



# THE URBN CENTER & ANNEX

Philadelphia, PA

Penn State AE Senior Thesis Project

Ghaith Yacoub | Construction Management

Dr. Robert Leicht | CM Advisor



I. Project Overview

I. History and Location

II. Background

II. Presentation Overview

III. Analysis#1: Demolition Alternatives

IV. Analysis#2: SIP Scheduling of the Steel Erection

V. Analysis#3: Prefabrication of the Curtain Walls

VI. Analysis#4: Supply Chain of the Mechanical System

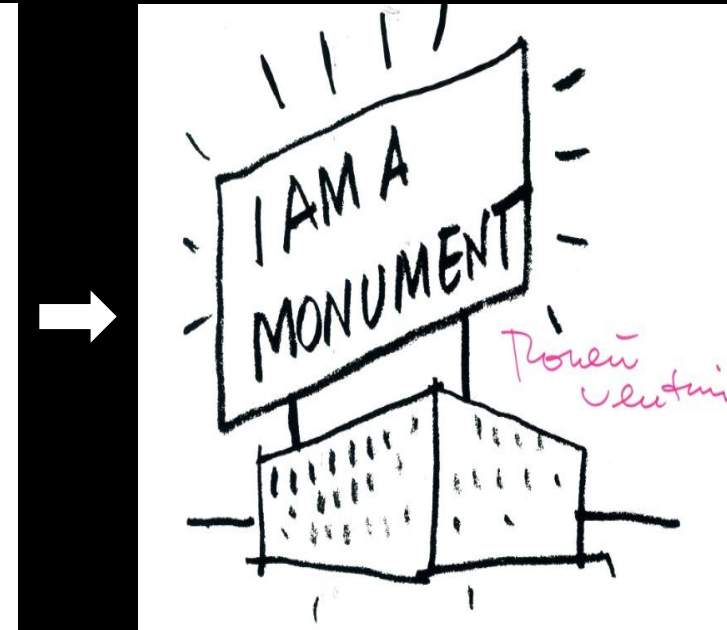
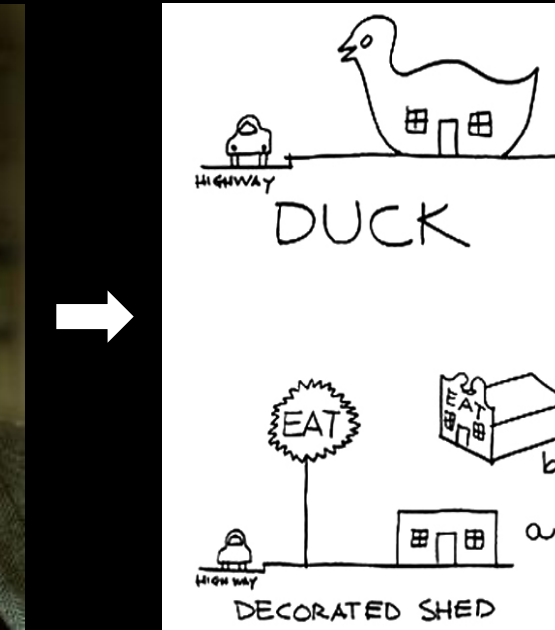
VII. Summary and Conclusion

VIII. Acknowledgments

Project Location:



Building's History:



## I. Project Overview

I. History and Location

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**Project Volume:** \$31 Million

**Size:** 145917 SF

**Construction Duration:** URBN Center: 10/11-9/12  
Annex: 12/11-10/12

**Delivery Method:** Design-Bid-Build. Lump-Sum Contract

**Renovation Scope:** Demo of core  
New Mezzanine levels  
Curtain walls  
MEP replacement

**Turner**



## Building Layout:

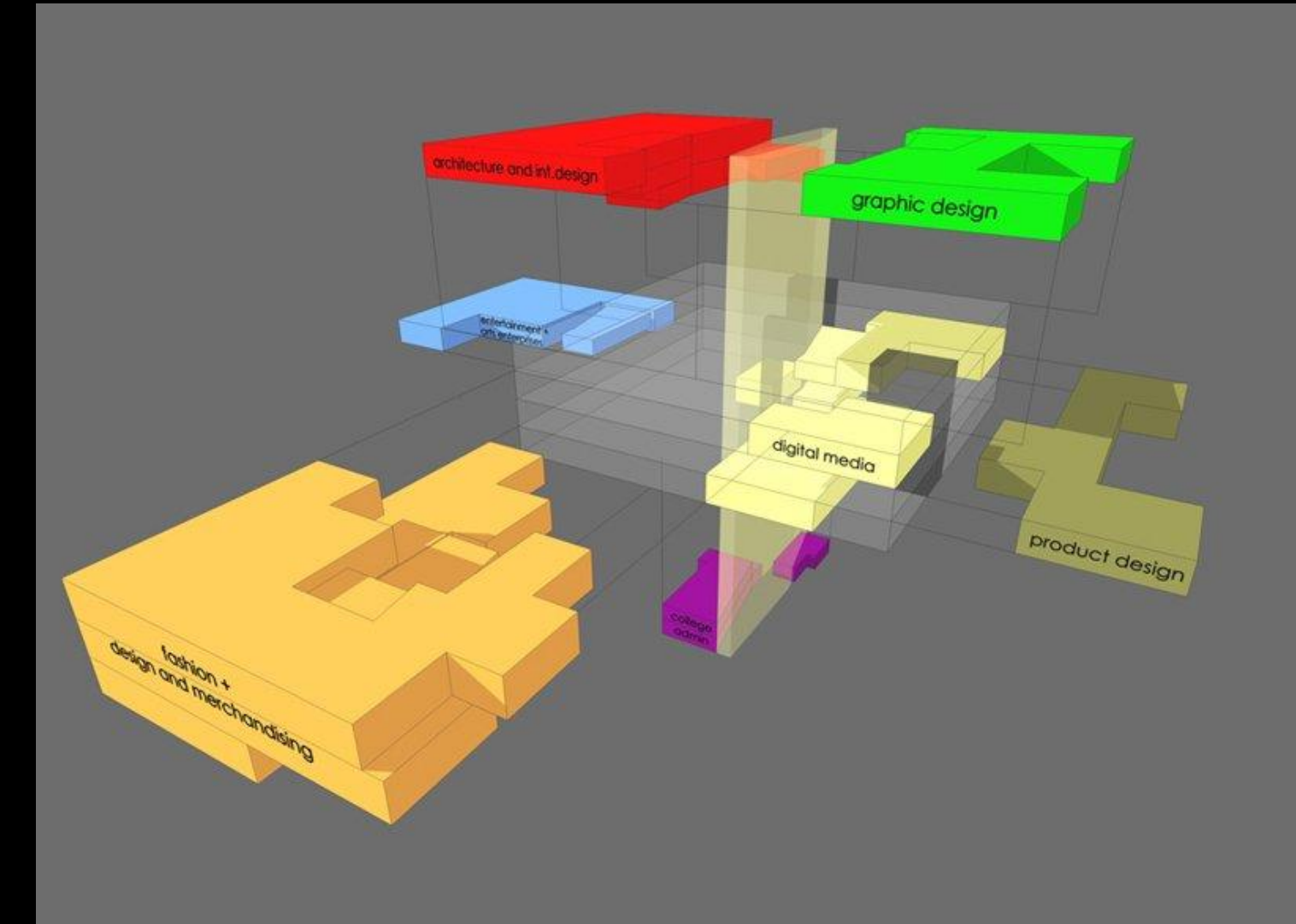


Photo Property of: MS&R LTD.

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### Construction Depths:

**Analysis # 1:** Demolition Alternatives for the Building's Core.

**Analysis # 2:** SIP Scheduling for the Steel Erection

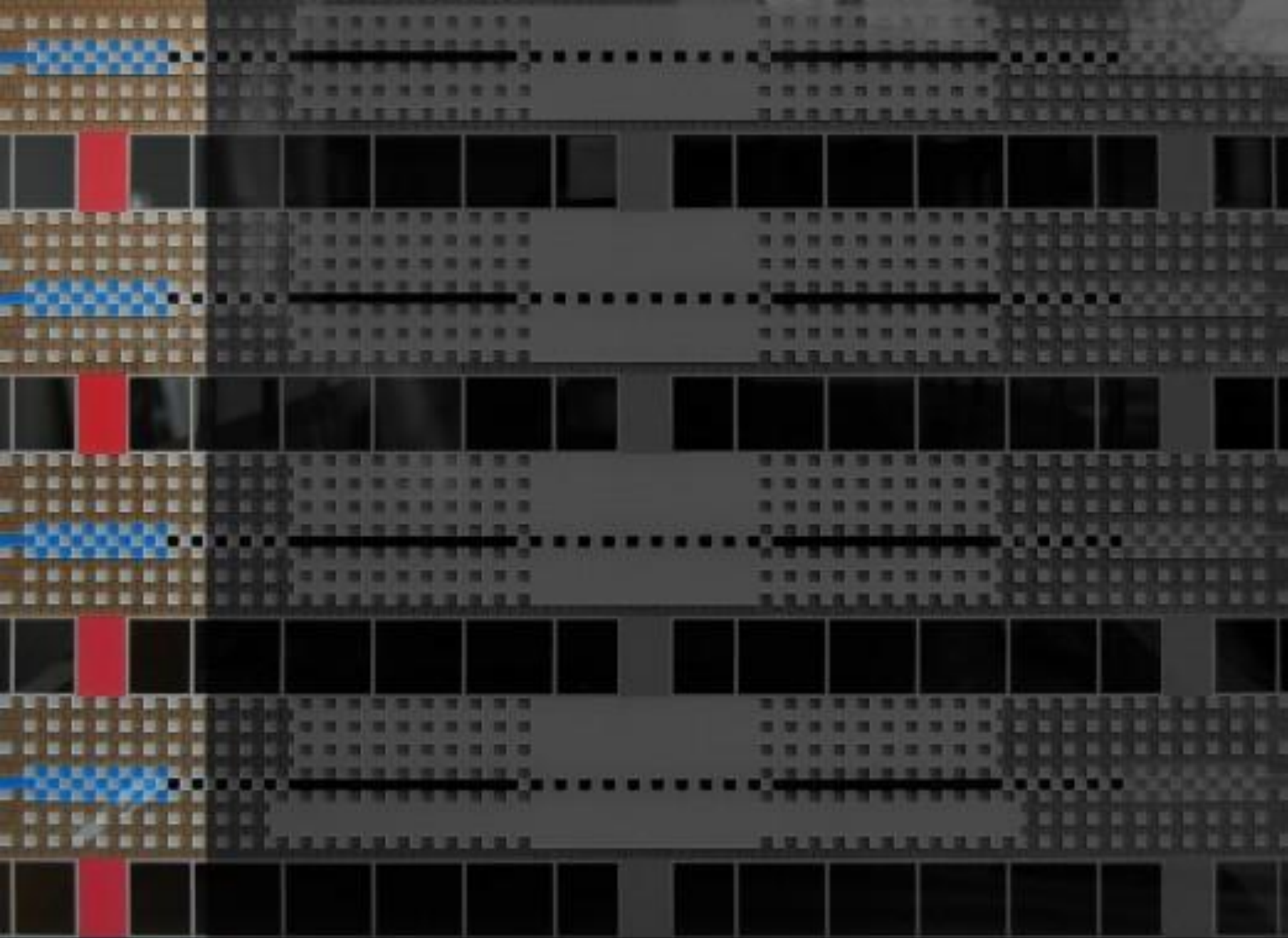
**Analysis # 3:** Prefabrication of the Curtain Walls

