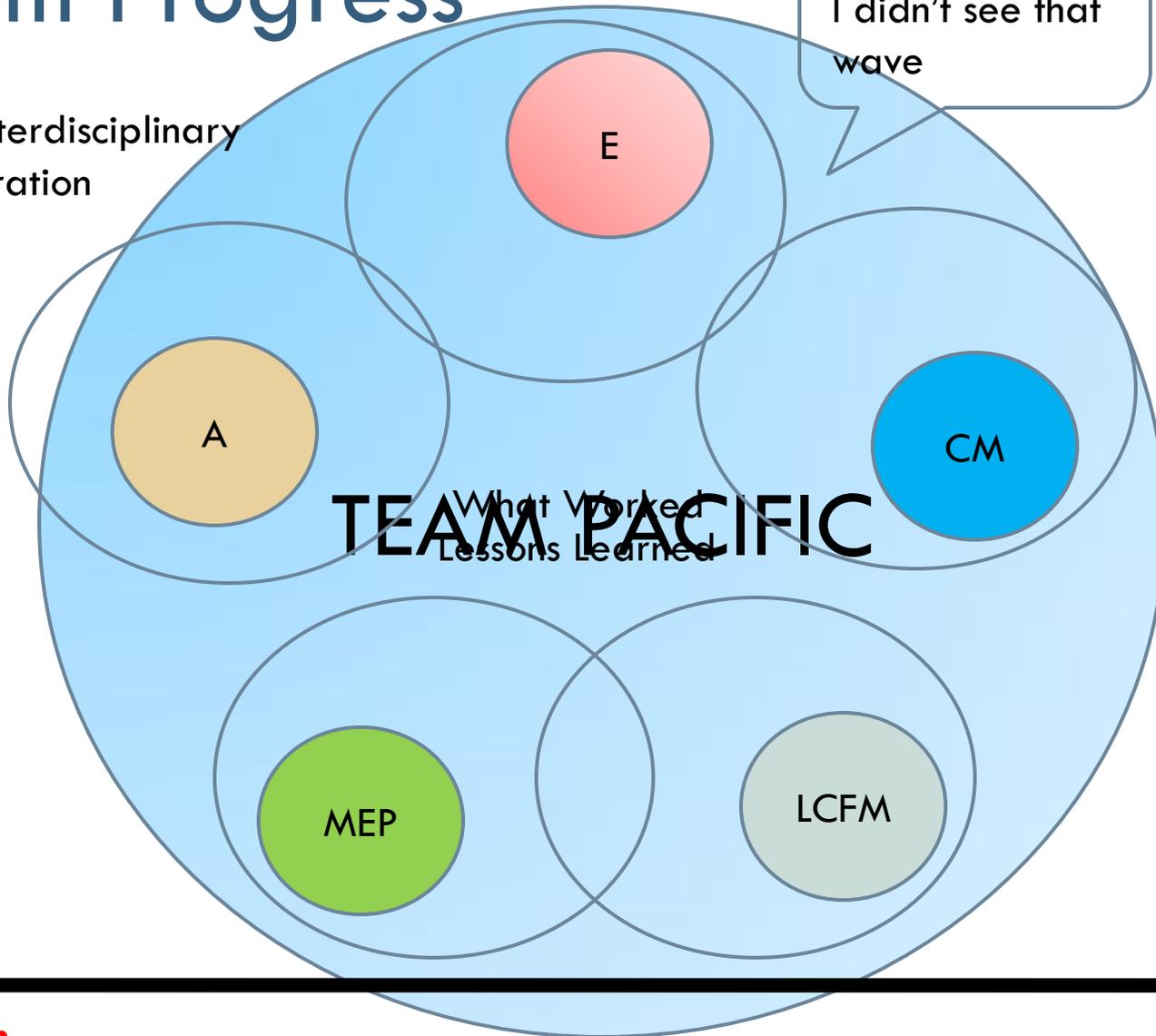
What	By	For	By When	Estimated Time	Date/Time Completed	Completion Status	Actual Time	File Name(s)	File Location(s)	Notes
Description of Deliverable	Use code from Sheet 2	Use code from Sheet 2	Original Committed Finish Date (PST)	Estimated hours needed to complete			Estimated hours used to complete	File Name(s)	File Location(s)	
Sketchup Model-Site Logistics	C-ML	CM	2/7/2011 11:00 PST	3	2/6/2011 13:30:00	Done	3	ML-20110206-Site logistics model-v1	Dropbox 7.1	
Floor Options Estimates	C-ML	E, A, C	2/7/2011 11:00 PST	2	2/5/2011 14:30 PST	Done	2	ML 20110205 Floor Cost Chart-v1	Dropbox 7.3.1	
Create TVJ Cluster slides for mentors	C-ML		2/4/2011 12:00:00	1	2/4/2011 0:00:00	Done	1.5			
Rough Scheduling	C-UA C-ML	CM	2/7/2011 11:00 PST 2/5/2011 13:00 PST	3	2/6/2010 9:00:00 pm PST 2/5/2011 13:30 PST	Done	2	UA-20110206_High	Dropbox 7.4.1	
Floor Estimating Meeting	E-GB	E, A, C		0.5		Done	0.5			
circulation area AC1	A	L-CG	2/8/2011 0:00:00							
roomprogramm AC2	A	L-CG	2/10/2011 0:00:00							
Create SketchUp model for grid prototype 2	E-GB	A, MEP	2/7/2011 23:00:00 PST	4	2/8/2011 21:00:00 PST	Done	6	GB-20110207-Concept1.v5	Dropbox 6.2 Concept Models	

