Spring 2006

Parkview at Bloomfield Station

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Structural Option

MAE/ BAE

Pennsylvania State University

Parkview at Bloomfield Station

Section I: Existing Building Description

- **Building Overview**
  - a.Building Envelope
  - b.Type of Construction
  - c.Electrical System
  - d.Lighting System
  - e.Mechanical System
  - f.Fire Protection and Plumbing
  - g.Other Building Systems
- **Original Structural System**
  - a.Building Framing
  - b.Hambro® Floor Framing
  - c.Site and Foundations
- **Building Parameters**
  - a.Original Design Theory
  - b.Building Code References
  - c.Building and Site Restrictions

Section II: Structural Depth Analysis

- **New Design Overview**
  - a.Architectural Changes
  - b.Gravity Structural Changes
  - c.Lateral Changes
- **New Design**
  - a.Design Criteria
  - b.Structural Analysis
  - c.RAM Model
    - Bar Joist on Steel Girders
    - Steel columns
    - Lateral Frames
    - Spread Footings
- **Review of Design Criteria**
- **Vibration Analysis**

Section III: Breadth Studies

- **Cost Advantages**
  - a.Footings
  - b.Columns
  - c.Floor System
  - d.Wall System
  - e.Conclusion
- **EIFS Recommendations**
  - a.Background
  - b.Benefits
  - c.Problems
  - d.Possible Solutions
  - e.Conclusion

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Parkview at Bloomfield Station

Section I:
Existing Building Description

Building Overview

Original Structural System

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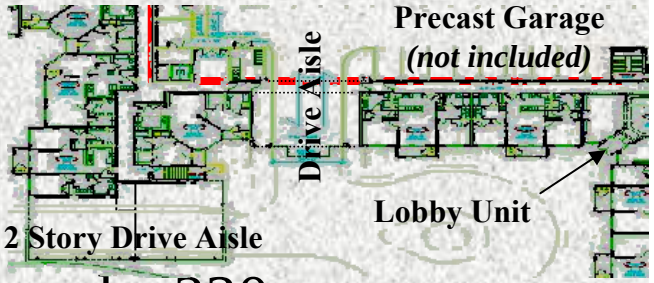
Building Overview



Project type: R-2 (6 story residential and a parking garage)

Location: Bloomfield, NJ

Occupancy: 197 condominium units and a 330 space garage

Special Site Features: Located between Second River, Washington St, and a Midtown Line train station

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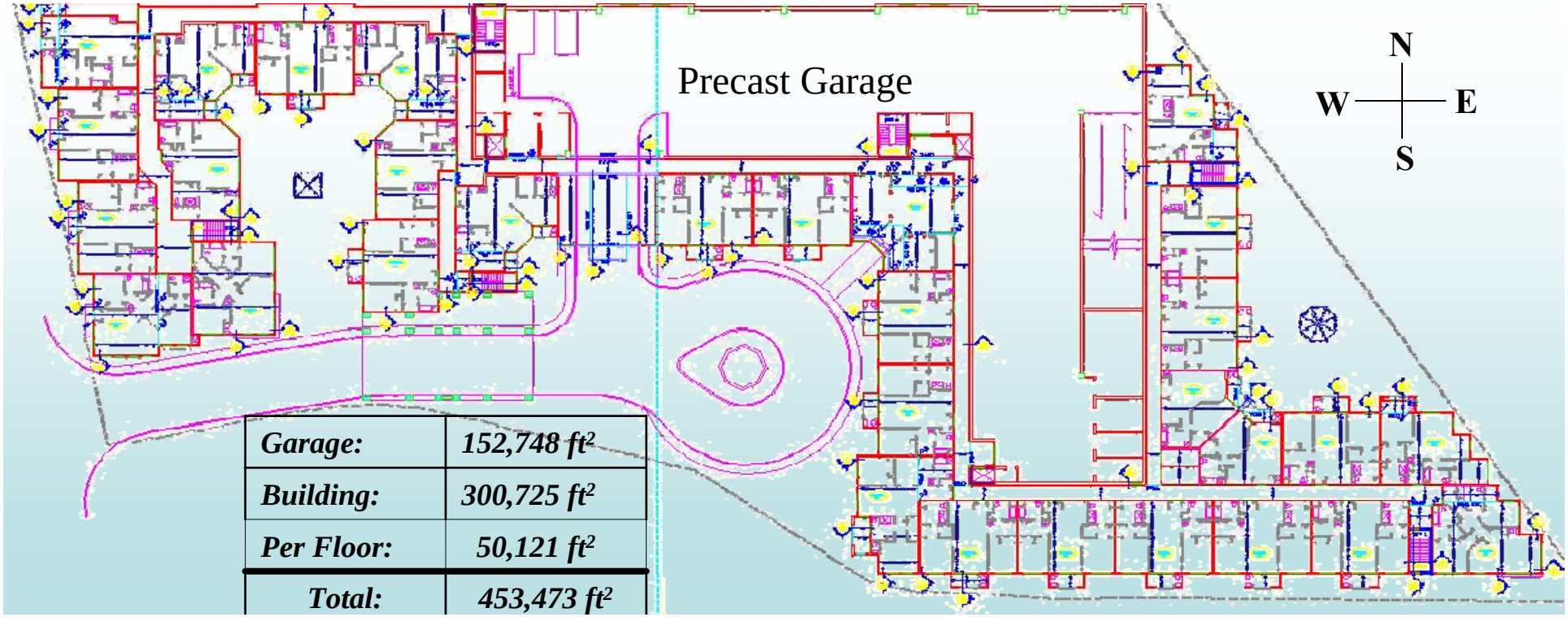
Building Overview



Garage:	***152,748 ft²***
Building:	***300,725 ft²***
Per Floor:	***50,121 ft²***
Total:	***453,473 ft²***

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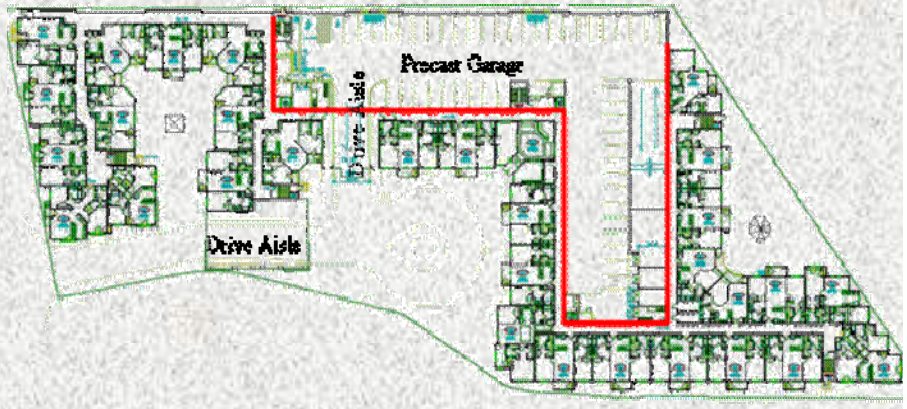
Building Overview

Cost:

Building: $56,936,063
Pre-cast Garage: $8,680,018
Overall Project: $65,616,081



Project delivery method:

Qualified Design-Bid-Build

Cladding:

Exterior Insulation and Finish System (EIFS)

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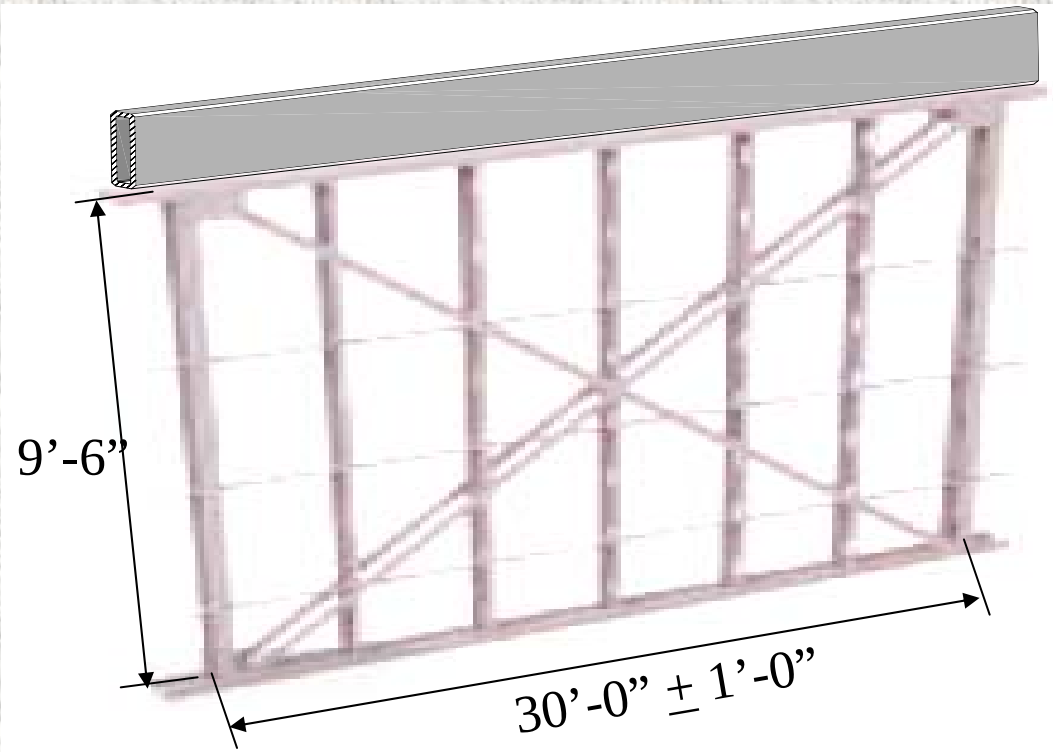
Original Structural System

Lightgage framing

~ Bearing Walls with tube steel cap

~ Shear Walls



<u>38 Total Lateral Shear Walls</u>

N-S direction: 18 shear walls

E-W direction: 20 shear walls

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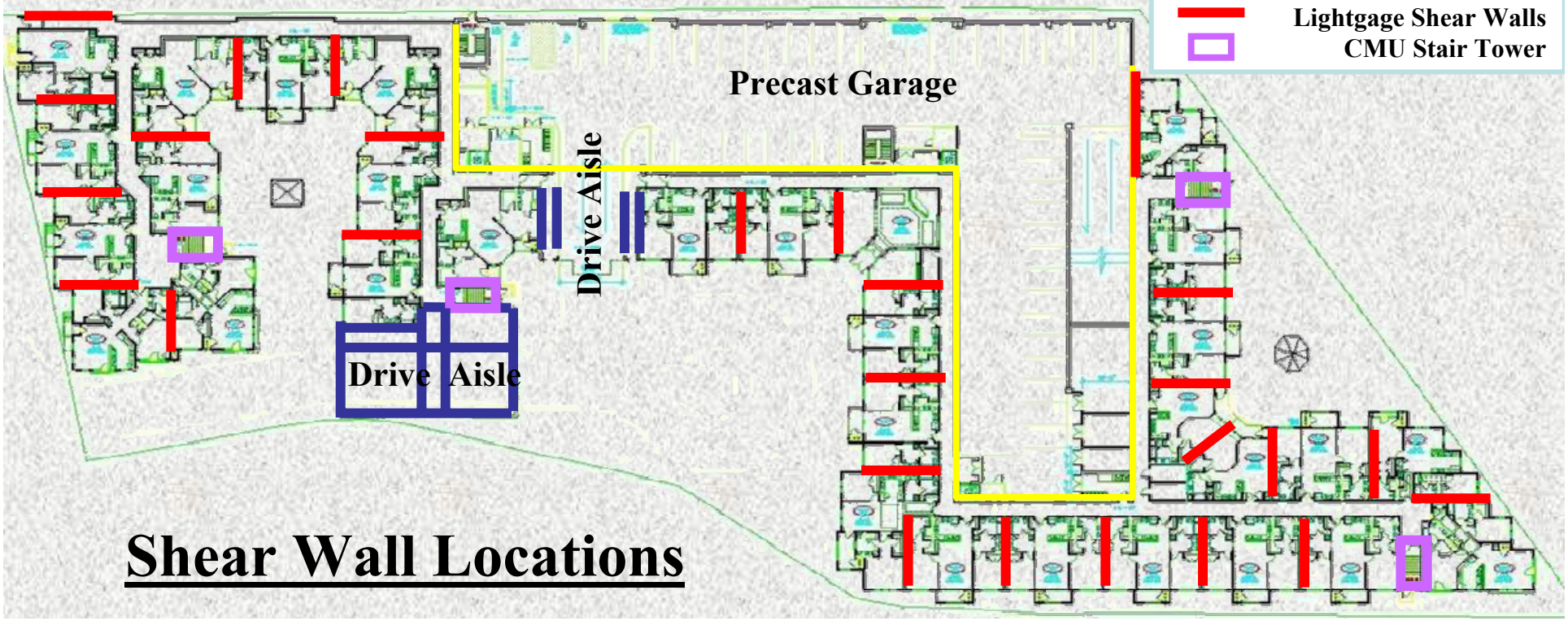
Original Structural System



