



GENERIC BUILDING NAME COMPOSITE STEEL REDESIGN

Harry Baker | Structural

Advised by Ali Said

OUTLINE

Existing Building

Alternate
Gravity Design

Alternate
Lateral Design

Construction Analysis



GENERIC BUILDING NAME
Harry Baker

Existing Building

Building Statistics

Programing

Structure

Alternate Gravity

Alternate Lateral

Construction Analysis

Occupancy or function Type

Size

Number of floors

Dates of construction (start – finish)

Cost

Project Delivery Method

Architect

MEP Engineer

Structural Engineer

Construction Management

Medical outpatient center

184000 sf

10 total floors, 1 partially below grade

September 9, 2015- late 2017

100 Million

Design-bid-build

Wilmot/ Sanz, inc.

James Posey Associates

Cagley & Associates

Whiting-Turner





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Construction Analysis

1 st	Intake, Pharmacy, Phlebotomy
2 nd	Patient Services, Clinical Research
3 rd	Mechanical, Canopy Framing
4 th	Imaging
5 th	Clinic, Administration
6 th	Infusion
7 th	Clinical Research, Clinic
8 th	Clinical Research
9 th	Clinical Research
10 th	Breast Clinic, Food Service
Roof	Elevator Rooms





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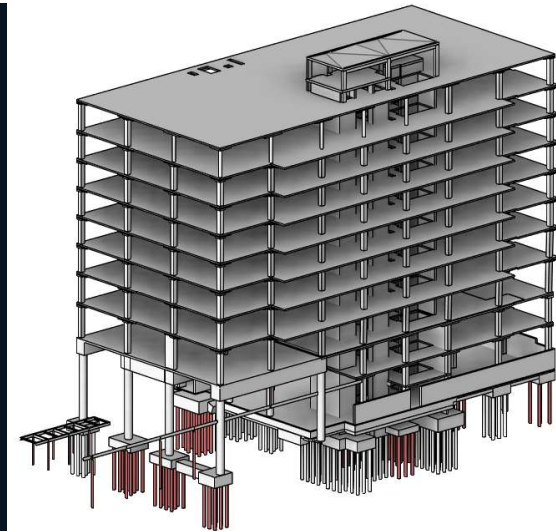
Construction Analysis

Foundation Auger Cast Piles

Lateral Reinforced Concrete Shear Walls

Gravity Two Way Concrete Flat Slab

Canopy Framing PT Beams





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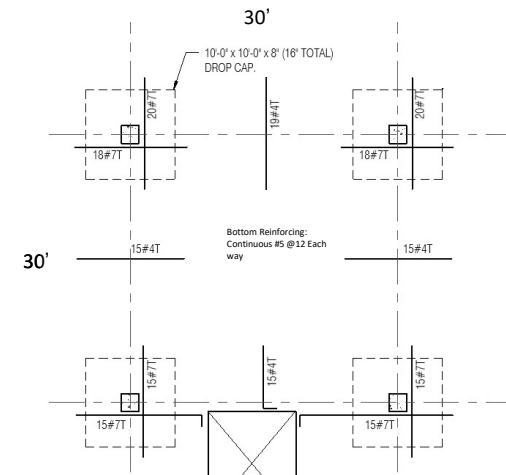
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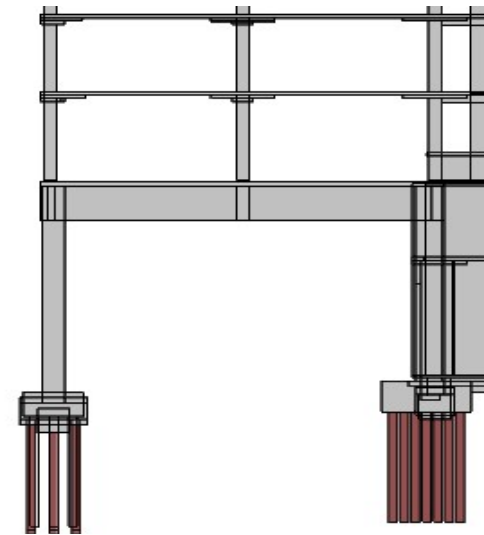
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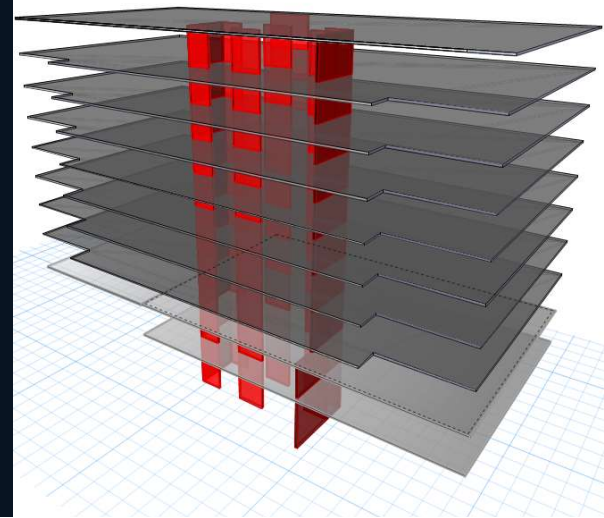
Construction Analysis

