Appendix C

Documentation of Structural Design and Modeling for Each Archetype Building

This Appendix provides the structural design details (element sizes, reinforcement, etc.) for each of the archetype buildings. In addition, this Appendix also provides the documentation of the modeling parameters used for the structural models of each archetype frame. This Appendix is organized sequentially in order of building ID number.

The body of this Appendix was created by graduate summer interns Brian S. Dean and Jason Chou; their work is greatly appreciated. Collaboratively with myself, they completed all the archetype building designs, created the OpenSees models, managed the OpenSees analyses, and organized the analysis results.

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1001

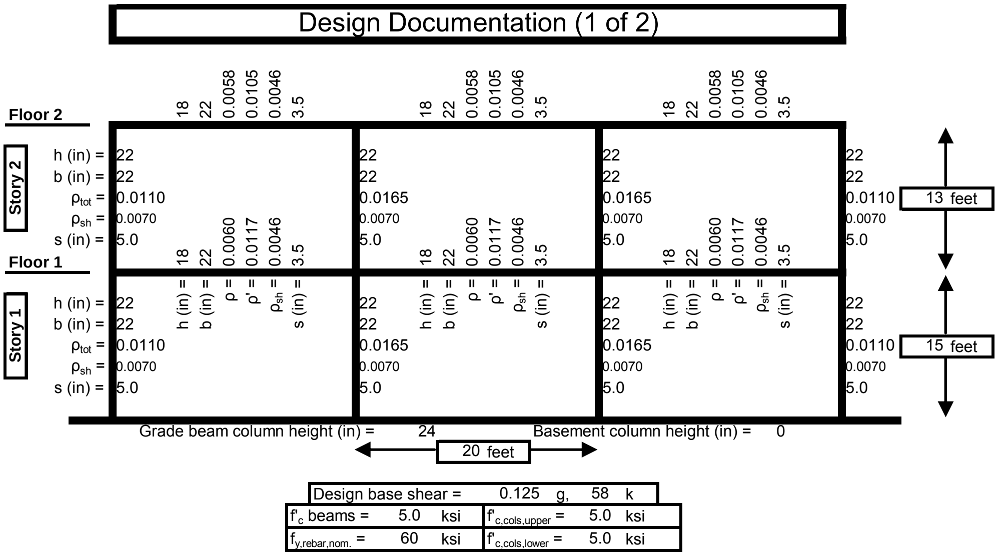
Number of Stories: 2

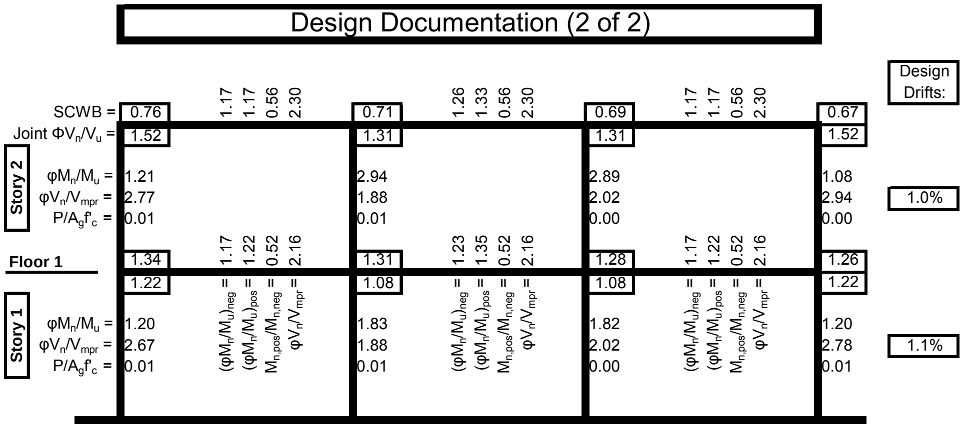
Fundamental Period (sec): 0.63

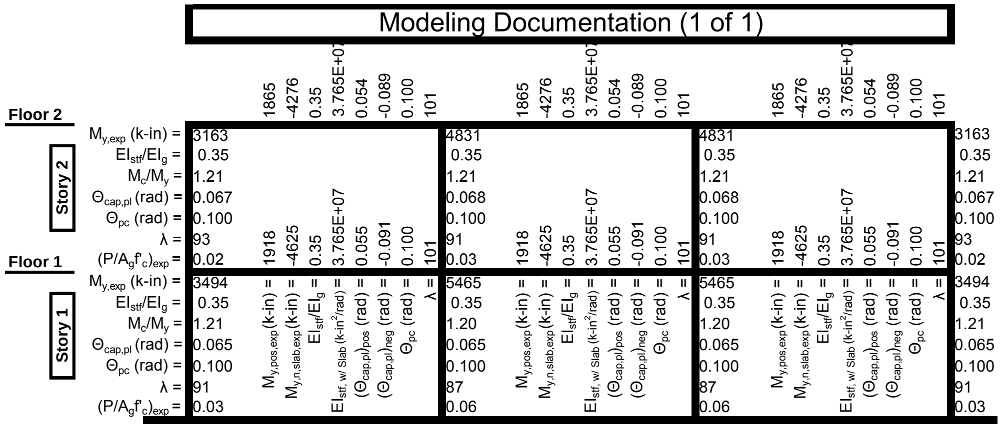
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined mostly by minimum size requirements and column-beam compatibility, in addition to joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES







Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.63 T_2 = 0.18 T_3 = 0.03

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1001a

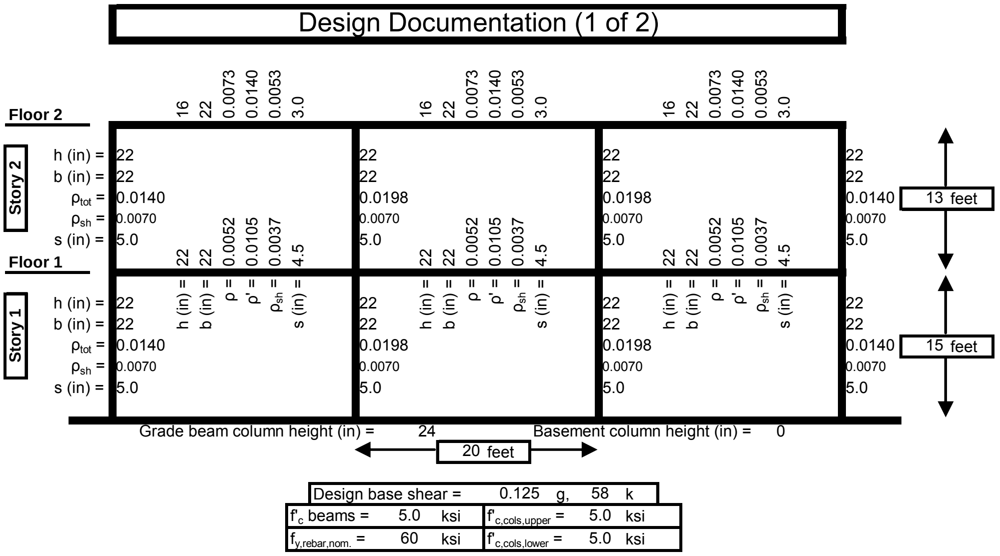
Number of Stories: 2

Fundamental Period (sec): 0.56

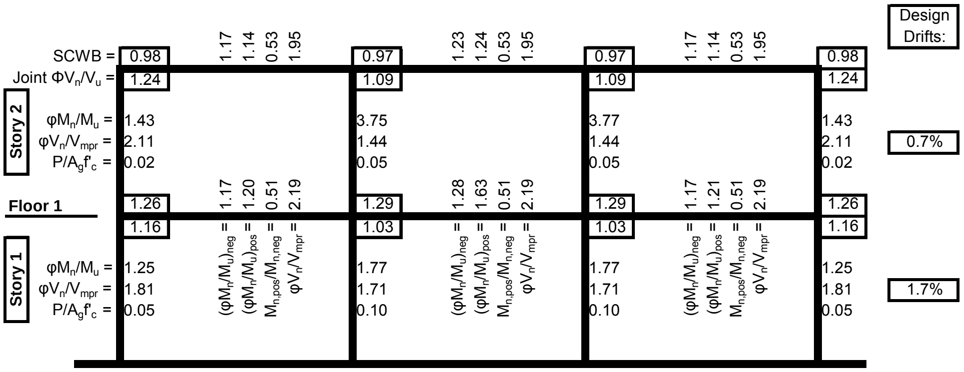
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by joint shear requirements and beam-column dimensional compatibility. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

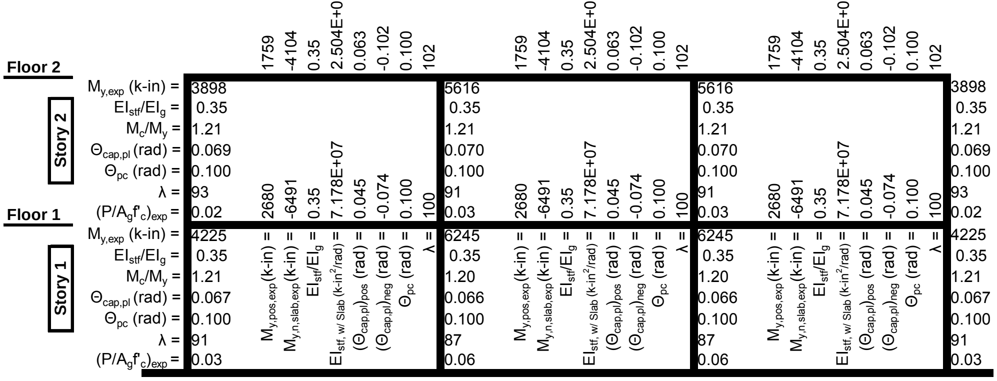
DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.56 T_2 = 0.18 T_3 = 0.03

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1002

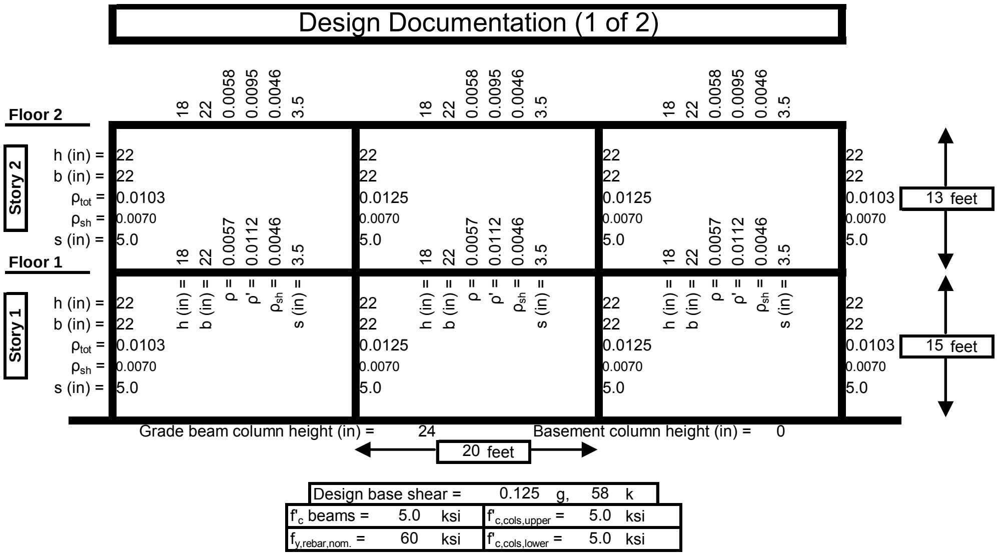
Number of Stories: 2

Fundamental Period (sec): 0.63

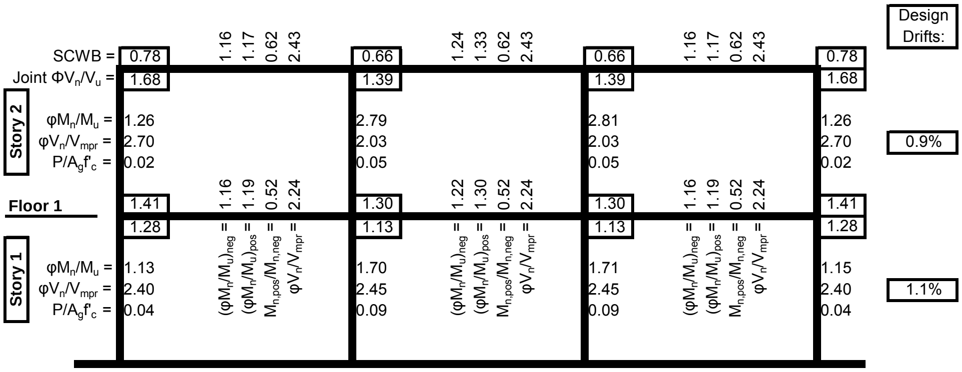
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined mostly by minimum size requirements and column-beam compatibility. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by flexural demands in the ground floor together with strong-column weak-beam (SCWB) ratios. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

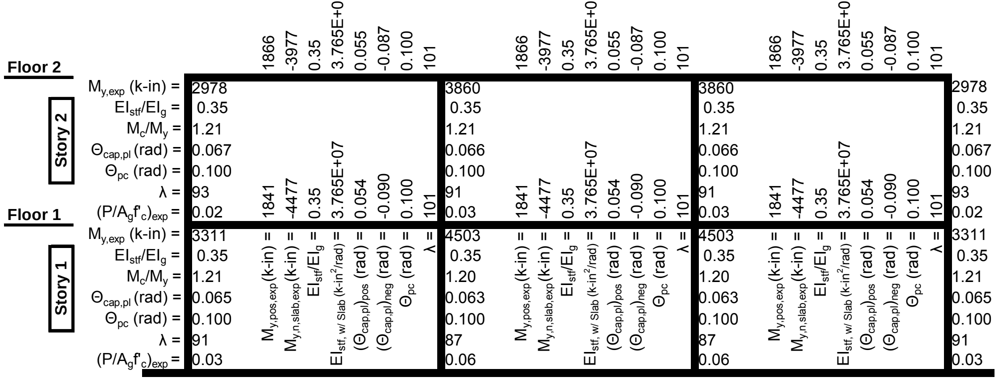
DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.63 T_2 = 0.18 T_3 = 0.03

$f_{y,rebar,expected}$ = 67 ksi

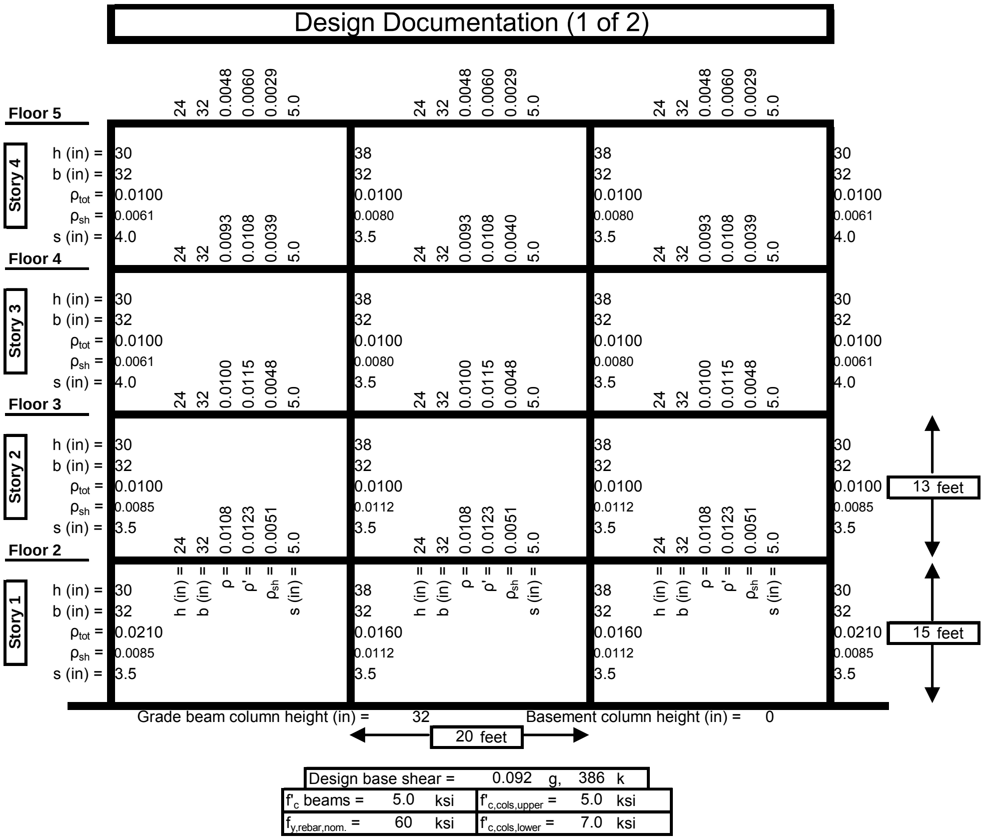
STRUCTURAL DESIGN AND MODELING SUMMARY

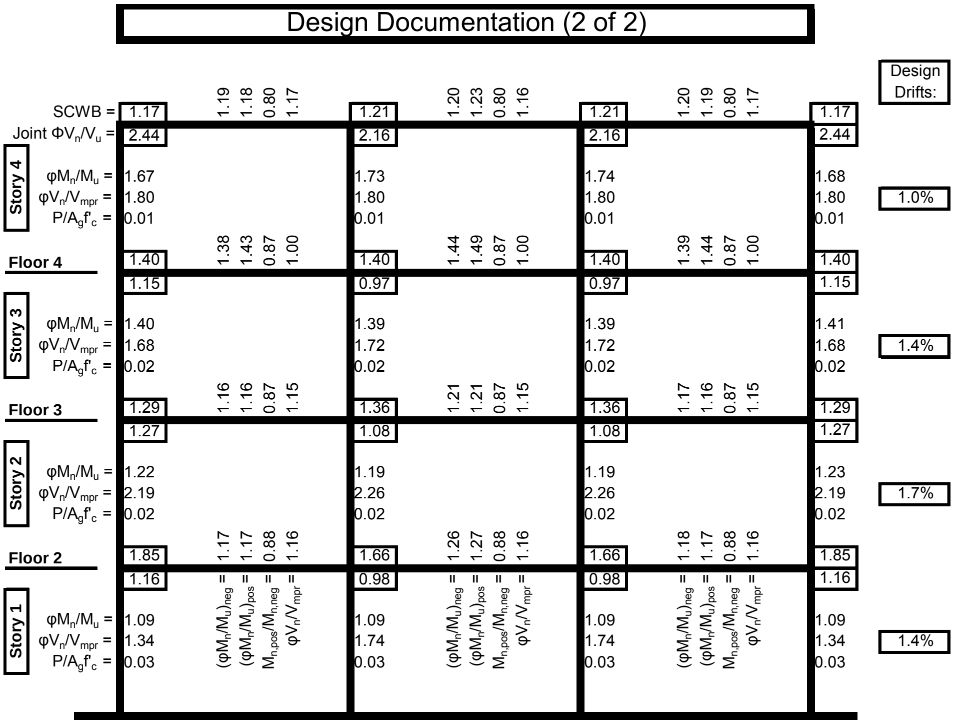
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1003
Number of Stories: 4
Fundamental Period (sec): 1.12

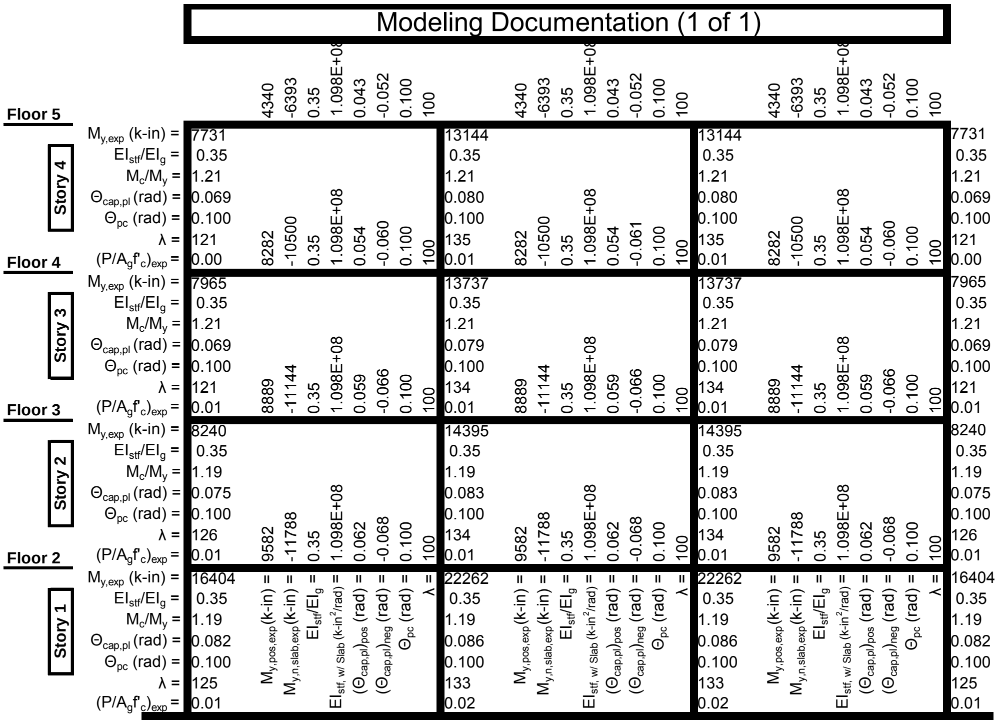
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined mostly by joint shear and minimum size requirements, in addition to column-beam compatibility considerations. The depth of the grade beams was increased to help alleviate joint shear concerns. Beam strengths were controlled by force demands, particularly lateral forces. Fourth floor beam strength was increased slightly to help reduce SCWB ratio at affected joints. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the first story, where flexural demands controlled. Concrete strength was increased to 7.0 ksi in the lower columns to help meet joint shear requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
24 32 0.0048 0.0060 0.0029 5.0
24 32 0.0048 0.0060 0.0029 5.0
24 32 0.0048 0.0060 0.0029 5.0
Story 4
h (in) = 30 | 38 | 38 | 30
b (in) = 32 | 32 | 32 | 32
ρ_{tot} = 0.0100 | 0.0100 | 0.0100 | 0.0100
ρ_{sh} = 0.0061 | 0.0080 | 0.0080 | 0.0061
s (in) = 4.0 | 3.5 | 3.5 | 4.0
Floor 4
24 32 0.0093 0.0108 0.0039 5.0
24 32 0.0093 0.0108 0.0040 5.0
24 32 0.0093 0.0108 0.0039 5.0
Story 3
h (in) = 30 | 38 | 38 | 30
b (in) = 32 | 32 | 32 | 32
ρ_{tot} = 0.0100 | 0.0100 | 0.0100 | 0.0100
ρ_{sh} = 0.0061 | 0.0080 | 0.0080 | 0.0061
s (in) = 4.0 | 3.5 | 3.5 | 4.0
Floor 3
24 32 0.0100 0.0115 0.0048 5.0
24 32 0.0100 0.0115 0.0048 5.0
24 32 0.0100 0.0115 0.0048 5.0
Story 2
h (in) = 30 | 38 | 38 | 30
b (in) = 32 | 32 | 32 | 32
ρ_{tot} = 0.0100 | 0.0100 | 0.0100 | 0.0100
ρ_{sh} = 0.0085 | 0.0112 | 0.0112 | 0.0085
s (in) = 3.5 | 3.5 | 3.5 | 3.5
13 feet
Floor 2
24 32 0.0108 0.0123 0.0051 5.0
24 32 0.0108 0.0123 0.0051 5.0
24 32 0.0108 0.0123 0.0051 5.0
h (in) = b (in) = ρ = ρ' = ρ_{sh} = s (in) =
Story 1
h (in) = 30 | 38 | 38 | 30
b (in) = 32 | 32 | 32 | 32
ρ_{tot} = 0.0210 | 0.0160 | 0.0160 | 0.0210
ρ_{sh} = 0.0085 | 0.0112 | 0.0112 | 0.0085
s (in) = 3.5 | 3.5 | 3.5 | 3.5
15 feet
Grade beam column height (in) = 32
Basement column height (in) = 0
20 feet
Design base shear = 0.092 g, 386 k
f'c beams = 5.0 ksi
$f'_{c,cols,upper}$ = 5.0 ksi
$f_{y,rebar,nom.}$ = 60 ksi
$f'_{c,cols,lower}$ = 7.0 ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 1.17 | 1.21 | 1.21 | 1.17
1.19 1.18 0.80 1.17
1.20 1.23 0.80 1.16
1.20 1.19 0.80 1.17
Joint $\Phi V_n/V_u$ = 2.44 | 2.16 | 2.16 | 2.44
Story 4
$\varphi M_n/M_u$ = 1.67 | 1.73 | 1.74 | 1.68
$\varphi V_n/V_{mpr}$ = 1.80 | 1.80 | 1.80 | 1.80
$P/A_g f'_c$ = 0.01 | 0.01 | 0.01 | 0.01
1.0%
Floor 4
1.38 1.43 0.87 1.00
1.44 1.49 0.87 1.00
1.39 1.44 0.87 1.00
1.40 | 1.40 | 1.40 | 1.40
1.15 | 0.97 | 0.97 | 1.15
Story 3
$\varphi M_n/M_u$ = 1.40 | 1.39 | 1.39 | 1.41
$\varphi V_n/V_{mpr}$ = 1.68 | 1.72 | 1.72 | 1.68
$P/A_g f'_c$ = 0.02 | 0.02 | 0.02 | 0.02
1.4%
Floor 3
1.16 1.16 0.87 1.15
1.21 1.21 0.87 1.15
1.17 1.16 0.87 1.15
1.29 | 1.36 | 1.36 | 1.29
1.27 | 1.08 | 1.08 | 1.27
Story 2
$\varphi M_n/M_u$ = 1.22 | 1.19 | 1.19 | 1.23
$\varphi V_n/V_{mpr}$ = 2.19 | 2.26 | 2.26 | 2.19
$P/A_g f'_c$ = 0.02 | 0.02 | 0.02 | 0.02
1.7%
Floor 2
1.17 1.17 0.88 1.16
1.26 1.27 0.88 1.16
1.18 1.17 0.88 1.16
1.85 | 1.66 | 1.66 | 1.85
1.16 | 0.98 | 0.98 | 1.16
$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =
Story 1
$\varphi M_n/M_u$ = 1.09 | 1.09 | 1.09 | 1.09
$\varphi V_n/V_{mpr}$ = 1.34 | 1.74 | 1.74 | 1.34
$P/A_g f'_c$ = 0.03 | 0.03 | 0.03 | 0.03
1.4%



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 2.69

Model periods (sec): T_1 = 1.12 T_2= 0.33 T_3 = 0.17

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1004

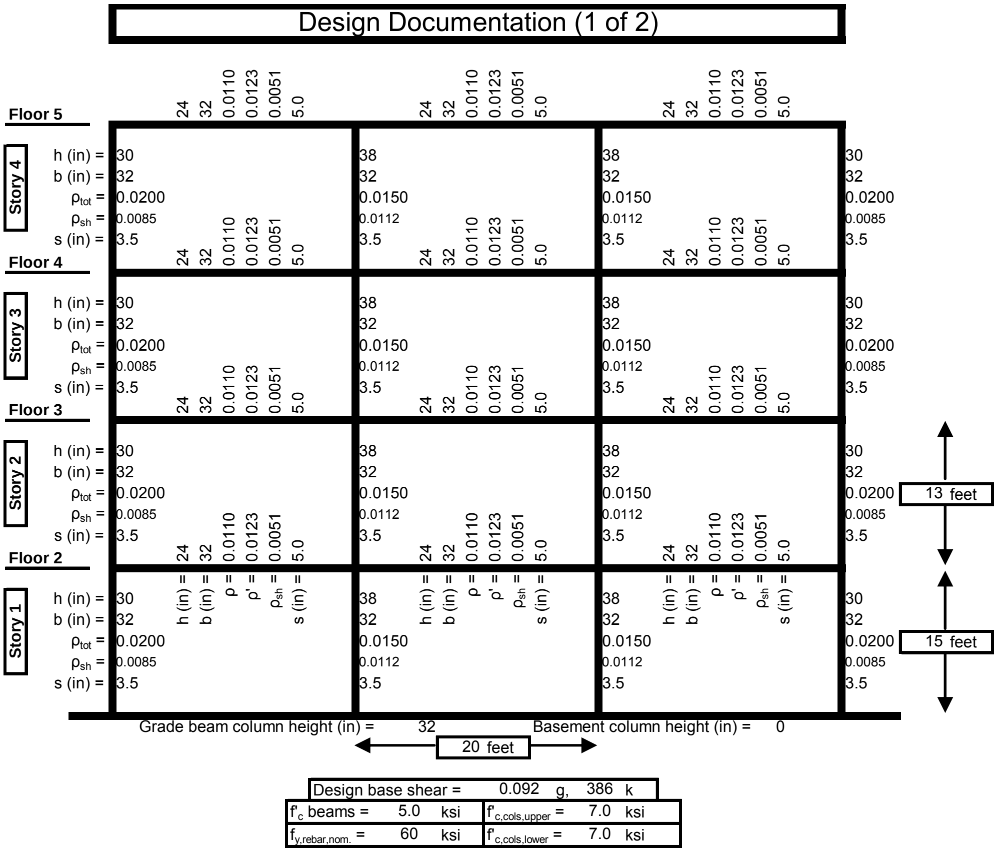
Number of Stories: 4

Fundamental Period (sec): 1.11

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

All floors designed according to ground floor requirements of index 1003. Column strengths re-adjusted to have both uniform reinforcement ratios and attempt to conform to SCWB requirements, which was difficult in a perimeter frame.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)

Joints and beams

Level		Column line 1	Bay 1	Column line 2	Bay 2	Column line 3	Bay 3	Column line 4
Roof	SCWB =	1.25		0.89		0.89		1.25
	Joint $\Phi V_n/V_u$ =	1.42		1.18		1.18		1.42
	$(\varphi M_n/M_u)_{neg}$ =		2.37		2.39		2.39	
	$(\varphi M_n/M_u)_{pos}$ =		2.66		2.77		2.68	
	$M_{n,pos}/M_{n,neg}$ =		0.90		0.90		0.90	
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15	
Floor 4	SCWB =	2.49		1.79		1.79		2.49
	Joint $\Phi V_n/V_u$ =	1.19		0.99		0.99		1.19
	$(\varphi M_n/M_u)_{neg}$ =		1.56		1.64		1.57	
	$(\varphi M_n/M_u)_{pos}$ =		1.69		1.76		1.70	
	$M_{n,pos}/M_{n,neg}$ =		0.90		0.90		0.90	
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15	
Floor 3	SCWB =	2.45		1.83		1.83		2.45
	Joint $\Phi V_n/V_u$ =	1.19		0.99		0.99		1.19
	$(\varphi M_n/M_u)_{neg}$ =		1.23		1.29		1.24	
	$(\varphi M_n/M_u)_{pos}$ =		1.28		1.34		1.28	
	$M_{n,pos}/M_{n,neg}$ =		0.90		0.90		0.90	
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15	
Floor 2	SCWB =	2.41		1.87		1.87		2.41
	Joint $\Phi V_n/V_u$ =	1.16		0.97		0.97		1.16
	$(\varphi M_n/M_u)_{neg}$ =		1.17		1.26		1.18	
	$(\varphi M_n/M_u)_{pos}$ =		1.19		1.30		1.20	
	$M_{n,pos}/M_{n,neg}$ =		0.90		0.90		0.90	
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15	

Columns

Story		Column line 1	Column line 2	Column line 3	Column line 4	Design Drifts:
Story 4	$\varphi M_n/M_u$ =	3.30	2.55	2.56	3.32	1.0%
	$\varphi V_n/V_{mpr}$ =	1.31	1.72	1.72	1.31	
	$P/A_gf'_c$ =	0.01	0.01	0.01	0.01	
Story 3	$\varphi M_n/M_u$ =	2.81	2.02	2.03	2.81	1.4%
	$\varphi V_n/V_{mpr}$ =	1.27	1.67	1.67	1.27	
	$P/A_gf'_c$ =	0.01	0.01	0.01	0.01	
Story 2	$\varphi M_n/M_u$ =	2.48	1.71	1.71	2.49	1.7%
	$\varphi V_n/V_{mpr}$ =	1.22	1.61	1.61	1.22	
	$P/A_gf'_c$ =	0.02	0.02	0.02	0.02	
Story 1	$\varphi M_n/M_u$ =	1.03	1.03	1.03	1.04	1.4%
	$\varphi V_n/V_{mpr}$ =	1.39	1.83	1.83	1.39	
	$P/A_gf'_c$ =	0.03	0.03	0.03	0.03	

Modeling Documentation (1 of 1)

Beams

Level		Bay 1	Bay 2	Bay 3
Floor 5	$M_{y,pos,exp}$ (k-in) =	9797	9797	9797
	$M_{y,n,slab,exp}$ (k-in) =	-11790	-11790	-11790
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.098E+08	1.098E+08	1.098E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.062	0.062	0.062
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$ (k-in) =	9797	9797	9797
	$M_{y,n,slab,exp}$ (k-in) =	-11790	-11790	-11790
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.098E+08	1.098E+08	1.098E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.062	0.062	0.062
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$ (k-in) =	9797	9797	9797
	$M_{y,n,slab,exp}$ (k-in) =	-11790	-11790	-11790
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.098E+08	1.098E+08	1.098E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.062	0.062	0.062
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 2	$M_{y,pos,exp}$ (k-in) =	9797	9797	9797
	$M_{y,n,slab,exp}$ (k-in) =	-11790	-11790	-11790
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.098E+08	1.098E+08	1.098E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.062	0.062	0.062
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100

Columns

Story		Column line 1	Column line 2	Column line 3	Column line 4
Story 4	$M_{y,exp}$ (k-in) =	15010	19305	19305	15010
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.088	0.088	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	127	135	135	127
	$(P/A_gf'_c)_{exp}$ =	0.00	0.00	0.00	0.00
Story 3	$M_{y,exp}$ (k-in) =	15237	19891	19891	15237
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.087	0.087	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	126	134	134	126
	$(P/A_gf'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 2	$M_{y,exp}$ (k-in) =	15462	20473	20473	15462
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.081	0.086	0.086	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	126	134	134	126
	$(P/A_gf'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 1	$M_{y,exp}$ (k-in) =	15687	21052	21052	15687
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.081	0.086	0.086	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	125	133	133	125
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 2.69

Model periods (sec): T_1 = 1.11 T_2 = 0.33 T_3 = 0.17

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

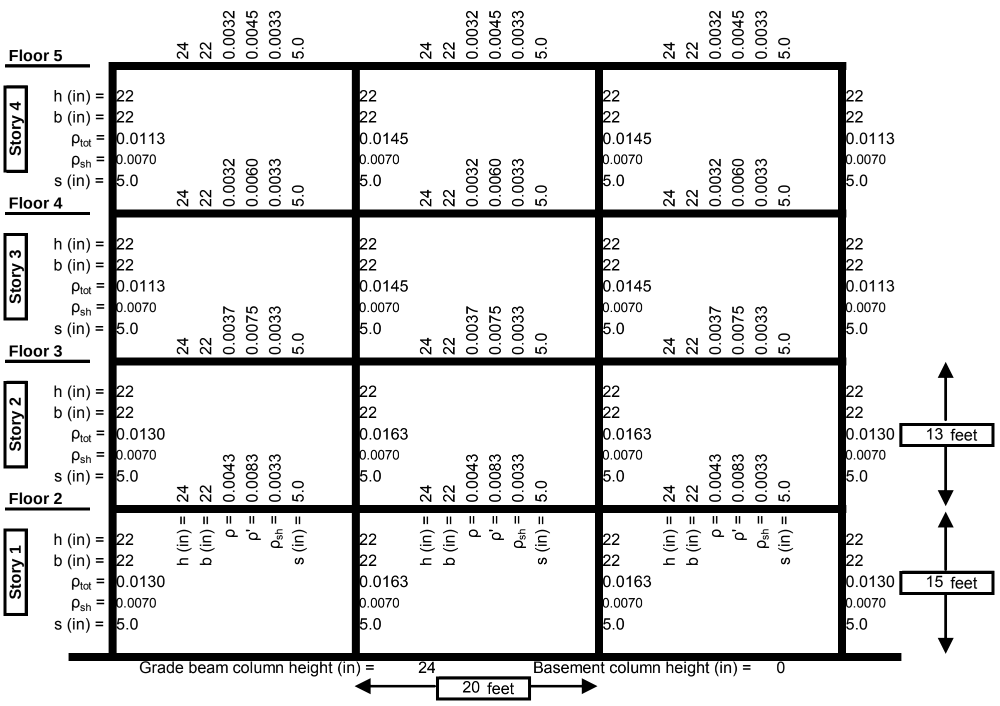
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1008
Number of Stories: 4
Fundamental Period (sec): 0.94

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined mostly by minimum size requirements and column-beam compatibility. Joint shear requirements dictated beam depths. The beams' negative strengths were controlled by force demands, particularly lateral forces, while their positive strengths were dictated by the minimum positive to negative strength ratio. Column strengths were determined by strong-column weak-beam (SCWB) ratios.   Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

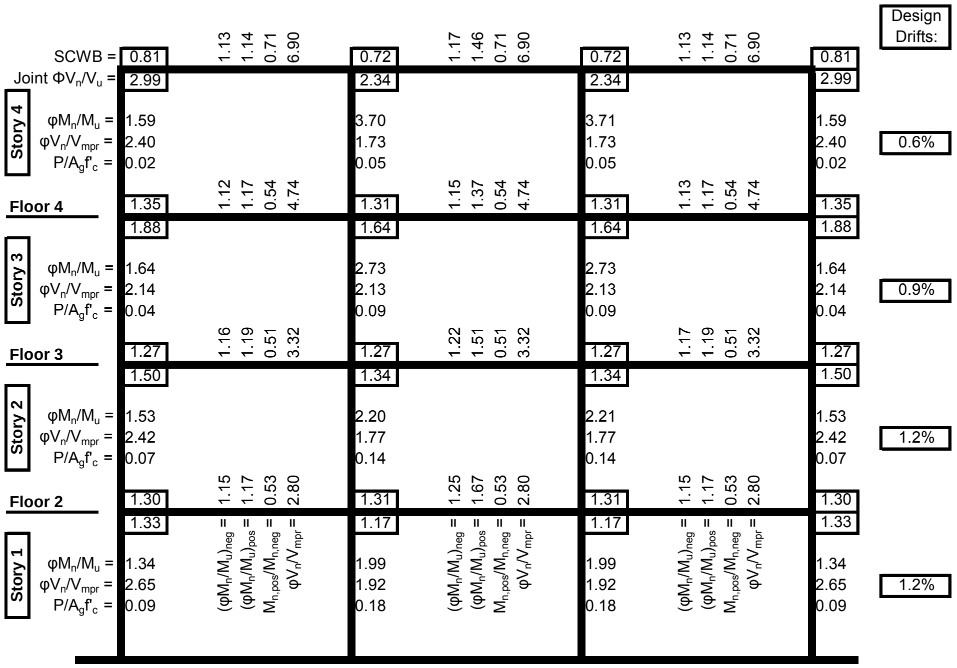
DESIGN AND MODELING DOCUMENTATION FIGURES

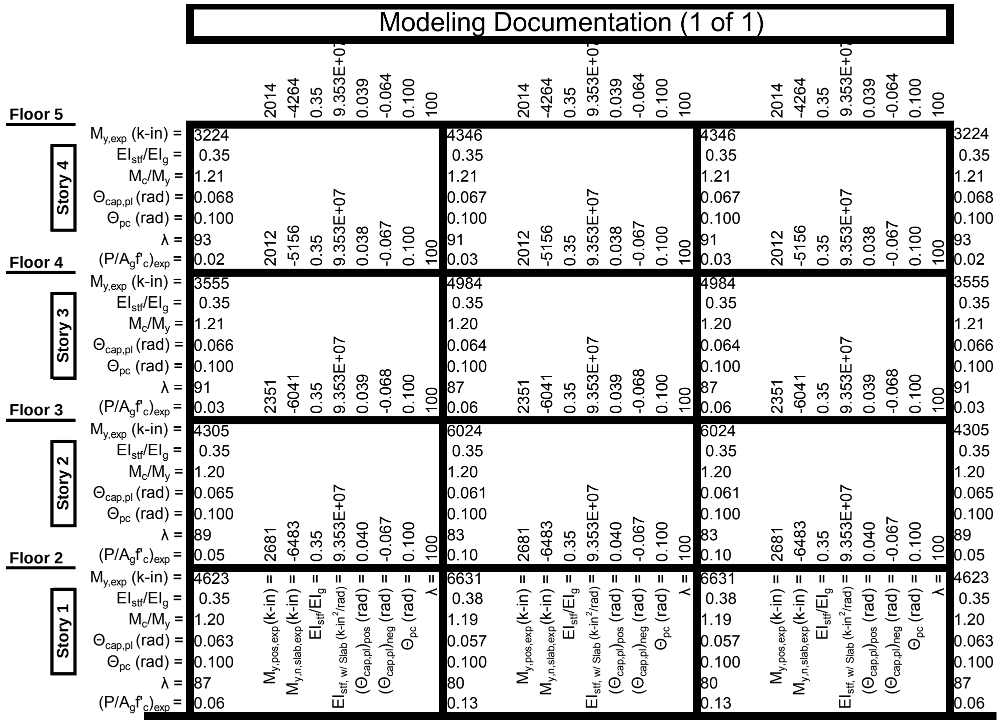
Design Documentation (1 of 2)



Design base shear =	0.092 g,	86 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	5.0 ksi

Design Documentation (2 of 2)





Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.94 T_2 = 0.30 T_3 = 0.17

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1009

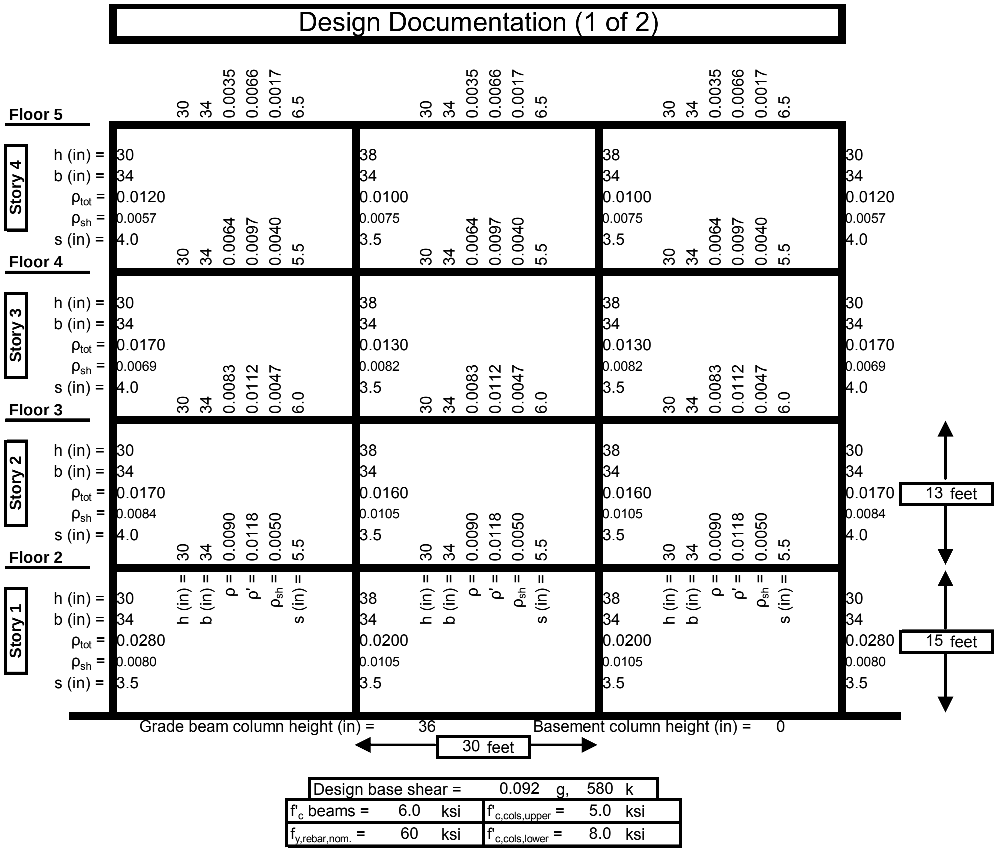
Number of Stories: 4

Fundamental Period (sec): 1.16

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined mostly by joint shear requirements, in addition to column-beam compatibility considerations. The depth of the grade beams was increased to help alleviate joint shear concerns. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the first story, where flexural demands controlled. Concrete strength was increased to 8.0 ksi in the lower columns to meet joint shear requirements. As a result, beam concrete strength was increased to 6.0 ksi to facilitate placement at joints by the contractor. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)

	Column line 1	Bay 1	Column line 2	Bay 2	Column line 3	Bay 3	Column line 4	Design Drifts:
		1.18 1.17 0.55 -2.29		1.21 1.31 0.55 -2.29		1.18 1.19 0.55 -2.29		
SCWB =	0.78		0.79		0.79		0.78	
Joint $\Phi V_n/V_u$ =	2.04		2.11		2.11		2.04	
Story 4								
$\varphi M_n/M_u$ =	1.36		1.42		1.42		1.37	
$\varphi V_n/V_{mpr}$ =	1.32		1.51		1.51		1.32	1.0%
$P/A_gf'_c$ =	0.01		0.02		0.02		0.01	
		1.18 1.20 0.67 1.15		1.20 1.26 0.67 1.16		1.19 1.21 0.67 1.15		
Floor 4	1.35		1.23		1.23		1.35	
	1.07		1.02		1.02		1.07	
Story 3								
$\varphi M_n/M_u$ =	1.77		1.48		1.48		1.77	
$\varphi V_n/V_{mpr}$ =	1.09		1.23		1.23		1.09	1.5%
$P/A_gf'_c$ =	0.03		0.04		0.04		0.03	
		1.08 1.09 0.75 1.21		1.10 1.15 0.75 1.21		1.08 1.10 0.75 1.21		
Floor 3	1.38		1.33		1.33		1.38	
	1.18		1.07		1.07		1.18	
Story 2								
$\varphi M_n/M_u$ =	1.35		1.40		1.40		1.35	
$\varphi V_n/V_{mpr}$ =	1.23		1.23		1.23		1.23	1.8%
$P/A_gf'_c$ =	0.03		0.04		0.04		0.03	
		1.05 1.05 0.77 1.23		1.09 1.16 0.77 1.24		1.06 1.06 0.77 1.23		
Floor 2	1.72		1.58		1.58		1.73	
	1.08		0.97		0.97		1.08	
Story 1		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		
$\varphi M_n/M_u$ =	1.11		1.09		1.09		1.12	
$\varphi V_n/V_{mpr}$ =	0.89		1.16		1.16		0.89	1.6%
$P/A_gf'_c$ =	0.04		0.05		0.05		0.04	

Modeling Documentation (1 of 1)

	Column line 1	Bay 1	Column line 2	Bay 2	Column line 3	Bay 3	Column line 4
Floor 5		5703 -12303 0.35 2.977E+08 0.028 -0.040 0.063 99		5703 -12303 0.35 2.977E+08 0.028 -0.040 0.063 99		5703 -12303 0.35 2.977E+08 0.028 -0.040 0.063 99	
Story 4							
$M_{y,exp}$ (k-in) =	10031		14669		14669		10031
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.21		1.21		1.21		1.21
$\Theta_{cap,pl}$ (rad) =	0.068		0.076		0.076		0.068
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	121		134		134		121
$(P/A_gf'_c)_{exp}$ =	0.01		0.01		0.01		0.01
Floor 4		10165 -17013 0.35 2.977E+08 0.045 -0.058 0.100 108		10165 -17013 0.35 2.977E+08 0.046 -0.058 0.100 108		10165 -17013 0.35 2.977E+08 0.045 -0.058 0.100 108	
Story 3							
$M_{y,exp}$ (k-in) =	14364		19841		19841		14364
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.21		1.21		1.21		1.21
$\Theta_{cap,pl}$ (rad) =	0.075		0.079		0.079		0.075
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	119		131		131		119
$(P/A_gf'_c)_{exp}$ =	0.02		0.03		0.03		0.02
Floor 3		13020 -19294 0.35 2.977E+08 0.049 -0.059 0.100 103		13020 -19294 0.35 2.977E+08 0.049 -0.059 0.100 103		13020 -19294 0.35 2.977E+08 0.049 -0.059 0.100 103	
Story 2							
$M_{y,exp}$ (k-in) =	14974		25132		25132		14974
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.18		1.18		1.18		1.18
$\Theta_{cap,pl}$ (rad) =	0.071		0.079		0.079		0.071
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	120		132		132		120
$(P/A_gf'_c)_{exp}$ =	0.02		0.03		0.03		0.02
Floor 2		14095 -20130 0.35 2.977E+08 0.053 -0.063 0.100 108		14095 -20130 0.35 2.977E+08 0.054 -0.063 0.100 108		14095 -20130 0.35 2.977E+08 0.053 -0.063 0.100 108	
Story 1		$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =		$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =		$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	
$M_{y,exp}$ (k-in) =	23835		31524		31524		23835
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.18		1.18		1.18		1.18
$\Theta_{cap,pl}$ (rad) =	0.079		0.080		0.080		0.079
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	124		130		130		124
$(P/A_gf'_c)_{exp}$ =	0.02		0.03		0.03		0.02