Shear Wall Locations

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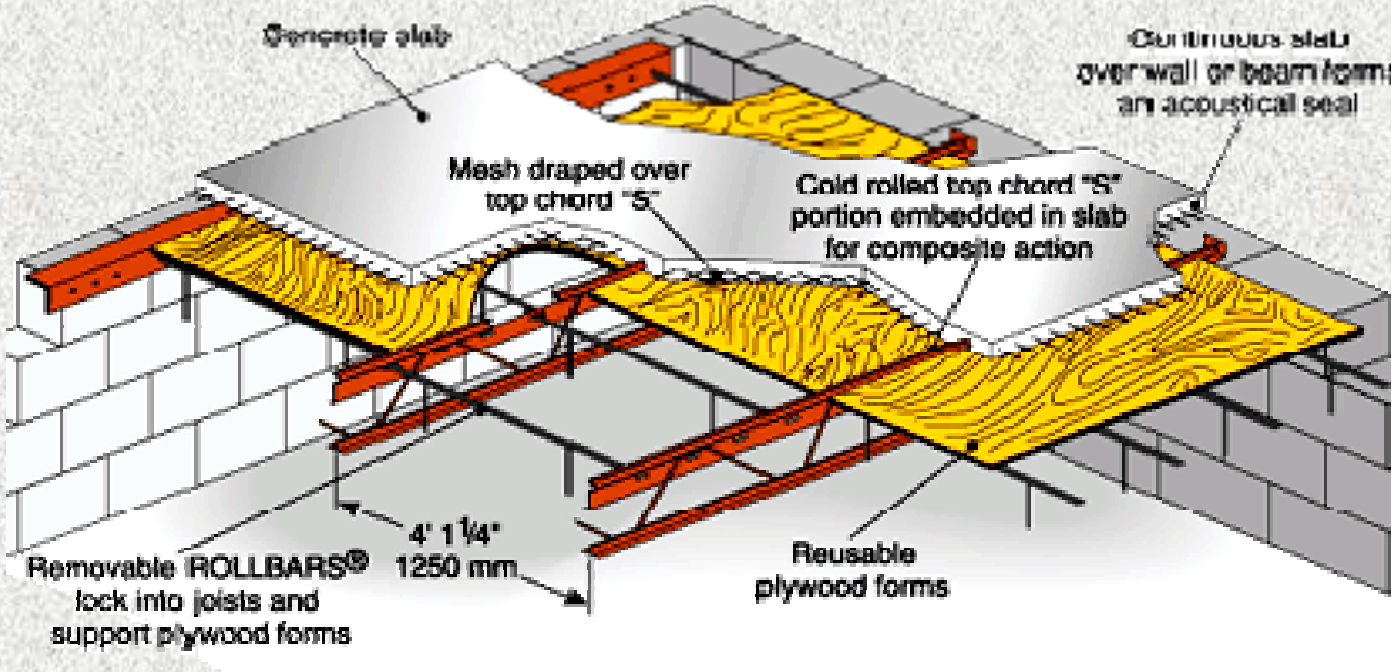
Original Structural System

Hambro® floor framing system



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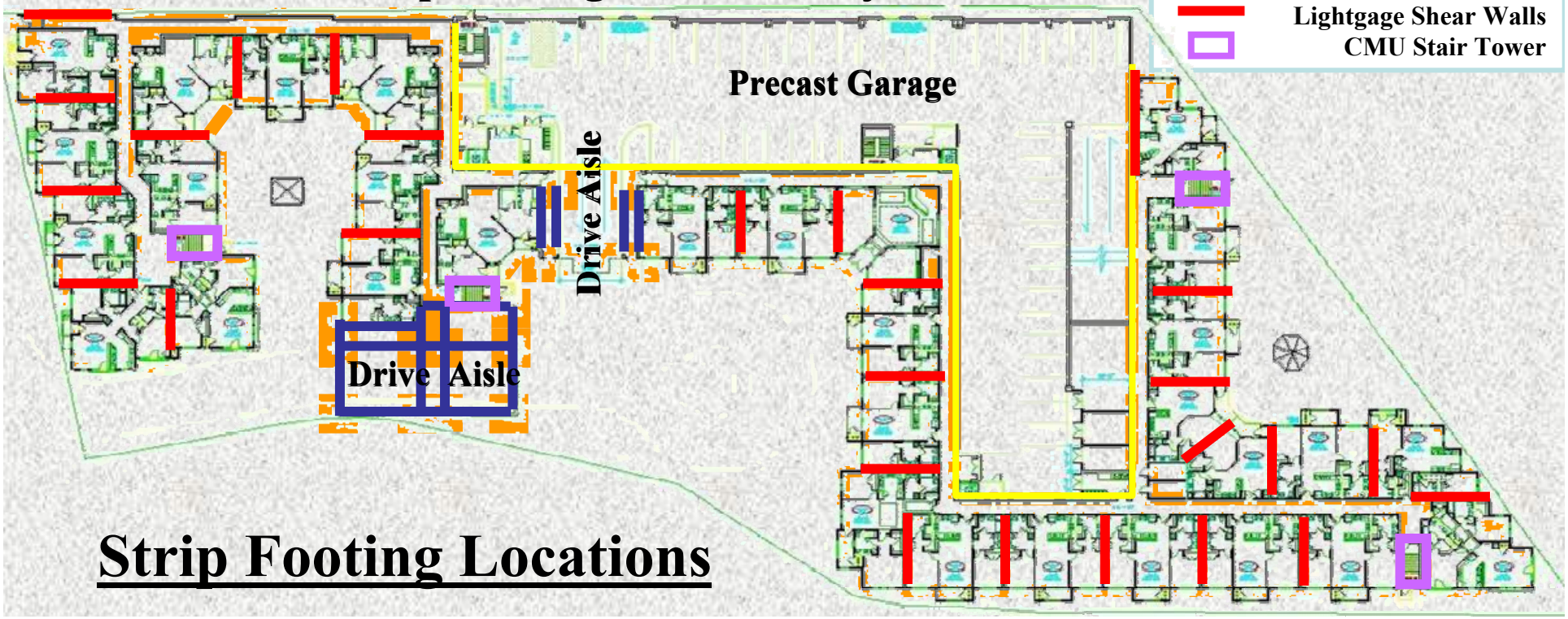
Original Structural System

Foundation ~ Strip footings under every wall



Strip Footing Locations

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Section II:
Structural Depth Analysis

New Design Overview

New Design

Review of Design Criteria

Vibration Analysis

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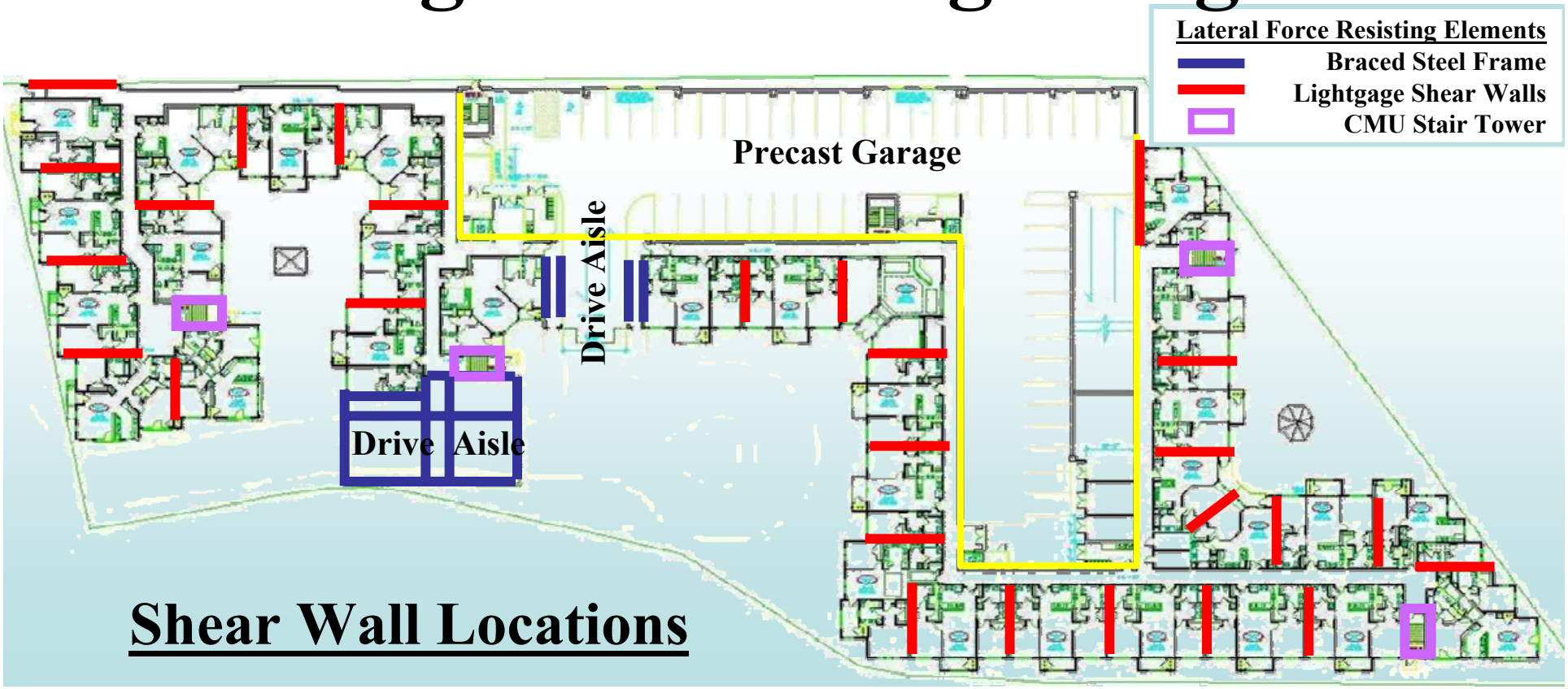
Original Building Design



Shear Wall Locations

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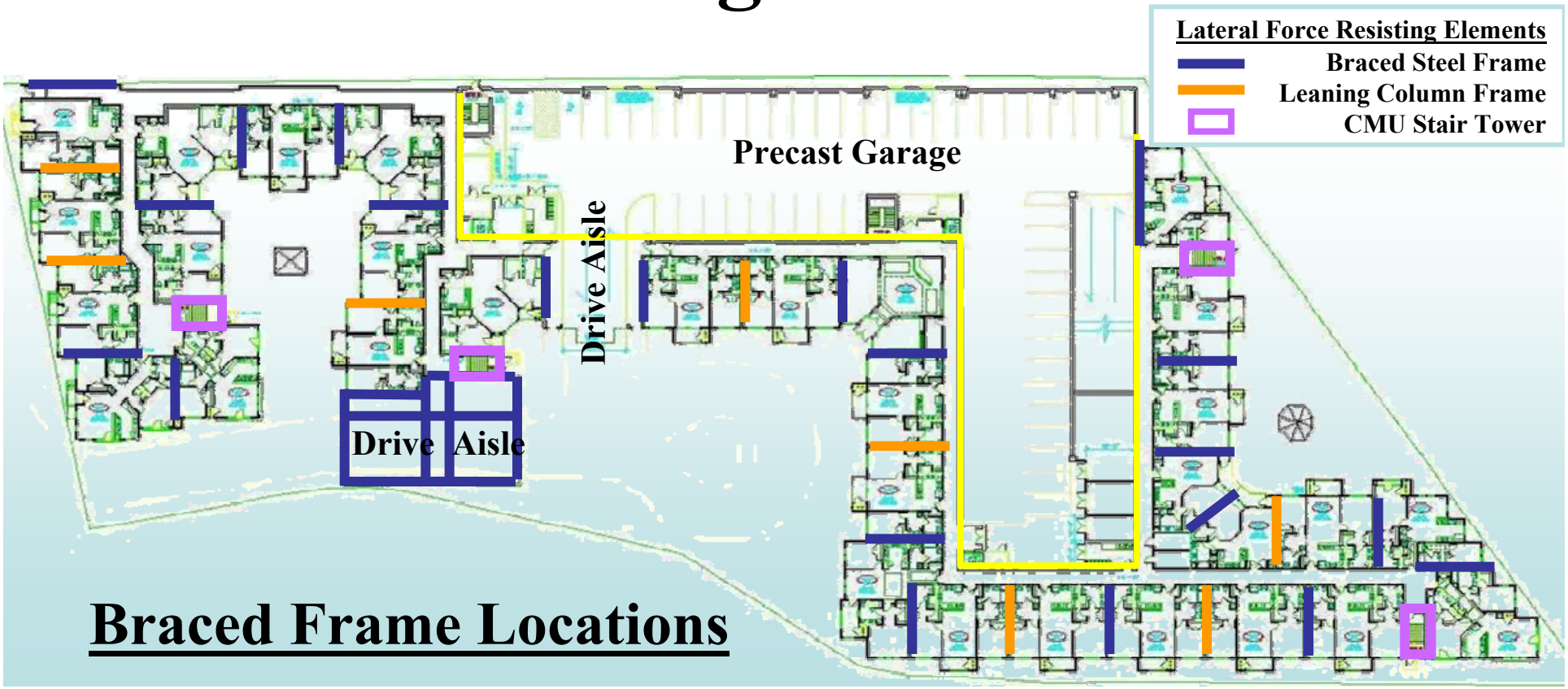
New Design Overview