Seismic

Direction	Base Shear [kips]	Deflection
EW	503	6.4"
NS	503	3.2"

Wind

Direction	Base Shear [kips]	Deflection
EW	880	10.6"
NS	455	2.5"





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Alternate Lateral

Structure

Construction Analysis

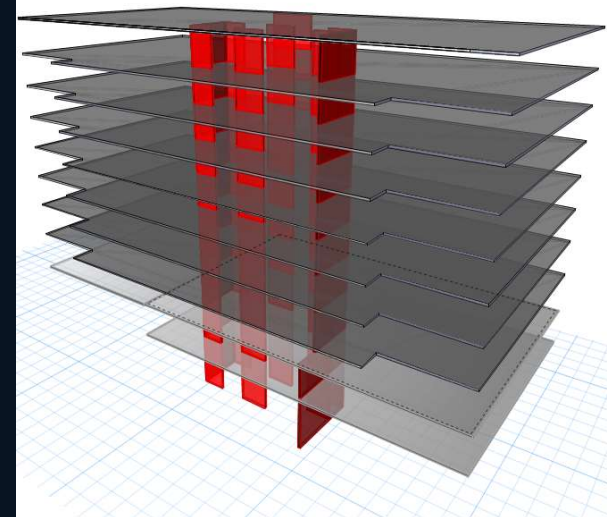
Seismic

Direction	Base Shear	Deflection
EW	503	6.4"
NS	503	3.2"

Wind

Direction	Base Shear [kips]	Deflection
EW	880	10.6"
NS	455	2.5"