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 4.03

Model periods (sec): T_1 = 1.16 T_2 = 0.35 T_3 = 0.18

$f_{y,rebar,expected}$ = 67 ksi

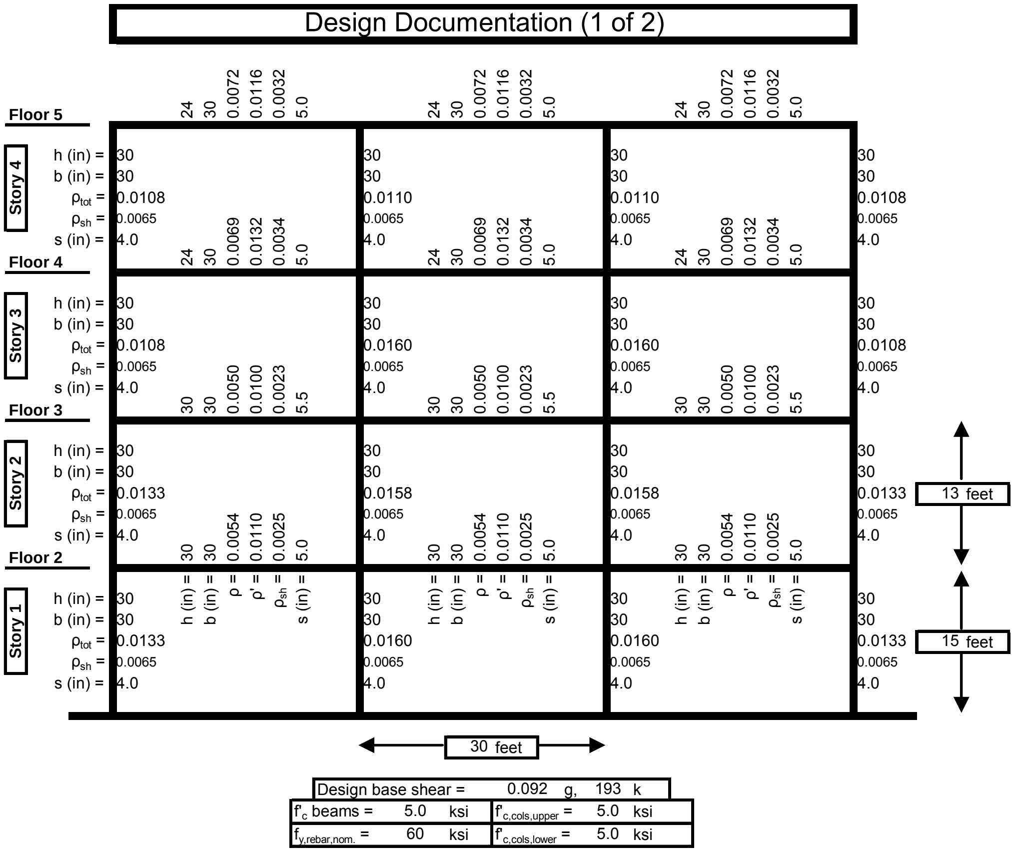
STRUCTURAL DESIGN AND MODELING SUMMARY

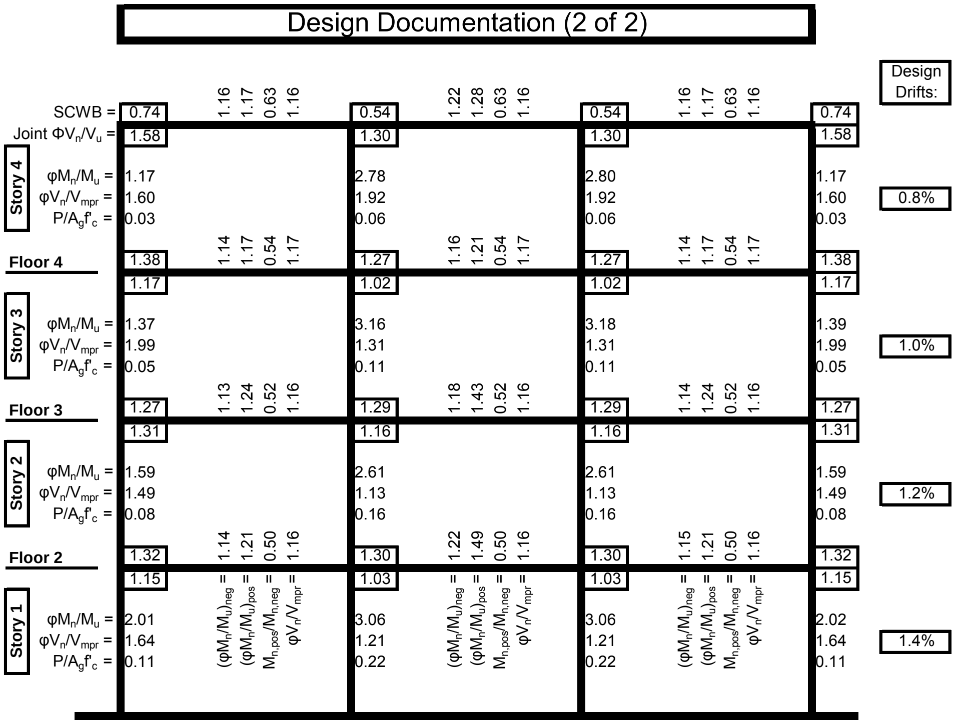
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1010
Number of Stories: 4
Fundamental Period (sec): 0.86

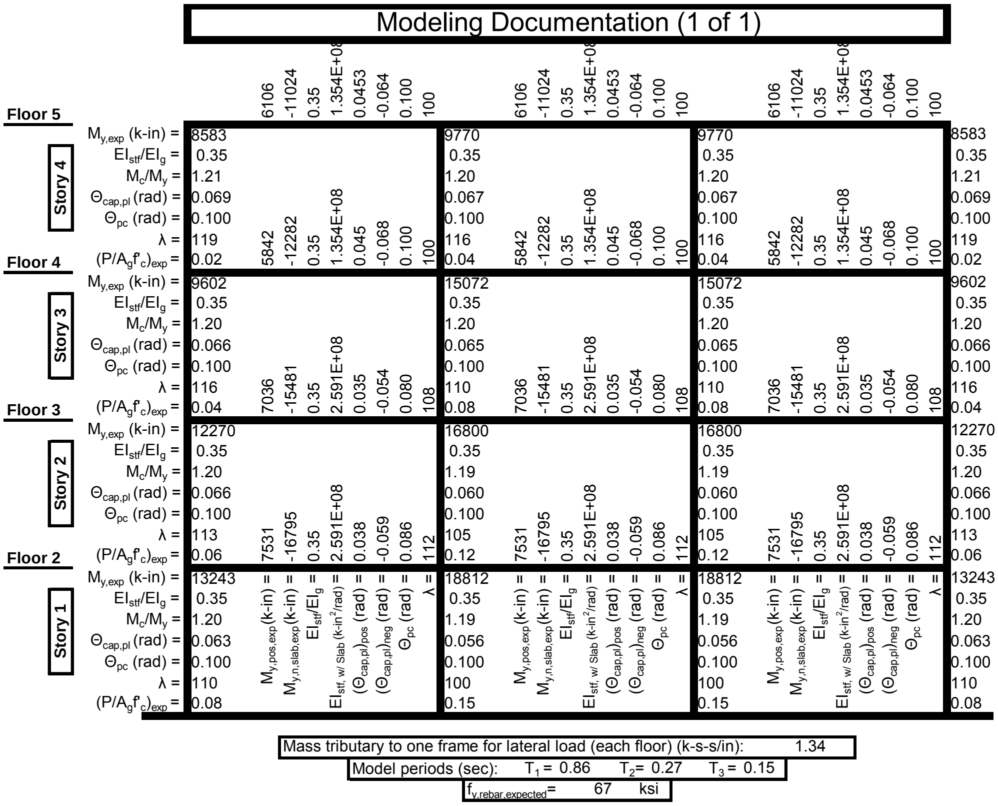
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
24 30 0.0072 0.0116 0.0032 5.0
Story 4
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρtot = 0.0108 | 0.0110 | 0.0110 | 0.0108
ρsh = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 4
24 30 0.0069 0.0132 0.0034 5.0
Story 3
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρtot = 0.0108 | 0.0160 | 0.0160 | 0.0108
ρsh = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 3
30 30 0.0050 0.0100 0.0023 5.5
Story 2
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρtot = 0.0133 | 0.0158 | 0.0158 | 0.0133
ρsh = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
13 feet
Floor 2
30 30 0.0054 0.0110 0.0025 5.0
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρtot = 0.0133 | 0.0160 | 0.0160 | 0.0133
ρsh = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
15 feet
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi


Design Documentation (2 of 2)
Design Drifts:
1.16 1.17 0.63 1.16 | 1.22 1.28 0.63 1.16 | 1.16 1.17 0.63 1.16
SCWB = 0.74 | 0.54 | 0.54 | 0.74
Joint ΦVn/Vu = 1.58 | 1.30 | 1.30 | 1.58
Story 4
φMn/Mu = 1.17 | 2.78 | 2.80 | 1.17
φVn/Vmpr = 1.60 | 1.92 | 1.92 | 1.60
P/Agf'c = 0.03 | 0.06 | 0.06 | 0.03
0.8%
1.14 1.17 0.54 1.17 | 1.16 1.21 0.54 1.17 | 1.14 1.17 0.54 1.17
Floor 4
1.38 | 1.27 | 1.27 | 1.38
1.17 | 1.02 | 1.02 | 1.17
Story 3
φMn/Mu = 1.37 | 3.16 | 3.18 | 1.39
φVn/Vmpr = 1.99 | 1.31 | 1.31 | 1.99
P/Agf'c = 0.05 | 0.11 | 0.11 | 0.05
1.0%
1.13 1.24 0.52 1.16 | 1.18 1.43 0.52 1.16 | 1.14 1.24 0.52 1.16
Floor 3
1.27 | 1.29 | 1.29 | 1.27
1.31 | 1.16 | 1.16 | 1.31
Story 2
φMn/Mu = 1.59 | 2.61 | 2.61 | 1.59
φVn/Vmpr = 1.49 | 1.13 | 1.13 | 1.49
P/Agf'c = 0.08 | 0.16 | 0.16 | 0.08
1.2%
1.14 1.21 0.50 1.16 | 1.22 1.49 0.50 1.16 | 1.15 1.21 0.50 1.16
Floor 2
1.32 | 1.30 | 1.30 | 1.32
1.15 | 1.03 | 1.03 | 1.15
(φMn/Mu)neg = (φMn/Mu)pos = Mn,pos/Mn,neg = φVn/Vmpr =
Story 1
φMn/Mu = 2.01 | 3.06 | 3.06 | 2.02
φVn/Vmpr = 1.64 | 1.21 | 1.21 | 1.64
P/Agf'c = 0.11 | 0.22 | 0.22 | 0.11
1.4%



STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 1011

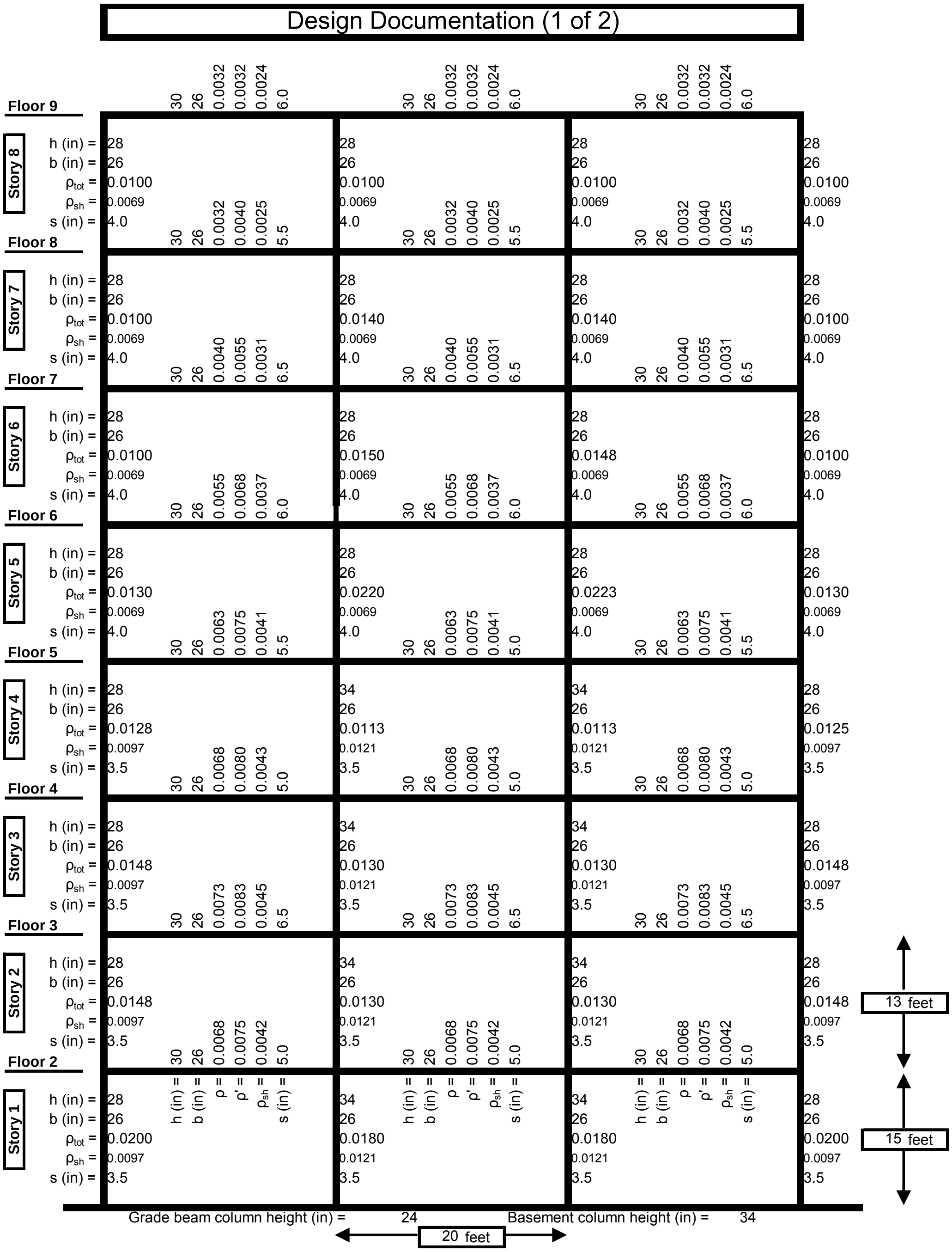
Number of Stories: 8

Fundamental Period (sec): 1.71

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

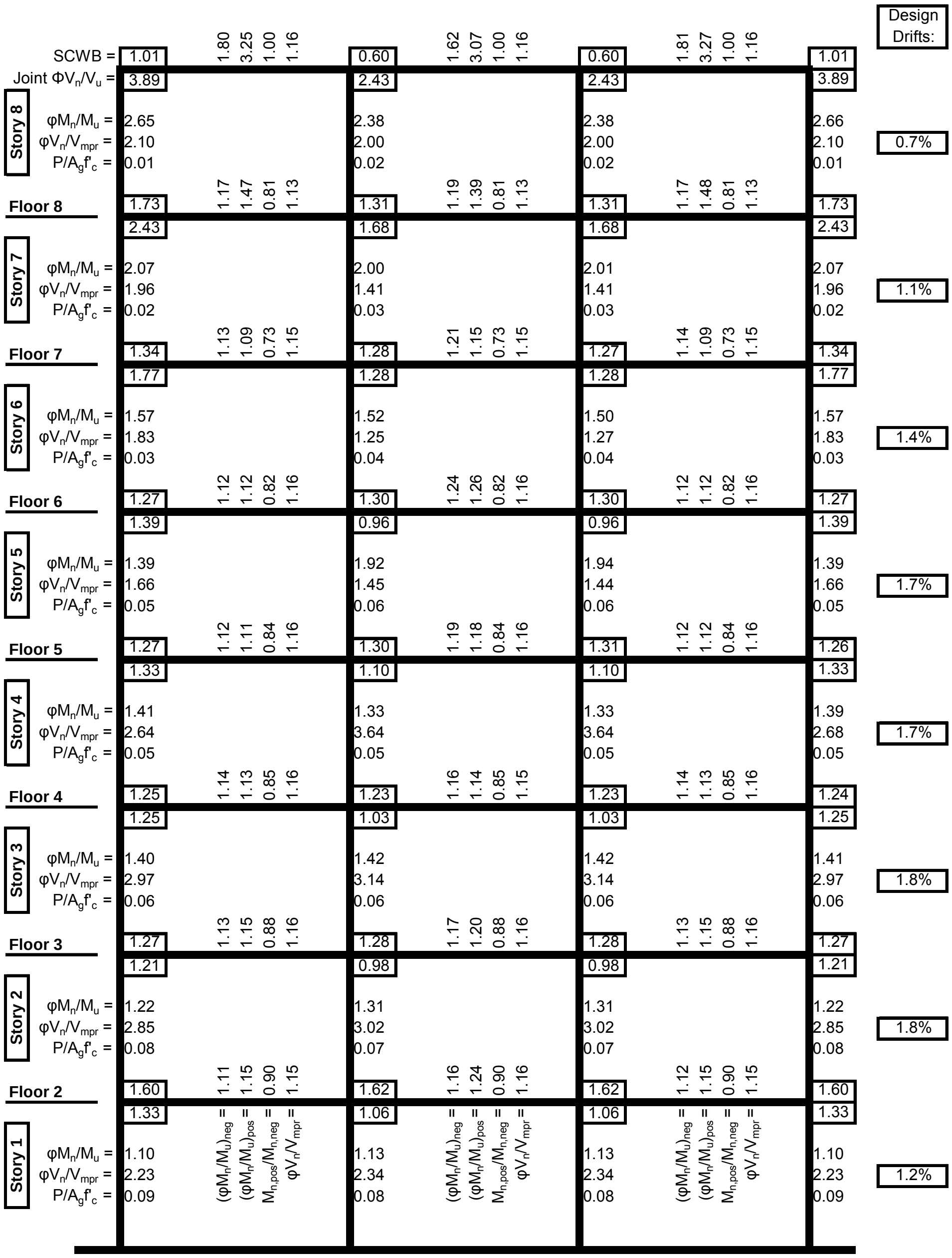
Initial member sizes (beam depths, column dimensions) were determined by joint shear requirements, particularly in the lower stories. Negative beam strengths were controlled by force demands, especially lateral forces, while positive beam strengths were dictated by the minimum positive-to-negative strength ratio. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the bottom floor columns, where strength was determined by flexural demand. Column concrete was stepped up to 6.0 ksi in the lower floors to meet joint shear requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	0.050 g,	281 k	
f'_c beams = 5.0 ksi		$f'_{c,cols,upper}$ = 5.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 6.0 ksi	

Design Documentation (2 of 2)



		1.80 3.25 1.00 1.16		1.62 3.07 1.00 1.16		1.81 3.27 1.00 1.16		Design Drifts:
SCWB =	1.01		0.60		0.60		1.01	
Joint $\Phi V_n/V_u$ =	3.89		2.43		2.43		3.89	
Story 8 $\varphi M_n/M_u$ =	2.65		2.38		2.38		2.66	
$\varphi V_n/V_{mpr}$ =	2.10		2.00		2.00		2.10	0.7%
$P/A_g f'_c$ =	0.01		0.02		0.02		0.01	
		1.17 1.47 0.81 1.13		1.19 1.39 0.81 1.13		1.17 1.48 0.81 1.13		
Floor 8	1.73		1.31		1.31		1.73	
	2.43		1.68		1.68		2.43	
Story 7 $\varphi M_n/M_u$ =	2.07		2.00		2.01		2.07	
$\varphi V_n/V_{mpr}$ =	1.96		1.41		1.41		1.96	1.1%
$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
		1.13 1.09 0.73 1.15		1.21 1.15 0.73 1.15		1.14 1.09 0.73 1.15		
Floor 7	1.34		1.28		1.27		1.34	
	1.77		1.28		1.28		1.77	
Story 6 $\varphi M_n/M_u$ =	1.57		1.52		1.50		1.57	
$\varphi V_n/V_{mpr}$ =	1.83		1.25		1.27		1.83	1.4%
$P/A_g f'_c$ =	0.03		0.04		0.04		0.03	
		1.12 1.12 0.82 1.16		1.24 1.26 0.82 1.16		1.12 1.12 0.82 1.16		
Floor 6	1.27		1.30		1.30		1.27	
	1.39		0.96		0.96		1.39	
Story 5 $\varphi M_n/M_u$ =	1.39		1.92		1.94		1.39	
$\varphi V_n/V_{mpr}$ =	1.66		1.45		1.44		1.66	1.7%
$P/A_g f'_c$ =	0.05		0.06		0.06		0.05	
		1.12 1.11 0.84 1.16		1.19 1.18 0.84 1.16		1.12 1.12 0.84 1.16		
Floor 5	1.27		1.30		1.31		1.26	
	1.33		1.10		1.10		1.33	
Story 4 $\varphi M_n/M_u$ =	1.41		1.33		1.33		1.39	
$\varphi V_n/V_{mpr}$ =	2.64		3.64		3.64		2.68	1.7%
$P/A_g f'_c$ =	0.05		0.05		0.05		0.05	
		1.14 1.13 0.85 1.16		1.16 1.14 0.85 1.15		1.14 1.13 0.85 1.16		
Floor 4	1.25		1.23		1.23		1.24	
	1.25		1.03		1.03		1.25	
Story 3 $\varphi M_n/M_u$ =	1.40		1.42		1.42		1.41	
$\varphi V_n/V_{mpr}$ =	2.97		3.14		3.14		2.97	1.8%
$P/A_g f'_c$ =	0.06		0.06		0.06		0.06	
		1.13 1.15 0.88 1.16		1.17 1.20 0.88 1.16		1.13 1.15 0.88 1.16		
Floor 3	1.27		1.28		1.28		1.27	
	1.21		0.98		0.98		1.21	
Story 2 $\varphi M_n/M_u$ =	1.22		1.31		1.31		1.22	
$\varphi V_n/V_{mpr}$ =	2.85		3.02		3.02		2.85	1.8%
$P/A_g f'_c$ =	0.08		0.07		0.07		0.08	
		1.11 1.15 0.90 1.15		1.16 1.24 0.90 1.16		1.12 1.15 0.90 1.15		
Floor 2	1.60		1.62		1.62		1.60	
	1.33		1.06		1.06		1.33	
		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		
Story 1 $\varphi M_n/M_u$ =	1.10		1.13		1.13		1.10	
$\varphi V_n/V_{mpr}$ =	2.23		2.34		2.34		2.23	1.2%
$P/A_g f'_c$ =	0.09		0.08		0.08		0.09	

Modeling Documentation (1 of 1)

Story 8	$M_{y,exp}$ (k-in) =	5449	5666	5666	5449
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.072	0.071	0.071	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	118	117	117	118
	$(P/A_g f'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 7	$M_{y,exp}$ (k-in) =	5666	8101	8101	5666
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.071	0.072	0.072	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	117	116	116	117
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 6	$M_{y,exp}$ (k-in) =	5882	9017	8892	5882
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.071	0.071	0.071	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	116	114	114	116
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 5	$M_{y,exp}$ (k-in) =	7601	12897	13021	7601
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.072	0.074	0.074	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	116	113	113	116
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 4	$M_{y,exp}$ (k-in) =	7732	11646	11646	7606
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.081	0.086	0.086	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	121	126	126	121
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 3	$M_{y,exp}$ (k-in) =	8945	13499	13499	8945
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.082	0.086	0.086	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	125	125	120
	$(P/A_g f'_c)_{exp}$ =	0.03	0.04	0.04	0.03
Story 2	$M_{y,exp}$ (k-in) =	9154	14003	14003	9154
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.081	0.085	0.085	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	124	124	119
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 1	$M_{y,exp}$ (k-in) =	11974	18322	18322	11974
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.084	0.087	0.087	0.084
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	122	122	119
	$(P/A_g f'_c)_{exp}$ =	0.04	0.06	0.06	0.04

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	3994	-5268	0.35	1.918E+08	0.0372	-0.042	0.086	103
	3994	-5268	0.35	1.918E+08	0.0372	-0.042	0.086	103
	3994	-5268	0.35	1.918E+08	0.0372	-0.042	0.086	103
Floor 8	3993	-6166	0.35	1.918E+08	0.038	-0.047	0.089	108
	3993	-6166	0.35	1.918E+08	0.038	-0.047	0.089	108
	3993	-6166	0.35	1.918E+08	0.038	-0.047	0.089	108
Floor 7	4903	-7927	0.35	1.918E+08	0.038	-0.048	0.100	99
	4903	-7927	0.35	1.918E+08	0.038	-0.048	0.100	99
	4903	-7927	0.35	1.918E+08	0.038	-0.048	0.100	99
Floor 6	6686	-9391	0.35	1.918E+08	0.045	-0.053	0.100	103
	6686	-9391	0.35	1.918E+08	0.045	-0.053	0.100	103
	6686	-9391	0.35	1.918E+08	0.045	-0.053	0.100	103
Floor 5	7572	-10266	0.35	1.918E+08	0.049	-0.057	0.100	108
	7572	-10266	0.35	1.918E+08	0.052	-0.059	0.100	112
	7572	-10266	0.35	1.918E+08	0.049	-0.057	0.100	108
Floor 4	8162	-10849	0.35	1.918E+08	0.053	-0.061	0.100	112
	8162	-10849	0.35	1.918E+08	0.053	-0.061	0.100	112
	8162	-10849	0.35	1.918E+08	0.053	-0.061	0.100	112
Floor 3	8749	-11143	0.35	1.918E+08	0.049	-0.054	0.100	99
	8749	-11143	0.35	1.918E+08	0.0488	-0.055	0.100	99
	8749	-11143	0.35	1.918E+08	0.0486	-0.054	0.100	99
Floor 2	8159	-10271	0.35	1.918E+08	0.053	-0.059	0.100	112
	8159	-10271	0.35	1.918E+08	0.053	-0.059	0.100	112
	8159	-10271	0.35	1.918E+08	0.053	-0.059	0.100	112

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): $T_1 =$ 1.71 $T_2 =$ 0.57 $T_3 =$ 0.32

$f_{y,rebar,expected} =$ 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

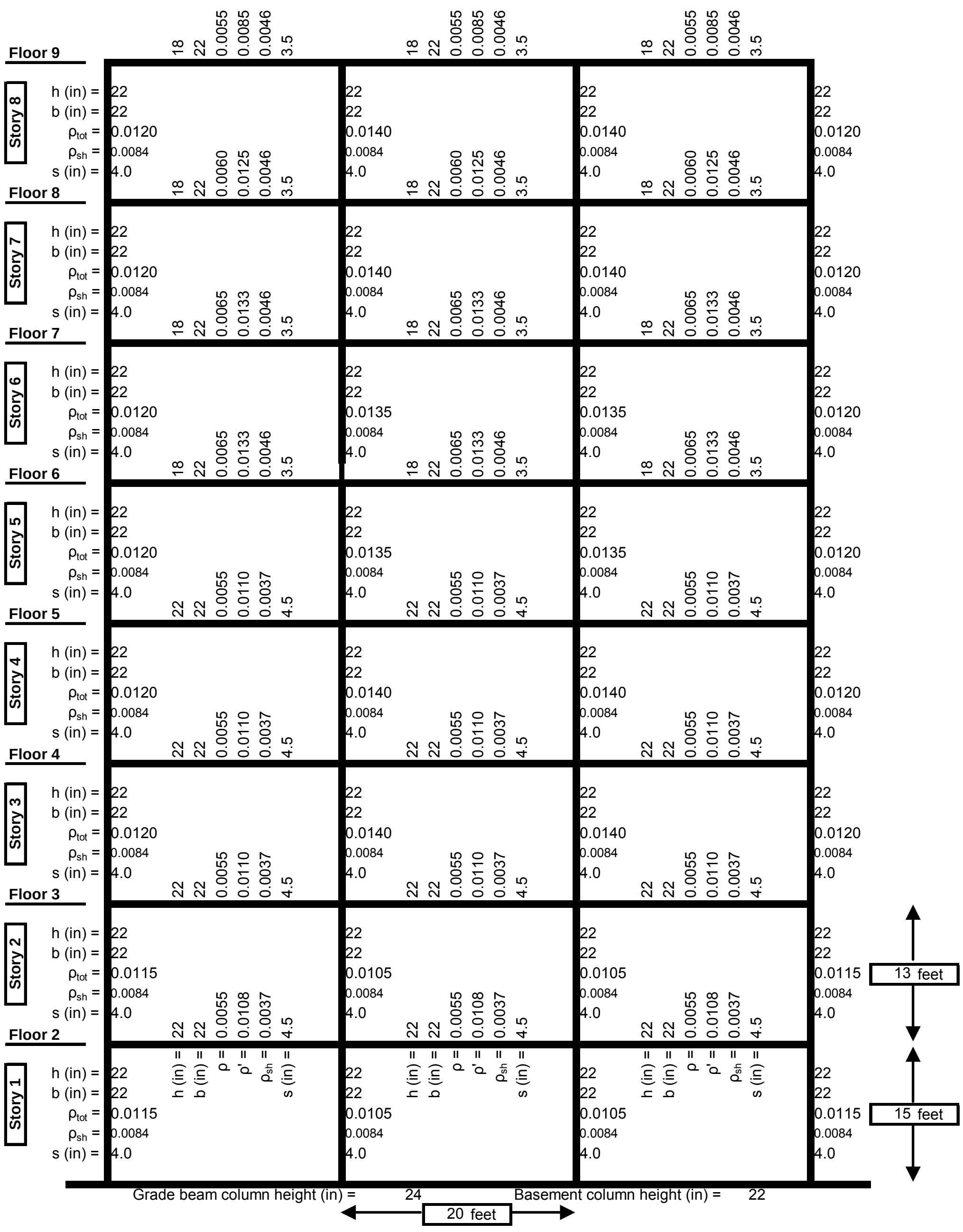
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1012
Number of Stories: 8
Fundamental Period (sec): 1.80

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Column concrete was stepped up to 6.0 ksi in all stories to meet joint shear requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

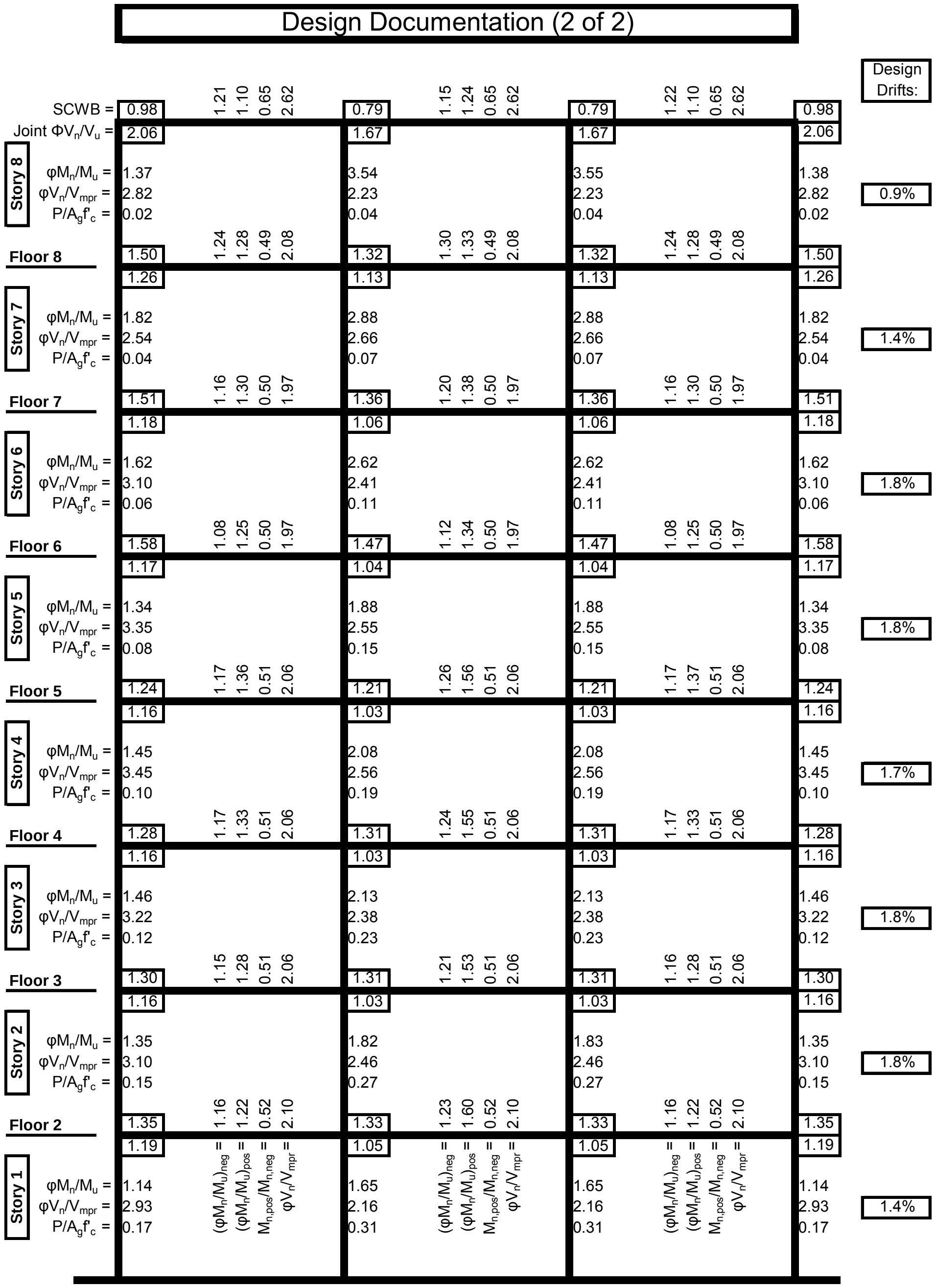
DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.050	g,	94	k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	6.0	ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.98 0.79 0.79 0.98
Joint $\Phi V_n/V_u$ = 2.06 1.67 1.67 2.06
1.21 1.10 0.65 2.62
1.15 1.24 0.65 2.62
1.22 1.10 0.65 2.62
Story 8
$\varphi M_n/M_u$ = 1.37 3.54 3.55 1.38
$\varphi V_n/V_{mpr}$ = 2.82 2.23 2.23 2.82
$P/A_g f'_c$ = 0.02 0.04 0.04 0.02
0.9%
1.24 1.28 0.49 2.08
1.30 1.33 0.49 2.08
1.24 1.28 0.49 2.08
Floor 8
1.50 1.32 1.32 1.50
1.26 1.13 1.13 1.26
Story 7
$\varphi M_n/M_u$ = 1.82 2.88 2.88 1.82
$\varphi V_n/V_{mpr}$ = 2.54 2.66 2.66 2.54
$P/A_g f'_c$ = 0.04 0.07 0.07 0.04
1.4%
1.16 1.30 0.50 1.97
1.20 1.38 0.50 1.97
1.16 1.30 0.50 1.97
Floor 7
1.51 1.36 1.36 1.51
1.18 1.06 1.06 1.18
Story 6
$\varphi M_n/M_u$ = 1.62 2.62 2.62 1.62
$\varphi V_n/V_{mpr}$ = 3.10 2.41 2.41 3.10
$P/A_g f'_c$ = 0.06 0.11 0.11 0.06
1.8%
1.08 1.25 0.50 1.97
1.12 1.34 0.50 1.97
1.08 1.25 0.50 1.97
Floor 6
1.58 1.47 1.47 1.58
1.17 1.04 1.04 1.17
Story 5
$\varphi M_n/M_u$ = 1.34 1.88 1.88 1.34
$\varphi V_n/V_{mpr}$ = 3.35 2.55 2.55 3.35
$P/A_g f'_c$ = 0.08 0.15 0.15 0.08
1.8%
1.17 1.36 0.51 2.06
1.26 1.56 0.51 2.06
1.17 1.37 0.51 2.06
Floor 5
1.24 1.21 1.21 1.24
1.16 1.03 1.03 1.16
Story 4
$\varphi M_n/M_u$ = 1.45 2.08 2.08 1.45
$\varphi V_n/V_{mpr}$ = 3.45 2.56 2.56 3.45
$P/A_g f'_c$ = 0.10 0.19 0.19 0.10
1.7%
1.17 1.33 0.51 2.06
1.24 1.55 0.51 2.06
1.17 1.33 0.51 2.06
Floor 4
1.28 1.31 1.31 1.28
1.16 1.03 1.03 1.16
Story 3
$\varphi M_n/M_u$ = 1.46 2.13 2.13 1.46
$\varphi V_n/V_{mpr}$ = 3.22 2.38 2.38 3.22
$P/A_g f'_c$ = 0.12 0.23 0.23 0.12
1.8%
1.15 1.28 0.51 2.06
1.21 1.53 0.51 2.06
1.16 1.28 0.51 2.06
Floor 3
1.30 1.31 1.31 1.30
1.16 1.03 1.03 1.16
Story 2
$\varphi M_n/M_u$ = 1.35 1.82 1.83 1.35
$\varphi V_n/V_{mpr}$ = 3.10 2.46 2.46 3.10
$P/A_g f'_c$ = 0.15 0.27 0.27 0.15
1.8%
1.16 1.22 0.52 2.10
1.23 1.60 0.52 2.10
1.16 1.22 0.52 2.10
Floor 2
1.35 1.33 1.33 1.35
1.19 1.05 1.05 1.19
Story 1
$\varphi M_n/M_u$ = 1.14 1.65 1.65 1.14
$\varphi V_n/V_{mpr}$ = 2.93 2.16 2.16 2.93
$P/A_g f'_c$ = 0.17 0.31 0.31 0.17
1.4%
$(\varphi M_n/M_u)_{neg}$ =
$(\varphi M_n/M_u)_{pos}$ =
$M_{n,pos}/M_{n,neg}$ =
$\varphi V_n/V_{mpr}$ =

Modeling Documentation (1 of 1)

		$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 8	1	3421	0.35	1.20	0.075	0.100	105	0.01
	2	4241	0.35	1.20	0.074	0.100	103	0.03
	3	4241	0.35	1.20	0.074	0.100	103	0.03
	4	3421	0.35	1.20	0.075	0.100	105	0.01
Story 7	1	3753	0.35	1.20	0.073	0.100	103	0.03
	2	4886	0.35	1.19	0.071	0.100	99	0.05
	3	4886	0.35	1.19	0.071	0.100	99	0.05
	4	3753	0.35	1.20	0.073	0.100	103	0.03
Story 6	1	4080	0.35	1.20	0.071	0.100	101	0.04
	2	5394	0.35	1.19	0.067	0.100	96	0.08
	3	5394	0.35	1.19	0.067	0.100	96	0.08
	4	4080	0.35	1.20	0.071	0.100	101	0.04
Story 5	1	4402	0.35	1.19	0.069	0.100	99	0.05
	2	6009	0.37	1.19	0.064	0.100	93	0.11
	3	6009	0.37	1.19	0.064	0.100	93	0.11
	4	4402	0.35	1.19	0.069	0.100	99	0.05
Story 4	1	4721	0.36	1.19	0.068	0.100	98	0.07
	2	6730	0.43	1.18	0.061	0.100	89	0.13
	3	6730	0.43	1.18	0.061	0.100	89	0.13
	4	4721	0.36	1.19	0.068	0.100	98	0.07
Story 3	1	5034	0.38	1.19	0.066	0.100	96	0.08
	2	7321	0.46	1.18	0.058	0.100	86	0.16
	3	7321	0.46	1.18	0.058	0.100	86	0.16
	4	5034	0.38	1.19	0.066	0.100	96	0.08
Story 2	1	5225	0.39	1.19	0.064	0.100	94	0.09
	2	7074	0.48	1.18	0.054	0.100	83	0.19
	3	7074	0.48	1.18	0.054	0.100	83	0.19
	4	5225	0.39	1.19	0.064	0.100	94	0.09
Story 1	1	5532	0.40	1.19	0.063	0.100	93	0.11
	2	7646	0.51	1.17	0.051	0.100	80	0.21
	3	7646	0.51	1.17	0.051	0.100	80	0.21
	4	5532	0.40	1.19	0.063	0.100	93	0.11

		$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	1	1770	-3664	0.35	3.765E+07	0.0542	-0.086	0.100	101
	2	1770	-3664	0.35	3.765E+07	0.0542	-0.086	0.100	101
	3	1770	-3664	0.35	3.765E+07	0.0542	-0.086	0.100	101
Floor 8	1	1920	-4856	0.35	3.765E+07	0.054	-0.092	0.100	101
	2	1920	-4856	0.35	3.765E+07	0.054	-0.092	0.100	101
	3	1920	-4856	0.35	3.765E+07	0.054	-0.092	0.100	101
Floor 7	1	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
	2	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
	3	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
Floor 6	1	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
	2	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
	3	2081	-5078	0.35	3.765E+07	0.056	-0.092	0.100	101
Floor 5	1	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
	2	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
	3	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
Floor 4	1	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
	2	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
	3	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
Floor 3	1	2819	-6744	0.35	7.178E+07	0.046	-0.075	0.100	100
	2	2819	-6744	0.35	7.178E+07	0.0455	-0.075	0.100	100
	3	2819	-6744	0.35	7.178E+07	0.0455	-0.075	0.100	100
Floor 2	1	2819	-6625	0.35	7.178E+07	0.046	-0.074	0.100	100
	2	2819	-6625	0.35	7.178E+07	0.046	-0.074	0.100	100
	3	2819	-6625	0.35	7.178E+07	0.046	-0.074	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.80 T_2 = 0.60 T_3 = 0.34

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

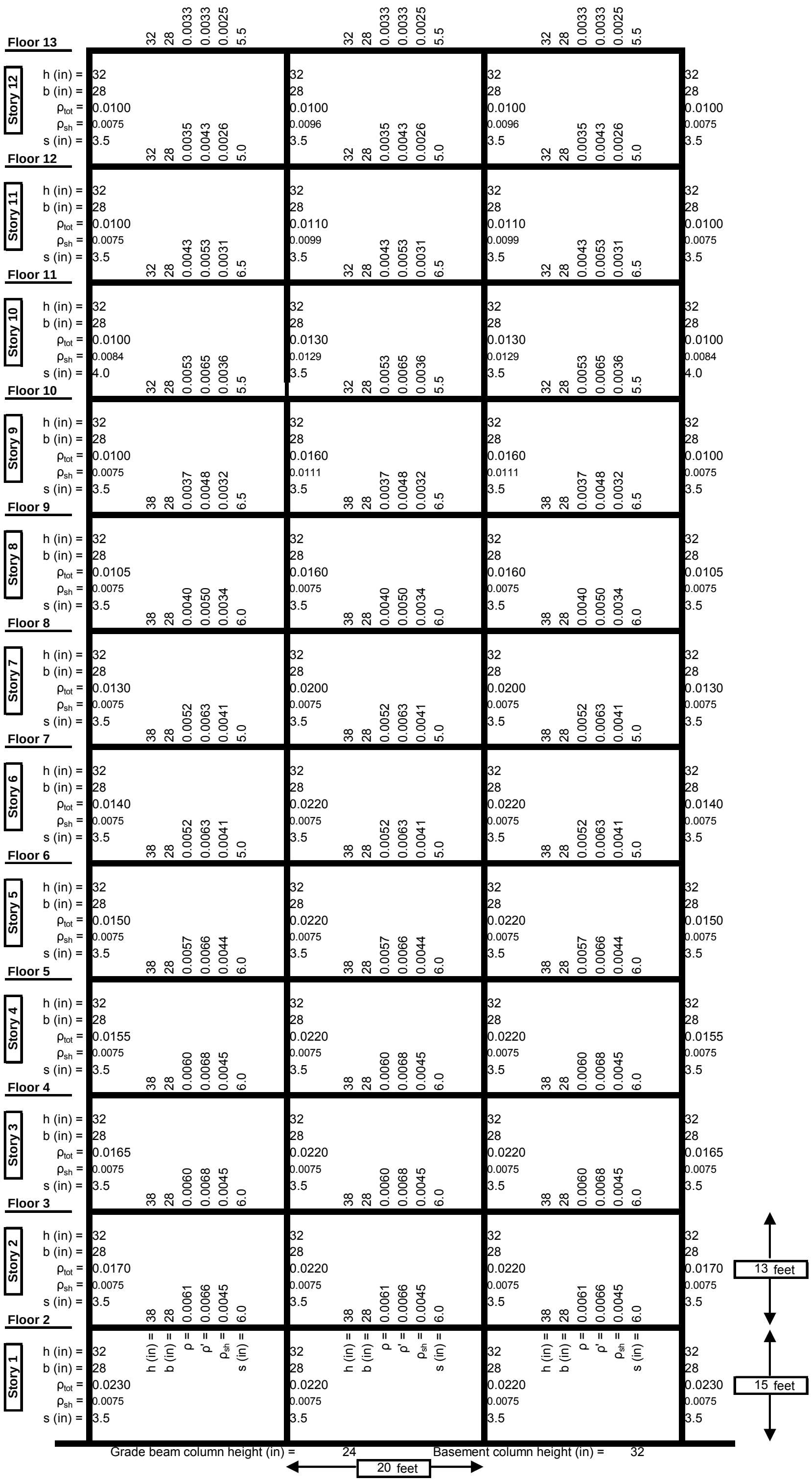
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1013
Number of Stories: 12
Fundamental Period (sec): 2.01

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by both drift limits and joint shear requirements. Negative beam strengths were controlled by force demands, particularly lateral forces, while positive beam strengths were determined by the minimum positive-to-negative strength ratio. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the lower story, where flexural demand controlled the design. Column concrete was stepped up to 7.0 ksi in the lower floors to meet joint shear requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



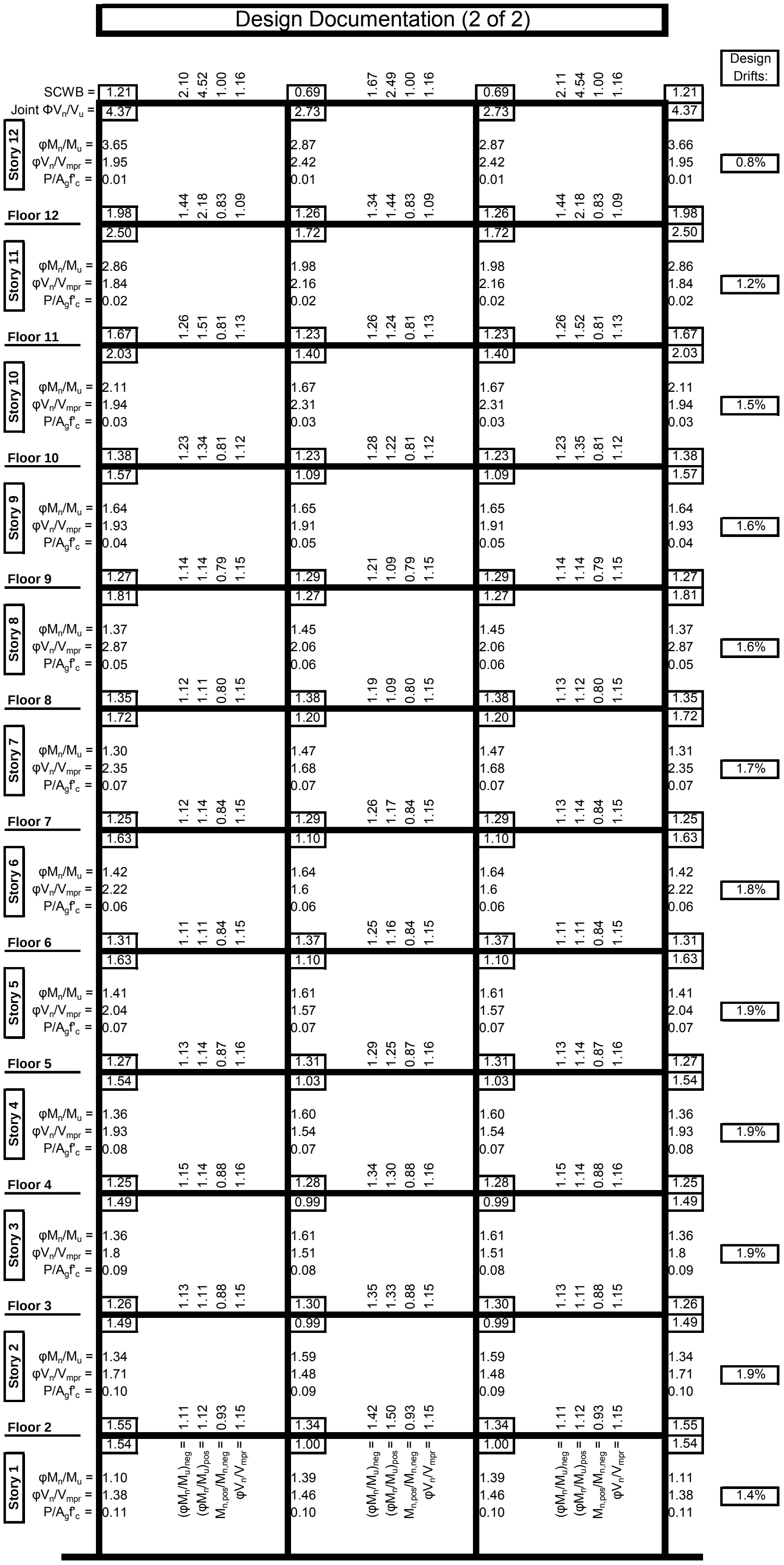
Story 12	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0100	0.0100	0.0100	0.0100
	ρ_{sh} =	0.0075	0.0096	0.0096	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 11	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0100	0.0110	0.0110	0.0100
	ρ_{sh} =	0.0075	0.0099	0.0099	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 10	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0100	0.0130	0.0130	0.0100
	ρ_{sh} =	0.0084	0.0129	0.0129	0.0084
	s (in) =	4.0	3.5	3.5	4.0
Story 9	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0100	0.0160	0.0160	0.0100
	ρ_{sh} =	0.0075	0.0111	0.0111	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 8	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0105	0.0160	0.0160	0.0105
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 7	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0130	0.0200	0.0200	0.0130
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 6	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0140	0.0220	0.0220	0.0140
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 5	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0150	0.0220	0.0220	0.0150
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 4	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0155	0.0220	0.0220	0.0155
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 3	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0165	0.0220	0.0220	0.0165
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 2	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0170	0.0220	0.0220	0.0170
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5
Story 1	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.0230	0.0220	0.0220	0.0230
	ρ_{sh} =	0.0075	0.0075	0.0075	0.0075
	s (in) =	3.5	3.5	3.5	3.5

Floor 13	h (in) =	32	32	32
	b (in) =	28	28	28
	ρ =	0.0033	0.0033	0.0033
	ρ' =	0.0033	0.0033	0.0033
	ρ_{sh} =	0.0025	0.0025	0.0025
	s (in) =	5.5	5.5	5.5
Floor 12	h (in) =	32	32	32
	b (in) =	28	28	28
	ρ =	0.0035	0.0035	0.0035
	ρ' =	0.0043	0.0043	0.0043
	ρ_{sh} =	0.0026	0.0026	0.0026
	s (in) =	5.0	5.0	5.0
Floor 11	h (in) =	32	32	32
	b (in) =	28	28	28
	ρ =	0.0043	0.0043	0.0043
	ρ' =	0.0053	0.0053	0.0053
	ρ_{sh} =	0.0031	0.0031	0.0031
	s (in) =	6.5	6.5	6.5
Floor 10	h (in) =	32	32	32
	b (in) =	28	28	28
	ρ =	0.0053	0.0053	0.0053
	ρ' =	0.0065	0.0065	0.0065
	ρ_{sh} =	0.0036	0.0036	0.0036
	s (in) =	5.5	5.5	5.5
Floor 9	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0037	0.0037	0.0037
	ρ' =	0.0048	0.0048	0.0048
	ρ_{sh} =	0.0032	0.0032	0.0032
	s (in) =	6.5	6.5	6.5
Floor 8	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0040	0.0040	0.0040
	ρ' =	0.0050	0.0050	0.0050
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	6.0	6.0	6.0
Floor 7	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0052	0.0052	0.0052
	ρ' =	0.0063	0.0063	0.0063
	ρ_{sh} =	0.0041	0.0041	0.0041
	s (in) =	5.0	5.0	5.0
Floor 6	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0052	0.0052	0.0052
	ρ' =	0.0063	0.0063	0.0063
	ρ_{sh} =	0.0041	0.0041	0.0041
	s (in) =	5.0	5.0	5.0
Floor 5	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0057	0.0057	0.0057
	ρ' =	0.0066	0.0066	0.0066
	ρ_{sh} =	0.0044	0.0044	0.0044
	s (in) =	6.0	6.0	6.0
Floor 4	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0060	0.0060	0.0060
	ρ' =	0.0068	0.0068	0.0068
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.0	6.0	6.0
Floor 3	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0060	0.0060	0.0060
	ρ' =	0.0068	0.0068	0.0068
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.0	6.0	6.0
Floor 2	h (in) =	38	38	38
	b (in) =	28	28	28
	ρ =	0.0061	0.0061	0.0061
	ρ' =	0.0066	0.0066	0.0066
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.0	6.0	6.0