IPD Production Plan



Team Progress

Good Interdisciplinary
Collaboration



What Worked
Lessons Learned

TEAM PACIFIC

Did this change?
I didn't see that
wave

Clustered Team
Dynamics

Fully Integrated
Team Dynamics

A

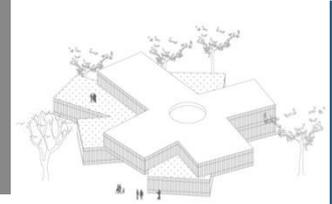
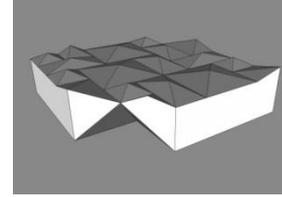
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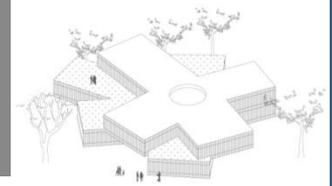
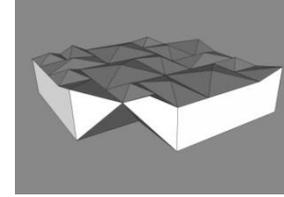
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Decision Matrix



- Aspects:
 - ▣ Aesthetics, “Wow”-Effect
 - ▣ User Experience
 - ▣ Functionality / Flexibility / Space Efficiency
 - ▣ Earthquake Performance
 - ▣ Structural Symmetry
 - ▣ Building and Life Cycle Costs
 - ▣ Construction Time / Constructability / Prefabrication
 - ▣ Energy Efficiency
 - ▣ MEP Implementation
 - ▣ Natural Ventilation and Light
 - ▣ Sustainability and Compliance with NATIVE

Decision Matrix



	Clockwork		Houses	
	ConXtech	Concrete MF	Steel MF	EBF
Team Pacific	309	277	344	357
Björn (owner)	411	379	330	320
Anirudh (owner)	407	357	345	323
total	1127	1013	1019	1000