$$h/400 = 4.5''$$



ALTERNATE DESGIN

Gravity System Steel Composite Beams

Lateral System Brace Frames

Canopy Framing Transfer Trusses



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Alternate Gravity

Alternate Lateral

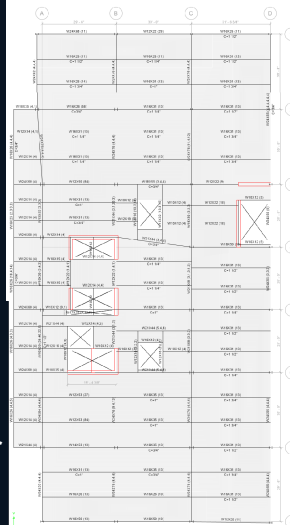
Construction Analysis

Typical Framing

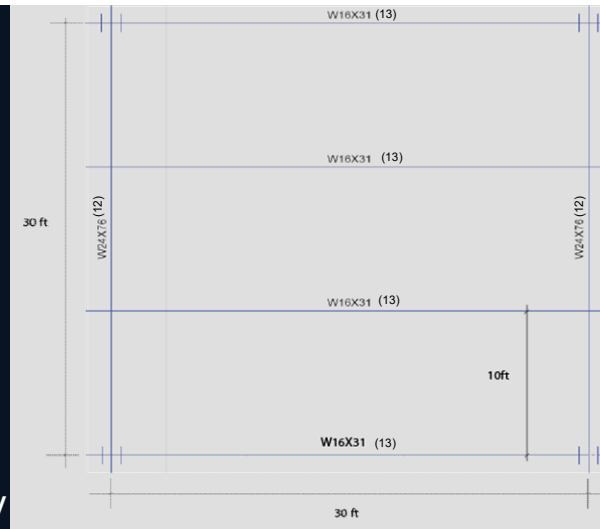
MRI Vibration

Transfer Trusses

Typical Floor
plan



Typical Bay





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Alternate Gravity

Typical Framing

MRI Vibration

Alternate Lateral

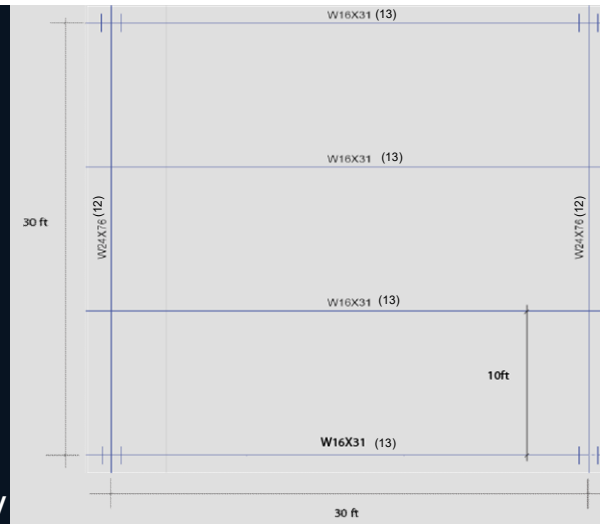
Transfer Trusses

Construction Analysis

2VLI19 Decking

SW=69psf
SDL=40psf
LL=95psf

Typical Bay





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Construction Analysis

Typical Framing

MRI Vibration

Transfer Trusses

Typical Beam

W16x31 (13)

Mu= 298 kft
 Φ Mn= 309 kft

Deflection

Camber: 1"
Allowable: 1.5"
Total: 1.3"
Wet Conc: .96"
LL : .98"

Typical Girder

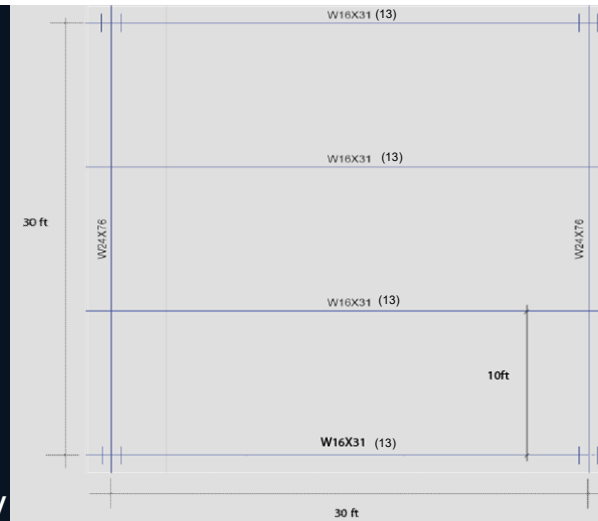
W24x76 (12)

Mu= 677 kft
 Φ Mn= 750 kft

Deflection

Allowable: 1" 1.5"
Wet Conc: .002"
LL : .2"

Typical Bay





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Typical Framing

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Transfer Trusses

Construction Analysis

Cantilevered Girders

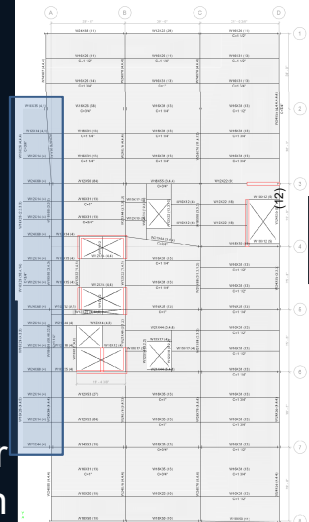
W24x68

$M_u = 397$ kft
 $L_b = 11.4$ ft
 $\Phi M_n = 570$ kft

Deflection

Allowable: .59"
Total: .39"
Wet Conc: .46"
LL : .18"