**Analysis # 4:** Supply Chain Research of the Mechanical System

### Breadth Topics:

**Structural Breadth #1:** Steel Beam Sizing (Related to Analysis #1)

**Mechanical Breadth #2:** Energy Comparison Between Chilled Beams and VAV System (Related to Analysis #4)

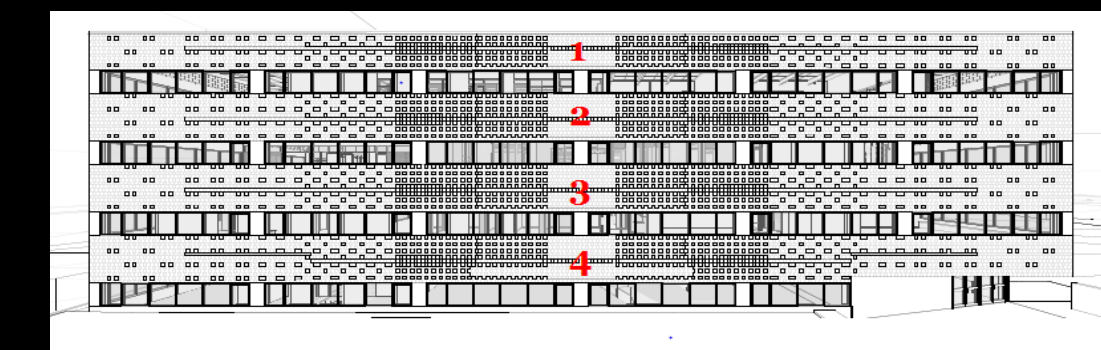
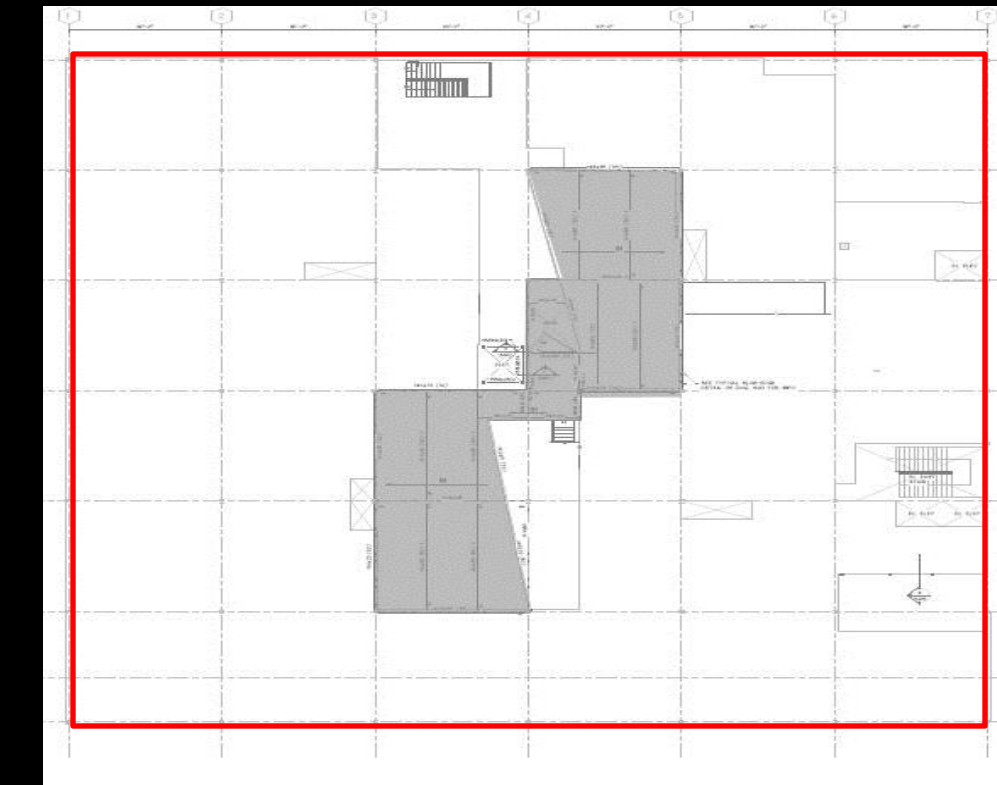
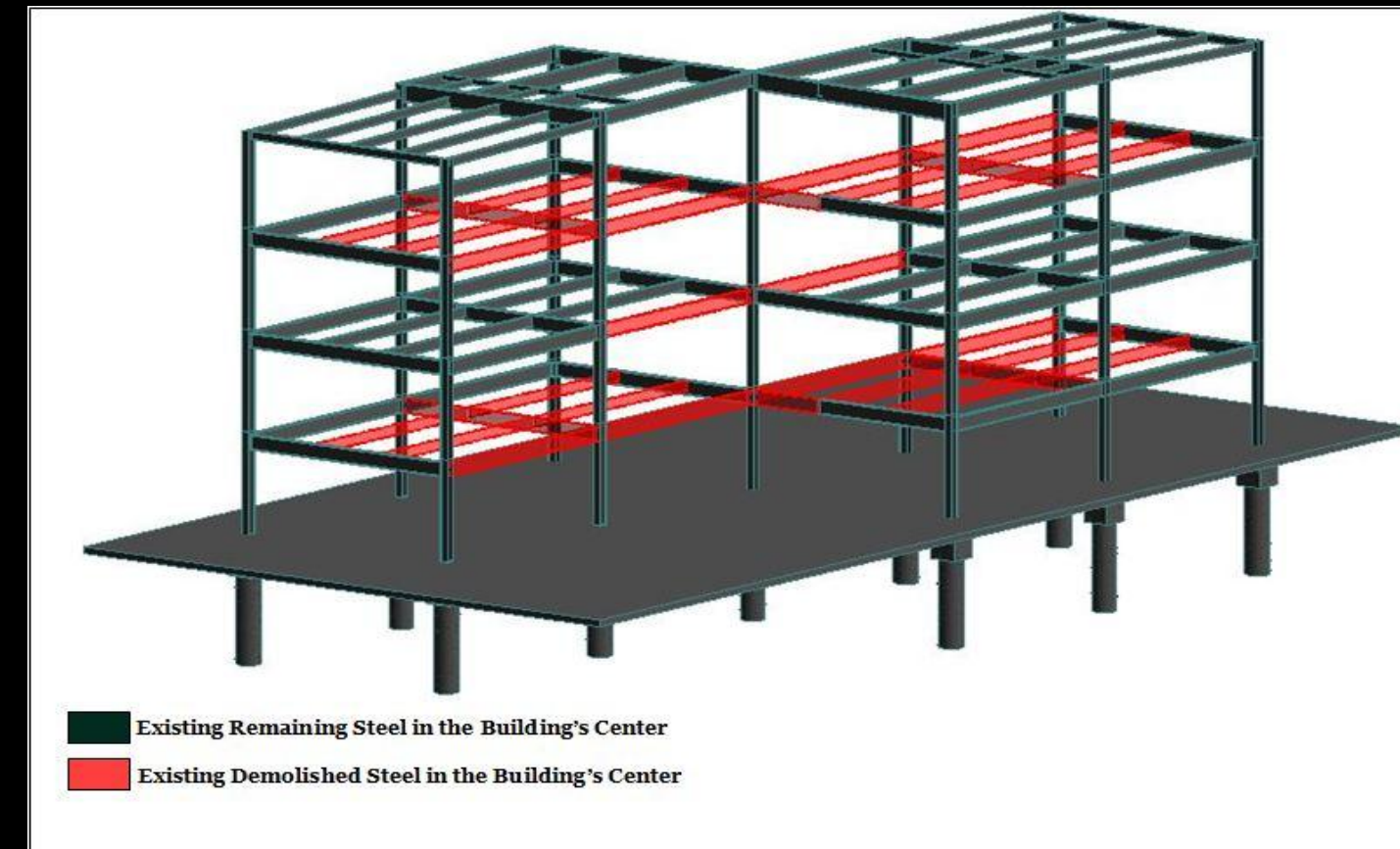


**ANALYSIS I**  
Demolition Alternatives for the Building's  
Core

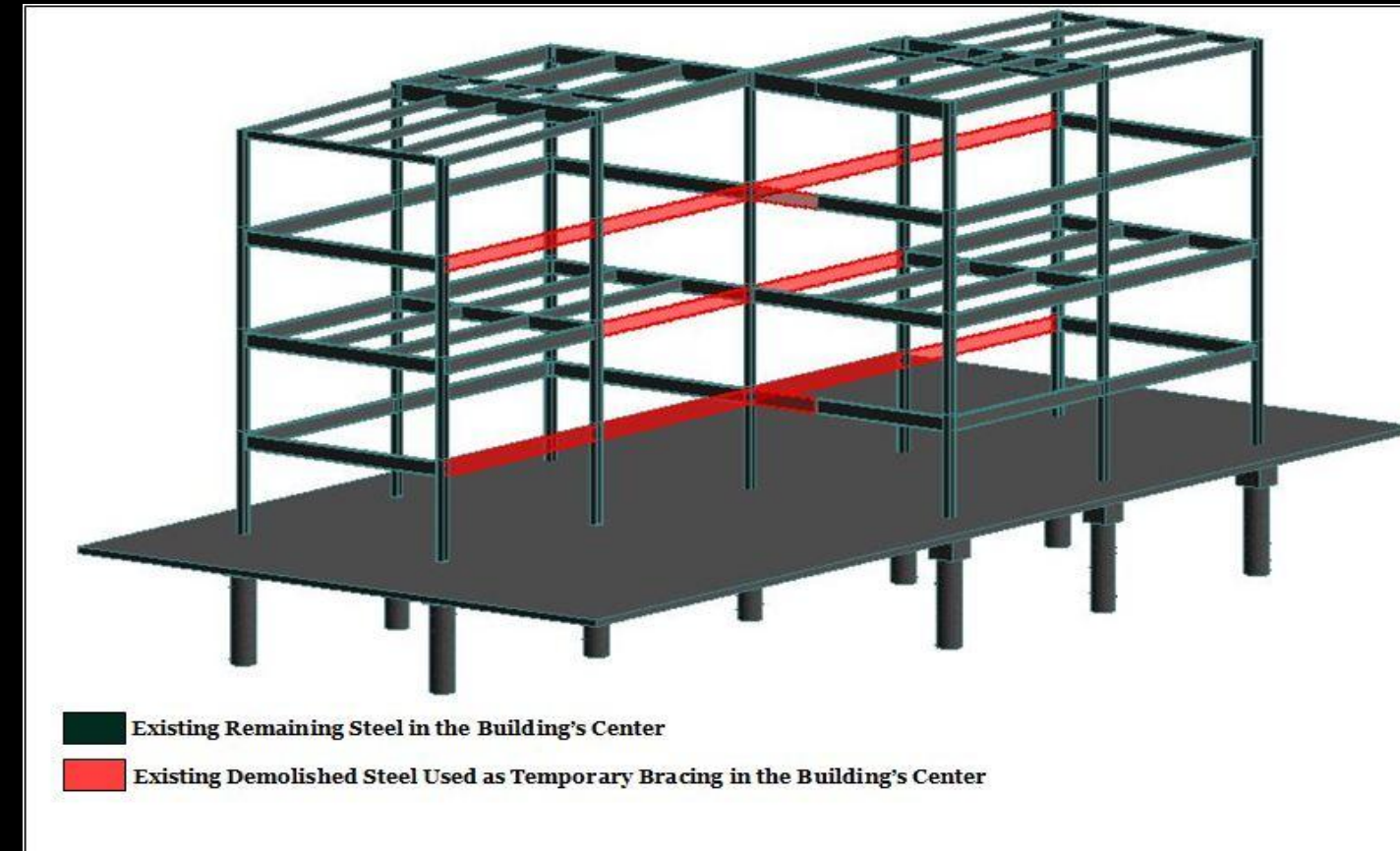


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  - I. Existing Demo
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**Concern:** Columns are un-braced for more than 14'



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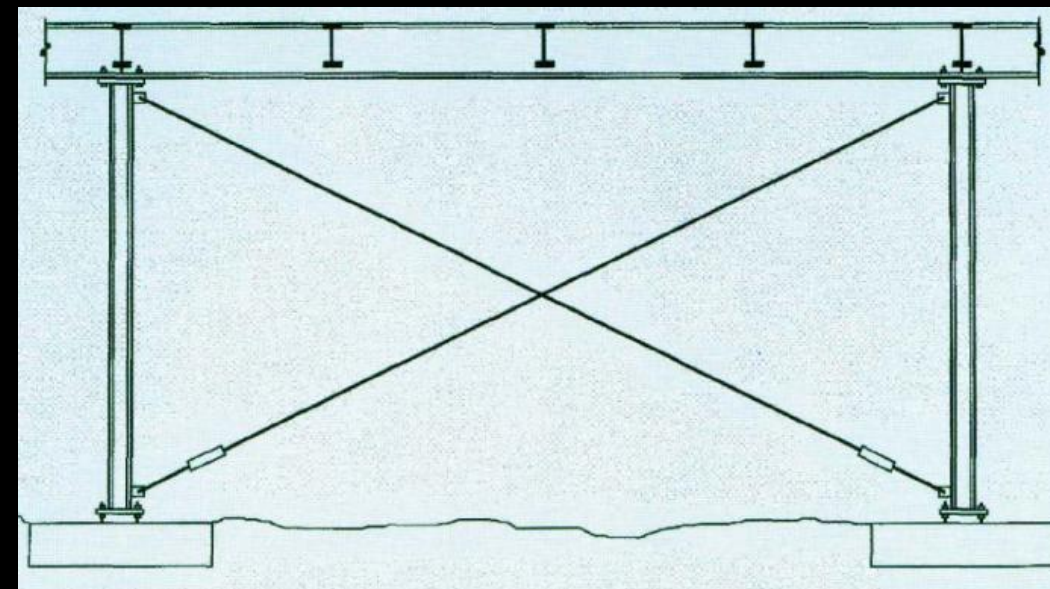
**Solution:** Maintain critical existing beams during demolition.