Grade beam column height (in) = 24

Basement column height (in) = 32

Design base shear =	0.044	g,	368	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	7.0	ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 1.21 0.69 0.69 1.21
Joint ΦVn/Vu = 4.37 2.73 2.73 4.37
2.10 4.52 1.00 1.16
1.67 2.49 1.00 1.16
2.11 4.54 1.00 1.16
Story 12
φMn/Mu = 3.65 2.87 2.87 3.66
φVn/Vmpr = 1.95 2.42 2.42 1.95
P/Agf'c = 0.01 0.01 0.01 0.01
0.8%
1.44 2.18 0.83 1.09
1.34 1.44 0.83 1.09
1.44 2.18 0.83 1.09
Floor 12
1.98 1.26 1.26 1.98
2.50 1.72 1.72 2.50
Story 11
φMn/Mu = 2.86 1.98 1.98 2.86
φVn/Vmpr = 1.84 2.16 2.16 1.84
P/Agf'c = 0.02 0.02 0.02 0.02
1.2%
1.26 1.51 0.81 1.13
1.26 1.24 0.81 1.13
1.26 1.52 0.81 1.13
Floor 11
1.67 1.23 1.23 1.67
2.03 1.40 1.40 2.03
Story 10
φMn/Mu = 2.11 1.67 1.67 2.11
φVn/Vmpr = 1.94 2.31 2.31 1.94
P/Agf'c = 0.03 0.03 0.03 0.03
1.5%
1.23 1.34 0.81 1.12
1.28 1.22 0.81 1.12
1.23 1.35 0.81 1.12
Floor 10
1.38 1.23 1.23 1.38
1.57 1.09 1.09 1.57
Story 9
φMn/Mu = 1.64 1.65 1.65 1.64
φVn/Vmpr = 1.93 1.91 1.91 1.93
P/Agf'c = 0.04 0.05 0.05 0.04
1.6%
1.14 1.14 0.79 1.15
1.21 1.09 0.79 1.15
1.14 1.14 0.79 1.15
Floor 9
1.27 1.29 1.29 1.27
1.81 1.27 1.27 1.81
Story 8
φMn/Mu = 1.37 1.45 1.45 1.37
φVn/Vmpr = 2.87 2.06 2.06 2.87
P/Agf'c = 0.05 0.06 0.06 0.05
1.6%
1.12 1.11 0.80 1.15
1.19 1.09 0.80 1.15
1.13 1.12 0.80 1.15
Floor 8
1.35 1.38 1.38 1.35
1.72 1.20 1.20 1.72
Story 7
φMn/Mu = 1.30 1.47 1.47 1.31
φVn/Vmpr = 2.35 1.68 1.68 2.35
P/Agf'c = 0.07 0.07 0.07 0.07
1.7%
1.12 1.14 0.84 1.15
1.26 1.17 0.84 1.15
1.13 1.14 0.84 1.15
Floor 7
1.25 1.29 1.29 1.25
1.63 1.10 1.10 1.63
Story 6
φMn/Mu = 1.42 1.64 1.64 1.42
φVn/Vmpr = 2.22 1.6 1.6 2.22
P/Agf'c = 0.06 0.06 0.06 0.06
1.8%
1.11 1.11 0.84 1.15
1.25 1.16 0.84 1.15
1.11 1.11 0.84 1.15
Floor 6
1.31 1.37 1.37 1.31
1.63 1.10 1.10 1.63
Story 5
φMn/Mu = 1.41 1.61 1.61 1.41
φVn/Vmpr = 2.04 1.57 1.57 2.04
P/Agf'c = 0.07 0.07 0.07 0.07
1.9%
1.13 1.14 0.87 1.16
1.29 1.25 0.87 1.16
1.13 1.14 0.87 1.16
Floor 5
1.27 1.31 1.31 1.27
1.54 1.03 1.03 1.54
Story 4
φMn/Mu = 1.36 1.60 1.60 1.36
φVn/Vmpr = 1.93 1.54 1.54 1.93
P/Agf'c = 0.08 0.07 0.07 0.08
1.9%
1.15 1.14 0.88 1.16
1.34 1.30 0.88 1.16
1.15 1.14 0.88 1.16
Floor 4
1.25 1.28 1.28 1.25
1.49 0.99 0.99 1.49
Story 3
φMn/Mu = 1.36 1.61 1.61 1.36
φVn/Vmpr = 1.8 1.51 1.51 1.8
P/Agf'c = 0.09 0.08 0.08 0.09
1.9%
1.13 1.11 0.88 1.15
1.35 1.33 0.88 1.15
1.13 1.11 0.88 1.15
Floor 3
1.26 1.30 1.30 1.26
1.49 0.99 0.99 1.49
Story 2
φMn/Mu = 1.34 1.59 1.59 1.34
φVn/Vmpr = 1.71 1.48 1.48 1.71
P/Agf'c = 0.10 0.09 0.09 0.10
1.9%
1.11 1.12 0.93 1.15
1.42 1.50 0.93 1.15
1.11 1.12 0.93 1.15
Floor 2
1.55 1.34 1.34 1.55
1.54 1.00 1.00 1.54
Story 1
φMn/Mu = 1.10 1.39 1.39 1.11
φVn/Vmpr = 1.38 1.46 1.46 1.38
P/Agf'c = 0.11 0.10 0.10 0.11
1.4%
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =

Modeling Documentation (1 of 1)

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	4981	-6358	0.35	2.379E+08	0.0389	-0.044	0.086	111
	4981	-6358	0.35	2.379E+08	0.0389	-0.044	0.086	111
	4981	-6358	0.35	2.379E+08	0.0389	-0.044	0.086	111
Floor 12	5339	-7812	0.35	2.379E+08	0.041	-0.048	0.090	116
	5339	-7812	0.35	2.379E+08	0.041	-0.048	0.090	116
	5339	-7812	0.35	2.379E+08	0.041	-0.048	0.090	116
Floor 11	6453	-9273	0.35	2.379E+08	0.039	-0.046	0.100	103
	6453	-9273	0.35	2.379E+08	0.039	-0.046	0.100	103
	6453	-9273	0.35	2.379E+08	0.039	-0.046	0.100	103
Floor 10	7930	-11091	0.35	2.379E+08	0.046	-0.054	0.100	111
	7930	-11091	0.35	2.379E+08	0.046	-0.054	0.100	111
	7930	-11091	0.35	2.379E+08	0.046	-0.054	0.100	111
Floor 9	8230	-12091	0.35	3.838E+08	0.039	-0.047	0.100	112
	8230	-12091	0.35	3.838E+08	0.039	-0.047	0.100	112
	8230	-12091	0.35	3.838E+08	0.039	-0.047	0.100	112
Floor 8	8771	-12624	0.35	3.838E+08	0.042	-0.049	0.100	116
	8771	-12624	0.35	3.838E+08	0.042	-0.049	0.100	116
	8771	-12624	0.35	3.838E+08	0.042	-0.049	0.100	116
Floor 7	11506	-15282	0.35	3.838E+08	0.051	-0.058	0.100	123
	11506	-15282	0.35	3.838E+08	0.0507	-0.058	0.100	123
	11506	-15282	0.35	3.838E+08	0.0507	-0.058	0.100	123
Floor 6	11506	-15282	0.35	3.838E+08	0.051	-0.058	0.100	123
	11506	-15282	0.35	3.838E+08	0.0507	-0.058	0.100	123
	11506	-15282	0.35	3.838E+08	0.0507	-0.058	0.100	123
Floor 5	12531	-15995	0.35	3.838E+08	0.049	-0.055	0.100	116
	12531	-15995	0.35	3.838E+08	0.0486	-0.055	0.100	116
	12531	-15995	0.35	3.838E+08	0.0486	-0.055	0.100	116
Floor 4	13066	-16525	0.35	3.838E+08	0.050	-0.055	0.100	116
	13066	-16525	0.35	3.838E+08	0.050	-0.055	0.100	116
	13066	-16525	0.35	3.838E+08	0.050	-0.055	0.100	116
Floor 3	13111	-16526	0.35	3.838E+08	0.050	-0.055	0.100	116
	13111	-16526	0.35	3.838E+08	0.050	-0.055	0.100	116
	13111	-16526	0.35	3.838E+08	0.050	-0.055	0.100	116
Floor 2	13306	-16004	0.35	3.838E+08	0.050	-0.054	0.100	116
	13306	-16004	0.35	3.838E+08	0.050	-0.054	0.100	116
	13306	-16004	0.35	3.838E+08	0.050	-0.054	0.100	116

	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_g f'_c)_{exp}$ =
Story 12	7808	0.35	1.21	0.078	0.100	129	0.00
	8058	0.35	1.21	0.086	0.100	128	0.01
	8058	0.35	1.21	0.086	0.100	128	0.01
	7808	0.35	1.21	0.078	0.100	129	0.00
Story 11	8058	0.35	1.21	0.077	0.100	128	0.01
	9282	0.35	1.21	0.086	0.100	127	0.02
	9282	0.35	1.21	0.086	0.100	127	0.02
	8058	0.35	1.21	0.077	0.100	128	0.01
Story 10	8306	0.35	1.21	0.078	0.100	123	0.01
	11221	0.35	1.21	0.096	0.100	126	0.03
	11221	0.35	1.21	0.096	0.100	126	0.03
	8306	0.35	1.21	0.078	0.100	123	0.01
Story 9	8553	0.35	1.21	0.076	0.100	127	0.02
	13867	0.35	1.21	0.091	0.100	124	0.03
	13867	0.35	1.21	0.091	0.100	124	0.03
	8553	0.35	1.21	0.076	0.100	127	0.02
Story 8	9163	0.35	1.21	0.076	0.100	126	0.02
	14338	0.35	1.20	0.076	0.100	123	0.04
	14338	0.35	1.20	0.076	0.100	123	0.04
	9163	0.35	1.21	0.076	0.100	126	0.02
Story 7	11221	0.35	1.21	0.077	0.100	126	0.03
	17681	0.35	1.20	0.078	0.100	121	0.05
	17681	0.35	1.20	0.078	0.100	121	0.05
	11221	0.35	1.21	0.077	0.100	126	0.03
Story 6	12251	0.35	1.19	0.072	0.100	126	0.02
	19678	0.35	1.19	0.074	0.100	123	0.04
	19678	0.35	1.19	0.074	0.100	123	0.04
	12251	0.35	1.19	0.072	0.100	126	0.02
Story 5	13217	0.35	1.19	0.072	0.100	126	0.02
	20140	0.35	1.19	0.073	0.100	122	0.05
	20140	0.35	1.19	0.073	0.100	122	0.05
	13217	0.35	1.19	0.072	0.100	126	0.02
Story 4	13818	0.35	1.19	0.072	0.100	125	0.03
	20600	0.35	1.19	0.072	0.100	121	0.06
	20600	0.35	1.19	0.072	0.100	121	0.06
	13818	0.35	1.19	0.072	0.100	125	0.03
Story 3	14779	0.35	1.19	0.072	0.100	125	0.03
	21057	0.35	1.19	0.071	0.100	120	0.06
	21057	0.35	1.19	0.071	0.100	120	0.06
	14779	0.35	1.19	0.072	0.100	125	0.03
Story 2	15376	0.35	1.19	0.072	0.100	124	0.03
	21512	0.35	1.18	0.070	0.100	119	0.07
	21512	0.35	1.18	0.070	0.100	119	0.07
	15376	0.35	1.19	0.072	0.100	124	0.03
Story 1	19933	0.35	1.19	0.075	0.100	124	0.04
	21964	0.35	1.18	0.070	0.100	118	0.07
	21964	0.35	1.18	0.070	0.100	118	0.07
	19933	0.35	1.19	0.075	0.100	124	0.04

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.01 T_2 = 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

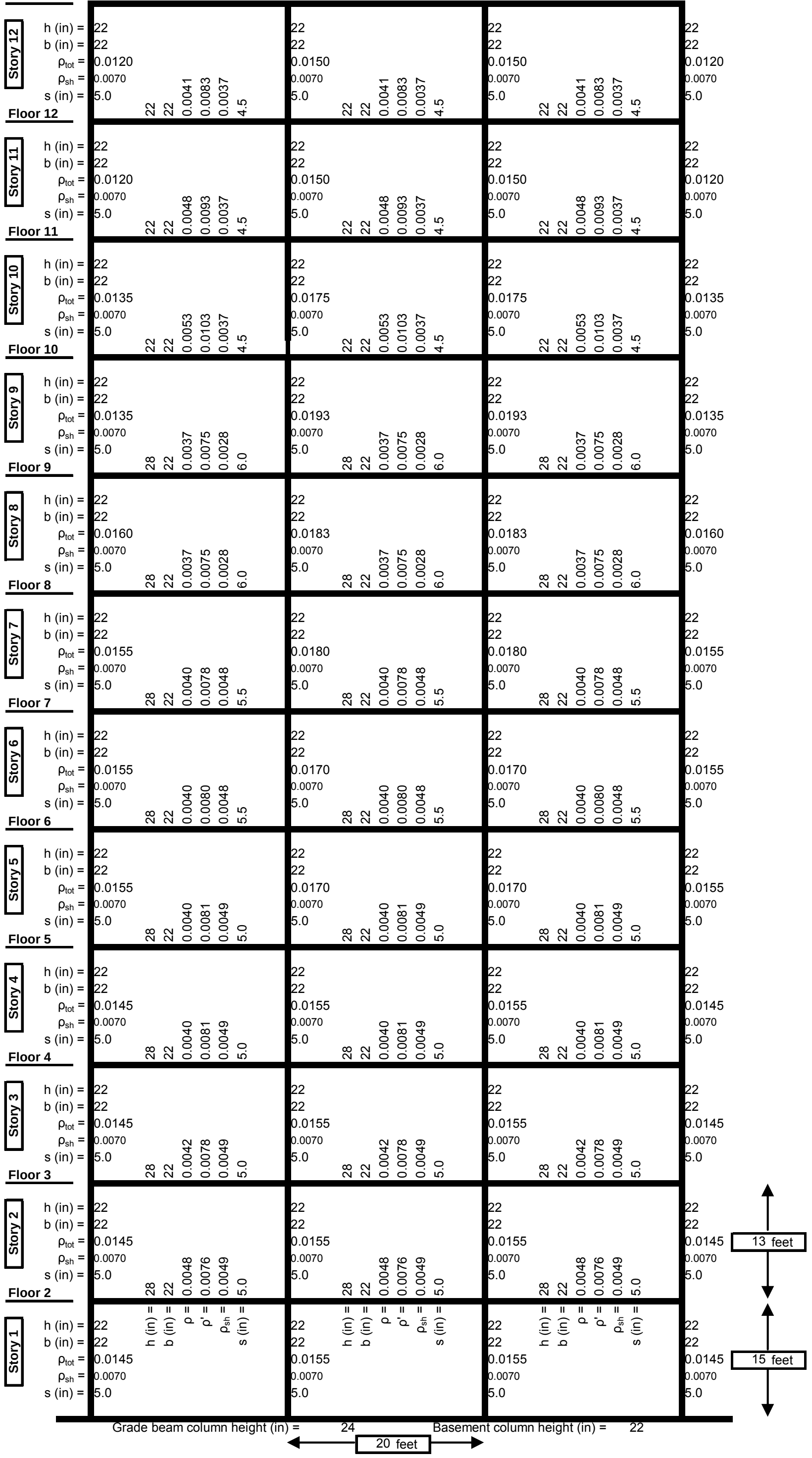
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1014
Number of Stories: 12
Fundamental Period (sec): 2.14

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by drift limits and joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Columns: h (in) = 22, b (in) = 22, ρ_{sh} = 0.0070, s (in) = 5.0 at all column lines and stories.

Story	ρ_{tot} column line 1	ρ_{tot} column line 2	ρ_{tot} column line 3	ρ_{tot} column line 4
Story 12	0.0120	0.0150	0.0150	0.0120
Story 11	0.0120	0.0150	0.0150	0.0120
Story 10	0.0135	0.0175	0.0175	0.0135
Story 9	0.0135	0.0193	0.0193	0.0135
Story 8	0.0160	0.0183	0.0183	0.0160
Story 7	0.0155	0.0180	0.0180	0.0155
Story 6	0.0155	0.0170	0.0170	0.0155
Story 5	0.0155	0.0170	0.0170	0.0155
Story 4	0.0145	0.0155	0.0155	0.0145
Story 3	0.0145	0.0155	0.0155	0.0145
Story 2	0.0145	0.0155	0.0155	0.0145
Story 1	0.0145	0.0155	0.0155	0.0145

Beams: the same values in all three bays.

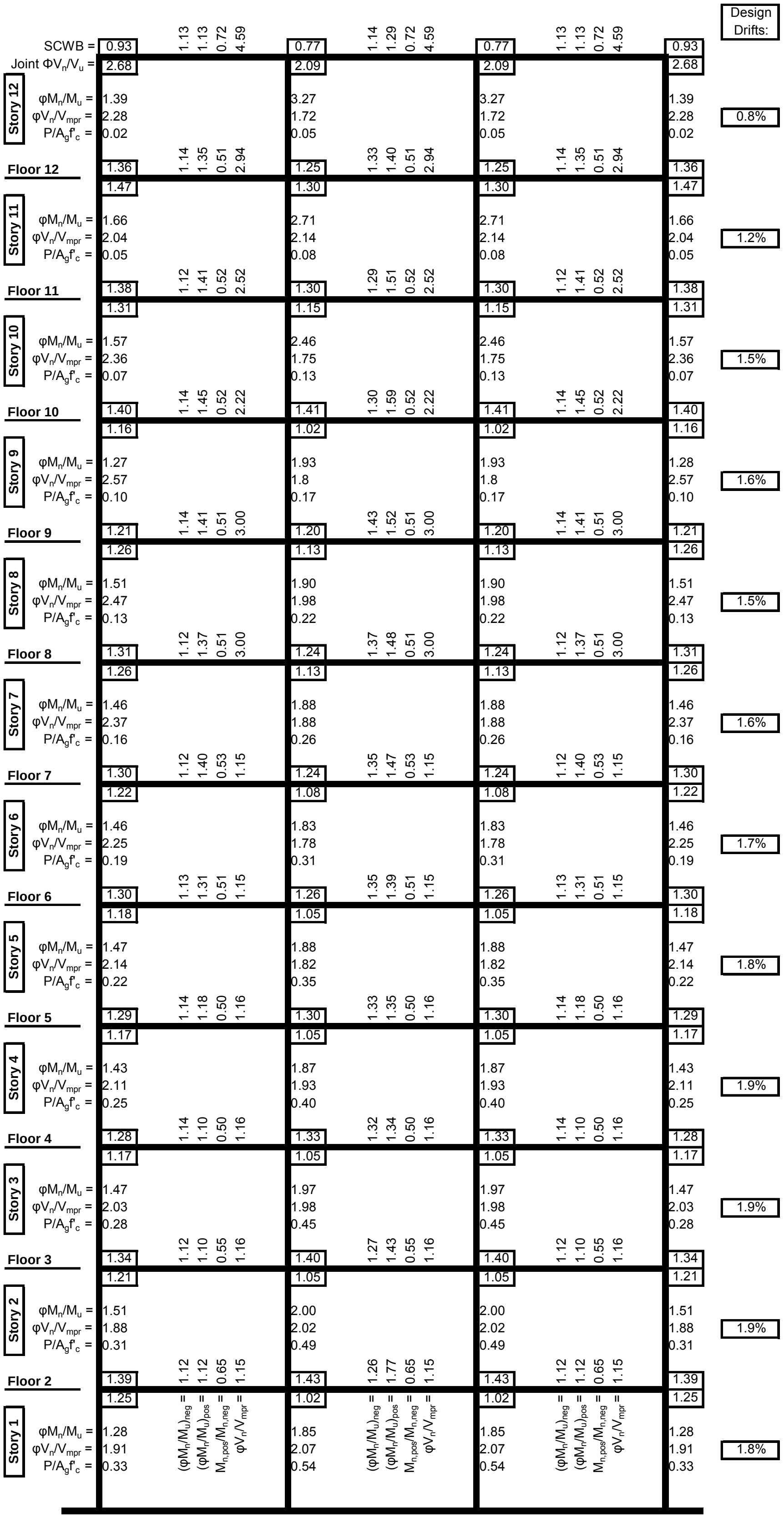
Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	22	22	0.0037	0.0053	0.0037	4.5
Floor 12	22	22	0.0041	0.0083	0.0037	4.5
Floor 11	22	22	0.0048	0.0093	0.0037	4.5
Floor 10	22	22	0.0053	0.0103	0.0037	4.5
Floor 9	28	22	0.0037	0.0075	0.0028	6.0
Floor 8	28	22	0.0037	0.0075	0.0028	6.0
Floor 7	28	22	0.0040	0.0078	0.0048	5.5
Floor 6	28	22	0.0040	0.0080	0.0048	5.5
Floor 5	28	22	0.0040	0.0081	0.0049	5.0
Floor 4	28	22	0.0040	0.0081	0.0049	5.0
Floor 3	28	22	0.0042	0.0078	0.0049	5.0
Floor 2	28	22	0.0048	0.0076	0.0049	5.0

Grade beam column height (in) = 24

Basement column height (in) = 22

Design base shear =	0.044	g,	123	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi

Design Documentation (2 of 2)



	SCWB =	0.93	1.13 1.13 0.72 4.59	0.77	1.14 1.29 0.72 4.59	0.77	1.13 1.13 0.72 4.59	0.93	Design Drifts:
	Joint $\Phi V_n/V_u$ =	2.68		2.09		2.09		2.68	
Story 12	$\phi M_n/M_u$ =	1.39		3.27		3.27		1.39	
	$\phi V_n/V_{mpr}$ =	2.28		1.72		1.72		2.28	0.8%
	$P/A_g f'_c$ =	0.02		0.05		0.05		0.02	
Floor 12		1.36	1.14 1.35 0.51 2.94	1.25	1.33 1.40 0.51 2.94	1.25	1.14 1.35 0.51 2.94	1.36	
		1.47		1.30		1.30		1.47	
Story 11	$\phi M_n/M_u$ =	1.66		2.71		2.71		1.66	
	$\phi V_n/V_{mpr}$ =	2.04		2.14		2.14		2.04	1.2%
	$P/A_g f'_c$ =	0.05		0.08		0.08		0.05	
Floor 11		1.38	1.12 1.41 0.52 2.52	1.30	1.29 1.51 0.52 2.52	1.30	1.12 1.41 0.52 2.52	1.38	
		1.31		1.15		1.15		1.31	
Story 10	$\phi M_n/M_u$ =	1.57		2.46		2.46		1.57	
	$\phi V_n/V_{mpr}$ =	2.36		1.75		1.75		2.36	1.5%
	$P/A_g f'_c$ =	0.07		0.13		0.13		0.07	
Floor 10		1.40	1.14 1.45 0.52 2.22	1.41	1.30 1.59 0.52 2.22	1.41	1.14 1.45 0.52 2.22	1.40	
		1.16		1.02		1.02		1.16	
Story 9	$\phi M_n/M_u$ =	1.27		1.93		1.93		1.28	
	$\phi V_n/V_{mpr}$ =	2.57		1.8		1.8		2.57	1.6%
	$P/A_g f'_c$ =	0.10		0.17		0.17		0.10	
Floor 9		1.21	1.14 1.41 0.51 3.00	1.20	1.43 1.52 0.51 3.00	1.20	1.14 1.41 0.51 3.00	1.21	
		1.26		1.13		1.13		1.26	
Story 8	$\phi M_n/M_u$ =	1.51		1.90		1.90		1.51	
	$\phi V_n/V_{mpr}$ =	2.47		1.98		1.98		2.47	1.5%
	$P/A_g f'_c$ =	0.13		0.22		0.22		0.13	
Floor 8		1.31	1.12 1.37 0.51 3.00	1.24	1.37 1.48 0.51 3.00	1.24	1.12 1.37 0.51 3.00	1.31	
		1.26		1.13		1.13		1.26	
Story 7	$\phi M_n/M_u$ =	1.46		1.88		1.88		1.46	
	$\phi V_n/V_{mpr}$ =	2.37		1.88		1.88		2.37	1.6%
	$P/A_g f'_c$ =	0.16		0.26		0.26		0.16	
Floor 7		1.30	1.12 1.40 0.53 1.15	1.24	1.35 1.47 0.53 1.15	1.24	1.12 1.40 0.53 1.15	1.30	
		1.22		1.08		1.08		1.22	
Story 6	$\phi M_n/M_u$ =	1.46		1.83		1.83		1.46	
	$\phi V_n/V_{mpr}$ =	2.25		1.78		1.78		2.25	1.7%
	$P/A_g f'_c$ =	0.19		0.31		0.31		0.19	
Floor 6		1.30	1.13 1.31 0.51 1.15	1.26	1.35 1.39 0.51 1.15	1.26	1.13 1.31 0.51 1.15	1.30	
		1.18		1.05		1.05		1.18	
Story 5	$\phi M_n/M_u$ =	1.47		1.88		1.88		1.47	
	$\phi V_n/V_{mpr}$ =	2.14		1.82		1.82		2.14	1.8%
	$P/A_g f'_c$ =	0.22		0.35		0.35		0.22	
Floor 5		1.29	1.14 1.18 0.50 1.16	1.30	1.33 1.35 0.50 1.16	1.30	1.14 1.18 0.50 1.16	1.29	
		1.17		1.05		1.05		1.17	
Story 4	$\phi M_n/M_u$ =	1.43		1.87		1.87		1.43	
	$\phi V_n/V_{mpr}$ =	2.11		1.93		1.93		2.11	1.9%
	$P/A_g f'_c$ =	0.25		0.40		0.40		0.25	
Floor 4		1.28	1.14 1.10 0.50 1.16	1.33	1.32 1.34 0.50 1.16	1.33	1.14 1.10 0.50 1.16	1.28	
		1.17		1.05		1.05		1.17	
Story 3	$\phi M_n/M_u$ =	1.47		1.97		1.97		1.47	
	$\phi V_n/V_{mpr}$ =	2.03		1.98		1.98		2.03	1.9%
	$P/A_g f'_c$ =	0.28		0.45		0.45		0.28	
Floor 3		1.34	1.12 1.10 0.55 1.16	1.40	1.27 1.43 0.55 1.16	1.40	1.12 1.10 0.55 1.16	1.34	
		1.21		1.05		1.05		1.21	
Story 2	$\phi M_n/M_u$ =	1.51		2.00		2.00		1.51	
	$\phi V_n/V_{mpr}$ =	1.88		2.02		2.02		1.88	1.9%
	$P/A_g f'_c$ =	0.31		0.49		0.49		0.31	
Floor 2		1.39	1.12 1.12 0.65 1.15	1.43	1.26 1.77 0.65 1.15	1.43	1.12 1.12 0.65 1.15	1.39	
		1.25	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.02	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.02	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.25	
Story 1	$\phi M_n/M_u$ =	1.28		1.85		1.85		1.28	
	$\phi V_n/V_{mpr}$ =	1.91		2.07		2.07		1.91	1.8%
	$P/A_g f'_c$ =	0.33		0.54		0.54		0.33	

Modeling Documentation (1 of 1)

Floor 13	$M_{y,pos,exp}$(k-in) =	1939	1939	1939
	$M_{y,n,slab,exp}$(k-in) =	-3976	-3976	-3976
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.178E+07	7.178E+07	7.178E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0432	0.0432	0.0432
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.07	-0.07	-0.07
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 12	$M_{y,pos,exp}$(k-in) =	2139	2139	2139
	$M_{y,n,slab,exp}$(k-in) =	-5428	-5428	-5428
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.178E+07	7.178E+07	7.178E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 11	$M_{y,pos,exp}$(k-in) =	2447	2447	2447
	$M_{y,n,slab,exp}$(k-in) =	-5908	-5908	-5908
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.178E+07	7.178E+07	7.178E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 10	$M_{y,pos,exp}$(k-in) =	2695	2695	2695
	$M_{y,n,slab,exp}$(k-in) =	-6386	-6386	-6386
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.178E+07	7.178E+07	7.178E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 9	$M_{y,pos,exp}$(k-in) =	3318	3318	3318
	$M_{y,n,slab,exp}$(k-in) =	-8239	-8239	-8239
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 8	$M_{y,pos,exp}$(k-in) =	3318	3318	3318
	$M_{y,n,slab,exp}$(k-in) =	-8239	-8239	-8239
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 7	$M_{y,pos,exp}$(k-in) =	3553	3553	3553
	$M_{y,n,slab,exp}$(k-in) =	-8449	-8449	-8449
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0443	0.0443
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.073	-0.073	-0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 6	$M_{y,pos,exp}$(k-in) =	3553	3553	3553
	$M_{y,n,slab,exp}$(k-in) =	-8656	-8656	-8656
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0444	0.0444
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 5	$M_{y,pos,exp}$(k-in) =	3535	3535	3535
	$M_{y,n,slab,exp}$(k-in) =	-8725	-8725	-8725
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.0463	0.0463
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.077	-0.077	-0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 4	$M_{y,pos,exp}$(k-in) =	3535	3535	3535
	$M_{y,n,slab,exp}$(k-in) =	-8725	-8725	-8725
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.0463	0.0463
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.077	-0.077	-0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 3	$M_{y,pos,exp}$(k-in) =	3770	3770	3770
	$M_{y,n,slab,exp}$(k-in) =	-8521	-8521	-8521
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0472	0.0472
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.076	-0.076	-0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 2	$M_{y,pos,exp}$(k-in) =	4284	4284	4284
	$M_{y,n,slab,exp}$(k-in) =	-8320	-8320	-8320
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.049	0.049
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109

Story 12	$M_{y,exp}$ (k-in) =	3409	4468	4468	3409
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.068	0.068	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	93	91	91	93
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 11	$M_{y,exp}$ (k-in) =	3738	5105	5105	3738
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.066	0.064	0.064	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	91	87	87	91
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 10	$M_{y,exp}$ (k-in) =	4426	6323	6323	4426
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.065	0.061	0.061	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	89	83	83	89
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 9	$M_{y,exp}$ (k-in) =	4744	7344	7344	4744
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.063	0.059	0.059	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	87	80	80	87
	$(P/A_gf'_c)_{exp}$ =	0.06	0.13	0.13	0.06
Story 8	$M_{y,exp}$ (k-in) =	5657	7699	7699	5657
	EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.062	0.055	0.055	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	85	77	77	85
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 7	$M_{y,exp}$ (k-in) =	5845	8223	8223	5845
	EI_{stf}/EI_g =	0.39	0.49	0.49	0.39
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.060	0.052	0.052	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	83	74	74	83
	$(P/A_gf'_c)_{exp}$ =	0.10	0.19	0.19	0.10
Story 6	$M_{y,exp}$ (k-in) =	6150	8561	8561	6150
	EI_{stf}/EI_g =	0.41	0.52	0.52	0.41
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.059	0.048	0.048	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	82	71	71	82
	$(P/A_gf'_c)_{exp}$ =	0.11	0.22	0.22	0.11
Story 5	$M_{y,exp}$ (k-in) =	6452	9126	9126	6452
	EI_{stf}/EI_g =	0.42	0.55	0.55	0.42
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.057	0.046	0.046	0.057
	Θ_{pc} (rad) =	0.100	0.091	0.091	0.100
	λ =	80	68	68	80
	$(P/A_gf'_c)_{exp}$ =	0.13	0.26	0.26	0.13
Story 4	$M_{y,exp}$ (k-in) =	6514	9329	9329	6514
	EI_{stf}/EI_g =	0.44	0.58	0.58	0.44
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.055	0.042	0.042	0.055
	Θ_{pc} (rad) =	0.100	0.081	0.081	0.100
	λ =	78	65	65	78
	$(P/A_gf'_c)_{exp}$ =	0.14	0.29	0.29	0.14
Story 3	$M_{y,exp}$ (k-in) =	6810	10570	10570	6810
	EI_{stf}/EI_g =	0.46	0.61	0.61	0.46
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.053	0.040	0.040	0.053
	Θ_{pc} (rad) =	0.100	0.073	0.073	0.100
	λ =	77	62	62	77
	$(P/A_gf'_c)_{exp}$ =	0.16	0.32	0.32	0.16
Story 2	$M_{y,exp}$ (k-in) =	7104	10626	10626	7104
	EI_{stf}/EI_g =	0.47	0.64	0.64	0.47
	M_c/M_y =	1.19	1.16	1.16	1.19
	$\Theta_{cap,pl}$ (rad) =	0.052	0.038	0.038	0.052
	Θ_{pc} (rad) =	0.100	0.065	0.065	0.100
	λ =	75	60	60	75
	$(P/A_gf'_c)_{exp}$ =	0.18	0.35	0.35	0.18
Story 1	$M_{y,exp}$ (k-in) =	7395	10687	10687	7395
	EI_{stf}/EI_g =	0.49	0.68	0.68	0.49
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.050	0.036	0.036	0.050
	Θ_{pc} (rad) =	0.100	0.058	0.058	0.100
	λ =	74	57	57	74
	$(P/A_gf'_c)_{exp}$ =	0.19	0.38	0.38	0.19

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.14 T_2 = 0.72 T_3 = 0.42

$f_{y,rebar,expected}$ = 67 ksi

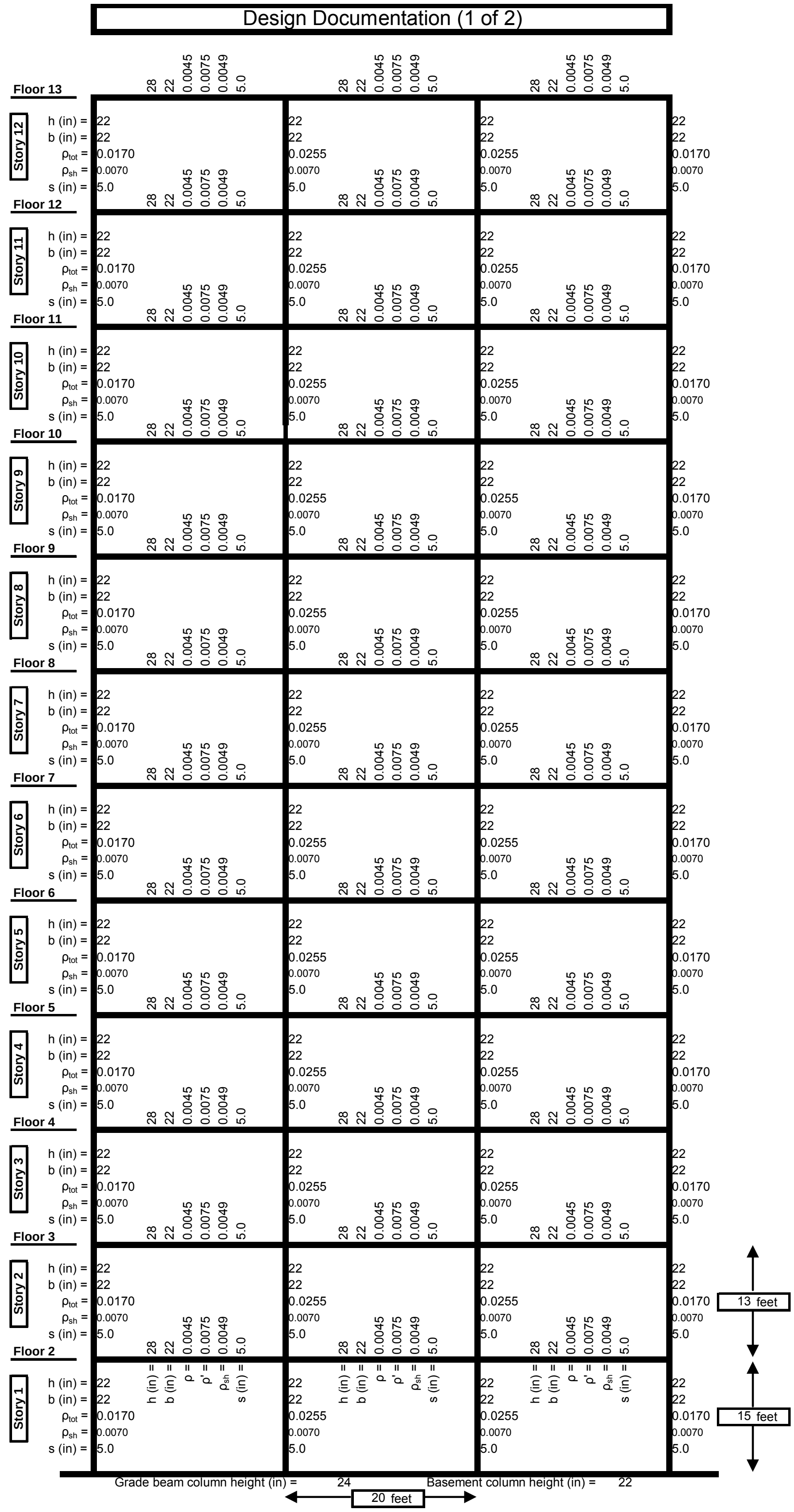
STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1015
Number of Stories: 12
Fundamental Period (sec): 2.13

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Beam and column sizes from ground floor of index 1014 were imposed throughout the building. Beam reinforcement was designed for flexure in the critical (third) floor, while column reinforcement was increased from that in index 1014 to meet SCWB requirements in the upper stories. Member size and reinforcement ratios were kept the same throughout all stories.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	0.044	g,	123	k		
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi	
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi	

Design Documentation (2 of 2)

									Design Drifts:
			2.83		2.91		2.83		
			2.07		2.41		2.07		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
	SCWB =	0.59		0.58		0.58		0.59	
	Joint $\Phi V_n/V_u$ =	1.68		1.40		1.40		1.68	
Story 12	$\varphi M_n/M_u$ =	2.03		4.72		4.73		2.04	
	$\varphi V_n/V_{mpr}$ =	1.62		1.07		1.07		1.62	0.5%
	$P/A_g f'_c$ =	0.02		0.05		0.05		0.02	
			1.64		2.12		1.64		
			2.26		2.32		2.26		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 12		1.21		1.19		1.19		1.21	
		1.34		1.11		1.11		1.34	
Story 11	$\varphi M_n/M_u$ =	1.98		3.55		3.55		1.98	
	$\varphi V_n/V_{mpr}$ =	1.48		1.39		1.39		1.48	0.8%
	$P/A_g f'_c$ =	0.05		0.08		0.08		0.05	
			1.45		1.82		1.45		
			2.07		2.21		2.07		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 11		1.27		1.26		1.26		1.27	
		1.34		1.11		1.11		1.34	
Story 10	$\varphi M_n/M_u$ =	1.79		2.93		2.93		1.79	
	$\varphi V_n/V_{mpr}$ =	1.90		1.30		1.30		1.90	1.1%
	$P/A_g f'_c$ =	0.08		0.12		0.12		0.08	
			1.29		1.62		1.29		
			1.92		2.04		1.92		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 10		1.32		1.33		1.33		1.32	
		1.30		1.08		1.08		1.30	
Story 9	$\varphi M_n/M_u$ =	1.68		2.61		2.61		1.68	
	$\varphi V_n/V_{mpr}$ =	2.11		1.46		1.46		2.11	1.3%
	$P/A_g f'_c$ =	0.11		0.17		0.17		0.11	
			1.19		1.48		1.19		
			1.78		1.91		1.78		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 9		1.36		1.39		1.39		1.36	
		1.26		1.05		1.05		1.26	
Story 8	$\varphi M_n/M_u$ =	1.62		2.44		2.44		1.62	
	$\varphi V_n/V_{mpr}$ =	2.36		1.65		1.65		2.36	1.5%
	$P/A_g f'_c$ =	0.13		0.21		0.21		0.13	
			1.13		1.38		1.13		
			1.67		1.83		1.67		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 8		1.40		1.46		1.46		1.40	
		1.26		1.05		1.05		1.26	
Story 7	$\varphi M_n/M_u$ =	1.59		2.37		2.37		1.59	
	$\varphi V_n/V_{mpr}$ =	2.24		1.58		1.58		2.24	1.6%
	$P/A_g f'_c$ =	0.16		0.26		0.26		0.16	
			1.09		1.32		1.09		
			1.59		1.68		1.59		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 7		1.44		1.53		1.53		1.44	
		1.26		1.05		1.05		1.26	
Story 6	$\varphi M_n/M_u$ =	1.58		2.35		2.35		1.58	
	$\varphi V_n/V_{mpr}$ =	2.13		1.50		1.50		2.13	1.7%
	$P/A_g f'_c$ =	0.19		0.30		0.30		0.19	
			1.07		1.27		1.07		
			1.45		1.59		1.46		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 6		1.47		1.60		1.60		1.47	
		1.26		1.05		1.05		1.26	
Story 5	$\varphi M_n/M_u$ =	1.59		2.38		2.38		1.59	
	$\varphi V_n/V_{mpr}$ =	2.04		1.54		1.54		2.04	1.8%
	$P/A_g f'_c$ =	0.22		0.35		0.35		0.22	
			1.06		1.24		1.06		
			1.33		1.54		1.33		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 5		1.50		1.67		1.67		1.50	
		1.26		1.05		1.05		1.26	
Story 4	$\varphi M_n/M_u$ =	1.61		2.45		2.45		1.61	
	$\varphi V_n/V_{mpr}$ =	1.96		1.57		1.57		1.96	1.9%
	$P/A_g f'_c$ =	0.25		0.39		0.39		0.25	
			1.07		1.23		1.07		
			1.23		1.53		1.23		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 4		1.53		1.73		1.73		1.53	
		1.26		1.05		1.05		1.26	
Story 3	$\varphi M_n/M_u$ =	1.65		2.56		2.56		1.65	
	$\varphi V_n/V_{mpr}$ =	1.75		1.61		1.61		1.75	1.9%
	$P/A_g f'_c$ =	0.28		0.44		0.44		0.28	
			1.08		1.22		1.08		
			1.17		1.53		1.17		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 3		1.55		1.80		1.80		1.55	
		1.26		1.05		1.05		1.26	
Story 2	$\varphi M_n/M_u$ =	1.69		2.58		2.58		1.69	
	$\varphi V_n/V_{mpr}$ =	1.78		1.65		1.65		1.78	1.9%
	$P/A_g f'_c$ =	0.31		0.49		0.49		0.31	
			1.11		1.24		1.11		
			1.05		1.66		1.05		
			0.61		0.61		0.61		
			1.17		1.17		1.17		
Floor 2		1.57		1.87		1.87		1.57	
		1.26		1.05		1.05		1.26	
			$(\varphi M_n/M_u)_{neg}$ =		$(\varphi M_n/M_u)_{neg}$ =		$(\varphi M_n/M_u)_{neg}$ =		
Story 1	$\varphi M_n/M_u$ =	1.43	$(\varphi M_n/M_u)_{pos}$ =	2.35	$(\varphi M_n/M_u)_{pos}$ =	2.35	$(\varphi M_n/M_u)_{pos}$ =	1.44	
	$\varphi V_n/V_{mpr}$ =	1.81	$M_{n,pos}/M_{n,neg}$ =	1.69	$M_{n,pos}/M_{n,neg}$ =	1.69	$M_{n,pos}/M_{n,neg}$ =	1.81	1.8%
	$P/A_g f'_c$ =	0.34	$\varphi V_n/V_{mpr}$ =	0.54	$\varphi V_n/V_{mpr}$ =	0.54	$\varphi V_n/V_{mpr}$ =	0.34	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	4629	7000	7000	4629
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.071	0.074	0.074	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	93	91	91	93
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 11	$M_{y,exp}$ (k-in) =	4952	7621	7621	4952
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.069	0.070	0.070	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	91	87	87	91
	$(P/A_g f'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 10	$M_{y,exp}$ (k-in) =	5270	8230	8230	5270
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.067	0.066	0.066	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	89	83	83	89
	$(P/A_g f'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 9	$M_{y,exp}$ (k-in) =	5585	8829	8829	5585
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.065	0.062	0.062	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	87	80	80	87
	$(P/A_g f'_c)_{exp}$ =	0.06	0.13	0.13	0.06
Story 8	$M_{y,exp}$ (k-in) =	5896	9419	9419	5896
	EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.063	0.058	0.058	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	85	77	77	85
	$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 7	$M_{y,exp}$ (k-in) =	6203	10001	10001	6203
	EI_{stf}/EI_g =	0.39	0.49	0.49	0.39
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.061	0.055	0.055	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	83	74	74	83
	$(P/A_g f'_c)_{exp}$ =	0.10	0.19	0.19	0.10
Story 6	$M_{y,exp}$ (k-in) =	6508	10574	10574	6508
	EI_{stf}/EI_g =	0.41	0.52	0.52	0.41
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.059	0.052	0.052	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	82	71	71	82
	$(P/A_g f'_c)_{exp}$ =	0.11	0.22	0.22	0.11
Story 5	$M_{y,exp}$ (k-in) =	6809	11141	11141	6809
	EI_{stf}/EI_g =	0.42	0.55	0.55	0.42
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.058	0.049	0.049	0.058
	Θ_{pc} (rad) =	0.100	0.091	0.091	0.100
	λ =	80	68	68	80
	$(P/A_g f'_c)_{exp}$ =	0.13	0.26	0.26	0.13
Story 4	$M_{y,exp}$ (k-in) =	7107	11701	11701	7107
	EI_{stf}/EI_g =	0.44	0.58	0.58	0.44
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.056	0.046	0.046	0.056
	Θ_{pc} (rad) =	0.100	0.081	0.081	0.100
	λ =	78	65	65	78
	$(P/A_g f'_c)_{exp}$ =	0.14	0.29	0.29	0.14
Story 3	$M_{y,exp}$ (k-in) =	7403	12787	12787	7403
	EI_{stf}/EI_g =	0.46	0.61	0.61	0.46
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.054	0.043	0.043	0.054
	Θ_{pc} (rad) =	0.100	0.073	0.073	0.100
	λ =	77	62	62	77
	$(P/A_g f'_c)_{exp}$ =	0.16	0.32	0.32	0.16
Story 2	$M_{y,exp}$ (k-in) =	7696	12742	12742	7696
	EI_{stf}/EI_g =	0.47	0.64	0.64	0.47
	M_c/M_y =	1.19	1.16	1.16	1.19
	$\Theta_{cap,pl}$ (rad) =	0.053	0.041	0.041	0.053
	Θ_{pc} (rad) =	0.100	0.065	0.065	0.100
	λ =	75	60	60	75
	$(P/A_g f'_c)_{exp}$ =	0.18	0.35	0.35	0.18
Story 1	$M_{y,exp}$ (k-in) =	7986	12703	12703	7986
	EI_{stf}/EI_g =	0.49	0.68	0.68	0.49
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.051	0.039	0.039	0.051
	Θ_{pc} (rad) =	0.100	0.058	0.058	0.100
	λ =	74	57	57	74
	$(P/A_g f'_c)_{exp}$ =	0.19	0.38	0.38	0.19

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 12	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
Floor 11	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
Floor 10	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
Floor 9	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
Floor 8	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
Floor 7	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 6	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 5	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 4	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 3	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.0483	-0.075	0.100	109
Floor 2	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109
	3995	-8246	0.35	1.471E+08	0.048	-0.075	0.100	109

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.13 T_2 = 0.70 T_3 = 0.41

$f_{y,rebar,expected}$ = 67 ksi

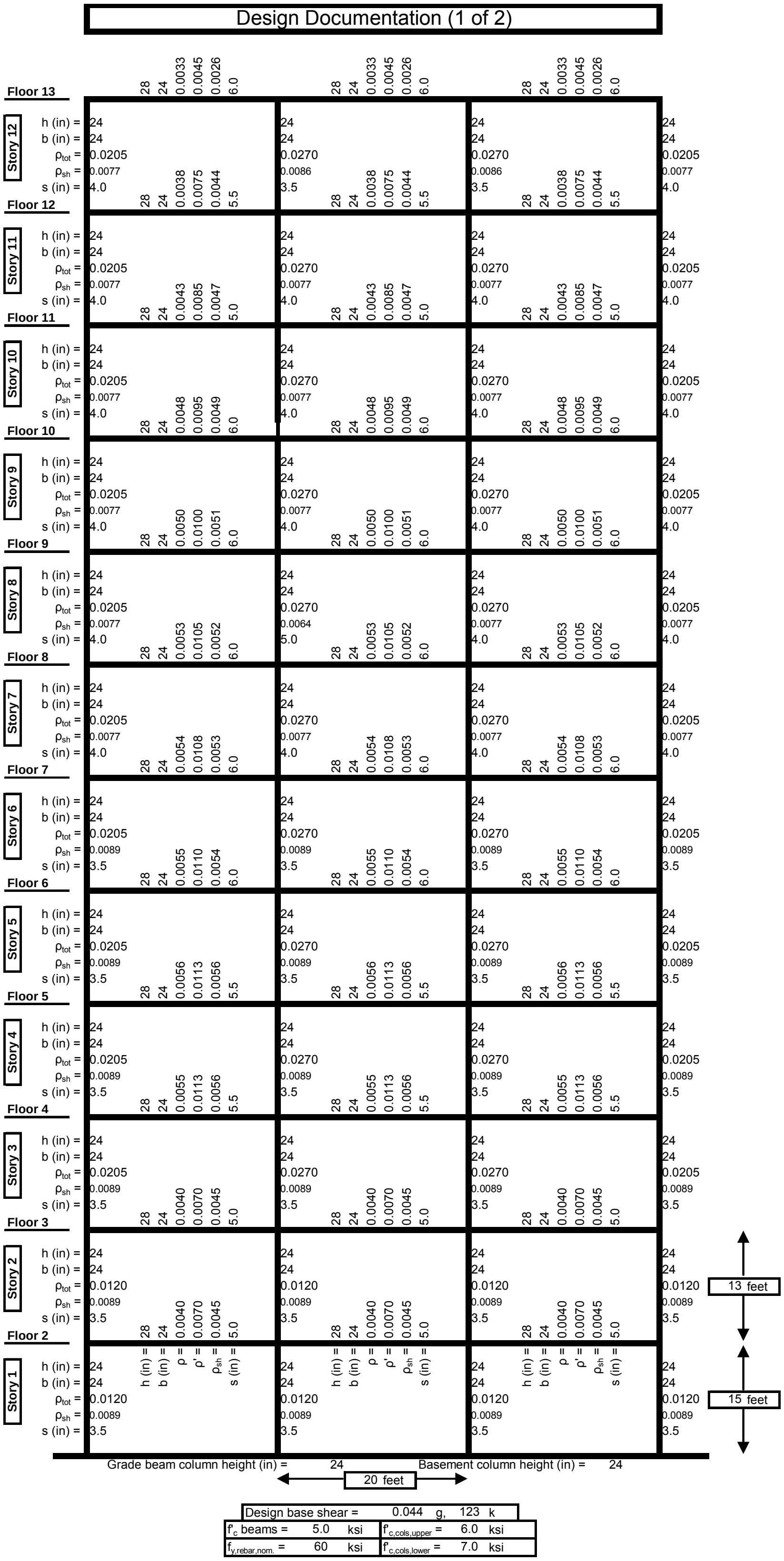
STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1017
Number of Stories: 12
Fundamental Period (sec): 1.92