Braced Frame Locations

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New Design Overview

Architectural Restrictions

~ Retain or increase the amount of rentable space

~ Retain the overall appearance of the building

~ Maintain the architectural detailing at the 2 story drive aisle

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New Design

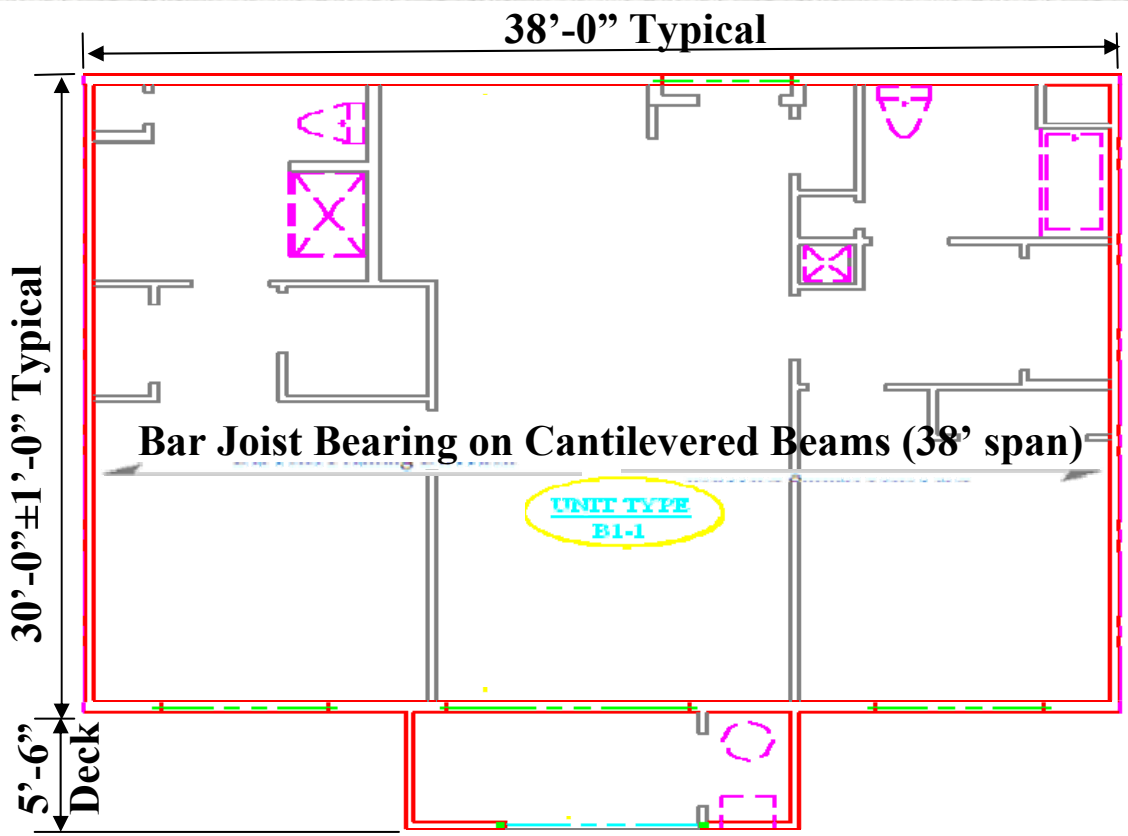
Bar Joist Attachment

Bar Joist:

~ 20K9 w/ 3 rows of bridging

Deck:

~ 0.6C28 CSV Conform deck w/ 3½" total slab depth



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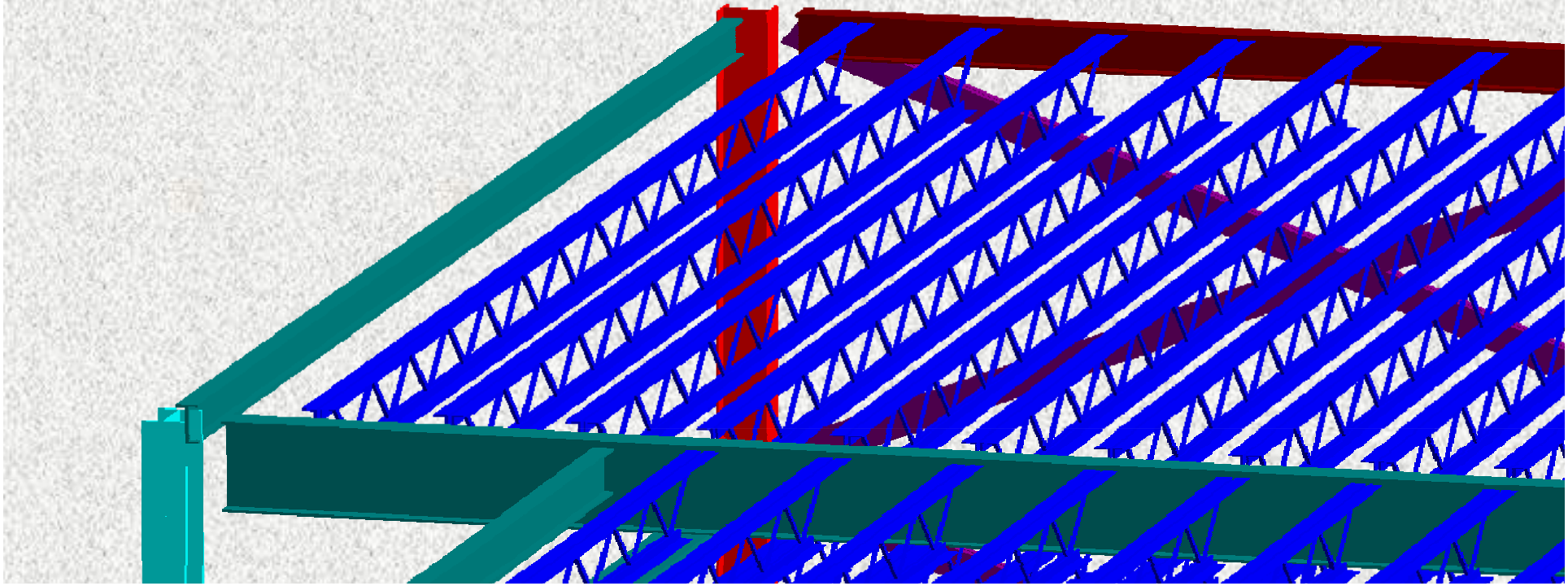
New Design

Bar Joist Attachment



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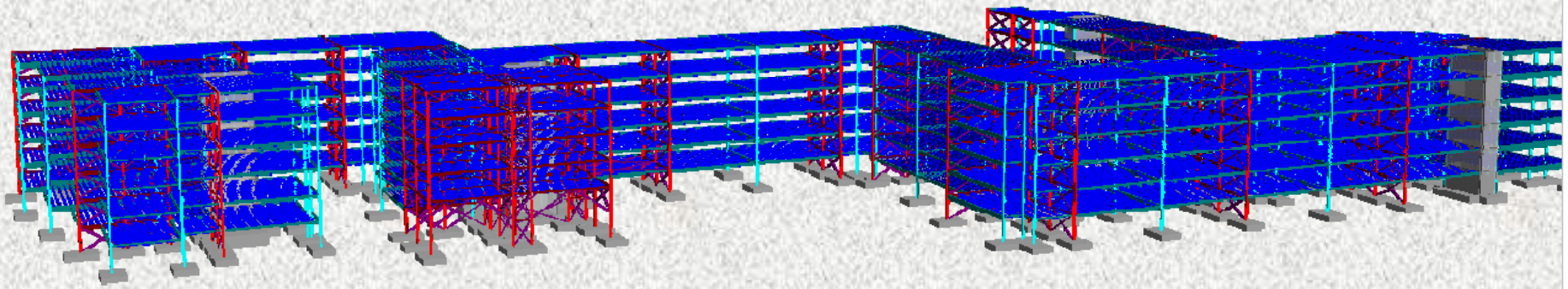

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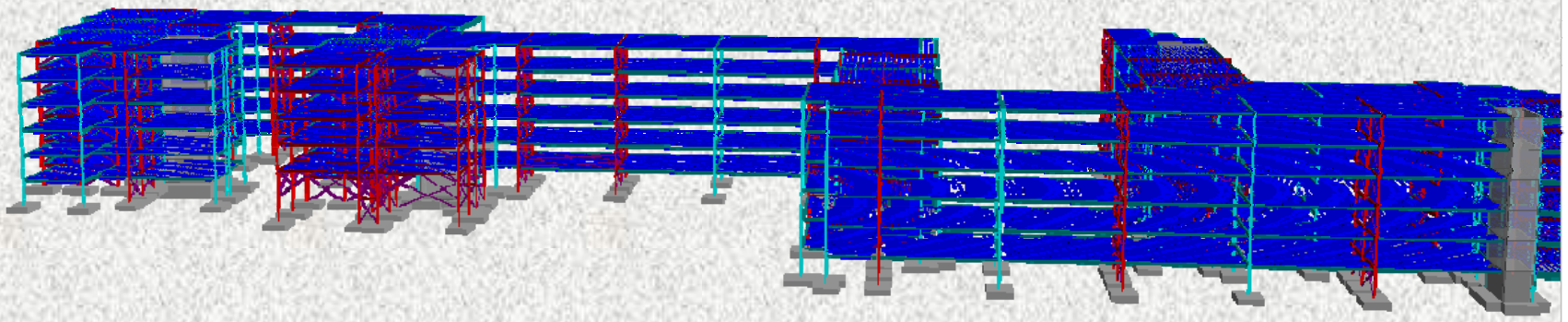

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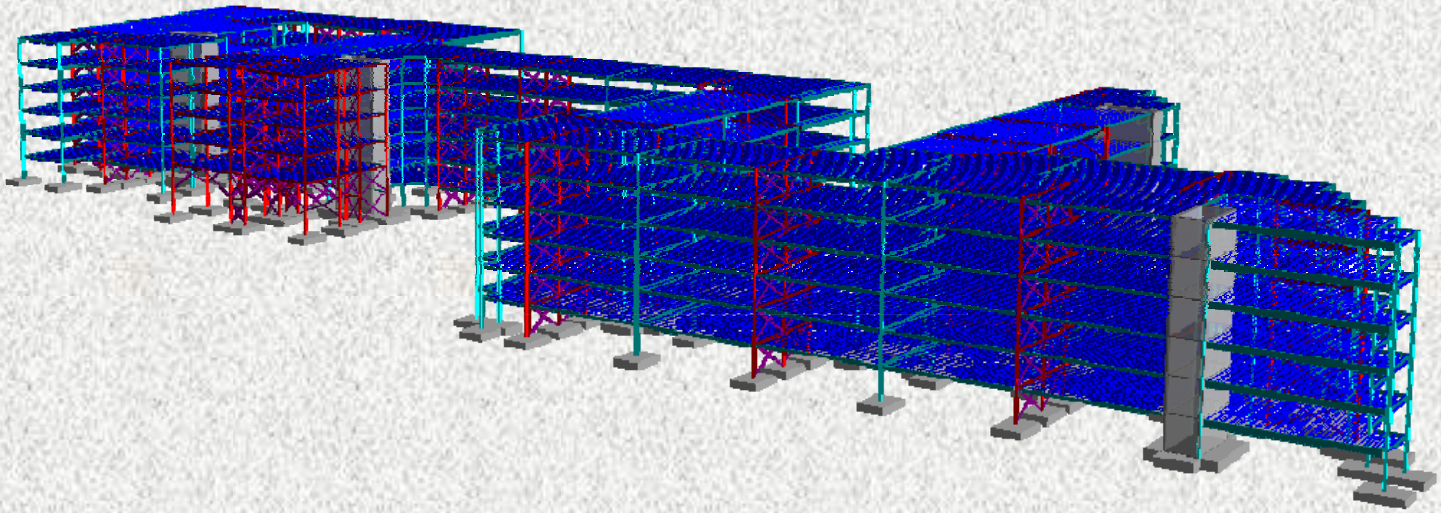

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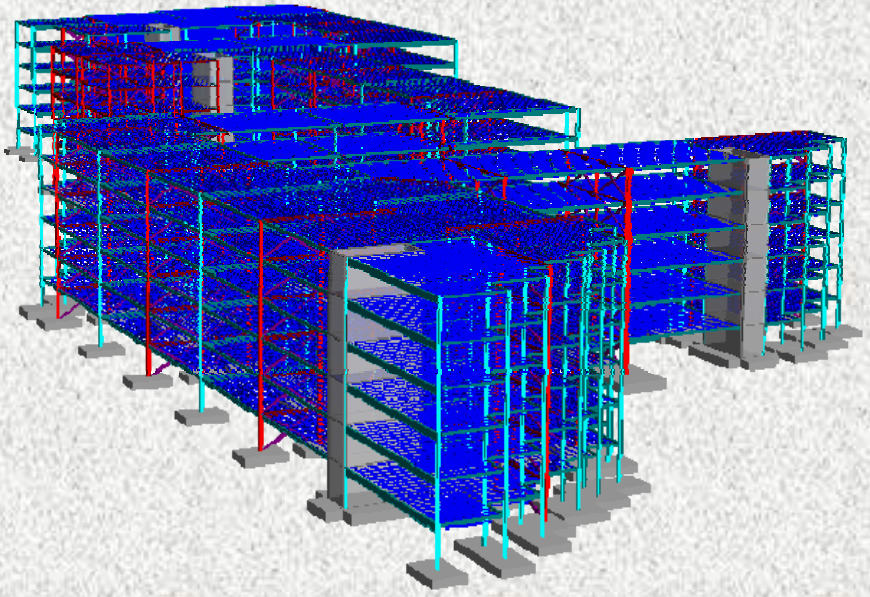