**Schedule Effects:** 10 Mondays.  
Recovered with overtime/2<sup>nd</sup> shift

URBN Center's Existing Demolition Schedule					Notes
Item	Level	Start	Finish	Duration (days)	
<b>Concrete Slab</b>	4	12/27/2012	12/30/2012	4	N/A
	3	1/3/2012	1/6/2012	4	
	2	1/9/2012	1/12/2012	4	
<b>Deck and Initial Beams</b>	4	1/10/2012	1/14/2012	4	15 Beams
	3	1/16/2012	1/19/2012	4	0 beams
	2	1/20/2012	1/25/2012	4	15 Beams
<b>Remaining Beams</b>	4	3/26/2012	3/27/2012	2	5 beams
	3	3/28/2012	3/29/2012	2	2 Beams
	2	3/26/2012	3/27/2012	2	5 Beams

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[Using AISC Guide: Erection Bracing of Low-Rise Structural Steel Buildings  
**Proposed Plan:** Remove all steel in 1 phase and implement Temporary bracing through either  
 A) Cross Cable Bracing



B) Temporary Beam Placement

**Cost of Cable Bracing:**

Item	Quantity	Unit	Cost per Unit (\$)	Total cost (\$)	Source
1/2" wire rope	5600	LF	1.33	7448	ACE Industries Inc
U-Bolt Clip	40	EA	0.88	35.2	ACE Industries Inc
Angles	40	EA	0.98	39.2	ACE Industries Inc
<b>Total Cost (\$)</b>				<b>7523</b>	

**Schedule Changes:**

URBN Center's Proposed Demolition Schedule					Notes
Item	Level	Start	Finish	Duration (days)	
<b>Concrete Slab</b>	4	12/27/2012	12/30/2012	4	N/A
	3	1/3/2012	1/6/2012	4	
	2	1/9/2012	1/12/2012	4	
<b>Deck and Beams</b>	4	1/10/2012	1/17/2012	6	20 Beams
	3	1/18/2012	1/23/2012	4	2 beams
	2	1/20/2012	1/25/2012	4	20 Beams
<b>Cable Installation</b>	4	1/10/2012	1/10/2012	1	N/A
	3	1/18/2012	1/18/2012	1	
	2	1/20/2012	1/20/2012	1	



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**Comparison Factors:**

Additional cost

Effects on next critical path item [ Steel erection]

Method	Advantages	Disadvantages
<b>Existing demolition method</b>	<ul style="list-style-type: none"> <li>• Limits additional labor</li> <li>• Does not interfere with the steel erection</li> <li>• Does not add additional cost to the project</li> </ul>	<ul style="list-style-type: none"> <li>• Need of demolition during the construction phase of the project.</li> <li>• Demo. Sub. Needs to come back to finish the scope.</li> </ul>
<b>Cable Cross Bracing</b>	<ul style="list-style-type: none"> <li>• Fast and easy installation</li> <li>• Allows for demolition of steel in one phase</li> <li>• cheap</li> </ul>	<ul style="list-style-type: none"> <li>• Additional Labor</li> <li>• Disrupts the steel erection</li> </ul>
<b>Temporary Beams</b>	<ul style="list-style-type: none"> <li>• NA</li> </ul>	<ul style="list-style-type: none"> <li>• Labor intensive</li> <li>• Availability of steel is questionable</li> <li>• Expensive</li> </ul>

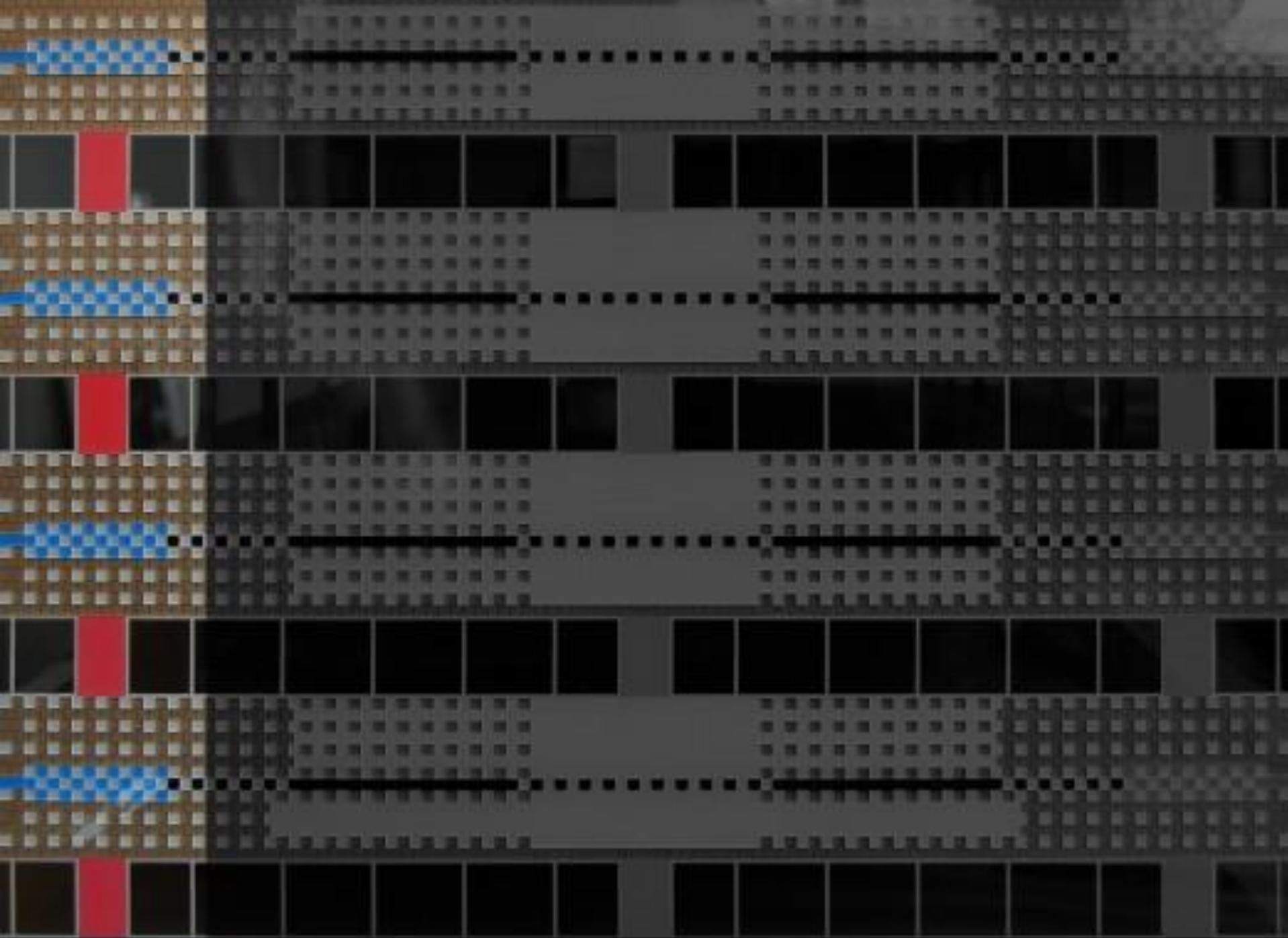
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**Existing demolition plan is most effective due to having no additional cost and no effect on the steel erection.**

**Time taken to develop demo plan [10 Days] allows for schedule Acceleration Opportunities**

Demolition Photos:





**ANALYSIS II**  
SIP Scheduling for Mezzanine Levels

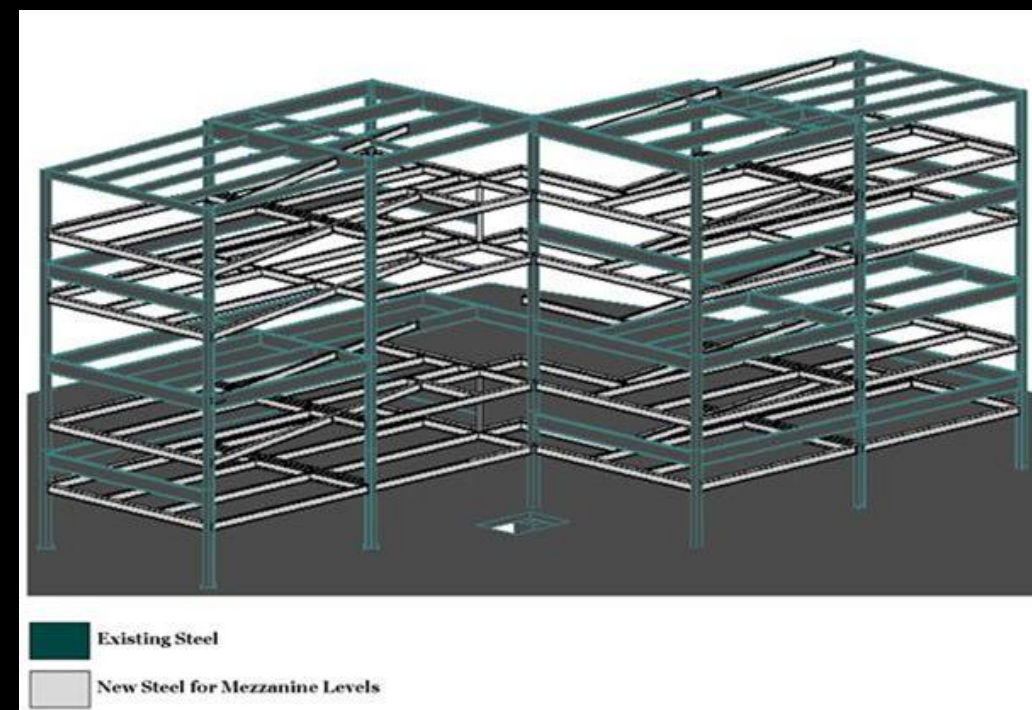


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Why?

Highly repetitive activities in mezzanine levels

Potential acceleration of critical path items



Structural Framing and Slab on Metal Deck Durations		
	Structural Framing	Slab on Metal Deck
Level	Duration (Days)	Duration (Days)
1A	8	1.5
2A	8	1.5
3A	8	1.5
4A	8	1.5

[38 DAYS TOTAL]

Structural Steel	Welding clip angles to existing steel
	Steel erection
	Installing safety cables
	Detail Welding
Slab on Metal Deck	Decking
	Installing Bent plates
	Slab prep
	Slab pouring

[STEEL ERECTION IS MOST CRITICAL]