Typical Floor
plan





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Alternate Gravity

Typical Framing

MRI Vibration

Alternate Lateral

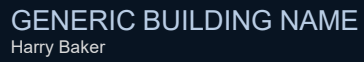
Transfer Trusses

Construction Analysis

MRI Rooms

4th Floor Plan





Construction Analysis

Dampening Factor = .007

MRI Framing





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Alternate Lateral

MRI Vibration

Transfer Trusses

Construction Analysis

Beam 16x26
 $W_j = 41838 \text{ lb}$
 $\Delta_j = .03''$

Girder 24x76
 $W_g = 68150 \text{ lb}$
 $\Delta_g = .12''$

$V = 490 \text{ mips}$

Added Columns

MRI Framing





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Construction Analysis

Typical Framing

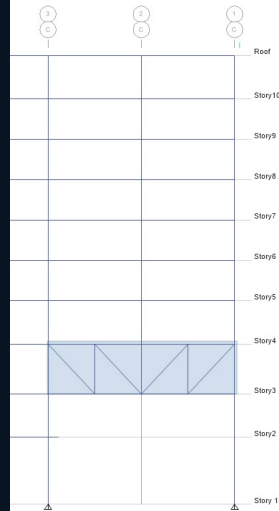
MRI Vibration

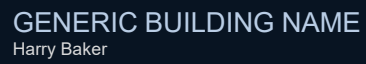
Transfer Trusses



Partial Third Floor Plan

Section View





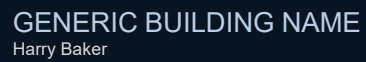
Construction Analysis

Transfer Trusses



The diagram shows a truss structure with nodes labeled A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The structure is supported by a pin support at node A and a roller support at node Z. External forces are applied at nodes B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The forces are represented by arrows pointing in various directions. The structure is divided into several panels by vertical members. The top chord consists of nodes A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The bottom chord consists of nodes A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The vertical members connect the top and bottom chords. The diagonal members connect the top and bottom chords at various angles. The structure is shown in a perspective view, with the top and bottom chords receding into the distance.

A 3D truss structure is shown, consisting of a rectangular frame with diagonal members. The structure is defined by nodes (small squares) and members (lines). A coordinate system is established at the bottom-left node, with the Z-axis pointing vertically upwards (blue arrow), the X-axis pointing horizontally to the right (red arrow), and the Y-axis pointing out of the page (blue arrow). The top edge of the structure is labeled 'Story1' and the bottom edge is labeled 'Base'. Vertical lines extend from the top nodes, and horizontal lines connect the bottom nodes, defining the structure's geometry.



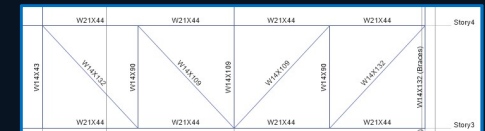
Construction Analysis

Typical Framing
MRI Vibration
Transfer Trusses

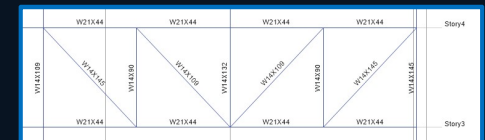


Partial Third Floor Plan

Exterior Truss



Interior Truss





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Alternate Gravity

Typical Framing

MRI Vibration

Alternate Lateral

Transfer Trusses

Construction Analysis



Partial Third Floor Plan

Maximum Deflection = 1.5"