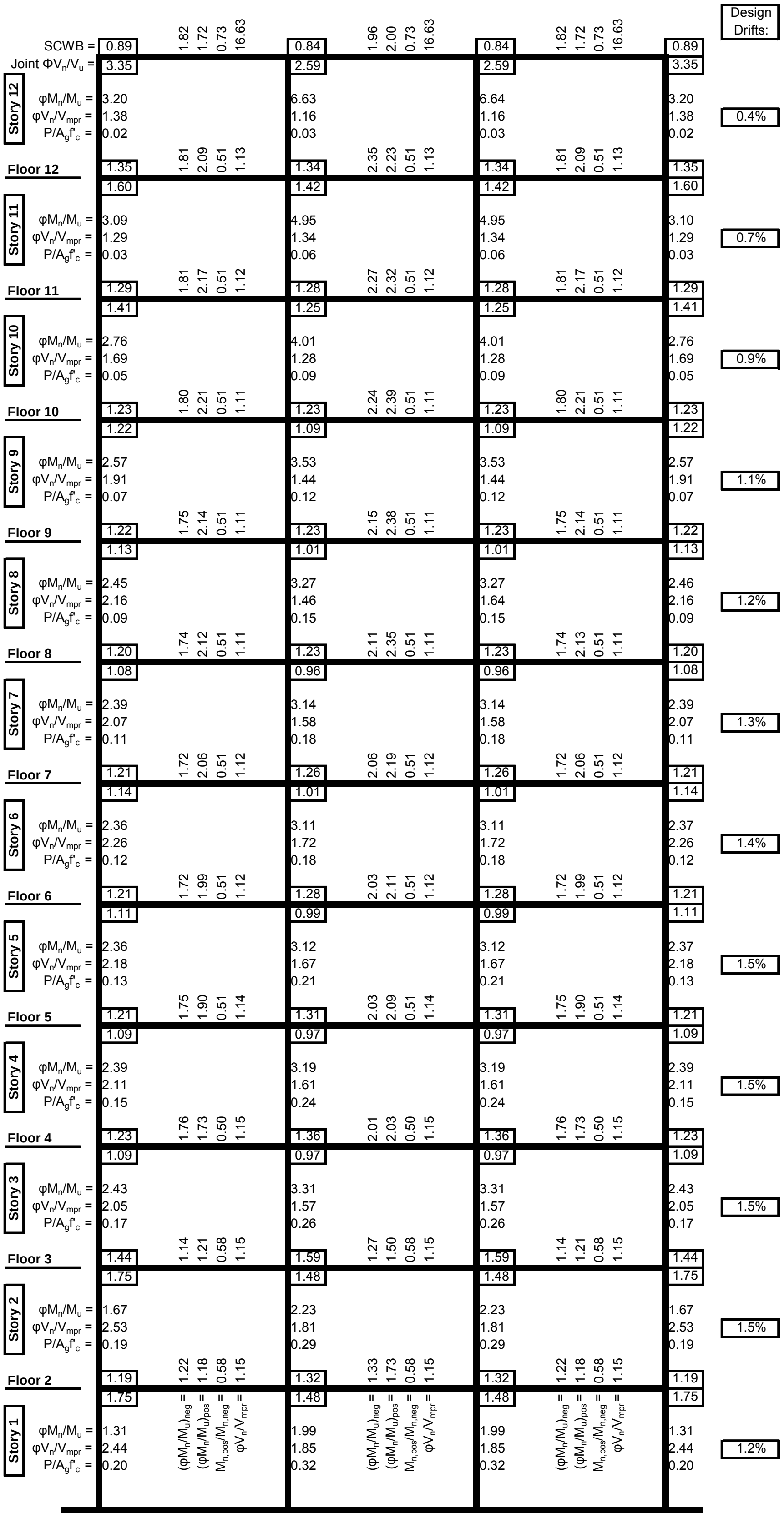
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Column sizes were increased from 22 inches square in index 1014 to 24 inches square in this design in order to meet SCWB and joint shear requirements in the upper floors while maintaining 65% weak story (actually the two lower stories) and not exceeding maximum reinforcement ratios. Column concrete strength was increased to 7.0 ksi in lower stories and 6.0 ksi in upper stories to meet joint shear requirements. Beam reinforcement was determined by demand in the bottom floor and then stepped up to meet 65% weak story requirement. Column strengths were determined by SCWB considerations.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 13
28 24 0.0033 0.0045 0.0026 6.0 | 28 24 0.0033 0.0045 0.0026 6.0 | 28 24 0.0033 0.0045 0.0026 6.0
Story 12
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0086 | 0.0086 | 0.0077
s (in) = 4.0 | 3.5 | 3.5 | 4.0
Floor 12
28 24 0.0038 0.0075 0.0044 5.5 | 28 24 0.0038 0.0075 0.0044 5.5 | 28 24 0.0038 0.0075 0.0044 5.5
Story 11
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0077 | 0.0077 | 0.0077
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 11
28 24 0.0043 0.0085 0.0047 5.0 | 28 24 0.0043 0.0085 0.0047 5.0 | 28 24 0.0043 0.0085 0.0047 5.0
Story 10
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0077 | 0.0077 | 0.0077
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 10
28 24 0.0048 0.0095 0.0049 6.0 | 28 24 0.0048 0.0095 0.0049 6.0 | 28 24 0.0048 0.0095 0.0049 6.0
Story 9
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0077 | 0.0077 | 0.0077
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 9
28 24 0.0050 0.0100 0.0051 6.0 | 28 24 0.0050 0.0100 0.0051 6.0 | 28 24 0.0050 0.0100 0.0051 6.0
Story 8
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0064 | 0.0077 | 0.0077
s (in) = 4.0 | 5.0 | 4.0 | 4.0
Floor 8
28 24 0.0053 0.0105 0.0052 6.0 | 28 24 0.0053 0.0105 0.0052 6.0 | 28 24 0.0053 0.0105 0.0052 6.0
Story 7
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0077 | 0.0077 | 0.0077 | 0.0077
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 7
28 24 0.0054 0.0108 0.0053 6.0 | 28 24 0.0054 0.0108 0.0053 6.0 | 28 24 0.0054 0.0108 0.0053 6.0
Story 6
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
Floor 6
28 24 0.0055 0.0110 0.0054 6.0 | 28 24 0.0055 0.0110 0.0054 6.0 | 28 24 0.0055 0.0110 0.0054 6.0
Story 5
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
Floor 5
28 24 0.0056 0.0113 0.0056 5.5 | 28 24 0.0056 0.0113 0.0056 5.5 | 28 24 0.0056 0.0113 0.0056 5.5
Story 4
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
Floor 4
28 24 0.0055 0.0113 0.0056 5.5 | 28 24 0.0055 0.0113 0.0056 5.5 | 28 24 0.0055 0.0113 0.0056 5.5
Story 3
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0205 | 0.0270 | 0.0270 | 0.0205
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
Floor 3
28 24 0.0040 0.0070 0.0045 5.0 | 28 24 0.0040 0.0070 0.0045 5.0 | 28 24 0.0040 0.0070 0.0045 5.0
Story 2
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0120 | 0.0120 | 0.0120 | 0.0120
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
13 feet
Floor 2
28 24 0.0040 0.0070 0.0045 5.0 | 28 24 0.0040 0.0070 0.0045 5.0 | 28 24 0.0040 0.0070 0.0045 5.0
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.0120 | 0.0120 | 0.0120 | 0.0120
ρsh = 0.0089 | 0.0089 | 0.0089 | 0.0089
s (in) = 3.5 | 3.5 | 3.5 | 3.5
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 24
20 feet
Design base shear = 0.044 g, 123 k
f'c beams = 5.0 ksi
f'c,cols,upper = 6.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 7.0 ksi

Design Documentation (2 of 2)



									Design Drifts:
	$(\varphi M_n/M_u)_{neg}$ =		1.82		1.96		1.82		
	$(\varphi M_n/M_u)_{pos}$ =		1.72		2.00		1.72		
	$M_{n,pos}/M_{n,neg}$ =		0.73		0.73		0.73		
	$\varphi V_n/V_{mpr}$ =		16.63		16.63		16.63		
	SCWB =	0.89		0.84		0.84		0.89	
	Joint $\Phi V_n/V_u$ =	3.35		2.59		2.59		3.35	
Story 12	$\varphi M_n/M_u$ =	3.20		6.63		6.64		3.20	
Story 12	$\varphi V_n/V_{mpr}$ =	1.38		1.16		1.16		1.38	0.4%
Story 12	$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
	$(\varphi M_n/M_u)_{neg}$ =		1.81		2.35		1.81		
	$(\varphi M_n/M_u)_{pos}$ =		2.09		2.23		2.09		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.13		1.13		1.13		
Floor 12	SCWB =	1.35		1.34		1.34		1.35	
Floor 12	Joint $\Phi V_n/V_u$ =	1.60		1.42		1.42		1.60	
Story 11	$\varphi M_n/M_u$ =	3.09		4.95		4.95		3.10	
Story 11	$\varphi V_n/V_{mpr}$ =	1.29		1.34		1.34		1.29	0.7%
Story 11	$P/A_g f'_c$ =	0.03		0.06		0.06		0.03	
	$(\varphi M_n/M_u)_{neg}$ =		1.81		2.27		1.81		
	$(\varphi M_n/M_u)_{pos}$ =		2.17		2.32		2.17		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.12		1.12		1.12		
Floor 11	SCWB =	1.29		1.28		1.28		1.29	
Floor 11	Joint $\Phi V_n/V_u$ =	1.41		1.25		1.25		1.41	
Story 10	$\varphi M_n/M_u$ =	2.76		4.01		4.01		2.76	
Story 10	$\varphi V_n/V_{mpr}$ =	1.69		1.28		1.28		1.69	0.9%
Story 10	$P/A_g f'_c$ =	0.05		0.09		0.09		0.05	
	$(\varphi M_n/M_u)_{neg}$ =		1.80		2.24		1.80		
	$(\varphi M_n/M_u)_{pos}$ =		2.21		2.39		2.21		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.11		1.11		1.11		
Floor 10	SCWB =	1.23		1.23		1.23		1.23	
Floor 10	Joint $\Phi V_n/V_u$ =	1.22		1.09		1.09		1.22	
Story 9	$\varphi M_n/M_u$ =	2.57		3.53		3.53		2.57	
Story 9	$\varphi V_n/V_{mpr}$ =	1.91		1.44		1.44		1.91	1.1%
Story 9	$P/A_g f'_c$ =	0.07		0.12		0.12		0.07	
	$(\varphi M_n/M_u)_{neg}$ =		1.75		2.15		1.75		
	$(\varphi M_n/M_u)_{pos}$ =		2.14		2.38		2.14		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.11		1.11		1.11		
Floor 9	SCWB =	1.22		1.23		1.23		1.22	
Floor 9	Joint $\Phi V_n/V_u$ =	1.13		1.01		1.01		1.13	
Story 8	$\varphi M_n/M_u$ =	2.45		3.27		3.27		2.46	
Story 8	$\varphi V_n/V_{mpr}$ =	2.16		1.46		1.64		2.16	1.2%
Story 8	$P/A_g f'_c$ =	0.09		0.15		0.15		0.09	
	$(\varphi M_n/M_u)_{neg}$ =		1.74		2.11		1.74		
	$(\varphi M_n/M_u)_{pos}$ =		2.12		2.35		2.13		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.11		1.11		1.11		
Floor 8	SCWB =	1.20		1.23		1.23		1.20	
Floor 8	Joint $\Phi V_n/V_u$ =	1.08		0.96		0.96		1.08	
Story 7	$\varphi M_n/M_u$ =	2.39		3.14		3.14		2.39	
Story 7	$\varphi V_n/V_{mpr}$ =	2.07		1.58		1.58		2.07	1.3%
Story 7	$P/A_g f'_c$ =	0.11		0.18		0.18		0.11	
	$(\varphi M_n/M_u)_{neg}$ =		1.72		2.06		1.72		
	$(\varphi M_n/M_u)_{pos}$ =		2.06		2.19		2.06		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.12		1.12		1.12		
Floor 7	SCWB =	1.21		1.26		1.26		1.21	
Floor 7	Joint $\Phi V_n/V_u$ =	1.14		1.01		1.01		1.14	
Story 6	$\varphi M_n/M_u$ =	2.36		3.11		3.11		2.37	
Story 6	$\varphi V_n/V_{mpr}$ =	2.26		1.72		1.72		2.26	1.4%
Story 6	$P/A_g f'_c$ =	0.12		0.18		0.18		0.12	
	$(\varphi M_n/M_u)_{neg}$ =		1.72		2.03		1.72		
	$(\varphi M_n/M_u)_{pos}$ =		1.99		2.11		1.99		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.12		1.12		1.12		
Floor 6	SCWB =	1.21		1.28		1.28		1.21	
Floor 6	Joint $\Phi V_n/V_u$ =	1.11		0.99		0.99		1.11	
Story 5	$\varphi M_n/M_u$ =	2.36		3.12		3.12		2.37	
Story 5	$\varphi V_n/V_{mpr}$ =	2.18		1.67		1.67		2.18	1.5%
Story 5	$P/A_g f'_c$ =	0.13		0.21		0.21		0.13	
	$(\varphi M_n/M_u)_{neg}$ =		1.75		2.03		1.75		
	$(\varphi M_n/M_u)_{pos}$ =		1.90		2.09		1.90		
	$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
	$\varphi V_n/V_{mpr}$ =		1.14		1.14		1.14		
Floor 5	SCWB =	1.21		1.31		1.31		1.21	
Floor 5	Joint $\Phi V_n/V_u$ =	1.09		0.97		0.97		1.09	
Story 4	$\varphi M_n/M_u$ =	2.39		3.19		3.19		2.39	
Story 4	$\varphi V_n/V_{mpr}$ =	2.11		1.61		1.61		2.11	1.5%
Story 4	$P/A_g f'_c$ =	0.15		0.24		0.24		0.15	
	$(\varphi M_n/M_u)_{neg}$ =		1.76		2.01		1.76		
	$(\varphi M_n/M_u)_{pos}$ =		1.73		2.03		1.73		
	$M_{n,pos}/M_{n,neg}$ =		0.50		0.50		0.50		
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
Floor 4	SCWB =	1.23		1.36		1.36		1.23	
Floor 4	Joint $\Phi V_n/V_u$ =	1.09		0.97		0.97		1.09	
Story 3	$\varphi M_n/M_u$ =	2.43		3.31		3.31		2.43	
Story 3	$\varphi V_n/V_{mpr}$ =	2.05		1.57		1.57		2.05	1.5%
Story 3	$P/A_g f'_c$ =	0.17		0.26		0.26		0.17	
	$(\varphi M_n/M_u)_{neg}$ =		1.14		1.27		1.14		
	$(\varphi M_n/M_u)_{pos}$ =		1.21		1.50		1.21		
	$M_{n,pos}/M_{n,neg}$ =		0.58		0.58		0.58		
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
Floor 3	SCWB =	1.44		1.59		1.59		1.44	
Floor 3	Joint $\Phi V_n/V_u$ =	1.75		1.48		1.48		1.75	
Story 2	$\varphi M_n/M_u$ =	1.67		2.23		2.23		1.67	
Story 2	$\varphi V_n/V_{mpr}$ =	2.53		1.81		1.81		2.53	1.5%
Story 2	$P/A_g f'_c$ =	0.19		0.29		0.29		0.19	
	$(\varphi M_n/M_u)_{neg}$ =		1.22		1.33		1.22		
	$(\varphi M_n/M_u)_{pos}$ =		1.18		1.73		1.18		
	$M_{n,pos}/M_{n,neg}$ =		0.58		0.58		0.58		
	$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
Floor 2	SCWB =	1.19		1.32		1.32		1.19	
Floor 2	Joint $\Phi V_n/V_u$ =	1.75		1.48		1.48		1.75	
Story 1	$\varphi M_n/M_u$ =	1.31		1.99		1.99		1.31	
Story 1	$\varphi V_n/V_{mpr}$ =	2.44		1.85		1.85		2.44	1.2%
Story 1	$P/A_g f'_c$ =	0.20		0.32		0.32		0.20	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	7234	9681	9681	7234
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.078	0.088	0.088	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	114	114	110
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	7587	10367	10367	7587
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.077	0.078	0.078	0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	105	105	108
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 10	$M_{y,exp}$ (k-in) =	7936	11043	11043	7936
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.075	0.075	0.075	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	102	102	106
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 9	$M_{y,exp}$ (k-in) =	8282	11709	11709	8282
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.074	0.072	0.072	0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	99	99	105
	$(P/A_gf'_c)_{exp}$ =	0.04	0.09	0.09	0.04
Story 8	$M_{y,exp}$ (k-in) =	8625	12366	12366	8625
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.072	0.060	0.069	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	86	96	103
	$(P/A_gf'_c)_{exp}$ =	0.06	0.11	0.11	0.06
Story 7	$M_{y,exp}$ (k-in) =	8965	13015	13015	8965
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.071	0.066	0.066	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	93	93	102
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 6	$M_{y,exp}$ (k-in) =	9334	13705	13705	9334
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.075	0.070	0.070	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	98	98	107
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 5	$M_{y,exp}$ (k-in) =	9671	14343	14343	9671
	EI_{stf}/EI_g =	0.35	0.42	0.42	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.073	0.067	0.067	0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	96	96	106
	$(P/A_gf'_c)_{exp}$ =	0.08	0.15	0.15	0.08
Story 4	$M_{y,exp}$ (k-in) =	10005	14975	14975	10005
	EI_{stf}/EI_g =	0.36	0.44	0.44	0.36
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.072	0.065	0.065	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	94	94	105
	$(P/A_gf'_c)_{exp}$ =	0.09	0.17	0.17	0.09
Story 3	$M_{y,exp}$ (k-in) =	10337	15601	15601	10337
	EI_{stf}/EI_g =	0.37	0.46	0.46	0.37
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.063	0.063	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	91	91	103
	$(P/A_gf'_c)_{exp}$ =	0.10	0.19	0.19	0.10
Story 2	$M_{y,exp}$ (k-in) =	7963	11463	11463	7963
	EI_{stf}/EI_g =	0.38	0.48	0.48	0.38
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.065	0.053	0.053	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	89	89	102
	$(P/A_gf'_c)_{exp}$ =	0.11	0.21	0.21	0.11
Story 1	$M_{y,exp}$ (k-in) =	8293	12073	12073	8293
	EI_{stf}/EI_g =	0.39	0.50	0.50	0.39
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.064	0.052	0.052	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	101	87	87	101
	$(P/A_gf'_c)_{exp}$ =	0.12	0.23	0.23	0.12

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	3175	-8021	0.35	1.522E+08	0.0336	-0.052	0.089	99
	3175	-8021	0.35	1.522E+08	0.0336	-0.052	0.089	99
	3175	-8021	0.35	1.522E+08	0.0336	-0.052	0.089	99
Floor 12	3648	-10732	0.35	1.522E+08	0.043	-0.070	0.100	104
	3648	-10732	0.35	1.522E+08	0.043	-0.070	0.100	104
	3648	-10732	0.35	1.522E+08	0.043	-0.070	0.100	104
Floor 11	4121	-11633	0.35	1.522E+08	0.046	-0.075	0.100	109
	4121	-11633	0.35	1.522E+08	0.046	-0.075	0.100	109
	4121	-11633	0.35	1.522E+08	0.046	-0.075	0.100	109
Floor 10	4594	-12532	0.35	1.522E+08	0.044	-0.071	0.100	99
	4594	-12532	0.35	1.522E+08	0.044	-0.071	0.100	99
	4594	-12532	0.35	1.522E+08	0.044	-0.071	0.100	99
Floor 9	4830	-12981	0.35	1.522E+08	0.045	-0.072	0.100	99
	4830	-12981	0.35	1.522E+08	0.045	-0.072	0.100	99
	4830	-12981	0.35	1.522E+08	0.045	-0.072	0.100	99
Floor 8	5065	-13429	0.35	1.522E+08	0.046	-0.073	0.100	99
	5065	-13429	0.35	1.522E+08	0.046	-0.073	0.100	99
	5065	-13429	0.35	1.522E+08	0.046	-0.073	0.100	99
Floor 7	5183	-13653	0.35	1.522E+08	0.047	-0.074	0.100	99
	5183	-13653	0.35	1.522E+08	0.0469	-0.074	0.100	99
	5183	-13653	0.35	1.522E+08	0.0469	-0.074	0.100	99
Floor 6	5301	-13877	0.35	1.522E+08	0.047	-0.074	0.100	99
	5301	-13877	0.35	1.522E+08	0.0474	-0.074	0.100	99
	5301	-13877	0.35	1.522E+08	0.0474	-0.074	0.100	99
Floor 5	5418	-14101	0.35	1.522E+08	0.050	-0.078	0.100	104
	5418	-14101	0.35	1.522E+08	0.0501	-0.078	0.100	104
	5418	-14101	0.35	1.522E+08	0.0501	-0.078	0.100	104
Floor 4	5301	-14098	0.35	1.522E+08	0.050	-0.079	0.100	104
	5301	-14098	0.35	1.522E+08	0.05	-0.079	0.100	104
	5301	-14098	0.35	1.522E+08	0.05	-0.079	0.100	104
Floor 3	3885	-10288	0.35	1.522E+08	0.045	-0.072	0.100	109
	3885	-10288	0.35	1.522E+08	0.0455	-0.072	0.100	109
	3885	-10288	0.35	1.522E+08	0.0455	-0.072	0.100	109
Floor 2	3885	-10288	0.35	1.522E+08	0.045	-0.072	0.100	109
	3885	-10288	0.35	1.522E+08	0.045	-0.072	0.100	109
	3885	-10288	0.35	1.522E+08	0.045	-0.072	0.100	109

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.92 T_2= 0.63 T_3= 0.37

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

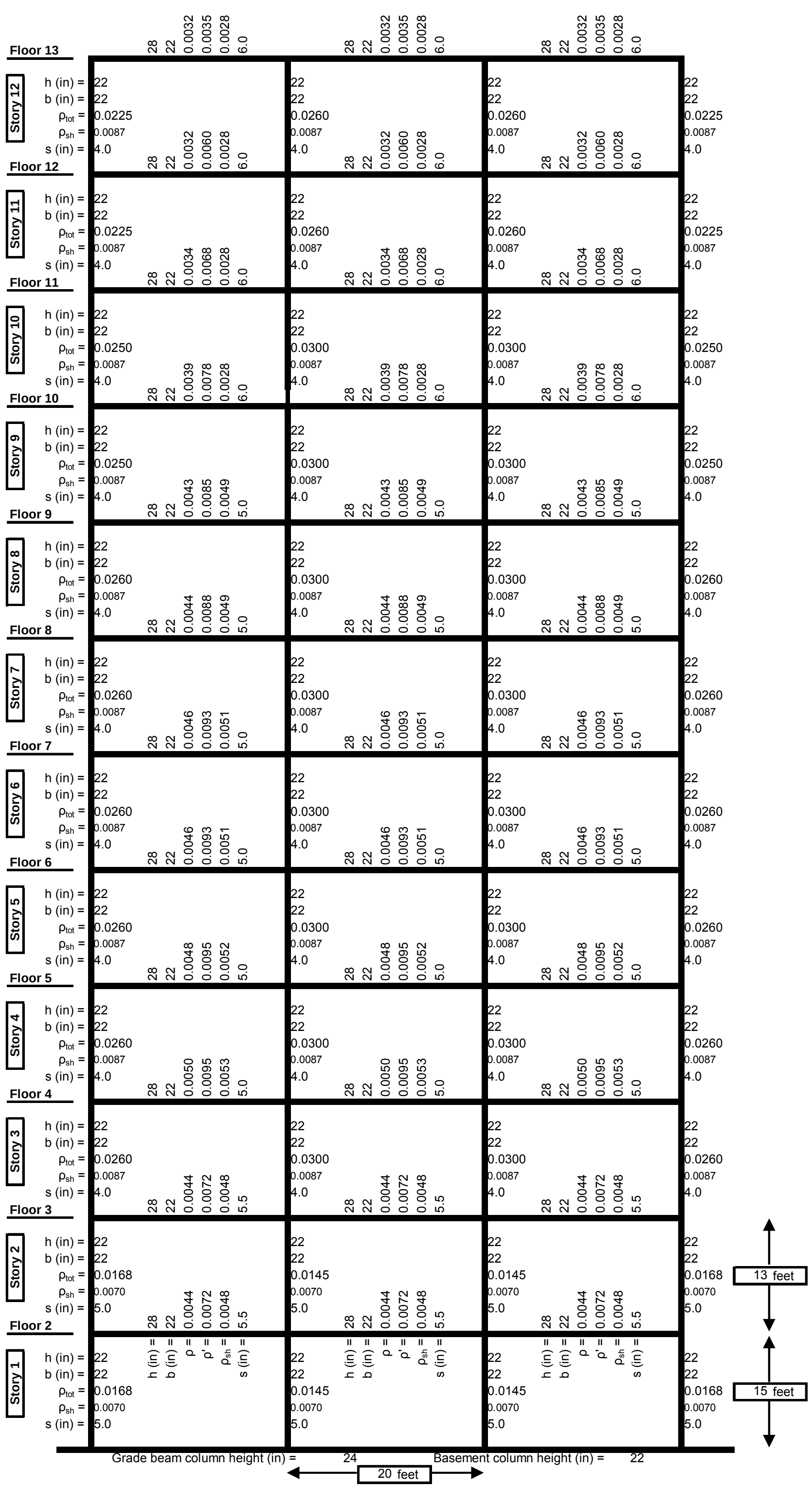
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1018
Number of Stories: 12
Fundamental Period (sec): 2.09

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Column sizes were returned to 22 inches square to meet drift requirements while still enabling SCWB and joint shear requirements to be met in the upper floors. Column concrete strength was increased to 7.0 ksi in the lower stories and 6.0 ksi in the upper stories to meet joint shear requirements. Beam reinforcement was determined by demand in the bottom floor and then stepped up to meet 80% weak story requirement. In some cases, positive bending strength was determined by the minimum positive-to-negative strength ratio. Column strengths were determined by SCWB considerations.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



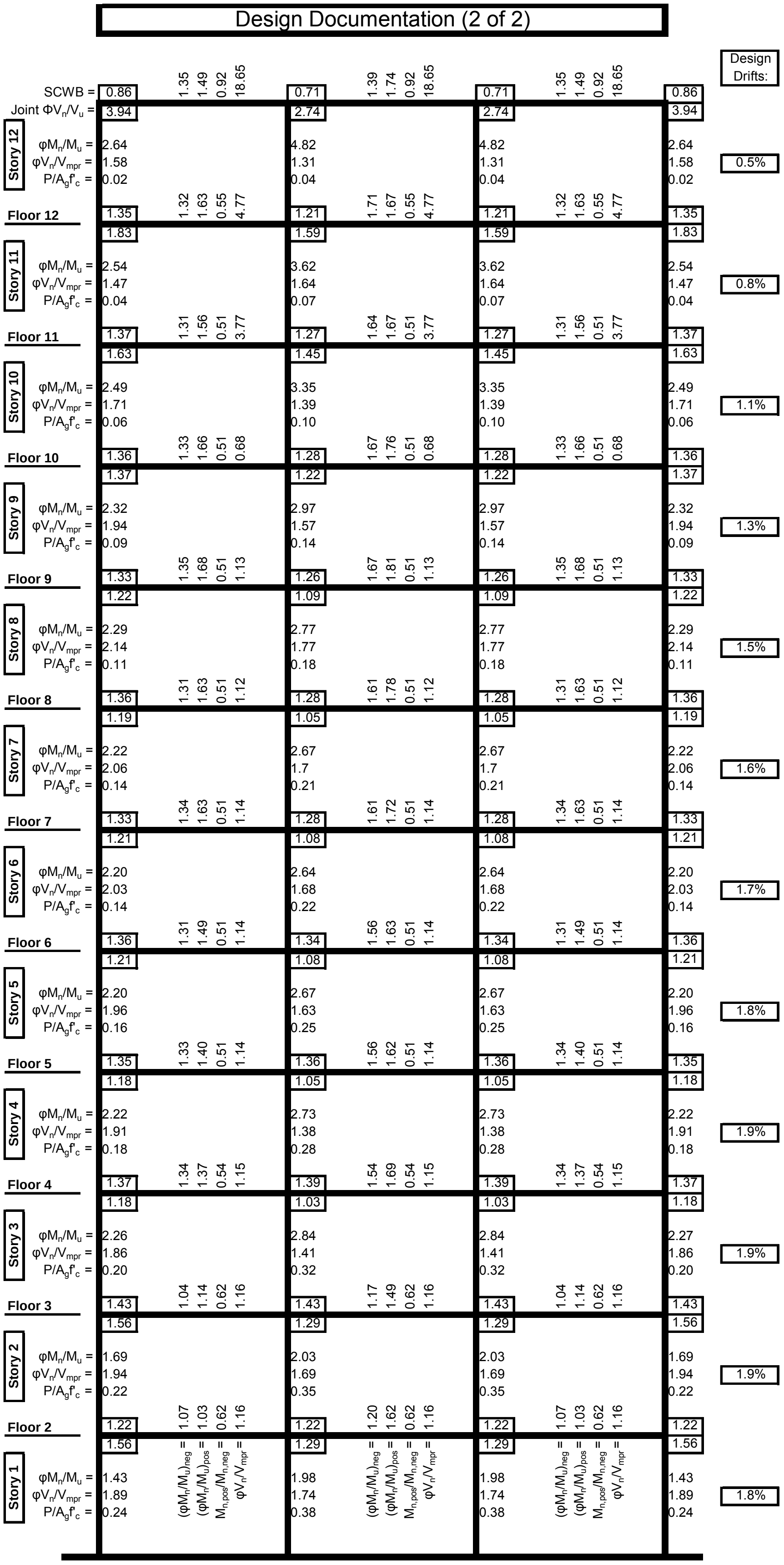
Story 12	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0225	0.0260	0.0260	0.0225
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 11	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0225	0.0260	0.0260	0.0225
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 10	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0250	0.0300	0.0300	0.0250
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 9	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0250	0.0300	0.0300	0.0250
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 8	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 7	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 6	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 5	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 4	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 3	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0260	0.0300	0.0300	0.0260
	ρ_{sh} =	0.0087	0.0087	0.0087	0.0087
	s (in) =	4.0	4.0	4.0	4.0
Story 2	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0168	0.0145	0.0145	0.0168
	ρ_{sh} =	0.0070	0.0070	0.0070	0.0070
	s (in) =	5.0	5.0	5.0	5.0
Story 1	h (in) =	22	22	22	22
	b (in) =	22	22	22	22
	ρ_{tot} =	0.0168	0.0145	0.0145	0.0168
	ρ_{sh} =	0.0070	0.0070	0.0070	0.0070
	s (in) =	5.0	5.0	5.0	5.0

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	28	22	0.0032	0.0035	0.0028	6.0	28	22	0.0032	0.0035	0.0028	6.0	28	22	0.0032	0.0035	0.0028	6.0
Floor 12	28	22	0.0032	0.0060	0.0028	6.0	28	22	0.0032	0.0060	0.0028	6.0	28	22	0.0032	0.0060	0.0028	6.0
Floor 11	28	22	0.0034	0.0068	0.0028	6.0	28	22	0.0034	0.0068	0.0028	6.0	28	22	0.0034	0.0068	0.0028	6.0
Floor 10	28	22	0.0039	0.0078	0.0028	6.0	28	22	0.0039	0.0078	0.0028	6.0	28	22	0.0039	0.0078	0.0028	6.0
Floor 9	28	22	0.0043	0.0085	0.0049	5.0	28	22	0.0043	0.0085	0.0049	5.0	28	22	0.0043	0.0085	0.0049	5.0
Floor 8	28	22	0.0044	0.0088	0.0049	5.0	28	22	0.0044	0.0088	0.0049	5.0	28	22	0.0044	0.0088	0.0049	5.0
Floor 7	28	22	0.0046	0.0093	0.0051	5.0	28	22	0.0046	0.0093	0.0051	5.0	28	22	0.0046	0.0093	0.0051	5.0
Floor 6	28	22	0.0046	0.0093	0.0051	5.0	28	22	0.0046	0.0093	0.0051	5.0	28	22	0.0046	0.0093	0.0051	5.0
Floor 5	28	22	0.0048	0.0095	0.0052	5.0	28	22	0.0048	0.0095	0.0052	5.0	28	22	0.0048	0.0095	0.0052	5.0
Floor 4	28	22	0.0050	0.0095	0.0053	5.0	28	22	0.0050	0.0095	0.0053	5.0	28	22	0.0050	0.0095	0.0053	5.0
Floor 3	28	22	0.0044	0.0072	0.0048	5.5	28	22	0.0044	0.0072	0.0048	5.5	28	22	0.0044	0.0072	0.0048	5.5
Floor 2	28	22	0.0044	0.0072	0.0048	5.5	28	22	0.0044	0.0072	0.0048	5.5	28	22	0.0044	0.0072	0.0048	5.5

Grade beam column height (in) = 24

Basement column height (in) = 22

Design base shear =	0.044 g,	123 k	
f'_c beams = 5.0 ksi		$f'_{c,cols,upper}$ = 6.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 7.0 ksi	


Design Documentation (2 of 2)
Design Drifts:
1.35 1.49 0.92 18.65
1.39 1.74 0.92 18.65
1.35 1.49 0.92 18.65
SCWB = 0.86 0.71 0.71 0.86
Joint $\Phi V_n/V_u$ = 3.94 2.74 2.74 3.94
Story 12
$\varphi M_n/M_u$ = 2.64 4.82 4.82 2.64
$\varphi V_n/V_{mpr}$ = 1.58 1.31 1.31 1.58
$P/A_gf'_c$ = 0.02 0.04 0.04 0.02
0.5%
1.32 1.63 0.55 4.77
1.71 1.67 0.55 4.77
1.32 1.63 0.55 4.77
Floor 12
1.35 1.21 1.21 1.35
1.83 1.59 1.59 1.83
Story 11
$\varphi M_n/M_u$ = 2.54 3.62 3.62 2.54
$\varphi V_n/V_{mpr}$ = 1.47 1.64 1.64 1.47
$P/A_gf'_c$ = 0.04 0.07 0.07 0.04
0.8%
1.31 1.56 0.51 3.77
1.64 1.67 0.51 3.77
1.31 1.56 0.51 3.77
Floor 11
1.37 1.27 1.27 1.37
1.63 1.45 1.45 1.63
Story 10
$\varphi M_n/M_u$ = 2.49 3.35 3.35 2.49
$\varphi V_n/V_{mpr}$ = 1.71 1.39 1.39 1.71
$P/A_gf'_c$ = 0.06 0.10 0.10 0.06
1.1%
1.33 1.66 0.51 0.68
1.67 1.76 0.51 0.68
1.33 1.66 0.51 0.68
Floor 10
1.36 1.28 1.28 1.36
1.37 1.22 1.22 1.37
Story 9
$\varphi M_n/M_u$ = 2.32 2.97 2.97 2.32
$\varphi V_n/V_{mpr}$ = 1.94 1.57 1.57 1.94
$P/A_gf'_c$ = 0.09 0.14 0.14 0.09
1.3%
1.35 1.68 0.51 1.13
1.67 1.81 0.51 1.13
1.35 1.68 0.51 1.13
Floor 9
1.33 1.26 1.26 1.33
1.22 1.09 1.09 1.22
Story 8
$\varphi M_n/M_u$ = 2.29 2.77 2.77 2.29
$\varphi V_n/V_{mpr}$ = 2.14 1.77 1.77 2.14
$P/A_gf'_c$ = 0.11 0.18 0.18 0.11
1.5%
1.31 1.63 0.51 1.12
1.61 1.78 0.51 1.12
1.31 1.63 0.51 1.12
Floor 8
1.36 1.28 1.28 1.36
1.19 1.05 1.05 1.19
Story 7
$\varphi M_n/M_u$ = 2.22 2.67 2.67 2.22
$\varphi V_n/V_{mpr}$ = 2.06 1.7 1.7 2.06
$P/A_gf'_c$ = 0.14 0.21 0.21 0.14
1.6%
1.34 1.63 0.51 1.14
1.61 1.72 0.51 1.14
1.34 1.63 0.51 1.14
Floor 7
1.33 1.28 1.28 1.33
1.21 1.08 1.08 1.21
Story 6
$\varphi M_n/M_u$ = 2.20 2.64 2.64 2.20
$\varphi V_n/V_{mpr}$ = 2.03 1.68 1.68 2.03
$P/A_gf'_c$ = 0.14 0.22 0.22 0.14
1.7%
1.31 1.49 0.51 1.14
1.56 1.63 0.51 1.14
1.31 1.49 0.51 1.14
Floor 6
1.36 1.34 1.34 1.36
1.21 1.08 1.08 1.21
Story 5
$\varphi M_n/M_u$ = 2.20 2.67 2.67 2.20
$\varphi V_n/V_{mpr}$ = 1.96 1.63 1.63 1.96
$P/A_gf'_c$ = 0.16 0.25 0.25 0.16
1.8%
1.33 1.40 0.51 1.14
1.56 1.62 0.51 1.14
1.34 1.40 0.51 1.14
Floor 5
1.35 1.36 1.36 1.35
1.18 1.05 1.05 1.18
Story 4
$\varphi M_n/M_u$ = 2.22 2.73 2.73 2.22
$\varphi V_n/V_{mpr}$ = 1.91 1.38 1.38 1.91
$P/A_gf'_c$ = 0.18 0.28 0.28 0.18
1.9%
1.34 1.37 0.54 1.15
1.54 1.69 0.54 1.15
1.34 1.37 0.54 1.15
Floor 4
1.37 1.39 1.39 1.37
1.18 1.03 1.03 1.18
Story 3
$\varphi M_n/M_u$ = 2.26 2.84 2.84 2.27
$\varphi V_n/V_{mpr}$ = 1.86 1.41 1.41 1.86
$P/A_gf'_c$ = 0.20 0.32 0.32 0.20
1.9%
1.04 1.14 0.62 1.16
1.17 1.49 0.62 1.16
1.04 1.14 0.62 1.16
Floor 3
1.43 1.43 1.43 1.43
1.56 1.29 1.29 1.56
Story 2
$\varphi M_n/M_u$ = 1.69 2.03 2.03 1.69
$\varphi V_n/V_{mpr}$ = 1.94 1.69 1.69 1.94
$P/A_gf'_c$ = 0.22 0.35 0.35 0.22
1.9%
1.07 1.03 0.62 1.16
1.20 1.62 0.62 1.16
1.07 1.03 0.62 1.16
Floor 2
1.22 1.22 1.22 1.22
1.56 1.29 1.29 1.56
Story 1
$\varphi M_n/M_u$ = 1.43 1.98 1.98 1.43
$\varphi V_n/V_{mpr}$ = 1.89 1.74 1.74 1.89
$P/A_gf'_c$ = 0.24 0.38 0.38 0.24
1.8%
$(\varphi M_n/M_u)_{neg}$ =
$(\varphi M_n/M_u)_{pos}$ =
$M_{n,pos}/M_{n,neg}$ =
$\varphi V_n/V_{mpr}$ =

Modeling Documentation (1 of 1)

Floor 13

$M_{y,pos,exp}$ (k-in) =	2885	2885	2885
$M_{y,n,slab,exp}$ (k-in) =	-6818	-6818	-6818
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.035	0.035	0.035
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.052	-0.052	-0.052
Θ_{pc} (rad) =	0.096	0.096	0.096
λ =	99	99	99

Story 12

$M_{y,exp}$ (k-in) =	5981	7143	7143	5981
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.20	1.20	1.20
$\Theta_{cap,pl}$ (rad) =	0.084	0.084	0.084	0.084
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	105	103	103	105
$(P/A_gf'_c)_{exp}$ =	0.01	0.03	0.03	0.01

Floor 12

$M_{y,pos,exp}$ (k-in) =	2883	2883	2883
$M_{y,n,slab,exp}$ (k-in) =	-8894	-8894	-8894
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.057	-0.057	-0.057
Θ_{pc} (rad) =	0.096	0.096	0.096
λ =	99	99	99

Story 11

$M_{y,exp}$ (k-in) =	6300	7768	7768	6300
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.082	0.080	0.080	0.082
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	103	99	99	103
$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03

Floor 11

$M_{y,pos,exp}$ (k-in) =	3017	3017	3017
$M_{y,n,slab,exp}$ (k-in) =	-9513	-9513	-9513
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
Θ_{pc} (rad) =	0.096	0.096	0.096
λ =	99	99	99

Story 10

$M_{y,exp}$ (k-in) =	7217	9335	9335	7217
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.081	0.079	0.079	0.081
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	101	96	96	101
$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04

Floor 10

$M_{y,pos,exp}$ (k-in) =	3452	3452	3452
$M_{y,n,slab,exp}$ (k-in) =	-10340	-10340	-10340
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
Θ_{pc} (rad) =	0.096	0.096	0.096
λ =	99	99	99

Story 9

$M_{y,exp}$ (k-in) =	7528	9936	9936	7528
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.079	0.075	0.075	0.079
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	99	93	93	99
$(P/A_gf'_c)_{exp}$ =	0.05	0.11	0.11	0.05

Floor 9

$M_{y,pos,exp}$ (k-in) =	3778	3778	3778
$M_{y,n,slab,exp}$ (k-in) =	-10958	-10958	-10958
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.077	-0.077	-0.077
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 8

$M_{y,exp}$ (k-in) =	8076	10529	10529	8076
EI_{stf}/EI_g =	0.36	0.43	0.43	0.36
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.078	0.071	0.071	0.078
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	98	89	89	98
$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07

Floor 8

$M_{y,pos,exp}$ (k-in) =	3886	3886	3886
$M_{y,n,slab,exp}$ (k-in) =	-11164	-11164	-11164
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.078	-0.078	-0.078
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 7

$M_{y,exp}$ (k-in) =	8381	11114	11114	8381
EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.076	0.068	0.068	0.076
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	96	86	86	96
$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08

Floor 7

$M_{y,pos,exp}$ (k-in) =	4103	4103	4103
$M_{y,n,slab,exp}$ (k-in) =	-11576	-11576	-11576
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0486	0.0486
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 6

$M_{y,exp}$ (k-in) =	8714	11735	11735	8714
EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.073	0.065	0.065	0.073
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	96	86	86	96
$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08

Floor 6

$M_{y,pos,exp}$ (k-in) =	4103	4103	4103
$M_{y,n,slab,exp}$ (k-in) =	-11576	-11576	-11576
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0486	0.0486
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 5

$M_{y,exp}$ (k-in) =	9016	12310	12310	9016
EI_{stf}/EI_g =	0.39	0.48	0.48	0.39
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.071	0.062	0.062	0.071
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	94	84	84	94
$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09

Floor 5

$M_{y,pos,exp}$ (k-in) =	4211	4211	4211
$M_{y,n,slab,exp}$ (k-in) =	-11781	-11781	-11781
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0492	0.0492
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.080	-0.080	-0.080
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 4

$M_{y,exp}$ (k-in) =	9316	12878	12878	9316
EI_{stf}/EI_g =	0.40	0.50	0.50	0.40
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.070	0.060	0.060	0.070
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	93	81	81	93
$(P/A_gf'_c)_{exp}$ =	0.10	0.21	0.21	0.10

Floor 4

$M_{y,pos,exp}$ (k-in) =	4427	4427	4427
$M_{y,n,slab,exp}$ (k-in) =	-11786	-11786	-11786
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.0502	0.0502
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	109	109	109

Story 3

$M_{y,exp}$ (k-in) =	9614	13441	13441	9614
EI_{stf}/EI_g =	0.41	0.52	0.52	0.41
M_c/M_y =	1.18	1.16	1.16	1.18
$\Theta_{cap,pl}$ (rad) =	0.069	0.057	0.057	0.069
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	92	79	79	92
$(P/A_gf'_c)_{exp}$ =	0.11	0.23	0.23	0.11

Floor 3

$M_{y,pos,exp}$ (k-in) =	3908	3908	3908
$M_{y,n,slab,exp}$ (k-in) =	-9897	-9897	-9897
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.0458	0.0458
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	104	104	104

Story 2

$M_{y,exp}$ (k-in) =	7715	10323	10323	7715
EI_{stf}/EI_g =	0.42	0.55	0.55	0.42
M_c/M_y =	1.18	1.16	1.16	1.18
$\Theta_{cap,pl}$ (rad) =	0.053	0.041	0.041	0.053
Θ_{pc} (rad) =	0.100	0.093	0.093	0.100
λ =	80	68	68	80
$(P/A_gf'_c)_{exp}$ =	0.13	0.25	0.25	0.13

Floor 2

$M_{y,pos,exp}$ (k-in) =	3908	3908	3908
$M_{y,n,slab,exp}$ (k-in) =	-9897	-9897	-9897
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	104	104	104

Story 1

$M_{y,exp}$ (k-in) =	8011	10870	10870	8011
EI_{stf}/EI_g =	0.43	0.57	0.57	0.43
M_c/M_y =	1.18	1.16	1.16	1.18
$\Theta_{cap,pl}$ (rad) =	0.052	0.040	0.040	0.052
Θ_{pc} (rad) =	0.100	0.085	0.085	0.100
λ =	79	66	66	79
$(P/A_gf'_c)_{exp}$ =	0.14	0.27	0.27	0.14

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.09 T_2 = 0.69 T_3 = 0.40

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

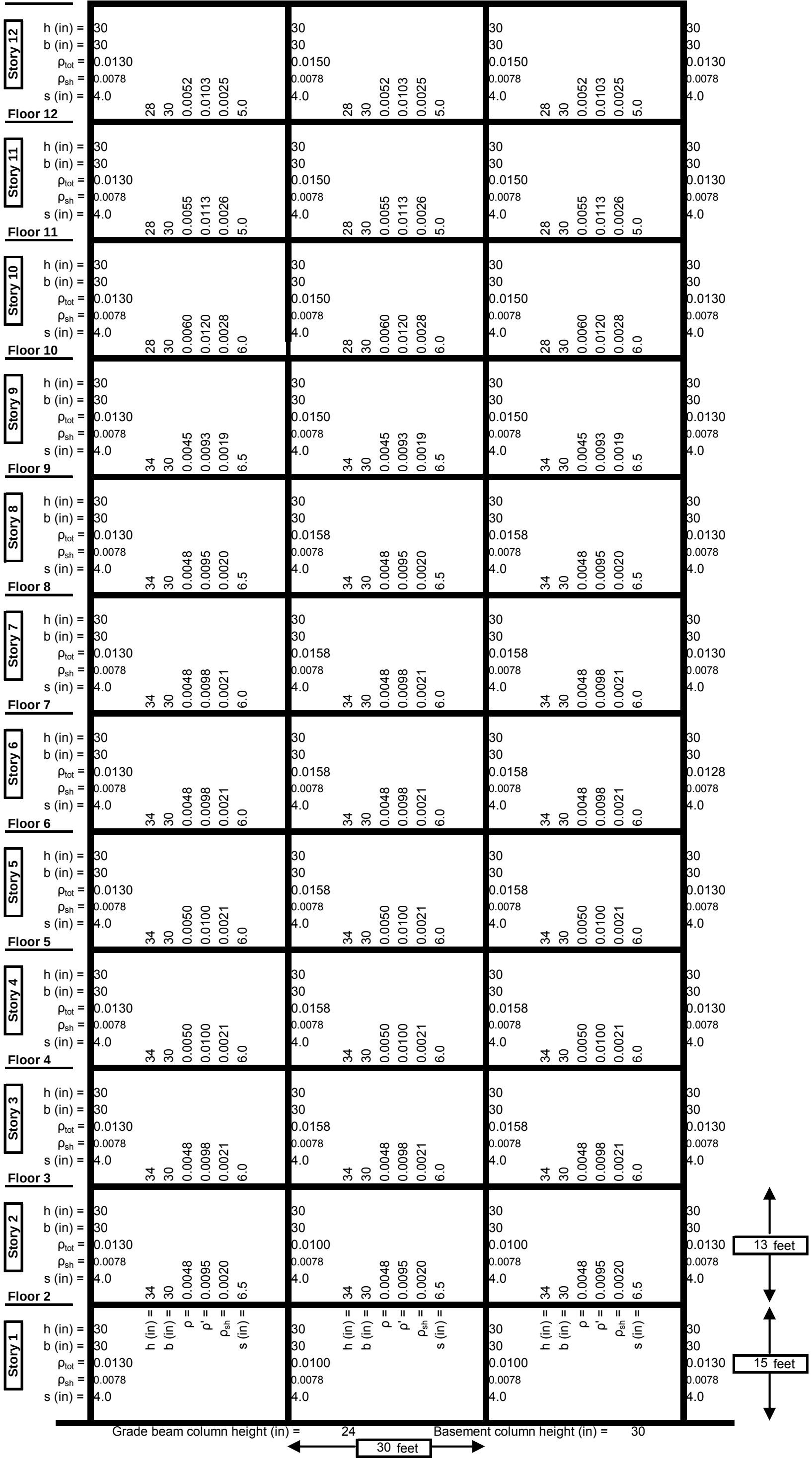
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1019
Number of Stories: 12
Fundamental Period (sec): 2.00

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by both drift limits and minimum joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios. Column concrete strength was increased to 6.0 ksi in order to meet joint shear requiremetns. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)

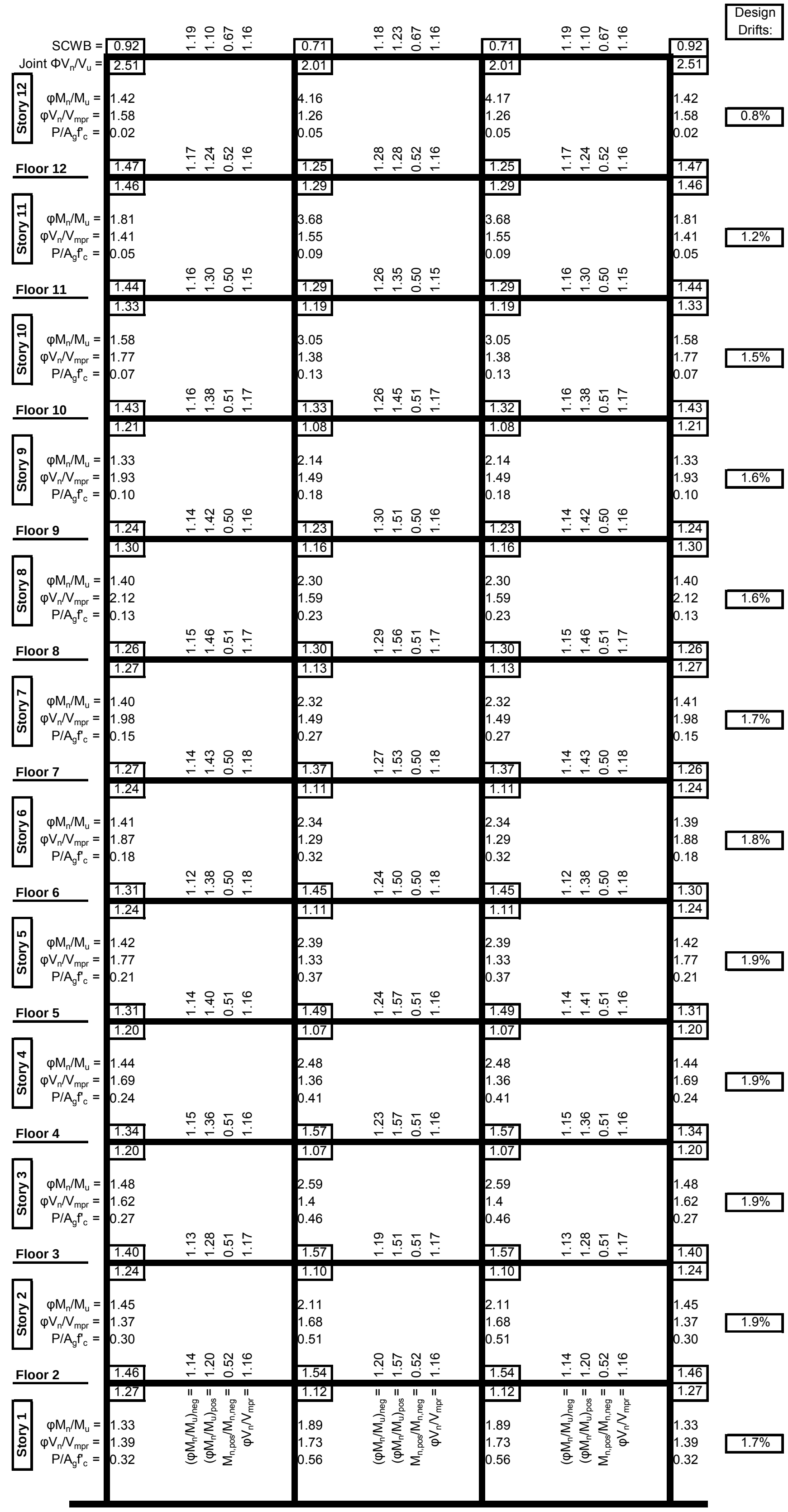


	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	30	30	0.0130	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 11	30	30	0.0130	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 10	30	30	0.0130	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 9	30	30	0.0130	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0150	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 8	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 7	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 6	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0128	0.0078	4.0
Story 5	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 4	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 3	30	30	0.0130	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0158	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 2	30	30	0.0130	0.0078	4.0	30	30	0.0100	0.0078	4.0	30	30	0.0100	0.0078	4.0	30	30	0.0130	0.0078	4.0
Story 1	30	30	0.0130	0.0078	4.0	30	30	0.0100	0.0078	4.0	30	30	0.0100	0.0078	4.0	30	30	0.0130	0.0078	4.0