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**Labor:**

- 1 foreman
- 2 erectors
- 1 crane operator
- 2 welders
- 1 Apprentice

**Equipment:**

- 26 Ton Mobile Crane
- Propane Powered Mini Crane
- Chain Falls
- Trolleys

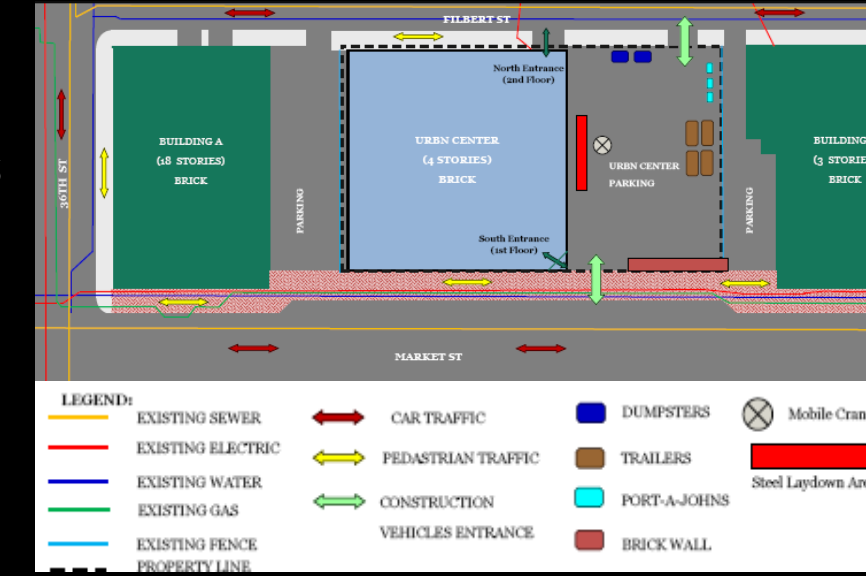


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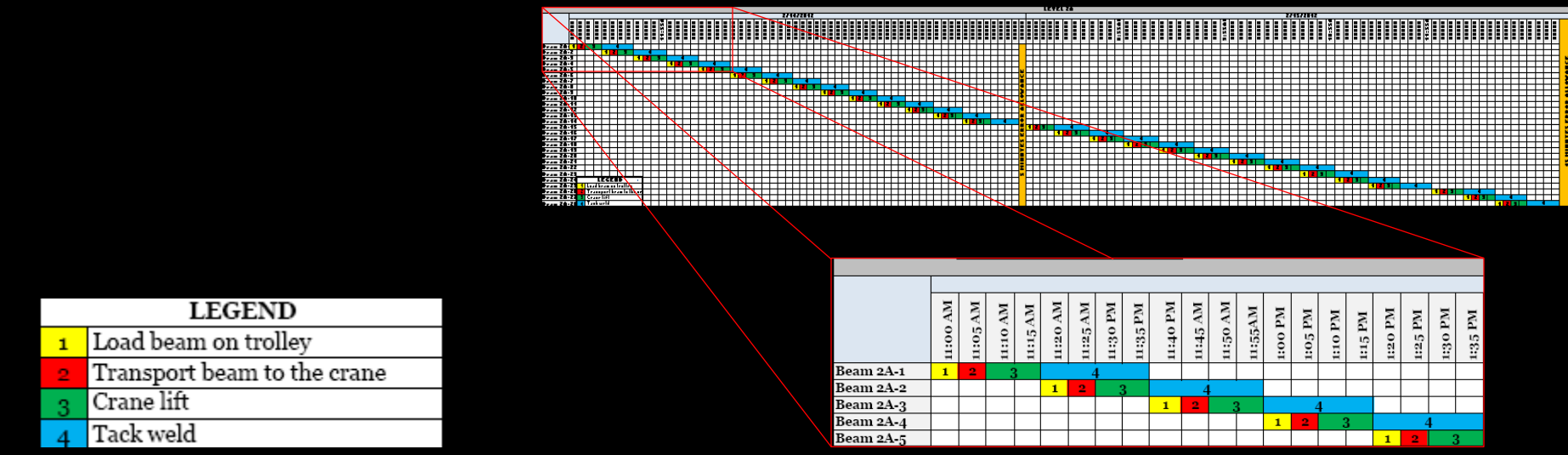
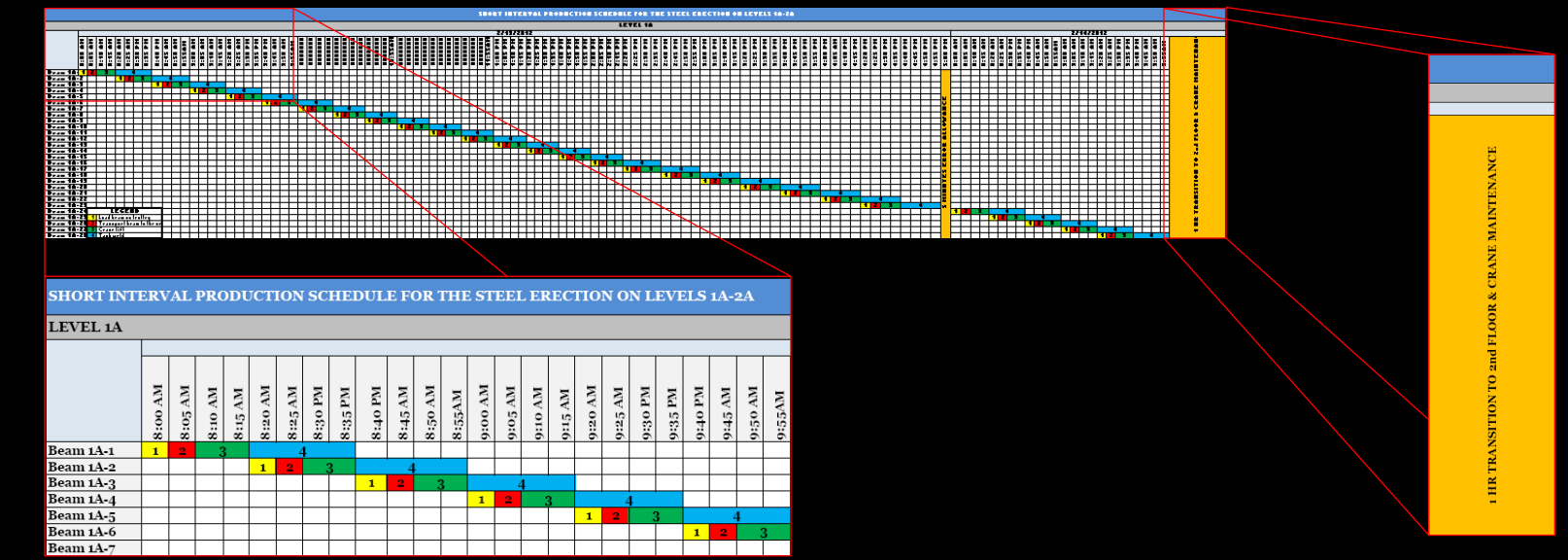
**Levels 1A-2A Sequence:**

Load beam on trolley..... 4 Mins  
 Transport beam inside the building..4 Mins  
 Crane lift.....8 Mins  
 Tack (initial) welding..... 20 Mins

Total member duration: 36 Mins  
 Total of 28 members on each level



LEVEL	Duration	Total hours (hrs)
<b>1A</b>	2/13/2012 (8AM-5PM)	8
	2/14/2012 (8AM-10AM)	2
<b>Crane transition period</b>		1
<b>2A</b>	2/14/2012 (11AM-5PM)	5
	2/15/2012 (8AM-2 :15 PM)	5.25
<b>Error Allowance</b>		0.75
<b>Total Duration (hrs)</b>		<b>22</b>
<b>Total Duration (work Days)</b>		<b>2.75</b>



**LEGEND**

1	Load beam on trolley
2	Transport beam to the crane
3	Crane lift
4	Tack weld

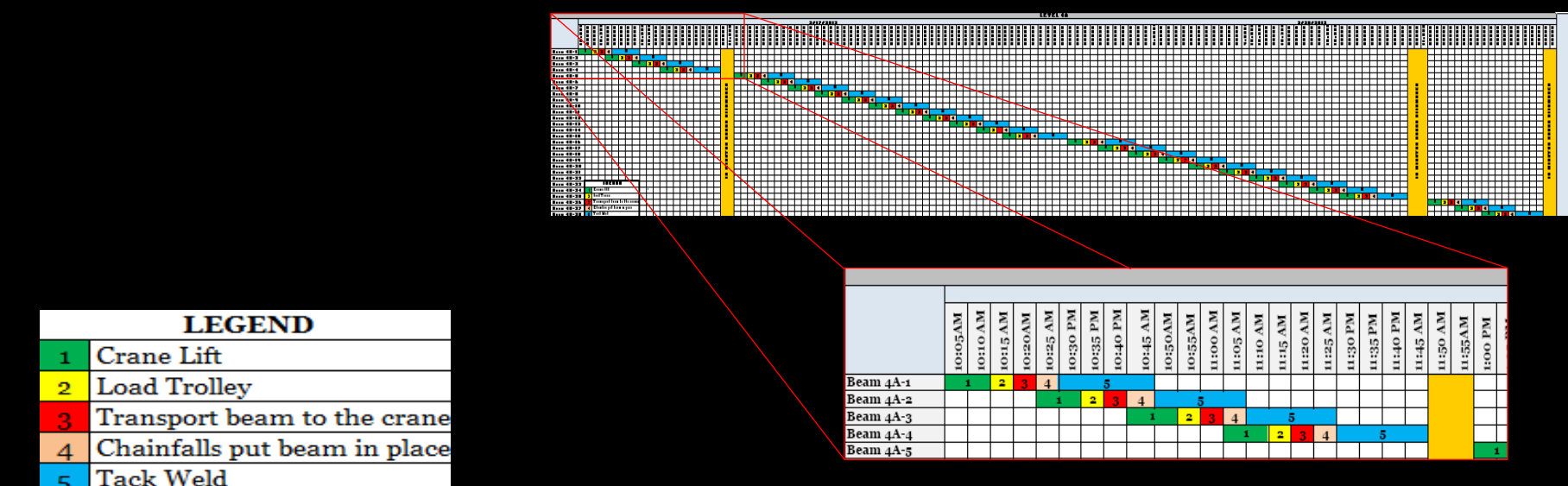
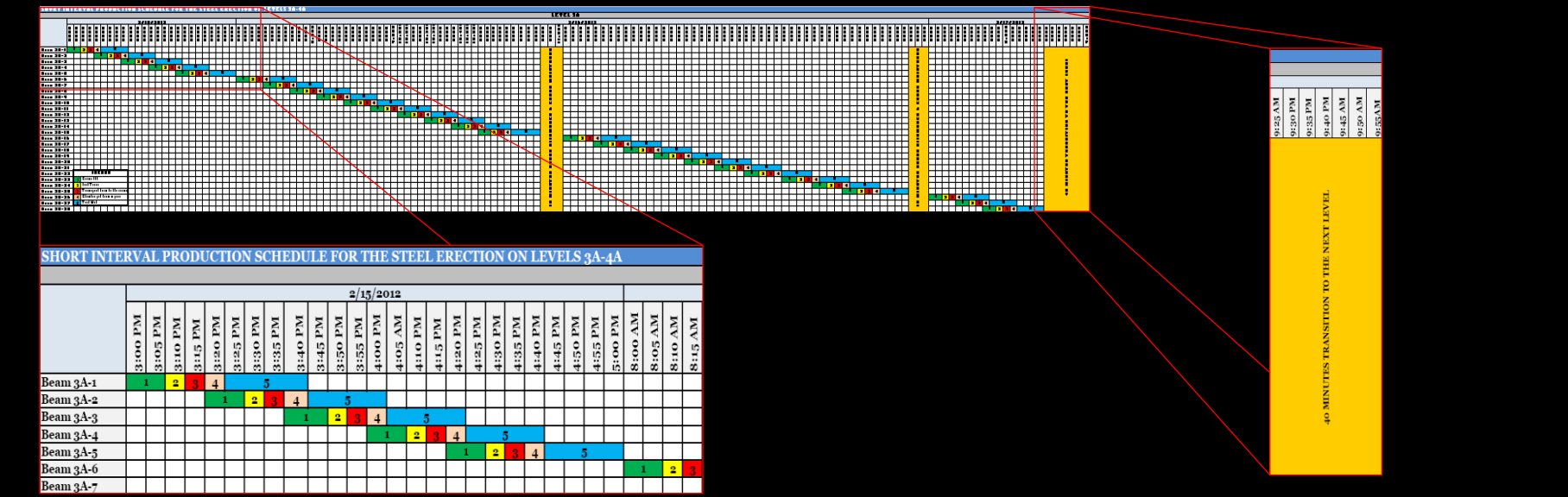
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**Levels 3A-4A Sequence:**

- Crane lift.....8mins
- Beam placement on trolley from window opening.....4mins
- Transporting the beam to center of the building.....4mins
- Using chain falls to move the beam into place.....4mins
- Tack welding.....20mins

Total member duration: 40 Mins  
Total of 28 members on each level

LEVEL	Duration	Total hours (hrs)
3A	2/15/2012 (3PM-5PM)	2
	2/16/2012 (8AM-5PM)	8
	2/17/2012 (8AM-9:20AM)	1.33
<b>Transition to the next floor</b>		0.66
4A	2/17/2012 (10AM-5PM)	6
	2/20/2012 (8AM-3:20 PM)	6.25
<b>Error Allowance</b>		.25
<b>Total Duration (hrs)</b>		<b>25</b>
<b>Total Duration (work Days)</b>		<b>3.13</b>



**LEGEND**

1	Crane Lift
2	Load Trolley
3	Transport beam to the crane
4	Chainfalls put beam in place
5	Tack Weld

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Activity	Duration (Days)
Welding clip angles to existing steel	4
Steel erection	5.88
Safety cables	4
Detail Welding	8
Decking and bent plates	8
Slab prep	4
Slab Pour	2
<b>Total days</b>	<b>35.88</b>

**Total Savings: 2.12 Work Days**

**General Conditions Cost/Day: \$6,031**

**General Conditions Savings: \$12,800**

Labor	Hourly Rate (\$/hr)	Hours	Cost (\$)
<b>Forman</b>	52.05	17	885
<b>Steel Worker (x2)</b>	50.05	17	851
<b>Crane Operator</b>	48.80	17	830
<b>Welder (x2)</b>	50.05	17	851
<b>Apprentice</b>	33.05	17	562
<b>Total Cost</b>			<b>\$3,980</b>