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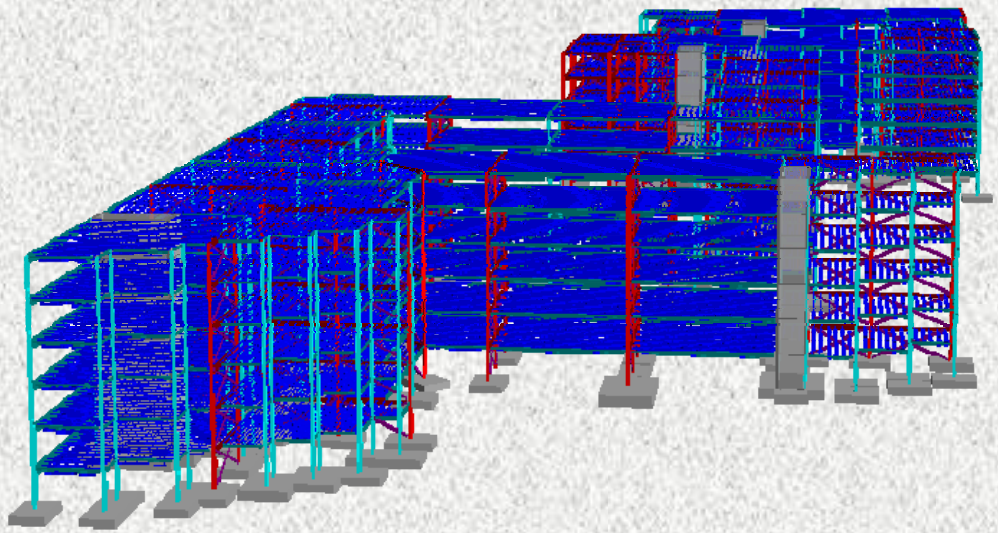

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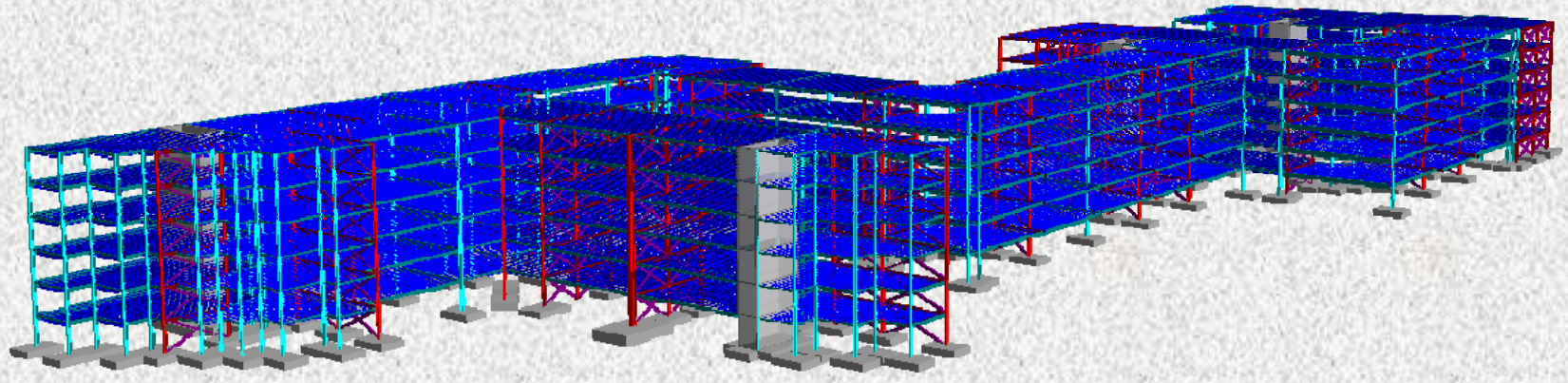

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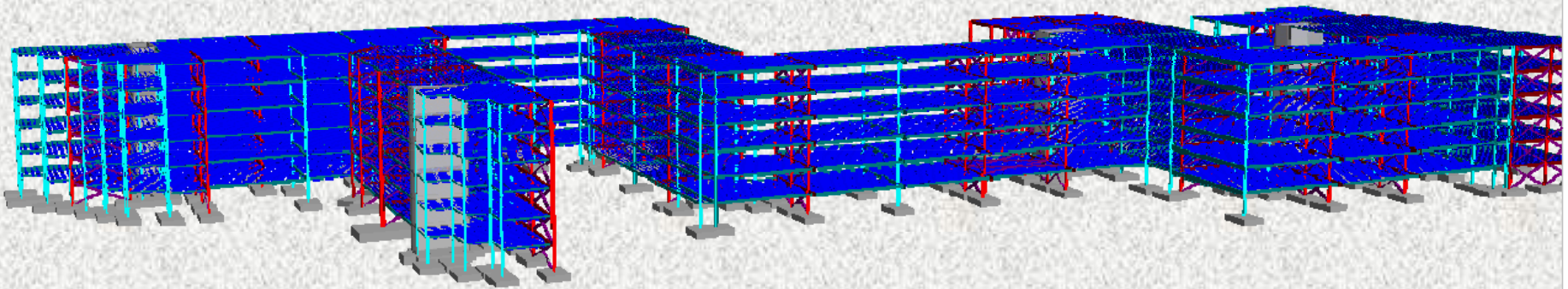

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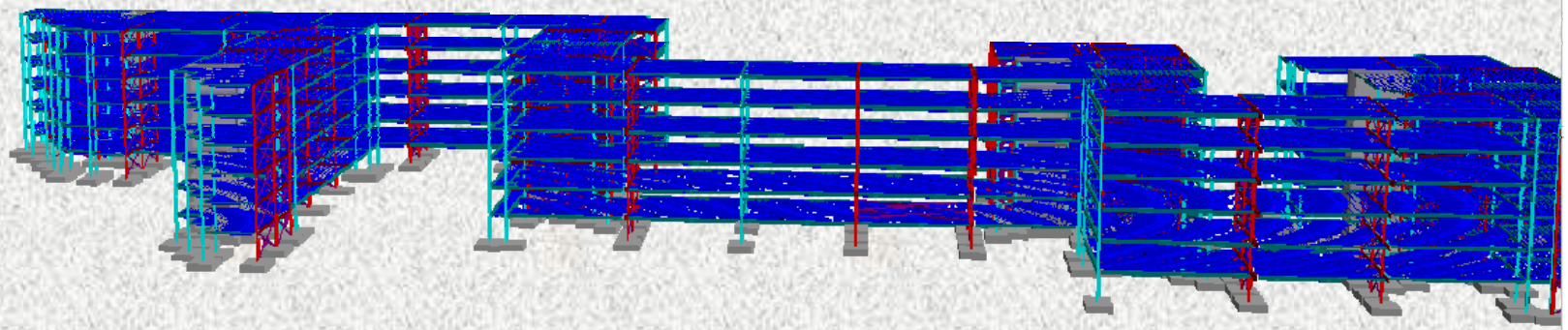

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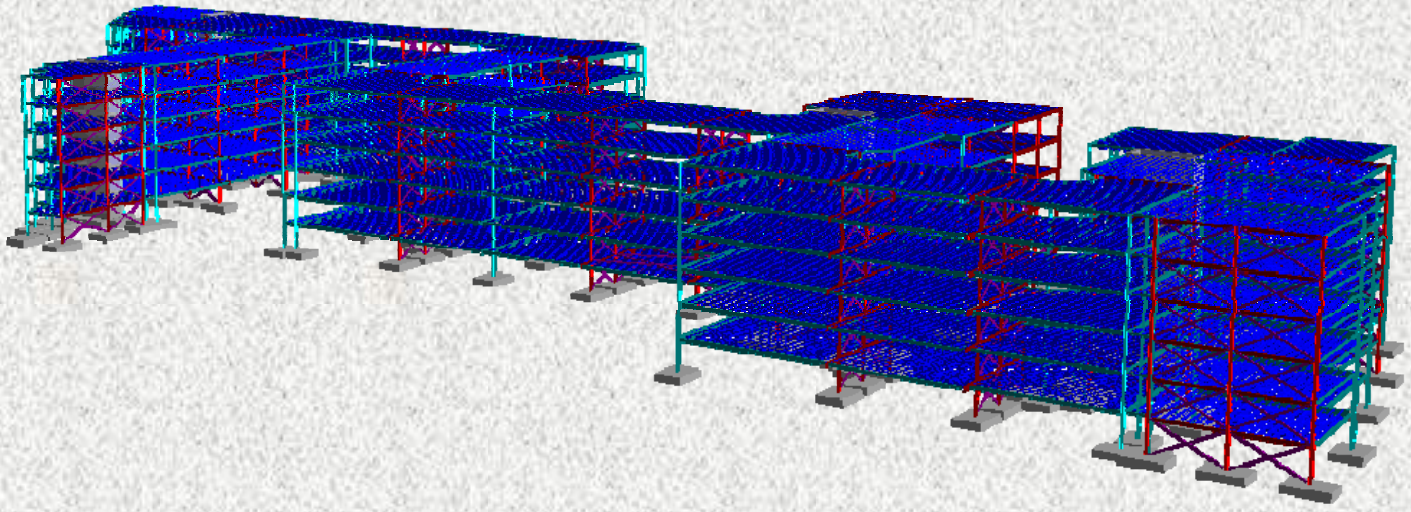

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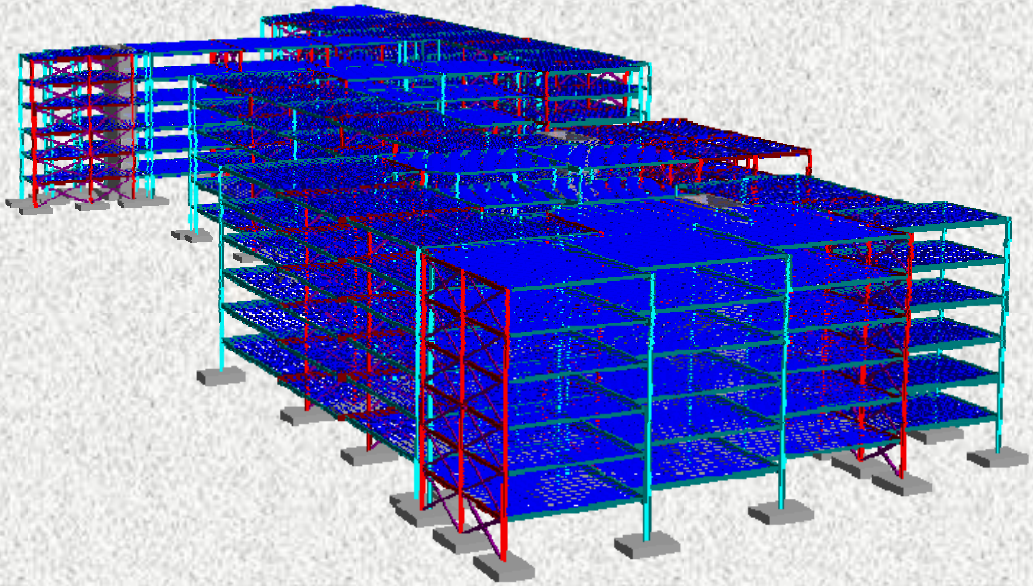

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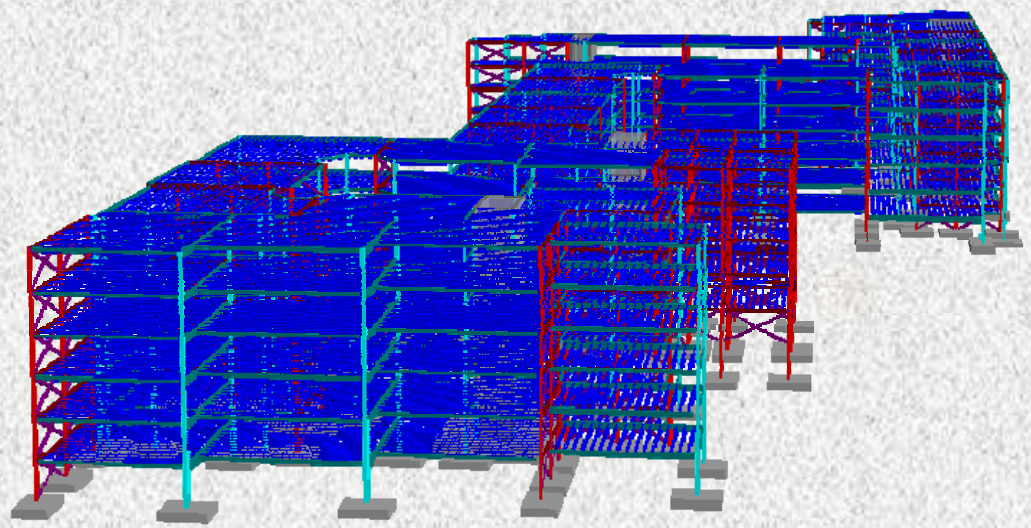