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	28	30	0.0050	0.0075	0.0021	6.0	28	30	0.0050	0.0075	0.0021	6.0	28	30	0.0050	0.0075	0.0021	6.0
Floor 12	28	30	0.0052	0.0103	0.0025	5.0	28	30	0.0052	0.0103	0.0025	5.0	28	30	0.0052	0.0103	0.0025	5.0
Floor 11	28	30	0.0055	0.0113	0.0026	5.0	28	30	0.0055	0.0113	0.0026	5.0	28	30	0.0055	0.0113	0.0026	5.0
Floor 10	28	30	0.0060	0.0120	0.0028	6.0	28	30	0.0060	0.0120	0.0028	6.0	28	30	0.0060	0.0120	0.0028	6.0
Floor 9	34	30	0.0045	0.0093	0.0019	6.5	34	30	0.0045	0.0093	0.0019	6.5	34	30	0.0045	0.0093	0.0019	6.5
Floor 8	34	30	0.0048	0.0095	0.0020	6.5	34	30	0.0048	0.0095	0.0020	6.5	34	30	0.0048	0.0095	0.0020	6.5
Floor 7	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0
Floor 6	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0
Floor 5	34	30	0.0050	0.0100	0.0021	6.0	34	30	0.0050	0.0100	0.0021	6.0	34	30	0.0050	0.0100	0.0021	6.0
Floor 4	34	30	0.0050	0.0100	0.0021	6.0	34	30	0.0050	0.0100	0.0021	6.0	34	30	0.0050	0.0100	0.0021	6.0
Floor 3	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0	34	30	0.0048	0.0098	0.0021	6.0
Floor 2	34	30	0.0048	0.0095	0.0020	6.5	34	30	0.0048	0.0095	0.0020	6.5	34	30	0.0048	0.0095	0.0020	6.5

Design base shear =	0.044	g,	276	k		
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi	
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	6.0	ksi	

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	10131	12491	12491	10131
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.074	0.073	0.073	0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	117	117	120
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 11	$M_{y,exp}$ (k-in) =	11148	14461	14461	11148
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.071	0.068	0.068	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	117	112	112	117
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 10	$M_{y,exp}$ (k-in) =	12147	16373	16373	12147
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.069	0.065	0.065	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	115	108	108	115
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 9	$M_{y,exp}$ (k-in) =	13129	18237	18237	13129
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.067	0.061	0.061	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	112	103	103	112
	$(P/A_gf'_c)_{exp}$ =	0.06	0.13	0.13	0.06
Story 8	$M_{y,exp}$ (k-in) =	14095	20553	20553	14095
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.065	0.058	0.058	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	99	99	110
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 7	$M_{y,exp}$ (k-in) =	15048	22336	22336	15048
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.063	0.054	0.054	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	95	95	108
	$(P/A_gf'_c)_{exp}$ =	0.10	0.19	0.19	0.10
Story 6	$M_{y,exp}$ (k-in) =	15987	24085	24085	15822
	EI_{stf}/EI_g =	0.35	0.44	0.44	0.35
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.062	0.051	0.051	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	91	91	105
	$(P/A_gf'_c)_{exp}$ =	0.11	0.23	0.23	0.11
Story 5	$M_{y,exp}$ (k-in) =	16914	25804	25804	16914
	EI_{stf}/EI_g =	0.35	0.47	0.47	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.060	0.048	0.048	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	87	87	103
	$(P/A_gf'_c)_{exp}$ =	0.13	0.26	0.26	0.13
Story 4	$M_{y,exp}$ (k-in) =	17830	27495	27495	17830
	EI_{stf}/EI_g =	0.36	0.50	0.50	0.36
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.058	0.046	0.046	0.058
	Θ_{pc} (rad) =	0.100	0.090	0.090	0.100
	λ =	101	83	83	101
	$(P/A_gf'_c)_{exp}$ =	0.15	0.29	0.29	0.15
Story 3	$M_{y,exp}$ (k-in) =	18736	33401	33401	18736
	EI_{stf}/EI_g =	0.37	0.53	0.53	0.37
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.056	0.043	0.043	0.056
	Θ_{pc} (rad) =	0.100	0.080	0.080	0.100
	λ =	99	80	80	99
	$(P/A_gf'_c)_{exp}$ =	0.16	0.32	0.32	0.16
Story 2	$M_{y,exp}$ (k-in) =	19631	29274	29274	19631
	EI_{stf}/EI_g =	0.39	0.56	0.56	0.39
	M_c/M_y =	1.18	1.15	1.15	1.18
	$\Theta_{cap,pl}$ (rad) =	0.055	0.039	0.039	0.055
	Θ_{pc} (rad) =	0.100	0.072	0.072	0.100
	λ =	97	77	77	97
	$(P/A_gf'_c)_{exp}$ =	0.18	0.36	0.36	0.18
Story 1	$M_{y,exp}$ (k-in) =	20517	29668	29668	20517
	EI_{stf}/EI_g =	0.40	0.59	0.59	0.40
	M_c/M_y =	1.18	1.15	1.15	1.18
	$\Theta_{cap,pl}$ (rad) =	0.053	0.036	0.036	0.053
	Θ_{pc} (rad) =	0.100	0.064	0.064	0.100
	λ =	95	74	74	95
	$(P/A_gf'_c)_{exp}$ =	0.19	0.39	0.39	0.19

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	6012	-10636	0.35	2.128E+08	0.0335	-0.047	0.074	99
	6012	-10636	0.35	2.128E+08	0.0335	-0.047	0.074	99
	6012	-10636	0.35	2.128E+08	0.0335	-0.047	0.074	99
Floor 12	6307	-13745	0.35	2.128E+08	0.038	-0.058	0.086	109
	6307	-13745	0.35	2.128E+08	0.038	-0.058	0.086	109
	6307	-13745	0.35	2.128E+08	0.038	-0.058	0.086	109
Floor 11	6637	-14869	0.35	2.128E+08	0.039	-0.060	0.090	109
	6637	-14869	0.35	2.128E+08	0.039	-0.060	0.090	109
	6637	-14869	0.35	2.128E+08	0.039	-0.060	0.090	109
Floor 10	7214	-15717	0.35	2.128E+08	0.038	-0.057	0.096	99
	7214	-15717	0.35	2.128E+08	0.038	-0.057	0.096	99
	7214	-15717	0.35	2.128E+08	0.038	-0.057	0.096	99
Floor 9	8432	-18855	0.35	3.675E+08	0.030	-0.047	0.070	106
	8432	-18855	0.35	3.675E+08	0.030	-0.047	0.070	106
	8432	-18855	0.35	3.675E+08	0.030	-0.047	0.070	106
Floor 8	8813	-19293	0.35	3.675E+08	0.031	-0.047	0.073	106
	8813	-19293	0.35	3.675E+08	0.031	-0.047	0.073	106
	8813	-19293	0.35	3.675E+08	0.031	-0.047	0.073	106
Floor 7	8814	-19724	0.35	3.675E+08	0.033	-0.050	0.074	110
	8814	-19724	0.35	3.675E+08	0.0325	-0.050	0.074	110
	8814	-19724	0.35	3.675E+08	0.0325	-0.050	0.074	110
Floor 6	8814	-19724	0.35	3.675E+08	0.033	-0.050	0.074	110
	8814	-19724	0.35	3.675E+08	0.0325	-0.050	0.074	110
	8814	-19724	0.35	3.675E+08	0.0325	-0.050	0.074	110
Floor 5	9268	-20163	0.35	3.675E+08	0.033	-0.050	0.076	110
	9268	-20163	0.35	3.675E+08	0.0332	-0.050	0.076	110
	9268	-20163	0.35	3.675E+08	0.0332	-0.050	0.076	110
Floor 4	9268	-20163	0.35	3.675E+08	0.033	-0.050	0.076	110
	9268	-20163	0.35	3.675E+08	0.0332	-0.050	0.076	110
	9268	-20163	0.35	3.675E+08	0.0332	-0.050	0.076	110
Floor 3	8931	-19726	0.35	3.675E+08	0.033	-0.050	0.074	110
	8931	-19726	0.35	3.675E+08	0.0326	-0.050	0.074	110
	8931	-19726	0.35	3.675E+08	0.0326	-0.050	0.074	110
Floor 2	8930	-19295	0.35	3.675E+08	0.031	-0.047	0.073	106
	8930	-19295	0.35	3.675E+08	0.031	-0.047	0.073	106
	8930	-19295	0.35	3.675E+08	0.031	-0.047	0.073	106

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 2.00 T_2 = 0.67 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

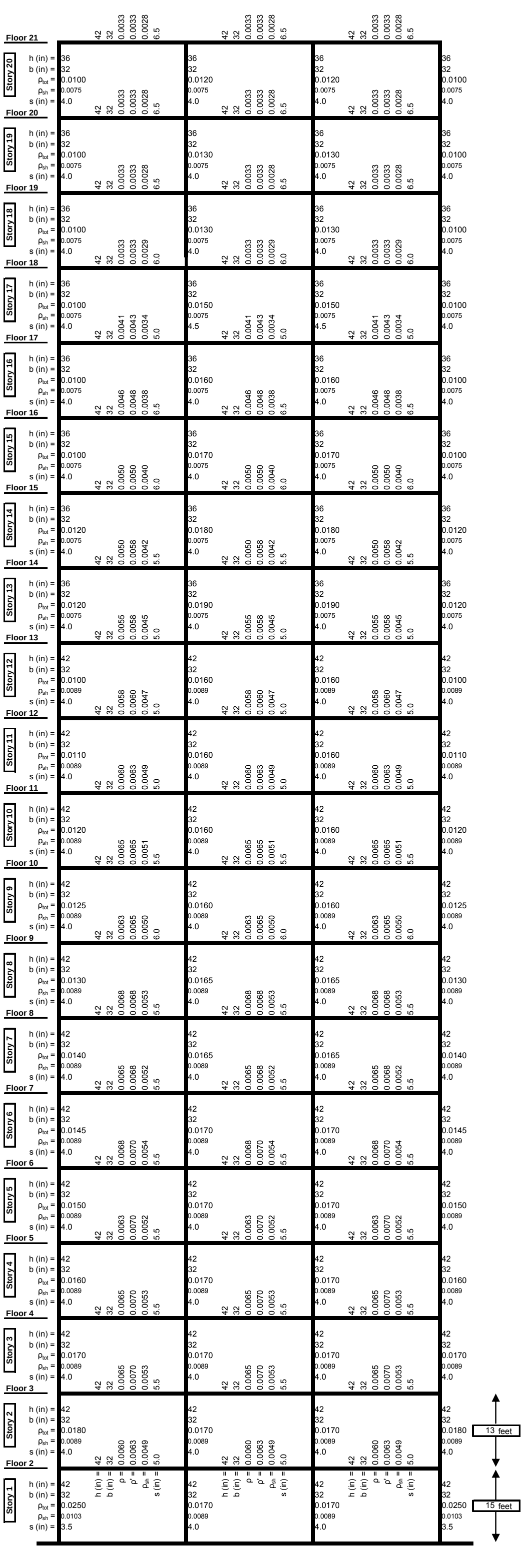
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1020
Number of Stories: 20
Fundamental Period (sec): 2.63

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by drift limits and column-beam compatibility considerations. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the bottom story where flexural considerations controlled and in the upper stories where minimum reinforcement ratios controlled. Column concrete was increased to 6.0 ksi in the lower stories to meet joint shear requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Columns:

	h (in)	b (in)	ρ_{tot}	ρ_{sh}	s (in)	h (in)	b (in)	ρ_{tot}	ρ_{sh}	s (in)	h (in)	b (in)	ρ_{tot}	ρ_{sh}	s (in)	h (in)	b (in)	ρ_{tot}	ρ_{sh}	s (in)
Story 20	36	32	0.0100	0.0075	4.0	36	32	0.0120	0.0075	4.0	36	32	0.0120	0.0075	4.0	36	32	0.0100	0.0075	4.0
Story 19	36	32	0.0100	0.0075	4.0	36	32	0.0130	0.0075	4.0	36	32	0.0130	0.0075	4.0	36	32	0.0100	0.0075	4.0
Story 18	36	32	0.0100	0.0075	4.0	36	32	0.0130	0.0075	4.0	36	32	0.0130	0.0075	4.0	36	32	0.0100	0.0075	4.0
Story 17	36	32	0.0100	0.0075	4.0	36	32	0.0150	0.0075	4.5	36	32	0.0150	0.0075	4.5	36	32	0.0100	0.0075	4.0
Story 16	36	32	0.0100	0.0075	4.0	36	32	0.0160	0.0075	4.0	36	32	0.0160	0.0075	4.0	36	32	0.0100	0.0075	4.0
Story 15	36	32	0.0100	0.0075	4.0	36	32	0.0170	0.0075	4.0	36	32	0.0170	0.0075	4.0	36	32	0.0100	0.0075	4.0
Story 14	36	32	0.0120	0.0075	4.0	36	32	0.0180	0.0075	4.0	36	32	0.0180	0.0075	4.0	36	32	0.0120	0.0075	4.0
Story 13	36	32	0.0120	0.0075	4.0	36	32	0.0190	0.0075	4.0	36	32	0.0190	0.0075	4.0	36	32	0.0120	0.0075	4.0
Story 12	42	32	0.0100	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0100	0.0089	4.0
Story 11	42	32	0.0110	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0110	0.0089	4.0
Story 10	42	32	0.0120	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0120	0.0089	4.0
Story 9	42	32	0.0125	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0160	0.0089	4.0	42	32	0.0125	0.0089	4.0
Story 8	42	32	0.0130	0.0089	4.0	42	32	0.0165	0.0089	4.0	42	32	0.0165	0.0089	4.0	42	32	0.0130	0.0089	4.0
Story 7	42	32	0.0140	0.0089	4.0	42	32	0.0165	0.0089	4.0	42	32	0.0165	0.0089	4.0	42	32	0.0140	0.0089	4.0
Story 6	42	32	0.0145	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0145	0.0089	4.0
Story 5	42	32	0.0150	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0150	0.0089	4.0
Story 4	42	32	0.0160	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0160	0.0089	4.0
Story 3	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0
Story 2	42	32	0.0180	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0180	0.0089	4.0
Story 1	42	32	0.0250	0.0103	3.5	42	32	0.0170	0.0089	4.0	42	32	0.0170	0.0089	4.0	42	32	0.0250	0.0103	3.5

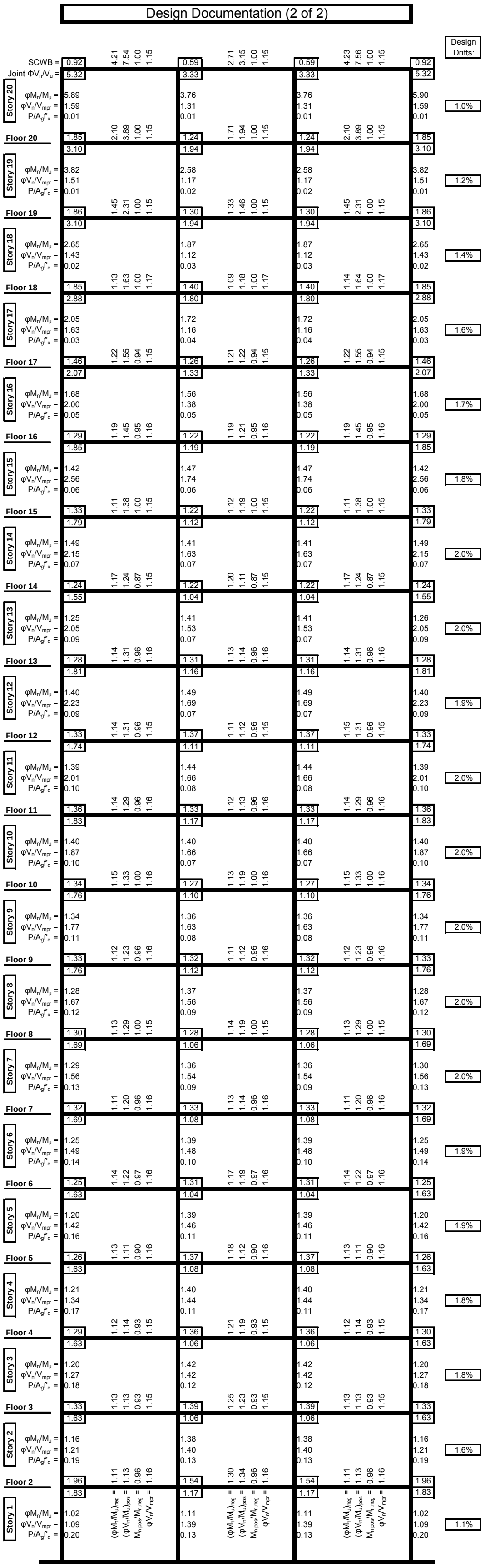
Beams:

	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)
Floor 21	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5
Floor 20	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5
Floor 19	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5	42	32	0.0033	0.0033	0.0028	6.5
Floor 18	42	32	0.0033	0.0033	0.0029	6.0	42	32	0.0033	0.0033	0.0029	6.0	42	32	0.0033	0.0033	0.0029	6.0
Floor 17	42	32	0.0041	0.0043	0.0034	5.0	42	32	0.0041	0.0043	0.0034	5.0	42	32	0.0041	0.0043	0.0034	5.0
Floor 16	42	32	0.0046	0.0048	0.0038	6.5	42	32	0.0046	0.0048	0.0038	6.5	42	32	0.0046	0.0048	0.0038	6.5
Floor 15	42	32	0.0050	0.0050	0.0040	6.0	42	32	0.0050	0.0050	0.0040	6.0	42	32	0.0050	0.0050	0.0040	6.0
Floor 14	42	32	0.0050	0.0058	0.0042	5.5	42	32	0.0050	0.0058	0.0042	5.5	42	32	0.0050	0.0058	0.0042	5.5
Floor 13	42	32	0.0055	0.0058	0.0045	5.0	42	32	0.0055	0.0058	0.0045	5.0	42	32	0.0055	0.0058	0.0045	5.0
Floor 12	42	32	0.0058	0.0060	0.0047	5.0	42	32	0.0058	0.0060	0.0047	5.0	42	32	0.0058	0.0060	0.0047	5.0
Floor 11	42	32	0.0060	0.0063	0.0049	5.0	42	32	0.0060	0.0063	0.0049	5.0	42	32	0.0060	0.0063	0.0049	5.0
Floor 10	42	32	0.0065	0.0065	0.0051	5.5	42	32	0.0065	0.0065	0.0051	5.5	42	32	0.0065	0.0065	0.0051	5.5
Floor 9	42	32	0.0063	0.0065	0.0050	6.0	42	32	0.0063	0.0065	0.0050	6.0	42	32	0.0063	0.0065	0.0050	6.0
Floor 8	42	32	0.0068	0.0068	0.0053	5.5	42	32	0.0068	0.0068	0.0053	5.5	42	32	0.0068	0.0068	0.0053	5.5
Floor 7	42	32	0.0065	0.0068	0.0052	5.5	42	32	0.0065	0.0068	0.0052	5.5	42	32	0.0065	0.0068	0.0052	5.5
Floor 6	42	32	0.0068	0.0070	0.0054	5.5	42	32	0.0068	0.0070	0.0054	5.5	42	32	0.0068	0.0070	0.0054	5.5
Floor 5	42	32	0.0063	0.0070	0.0052	5.5	42	32	0.0063	0.0070	0.0052	5.5	42	32	0.0063	0.0070	0.0052	5.5
Floor 4	42	32	0.0065	0.0070	0.0053	5.5	42	32	0.0065	0.0070	0.0053	5.5	42	32	0.0065	0.0070	0.0053	5.5
Floor 3	42	32	0.0065	0.0070	0.0053	5.5	42	32	0.0065	0.0070	0.0053	5.5	42	32	0.0065	0.0070	0.0053	5.5
Floor 2	42	32	0.0060	0.0063	0.0049	5.0	42	32	0.0060	0.0063	0.0049	5.0	42	32	0.0060	0.0063	0.0049	5.0

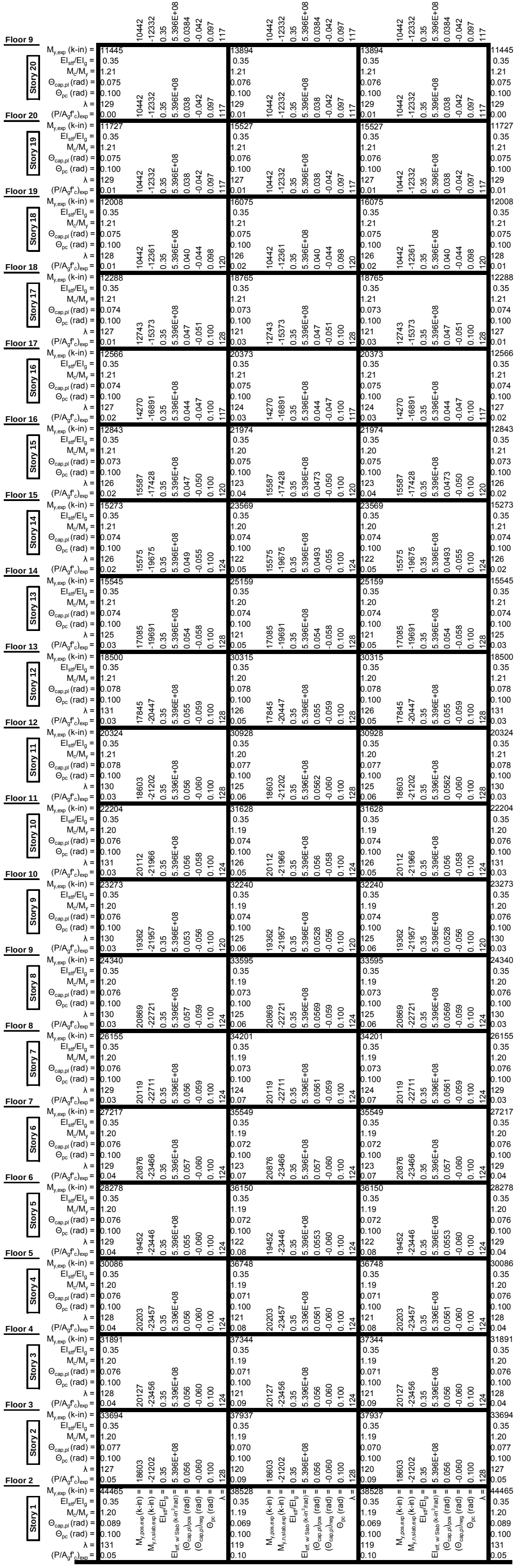
Grade beam column height (in) = 24

Basement column height (in) = 42

Design base shear =	0.044	g,	613	k	
f'_c beams =	5.0 ksi		$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60 ksi		$f'_{c,cols,lower}$ =	6.0	ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.92 0.59 0.59 0.92
Joint ΦVn/Vu = 5.32 3.33 3.33 5.32
4.21 7.54 1.00 1.15
2.71 3.15 1.00 1.15
4.23 7.56 1.00 1.15
Story 20
φMn/Mu = 5.89 3.76 3.76 5.90
φVn/Vmpr = 1.59 1.31 1.31 1.59
P/Agf'c = 0.01 0.01 0.01 0.01
1.0%
2.10 3.89 1.00 1.15
1.71 1.94 1.00 1.15
2.10 3.89 1.00 1.15
Floor 20
1.85 1.24 1.24 1.85
3.10 1.94 1.94 3.10
Story 19
φMn/Mu = 3.82 2.58 2.58 3.82
φVn/Vmpr = 1.51 1.17 1.17 1.51
P/Agf'c = 0.01 0.02 0.02 0.01
1.2%
1.45 2.31 1.00 1.15
1.33 1.46 1.00 1.15
1.45 2.31 1.00 1.15
Floor 19
1.86 1.30 1.30 1.86
3.10 1.94 1.94 3.10
Story 18
φMn/Mu = 2.65 1.87 1.87 2.65
φVn/Vmpr = 1.43 1.12 1.12 1.43
P/Agf'c = 0.02 0.03 0.03 0.02
1.4%
1.13 1.63 1.00 1.17
1.09 1.18 1.00 1.17
1.14 1.64 1.00 1.17
Floor 18
1.85 1.40 1.40 1.85
2.88 1.80 1.80 2.88
Story 17
φMn/Mu = 2.05 1.72 1.72 2.05
φVn/Vmpr = 1.63 1.16 1.16 1.63
P/Agf'c = 0.03 0.04 0.04 0.03
1.6%
1.22 1.55 0.94 1.15
1.21 1.22 0.94 1.15
1.22 1.55 0.94 1.15
Floor 17
1.46 1.26 1.26 1.46
2.07 1.33 1.33 2.07
Story 16
φMn/Mu = 1.68 1.56 1.56 1.68
φVn/Vmpr = 2.00 1.38 1.38 2.00
P/Agf'c = 0.05 0.05 0.05 0.05
1.7%
1.19 1.45 0.95 1.16
1.19 1.21 0.95 1.16
1.19 1.45 0.95 1.16
Floor 16
1.29 1.22 1.22 1.29
1.85 1.19 1.19 1.85
Story 15
φMn/Mu = 1.42 1.47 1.47 1.42
φVn/Vmpr = 2.56 1.74 1.74 2.56
P/Agf'c = 0.06 0.06 0.06 0.06
1.8%
1.11 1.38 1.00 1.15
1.12 1.19 1.00 1.15
1.11 1.38 1.00 1.15
Floor 15
1.33 1.22 1.22 1.33
1.79 1.12 1.12 1.79
Story 14
φMn/Mu = 1.49 1.41 1.41 1.49
φVn/Vmpr = 2.15 1.63 1.63 2.15
P/Agf'c = 0.07 0.07 0.07 0.07
2.0%
1.17 1.24 0.87 1.15
1.20 1.11 0.87 1.15
1.17 1.24 0.87 1.15
Floor 14
1.24 1.22 1.22 1.24
1.55 1.04 1.04 1.55
Story 13
φMn/Mu = 1.25 1.41 1.41 1.26
φVn/Vmpr = 2.05 1.53 1.53 2.05
P/Agf'c = 0.09 0.07 0.07 0.09
2.0%
1.14 1.31 0.96 1.16
1.13 1.14 0.96 1.16
1.14 1.31 0.96 1.16
Floor 13
1.28 1.31 1.31 1.28
1.81 1.16 1.16 1.81
Story 12
φMn/Mu = 1.40 1.49 1.49 1.40
φVn/Vmpr = 2.23 1.69 1.69 2.23
P/Agf'c = 0.09 0.07 0.07 0.09
1.9%
1.14 1.31 0.96 1.15
1.11 1.12 0.96 1.15
1.15 1.31 0.96 1.15
Floor 12
1.33 1.37 1.37 1.33
1.74 1.11 1.11 1.74
Story 11
φMn/Mu = 1.39 1.44 1.44 1.39
φVn/Vmpr = 2.01 1.66 1.66 2.01
P/Agf'c = 0.10 0.08 0.08 0.10
2.0%
1.14 1.29 0.96 1.16
1.12 1.13 0.96 1.16
1.14 1.29 0.96 1.16
Floor 11
1.36 1.33 1.33 1.36
1.83 1.17 1.17 1.83
Story 10
φMn/Mu = 1.40 1.40 1.40 1.40
φVn/Vmpr = 1.87 1.66 1.66 1.87
P/Agf'c = 0.10 0.07 0.07 0.10
2.0%
1.15 1.33 1.00 1.16
1.13 1.19 1.00 1.16
1.15 1.33 1.00 1.16
Floor 10
1.34 1.27 1.27 1.34
1.76 1.10 1.10 1.76
Story 9
φMn/Mu = 1.34 1.36 1.36 1.34
φVn/Vmpr = 1.77 1.63 1.63 1.77
P/Agf'c = 0.11 0.08 0.08 0.11
2.0%
1.12 1.23 0.96 1.16
1.11 1.12 0.96 1.16
1.12 1.23 0.96 1.16
Floor 9
1.33 1.32 1.32 1.33
1.76 1.12 1.12 1.76
Story 8
φMn/Mu = 1.28 1.37 1.37 1.28
φVn/Vmpr = 1.67 1.56 1.56 1.67
P/Agf'c = 0.12 0.09 0.09 0.12
2.0%
1.13 1.29 1.00 1.15
1.14 1.19 1.00 1.15
1.13 1.29 1.00 1.15
Floor 8
1.30 1.28 1.28 1.30
1.69 1.06 1.06 1.69
Story 7
φMn/Mu = 1.29 1.36 1.36 1.30
φVn/Vmpr = 1.56 1.54 1.54 1.56
P/Agf'c = 0.13 0.09 0.09 0.13
2.0%
1.11 1.20 0.96 1.16
1.13 1.14 0.96 1.16
1.11 1.20 0.96 1.16
Floor 7
1.32 1.33 1.33 1.32
1.69 1.08 1.08 1.69
Story 6
φMn/Mu = 1.25 1.39 1.39 1.25
φVn/Vmpr = 1.49 1.48 1.48 1.49
P/Agf'c = 0.14 0.10 0.10 0.14
1.9%
1.14 1.22 0.97 1.16
1.17 1.19 0.97 1.16
1.14 1.22 0.97 1.16
Floor 6
1.25 1.31 1.31 1.25
1.63 1.04 1.04 1.63
Story 5
φMn/Mu = 1.20 1.39 1.39 1.20
φVn/Vmpr = 1.42 1.46 1.46 1.42
P/Agf'c = 0.16 0.11 0.11 0.16
1.9%
1.13 1.11 0.90 1.16
1.18 1.12 0.90 1.16
1.13 1.11 0.90 1.16
Floor 5
1.26 1.37 1.37 1.26
1.63 1.08 1.08 1.63
Story 4
φMn/Mu = 1.21 1.40 1.40 1.21
φVn/Vmpr = 1.34 1.44 1.44 1.34
P/Agf'c = 0.17 0.11 0.11 0.17
1.8%
1.12 1.14 0.93 1.15
1.21 1.19 0.93 1.15
1.12 1.14 0.93 1.15
Floor 4
1.29 1.36 1.36 1.30
1.63 1.06 1.06 1.63
Story 3
φMn/Mu = 1.20 1.42 1.42 1.20
φVn/Vmpr = 1.27 1.42 1.42 1.27
P/Agf'c = 0.18 0.12 0.12 0.18
1.8%
1.13 1.13 0.93 1.15
1.25 1.23 0.93 1.15
1.13 1.13 0.93 1.15
Floor 3
1.33 1.39 1.39 1.33
1.63 1.06 1.06 1.63
Story 2
φMn/Mu = 1.16 1.38 1.38 1.16
φVn/Vmpr = 1.21 1.40 1.40 1.21
P/Agf'c = 0.19 0.13 0.13 0.19
1.6%
1.11 1.13 0.96 1.16
1.30 1.34 0.96 1.16
1.11 1.13 0.96 1.16
Floor 2
1.96 1.54 1.54 1.96
1.83 1.17 1.17 1.83
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
Story 1
φMn/Mu = 1.02 1.11 1.11 1.02
φVn/Vmpr = 1.09 1.39 1.39 1.09
P/Agf'c = 0.20 0.13 0.13 0.20
1.1%

Modeling Documentation (1 of 1)



	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 20	11445	0.35	1.21	0.075	0.100	129	0.00
Story 19	11727	0.35	1.21	0.075	0.100	129	0.01
Story 18	12008	0.35	1.21	0.075	0.100	128	0.01
Story 17	12288	0.35	1.21	0.074	0.100	127	0.01
Story 16	12566	0.35	1.21	0.074	0.100	127	0.02
Story 15	12843	0.35	1.21	0.073	0.100	126	0.02
Story 14	15273	0.35	1.21	0.074	0.100	126	0.02
Story 13	15545	0.35	1.21	0.074	0.100	125	0.03
Story 12	18500	0.35	1.21	0.078	0.100	131	0.03
Story 11	20324	0.35	1.21	0.078	0.100	130	0.03
Story 10	22204	0.35	1.20	0.076	0.100	131	0.03
Story 9	23273	0.35	1.20	0.076	0.100	130	0.03
Story 8	24340	0.35	1.20	0.076	0.100	130	0.03
Story 7	26155	0.35	1.20	0.076	0.100	129	0.03
Story 6	27217	0.35	1.20	0.076	0.100	129	0.04
Story 5	28278	0.35	1.20	0.076	0.100	129	0.04
Story 4	30086	0.35	1.20	0.076	0.100	128	0.04
Story 3	31891	0.35	1.20	0.076	0.100	128	0.04
Story 2	33694	0.35	1.20	0.077	0.100	127	0.05
Story 1	44465	0.35	1.20	0.089	0.100	131	0.05

	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 20	13894	0.35	1.21	0.076	0.100	129	0.01
Story 19	15527	0.35	1.21	0.076	0.100	127	0.01
Story 18	16075	0.35	1.21	0.075	0.100	126	0.02
Story 17	18765	0.35	1.21	0.073	0.100	121	0.03
Story 16	20373	0.35	1.21	0.075	0.100	124	0.03
Story 15	21974	0.35	1.20	0.075	0.100	123	0.04
Story 14	23569	0.35	1.20	0.074	0.100	122	0.05
Story 13	25159	0.35	1.20	0.074	0.100	121	0.05
Story 12	30315	0.35	1.20	0.078	0.100	126	0.05
Story 11	30928	0.35	1.20	0.077	0.100	125	0.06
Story 10	31628	0.35	1.19	0.074	0.100	126	0.05
Story 9	32240	0.35	1.19	0.074	0.100	125	0.06
Story 8	33595	0.35	1.19	0.073	0.100	125	0.06
Story 7	34201	0.35	1.19	0.073	0.100	124	0.07
Story 6	35549	0.35	1.19	0.072	0.100	123	0.07
Story 5	36150	0.35	1.19	0.072	0.100	122	0.08
Story 4	36748	0.35	1.19	0.071	0.100	121	0.08
Story 3	37344	0.35	1.19	0.071	0.100	121	0.09
Story 2	37937	0.35	1.19	0.070	0.100	120	0.09
Story 1	38528	0.35	1.19	0.069	0.100	119	0.10

	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 20	13894	0.35	1.21	0.076	0.100	129	0.01
Story 19	15527	0.35	1.21	0.076	0.100	127	0.01
Story 18	16075	0.35	1.21	0.075	0.100	126	0.02
Story 17	18765	0.35	1.21	0.073	0.100	121	0.03
Story 16	20373	0.35	1.21	0.075	0.100	124	0.03
Story 15	21974	0.35	1.20	0.075	0.100	123	0.04
Story 14	23569	0.35	1.20	0.074	0.100	122	0.05
Story 13	25159	0.35	1.20	0.074	0.100	121	0.05
Story 12	30315	0.35	1.20	0.078	0.100	126	0.05
Story 11	30928	0.35	1.20	0.077	0.100	125	0.06
Story 10	31628	0.35	1.19	0.074	0.100	126	0.05
Story 9	32240	0.35	1.19	0.074	0.100	125	0.06
Story 8	33595	0.35	1.19	0.073	0.100	125	0.06
Story 7	34201	0.35	1.19	0.073	0.100	124	0.07
Story 6	35549	0.35	1.19	0.072	0.100	123	0.07
Story 5	36150	0.35	1.19	0.072	0.100	122	0.08
Story 4	36748	0.35	1.19	0.071	0.100	121	0.08
Story 3	37344	0.35	1.19	0.071	0.100	121	0.09
Story 2	37937	0.35	1.19	0.070	0.100	120	0.09
Story 1	38528	0.35	1.19	0.069	0.100	119	0.10

	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 20	11445	0.35	1.21	0.075	0.100	129	0.00
Story 19	11727	0.35	1.21	0.075	0.100	129	0.01
Story 18	12008	0.35	1.21	0.075	0.100	128	0.01
Story 17	12288	0.35	1.21	0.074	0.100	127	0.01
Story 16	12566	0.35	1.21	0.074	0.100	127	0.02
Story 15	12843	0.35	1.21	0.073	0.100	126	0.02
Story 14	15273	0.35	1.21	0.074	0.100	126	0.02
Story 13	15545	0.35	1.21	0.074	0.100	125	0.03
Story 12	18500	0.35	1.21	0.078	0.100	131	0.03
Story 11	20324	0.35	1.21	0.078	0.100	130	0.03
Story 10	22204	0.35	1.20	0.076	0.100	131	0.03
Story 9	23273	0.35	1.20	0.076	0.100	130	0.03
Story 8	24340	0.35	1.20	0.076	0.100	130	0.03
Story 7	26155	0.35	1.20	0.076	0.100	129	0.03
Story 6	27217	0.35	1.20	0.076	0.100	129	0.04
Story 5	28278	0.35	1.20	0.076	0.100	129	0.04
Story 4	30086	0.35	1.20	0.076	0.100	128	0.04
Story 3	31891	0.35	1.20	0.076	0.100	128	0.04
Story 2	33694	0.35	1.20	0.077	0.100	127	0.05
Story 1	44465	0.35	1.20	0.089	0.100	131	0.05

	$M_{y,pos,exp}$ (k-in) =	$M_{y,n,slab,exp}$ (k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	10442	-12332	0.35	5.396E+08	0.0384	-0.042	0.097	117
Floor 20	10442	-12332	0.35	5.396E+08	0.038	-0.042	0.097	117
Floor 19	10442	-12332	0.35	5.396E+08	0.038	-0.042	0.097	117
Floor 18	10442	-12361	0.35	5.396E+08	0.040	-0.044	0.098	120
Floor 17	12743	-15373	0.35	5.396E+08	0.047	-0.051	0.100	128
Floor 16	14270	-16891	0.35	5.396E+08	0.044	-0.047	0.100	117
Floor 15	15587	-17428	0.35	5.396E+08	0.047	-0.050	0.100	120
Floor 14	15575	-19675	0.35	5.396E+08	0.049	-0.055	0.100	124
Floor 13	17085	-19691	0.35	5.396E+08	0.054	-0.058	0.100	128
Floor 12	17845	-20447	0.35	5.396E+08	0.055	-0.059	0.100	128
Floor 11	18603	-21202	0.35	5.396E+08	0.056	-0.060	0.100	128
Floor 10	20112	-21966	0.35	5.396E+08	0.056	-0.058	0.100	124
Floor 9	19362	-21957	0.35	5.396E+08	0.053	-0.056	0.100	120
Floor 8	20869	-22721	0.35	5.396E+08	0.057	-0.059	0.100	124
Floor 7	20119	-22711	0.35	5.396E+08	0.056	-0.059	0.100	124
Floor 6	20876	-23466	0.35	5.396E+08	0.057	-0.060	0.100	124
Floor 5	19452	-23446	0.35	5.396E+08	0.055	-0.060	0.100	124
Floor 4	20203	-23457	0.35	5.396E+08	0.056	-0.060	0.100	124
Floor 3	20127	-23456	0.35	5.396E+08	0.056	-0.060	0.100	124
Floor 2	18603	-21202	0.35	5.396E+08	0.056	-0.060	0.100	128

	$M_{y,pos,exp}$ (k-in) =	$M_{y,n,slab,exp}$ (k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	10442	-12332	0.35	5.396E+08	0.0384	-0.042	0.097	117
Floor 20	10442	-12332	0.35	5.396E+08	0.038	-0.042	0.097	117
Floor 19	10442	-12332	0.35	5.396E+08	0.038	-0.042	0.097	117
Floor 18	10442	-12361	0.35	5.396E+08	0.040	-0.044	0.098	120
Floor 17	12743	-15373	0.35	5.396E+08	0.047	-0.051	0.100	128
Floor 16	14270	-16891	0.35	5.396E+08	0.044	-0.047	0.100	117
Floor 15	15587	-17428	0.35	5.396E+08	0.0473	-0.050	0.100	120
Floor 14	15575	-19675	0.35	5.396E+08	0.0493	-0.055	0.100	124
Floor 13	17085	-19691	0.35	5.396E+08	0.054	-0.058	0.100	128
Floor 12	17845	-20447	0.35	5.396E+08	0.055	-0.059	0.100	128
Floor 11	18603	-21202	0.35	5.396E+08	0.0562	-0.060	0.100	128
Floor 10	20112	-21966	0.35	5.396E+08	0.056	-0.058	0.100	124
Floor 9	19362	-21957	0.35	5.396E+08	0.0528	-0.056	0.100	120
Floor 8	20869	-22721	0.35	5.396E+08	0.0569	-0.059	0.100	124
Floor 7	20119	-22711	0.35	5.396E+08	0.0561	-0.059	0.100	124
Floor 6	20876	-23466	0.35	5.396E+08	0.057	-0.060	0.100	124
Floor 5	19452	-23446	0.35	5.396E+08	0.0553	-0.060	0.100	124
Floor 4	20203	-23457	0.35	5.396E+08	0.0561	-0.060	0.100	124
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Floor 2	18603	-21202	0.35	5.396E+08	0.056	-0.060	0.100	128

	$M_{y,pos,exp}$ (k-in) =	$M_{y,n,slab,exp}$ (k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
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Floor 8	20869	-22721	0.35	5.396E+08	0.0569	-0.059	0.100	124
Floor 7	20119	-22711	0.35	5.396E+08	0.0561	-0.059	0.100	124
Floor 6	20876	-23466	0.35	5.396E+08	0.057	-0.060	0.100	124
Floor 5	19452	-23446	0.35	5.396E+08	0.0553	-0.060	0.100	124
Floor 4	20203	-23457	0.35	5.396E+08	0.0561	-0.060	0.100	124
Floor 3	20127	-23456	0.35	5.396E+08	0.056	-0.060	0.100	124
Floor 2	18603	-21202	0.35	5.396E+08	0.056	-0.060	0.100	128

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.63 T_2 = 0.85 T_3 = 0.46

$f_{y,rebar,expected}$ = 67 ksi

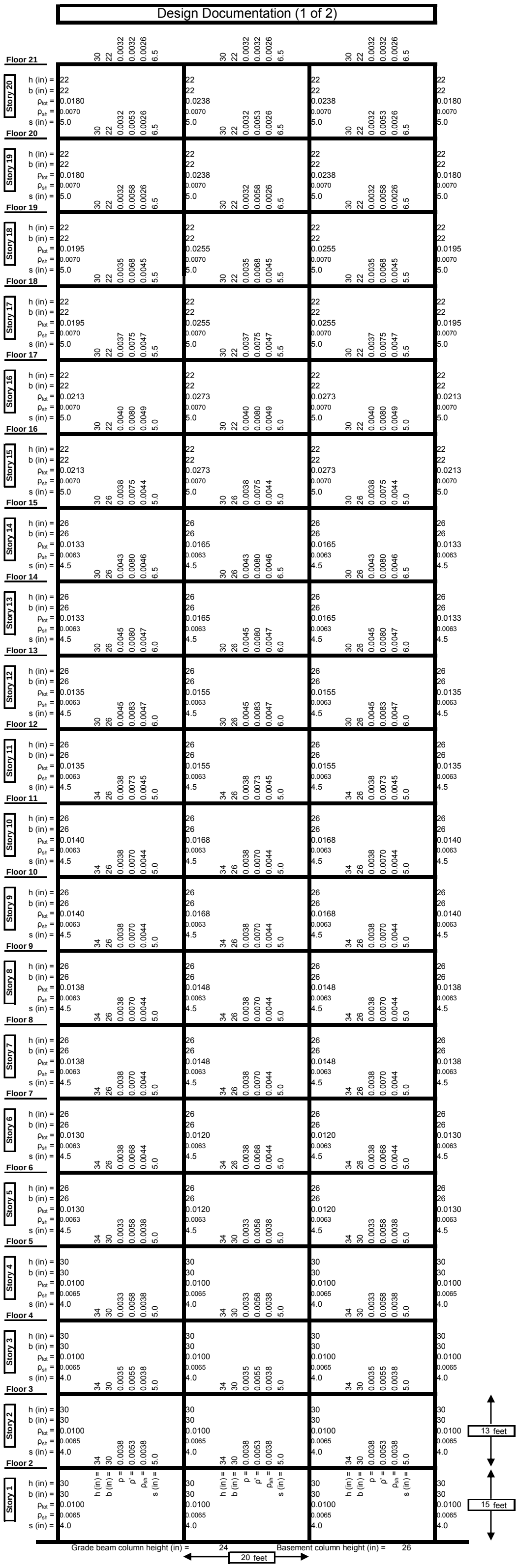
STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1021
Number of Stories: 20
Fundamental Period (sec): 2.36

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Initial member sizes (beam depths, column dimensions) were determined by both drift limits and minimum joint shear requirements. Beam strengths were controlled by force demands, particularly lateral forces. Column strengths were determined by strong-column weak-beam (SCWB) ratios except in the lower stories, where they were controlled by minimum reinforcement requirements. Beam stirrups were controlled by shear capacity design. The column stirrups were controlled by both the shear capacity design and the confinement requirements.