**[ TOTAL SAVINGS = \$16,780 ]**

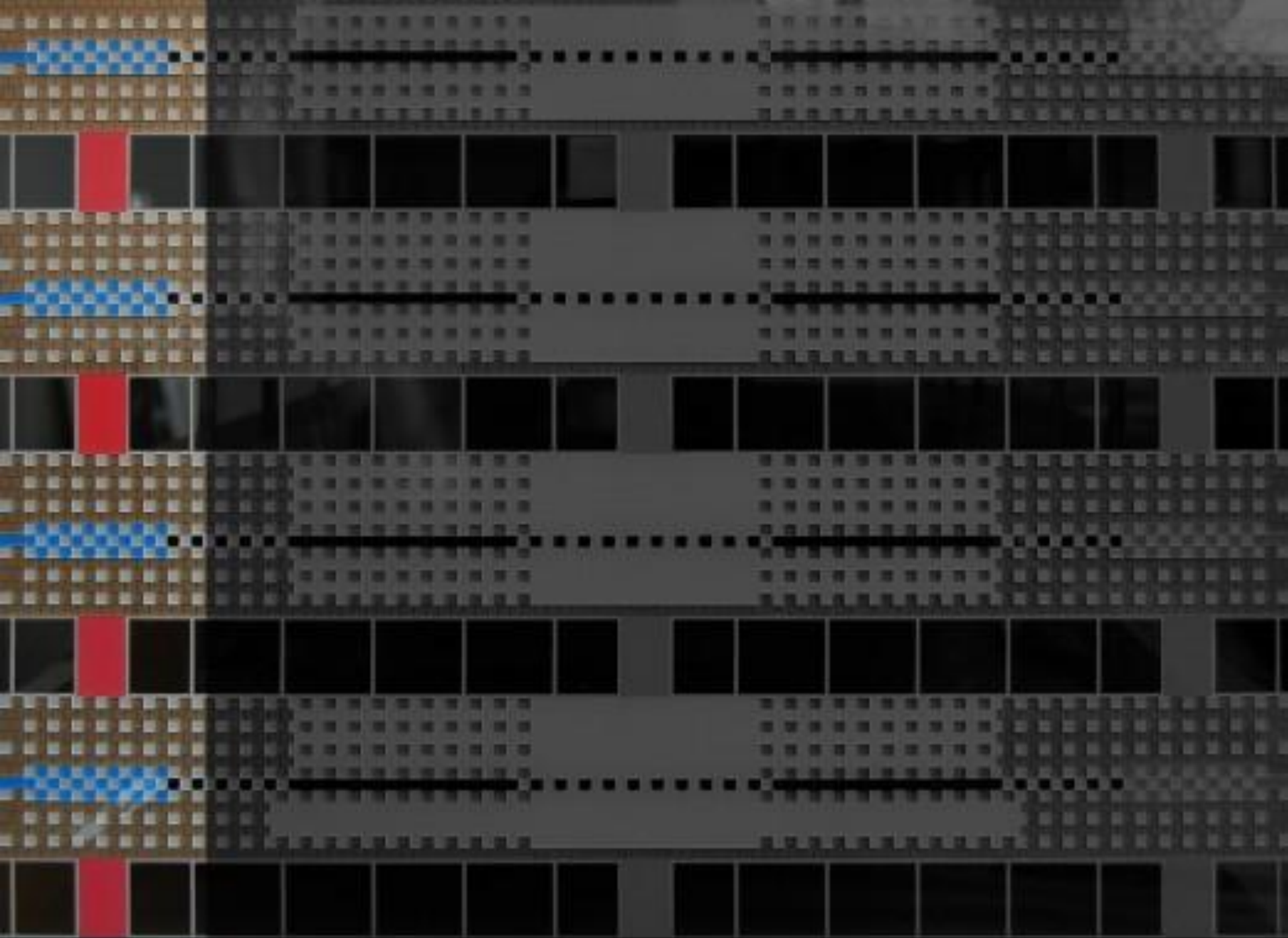


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**Schedule acceleration is possible  
With the commitment from all parties  
involved.**

**Mezzanine Photo:**





### ANALYSIS III

Prefabrication of the Curtain Walls

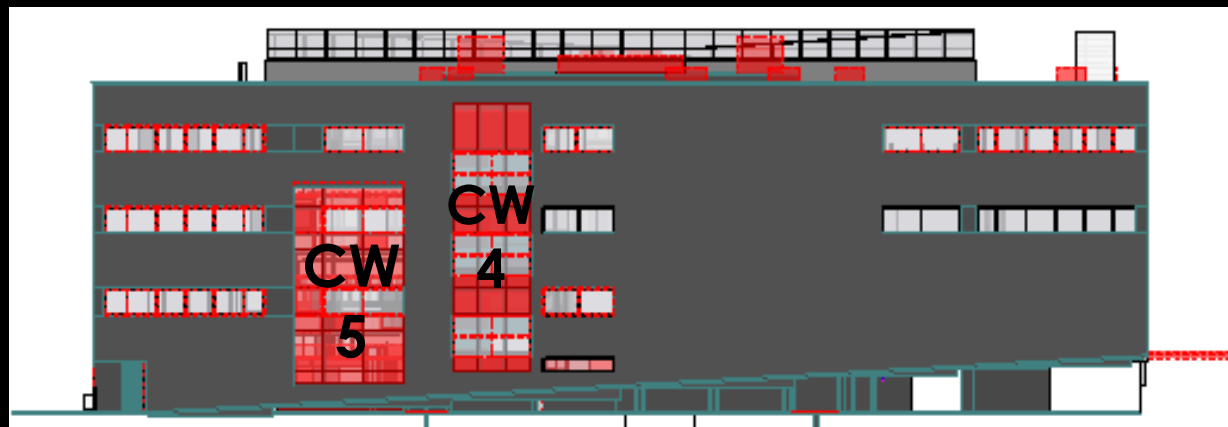


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North Elevation:



East Elevation:



Curtain Wall Label	Curtain Wall Dimensions (ft)	Area (SF)
CW 1	40 x 25	1000
CW2	40 x 15	600
CW3	25 x 25	625
CW4	45 x 15	675
CW5	35 x 20	700
<b>Total Area:</b>		<b>3600 SF</b>

Curtain Wall	Duration	Start	Finish
CW1	7	4/26/12	5/4/12
CW2	5	5/5/12	5/11/12
CW3	5	5/12/12	5/16/12
CW4	5	5/19/12	5/23/12
CW5	4	5/25/12	5/29/12
<b>Total</b>	<b>26</b>	<b>4/26/12</b>	<b>5/29/12</b>

RS Means Code	Item	Quantity	Unit	Daily Labor				Bare Cost			Total Inc O&P	
				Crew	Output	Hrs	Units	Material	Labor	Equip.		Total
08 44 13 10	Glazed C-Wall	3600	SF	H1	205	0.156	SF	34	7.2		41.2	49.5
<b>Total Cost</b>	<b>\$</b>											<b>178,200.00</b>

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**Benefits:**

- Quality Control
- Safety
- Reduction of field labor

**Technique:**

- System is spliced in Panels:
  - width= 4 or 5ft
  - Height= 5 or 10 ft
- Most labor preformed in factory environment
- 20-40 panels per day

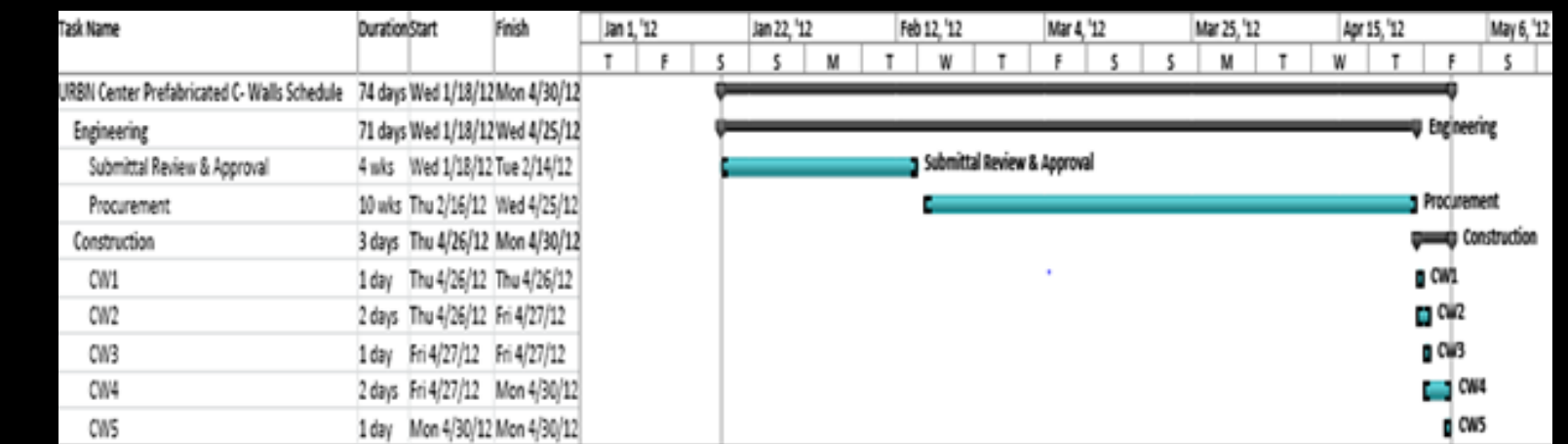
**Construction Considerations:**

Delivery ≈ 45 panels/truck  
Stored on East Parking lot



Curtain Wall	Number of Panels
CW1	20
CW2	12
CW3	15
CW4	15
CW5	15
<b>Total</b>	<b>80</b>

Materials				
Item	Quantity	Unit	Cost/Unit (\$/SF)	Total Cost (\$)
Prefab C-Wall	3600	SF	55	198,000
Labor				
	Total hrs	Rate/hr (\$/Hr)	Total Cost (\$)	
Glazier	24	43.30	1039	
Glazier	24	43.30	1039	
Helper	24	33.75	810	
<b>Total Cost</b>			<b>\$200,888</b>	



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## Schedule Acceleration:

**23 Days of installation time**

Item	Cost (\$)		Cost Savings (\$)
	Stick Built	Prefabricated	
<b>Material</b>	122,400	198,000	<b>-75,600</b>
<b>General Conditions</b>	156806	18093	<b>+138713</b>
<b>On-Site Labor</b>	25,030	2,888	<b>+22140</b>
<b>Total Savings (\$)</b>			<b>+85,253</b>

**[Cumulative savings ≈ \$102,000 ]**

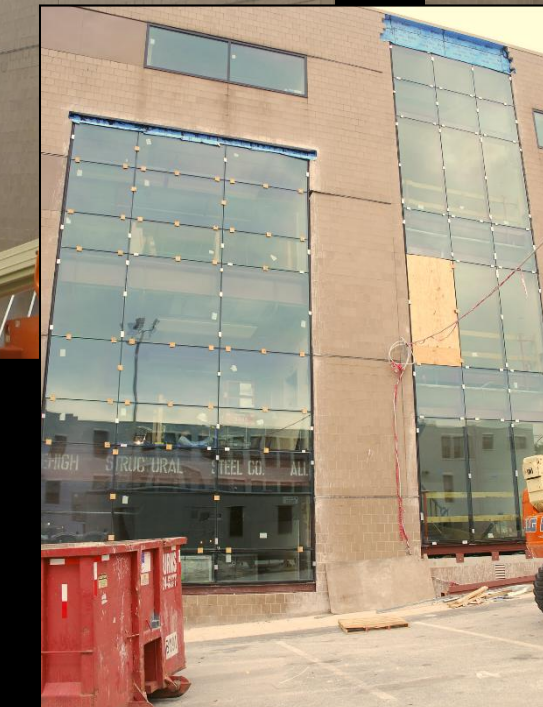
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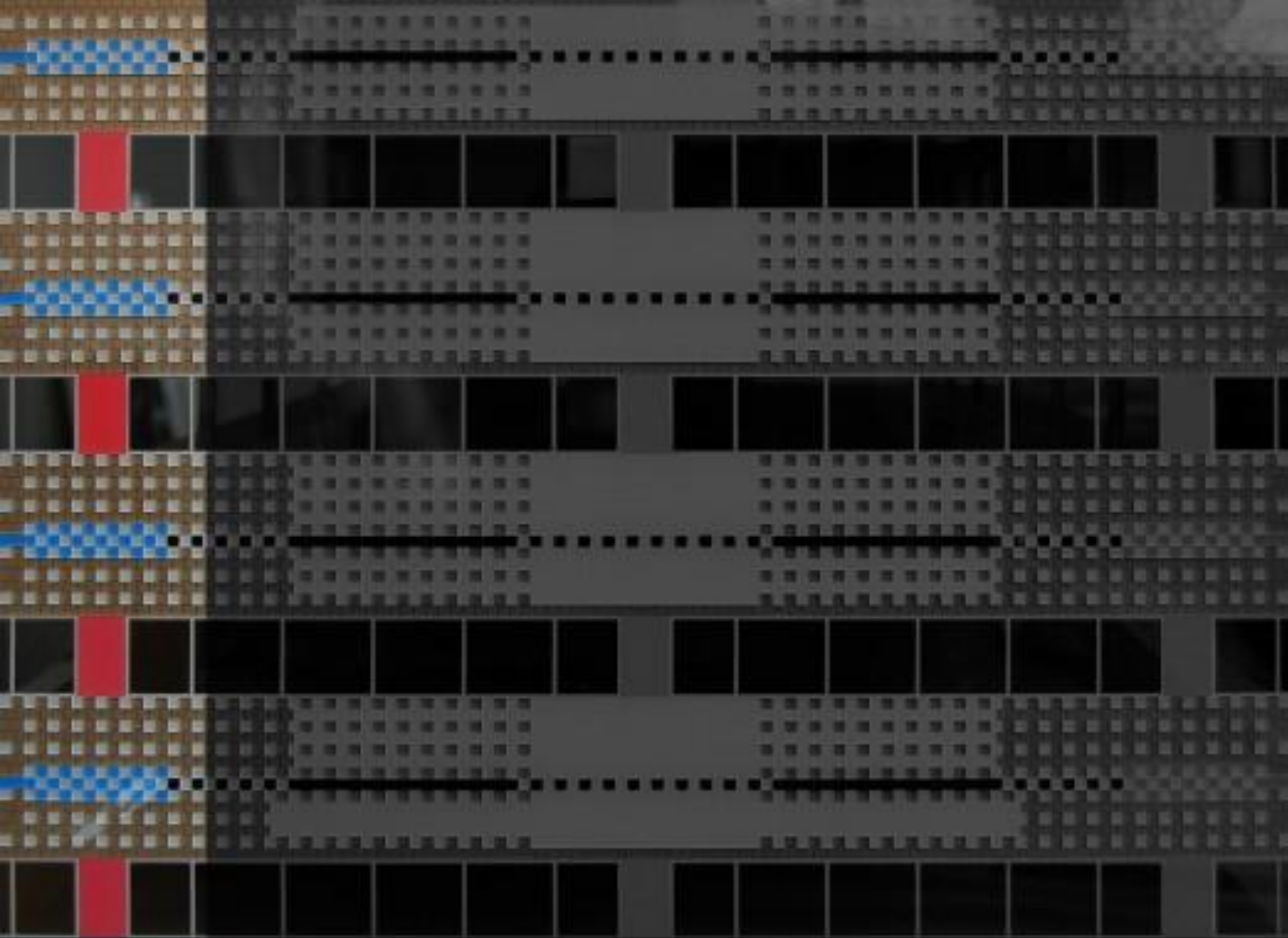
**Begin Prefabrication process  
very early in the design**