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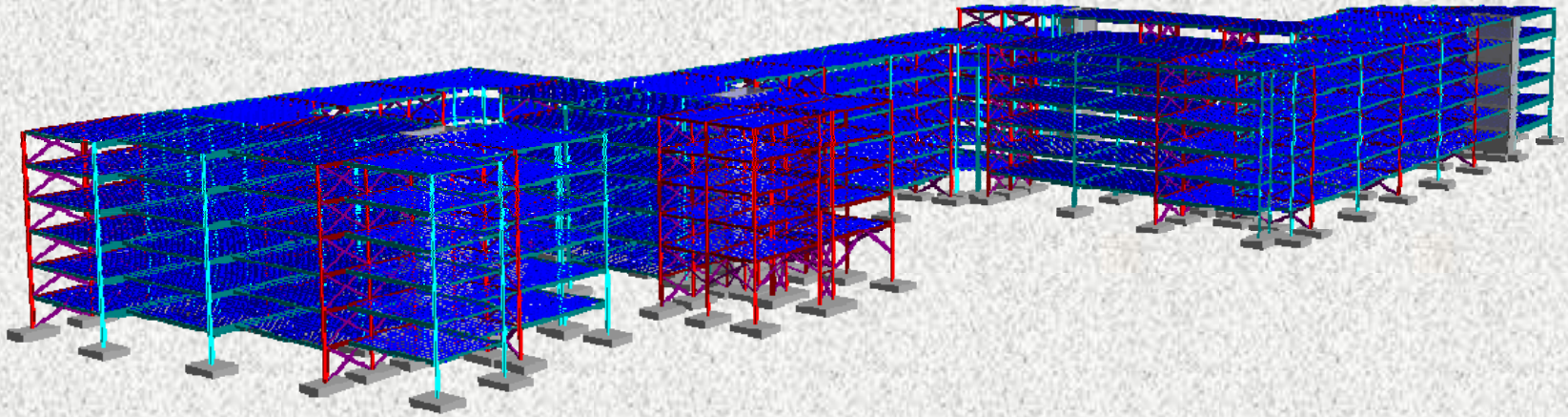

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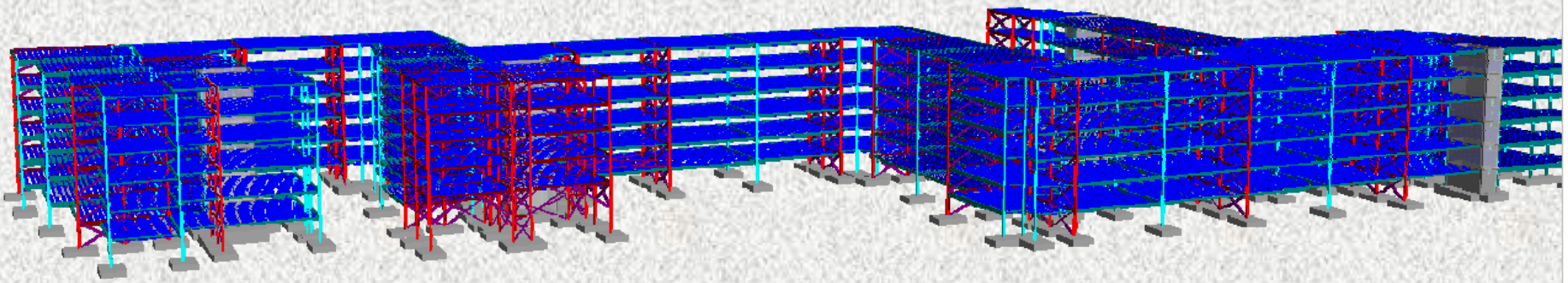

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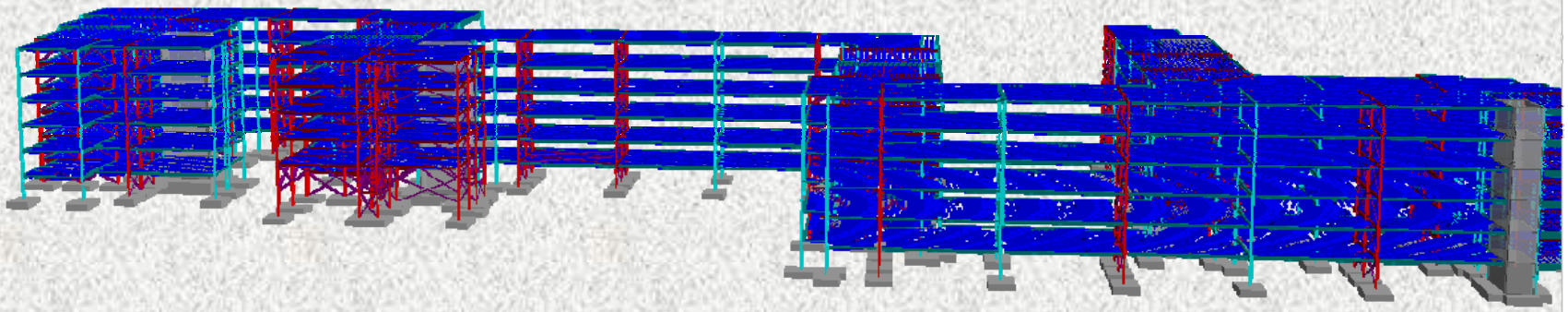

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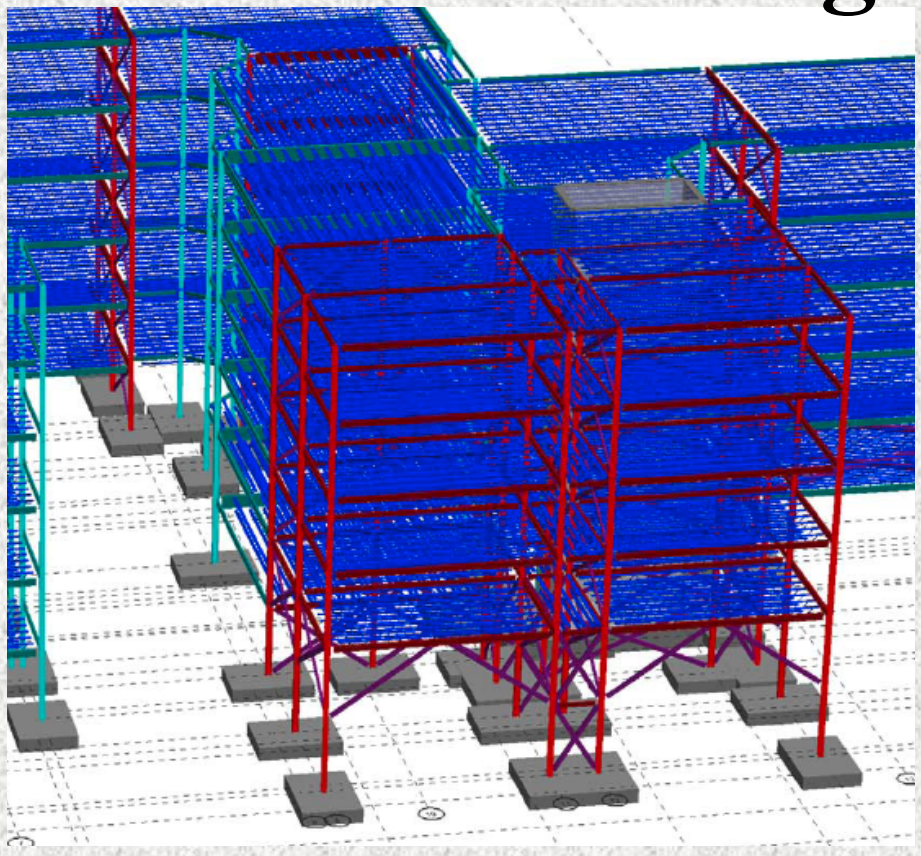

Two Story Drive Aisle

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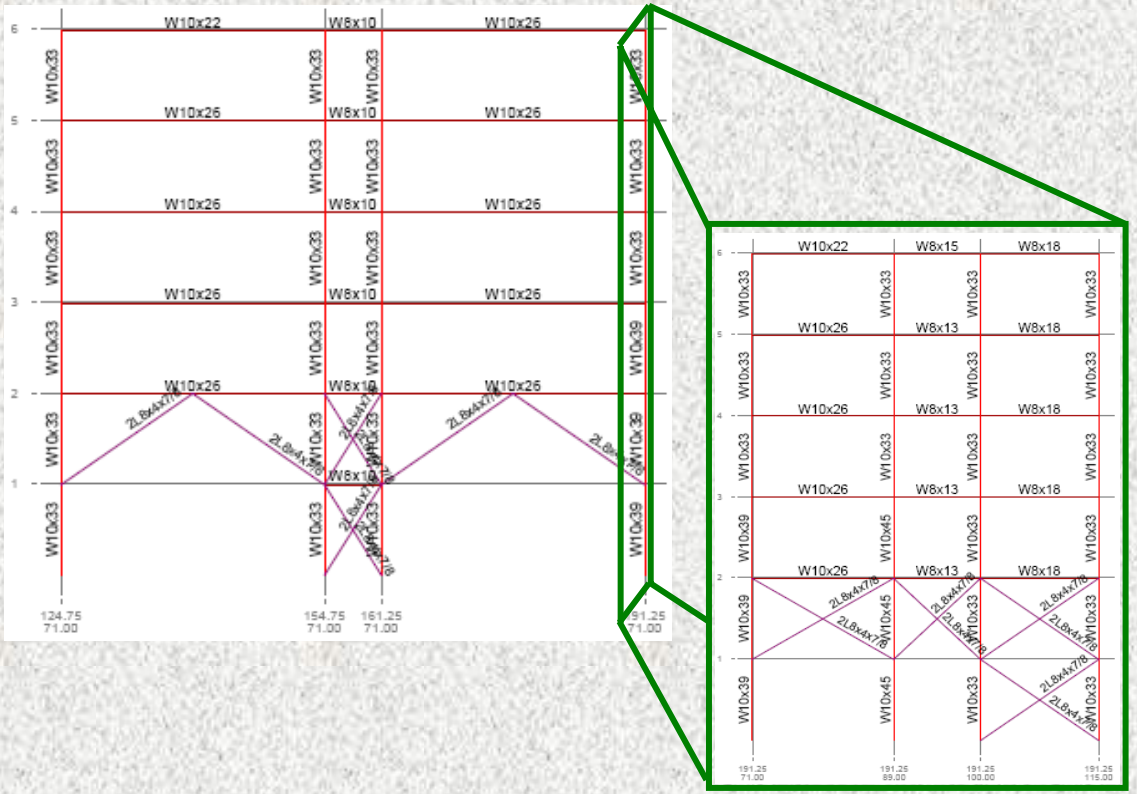
New Design

Unique Frames at the 2 story drive aisle

*allows architectural detailing



Parkview at Bloomfield Station

New Design

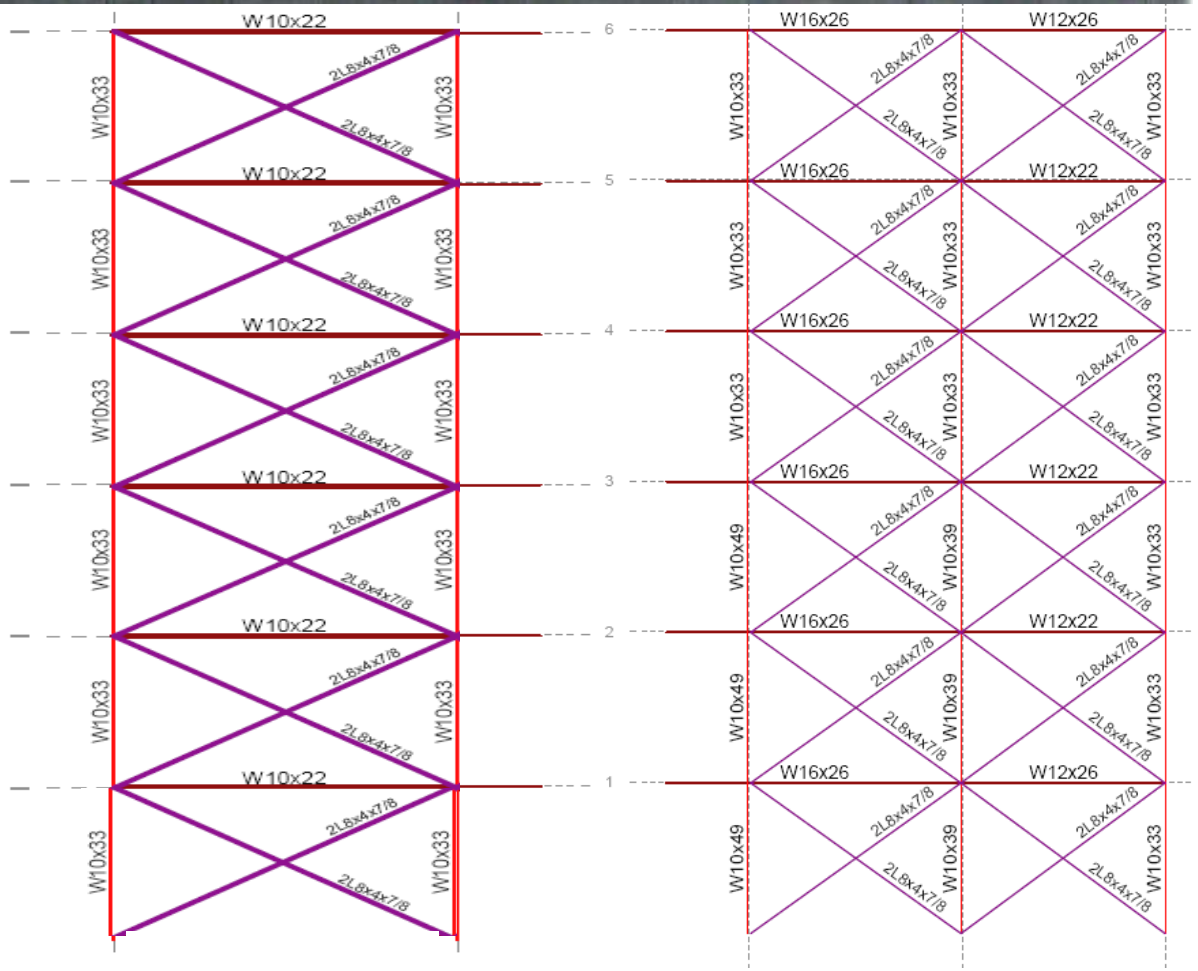
Typical Lateral Frames

Typical Sizes

Columns: W10x33

Beams: W10x22, W12x22 and W16x26

Braces: 2L 8”x4”x7/8”