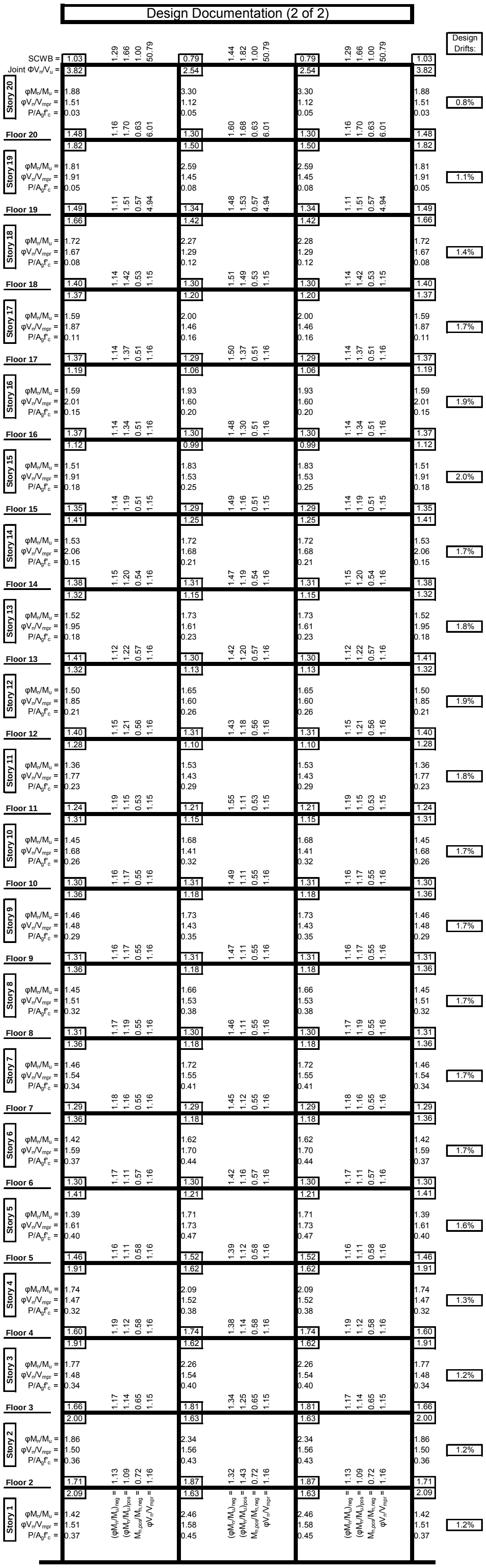
DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	0.044	g,	204	k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi

Design Documentation (2 of 2)



	SCWB =	SCWB =	SCWB =	SCWB =	Joint $\Phi V_n/V_u$ =	Joint $\Phi V_n/V_u$ =	Joint $\Phi V_n/V_u$ =	Joint $\Phi V_n/V_u$ =
	1.03	0.79	0.79	1.03	3.82	2.54	2.54	3.82
Floor 20	1.48	1.30	1.30	1.48	1.82	1.50	1.50	1.82
Floor 19	1.49	1.34	1.34	1.49	1.66	1.42	1.42	1.66
Floor 18	1.40	1.30	1.30	1.40	1.37	1.20	1.20	1.37
Floor 17	1.37	1.29	1.29	1.37	1.19	1.06	1.06	1.19
Floor 16	1.37	1.30	1.30	1.37	1.12	0.99	0.99	1.12
Floor 15	1.35	1.29	1.29	1.35	1.41	1.25	1.25	1.41
Floor 14	1.38	1.31	1.31	1.38	1.32	1.15	1.15	1.32
Floor 13	1.41	1.30	1.30	1.41	1.32	1.13	1.13	1.32
Floor 12	1.40	1.31	1.31	1.40	1.28	1.10	1.10	1.28
Floor 11	1.24	1.21	1.21	1.24	1.31	1.15	1.15	1.31
Floor 10	1.30	1.31	1.31	1.30	1.36	1.18	1.18	1.36
Floor 9	1.31	1.31	1.31	1.31	1.36	1.18	1.18	1.36
Floor 8	1.31	1.30	1.30	1.31	1.36	1.18	1.18	1.36
Floor 7	1.29	1.29	1.29	1.29	1.36	1.18	1.18	1.36
Floor 6	1.30	1.30	1.30	1.30	1.41	1.21	1.21	1.41
Floor 5	1.46	1.52	1.52	1.46	1.91	1.62	1.62	1.91
Floor 4	1.60	1.74	1.74	1.60	1.91	1.62	1.62	1.91
Floor 3	1.66	1.81	1.81	1.66	2.00	1.63	1.63	2.00
Floor 2	1.71	1.87	1.87	1.71	2.09	1.63	1.63	2.09

	$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =	$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =	$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =
	1.29	1.66	1.00	50.79	1.44	1.82	1.00	50.79	1.29	1.66	1.00	50.79
Floor 20	1.16	1.70	0.63	6.01	1.60	1.68	0.63	6.01	1.16	1.70	0.63	6.01
Floor 19	1.11	1.51	0.57	4.94	1.48	1.53	0.57	4.94	1.11	1.51	0.57	4.94
Floor 18	1.14	1.42	0.53	1.15	1.51	1.49	0.53	1.15	1.14	1.42	0.53	1.15
Floor 17	1.14	1.37	0.51	1.16	1.50	1.37	0.51	1.16	1.14	1.37	0.51	1.16
Floor 16	1.14	1.34	0.51	1.16	1.48	1.30	0.51	1.16	1.14	1.34	0.51	1.16
Floor 15	1.14	1.19	0.51	1.15	1.49	1.16	0.51	1.15	1.14	1.19	0.51	1.15
Floor 14	1.15	1.20	0.54	1.16	1.47	1.19	0.54	1.16	1.15	1.20	0.54	1.16
Floor 13	1.12	1.22	0.57	1.16	1.42	1.20	0.57	1.16	1.12	1.22	0.57	1.16
Floor 12	1.15	1.21	0.56	1.16	1.43	1.18	0.56	1.16	1.15	1.21	0.56	1.16
Floor 11	1.19	1.15	0.53	1.15	1.55	1.11	0.53	1.15	1.19	1.15	0.53	1.15
Floor 10	1.16	1.17	0.55	1.16	1.49	1.11	0.55	1.16	1.16	1.17	0.55	1.16
Floor 9	1.16	1.17	0.55	1.16	1.47	1.11	0.55	1.16	1.16	1.17	0.55	1.16
Floor 8	1.17	1.19	0.55	1.16	1.46	1.11	0.55	1.16	1.17	1.19	0.55	1.16
Floor 7	1.18	1.16	0.55	1.16	1.45	1.12	0.55	1.16	1.18	1.16	0.55	1.16
Floor 6	1.17	1.11	0.57	1.16	1.42	1.16	0.57	1.16	1.17	1.11	0.57	1.16
Floor 5	1.16	1.11	0.58	1.16	1.39	1.12	0.58	1.16	1.16	1.11	0.58	1.16
Floor 4	1.19	1.12	0.58	1.16	1.38	1.14	0.58	1.16	1.19	1.12	0.58	1.16
Floor 3	1.17	1.14	0.65	1.15	1.34	1.25	0.65	1.15	1.17	1.14	0.65	1.15
Floor 2	1.13	1.09	0.72	1.16	1.32	1.43	0.72	1.16	1.13	1.09	0.72	1.16

	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	Design Drifts:
Story 20	1.88	1.51	0.03	3.30	1.12	0.05	3.30	1.12	0.05	1.88	1.51	0.03	0.8%
Story 19	1.81	1.91	0.05	2.59	1.45	0.08	2.59	1.45	0.08	1.81	1.91	0.05	1.1%
Story 18	1.72	1.67	0.08	2.27	1.29	0.12	2.28	1.29	0.12	1.72	1.67	0.08	1.4%
Story 17	1.59	1.87	0.11	2.00	1.46	0.16	2.00	1.46	0.16	1.59	1.87	0.11	1.7%
Story 16	1.59	2.01	0.15	1.93	1.60	0.20	1.93	1.60	0.20	1.59	2.01	0.15	1.9%
Story 15	1.51	1.91	0.18	1.83	1.53	0.25	1.83	1.53	0.25	1.51	1.91	0.18	2.0%
Story 14	1.53	2.06	0.15	1.72	1.68	0.21	1.72	1.68	0.21	1.53	2.06	0.15	1.7%
Story 13	1.52	1.95	0.18	1.73	1.61	0.23	1.73	1.61	0.23	1.52	1.95	0.18	1.8%
Story 12	1.50	1.85	0.21	1.65	1.60	0.26	1.65	1.60	0.26	1.50	1.85	0.21	1.9%
Story 11	1.36	1.77	0.23	1.53	1.43	0.29	1.53	1.43	0.29	1.36	1.77	0.23	1.8%
Story 10	1.45	1.68	0.26	1.68	1.41	0.32	1.68	1.41	0.32	1.45	1.68	0.26	1.7%
Story 9	1.46	1.48	0.29	1.73	1.43	0.35	1.73	1.43	0.35	1.46	1.48	0.29	1.7%
Story 8	1.45	1.51	0.32	1.66	1.53	0.38	1.66	1.53	0.38	1.45	1.51	0.32	1.7%
Story 7	1.46	1.54	0.34	1.72	1.55	0.41	1.72	1.55	0.41	1.46	1.54	0.34	1.7%
Story 6	1.42	1.59	0.37	1.62	1.70	0.44	1.62	1.70	0.44	1.42	1.59	0.37	1.7%
Story 5	1.39	1.61	0.40	1.71	1.73	0.47	1.71	1.73	0.47	1.39	1.61	0.40	1.6%
Story 4	1.74	1.47	0.32	2.09	1.52	0.38	2.09	1.52	0.38	1.74	1.47	0.32	1.3%
Story 3	1.77	1.48	0.34	2.26	1.54	0.40	2.26	1.54	0.40	1.77	1.48	0.34	1.2%
Story 2	1.86	1.50	0.36	2.34	1.56	0.43	2.34	1.56	0.43	1.86	1.50	0.36	1.2%
Story 1	1.42	1.51	0.37	2.46	1.58	0.45	2.46	1.58	0.45	1.42	1.51	0.37	1.2%

Modeling Documentation (1 of 1)

Story	$M_{y,exp}$ (k-in)	EI_{stf}/EI_g	M_c/M_y	$\Theta_{cap,pl}$ (rad)	Θ_{pc} (rad)	λ	$(P/A_gf'_c)_{exp}$
Story 20	4872	0.35	1.21	0.071	0.100	93	0.02
	6580	0.35	1.21	0.073	0.100	91	0.03
	6580	0.35	1.21	0.073	0.100	91	0.03
	4872	0.35	1.21	0.071	0.100	93	0.02
Story 19	5194	0.35	1.21	0.069	0.100	91	0.03
	7202	0.35	1.20	0.069	0.100	87	0.06
	7202	0.35	1.20	0.069	0.100	87	0.06
	5194	0.35	1.21	0.069	0.100	91	0.03
Story 18	5872	0.35	1.20	0.068	0.100	89	0.05
	8230	0.35	1.20	0.066	0.100	83	0.10
	8230	0.35	1.20	0.066	0.100	83	0.10
	5872	0.35	1.20	0.068	0.100	89	0.05
Story 17	6185	0.35	1.20	0.066	0.100	87	0.06
	8829	0.36	1.19	0.062	0.100	80	0.13
	8829	0.36	1.19	0.062	0.100	80	0.13
	6185	0.35	1.20	0.066	0.100	87	0.06
Story 16	6912	0.38	1.20	0.065	0.100	85	0.08
	9835	0.46	1.19	0.059	0.100	77	0.16
	9835	0.46	1.19	0.059	0.100	77	0.16
	6912	0.38	1.20	0.065	0.100	85	0.08
Story 15	7217	0.39	1.20	0.063	0.100	83	0.10
	10416	0.49	1.18	0.056	0.100	74	0.19
	10416	0.49	1.18	0.056	0.100	74	0.19
	7217	0.39	1.20	0.063	0.100	83	0.10
Story 14	8513	0.35	1.20	0.061	0.100	99	0.08
	12372	0.41	1.19	0.054	0.100	89	0.16
	12372	0.41	1.19	0.054	0.100	89	0.16
	8513	0.35	1.20	0.061	0.100	99	0.08
Story 13	8881	0.35	1.20	0.060	0.100	97	0.09
	13066	0.43	1.18	0.052	0.100	86	0.18
	13066	0.43	1.18	0.052	0.100	86	0.18
	8881	0.35	1.20	0.060	0.100	97	0.09
Story 12	9350	0.35	1.20	0.058	0.100	96	0.10
	13337	0.45	1.18	0.049	0.099	84	0.21
	13337	0.45	1.18	0.049	0.099	84	0.21
	9350	0.35	1.20	0.058	0.100	96	0.10
Story 11	9712	0.36	1.19	0.057	0.100	95	0.11
	14015	0.47	1.18	0.047	0.091	81	0.23
	14015	0.47	1.18	0.047	0.091	81	0.23
	9712	0.36	1.19	0.057	0.100	95	0.11
Story 10	10278	0.37	1.19	0.056	0.100	93	0.13
	15202	0.50	1.17	0.046	0.084	79	0.25
	15202	0.50	1.17	0.046	0.084	79	0.25
	10278	0.37	1.19	0.056	0.100	93	0.13
Story 9	10634	0.38	1.19	0.055	0.100	92	0.14
	15865	0.52	1.17	0.044	0.078	77	0.28
	15865	0.52	1.17	0.044	0.078	77	0.28
	10634	0.38	1.19	0.055	0.100	92	0.14
Story 8	10884	0.40	1.19	0.054	0.100	90	0.15
	15691	0.54	1.17	0.041	0.072	74	0.30
	15691	0.54	1.17	0.041	0.072	74	0.30
	10884	0.40	1.19	0.054	0.100	90	0.15
Story 7	11234	0.41	1.19	0.053	0.100	89	0.16
	17795	0.56	1.17	0.040	0.067	72	0.32
	17795	0.56	1.17	0.040	0.067	72	0.32
	11234	0.41	1.19	0.053	0.100	89	0.16
Story 6	11273	0.42	1.19	0.051	0.100	88	0.17
	16718	0.59	1.16	0.037	0.061	70	0.34
	16718	0.59	1.16	0.037	0.061	70	0.34
	11273	0.42	1.19	0.051	0.100	88	0.17
Story 5	11619	0.43	1.18	0.050	0.100	86	0.18
	16824	0.61	1.16	0.036	0.057	68	0.37
	16824	0.61	1.16	0.036	0.057	68	0.37
	11619	0.43	1.18	0.050	0.100	86	0.18
Story 4	14439	0.36	1.19	0.055	0.100	101	0.15
	21076	0.50	1.17	0.042	0.075	83	0.29
	21076	0.50	1.17	0.042	0.075	83	0.29
	14439	0.36	1.19	0.055	0.100	101	0.15
Story 3	14847	0.37	1.19	0.054	0.100	100	0.15
	24603	0.52	1.17	0.041	0.071	81	0.31
	24603	0.52	1.17	0.041	0.071	81	0.31
	14847	0.37	1.19	0.054	0.100	100	0.15
Story 2	15251	0.37	1.19	0.053	0.100	99	0.16
	24748	0.53	1.16	0.039	0.067	80	0.33
	24748	0.53	1.16	0.039	0.067	80	0.33
	15251	0.37	1.19	0.053	0.100	99	0.16
Story 1	15654	0.38	1.19	0.052	0.100	97	0.17
	24898	0.55	1.16	0.038	0.063	78	0.34
	24898	0.55	1.16	0.038	0.063	78	0.34
	15654	0.38	1.19	0.052	0.100	97	0.17

Floor	$M_{y,pos,exp}$ (k-in)	$M_{y,n,slab,exp}$ (k-in)	EI_{stf}/EI_g	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad)	$(\Theta_{cap,pl})_{pos}$ (rad)	$(\Theta_{cap,pl})_{neg}$ (rad)	Θ_{pc} (rad)	λ
Floor 9	3379	-5283	0.35	1.791E+0	0.0332	-0.048	0.090	99
	3379	-5283	0.35	1.791E+0	0.0332	-0.048	0.090	99
	3379	-5283	0.35	1.791E+0	0.0332	-0.048	0.090	99
Floor 20	3379	-7268	0.35	1.791E+08	0.032	-0.051	0.090	99
	3379	-7268	0.35	1.791E+08	0.032	-0.051	0.090	99
	3379	-7268	0.35	1.791E+08	0.032	-0.051	0.090	99
Floor 19	3378	-7757	0.35	1.791E+08	0.032	-0.052	0.090	99
	3378	-7757	0.35	1.791E+08	0.032	-0.052	0.090	99
	3378	-7757	0.35	1.791E+08	0.032	-0.052	0.090	99
Floor 18	3632	-8732	0.35	1.791E+08	0.042	-0.070	0.100	108
	3632	-8732	0.35	1.791E+08	0.042	-0.070	0.100	108
	3632	-8732	0.35	1.791E+08	0.042	-0.070	0.100	108
Floor 17	3886	-9461	0.35	1.791E+08	0.044	-0.073	0.100	108
	3886	-9461	0.35	1.791E+08	0.044	-0.073	0.100	108
	3886	-9461	0.35	1.791E+08	0.044	-0.073	0.100	108
Floor 16	4158	-9948	0.35	1.791E+08	0.047	-0.076	0.100	112
	4158	-9948	0.35	1.791E+08	0.047	-0.076	0.100	112
	4158	-9948	0.35	1.791E+08	0.047	-0.076	0.100	112
Floor 15	4615	-10849	0.35	1.918E+08	0.045	-0.072	0.100	112
	4615	-10849	0.35	1.918E+08	0.0445	-0.072	0.100	112
	4615	-10849	0.35	1.918E+08	0.0445	-0.072	0.100	112
Floor 14	5202	-11428	0.35	1.918E+08	0.041	-0.065	0.100	99
	5202	-11428	0.35	1.918E+08	0.0414	-0.065	0.100	99
	5202	-11428	0.35	1.918E+08	0.0414	-0.065	0.100	99
Floor 13	5501	-11432	0.35	1.918E+08	0.044	-0.067	0.100	103
	5501	-11432	0.35	1.918E+08	0.0439	-0.067	0.100	103
	5501	-11432	0.35	1.918E+08	0.0439	-0.067	0.100	103
Floor 12	5501	-11717	0.35	1.918E+08	0.044	-0.068	0.100	103
	5501	-11717	0.35	1.918E+08	0.044	-0.068	0.100	103
	5501	-11717	0.35	1.918E+08	0.044	-0.068	0.100	103
Floor 11	6058	-13600	0.35	2.727E+08	0.045	-0.071	0.100	118
	6058	-13600	0.35	2.727E+08	0.0451	-0.071	0.100	118
	6058	-13600	0.35	2.727E+08	0.0451	-0.071	0.100	118
Floor 10	6058	-13223	0.35	2.727E+08	0.045	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
Floor 9	6058	-13223	0.35	2.727E+08	0.045	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
Floor 8	6058	-13223	0.35	2.727E+08	0.045	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
Floor 7	6058	-13223	0.35	2.727E+08	0.045	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
	6058	-13223	0.35	2.727E+08	0.0451	-0.070	0.100	118
Floor 6	6057	-12845	0.35	2.727E+08	0.045	-0.069	0.100	118
	6057	-12845	0.35	2.727E+08	0.0451	-0.069	0.100	118
	6057	-12845	0.35	2.727E+08	0.0451	-0.069	0.100	118
Floor 5	6122	-12729	0.35	2.912E+08	0.042	-0.065	0.100	118
	6122	-12729	0.35	2.912E+08	0.0423	-0.065	0.100	118
	6122	-12729	0.35	2.912E+08	0.0423	-0.065	0.100	118
Floor 4	6122	-12729	0.35	2.912E+08	0.042	-0.065	0.100	118
	6122	-12729	0.35	2.912E+08	0.0423	-0.065	0.100	118
	6122	-12729	0.35	2.912E+08	0.0423	-0.065	0.100	118
Floor 3	6531	-12293	0.35	2.912E+08	0.043	-0.063	0.100	118
	6531	-12293	0.35	2.912E+08	0.043	-0.063	0.100	118
	6531	-12293	0.35	2.912E+08	0.043	-0.063	0.100	118
Floor 2	6986	-11856	0.35	2.912E+08	0.044	-0.062	0.100	118
	6986	-11856	0.35	2.912E+08	0.044	-0.062	0.100	118
	6986	-11856	0.35	2.912E+08	0.044	-0.062	0.100	118

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.36 T_2 = 0.81 T_3 = 0.46

$f_{y,rebar,expected}$ = 67 ksi

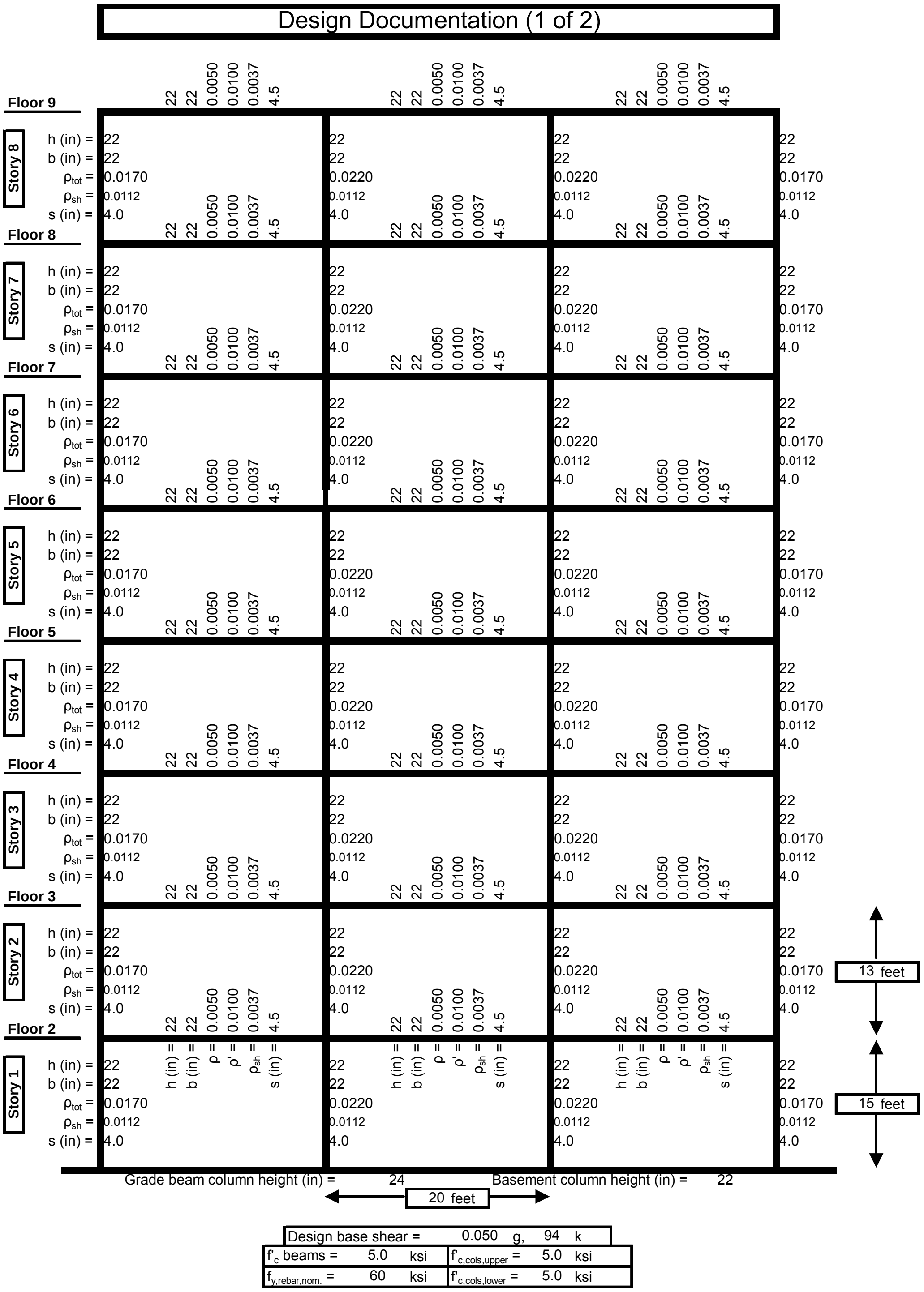
STRUCTURAL DESIGN AND MODELING SUMMARY

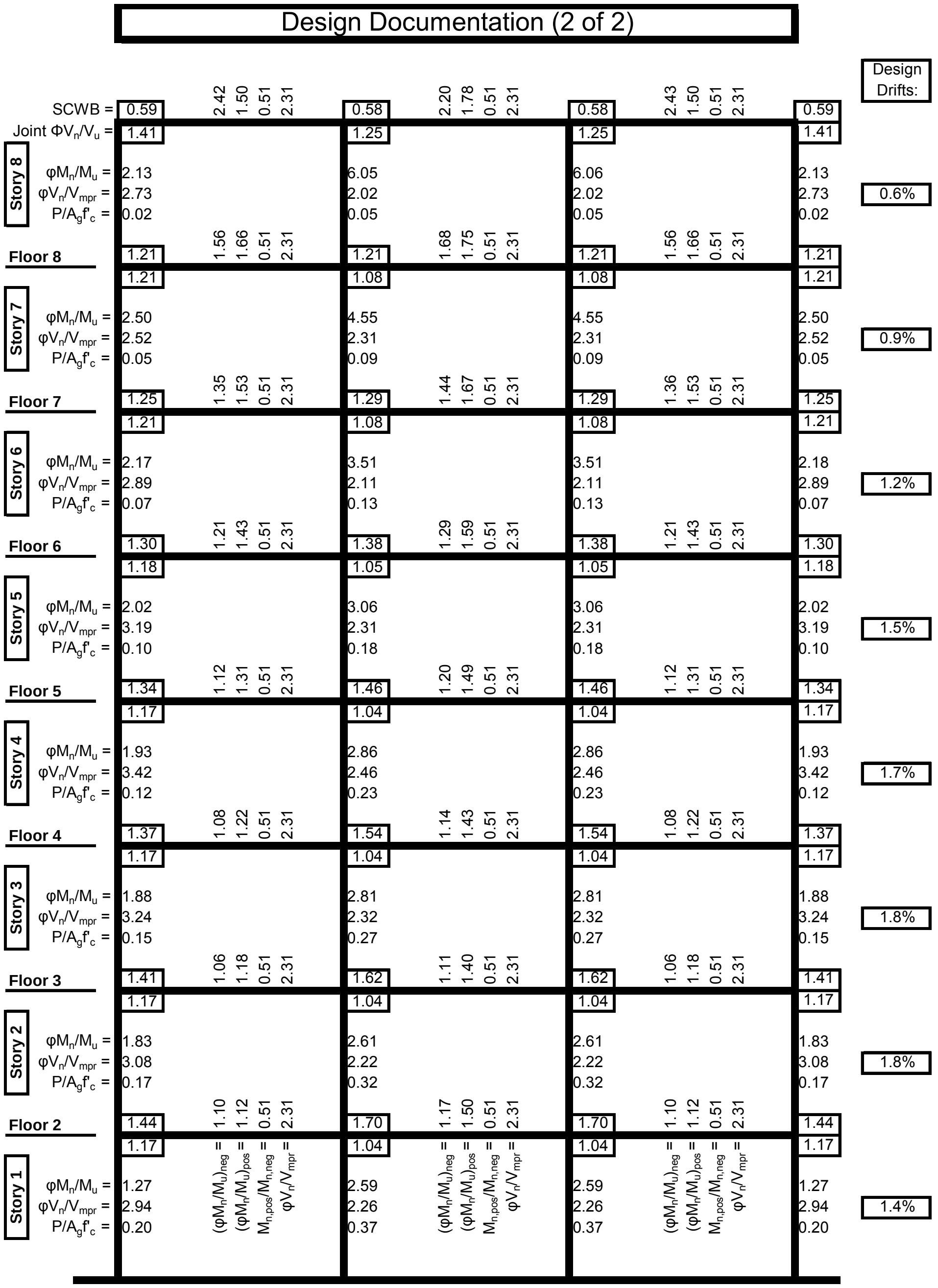
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1022
Number of Stories: 8
Fundamental Period (sec): 1.80

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

All members sized according to ground floor requirements for index 1012. Columns reinforced to be uniform and meet SCWB requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 9
22 22 0.0050 0.0100 0.0037 4.5
Story 8
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 8
22 22 0.0050 0.0100 0.0037 4.5
Story 7
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 7
22 22 0.0050 0.0100 0.0037 4.5
Story 6
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 6
22 22 0.0050 0.0100 0.0037 4.5
Story 5
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 5
22 22 0.0050 0.0100 0.0037 4.5
Story 4
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 4
22 22 0.0050 0.0100 0.0037 4.5
Story 3
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 3
22 22 0.0050 0.0100 0.0037 4.5
Story 2
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
13 feet
Floor 2
22 22 0.0050 0.0100 0.0037 4.5
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 22 | 22 | 22 | 22
b (in) = 22 | 22 | 22 | 22
ρtot = 0.0170 | 0.0220 | 0.0220 | 0.0170
ρsh = 0.0112 | 0.0112 | 0.0112 | 0.0112
s (in) = 4.0 | 4.0 | 4.0 | 4.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 22
20 feet
Design base shear = 0.050 g, 94 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.59 0.58 0.58 0.59
Joint $\Phi V_n/V_u$ = 1.41 1.25 1.25 1.41
2.42 1.50 0.51 2.31
2.20 1.78 0.51 2.31
2.43 1.50 0.51 2.31
Story 8
$\varphi M_n/M_u$ = 2.13 6.05 6.06 2.13
$\varphi V_n/V_{mpr}$ = 2.73 2.02 2.02 2.73
$P/A_g f'_c$ = 0.02 0.05 0.05 0.02
0.6%
1.56 1.66 0.51 2.31
1.68 1.75 0.51 2.31
1.56 1.66 0.51 2.31
Floor 8
1.21 1.21 1.21 1.21
1.21 1.08 1.08 1.21
Story 7
$\varphi M_n/M_u$ = 2.50 4.55 4.55 2.50
$\varphi V_n/V_{mpr}$ = 2.52 2.31 2.31 2.52
$P/A_g f'_c$ = 0.05 0.09 0.09 0.05
0.9%
1.35 1.53 0.51 2.31
1.44 1.67 0.51 2.31
1.36 1.53 0.51 2.31
Floor 7
1.25 1.29 1.29 1.25
1.21 1.08 1.08 1.21
Story 6
$\varphi M_n/M_u$ = 2.17 3.51 3.51 2.18
$\varphi V_n/V_{mpr}$ = 2.89 2.11 2.11 2.89
$P/A_g f'_c$ = 0.07 0.13 0.13 0.07
1.2%
1.21 1.43 0.51 2.31
1.29 1.59 0.51 2.31
1.21 1.43 0.51 2.31
Floor 6
1.30 1.38 1.38 1.30
1.18 1.05 1.05 1.18
Story 5
$\varphi M_n/M_u$ = 2.02 3.06 3.06 2.02
$\varphi V_n/V_{mpr}$ = 3.19 2.31 2.31 3.19
$P/A_g f'_c$ = 0.10 0.18 0.18 0.10
1.5%
1.12 1.31 0.51 2.31
1.20 1.49 0.51 2.31
1.12 1.31 0.51 2.31
Floor 5
1.34 1.46 1.46 1.34
1.17 1.04 1.04 1.17
Story 4
$\varphi M_n/M_u$ = 1.93 2.86 2.86 1.93
$\varphi V_n/V_{mpr}$ = 3.42 2.46 2.46 3.42
$P/A_g f'_c$ = 0.12 0.23 0.23 0.12
1.7%
1.08 1.22 0.51 2.31
1.14 1.43 0.51 2.31
1.08 1.22 0.51 2.31
Floor 4
1.37 1.54 1.54 1.37
1.17 1.04 1.04 1.17
Story 3
$\varphi M_n/M_u$ = 1.88 2.81 2.81 1.88
$\varphi V_n/V_{mpr}$ = 3.24 2.32 2.32 3.24
$P/A_g f'_c$ = 0.15 0.27 0.27 0.15
1.8%
1.06 1.18 0.51 2.31
1.11 1.40 0.51 2.31
1.06 1.18 0.51 2.31
Floor 3
1.41 1.62 1.62 1.41
1.17 1.04 1.04 1.17
Story 2
$\varphi M_n/M_u$ = 1.83 2.61 2.61 1.83
$\varphi V_n/V_{mpr}$ = 3.08 2.22 2.22 3.08
$P/A_g f'_c$ = 0.17 0.32 0.32 0.17
1.8%
1.10 1.12 0.51 2.31
1.17 1.50 0.51 2.31
1.10 1.12 0.51 2.31
Floor 2
1.44 1.70 1.70 1.44
1.17 1.04 1.04 1.17
$(\varphi M_n/M_u)_{neg}$ =
$(\varphi M_n/M_u)_{pos}$ =
$M_{n,pos}/M_{n,neg}$ =
$\varphi V_n/V_{mpr}$ =
Story 1
$\varphi M_n/M_u$ = 1.27 2.59 2.59 1.27
$\varphi V_n/V_{mpr}$ = 2.94 2.26 2.26 2.94
$P/A_g f'_c$ = 0.20 0.37 0.37 0.20
1.4%

Modeling Documentation (1 of 1)

Story	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 8	4629	0.35	1.21	0.091	0.100	104	0.02
	6158	0.35	1.21	0.092	0.100	102	0.03
	6158	0.35	1.21	0.092	0.100	102	0.03
	4629	0.35	1.21	0.091	0.100	104	0.02
Story 7	4952	0.35	1.21	0.088	0.100	102	0.03
	6783	0.35	1.20	0.087	0.100	98	0.06
	6783	0.35	1.20	0.087	0.100	98	0.06
	4952	0.35	1.21	0.088	0.100	102	0.03
Story 6	5270	0.35	1.20	0.086	0.100	100	0.05
	7396	0.35	1.20	0.082	0.100	94	0.10
	7396	0.35	1.20	0.082	0.100	94	0.10
	5270	0.35	1.20	0.086	0.100	100	0.05
Story 5	5585	0.35	1.20	0.083	0.100	98	0.06
	7997	0.38	1.19	0.077	0.100	90	0.13
	7997	0.38	1.19	0.077	0.100	90	0.13
	5585	0.35	1.20	0.083	0.100	98	0.06
Story 4	5896	0.38	1.20	0.081	0.100	96	0.08
	8589	0.46	1.19	0.073	0.100	86	0.16
	8589	0.46	1.19	0.073	0.100	86	0.16
	5896	0.38	1.20	0.081	0.100	96	0.08
Story 3	6203	0.39	1.20	0.078	0.100	94	0.10
	9171	0.49	1.18	0.069	0.100	83	0.19
	9171	0.49	1.18	0.069	0.100	83	0.19
	6203	0.39	1.20	0.078	0.100	94	0.10
Story 2	6508	0.41	1.19	0.076	0.100	92	0.11
	9745	0.52	1.18	0.065	0.100	79	0.22
	9745	0.52	1.18	0.065	0.100	79	0.22
	6508	0.41	1.19	0.076	0.100	92	0.11
Story 1	6809	0.42	1.19	0.074	0.100	90	0.13
	10311	0.55	1.17	0.061	0.100	76	0.26
	10311	0.55	1.17	0.061	0.100	76	0.26
	6809	0.42	1.19	0.074	0.100	90	0.13

Floor	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
Floor 8	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
Floor 7	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
Floor 6	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
Floor 5	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
Floor 4	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
Floor 3	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.0446	-0.074	0.100	100
Floor 2	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100
	2571	-7650	0.35	7.178E+07	0.045	-0.074	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.80 T_2= 0.58 T_3= 0.34

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

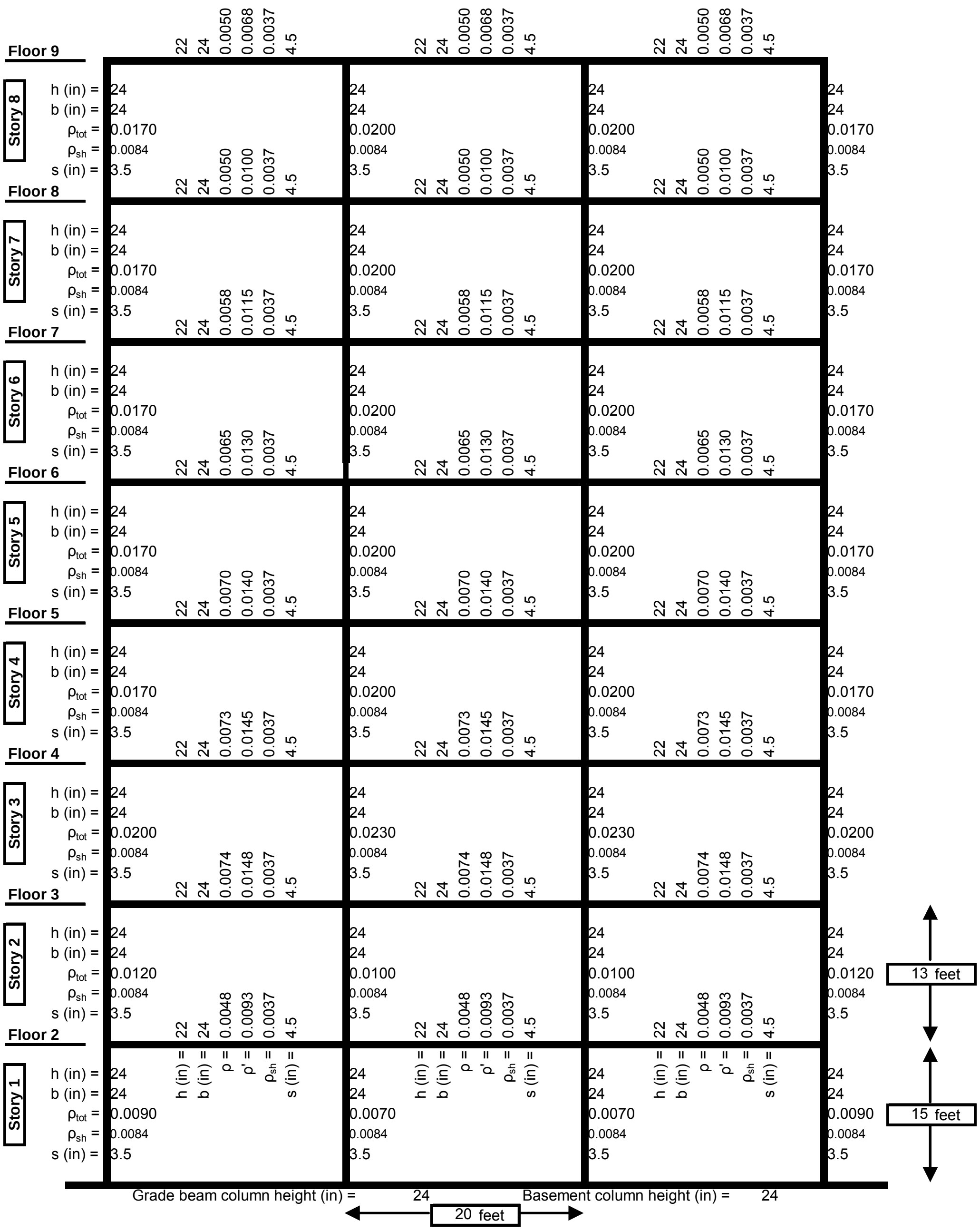
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1023
Number of Stories: 8
Fundamental Period (sec): 1.57

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

First floor beams initially reinforced for flexure, then above beams sized to meet 65% weak story requirement. Columns initially sized to 24 inches square to alleviate joint shear problems. Columns reinforced to meet SCWB provisions while not overstrengthening the first story columns. To do this, first story column reinforcement ratios were allowed below the minimum allowed by code. Column strengths increased to 6.0 ksi in upper stories and 8.0 ksi in lower stories to meet joint shear requirements. Beam strength increased to 6.0 ksi to facilitate joint concrete placement by contractor.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.050 g,	94 k	
f'_c beams = 6.0 ksi		$f'_{c,cols,upper}$ = 6.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 8.0 ksi	

Design Documentation (2 of 2)

SCWB =	0.93	1.77 1.73 0.75 5.75	0.78	1.67 2.01 0.75 5.75	0.78	1.77 1.73 0.75 5.75	0.93	Design Drifts:
Joint ΦV$_n$/V$_u$ =	2.50		1.91		1.91		2.50	
Story 8 φM$_n$/M$_u$ =	2.68		6.77		6.78		2.68	
φV$_n$/V$_{mpr}$ =	1.87		1.52		1.52		1.87	0.6%
P/A$_g$f'$_c$ =	0.02		0.03		0.03		0.02	
Floor 8	1.49	1.73 1.86 0.51 3.45	1.36	1.87 1.95 0.51 3.45	1.36	1.73 1.86 0.51 3.45	1.49	
	1.45		1.29		1.29		1.45	
Story 7 φM$_n$/M$_u$ =	3.36		5.28		5.28		3.37	
φV$_n$/V$_{mpr}$ =	1.75		1.89		1.89		1.75	0.9%
P/A$_g$f'$_c$ =	0.03		0.06		0.06		0.03	
Floor 7	1.41	1.73 2.00 0.51 2.70	1.31	1.85 2.14 0.51 2.70	1.31	1.73 2.00 0.51 2.70	1.41	
	1.26		1.12		1.12		1.26	
Story 6 φM$_n$/M$_u$ =	2.90		4.31		4.31		2.90	
φV$_n$/V$_{mpr}$ =	1.63		1.75		1.75		1.63	1.3%
P/A$_g$f'$_c$ =	0.05		0.09		0.09		0.05	
Floor 6	1.34	1.74 2.06 0.51 0.72	1.26	1.86 2.21 0.51 0.72	1.26	1.74 2.06 0.51 0.72	1.34	
	1.09		0.97		0.97		1.09	
Story 5 φM$_n$/M$_u$ =	2.66		3.70		3.70		2.67	
φV$_n$/V$_{mpr}$ =	2.46		1.93		1.93		2.46	1.5%
P/A$_g$f'$_c$ =	0.07		0.13		0.13		0.07	
Floor 5	1.31	1.74 2.04 0.51 0.69	1.26	1.85 2.25 0.51 0.69	1.26	1.74 2.04 0.51 0.69	1.31	
	1.15		1.02		1.02		1.15	
Story 4 φM$_n$/M$_u$ =	2.54		3.44		3.44		2.54	
φV$_n$/V$_{mpr}$ =	2.76		2.15		2.15		2.76	1.7%
P/A$_g$f'$_c$ =	0.06		0.12		0.12		0.06	
Floor 4	1.40	1.72 1.99 0.51 0.68	1.36	1.82 2.25 0.51 0.68	1.36	1.72 1.99 0.51 0.68	1.40	
	1.11		0.99		0.99		1.11	
Story 3 φM$_n$/M$_u$ =	2.78		3.70		3.70		2.78	
φV$_n$/V$_{mpr}$ =	2.38		1.89		1.89		2.38	1.8%
P/A$_g$f'$_c$ =	0.08		0.14		0.14		0.08	
Floor 3	1.26	1.74 1.98 0.51 0.67	1.19	1.81 2.25 0.51 0.67	1.19	1.74 1.98 0.51 0.67	1.26	
	1.09		0.97		0.97		1.09	
Story 2 φM$_n$/M$_u$ =	1.81		2.08		2.08		1.81	
φV$_n$/V$_{mpr}$ =	3.06		2.59		2.59		3.06	1.8%
P/A$_g$f'$_c$ =	0.09		0.17		0.17		0.09	
Floor 2	1.30	1.17 1.25 0.52 3.93	1.28	1.24 1.57 0.52 3.93	1.28	1.17 1.25 0.52 3.93	1.30	
	1.74	(φM$_n$/M$_u$)$_{neg}$ = (φM$_n$/M$_u$)$_{pos}$ = M$_{n,pos}$/M$_{n,neg}$ = φV$_n$/V$_{mpr}$ =	1.54	(φM$_n$/M$_u$)$_{neg}$ = (φM$_n$/M$_u$)$_{pos}$ = M$_{n,pos}$/M$_{n,neg}$ = φV$_n$/V$_{mpr}$ =	1.54	(φM$_n$/M$_u$)$_{neg}$ = (φM$_n$/M$_u$)$_{pos}$ = M$_{n,pos}$/M$_{n,neg}$ = φV$_n$/V$_{mpr}$ =	1.74	
Story 1 φM$_n$/M$_u$ =	0.97		1.89		1.89		0.97	
φV$_n$/V$_{mpr}$ =	3.31		2.68		2.68		3.31	1.4%
P/A$_g$f'$_c$ =	0.11		0.19		0.19		0.11	

Modeling Documentation (1 of 1)

Story 8	$M_{y,exp}$ (k-in) =	6098	7426	7426	6098
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.081	0.081	0.081	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	116	114	114	116
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 7	$M_{y,exp}$ (k-in) =	6455	8122	8122	6455
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.079	0.078	0.078	0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	114	111	111	114
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 6	$M_{y,exp}$ (k-in) =	6808	8806	8806	6808
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.078	0.075	0.075	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	112	107	107	112
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 5	$M_{y,exp}$ (k-in) =	7157	9478	9478	7157
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.076	0.072	0.072	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	111	104	104	111
	$(P/A_gf'_c)_{exp}$ =	0.04	0.09	0.09	0.04
Story 4	$M_{y,exp}$ (k-in) =	7550	10212	10212	7550
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.070	0.067	0.067	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	111	105	105	111
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 3	$M_{y,exp}$ (k-in) =	8860	11826	11826	8860
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.066	0.066	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	103	103	110
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 2	$M_{y,exp}$ (k-in) =	6636	8351	8351	6636
	EI_{stf}/EI_g =	0.35	0.39	0.39	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.065	0.058	0.058	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	101	101	109
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 1	$M_{y,exp}$ (k-in) =	6018	8050	8050	6018
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.063	0.055	0.055	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	98	98	107
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	2817	-6453	0.35	8.137E+07	0.0441	-0.065	0.100	100
	2817	-6453	0.35	8.137E+07	0.0441	-0.065	0.100	100
	2817	-6453	0.35	8.137E+07	0.0441	-0.065	0.100	100
Floor 8	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
Floor 7	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
Floor 6	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
Floor 5	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
Floor 4	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
Floor 3	4098	-10594	0.35	8.137E+07	0.047	-0.073	0.100	100
	4098	-10594	0.35	8.137E+07	0.0467	-0.073	0.100	100
	4098	-10594	0.35	8.137E+07	0.0467	-0.073	0.100	100
Floor 2	2677	-7753	0.35	8.137E+07	0.043	-0.070	0.100	100
	2677	-7753	0.35	8.137E+07	0.043	-0.070	0.100	100
	2677	-7753	0.35	8.137E+07	0.043	-0.070	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.57 T_2 = 0.51 T_3 = 0.29

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

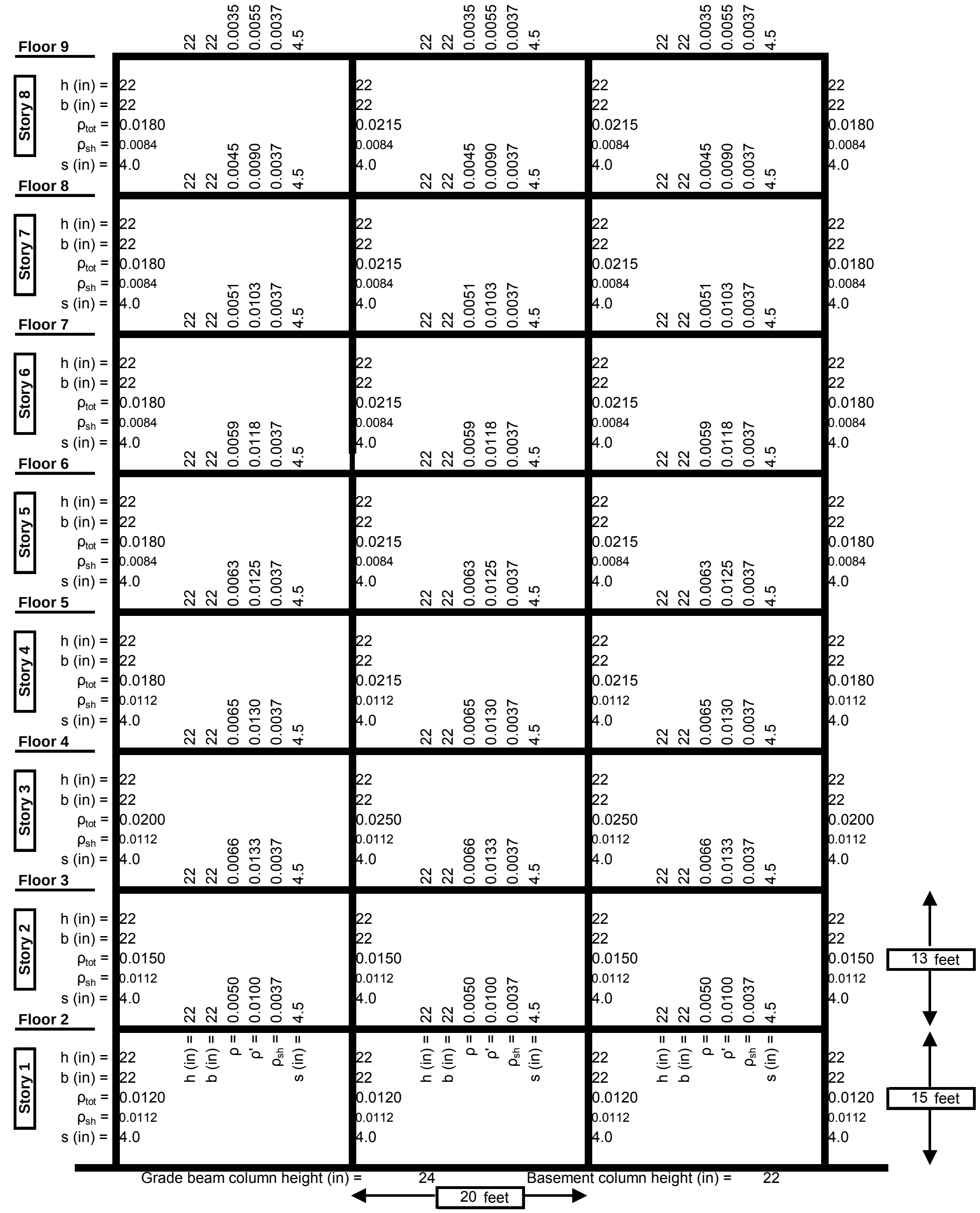
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 1024
Number of Stories: 8
Fundamental Period (sec): 1.71

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

First floor beams initially reinforced for flexure, then above beams sized to meet 85% weak story requirement. Columns reinforced to meet SCWB provisions while not overstrengthening the first story columns. Column strengths increased to 6.0 ksi in upper stories and 8.0 ksi in lower stories to meet joint shear requirements. Beam strength increased to 6.0 ksi to facilitate joint concrete placement by contractor.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



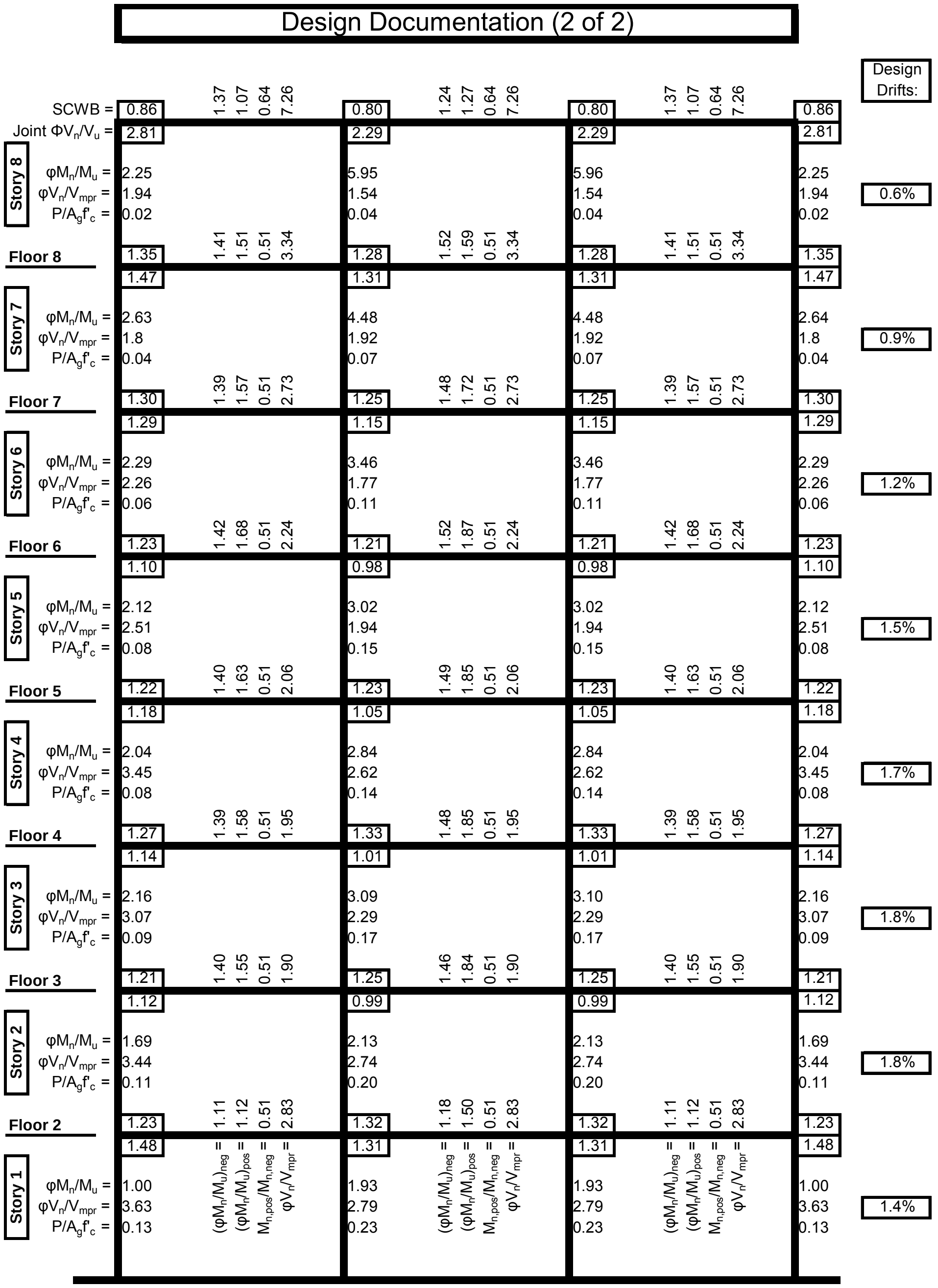
Story 8 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0180	0.0215	0.0215	0.0180
ρ_{sh} =	0.0084	0.0084	0.0084	0.0084
s (in) =	4.0	4.0	4.0	4.0
Story 7 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0180	0.0215	0.0215	0.0180
ρ_{sh} =	0.0084	0.0084	0.0084	0.0084
s (in) =	4.0	4.0	4.0	4.0
Story 6 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0180	0.0215	0.0215	0.0180
ρ_{sh} =	0.0084	0.0084	0.0084	0.0084
s (in) =	4.0	4.0	4.0	4.0
Story 5 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0180	0.0215	0.0215	0.0180
ρ_{sh} =	0.0084	0.0084	0.0084	0.0084
s (in) =	4.0	4.0	4.0	4.0
Story 4 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0180	0.0215	0.0215	0.0180
ρ_{sh} =	0.0112	0.0112	0.0112	0.0112
s (in) =	4.0	4.0	4.0	4.0
Story 3 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0200	0.0250	0.0250	0.0200
ρ_{sh} =	0.0112	0.0112	0.0112	0.0112
s (in) =	4.0	4.0	4.0	4.0
Story 2 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0150	0.0150	0.0150	0.0150
ρ_{sh} =	0.0112	0.0112	0.0112	0.0112
s (in) =	4.0	4.0	4.0	4.0
Story 1 h (in) =	22	22	22	22
b (in) =	22	22	22	22
ρ_{tot} =	0.0120	0.0120	0.0120	0.0120
ρ_{sh} =	0.0112	0.0112	0.0112	0.0112
s (in) =	4.0	4.0	4.0	4.0