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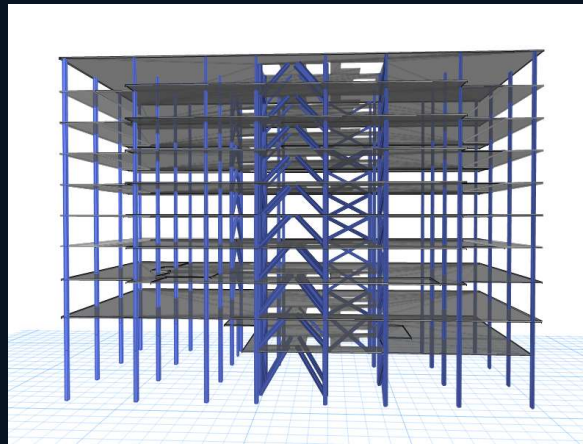
Alternate Gravity

Alternate Lateral

Construction Analysis

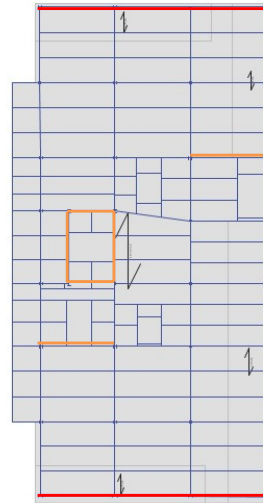
Brace Frames

Shear Walls



Moment Frames

Brace Frames





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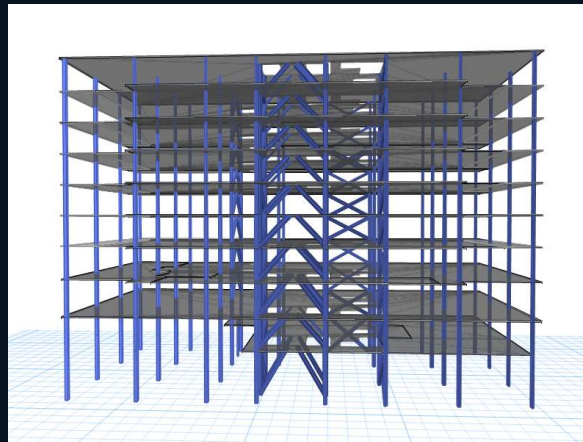
Alternate Gravity

Alternate Lateral

Construction Analysis

Brace Frames

Shear Walls



Maximum deflection = 6"

Could not achieve less
than $h/360$ displacement
requirements of 5"



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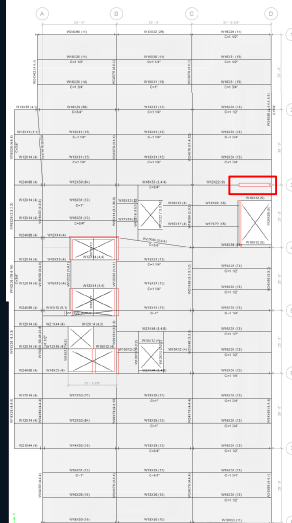
Alternate Gravity

Alternate Lateral

Brace Frames

Shear Walls

Construction Analysis



Added Shear Wall

Shear Wall Floor Plan

Shear Walls were increased
to 12"

Original Reinforcement
used

Maximum Deflection = 3.7"



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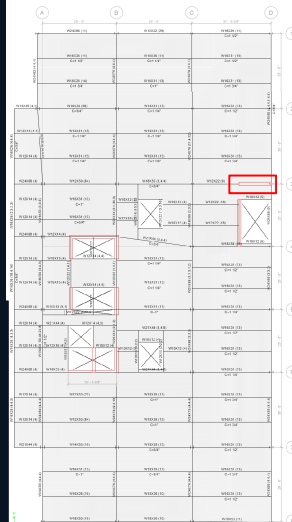
Alternate Gravity

Alternate Lateral

Brace Frames

Shear Walls

Construction Analysis



Added Shear Wall

SW 10 Reinforcement
#4 @ 12 oc Vertical
#5 @ 12 oc Horizontal

Shear Wall Floor Plan

DESIGN COMPARISONS

Cost and Schedule



GENERIC BUILDING NAME
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Existing Building

Alternate Gravity

Alternate Lateral

Construction Analysis

Critical Path

Cost Estimate

Concrete Critical Path Typical Floor

Critical Path Items	Days
Slab Formwork	8
Slab Rebar	8
Slab Placement	1
Slab Curing	1
Shear Wall/Columns Formwork	8
Shear Wall/Columns Rebar	1
Shear Wall/Columns Placment	8
Shear Wall/Columns Cuing	1
Total Days Per Floor	36