**Avoid Customization**

**Design for Prefabrication**

### Curtain Walls Photos:

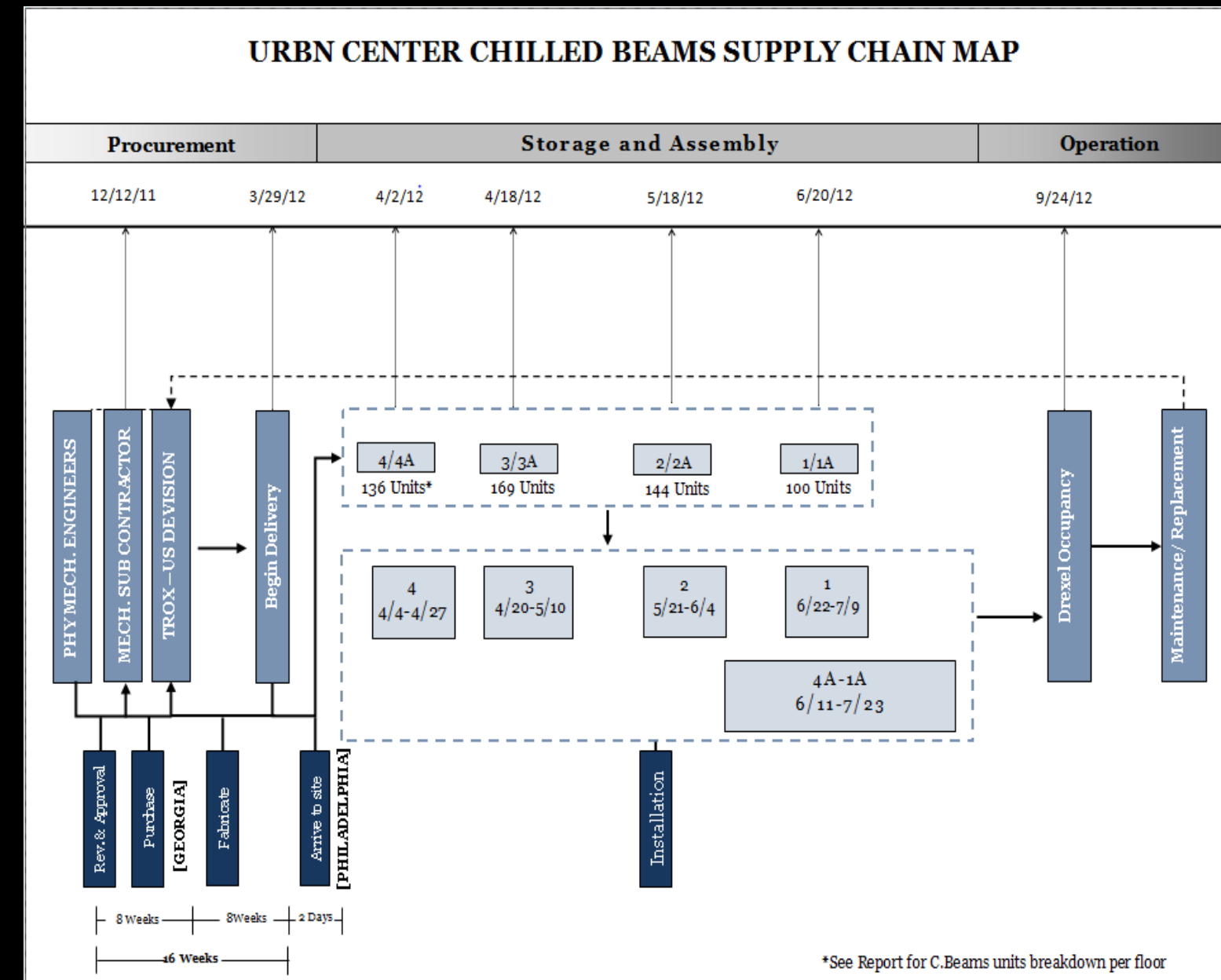




**ANALYSIS IV**  
Supply Chain of the Mechanical System



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  - I. Chilled Beam Supply Chain**
  - II. VAV Supply Chain
  - III. Breadth II: Energy Comparison
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- 16 Week Procurement
- Limited Suppliers
- Delivery relevant to construction sequence

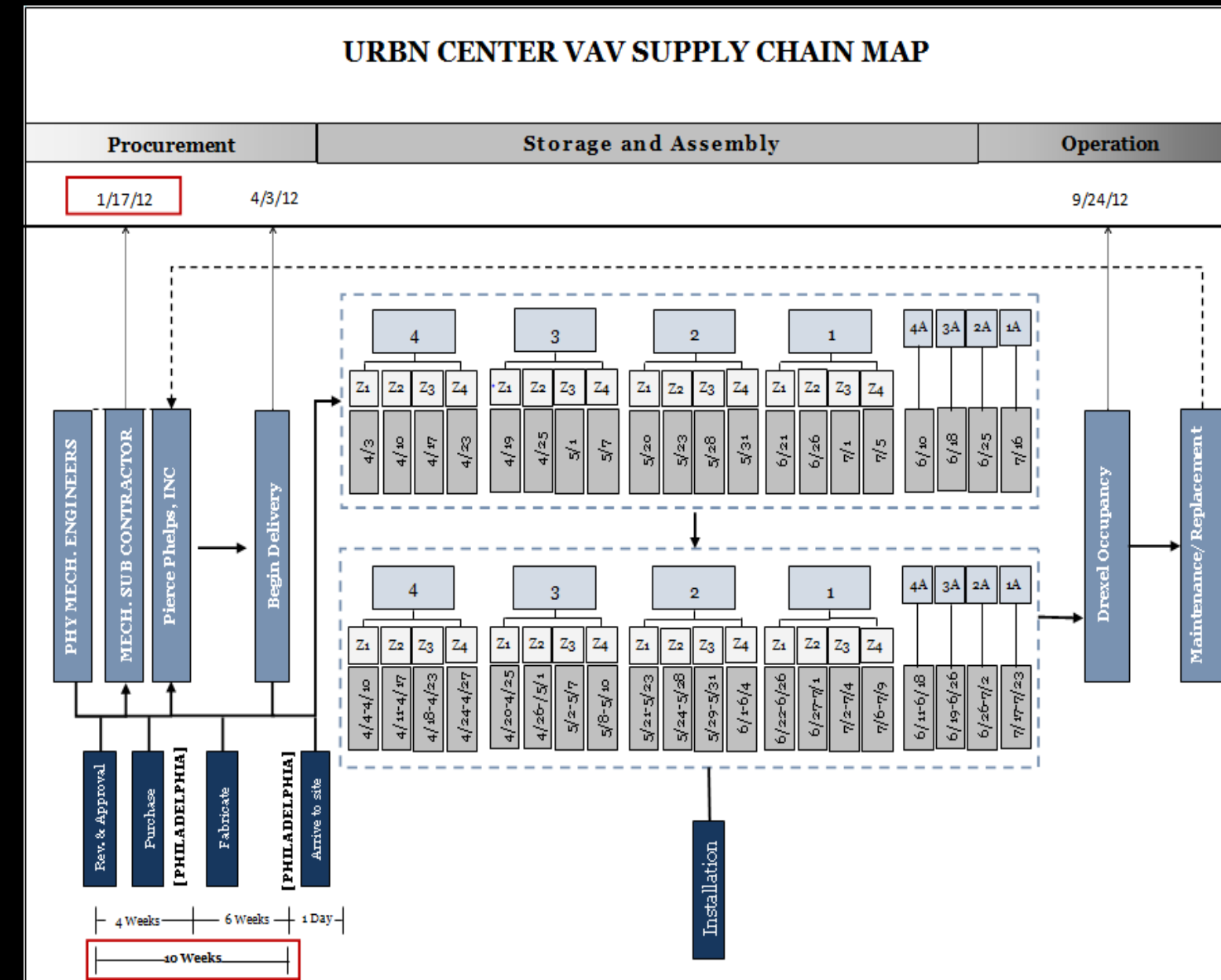


CHILLED BEAMS QUANTITIES PER LEVEL		
Level	Quantity	Shipment
1	110	1
1A	26	
2	149	2
2A	20	
3	118	3
3A	26	
4	82	4
4A	18	

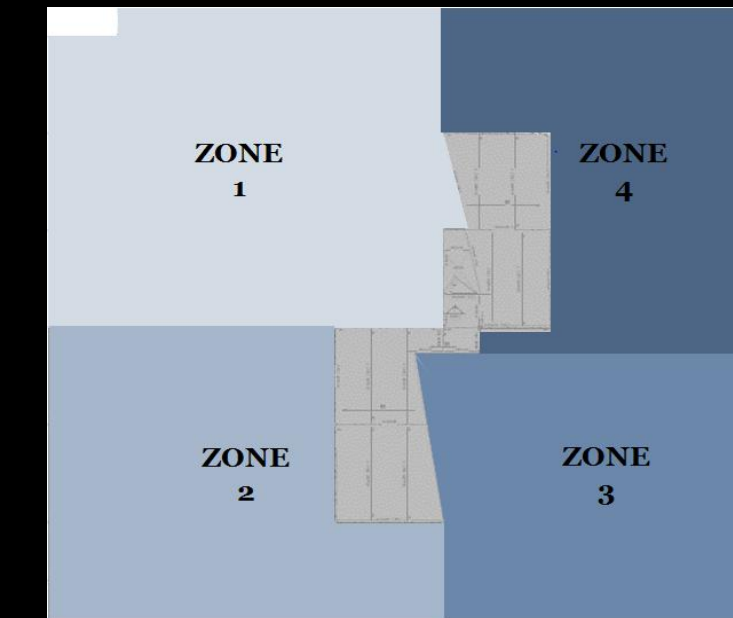


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- I. Chilled Beam Supply Chain
- II. VAV Supply Chain**
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- 10 Week procurement
- Availability of local vendors
- Same day delivery option
- Avoiding a congested site



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Internal Load Templates - Project

Alternative: Alternative 1  
Description: Classroom

People...  
Type: Classroom  
Density: 20 sq ft/person  
Sensible: 250 Btu/h  
Latent: 200 Btu/h

Workstations...  
Density: 1 workstation/person

Lighting...  
Type: Recessed fluorescent, not vented, 80% load to space  
Heat gain: 1 W/sq ft

Miscellaneous loads...  
Type: Std School Equipment  
Energy: 0.22 W/sq ft  
Energy meter: Electricity

Airflow Templates - Project

Alternative: Alternative 1  
Description: classroom

Main supply...  
Cooling: To be calculated  
Heating: To be calculated

Ventilation...  
Apply ASHRAE Std 62.1-2004/2007: Yes  
Type: Classrooms (age 9 plus)  
Peop-based: 10 cfm/person  
Area-based: 0.12 cfm/sq ft