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 9	22	22	0.0035	0.0055	0.0037	4.5
	22	22	0.0035	0.0055	0.0037	4.5
	22	22	0.0035	0.0055	0.0037	4.5
Floor 8	22	22	0.0045	0.0090	0.0037	4.5
	22	22	0.0045	0.0090	0.0037	4.5
	22	22	0.0045	0.0090	0.0037	4.5
Floor 7	22	22	0.0051	0.0103	0.0037	4.5
	22	22	0.0051	0.0103	0.0037	4.5
	22	22	0.0051	0.0103	0.0037	4.5
Floor 6	22	22	0.0059	0.0118	0.0037	4.5
	22	22	0.0059	0.0118	0.0037	4.5
	22	22	0.0059	0.0118	0.0037	4.5
Floor 5	22	22	0.0063	0.0125	0.0037	4.5
	22	22	0.0063	0.0125	0.0037	4.5
	22	22	0.0063	0.0125	0.0037	4.5
Floor 4	22	22	0.0065	0.0130	0.0037	4.5
	22	22	0.0065	0.0130	0.0037	4.5
	22	22	0.0065	0.0130	0.0037	4.5
Floor 3	22	22	0.0066	0.0133	0.0037	4.5
	22	22	0.0066	0.0133	0.0037	4.5
	22	22	0.0066	0.0133	0.0037	4.5
Floor 2	22	22	0.0050	0.0100	0.0037	4.5
	22	22	0.0050	0.0100	0.0037	4.5
	22	22	0.0050	0.0100	0.0037	4.5

Grade beam column height (in) = 24

Basement column height (in) = 22

Design base shear =	0.050 g, 94 k		
f'_c beams = 6.0 ksi		$f'_{c,cols,upper}$ = 6.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 8.0 ksi	


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.86 | 1.37 1.07 0.64 7.26 | 0.80 | 1.24 1.27 0.64 7.26 | 0.80 | 1.37 1.07 0.64 7.26 | 0.86
Joint ΦVn/Vu = 2.81 | 2.29 | 2.29 | 2.81
Story 8
φMn/Mu = 2.25 | 5.95 | 5.96 | 2.25
φVn/Vmpr = 1.94 | 1.54 | 1.54 | 1.94
P/Agf'c = 0.02 | 0.04 | 0.04 | 0.02
0.6%
1.41 1.51 0.51 3.34 | 1.52 1.59 0.51 3.34 | 1.41 1.51 0.51 3.34
Floor 8
1.35 | 1.28 | 1.28 | 1.35
1.47 | 1.31 | 1.31 | 1.47
Story 7
φMn/Mu = 2.63 | 4.48 | 4.48 | 2.64
φVn/Vmpr = 1.8 | 1.92 | 1.92 | 1.8
P/Agf'c = 0.04 | 0.07 | 0.07 | 0.04
0.9%
1.39 1.57 0.51 2.73 | 1.48 1.72 0.51 2.73 | 1.39 1.57 0.51 2.73
Floor 7
1.30 | 1.25 | 1.25 | 1.30
1.29 | 1.15 | 1.15 | 1.29
Story 6
φMn/Mu = 2.29 | 3.46 | 3.46 | 2.29
φVn/Vmpr = 2.26 | 1.77 | 1.77 | 2.26
P/Agf'c = 0.06 | 0.11 | 0.11 | 0.06
1.2%
1.42 1.68 0.51 2.24 | 1.52 1.87 0.51 2.24 | 1.42 1.68 0.51 2.24
Floor 6
1.23 | 1.21 | 1.21 | 1.23
1.10 | 0.98 | 0.98 | 1.10
Story 5
φMn/Mu = 2.12 | 3.02 | 3.02 | 2.12
φVn/Vmpr = 2.51 | 1.94 | 1.94 | 2.51
P/Agf'c = 0.08 | 0.15 | 0.15 | 0.08
1.5%
1.40 1.63 0.51 2.06 | 1.49 1.85 0.51 2.06 | 1.40 1.63 0.51 2.06
Floor 5
1.22 | 1.23 | 1.23 | 1.22
1.18 | 1.05 | 1.05 | 1.18
Story 4
φMn/Mu = 2.04 | 2.84 | 2.84 | 2.04
φVn/Vmpr = 3.45 | 2.62 | 2.62 | 3.45
P/Agf'c = 0.08 | 0.14 | 0.14 | 0.08
1.7%
1.39 1.58 0.51 1.95 | 1.48 1.85 0.51 1.95 | 1.39 1.58 0.51 1.95
Floor 4
1.27 | 1.33 | 1.33 | 1.27
1.14 | 1.01 | 1.01 | 1.14
Story 3
φMn/Mu = 2.16 | 3.09 | 3.10 | 2.16
φVn/Vmpr = 3.07 | 2.29 | 2.29 | 3.07
P/Agf'c = 0.09 | 0.17 | 0.17 | 0.09
1.8%
1.40 1.55 0.51 1.90 | 1.46 1.84 0.51 1.90 | 1.40 1.55 0.51 1.90
Floor 3
1.21 | 1.25 | 1.25 | 1.21
1.12 | 0.99 | 0.99 | 1.12
Story 2
φMn/Mu = 1.69 | 2.13 | 2.13 | 1.69
φVn/Vmpr = 3.44 | 2.74 | 2.74 | 3.44
P/Agf'c = 0.11 | 0.20 | 0.20 | 0.11
1.8%
1.11 1.12 0.51 2.83 | 1.18 1.50 0.51 2.83 | 1.11 1.12 0.51 2.83
Floor 2
1.23 | 1.32 | 1.32 | 1.23
1.48 | 1.31 | 1.31 | 1.48
Story 1
φMn/Mu = 1.00 | 1.93 | 1.93 | 1.00
φVn/Vmpr = 3.63 | 2.79 | 2.79 | 3.63
P/Agf'c = 0.13 | 0.23 | 0.23 | 0.13
1.4%
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =

Modeling Documentation (1 of 1)

Story 8	$M_{y,exp}$ (k-in) =	4889	6059	6059	4889
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.078	0.079	0.079	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	103	103	105
	$(P/A_gf'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 7	$M_{y,exp}$ (k-in) =	5213	6689	6689	5213
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.077	0.075	0.075	0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	99	99	103
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 6	$M_{y,exp}$ (k-in) =	5533	7307	7307	5533
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.075	0.071	0.071	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	101	96	96	101
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 5	$M_{y,exp}$ (k-in) =	5849	7914	7914	5849
	EI_{stf}/EI_g =	0.35	0.36	0.36	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.073	0.068	0.068	0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	93	93	99
	$(P/A_gf'_c)_{exp}$ =	0.05	0.11	0.11	0.05
Story 4	$M_{y,exp}$ (k-in) =	6204	8576	8576	6204
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.076	0.071	0.071	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	93	93	100
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 3	$M_{y,exp}$ (k-in) =	6997	10002	10002	6997
	EI_{stf}/EI_g =	0.36	0.42	0.42	0.36
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.076	0.071	0.071	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	98	91	91	98
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 2	$M_{y,exp}$ (k-in) =	6110	8219	8219	6110
	EI_{stf}/EI_g =	0.37	0.44	0.44	0.37
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.063	0.063	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	89	89	97
	$(P/A_gf'_c)_{exp}$ =	0.07	0.14	0.14	0.07
Story 1	$M_{y,exp}$ (k-in) =	5702	8091	8091	5702
	EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.068	0.059	0.059	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	96	86	86	96
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08

Floor 9	$M_{y,pos,exp}$(k-in) =	1828	1828	1828
	$M_{y,n,slab,exp}$(k-in) =	-5532	-5532	-5532
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0406	0.0406	0.0406
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 8	$M_{y,pos,exp}$(k-in) =	2329	2329	2329
	$M_{y,n,slab,exp}$(k-in) =	-7205	-7205	-7205
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 7	$M_{y,pos,exp}$(k-in) =	2641	2641	2641
	$M_{y,n,slab,exp}$(k-in) =	-7799	-7799	-7799
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 6	$M_{y,pos,exp}$(k-in) =	3014	3014	3014
	$M_{y,n,slab,exp}$(k-in) =	-8510	-8510	-8510
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 5	$M_{y,pos,exp}$(k-in) =	3200	3200	3200
	$M_{y,n,slab,exp}$(k-in) =	-8864	-8864	-8864
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$(k-in) =	3324	3324	3324
	$M_{y,n,slab,exp}$(k-in) =	-9101	-9101	-9101
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$(k-in) =	3385	3385	3385
	$M_{y,n,slab,exp}$(k-in) =	-9219	-9219	-9219
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0454	0.0454
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.073	-0.073	-0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 2	$M_{y,pos,exp}$(k-in) =	2578	2578	2578
	$M_{y,n,slab,exp}$(k-in) =	-7681	-7681	-7681
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.863E+07	7.863E+07	7.863E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.71 T_2= 0.56 T_3 = 0.32

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2001

Number of Stories: 4

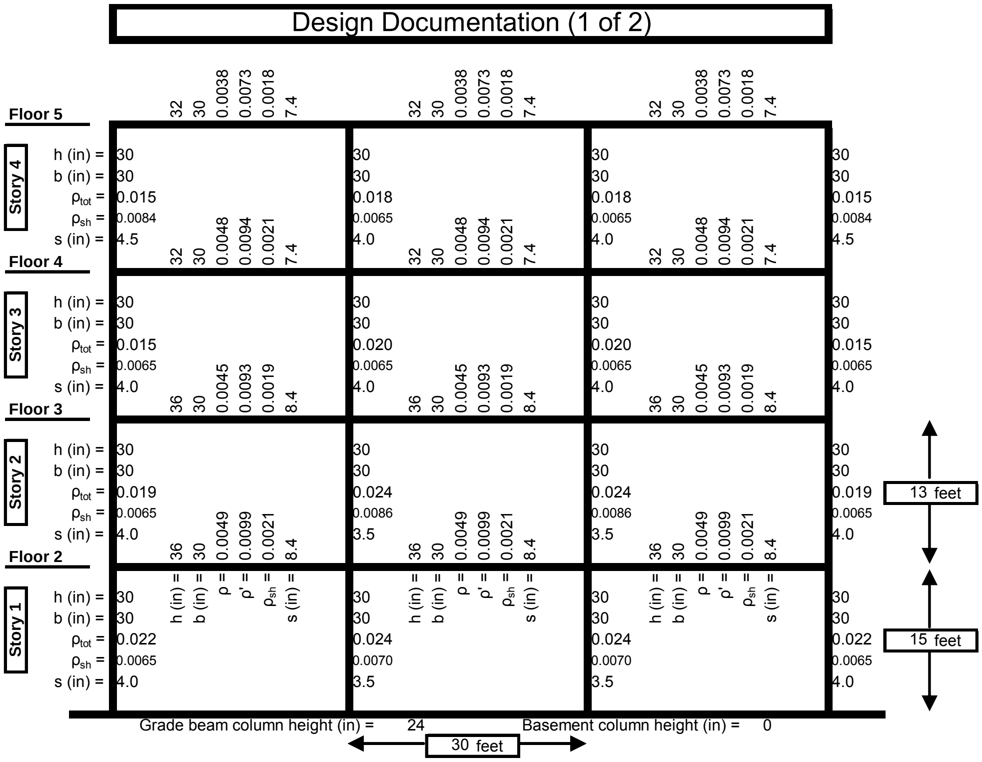
Fundamental Period (sec): 0.74

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

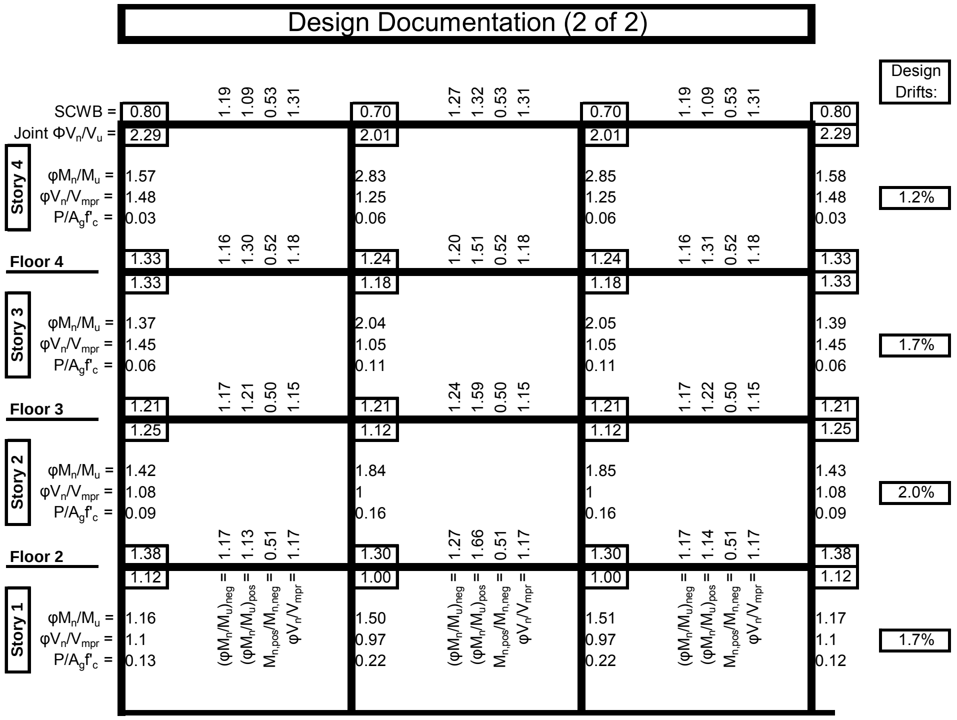
2001 R=4

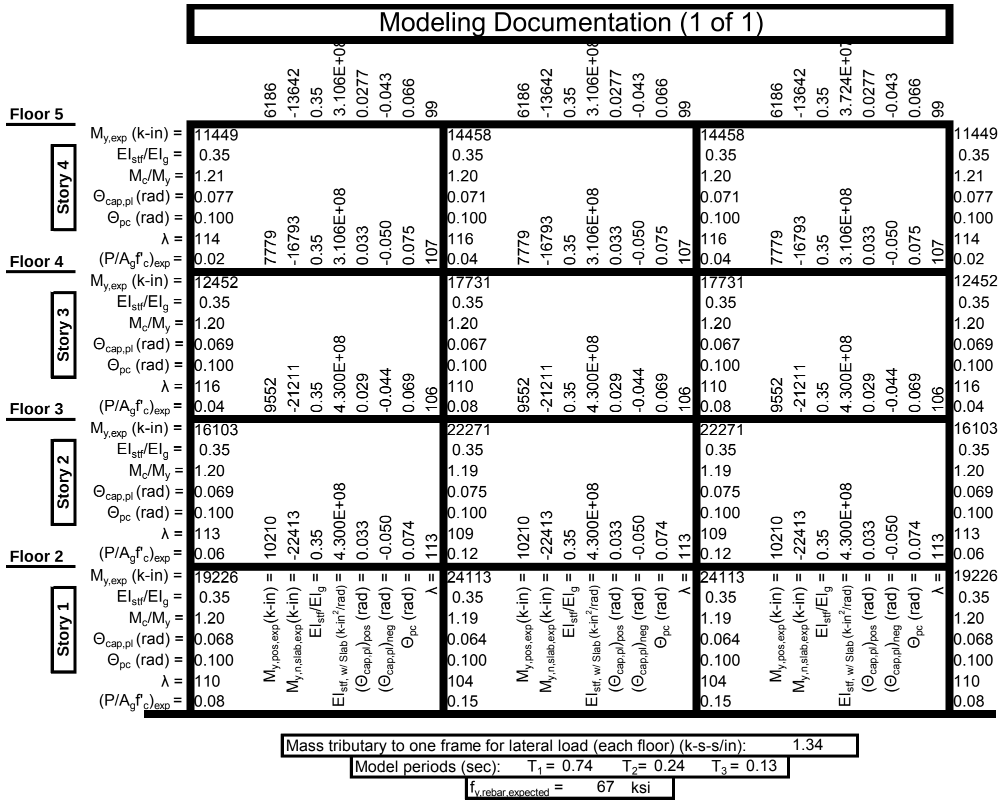
The beam depths were controlled by drift limits, caused by large lateral force demand due to the low R value. Both negative and positive flexural beam strength was controlled by strength demands, but then additional steel was added to 5 bays to meet the minimum reinforcement requirements (this was needed due to large beam sizes). Column flexural strengths were controlled by the strong-column weak-beam ratio, except 1 by strength demand. Beam stirrups were controlled by both minimum requirements and by the capacity shear design, more by capacity demand. Most of column stirrups were controlled by both minimum confinement requirements and only two columns had added stirrups for capacity shear demand. Joint shear did not control design because elements were already large due to drift demands.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	0.185 g,	386 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	5.0 ksi





STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2003

Number of Stories: 4

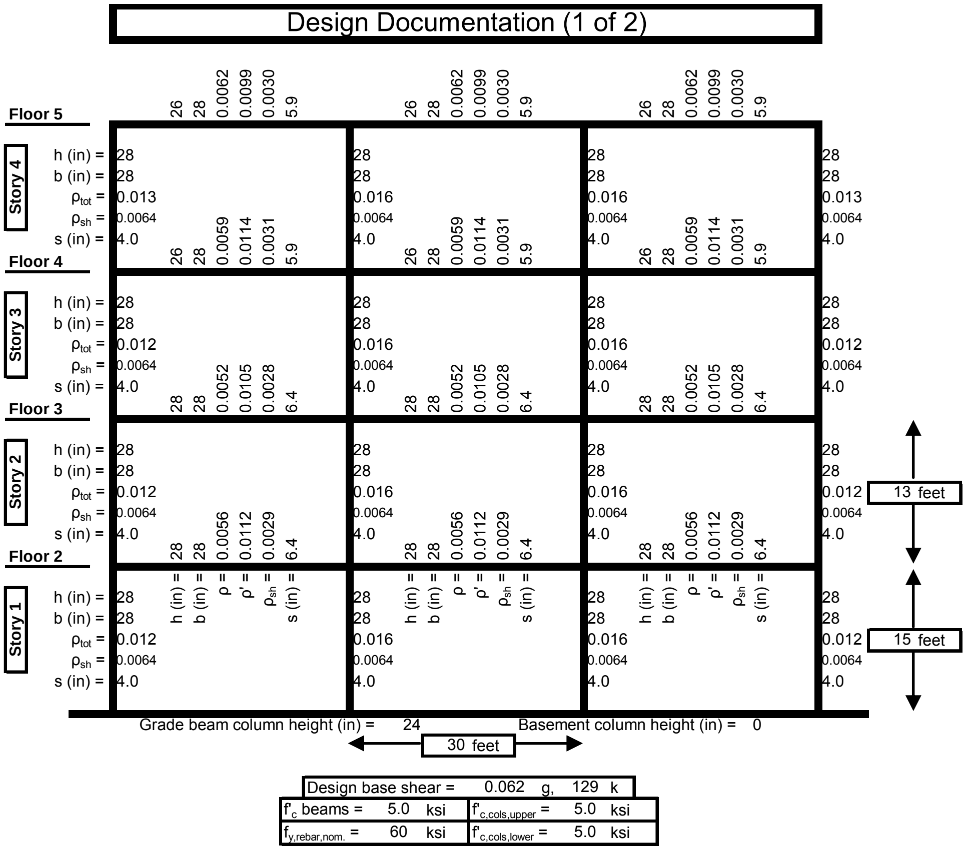
Fundamental Period (sec): 0.97

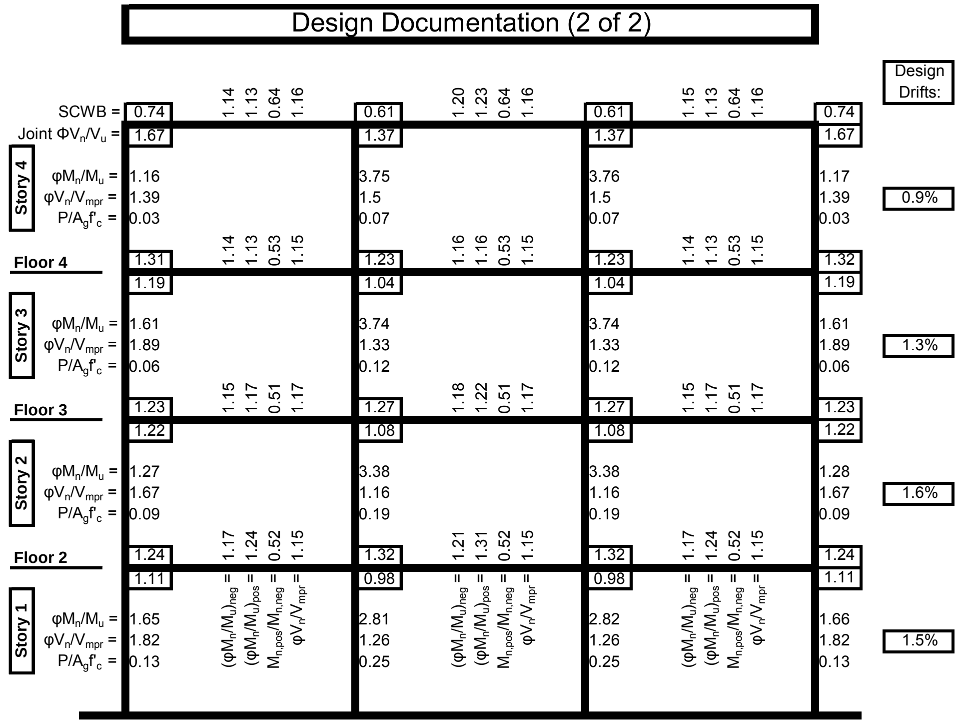
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

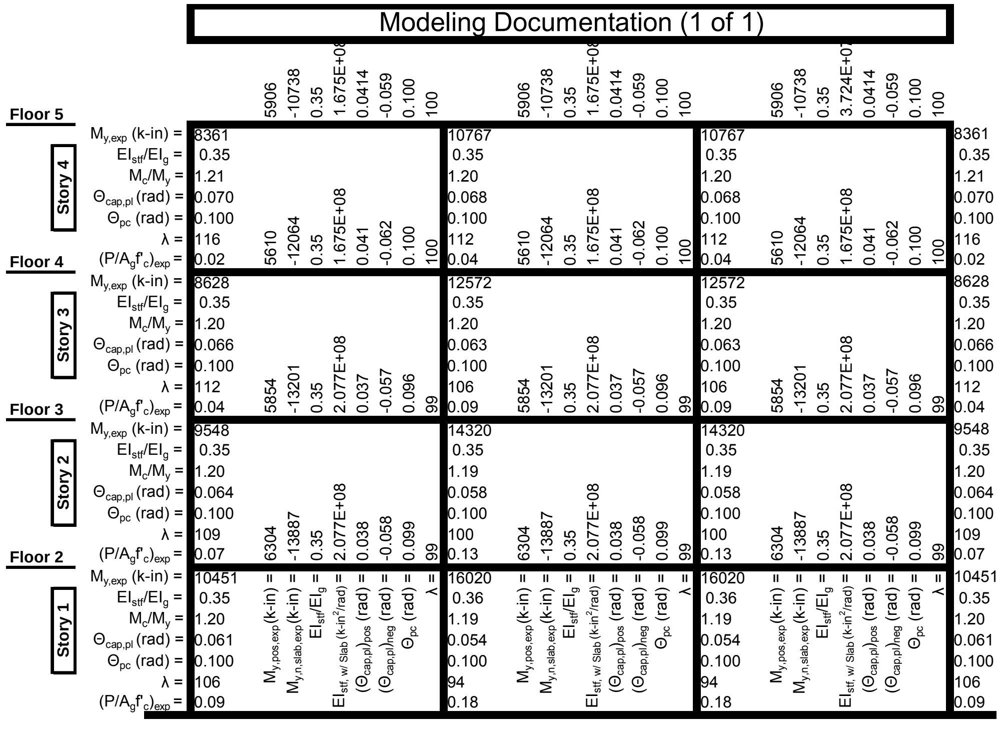
2003 R=12

The column size and beam depth were controlled by joint shear demand. Both negative and positive flexural beam strength was controlled by strength demands. More reinforcements were added to beams in four bays in order make consistent reinforcement for each floor. Two story beams had additional reinforcement added to meet the minimum positive and negative ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 1 by strength demand. All beam stirrups were controlled by the capacity shear design. All of column stirrups were controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES







Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.97 T_2= 0.30 T_3= 0.16

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2005
Number of Stories: 4
Fundamental Period (sec): 0.86

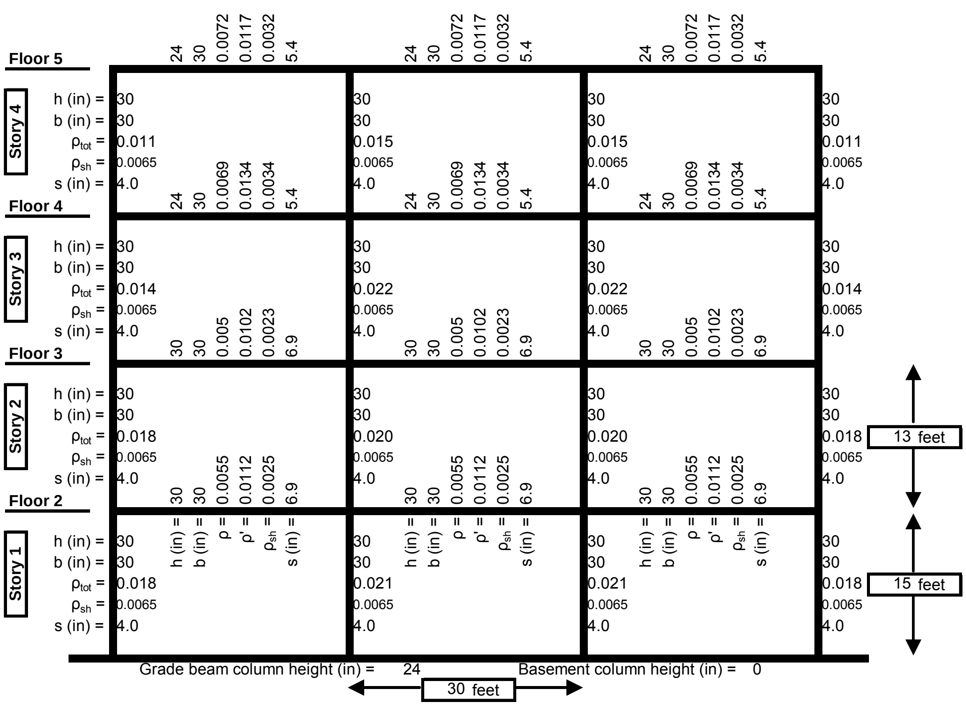
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2005 SCWB=1.5

Beam depths were controlled by joint shear. Both negative and positive flexural beam strength was controlled by strength demands. Four bays have reinforcement added to keep reinforcement constant for each level. Two stories had added reinforcement to meet the positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. Beam stirrups were controlled by the capacity shear design, were as column stirrups were controlled by minimum confinement requirements.

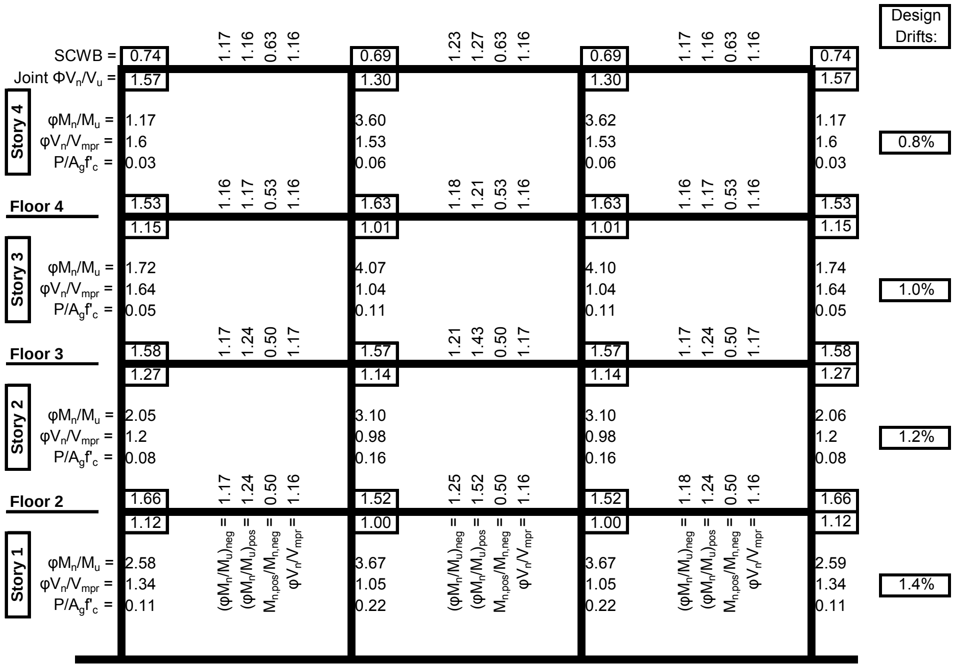
DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.092 g,	193 k	
f'_c beams = 5.0 ksi		$f'_{c,cols,upper}$ = 5.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 5.0 ksi	

Design Documentation (2 of 2)



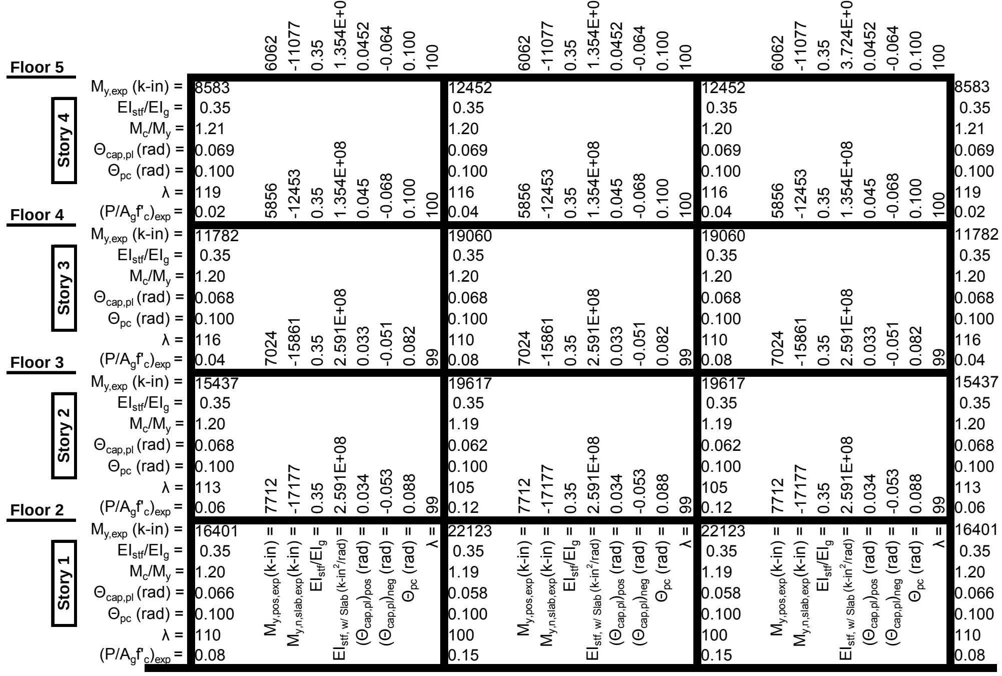
Columns and joints:

		Column line 1	Column line 2	Column line 3	Column line 4	Design Drifts:
Floor 5	SCWB =	0.74	0.69	0.69	0.74	
	Joint $\Phi V_n/V_u$ =	1.57	1.30	1.30	1.57	
Story 4	$\varphi M_n/M_u$ =	1.17	3.60	3.62	1.17	
	$\varphi V_n/V_{mpr}$ =	1.6	1.53	1.53	1.6	0.8%
	$P/A_gf'_c$ =	0.03	0.06	0.06	0.03	
Floor 4		1.53	1.63	1.63	1.53	
		1.15	1.01	1.01	1.15	
Story 3	$\varphi M_n/M_u$ =	1.72	4.07	4.10	1.74	
	$\varphi V_n/V_{mpr}$ =	1.64	1.04	1.04	1.64	1.0%
	$P/A_gf'_c$ =	0.05	0.11	0.11	0.05	
Floor 3		1.58	1.57	1.57	1.58	
		1.27	1.14	1.14	1.27	
Story 2	$\varphi M_n/M_u$ =	2.05	3.10	3.10	2.06	
	$\varphi V_n/V_{mpr}$ =	1.2	0.98	0.98	1.2	1.2%
	$P/A_gf'_c$ =	0.08	0.16	0.16	0.08	
Floor 2		1.66	1.52	1.52	1.66	
		1.12	1.00	1.00	1.12	
Story 1	$\varphi M_n/M_u$ =	2.58	3.67	3.67	2.59	
	$\varphi V_n/V_{mpr}$ =	1.34	1.05	1.05	1.34	1.4%
	$P/A_gf'_c$ =	0.11	0.22	0.22	0.11	

Beams:

		Bay 1	Bay 2	Bay 3
Floor 5	$(\varphi M_n/M_u)_{neg}$ =	1.17	1.23	1.17
	$(\varphi M_n/M_u)_{pos}$ =	1.16	1.27	1.16
	$M_{n,pos}/M_{n,neg}$ =	0.63	0.63	0.63
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16
Floor 4	$(\varphi M_n/M_u)_{neg}$ =	1.16	1.18	1.16
	$(\varphi M_n/M_u)_{pos}$ =	1.17	1.21	1.17
	$M_{n,pos}/M_{n,neg}$ =	0.53	0.53	0.53
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16
Floor 3	$(\varphi M_n/M_u)_{neg}$ =	1.17	1.21	1.17
	$(\varphi M_n/M_u)_{pos}$ =	1.24	1.43	1.24
	$M_{n,pos}/M_{n,neg}$ =	0.50	0.50	0.50
	$\varphi V_n/V_{mpr}$ =	1.17	1.17	1.17
Floor 2	$(\varphi M_n/M_u)_{neg}$ =	1.17	1.25	1.18
	$(\varphi M_n/M_u)_{pos}$ =	1.24	1.52	1.24
	$M_{n,pos}/M_{n,neg}$ =	0.50	0.50	0.50
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16

Modeling Documentation (1 of 1)



Columns:

		Column line 1	Column line 2	Column line 3	Column line 4
Story 4	$M_{y,exp}$ (k-in) =	8583	12452	12452	8583
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.069	0.069	0.069	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	116	116	119
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 3	$M_{y,exp}$ (k-in) =	11782	19060	19060	11782
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.068	0.068	0.068	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	116	110	110	116
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 2	$M_{y,exp}$ (k-in) =	15437	19617	19617	15437
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.068	0.062	0.062	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	113	105	105	113
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 1	$M_{y,exp}$ (k-in) =	16401	22123	22123	16401
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.066	0.058	0.058	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	100	100	110
	$(P/A_gf'_c)_{exp}$ =	0.08	0.15	0.15	0.08

Beams:

		Bay 1	Bay 2	Bay 3
Floor 5	$M_{y,pos,exp}$(k-in) =	6062	6062	6062
	$M_{y,n,slab,exp}$(k-in) =	-11077	-11077	-11077
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\text{ w/ Slab}}$ (k-in^2/rad) =	1.354E+08	1.354E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0452	0.0452	0.0452
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.064	-0.064	-0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$(k-in) =	5856	5856	5856
	$M_{y,n,slab,exp}$(k-in) =	-12453	-12453	-12453
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\text{ w/ Slab}}$ (k-in^2/rad) =	1.354E+08	1.354E+08	1.354E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$(k-in) =	7024	7024	7024
	$M_{y,n,slab,exp}$(k-in) =	-15861	-15861	-15861
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\text{ w/ Slab}}$ (k-in^2/rad) =	2.591E+08	2.591E+08	2.591E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.033	0.033	0.033
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.051	-0.051	-0.051
	Θ_{pc} (rad) =	0.082	0.082	0.082
	λ =	99	99	99
Floor 2	$M_{y,pos,exp}$(k-in) =	7712	7712	7712
	$M_{y,n,slab,exp}$(k-in) =	-17177	-17177	-17177
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\text{ w/ Slab}}$ (k-in^2/rad) =	2.591E+08	2.591E+08	2.591E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.088	0.088	0.088
	λ =	99	99	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.86 T_2 = 0.27 T_3 = 0.15

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2006

Number of Stories: 4

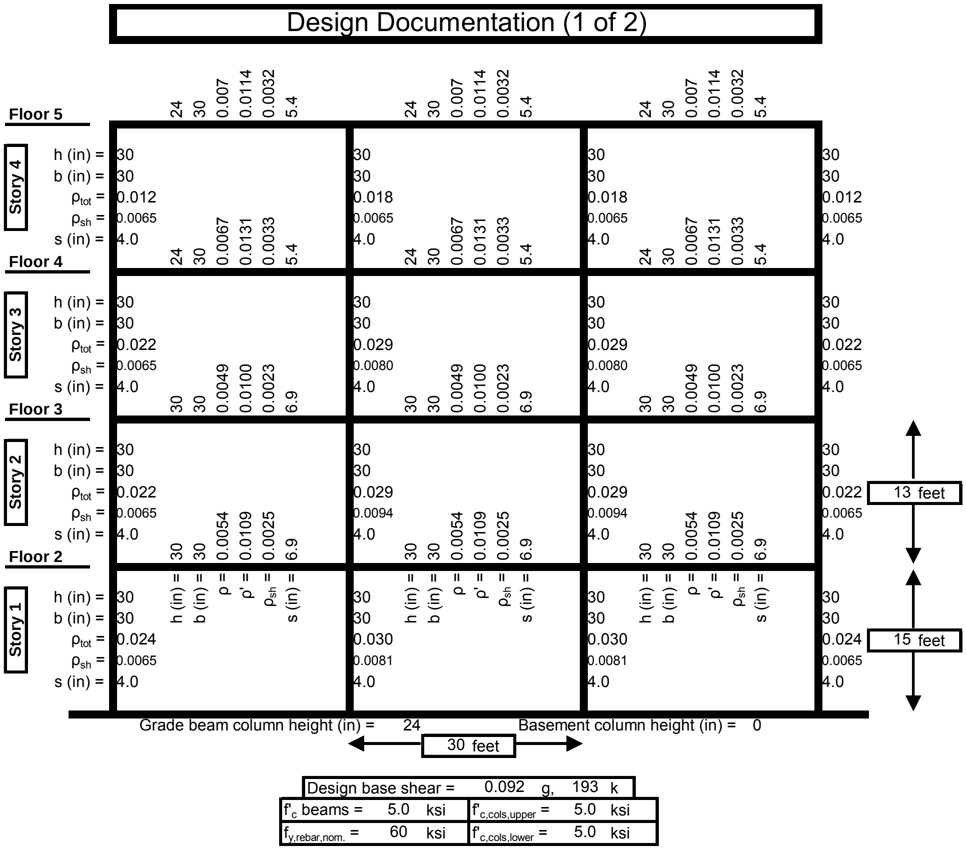
Fundamental Period (sec): 0.85

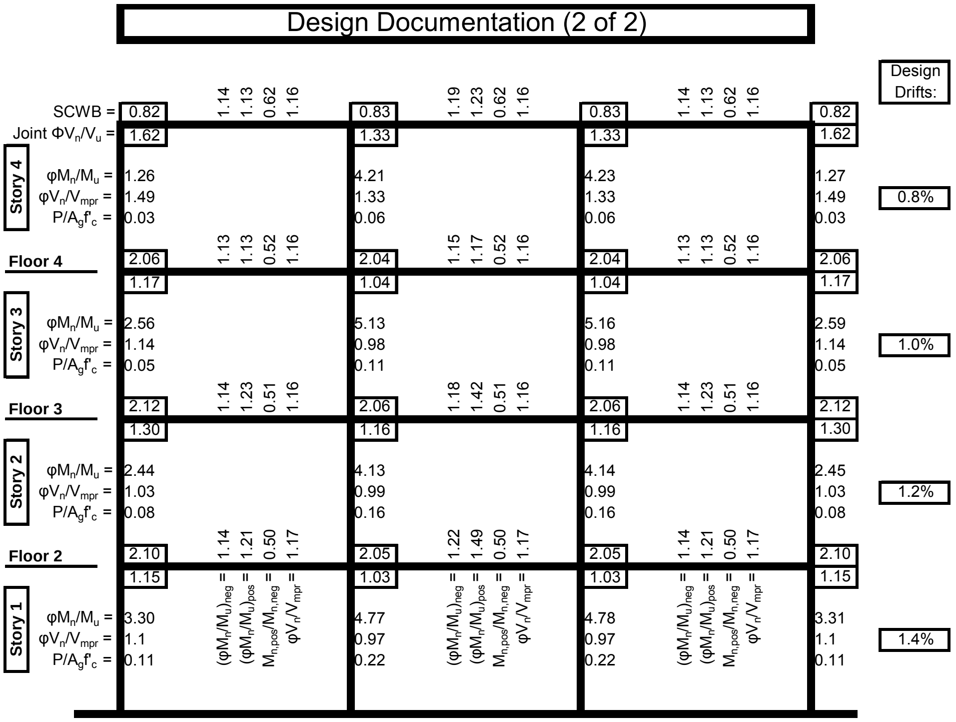
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

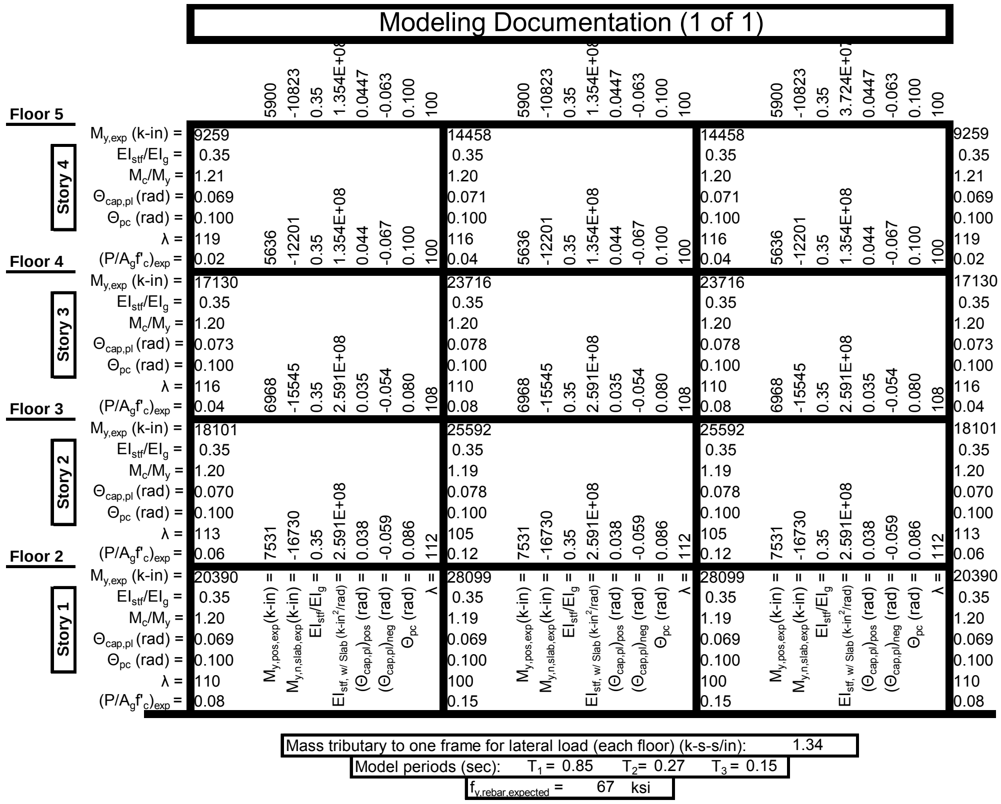
2006 SCWB=2.0

Column sizes were controlled by joint shear as in baseline case. To satisfy SCWB adding more reinforcement was required. Both negative and positive flexural beam strength was controlled by strength demands. Four bays' reinforcements were added to alter beam design to use same rho and rhoPrime for each level. All column flexural strengths were controlled by the strong-column weak-beam ratio. Beam stirrups were controlled by capacity shear design. Column stirrups were controlled by both capacity shear design as well as minimum reinforcement requirement (half-half).