A

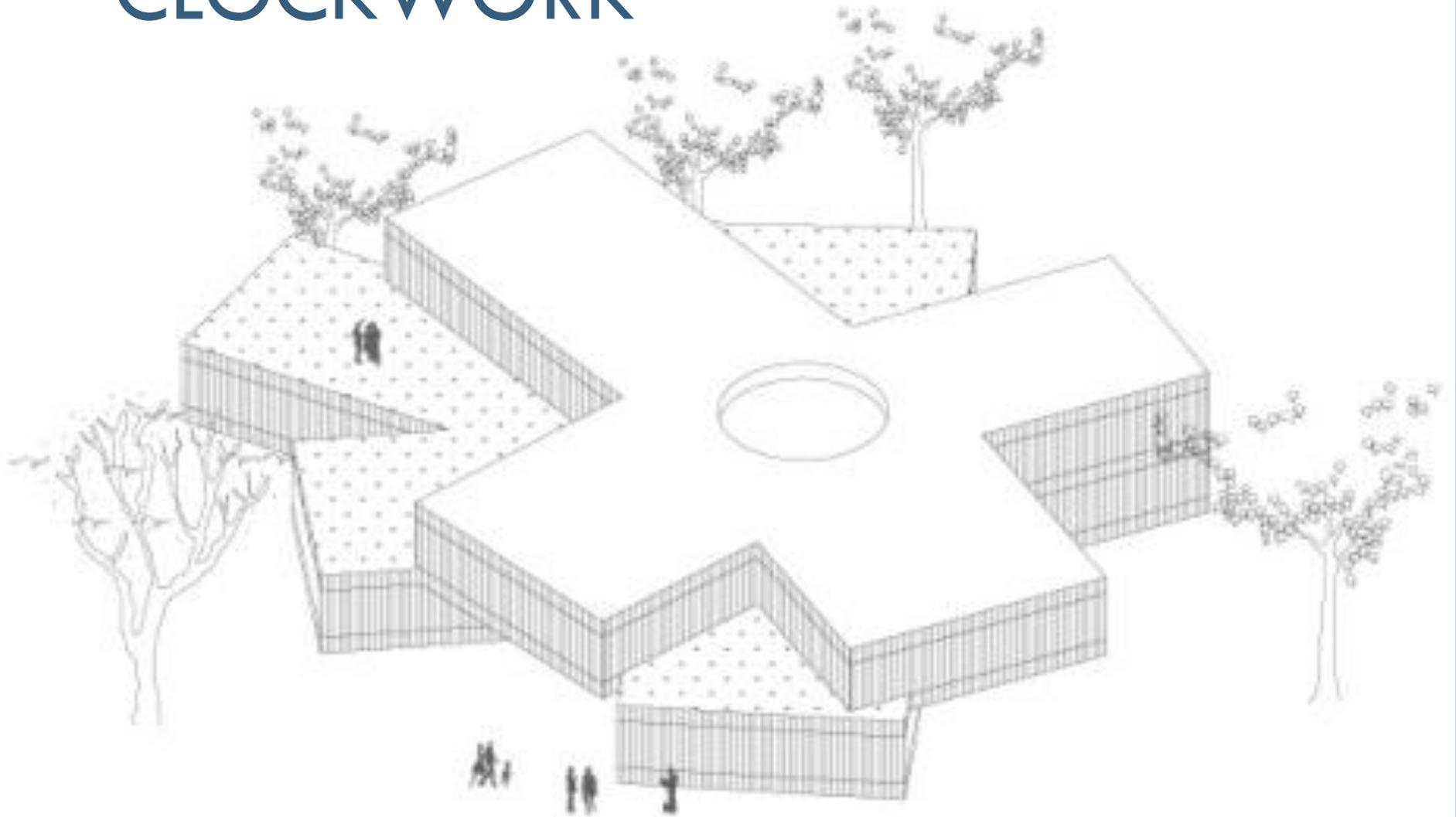
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Team Pacific presents ... CLOCKWORK



Team Pacific would like to thank:



Renate Fruchter
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Greg Luth
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Eric Borchers
Henry Tooryani
Professor Kolderup
Dennis Kwan