Infiltration...  
Type: Neutral Average Const

VAV control...  
Clg VAV min: % Clg Airflow  
Htg VAV max: % Clg Airflow

Create Rooms - Single Worksheet

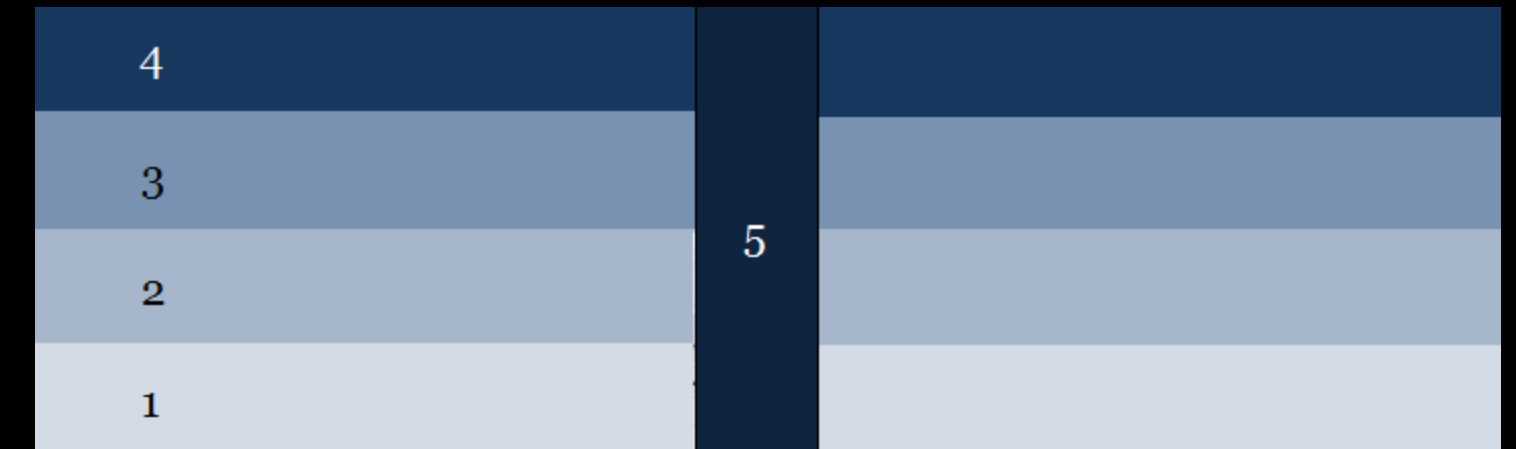
Alternative 1  
Room description: Floor 2

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)	Window
Wall-2	185	14	180	28.5	0	0	✓
Wall-3	185	14	90	28.5	0	0	✓
Wall-4	185	14	0	27	0	0	✓

Internal loads...  
People: 20 sq ft/person  
Lighting: 1 W/sq ft  
Misc loads: 0.22 W/sq ft

Airflows...  
Peop-based: 10 cfm/person  
Area-based: 0.12 cfm/sq ft  
Cooling VAV min: % Clg Airflow  
Heating VAV max: % Clg Airflow

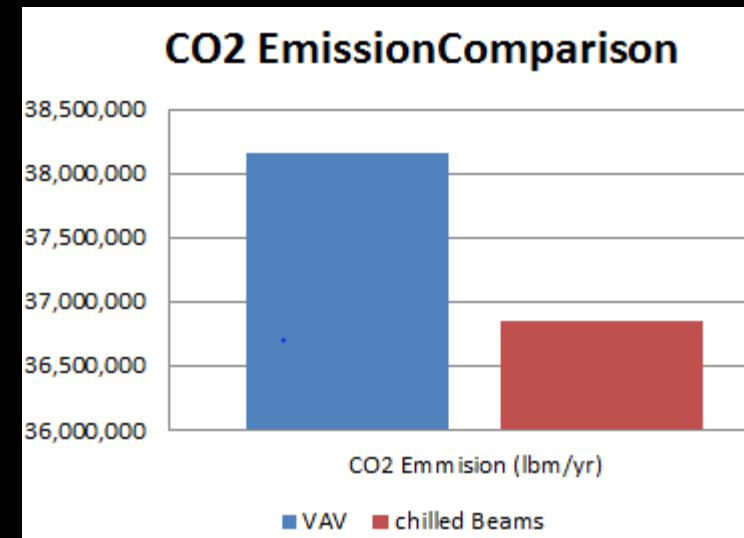
- Model based on two space types:
  - Classroom
  - Atrium (lobby)



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----- Monthly Energy Consumption -----													
Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<b>VAV System</b>													
<b>Electric</b>													
On-Pk Cons. (kWh)	39,658	34,822	49,528	54,571	77,301	89,457	101,969	96,920	70,189	60,631	50,620	41,765	<b>767,432</b>
On-Pk Demand (kW)	280	279	291	324	392	492	564	494	428	337	313	284	564
<b>Chilled Beam System</b>													
<b>Electric</b>													
On-Pk Cons. (kWh)	40,730	36,837	43,424	40,670	72,909	96,112	113,808	104,830	65,126	47,567	40,241	38,986	<b>741,239</b>
On-Pk Demand (kW)	185	185	352	366	446	507	562	506	452	366	362	185	562

**Chilled Beams use 26193 KWH less/year**



Year	Cost (\$/KWh)	Savings/yr	Coumlative Savings
1	0.156	4086.11	4086.11
2	0.157	4112.30	8198.41
3	0.158	4138.49	12336.90
4	0.159	4164.69	16501.59
5	0.16	4190.88	20692.47
6	0.161	4217.07	24909.54
7	0.162	4243.27	29152.81
8	0.163	4269.46	33422.27
9	0.164	4295.65	37717.92
10	0.165	4321.85	42039.77
11	0.166	4348.04	46387.80
12	0.167	4374.23	50762.03
13	0.168	4400.42	55162.46
14	0.169	4426.62	59589.08
15	0.17	4452.81	64041.89
16	0.171	4479.00	68520.89
17	0.172	4505.20	73026.08
18	0.173	4531.39	77557.47
19	0.174	4557.58	82115.06
20	0.175	4583.78	86698.83
21	0.176	4609.97	91308.80
22	0.177	4636.16	95944.96
23	0.178	4662.35	100607.31
24	0.179	4688.55	105295.86
25	0.18	4714.74	110010.60
26	0.181	4740.93	114751.53
27	0.182	4767.13	119518.66
28	0.183	4793.32	124311.98
29	0.184	4819.51	129131.49
30	0.185	4845.71	133977.20
<b>Total Savings</b>			<b>133977.20</b>

**Cost Return During 30 year life cycle ≈ \$140,000**

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**VAV has more benefits in terms of Supply Chain**

**Chilled Beams provide cost savings through  
out the life cycle**



**Chilled Beams Photos:**



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### Analysis I: Demo Alt

- Existing Method is most efficient
  - No additional Cost
  - Minimum effect on the critical path

### Analysis II: Steel Erection SIP

- Schedule Savings: 2.12 Days
- Cost Savings: \$16,780

**Total Schedule Savings: 25.12 Days**

**Total Cost Savings: \$102,000**

### Analysis III: Curtain Walls Prefab.

- Schedule Savings: 23 Days
- Cost Savings: \$85,253

### Analysis IV: C-Beams VS. VAV

- VAV: More efficient supply chain
- C-Beams: Cost savings over lifecycle≈\$140,000

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Industry Acknowledgments:



Mr. Adam Rockmacher—Turner  
Ms. Nicole Barbero—Turner  
Mr. Christopher Renshaw—Turner



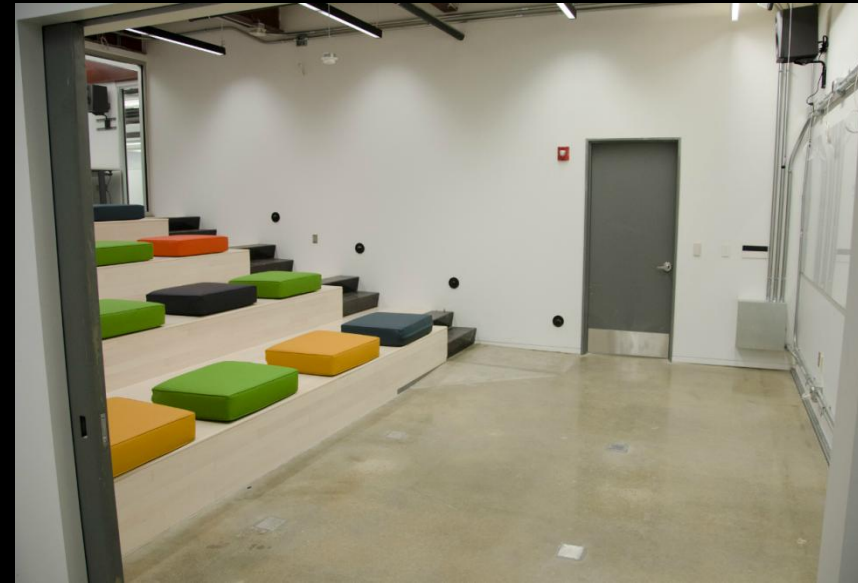
Ethan Marchant—MS&R LTD



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Dr. Robert Leicht—CM Thesis Faculty Advisor  
Mr. Logan Gray—AE graduate



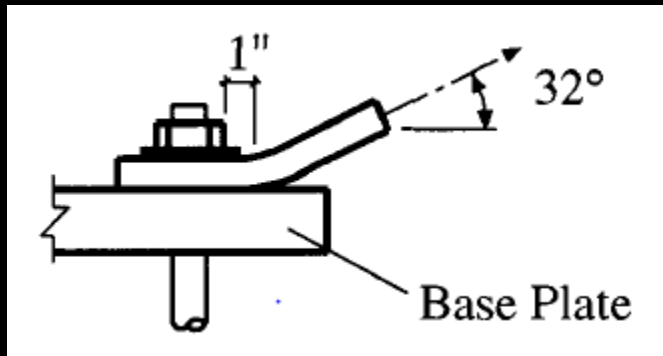


Questions?

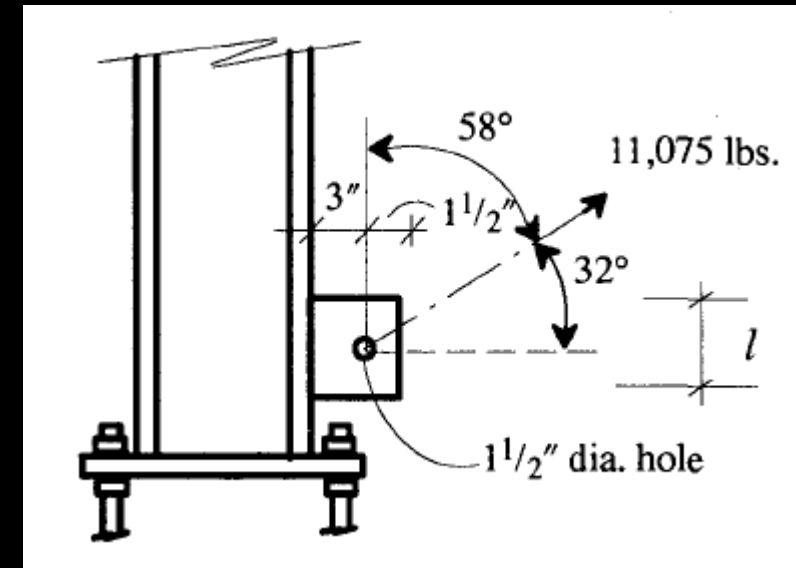


Cable Bracing:

(from AISC Design Guide: Erection Bracing of Low-Rise Structural Steel Frames)



Option A



Option B

Temp. Beam Calculation

Level 1A Example Calculation.

Dead Load: Beam not supporting Deck/slab. Beam is only there temporarily  
 → use 5 PSF allowance for beam selfweight  
 ↳ From ASTM A992 Grade 50 wide Flange Columns.

Live load: Assume  $F_y = 50 \text{ ksi}$

$k_{LT} = 2 \times (30' \times 30') = 1800 \text{ PSF} > 400$   
 ↳ For interior Beams. ∴ Reducible.