Parkview at Bloomfield Station

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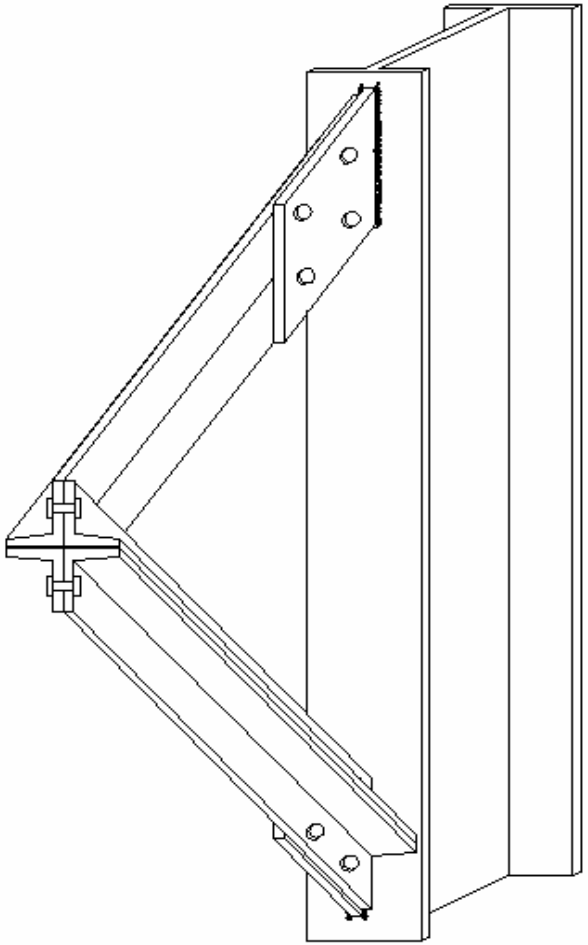

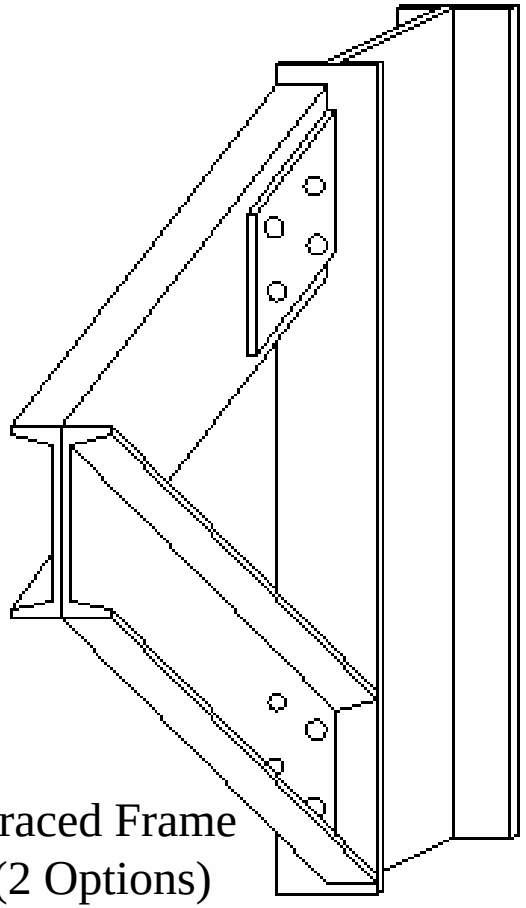

Braced Frame
(2 Options)

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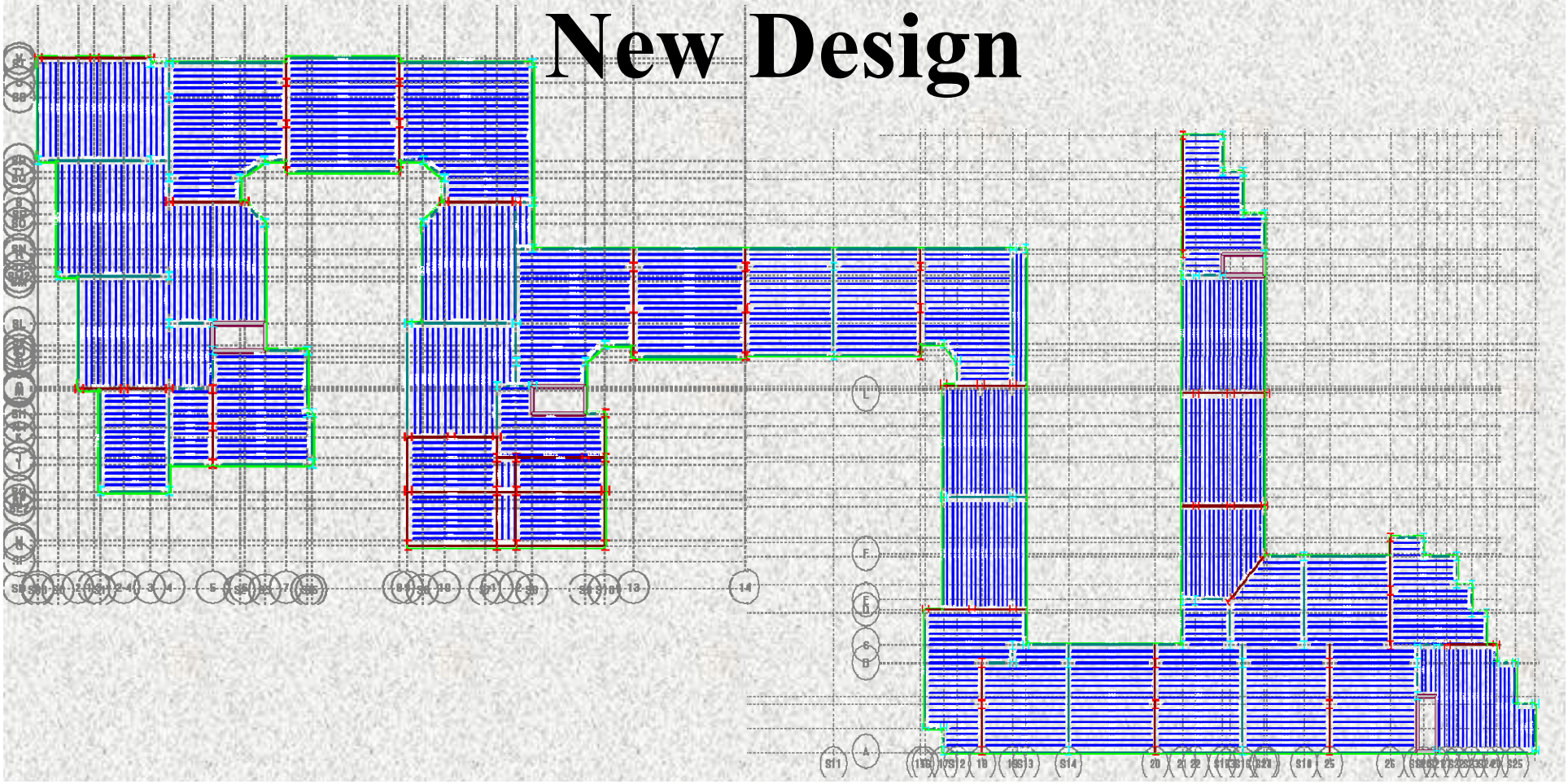
New Design



Parkview at Bloomfield Station

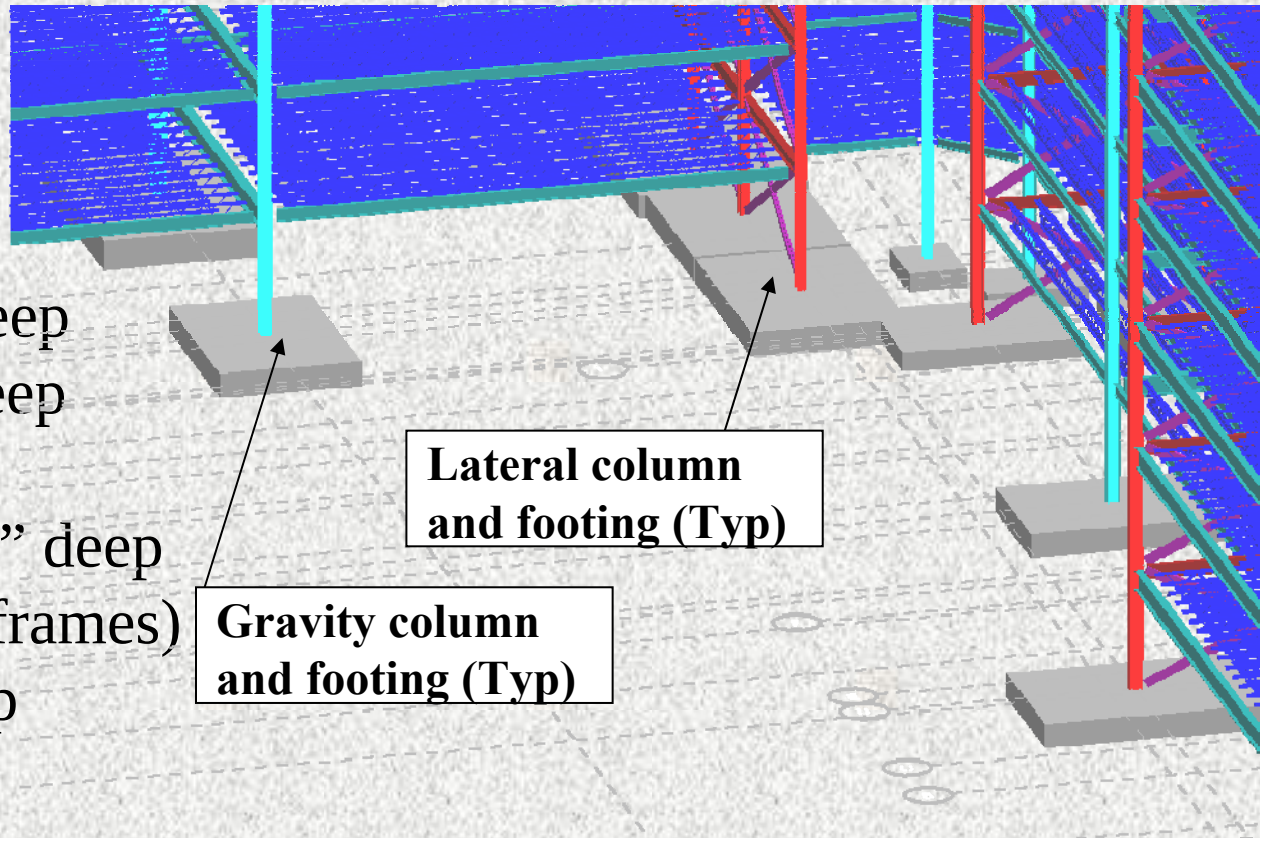
New Design

Foundation

Typical Sizes

Gravity: 4’x4’x1½’ deep
to 14’x14’x2’ deep

Lateral: 9’x30’-6’x1’-6” deep
(single bay frames)
up to 14’x36’x3’ deep



Parkview at Bloomfield Station

Review of Design Criteria

Architectural Restrictions

- √ Retained the amount of rentable space
- √ Retain the overall appearance of the building
- √ Maintain the architectural detailing at the 2 story drive aisle

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Section III:

Breadth Topics

Cost Advantages

EIFS Recommendations

Parkview at Bloomfield Station

Cost Advantages

Comparing original and new design:

~ Foundation
~ Column
~ Floor System
~ Wall

Parkview at Bloomfield Station

NEW CONDITIONS
*All values based on RS Means Assembly Cost Data 31st ED 2006

NEW FOUNDATION
Spread footing (3 ksf soil)

capacity	costs (per spread footing) material	installation	total	spread quantity	total
700k	4075	3100	7175	12	$86,100
500k	2575	2063	4638	31	$143,778
300k	1075	1025	2100	37	$77,700
200k	585	625	1210	33	$39,930
100k	214	282	496	35	$17,360
50k	107	166	273	9	$2,457
			Total per floor		$367,325
			Total for the 6 story building		$367,325

NEW FOUNDATION
Strip footing (3 ksf soil)

capacity	costs (per foot of footing) material	installation	total	strip length (feet)	total
20klf	70.00	53.50	123.50	0	$0
15klf	45.00	40.00	85.00	0	$0
10klf	20.00	24.00	44.00	0	$0
5.1klf	12.15	18.80	30.95	232	$7,180
2.6klf	5.90	11.30	17.20	0	$0
			Total per floor		$7,180
			Total for the 6 story building		$7,180

ORIGINAL CONDITIONS
*All values based on RS Means Assembly Cost Data 31st ED 2006

ORIGINAL FOUNDATION
Spread footing (3 ksf soil)

capacity	costs (per spread footing) material	installation	total	spread quantity	total
700k	4075	3100	7175	18	$129,150
500k	2575	2063	4638	8	$37,104
300k	1075	1025	2100	4	$8,400
200k	585	625	1210	1	$1,210
100k	214	282	496	12	$5,952
50k	107	166	273	0	$0 on strip ftg
				per floor	$181,816
				y building	$181,816

New Foundation: -$46,848

ORIGINAL FOUNDATION
Strip footing (3 ksf soil) total length 2480 feet

capacity	costs (per foot of footing) material	installation	total	strip length (feet)	total
20klf	70.00	53.50	123.50	310	$38,291
15klf	45.00	40.00	85.00	868	$73,792
10klf	20.00	24.00	44.00	95	$4,180
5.1klf	12.15	18.80	30.95	232	$7,180
2.6klf	5.90	11.30	17.20	1302	$22,398
				Total per floor	$145,841
				Total for the 6 story building	$145,841

Parkview at Bloomfield Station

NEW CONDITIONS

*All values based on RS Means Assembly Cost Data 31st ED 2006

NEW COLUMN LAYOUT (unsupported 10 feet)

Wide flange columns (84 gravity & 73 Lateral frame columns)

Type A capacity	costs (per column) material	installation	total	weight (plf)	column quantity	total
700k	173.00	8.90	181.90	136	12	$2,183
500k	125.00	8.90	133.90	136	31	$4,151
300k	77.50	8.90	86.40	61	37	$3,197
200k	57.00	8.90	65.90	45	33	$2,175
100k	44.50	6.65	51.15	40	35	$1,790
50k	20.50	8.90	29.40	16	9	$265
					Total per floor	$13,760
					Total for 6 story building	$82,560

NEW BAY LAYOUT

Steel joists on beams (30x35 feet^2 bays)

capacity	costs (per column) material	installation	total	ft^2 quantity	total
148 psf	12.40	5.25	17.65	50120	$884,618
				Total per floor	$884,618
				Total for the 6 story building	$5,307,708

ORIGINAL CONDITIONS

*All values based on RS Means Assembly Cost Data 31st ED 2006

ORIGINAL COLUMN LAYOUT (unsupported 10 feet)

Tube steel columns (walls act as lateral frame)

Type F,D capacity	costs (per column) material	installation	total	weight (plf)	column quantity	total
700k	131.00	8.90	139.90	103.3	12	$1,679
500k	96.00	8.90	104.90	103.3	14	$1,469
300k	61.00	8.90	69.90	47.9	4	$280
200k	48.00	8.90	56.90	37.7	1	$57
100k	24.00	8.90	32.90	19.02	19	$625
50k	15.50	8.90	24.40	12.21	91	$2,220
					per floor	$6,329
					story building	$37,976

New Columns: -$44,584

ORIGINAL BAY LAYOUT

Hambro joists on bearing wall: (30x35 feet^2 bays)

capacity	costs (per column) material	installation	total	ft^2 quantity	total
173 psf	11.00	8.50	19.50	50120	$977,340
					$977,340
				g	$5,864,040

New Floor System: +$556,332

Parkview at Bloomfield Station

NEW CONDITIONS
*All values based on RS Means Assembly Cost Data 31st ED 2006

NEW WALL SYSTEM 8 foot height
non-bearing light gage studs (24 inches on center with light gage cap)

	costs (per foot of wall length)			length	
item	material	installation	total	(feet)	total
wall	2.65	6.2	8.85	4931	$43,638
cap	0.27	0.62	0.89	4931	$4,388
			Total per floor		$48,026
			Total for the 6 story building		$48,026

totals	$5,812,800

ORIGINAL CONDITIONS
*All values based on RS Means Assembly Cost Data 31st ED 2006

ORIGINAL WALL SYSTEM 8 foot height
Bearing light gage studs (12 inches on center with tube steel cap)

	costs (per foot of wall length)			length	
item	material	installation	total	(feet)	total
wall	3.10	6.73	9.83	4931	$48,470
cap	4.80	0.89	5.69	4931	$28,056
			Total per floor		$76,526
			e 6 story building		$76,526

totals	$6,306,200

New Walls: +$28,500

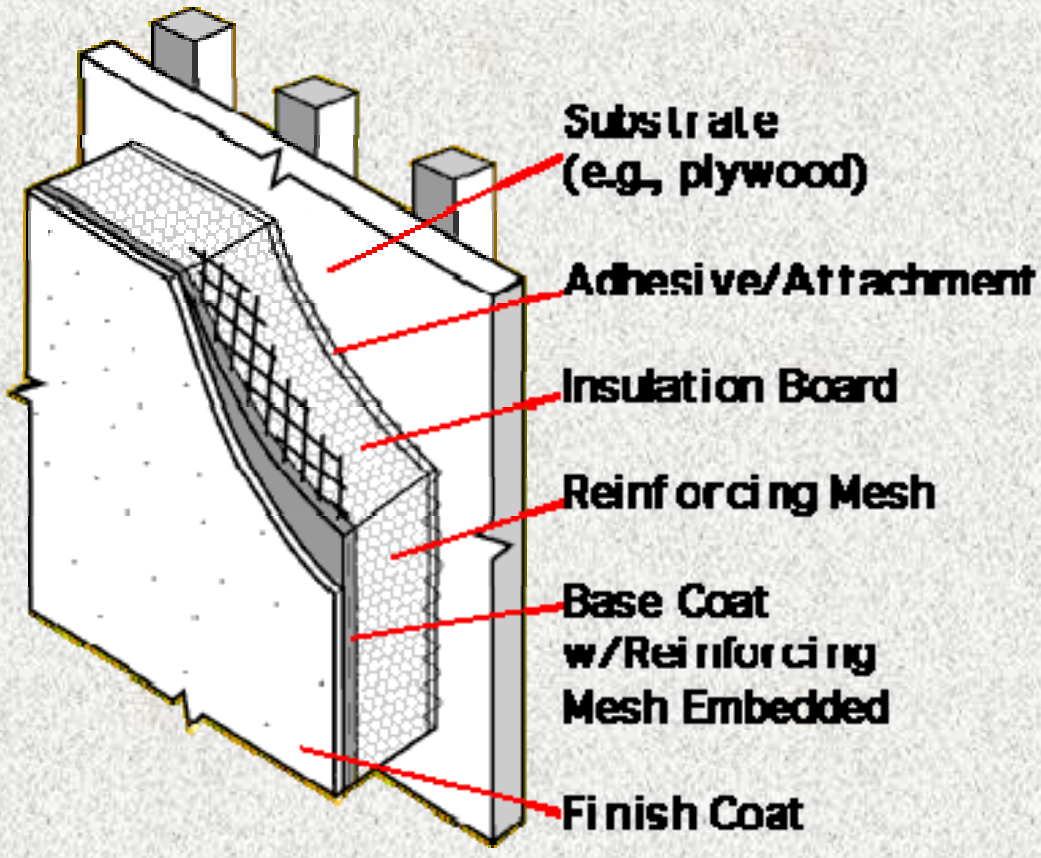
Savings of $493,400

Total Savings: +$493,400

Parkview at Bloomfield Station

EIFS Recommendations

Original System



Typical EIFS assembly

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Parkview at Bloomfield Station

EIFS Recommendations

Problems

~ Water penetration

~ Wind

~ Openings

~ Improper assembly

South-East wing

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EIFS Recommendations

It is recommended to use Drainable EIFS

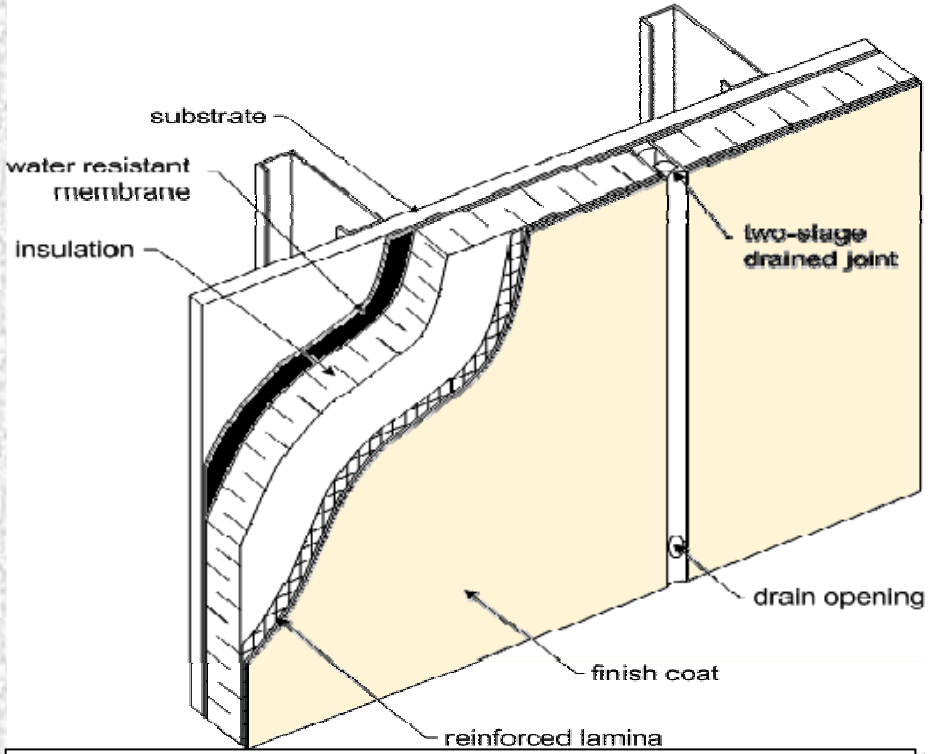
Advantages

~ A factor of safety against faulty workmanship

~ Water resistant membrane

~ Drainable system

~ Any color building is possible



Drainable EIFS

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Michael Stansbury ~ Consulting Structural Engineer
Toll Brothers, Inc. ~ Project Owner
Minno & Wasko ~ Project Architect

Lauren Whitaker ~ my wife
My family
Jesus

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Questions

or

Comments?

or

Lunch?