Steel Critical Path Typical Floor

Critical Path	Days
Framing	14
Shear Wall Formwork	9
Shear Wall Reinforcing	2
Slab Pour	1
Curing	1
Shear Wall Placement	1
Total Days Per Floor	28



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Alternate Gravity

Alternate Lateral

Construction Analysis

Critical Path

Cost Estimate

Concrete Estimate

Item	Quantity		Total O&P	Cost
Slab Concrete	CY	457.913333	121	\$ 55,407.51
Slab Form Work	SF	18545.49	8.2	\$ 152,073.02
Placing Concrete	CY	457.913333	31.5	\$ 14,424.27
Rebar high chairs	EA	64	65	\$ 4,160.00
rebar slab NS	LB	21008.75	1	\$ 21,008.75
rebar slab EW	Ton	21866.25	1	\$ 21,866.25
Columns Formwork	LF	364	10.9	\$ 3,967.60
Columns Concrete	CF	1456	121	\$ 176,176.00
Placing Column	CF	1456	87	\$ 126,672.00
Rebar Columns	LB	4253.2	1.13	\$ 4,806.12
Shear Walls Formwork	SFC A	2992.16658	9.95	\$ 29,772.06
Walls Concrete	CF	1505.83329	121	\$ 182,205.83
Shear walls Rebar	LB	7736.89583	0.87	\$ 6,731.10
Placing Walls	CF	1505.83329	42	\$ 63,245.00

Total = \$800,000

Steel Estimate

Item	Quantity		Days	Total O&P	Cost
Studs	EA	1483	2	2.35	\$ 3,485.05
Edging	EA	735	3	35.5	\$ 26,092.50
Decking	SF	18545.49	1	3.29	\$ 61,014.66
Concrete	CY	3836.99793		121	\$ 464,276.75
Placing Concrete	CY	3836.99793	12	31.5	\$ 120,865.43
Shear Walls Formwork	SFCA	3609.66658	9	9.95	\$ 35,916.18
Shear Walls Rebar	Ton	11378.2649	2	0.87	\$ 9,899.09
Shear Walls Placement	CY	57.7528721	1	42	\$ 2,425.62
Shear Walls Concrete	CY	57.7528721		121	\$ 6,988.10
Framing	Ton	97.84695	1	4000	\$ 391,387.80

Total = \$1,100,000



Typical Floor Cost

Typical Floor Schedule

Existing Building

Two Way Flat Slab \$1,100,000

Two Way Flat Slab 36 days

Alternate Gravity

Composite Steel \$800,000

Composite Steel 28 days

Alternate Lateral

Percent Difference %27

Schedule Difference 8 days

Construction Analysis

Critical Path
Cost Estimate



Special Thank you to...

Dr. Aly Said
Carmine Floia and Cagley and Associates
Michael Donovan and Shane McCrory
Nate Roberts and Marie Rottschaefer

[Existing Building](#)

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[Construction Analysis](#)

Appendix B Mechanical Conflicts

Story	Ceiling to Floor [in]	Beam Height [in]	Girder Height [in]	Clear Space Beam [in]	Clear Space Girder [in]
1	96	16	21	68	63
2	54	18	24	24	18
3					
4	54	16	24	26	18
5	54	16	24	26	18
6	54	16	24	26	18
7	54	16	24	26	18
8	54	16	24	26	18
9	47	16	24	19	11
10	54	16	24	26	18

Floor	Nearest Grid Lines	Top Duct size	Bottom Duct Size	Target Height [in]	Redesign Top size	Redesign Bottom Size
2	C4	18"X12"	34"X16"	24	8"X30"	34"x16"
4	C6	32"X14"	26"X14"	26	12"X49"	30"X12"
9	C6	14"X12"	30"x16"	26	8"X25"	30"X16"
9	B6	18"X10"	18"X16"	24	12"X15"	12"X25"