$L = 10 \text{ PSF} \left\{ \begin{array}{l} 0.5 \\ 0.25 + \frac{15}{\sqrt{1800}} \end{array} \right. = 6.03 \text{ PSF.}$

Load Combination:  
 $1.2D + 1.6L = (1.2 \times 5 \text{ PSF}) + 1.6 (6.03 \text{ PSF})$   
 $= 6 \text{ PSF} + 9.65 \text{ PSF} = 15.65 \text{ PSF.}$

$w_u = \frac{(15.65 \text{ PSF})(30')}{1000} = 0.47 \text{ klf}$

$S_{reqd} (V) = \frac{(0.47)(30)}{2} = 7.1 \text{ k}$

Moment (M) =  $\frac{(7.1)(15)}{2} = 107 \text{ kft}$

From AISC Steel Manual, Pg 3-26 [See Appendix F]

LRFD Moment = 110 kft  
 (Most Economical) ⇒ Use W12X22 Beam

$\phi_B M_n = 110 \text{ kft} > 107 \text{ kft}$   
 ∴ OK

Level (A): (4) W12X22  
 (B): (4) W12X22  
 (C): (4) W12X22

Total: (12) W12X22 Beams needed

DESIGN OF FLEXURAL MEMBERS

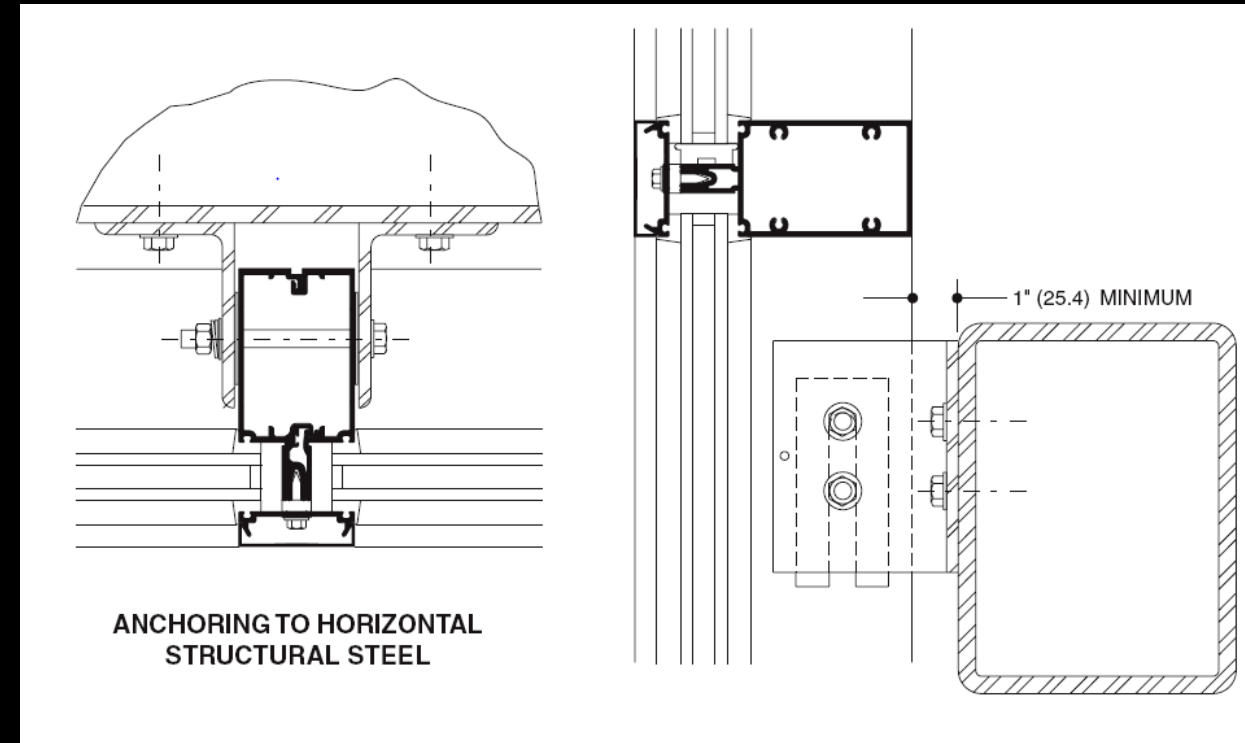
Table 3-2 (continued)  
 W-Shapes  
 Selection by  $Z_x$   $F_y = 50 \text{ ksi}$

Shape	$Z_x$ in <sup>3</sup>	$M_p / S_x$		$M_n / S_x$		$\phi_p R_f$		$L_p$ ft	$L_r$ ft	$L_c$ ft	$M_p / S_x$		$M_n / S_x$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD				ASD	LRFD		
W18-35	66.5	166	249	101	151	8.14	12.3	4.31	12.3	510	106	159		
W12-45	64.2	160	241	101	151	3.80	5.80	6.89	22.4	348	81.1	122		
W16-36	64.0	100	240	96.7	148	6.24	9.30	5.37	15.2	448	93.8	141		
W14-38	61.5	153	231	95.4	143	5.37	8.20	5.47	16.2	385	87.4	131		
W10-49	60.4	151	227	95.4	143	2.46	3.71	8.97	31.6	272	66.0	102		
W8-55	59.8	149	224	90.8	137	1.70	2.55	7.42	41.6	229	89.3	134		
W12-40	57.0	142	214	89.9	135	5.66	8.54	6.85	21.1	307	70.2	105		
W10-45	54.9	137	205	85.8	129	2.59	3.89	7.10	26.9	248	70.7	100		
W14-34	54.6	136	205	84.9	128	5.01	7.55	5.40	15.6	340	79.8	120		
W16-31	54.0	135	203	82.4	124	6.96	10.3	4.13	11.8	375	87.5	131		
W12-35	51.2	128	192	79.6	120	4.24	6.45	5.44	16.6	295	75.0	113		
W8-48	49.0	122	184	75.4	113	1.67	2.50	7.55	35.2	184	68.0	102		
W14-30	47.3	118	177	73.4	110	4.63	6.95	5.26	14.9	291	74.5	112		
W10-29	46.8	117	176	73.5	111	2.53	3.78	6.99	24.2	209	62.5	93.7		
W16-26	44.2	110	166	67.1	101	5.93	8.98	3.96	11.2	301	70.5	106		
W12-30	43.1	108	162	67.4	101	3.97	5.96	5.27	15.6	238	64.0	95.9		
W14-26	40.2	100	151	61.7	92.7	5.33	8.11	3.81	11.0	245	70.9	106		
W8-40	39.8	99.3	149	62.0	93.2	1.64	2.46	7.21	20.9	146	59.4	89.1		
W10-33	38.9	98.2	148	61.1	91.9	2.39	3.62	6.85	21.8	171	56.4	84.7		
W12-26	37.2	92.8	140	58.3	87.7	3.61	5.46	5.33	14.9	204	56.1	84.2		
W10-30	36.6	91.3	137	56.6	85.1	3.08	4.61	4.84	16.1	170	53.0	84.5		
W8-35	34.7	86.0	130	54.5	81.9	1.62	2.43	7.17	27.0	127	50.3	75.5		
W14-22	33.2	82.8	125	50.6	76.1	4.78	7.27	3.67	10.4	199	63.0	94.5		
W10-26	31.3	78.1	117	48.7	73.2	2.91	4.54	4.80	14.6	144	53.6	80.3		
W8-31	30.4	75.8	114	48.0	72.2	1.58	2.37	7.18	24.8	110	45.6	68.4		
W12-22	29.3	73.1	110	44.4	66.7	4.60	7.06	3.00	9.13	156	64.0	95.9		
W8-28	27.2	67.8	102	42.4	63.8	1.67	2.50	5.72	21.0	98.0	45.9	68.9		
W10-22	26.0	64.9	97.8	40.5	60.9	2.68	4.02	4.70	13.8	118	49.0	73.4		
W12-19	24.7	61.5	92.6	37.2	56.9	4.27	6.43	2.90	8.61	130	57.3	86.0		
W8-24	23.1	57.5	86.6	36.5	54.9	1.60	2.40	5.69	18.9	82.7	38.9	58.3		
W10-19	21.6	53.9	81.0	32.8	49.4	3.18	4.76	3.09	9.73	96.3	51.0	76.5		
W8-21	20.4	50.9	75.5	31.8	47.8	1.85	2.77	4.45	14.8	75.3	41.4	62.1		

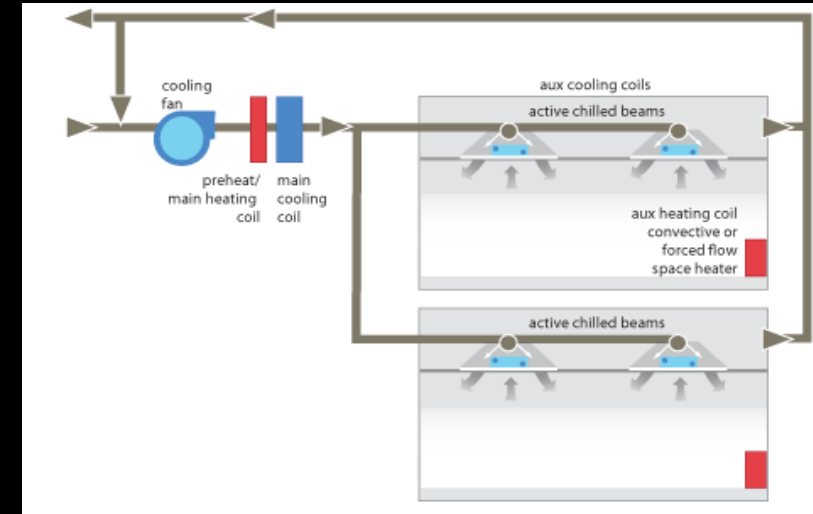
ASD LRFD <sup>1</sup>Shape exceeds compact limit for bracing with  $F_y = 50 \text{ ksi}$ .  
<sup>2</sup>Shape does not meet the  $L_c$  limit for shear in AISC Specification Section G2.1(a) with  $F_y = 50 \text{ ksi}$ .  
 Therefore,  $\phi_v = 0.90$  and  $C_b = 1.67$ .



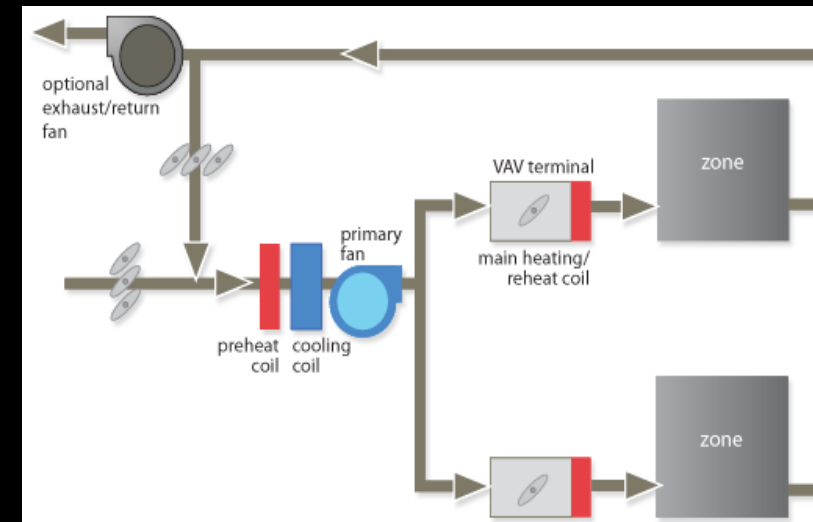
Curtain Wall Connection:



Chilled Beam System Schematic:



VAV System Schematic:



SYSTEM SUMMARY  
DESIGN COOLING CAPACITIES  
By Ghaith Yacoub

VAV System

Building Airside Systems and Plant Capacities

Plant System	Peak Plant Loads										Block Plant Loads						
	Main Coil ton	Aux Coil ton	Opt Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Total Peak ton	Tim Of mo/	Main Coil ton	Aux Coil ton	Opt Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Total Block ton
					Desic ton	Desic ton								Desic ton	Desic ton		
Cooling plant - 001	680.1	0.0	0.0	0.0	0.0	0.0	0.0	680.1	7/16	672.0	0.0	0.0	0.0	0.0	0.0	0.0	672.0
System - 001	680.1	0.0	0.0	0.0	0.0	0.0	0.0	680.1	7/16	672.0	0.0	0.0	0.0	0.0	0.0	0.0	672.0
<b>Building totals</b>	<b>680.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>680.1</b>		<b>672.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>672.0</b>

Building peak load is 680.1 tons. Building maximum block load of 672.0 tons occurs in July at hour 16 based on system simulation.

Chilled-Beam System

Building Airside Systems and Plant Capacities

Plant System	Peak Plant Loads										Block Plant Loads						
	Main Coil ton	Aux Coil ton	Opt Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Total Peak ton	Tim Of mo/	Main Coil ton	Aux Coil ton	Opt Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Total Block ton
					Desic ton	Desic ton								Desic ton	Desic ton		
Cooling plant - 001	740.4	289.6	0.0	0.0	0.0	0.0	0.0	1,030.0	7/16	537.5	74.1	0.0	0.0	0.0	0.0	0.0	611.7
System - 001	740.4	289.6	0.0	0.0	0.0	0.0	0.0	1,030.0	7/16	537.5	74.1	0.0	0.0	0.0	0.0	0.0	611.7
<b>Building totals</b>	<b>740.4</b>	<b>289.6</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>1,030.0</b>		<b>537.5</b>	<b>74.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>611.7</b>

Building peak load is 1,030.0 tons. Building maximum block load of 611.7 tons occurs in July at hour 16 based on system simulation.