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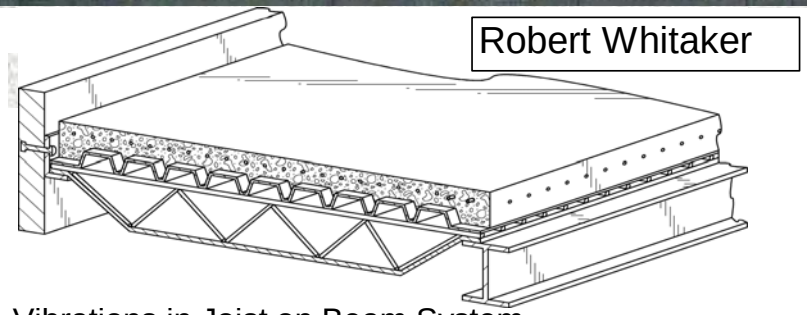
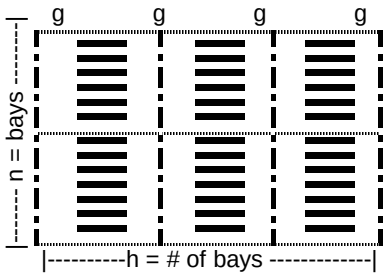


Robert Whitaker



Plan view

Design Loads	
DL	17.55 psf
LL	60 psf

Vibrations in Joist on Beam System

Based on AISC Steel design guide 11 ex 4.6 & 6.2

20K9	
w_{self} (plf)	10.8
$w_{total\ allow}$ (plf)	279.0
$w_{joist\ design}$ (plf)	233.1
d (in)	20.0
M_{allow} (ft-k)	49.48
A_{bottom} (in^2)	1.04
A_{top} (in^2)	1.30
A_{cord} (in^2)	2.34
I_{cord} (in^4)	208.9
I_{comp} (in^4)	466.0
y_c (in)	8.94

for spans of 38 feet

ok

W16x31	
w_{self} (plf)	31.0
A (in^2)	9.13
d (in)	15.70
Ix (in^4)	375.0

f_{allow} (k)	30 kip
ρ_{conc} (pcf)	145 pcf
Es (ksi)	29000 ksi
f'c (ksi)	3 ksi

Ec	3024 ksi
n	7.10

t_{conc}	3.00 in	*update Ws+d value	
t_{deck}	0.50 in		
t_{tot}	3.50 in	teff =	3.25 in

building	
n (# bays)	2 bays
h (# bays)	3 bays

LOADS		
Ws+d	39 psf	<== look up value in deck manual
DL	4.0 psf	<== 4 psf typ office service load
LL	11.0 psf	<== 11 psf typ office service load

Length	
Girder (Lg)	15 feet
Joist (Lj)	38 feet
Joist Spaci	2 feet

	joist		**girder**	
L min =	24	182.4	72	456
Leff =>	24 in		72 in	

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Vibration Analysis

AISC Design Guide 11 criteria

Table 4.1
Recommended Values of Parameters in Equation (4.1) and a_o / g Limits

	Constant Force P_o	Damping Ratio β	Acceleration Limit $a_o / g \times 100\%$
Offices, Residences, Churches	0.29 kN (65 lb)	0.02–0.05*	0.5%
Shopping Malls	0.29 kN (65 lb)	0.02	1.5%
Footbridges—Indoor	0.41 kN (92 lb)	0.01	1.5%
Footbridges—Outdoor	0.41 kN (92 lb)	0.01	5.0%

* 0.02 for floors with few non-structural components (ceilings, ducts, partitions, etc.) as can occur in open work areas and churches,
0.03 for floors with non-structural components and furnishings, but with only small demountable partitions, typical of many modular office areas,
0.05 for full height partitions between floors.

Table 6.1
Vibration Criteria for Sensitive Equipment

Facility Equipment or Use	Vibrational Velocity* (μ in./sec)	Vibrational Velocity* (μm/sec)
Computer systems; Operating Rooms**; Surgery; Bench microscopes at up to 100x magnification;	8,000	200
Laboratory robots	4,000	100
Bench microscopes at up to 400x magnification; Optical and other precision balances; Coordinate measuring machines; Metrology laboratories; Optical comparators; Microelectronics manufacturing equipment—Class A***	2,000	50

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Vibration Analysis

Stiffness analysis	(fn< 9 Hz, no need to check stiffness analysis)		
using a	0.224	kip load	
$\Delta_{j\ applied}$	0.04282	in	
$\Delta_{j\ pannel}$	0.00714	in	
$\Delta_{gPannel}$	0.00145	in	(fn= 4.30 Hz)
Δ_{total}	0.00786	in	fn ok
K_{floor}	28.5	kip/in	**>5.7kip/in limit ok**

Walking Evaluation					(fn= 4.30 Hz)
$W_{PANELtot}$	43.9	kips			
β	0.030	Res._mid low damp	table 4.1		
βW	1316.4	#			
P_o	65.0	#	table 4.1	compare with table 4.1	
a_p/g =	0.01098	=	1.098% g	fails > 0.5%	**fails**
Fails, need to increase joist size or slab thickness (delta j controls)					

MODERATE WALK	<------			
W person	185	#		
step/min	75	step/min		
Fm/W	1.5	(table 6.2)	Uv=	5500 # Hz^2
Fm	277.5	#		
f_o	2.5	hz	(figure 6.5)	
f_n/f_o	1.718	>>0.5	use eq 6.4b	
$T_o=1/f_o$	0.4	sec		
f_n*T_o	1.718	> 0.5		
Am	0.169			
X max	1573	in x 10^-6		
V	**42,862**	**x 10^-6 in /sec**	compare with table 6.1 values	

SLOW WALK				
W person	185	#		
step/min	50	step/min		
Fm/W	1.3	(table 6.2)	Uv=	1500 # Hz^2
Fm	240.5	#		
f_o	1.4	hz	(figure 6.5)	
f_n/f_o	3.07	>>0.5	use eq 6.4b	
$T_o=1/f_o$	0.7143	sec		
f_n*T_o	3.07	> 0.5		
Am	0.053			
X max	428	in x 10^-6		
V	**11,690**	**x 10^-6 in /sec**	compare with table 6.1 values	

a/g=.011

V=157000x10^-6 in/sec

Parkview at Bloomfield Station

Vibration Analysis

t_{conc}	5.00 in
t_{deck}	3.00 in
t_{tot}	8.00 in

Stiffness analysis **(fn< 9 Hz, no need to check stiffness analysis)**

using a 0.224 kip load

$\Delta_{j\ applied}$	0.02629	in	
$\Delta_{j\ pannel}$	0.00326	in	
$\Delta_{gPannel}$	0.00105	in	(fn= 4.11 Hz)
Δ_{total}	0.00378	in	fn ok
K_{floor}	59.2	kip/in	**>5.7kip/in limit ok**

Walking Evaluation (fn= 4.11 Hz)

$W_{PANELtot}$	77.7 kips			
β	0.030	Res._mid low damp	table 4.1	
βW	2330.9 #			
P_o	65.0 #	table 4.1	compare with table 4.1	
a_p/g =	0.00662 =	0.662% g fails >	0.5%	**fails**

Fails, need to increase joist size or slab thickness (delta j controls)

Stiffness analysis **(fn< 9 Hz, no need to check stiffness analysis)**

using a 0.224 kip load

$\Delta_{j\ applied}$	0.02629	in	
$\Delta_{j\ pannel}$	0.00326	in	
$\Delta_{gPannel}$	0.00105	in	(fn= 4.11 Hz)
Δ_{total}	0.00378	in	fn ok
K_{floor}	59.2	kip/in	**>5.7kip/in limit ok**

Walking Evaluation (fn= 4.11 Hz)

$W_{PANELtot}$	77.7 kips			
β	0.040	Res._mid high damp	table 4.1	
βW	3107.9 #			
P_o	65.0 #	table 4.1	compare with table 4.1	
a_p/g =	0.00496 =	0.496% g <	0.5%	**ok**

Parkview at Bloomfield Station

Vibration Analysis

MODERATE WALK	<------				
W person	185 #				
step/min	75 step/min				
Fm/W	1.5	(table 6.2)	Uv=	5500 # Hz^2	
Fm	277.5 #				
f_o	2.5 hz	(figure 6.5)			
f_n/f_o	1.644 >>0.5	use eq 6.4b			
$T_o=1/f_o$	0.4 sec				
f_n*T_o	1.644 > 0.5				
Am	0.185				
X max	807 in x 10^-6				
V	**21,045 x 10^-6 in /sec**	compare with table 6.1 values			

SLOW WALK					
W person	185 #				
step/min	50 step/min				
Fm/W	1.3	(table 6.2)	Uv=	1500 # Hz^2	
Fm	240.5 #				
f_o	1.4 hz	(figure 6.5)			
f_n/f_o	2.94 >>0.5	use eq 6.4b			
$T_o=1/f_o$	0.7143 sec				
f_n*T_o	2.94 > 0.5				
Am	0.058				
X max	219 in x 10^-6				
V	**5,740 x 10^-6 in /sec**	compare with table 6.1 values			

Parkview at Bloomfield Station

Vibration Analysis

28k12		
w_{self}	(plf)	17.1
$w_{total\ allow}$	(plf)	461.0
$w_{joist\ design}$	(plf)	319.1
d	(in)	28.0
M_{allow}	(ft-k)	81.76
A_{bottom}	(in^2)	1.21
A_{top}	(in^2)	1.51
A_{cord}	(in^2)	2.73
I_{cord}	(in^4)	490.5
I_{comp}	(in^4)	1570.9
y_c	(in)	12.50

for spans of 38 feet

ok

W16x31	
w_{self} (plf)	31.0
A (in^2)	9.13
d (in)	15.70
Ix (in^4)	375.0

f_{allow} (k)	30 kip
ρ_{conc} (pcf)	145 pcf
Es (ksi)	29000 ksi
f'c (ksi)	3 ksi

Ec	3024 ksi
n	7.10

t_{conc}	5.00 in
t_{deck}	3.00 in
t_{tot}	8.00 in

*update Ws+d value

teff = 6.50 in

building	
n (# bays)	2 bays
h (# bays)	3 bays

LOADS		
Ws+d	82 psf	<== look up value in deck manual
DL	4.0 psf	<== 4 psf typ office service load
LL	11.0 psf	<== 11 psf typ office service load

Length	
Girder (Lg)	15 feet
Joist (Lj)	38 feet
Joist Spaci	2 feet

	joist	
L min =	24	182.4
Leff =>	24 in	

	girder	
L min =	72	456
Leff =>	72 in	

Parkview at Bloomfield Station

Vibration Analysis

Stiffness analysis **(fn ok, no need to check stiffness analysis)**

using a 0.224 kip load

$\Delta_{j\ applied}$	0.01521 in		
$\Delta_{j\ pannel}$	0.00196 in		
$\Delta_{gPannel}$	0.00105 in	(fn= 5.67 Hz)	
Δ_{total}	0.00248 in	fn ok	
K_{floor}	90.4 kip/in	**>5.7kip/in limit ok**	

MODERATE WALK <------

W person	185 #			
step/min	75 step/min			
Fm/W	1.5	(table 6.2)	Uv=	5500 # Hz^2
Fm	277.5 #			
f_o	2.5 hz	(figure 6.5)		
f_n/f_o	2.269 >>0.5	use eq 6.4b		
$T_o=1/f_o$	0.4 sec			
f_n*T_o	2.269 > 0.5			
Am	0.097			
X max	267 in x 10^-6			
V	**9,598 x 10^-6 in /sec**	compare with table 6.1 values		

Walking Evaluation (fn= 5.67 Hz)

$W_{PANELtot}$	60.8 kips			
β	0.030	Res._mid low damp	table 4.1	
βW	1824.1 #			
P_o	65.0 #	table 4.1	compare with table 4.1	
a_p/g =	0.00490 =	0.490% g <	0.5%	**ok**

SLOW WALK

W person	185 #			
step/min	50 step/min			
Fm/W	1.3	(table 6.2)	Uv=	1500 # Hz^2
Fm	240.5 #			
f_o	1.4 hz	(figure 6.5)		
f_n/f_o	4.05 >>0.5	use eq 6.4b		
$T_o=1/f_o$	0.7143 sec			
f_n*T_o	4.05 > 0.5			
Am	0.030			
X max	73 in x 10^-6			
V	**2,618 x 10^-6 in /sec**	compare with table 6.1 values		

Robert Whitaker

Robert S. Whitaker
Structural Option
Parkview at Bloomfield Station
Bloomfield, NJ

Structural
- *Floor system*: 16" Hambro Floor System w/ 3" slab
- *Interior Bearing walls*: 4" light gage shear walls w/ tube steel top plates
- *Exterior Bearing walls*: 6" light gage shear walls w/ tube steel top plates
- *Columns:* HSS 3x3x1/4" to HSS 7x3x3/8"
- Beams: typical beam is a W10x12, HSS 4x4x5/16", or HSS 6x4x5/16"
- *Roof*: light gage roof trusses w/ portions of flat roof
- *Foundation:* continuous grade beam footing
- *Garage foundation:* 100 ton H piles 42-53 ft deep

Architectural
- 6 story residential building surrounding a pre-cast parking garage
- Long irregular footprint
- 197 condominium units & a 330 space garage
- Building is nestled between Second River, Washington St, and a Midtown Line train station
- The exterior wall cladding is an Exterior Finish and Insulation System (EFIS)
- Gable roof with either a 12:12 or 8:12 slope

Codes
- IBC 2000 NJ
- Fair Housing
- ASCE7-02

Mechanical
- Unit temperature controls
- Gas fired furnaces
- Air handling unit/condensing unit refrigerant loop
- Individual unit water heaters

Transportation
- (2) 2,500lbs & (1) 3,500lbs elevator
- Six full stair towers

Size

Total:	453,473 ft^2
Building:	300,725 ft^2
Garage:	152,748 ft^2

General information
- **Cost:**
  - Overall Project: $65,616,081
  - Building: $56,936,063
  - Pre-cast Garage: $8,680,018
- **Project delivery method:** Qualified Design-Bid-Build
- **Construction start-finish:** November 10, 2005-TBD

Use Group
- *Building*:R2
- *Garage:S-2*

Electrical
- Electric baseboard
- 125A 1P3W panels
- 2 building transformers
- (2) 3000A switchboards
- 250 KW 120/208 diesel fired emergency generator
- Duct banks for CATV/Tele utilities

Project Team:

Owners:	Toll Brothers, Inc.
Architect:	Minno and Wasko
Structural Engineer:	Cates Engineering
Pre-cast Engineer:	Unistress Corp.
Civil Engineer:	PMK Group
MEP Engineer:	R.W. Sullivan, Inc.
Contractor/ CM:	Bovis - lend lease

Fire Protection
- Wet sprinkler in main building
- Dry sprinkler in garage & attic
- 1,500 GPM fire & jockey pump

Special Systems
- 15 panel point security system