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
24 30 0.007 0.0114 0.0032 5.4
24 30 0.007 0.0114 0.0032 5.4
24 30 0.007 0.0114 0.0032 5.4
Story 4
h (in) = 30 30 30 30
b (in) = 30 30 30 30
ρtot = 0.012 0.018 0.018 0.012
ρsh = 0.0065 0.0065 0.0065 0.0065
s (in) = 4.0 4.0 4.0 4.0
Floor 4
24 30 0.0067 0.0131 0.0033 5.4
24 30 0.0067 0.0131 0.0033 5.4
24 30 0.0067 0.0131 0.0033 5.4
Story 3
h (in) = 30 30 30 30
b (in) = 30 30 30 30
ρtot = 0.022 0.029 0.029 0.022
ρsh = 0.0065 0.0080 0.0080 0.0065
s (in) = 4.0 4.0 4.0 4.0
Floor 3
30 30 0.0049 0.0100 0.0023 6.9
30 30 0.0049 0.0100 0.0023 6.9
30 30 0.0049 0.0100 0.0023 6.9
Story 2
h (in) = 30 30 30 30
b (in) = 30 30 30 30
ρtot = 0.022 0.029 0.029 0.022
ρsh = 0.0065 0.0094 0.0094 0.0065
s (in) = 4.0 4.0 4.0 4.0
13 feet
Floor 2
30 30 0.0054 0.0109 0.0025 6.9
30 30 0.0054 0.0109 0.0025 6.9
30 30 0.0054 0.0109 0.0025 6.9
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 30 30 30 30
b (in) = 30 30 30 30
ρtot = 0.024 0.030 0.030 0.024
ρsh = 0.0065 0.0081 0.0081 0.0065
s (in) = 4.0 4.0 4.0 4.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi


Design Documentation (2 of 2)
Design Drifts:
1.14 1.13 0.62 1.16
1.19 1.23 0.62 1.16
1.14 1.13 0.62 1.16
SCWB = 0.82 0.83 0.83 0.82
Joint ΦVn/Vu = 1.62 1.33 1.33 1.62
Story 4
φMn/Mu = 1.26 4.21 4.23 1.27
φVn/Vmpr = 1.49 1.33 1.33 1.49
P/Agf'c = 0.03 0.06 0.06 0.03
0.8%
1.13 1.13 0.52 1.16
1.15 1.17 0.52 1.16
1.13 1.13 0.52 1.16
Floor 4
2.06 2.04 2.04 2.06
1.17 1.04 1.04 1.17
Story 3
φMn/Mu = 2.56 5.13 5.16 2.59
φVn/Vmpr = 1.14 0.98 0.98 1.14
P/Agf'c = 0.05 0.11 0.11 0.05
1.0%
1.14 1.23 0.51 1.16
1.18 1.42 0.51 1.16
1.14 1.23 0.51 1.16
Floor 3
2.12 2.06 2.06 2.12
1.30 1.16 1.16 1.30
Story 2
φMn/Mu = 2.44 4.13 4.14 2.45
φVn/Vmpr = 1.03 0.99 0.99 1.03
P/Agf'c = 0.08 0.16 0.16 0.08
1.2%
1.14 1.21 0.50 1.17
1.22 1.49 0.50 1.17
1.14 1.21 0.50 1.17
Floor 2
2.10 2.05 2.05 2.10
1.15 1.03 1.03 1.15
(φMn/Mu)neg = (φMn/Mu)pos = Mn,pos/Mn,neg = φVn/Vmpr =
Story 1
φMn/Mu = 3.30 4.77 4.78 3.31
φVn/Vmpr = 1.1 0.97 0.97 1.1
P/Agf'c = 0.11 0.22 0.22 0.11
1.4%



STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2007

Number of Stories: 4

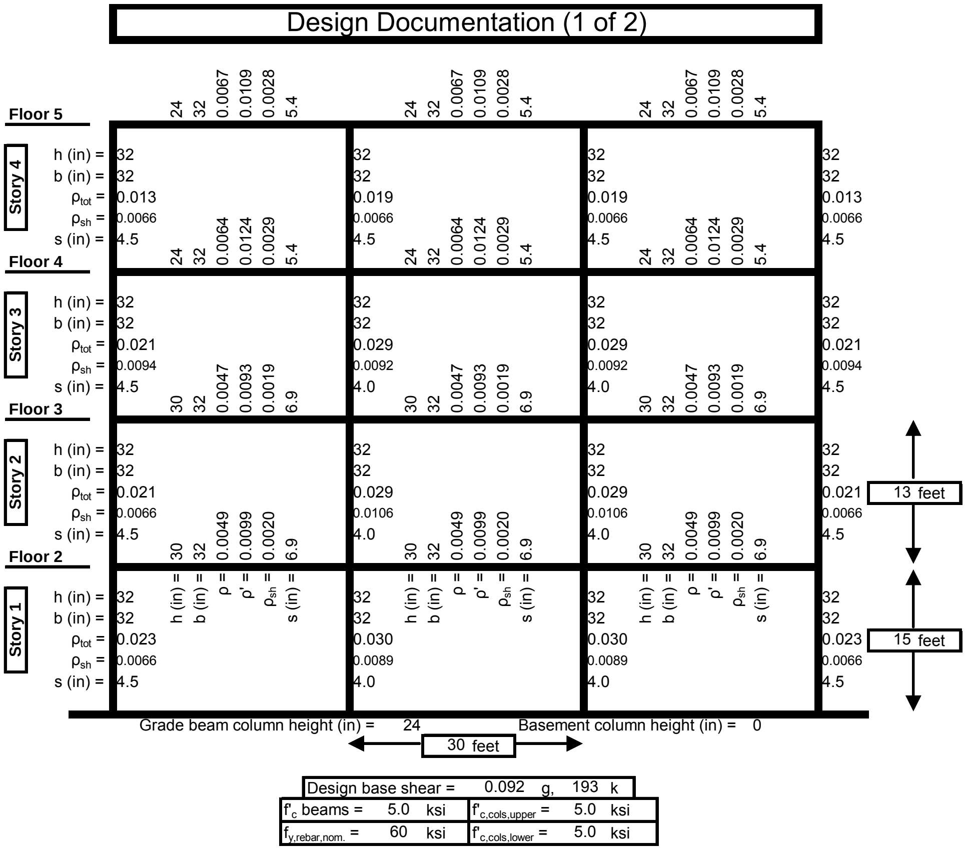
Fundamental Period (sec): 0.79

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2007 SCWB=2.5

Compared to the baseline design, column sizes were increased to meet strong-column weak-beam ratio (>2.5). Both negative and positive flexural beam strength was controlled by strength demands. Few additional beam reinforcements in two floors were added to alter beam design to use same rho and rhoPrime. Two floors had additional reinforcement added to meet the minimum positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. All beam stirrups were controlled by the capacity shear design. Most column stirrups were controlled by the capacity shear design while 4 story columns were controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)

								Design Drifts:
	SCWB =	1.05		1.03		1.03		1.05	
	Joint $\Phi V_n/V_u$ =	1.80		1.48		1.48		1.80	
	$(\varphi M_n/M_u)_{neg}$ =		1.18		1.23		1.18		
	$(\varphi M_n/M_u)_{pos}$ =		1.18		1.26		1.18		
	$M_{n,pos}/M_{n,neg}$ =		0.63		0.63		0.63		
	$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16		
Story 4	$\varphi M_n/M_u$ =	1.60		5.16		5.18		1.61	
Story 4	$\varphi V_n/V_{mpr}$ =	1.33		1.21		1.21		1.33	0.7%
Story 4	$P/A_g f'_c$ =	0.02		0.05		0.05		0.02	
Floor 4	$(\varphi M_n/M_u)_{neg}$ =		1.17		1.18		1.17		
Floor 4	$(\varphi M_n/M_u)_{pos}$ =		1.17		1.20		1.17		
Floor 4	$M_{n,pos}/M_{n,neg}$ =		0.53		0.53		0.53		
Floor 4	$\varphi V_n/V_{mpr}$ =		1.17		1.17		1.17		
Floor 4	SCWB =	2.49		2.50		2.50		2.49	
Floor 4	Joint $\Phi V_n/V_u$ =	1.33		1.17		1.17		1.33	
Story 3	$\varphi M_n/M_u$ =	2.98		6.27		6.32		3.01	
Story 3	$\varphi V_n/V_{mpr}$ =	1.15		1.02		1.02		1.15	0.9%
Story 3	$P/A_g f'_c$ =	0.05		0.09		0.09		0.05	
Floor 3	$(\varphi M_n/M_u)_{neg}$ =		1.14		1.18		1.15		
Floor 3	$(\varphi M_n/M_u)_{pos}$ =		1.27		1.43		1.27		
Floor 3	$M_{n,pos}/M_{n,neg}$ =		0.52		0.52		0.52		
Floor 3	$\varphi V_n/V_{mpr}$ =		1.17		1.17		1.17		
Floor 3	SCWB =	2.50		2.51		2.51		2.50	
Floor 3	Joint $\Phi V_n/V_u$ =	1.50		1.33		1.33		1.50	
Story 2	$\varphi M_n/M_u$ =	2.88		5.05		5.07		2.89	
Story 2	$\varphi V_n/V_{mpr}$ =	1.02		1.03		1.03		1.02	1.0%
Story 2	$P/A_g f'_c$ =	0.07		0.14		0.14		0.07	
Floor 2	$(\varphi M_n/M_u)_{neg}$ =		1.13		1.19		1.13		
Floor 2	$(\varphi M_n/M_u)_{pos}$ =		1.21		1.43		1.21		
Floor 2	$M_{n,pos}/M_{n,neg}$ =		0.50		0.50		0.50		
Floor 2	$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16		
Floor 2	SCWB =	2.50		2.51		2.51		2.51	
Floor 2	Joint $\Phi V_n/V_u$ =	1.35		1.21		1.21		1.35	
Story 1	$\varphi M_n/M_u$ =	3.74		5.78		5.79		3.74	
Story 1	$\varphi V_n/V_{mpr}$ =	1.09		1		1		1.09	1.1%
Story 1	$P/A_g f'_c$ =	0.10		0.19		0.19		0.10	

Modeling Documentation (1 of 1)

Floor 5	$M_{y,pos,exp}$ (k-in) =		6074		6074		6074	
Floor 5	$M_{y,n,slab,exp}$ (k-in) =		-11028		-11028		-11028	
Floor 5	EI_{stf}/EI_g =		0.35		0.35		0.35	
Floor 5	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =		1.387E+08		1.387E+08		3.724E+07	
Floor 5	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.0423		0.0423		0.0423	
Floor 5	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.059		-0.059		-0.059	
Floor 5	Θ_{pc} (rad) =		0.096		0.096		0.096	
Floor 5	λ =		100		100		100	
Story 4	$M_{y,exp}$ (k-in) =	12047		18287		18287		12047
Story 4	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
Story 4	M_c/M_y =	1.21		1.21		1.21		1.21
Story 4	$\Theta_{cap,pl}$ (rad) =	0.068		0.070		0.070		0.068
Story 4	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
Story 4	λ =	117		115		115		117
Story 4	$(P/A_g f'_c)_{exp}$ =	0.02		0.03		0.03		0.02
Floor 4	$M_{y,pos,exp}$ (k-in) =		5792		5792		5792	
Floor 4	$M_{y,n,slab,exp}$ (k-in) =		-12290		-12290		-12290	
Floor 4	EI_{stf}/EI_g =		0.35		0.35		0.35	
Floor 4	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =		1.387E+08		1.387E+08		1.387E+08	
Floor 4	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.042		0.042		0.042	
Floor 4	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.063		-0.063		-0.063	
Floor 4	Θ_{pc} (rad) =		0.100		0.100		0.100	
Floor 4	λ =		100		100		100	
Story 3	$M_{y,exp}$ (k-in) =	19935		28781		28781		19935
Story 3	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
Story 3	M_c/M_y =	1.21		1.20		1.20		1.21
Story 3	$\Theta_{cap,pl}$ (rad) =	0.082		0.084		0.084		0.082
Story 3	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
Story 3	λ =	115		114		114		115
Story 3	$(P/A_g f'_c)_{exp}$ =	0.03		0.07		0.07		0.03
Floor 3	$M_{y,pos,exp}$ (k-in) =		7065		7065		7065	
Floor 3	$M_{y,n,slab,exp}$ (k-in) =		-15406		-15406		-15406	
Floor 3	EI_{stf}/EI_g =		0.35		0.35		0.35	
Floor 3	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =		2.654E+08		2.654E+08		2.654E+08	
Floor 3	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.030		0.030		0.030	
Floor 3	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.046		-0.046		-0.046	
Floor 3	Θ_{pc} (rad) =		0.069		0.069		0.069	
Floor 3	λ =		99		99		99	
Story 2	$M_{y,exp}$ (k-in) =	20979		30596		30596		20979
Story 2	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
Story 2	M_c/M_y =	1.20		1.20		1.20		1.20
Story 2	$\Theta_{cap,pl}$ (rad) =	0.068		0.084		0.084		0.068
Story 2	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
Story 2	λ =	112		109		109		112
Story 2	$(P/A_g f'_c)_{exp}$ =	0.05		0.10		0.10		0.05
Floor 2	$M_{y,pos,exp}$ (k-in) =		7299		7299		7299	
Floor 2	$M_{y,n,slab,exp}$ (k-in) =		-16318		-16318		-16318	
Floor 2	EI_{stf}/EI_g =		0.35		0.35		0.35	
Floor 2	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =		2.654E+08		2.654E+08		2.654E+08	
Floor 2	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.032		0.032		0.032	
Floor 2	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.050		-0.050		-0.050	
Floor 2	Θ_{pc} (rad) =		0.072		0.072		0.072	
Floor 2	λ =		103		103		103	
Story 1	$M_{y,exp}$ (k-in) =	23447		32991		32991		23447
Story 1	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
Story 1	M_c/M_y =	1.20		1.19		1.19		1.20
Story 1	$\Theta_{cap,pl}$ (rad) =	0.067		0.073		0.073		0.067
Story 1	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
Story 1	λ =	110		105		105		110
Story 1	$(P/A_g f'_c)_{exp}$ =	0.07		0.14		0.14		0.07

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.79 T_2 = 0.25 T_3 = 0.13

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

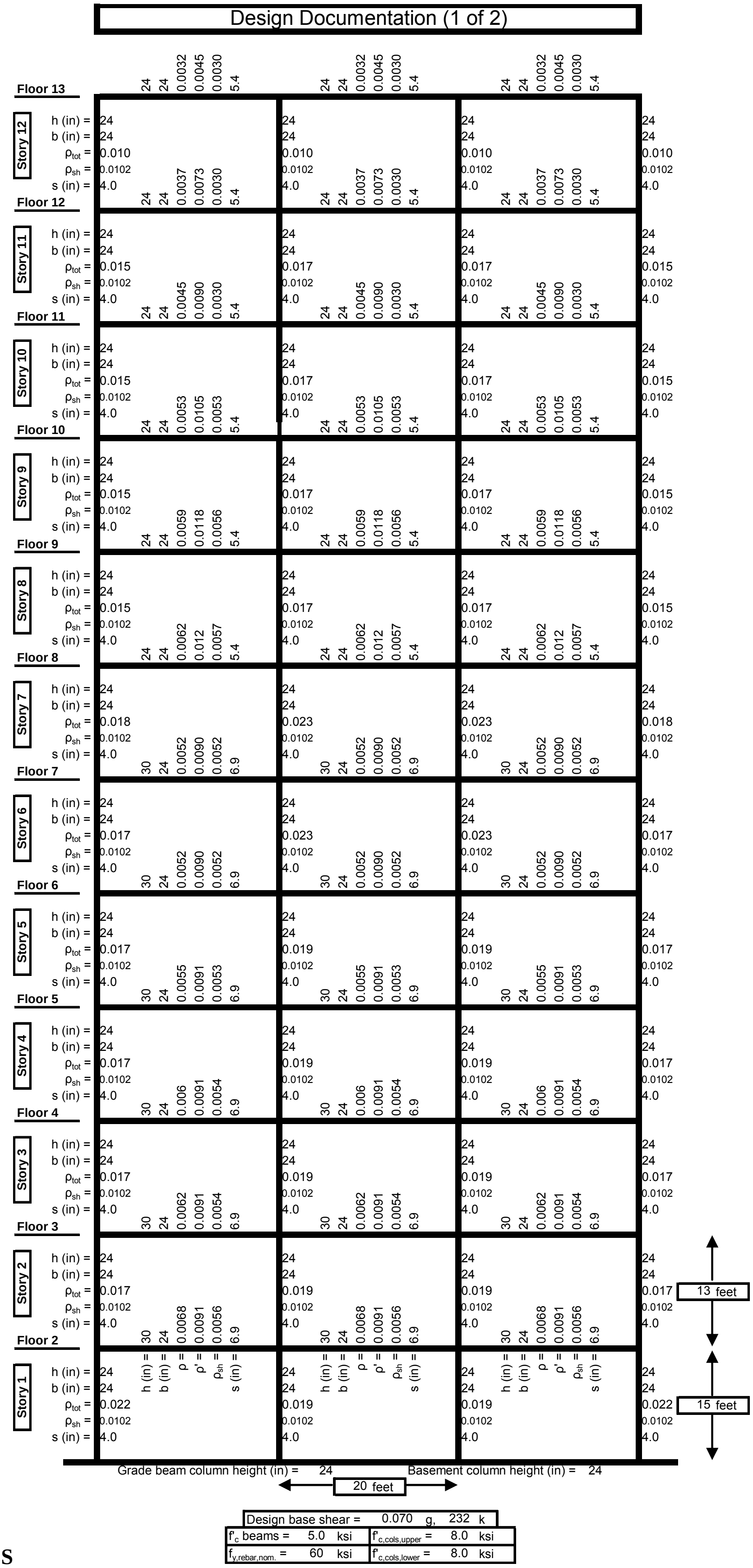
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2008
Number of Stories: 12
Fundamental Period (sec): 1.83

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2008 R=4

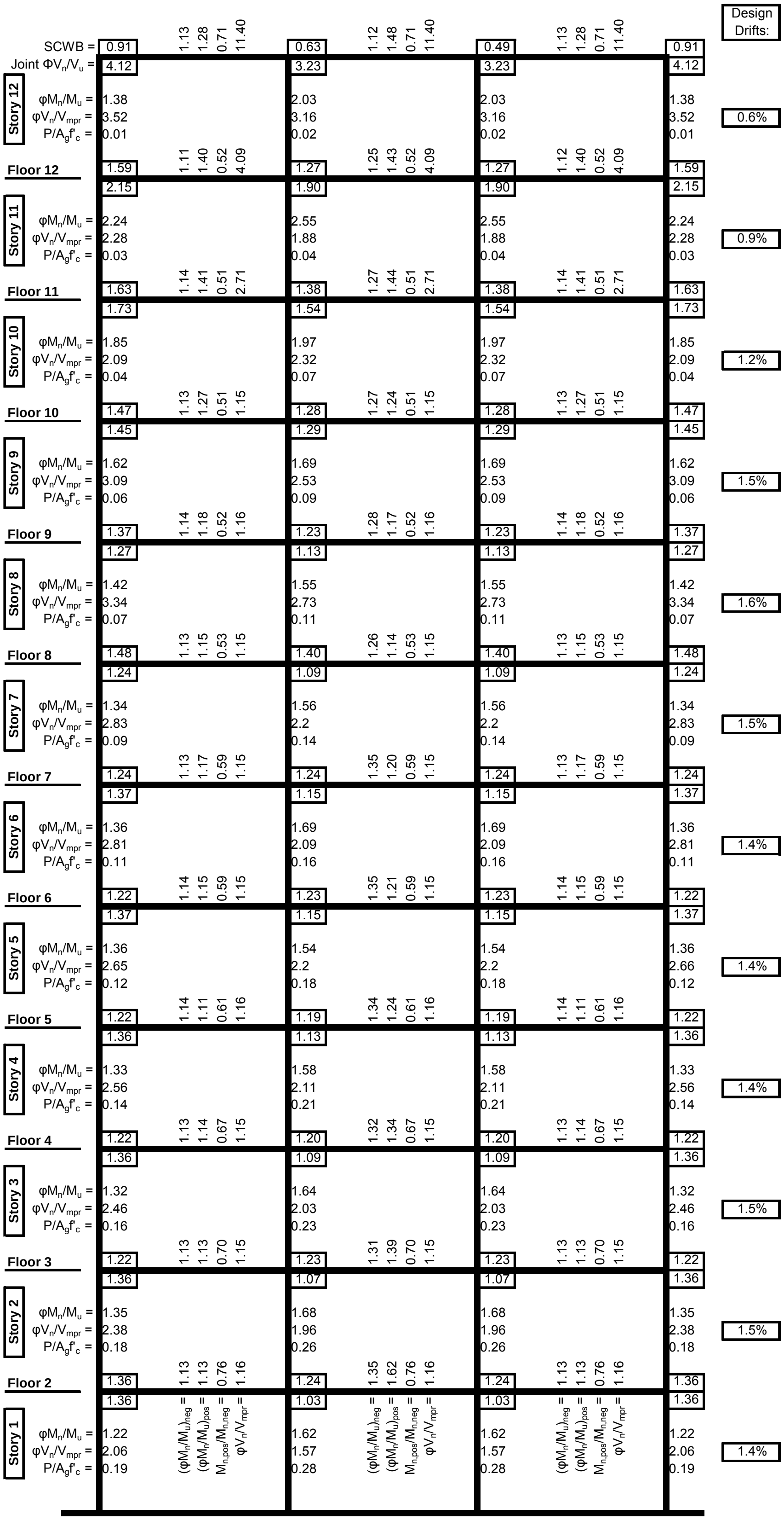
From the baseline design, beam and column sizes were made lager as the lateral demand is larger from smaller R value. Joint shear controls as using a concrete strength of 8ksi in column is not enough; thus beams larger. Above explains the reason for low drift. Positive bending strengths were controlled by primarily strength demand, 6 bays had min reinforcement imposed. Negative bending strengths were controlled by strength demands. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the minimum positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. Beam stirrups were controlled by both the capacity shear design and min reinforcement requirement. Column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION


Design Documentation (1 of 2)
Floor 13
24 24 0.0032 0.0045 0.0030 5.4
24 24 0.0032 0.0045 0.0030 5.4
24 24 0.0032 0.0045 0.0030 5.4
Story 12
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.010 | 0.010 | 0.010 | 0.010
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 12
24 24 0.0037 0.0073 0.0030 5.4
24 24 0.0037 0.0073 0.0030 5.4
24 24 0.0037 0.0073 0.0030 5.4
Story 11
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.015 | 0.017 | 0.017 | 0.015
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 11
24 24 0.0045 0.0090 0.0030 5.4
24 24 0.0045 0.0090 0.0030 5.4
24 24 0.0045 0.0090 0.0030 5.4
Story 10
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.015 | 0.017 | 0.017 | 0.015
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 10
24 24 0.0053 0.0105 0.0053 5.4
24 24 0.0053 0.0105 0.0053 5.4
24 24 0.0053 0.0105 0.0053 5.4
Story 9
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.015 | 0.017 | 0.017 | 0.015
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 9
24 24 0.0059 0.0118 0.0056 5.4
24 24 0.0059 0.0118 0.0056 5.4
24 24 0.0059 0.0118 0.0056 5.4
Story 8
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.015 | 0.017 | 0.017 | 0.015
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 8
24 24 0.0062 0.012 0.0057 5.4
24 24 0.0062 0.012 0.0057 5.4
24 24 0.0062 0.012 0.0057 5.4
Story 7
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.018 | 0.023 | 0.023 | 0.018
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 7
30 24 0.0052 0.0090 0.0052 6.9
30 24 0.0052 0.0090 0.0052 6.9
30 24 0.0052 0.0090 0.0052 6.9
Story 6
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.017 | 0.023 | 0.023 | 0.017
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 6
30 24 0.0052 0.0090 0.0052 6.9
30 24 0.0052 0.0090 0.0052 6.9
30 24 0.0052 0.0090 0.0052 6.9
Story 5
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.017 | 0.019 | 0.019 | 0.017
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 5
30 24 0.0055 0.0091 0.0053 6.9
30 24 0.0055 0.0091 0.0053 6.9
30 24 0.0055 0.0091 0.0053 6.9
Story 4
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.017 | 0.019 | 0.019 | 0.017
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 4
30 24 0.006 0.0091 0.0054 6.9
30 24 0.006 0.0091 0.0054 6.9
30 24 0.006 0.0091 0.0054 6.9
Story 3
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.017 | 0.019 | 0.019 | 0.017
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 3
30 24 0.0062 0.0091 0.0054 6.9
30 24 0.0062 0.0091 0.0054 6.9
30 24 0.0062 0.0091 0.0054 6.9
Story 2
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.017 | 0.019 | 0.019 | 0.017
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
13 feet
Floor 2
30 24 0.0068 0.0091 0.0056 6.9
30 24 0.0068 0.0091 0.0056 6.9
30 24 0.0068 0.0091 0.0056 6.9
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 24 | 24 | 24 | 24
b (in) = 24 | 24 | 24 | 24
ρtot = 0.022 | 0.019 | 0.019 | 0.022
ρsh = 0.0102 | 0.0102 | 0.0102 | 0.0102
s (in) = 4.0 | 4.0 | 4.0 | 4.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 24
20 feet
Design base shear = 0.070 g, 232 k
f'c beams = 5.0 ksi
f'c,cols,upper = 8.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 8.0 ksi

FIGURES

Design Documentation (2 of 2)



						Design Drifts:
	SCWB =	0.91	0.63	0.49	0.91	
	Joint $\Phi V_n/V_u$ =	4.12	3.23	3.23	4.12	
Story 12	$\varphi M_n/M_u$ =	1.38	2.03	2.03	1.38	
	$\varphi V_n/V_{mpr}$ =	3.52	3.16	3.16	3.52	0.6%
	$P/A_g f'_c$ =	0.01	0.02	0.02	0.01	
Floor 12		1.59	1.27	1.27	1.59	
		2.15	1.90	1.90	2.15	
Story 11	$\varphi M_n/M_u$ =	2.24	2.55	2.55	2.24	
	$\varphi V_n/V_{mpr}$ =	2.28	1.88	1.88	2.28	0.9%
	$P/A_g f'_c$ =	0.03	0.04	0.04	0.03	
Floor 11		1.63	1.38	1.38	1.63	
		1.73	1.54	1.54	1.73	
Story 10	$\varphi M_n/M_u$ =	1.85	1.97	1.97	1.85	
	$\varphi V_n/V_{mpr}$ =	2.09	2.32	2.32	2.09	1.2%
	$P/A_g f'_c$ =	0.04	0.07	0.07	0.04	
Floor 10		1.47	1.28	1.28	1.47	
		1.45	1.29	1.29	1.45	
Story 9	$\varphi M_n/M_u$ =	1.62	1.69	1.69	1.62	
	$\varphi V_n/V_{mpr}$ =	3.09	2.53	2.53	3.09	1.5%
	$P/A_g f'_c$ =	0.06	0.09	0.09	0.06	
Floor 9		1.37	1.23	1.23	1.37	
		1.27	1.13	1.13	1.27	
Story 8	$\varphi M_n/M_u$ =	1.42	1.55	1.55	1.42	
	$\varphi V_n/V_{mpr}$ =	3.34	2.73	2.73	3.34	1.6%
	$P/A_g f'_c$ =	0.07	0.11	0.11	0.07	
Floor 8		1.48	1.40	1.40	1.48	
		1.24	1.09	1.09	1.24	
Story 7	$\varphi M_n/M_u$ =	1.34	1.56	1.56	1.34	
	$\varphi V_n/V_{mpr}$ =	2.83	2.2	2.2	2.83	1.5%
	$P/A_g f'_c$ =	0.09	0.14	0.14	0.09	
Floor 7		1.24	1.24	1.24	1.24	
		1.37	1.15	1.15	1.37	
Story 6	$\varphi M_n/M_u$ =	1.36	1.69	1.69	1.36	
	$\varphi V_n/V_{mpr}$ =	2.81	2.09	2.09	2.81	1.4%
	$P/A_g f'_c$ =	0.11	0.16	0.16	0.11	
Floor 6		1.22	1.23	1.23	1.22	
		1.37	1.15	1.15	1.37	
Story 5	$\varphi M_n/M_u$ =	1.36	1.54	1.54	1.36	
	$\varphi V_n/V_{mpr}$ =	2.65	2.2	2.2	2.66	1.4%
	$P/A_g f'_c$ =	0.12	0.18	0.18	0.12	
Floor 5		1.22	1.19	1.19	1.22	
		1.36	1.13	1.13	1.36	
Story 4	$\varphi M_n/M_u$ =	1.33	1.58	1.58	1.33	
	$\varphi V_n/V_{mpr}$ =	2.56	2.11	2.11	2.56	1.4%
	$P/A_g f'_c$ =	0.14	0.21	0.21	0.14	
Floor 4		1.22	1.20	1.20	1.22	
		1.36	1.09	1.09	1.36	
Story 3	$\varphi M_n/M_u$ =	1.32	1.64	1.64	1.32	
	$\varphi V_n/V_{mpr}$ =	2.46	2.03	2.03	2.46	1.5%
	$P/A_g f'_c$ =	0.16	0.23	0.23	0.16	
Floor 3		1.22	1.23	1.23	1.22	
		1.36	1.07	1.07	1.36	
Story 2	$\varphi M_n/M_u$ =	1.35	1.68	1.68	1.35	
	$\varphi V_n/V_{mpr}$ =	2.38	1.96	1.96	2.38	1.5%
	$P/A_g f'_c$ =	0.18	0.26	0.26	0.18	
Floor 2		1.36	1.24	1.24	1.36	
		1.36	1.03	1.03	1.36	
Story 1	$\varphi M_n/M_u$ =	1.22	1.62	1.62	1.22	
	$\varphi V_n/V_{mpr}$ =	2.06	1.57	1.57	2.06	1.4%
	$P/A_g f'_c$ =	0.19	0.28	0.28	0.19	

	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.12	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.28	1.48	1.28
	$M_{n,pos}/M_{n,neg}$ =	0.71	0.71	0.71
	$\varphi V_n/V_{mpr}$ =	11.40	11.40	11.40
Floor 12	$(\varphi M_n/M_u)_{neg}$ =	1.11	1.25	1.12
	$(\varphi M_n/M_u)_{pos}$ =	1.40	1.43	1.40
	$M_{n,pos}/M_{n,neg}$ =	0.52	0.52	0.52
	$\varphi V_n/V_{mpr}$ =	4.09	4.09	4.09
Floor 11	$(\varphi M_n/M_u)_{neg}$ =	1.14	1.27	1.14
	$(\varphi M_n/M_u)_{pos}$ =	1.41	1.44	1.41
	$M_{n,pos}/M_{n,neg}$ =	0.51	0.51	0.51
	$\varphi V_n/V_{mpr}$ =	2.71	2.71	2.71
Floor 10	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.27	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.27	1.24	1.27
	$M_{n,pos}/M_{n,neg}$ =	0.51	0.51	0.51
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 9	$(\varphi M_n/M_u)_{neg}$ =	1.14	1.28	1.14
	$(\varphi M_n/M_u)_{pos}$ =	1.18	1.17	1.18
	$M_{n,pos}/M_{n,neg}$ =	0.52	0.52	0.52
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16
Floor 8	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.26	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.15	1.14	1.15
	$M_{n,pos}/M_{n,neg}$ =	0.53	0.53	0.53
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 7	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.35	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.17	1.20	1.17
	$M_{n,pos}/M_{n,neg}$ =	0.59	0.59	0.59
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 6	$(\varphi M_n/M_u)_{neg}$ =	1.14	1.35	1.14
	$(\varphi M_n/M_u)_{pos}$ =	1.15	1.21	1.15
	$M_{n,pos}/M_{n,neg}$ =	0.59	0.59	0.59
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 5	$(\varphi M_n/M_u)_{neg}$ =	1.14	1.34	1.14
	$(\varphi M_n/M_u)_{pos}$ =	1.11	1.24	1.11
	$M_{n,pos}/M_{n,neg}$ =	0.61	0.61	0.61
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16
Floor 4	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.32	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.14	1.34	1.14
	$M_{n,pos}/M_{n,neg}$ =	0.67	0.67	0.67
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 3	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.31	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.13	1.39	1.13
	$M_{n,pos}/M_{n,neg}$ =	0.70	0.70	0.70
	$\varphi V_n/V_{mpr}$ =	1.15	1.15	1.15
Floor 2	$(\varphi M_n/M_u)_{neg}$ =	1.13	1.35	1.13
	$(\varphi M_n/M_u)_{pos}$ =	1.13	1.62	1.13
	$M_{n,pos}/M_{n,neg}$ =	0.76	0.76	0.76
	$\varphi V_n/V_{mpr}$ =	1.16	1.16	1.16

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	3826	4199	4199	3826
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.072	0.070	0.070	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	109	109	110
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	5838	7200	7200	5838
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.073	0.072	0.072	0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	106	106	109
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 10	$M_{y,exp}$ (k-in) =	6198	7897	7897	6198
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.072	0.070	0.070	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	104	104	108
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 9	$M_{y,exp}$ (k-in) =	6553	8582	8582	6553
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.068	0.068	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	102	102	106
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 8	$M_{y,exp}$ (k-in) =	6906	9256	9256	6906
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.070	0.066	0.066	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	100	100	105
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 7	$M_{y,exp}$ (k-in) =	8218	11747	11747	8218
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.067	0.067	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	104	97	97	104
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 6	$M_{y,exp}$ (k-in) =	8161	12477	12477	8161
	EI_{stf}/EI_g =	0.35	0.39	0.39	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.069	0.065	0.065	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	95	95	103
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 5	$M_{y,exp}$ (k-in) =	8582	11931	11931	8582
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.068	0.061	0.061	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	93	93	102
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 4	$M_{y,exp}$ (k-in) =	8840	12568	12568	8840
	EI_{stf}/EI_g =	0.35	0.42	0.42	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.067	0.059	0.059	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	101	91	91	101
	$(P/A_gf'_c)_{exp}$ =	0.08	0.15	0.15	0.08
Story 3	$M_{y,exp}$ (k-in) =	9176	13197	13197	9176
	EI_{stf}/EI_g =	0.35	0.44	0.44	0.35
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.066	0.058	0.058	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	89	89	100
	$(P/A_gf'_c)_{exp}$ =	0.08	0.17	0.17	0.08
Story 2	$M_{y,exp}$ (k-in) =	9509	13820	13820	9509
	EI_{stf}/EI_g =	0.36	0.45	0.45	0.36
	M_c/M_y =	1.17	1.16	1.16	1.17
	$\Theta_{cap,pl}$ (rad) =	0.065	0.056	0.056	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	87	87	99
	$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 1	$M_{y,exp}$ (k-in) =	11350	14357	14357	11350
	EI_{stf}/EI_g =	0.37	0.47	0.47	0.37
	M_c/M_y =	1.17	1.16	1.16	1.17
	$\Theta_{cap,pl}$ (rad) =	0.066	0.054	0.054	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	85	85	97
	$(P/A_gf'_c)_{exp}$ =	0.10	0.20	0.20	0.10

Floor 13	$M_{y,pos,exp}$(k-in) =	2197	2197	2197
	$M_{y,n,slab,exp}$(k-in) =	-4522	-4522	-4522
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.038	0.038	0.038
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.061	-0.061	-0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 12	$M_{y,pos,exp}$(k-in) =	2529	2529	2529
	$M_{y,n,slab,exp}$(k-in) =	-6304	-6304	-6304
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.038	0.038	0.038
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.065	-0.065	-0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 11	$M_{y,pos,exp}$(k-in) =	3085	3085	3085
	$M_{y,n,slab,exp}$(k-in) =	-7426	-7426	-7426
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.039	0.039	0.039
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.065	-0.065	-0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 10	$M_{y,pos,exp}$(k-in) =	3583	3583	3583
	$M_{y,n,slab,exp}$(k-in) =	-8383	-8383	-8383
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.050	0.050
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.081	-0.081	-0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 9	$M_{y,pos,exp}$(k-in) =	4044	4044	4044
	$M_{y,n,slab,exp}$(k-in) =	-9178	-9178	-9178
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.053	0.053	0.053
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 8	$M_{y,pos,exp}$(k-in) =	4225	4225	4225
	$M_{y,n,slab,exp}$(k-in) =	-9338	-9338	-9338
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.054	0.054	0.054
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 7	$M_{y,pos,exp}$(k-in) =	5892	5892	5892
	$M_{y,n,slab,exp}$(k-in) =	-11757	-11757	-11757
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0469	0.0469
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 6	$M_{y,pos,exp}$(k-in) =	5892	5892	5892
	$M_{y,n,slab,exp}$(k-in) =	-11757	-11757	-11757
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0469	0.0469
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 5	$M_{y,pos,exp}$(k-in) =	6143	6143	6143
	$M_{y,n,slab,exp}$(k-in) =	-11850	-11850	-11850
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.048	0.0477	0.0477
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 4	$M_{y,pos,exp}$(k-in) =	6690	6690	6690
	$M_{y,n,slab,exp}$(k-in) =	-11858	-11858	-11858
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0492	0.0492
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.069	-0.069	-0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 3	$M_{y,pos,exp}$(k-in) =	6985	6985	6985
	$M_{y,n,slab,exp}$(k-in) =	-11862	-11862	-11862
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.05	0.05
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.069	-0.069	-0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 2	$M_{y,pos,exp}$(k-in) =	7630	7630	7630
	$M_{y,n,slab,exp}$(k-in) =	-11872	-11872	-11872
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.054	0.054	0.054
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	108	108	108

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.83 T_2= 0.62 T_3 = 0.36

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2009

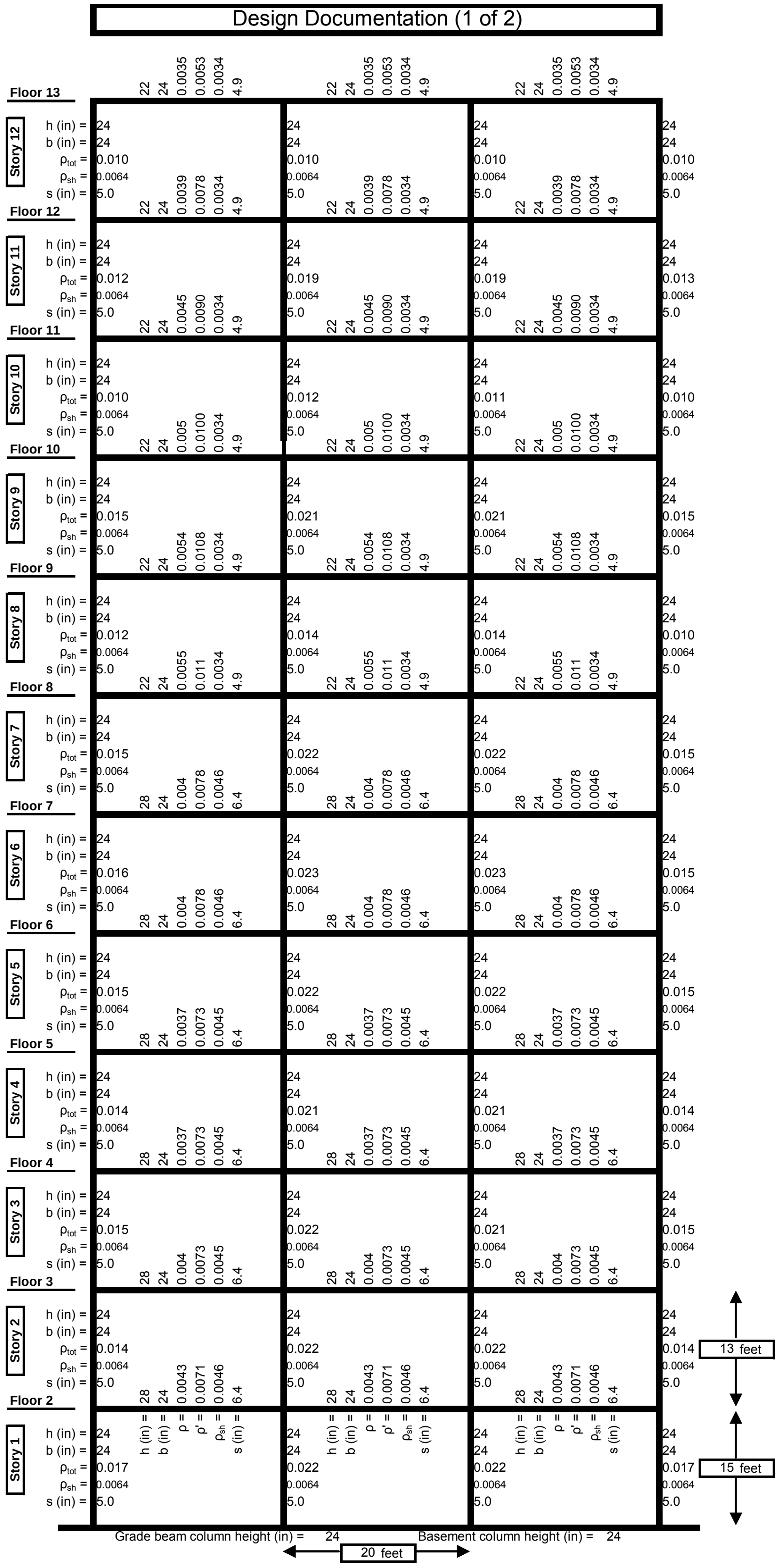
Number of Stories: 12

Fundamental Period (sec): 1.99

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2009 (R=8, SCWB=1.2, Drift Limit=0.02)
This twelve story baseline design is controlled both by joint shear and drift limits. Both positive and negative bending strength were controlled by strength demands. Few additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 3 by strength demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). All column stirrups were controlled by the minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	0.044 g,	232 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	5.0 ksi

Design Documentation (2 of 2)

	SCWB =	0.96	1.19 1.20 0.67 6.36	0.58	1.25 1.36 0.67 6.36	0.48	1.19 1.20 0.67 6.36	0.87	Design Drifts:
	Joint $\Phi V_n/V_u$ =	2.93		2.35		2.35		2.93	
Story 12	$\phi M_n/M_u$ =	1.45		2.32		2.35		1.31	
	$\phi V_n/V_{mpr}$ =	2.44		2.55		2.58		2.58	0.7%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 12		1.52	1.17 1.37 0.51 3.68	1.30	1.37 1.46 0.51 3.68	1.32	1.17 1.37 0.51 3.68	1.47	
		1.70		1.51		1.51		1.70	
Story 11	$\phi M_n/M_u$ =	2.01		3.53		3.56		2.04	
	$\phi V_n/V_{mpr}$ =	1.99		1.41		1.41		2.08	1.1%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 11		1.31	1.18 1.43 0.51 2.90	1.21	1.35 1.54 0.51 2.90	1.21	1.18 1.43 0.51 2.90	1.30	
		1.47		1.30		1.30		1.47	
Story 10	$\phi M_n/M_u$ =	1.38		1.65		1.63		1.33	
	$\phi V_n/V_{mpr}$ =	2.41		2.24		2.3		2.6	1.4%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 10		1.30	1.16 1.46 0.51 2.48	1.20	1.32 1.55 0.51 2.48	1.19	1.16 1.46 0.51 2.48	1.28	
		1.29		1.15		1.15		1.29	
Story 9	$\phi M_n/M_u$ =	1.70		2.42		2.44		1.71	
	$\phi V_n/V_{mpr}$ =	2.03		1.46		1.47		2.15	1.7%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 9		1.27	1.15 1.45 0.52 2.22	1.20	1.30 1.58 0.52 2.22	1.20	1.15 1.45 0.52 2.22	1.27	
		1.19		1.05		1.05		1.19	
Story 8	$\phi M_n/M_u$ =	1.17		1.39		1.38		1.16	
	$\phi V_n/V_{mpr}$ =	3.03		2.49		2.55		3.24	1.9%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 8		1.26	1.14 1.40 0.51 2.17	1.20	1.27 1.50 0.51 2.17	1.20	1.14 1.40 0.51 2.17	1.27	
		1.16		1.03		1.03		1.16	
Story 7	$\phi M_n/M_u$ =	1.28		1.68		1.69		1.30	
	$\phi V_n/V_{mpr}$ =	2.33		1.65		1.64		2.29	1.8%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 7		1.19	1.17 1.34 0.53 1.16	1.20	1.38 1.41 0.53 1.16	1.20	1.18 1.34 0.53 1.16	1.20	
		1.33		1.17		1.17		1.33	
Story 6	$\phi M_n/M_u$ =	1.44		1.84		1.82		1.43	
	$\phi V_n/V_{mpr}$ =	2.19		1.53		1.55		2.21	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 6		1.20	1.18 1.33 0.53 1.16	1.21	1.37 1.40 0.53 1.16	1.20	1.18 1.33 0.53 1.16	1.21	
		1.33		1.17		1.17		1.33	
Story 5	$\phi M_n/M_u$ =	1.35		1.69		1.70		1.37	
	$\phi V_n/V_{mpr}$ =	2.35		1.63		1.64		2.21	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 5		1.20	1.11 1.17 0.52 1.15	1.21	1.27 1.27 0.52 1.15	1.21	1.12 1.17 0.52 1.15	1.20	
		1.41		1.25		1.25		1.41	
Story 4	$\phi M_n/M_u$ =	1.27		1.59		1.59		1.26	
	$\phi V_n/V_{mpr}$ =	2.43		1.72		1.71		2.48	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 4		1.20	1.11 1.09 0.52 1.15	1.20	1.25 1.24 0.52 1.15	1.19	1.11 1.09 0.52 1.15	1.19	
		1.41		1.25		1.25		1.41	
Story 3	$\phi M_n/M_u$ =	1.34		1.63		1.62		1.34	
	$\phi V_n/V_{mpr}$ =	2.31		1.65		1.67		2.31	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 3		1.20	1.12 1.11 0.55 1.15	1.20	1.24 1.32 0.55 1.15	1.20	1.13 1.11 0.55 1.15	1.20	
		1.41		1.22		1.22		1.41	
Story 2	$\phi M_n/M_u$ =	1.25		1.61		1.61		1.24	
	$\phi V_n/V_{mpr}$ =	2.51		1.63		1.64		2.46	1.7%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 2		1.31	1.14 1.13 0.62 1.16	1.19	1.24 1.57 0.62 1.16	1.20	1.14 1.14 0.62 1.16	1.31	
		1.46	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.21	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.21	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.46	
Story 1	$\phi M_n/M_u$ =	1.16		1.43		1.44		1.16	
	$\phi V_n/V_{mpr}$ =	2.06		1.65		1.64		2.09	1.5%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	3794	4160	4160	3794
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.061	0.060	0.060	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	98	96	96	98
	$(P/A_g f'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 11	$M_{y,exp}$ (k-in) =	4894	7612	7692	5056
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.061	0.061	0.061	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	96	93	93	96
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 10	$M_{y,exp}$ (k-in) =	4521	6053	5973	4521
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.059	0.055	0.055	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	95	90	90	95
	$(P/A_g f'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 9	$M_{y,exp}$ (k-in) =	6327	9837	9837	6327
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.059	0.057	0.057	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	93	87	87	93
	$(P/A_g f'_c)_{exp}$ =	0.05	0.11	0.11	0.05
Story 8	$M_{y,exp}$ (k-in) =	5709	8188	8109	5226
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.056	0.051	0.051	0.056
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	92	84	84	92
	$(P/A_g f'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 7	$M_{y,exp}$ (k-in) =	7174	11218	11297	7014
	EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.057	0.052	0.052	0.056
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	90	81	81	90
	$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 6	$M_{y,exp}$ (k-in) =	7831	12411	12331	7591
	EI_{stf}/EI_g =	0.36	0.46	0.46	0.36
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.056	0.050	0.050	0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	88	78	78	88
	$(P/A_g f'_c)_{exp}$ =	0.09	0.19	0.19	0.09
Story 5	$M_{y,exp}$ (k-in) =	7766	12564	12564	7926
	EI_{stf}/EI_g =	0.38	0.48	0.48	0.38
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.054	0.047	0.047	0.054
	Θ_{pc} (rad) =	0.100	0.096	0.096	0.100
	λ =	87	75	75	87
	$(P/A_g f'_c)_{exp}$ =	0.11	0.22	0.22	0.11
Story 4	$M_{y,exp}$ (k-in) =	7939	12868	12868	7939
	EI_{stf}/EI_g =	0.39	0.51	0.51	0.39
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.052	0.044	0.044	0.052
	Θ_{pc} (rad) =	0.100	0.088	0.088	0.100
	λ =	85	73	73	85
	$(P/A_g f'_c)_{exp}$ =	0.12	0.24	0.24	0.12
Story 3	$M_{y,exp}$ (k-in) =	8506	13721	13642	8585
	EI_{stf}/EI_g =	0.40	0.54	0.54	0.40
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.051	0.042	0.042	0.051
	Θ_{pc} (rad) =	0.100	0.080	0.080	0.100
	λ =	84	70	70	84
	$(P/A_g f'_c)_{exp}$ =	0.13	0.27	0.27	0.13
Story 2	$M_{y,exp}$ (k-in) =	8514	14410	14410	8594
	EI_{stf}/EI_g =	0.42	0.56	0.56	0.42
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.050	0.040	0.040	0.050
	Θ_{pc} (rad) =	0.100	0.073	0.073	0.100
	λ =	82	68	68	82
	$(P/A_g f'_c)_{exp}$ =	0.15	0.30	0.30	0.15
Story 1	$M_{y,exp}$ (k-in) =	9789	15846	15921	9710
	EI_{stf}/EI_g =	0.43	0.59	0.59	0.43
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.050	0.038	0.038	0.050
	Θ_{pc} (rad) =	0.100	0.066	0.066	0.100
	λ =	81	65	65	81
	$(P/A_g f'_c)_{exp}$ =	0.16	0.32	0.32	0.16

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	1977	-4223	0.35	7.428E+0	0.0413	-0.067	0.100	100
	1977	-4223	0.35	7.428E+0	0.0413	-0.067	0.100	100
	1977	-4223	0.35	3.724E+0	0.0413	-0.067	0.100	100
Floor 12	2196	-5545	0.35	7.428E+07	0.041	-0.071	0.100	100
	2196	-5545	0.35	7.428E+07	0.041	-0.071	0.100	100
	2196	-5545	0.35	7.428E+07	0.041	-0.071	0.100	100
Floor 11	2533	-6201	0.35	7.428E+07	0.042	-0.071	0.100	100
	2533	-6201	0.35	7.428E+07	0.042	-0.071	0.100	100
	2533	-6201	0.35	7.428E+07	0.042	-0.071	0.100	100
Floor 10	2804	-6724	0.35	7.428E+07	0.043	-0.071	0.100	100
	2804	-6724	0.35	7.428E+07	0.043	-0.071	0.100	100
	2804	-6724	0.35	7.428E+07	0.043	-0.071	0.100	100
Floor 9	3046	-7115	0.35	7.428E+07	0.044	-0.071	0.100	100
	3046	-7115	0.35	7.428E+07	0.044	-0.071	0.100	100
	3046	-7115	0.35	7.428E+07	0.044	-0.071	0.100	100
Floor 8	3059	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
	3059	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
	3059	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
Floor 7	3876	-9064	0.35	1.522E+08	0.042	-0.068	0.100	99
	3876	-9064	0.35	1.522E+08	0.0421	-0.068	0.100	99
	3876	-9064	0.35	1.522E+08	0.0421	-0.068	0.100	99
Floor 6	3876	-9064	0.35	1.522E+08	0.042	-0.068	0.100	99
	3876	-9064	0.35	1.522E+08	0.0421	-0.068	0.100	99
	3876	-9064	0.35	1.522E+08	0.0421	-0.068	0.100	99
Floor 5	3619	-8685	0.35	1.522E+08	0.041	-0.068	0.100	99
	3619	-8685	0.35	1.522E+08	0.0411	-0.068	0.100	99
	3619	-8685	0.35	1.522E+08	0.0411	-0.068	0.100	99
Floor 4	3619	-8685	0.35	1.522E+08	0.041	-0.068	0.100	99
	3619	-8685	0.35	1.522E+08	0.0411	-0.068	0.100	99
	3619	-8685	0.35	1.522E+08	0.0411	-0.068	0.100	99
Floor 3	3876	-8688	0.35	1.522E+08	0.042	-0.067	0.100	99
	3876	-8688	0.35	1.522E+08	0.042	-0.067	0.100	99
	3876	-8688	0.35	1.522E+08	0.042	-0.067	0.100	99
Floor 2	4202	-8464	0.35	1.522E+08	0.043	-0.066	0.100	99
	4202	-8464	0.35	1.522E+08	0.043	-0.066	0.100	99
	4202	-8464	0.35	1.522E+08	0.043	-0.066	0.100	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.99 T_2 = 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2010
Number of Stories: 12
Fundamental Period (sec): 2.40

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2038 Perimeter Frame, R=12

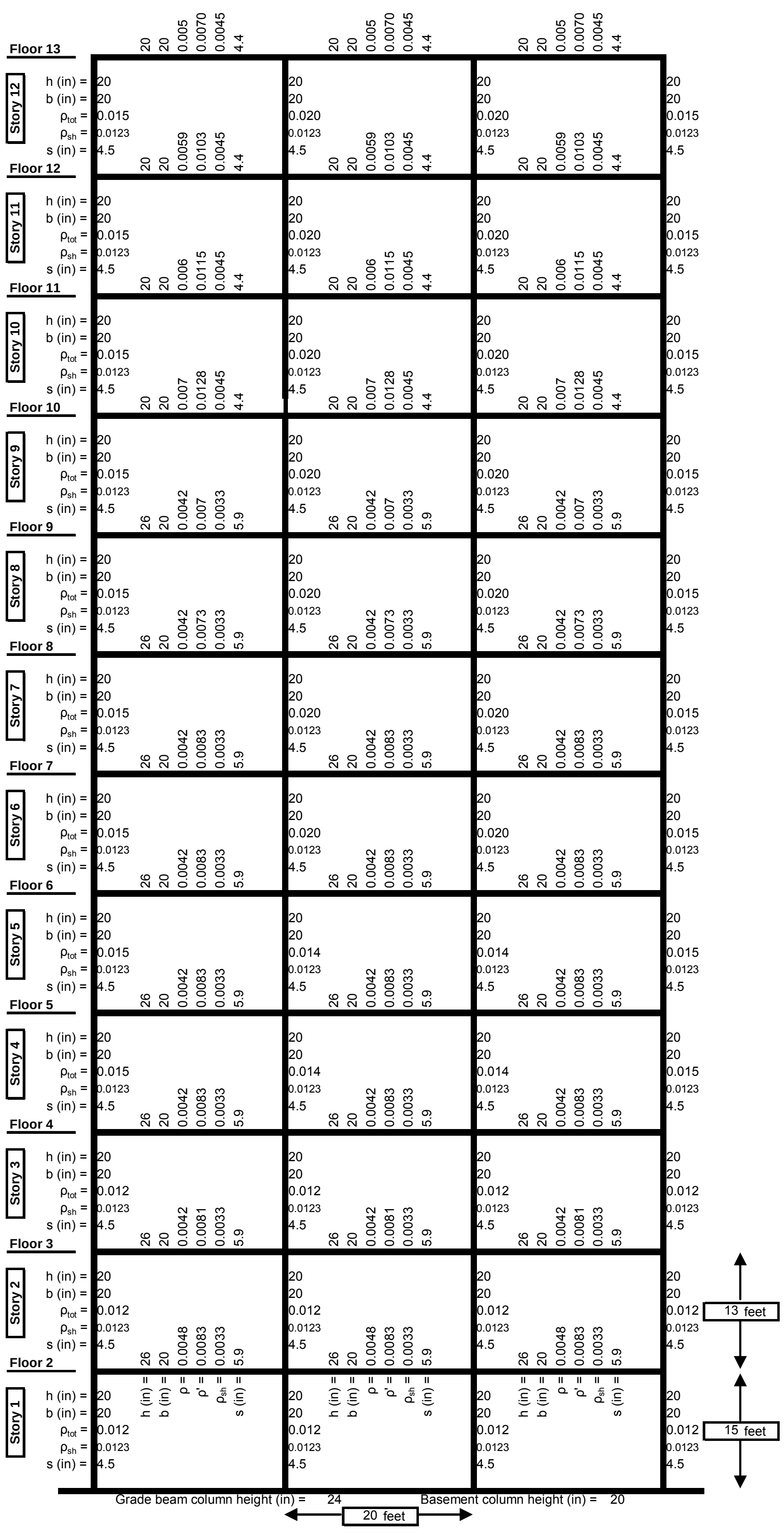
Note: In order to see the effects of design strength changes the minimum base shear demand from eqn 9.5.5.2.1-3 was not imposed in this design.

From the baseline design, beam and column sizes were reduced as the lateral demand is reduced from larger R value. Both drift and joint shear controlled. Concrete strength of 7 ksi is used to satisfy joint shear like the baseline design and still have small section size to put drift towards allowable limit.

Both positive and negative beam bending strength were mainly controlled by strength demands. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Column strength governed by SCWB ratio except two were governed by flexural strength demand. Beam stirrups were controlled by both minimum requirement and capacity demand. Column stirrups were controlled by the minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 11	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 10	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 9	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 8	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 7	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 6	20	20	0.015	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.020	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 5	20	20	0.015	0.0123	4.5	20	20	0.014	0.0123	4.5	20	20	0.014	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 4	20	20	0.015	0.0123	4.5	20	20	0.014	0.0123	4.5	20	20	0.014	0.0123	4.5	20	20	0.015	0.0123	4.5
Story 3	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5
Story 2	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5
Story 1	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5	20	20	0.012	0.0123	4.5

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	20	20	0.005	0.0070	0.0045	4.4	20	20	0.005	0.0070	0.0045	4.4	20	20	0.005	0.0070	0.0045	4.4
Floor 12	20	20	0.0059	0.0103	0.0045	4.4	20	20	0.0059	0.0103	0.0045	4.4	20	20	0.0059	0.0103	0.0045	4.4
Floor 11	20	20	0.006	0.0115	0.0045	4.4	20	20	0.006	0.0115	0.0045	4.4	20	20	0.006	0.0115	0.0045	4.4
Floor 10	20	20	0.007	0.0128	0.0045	4.4	20	20	0.007	0.0128	0.0045	4.4	20	20	0.007	0.0128	0.0045	4.4
Floor 9	26	20	0.0042	0.007	0.0033	5.9	26	20	0.0042	0.007	0.0033	5.9	26	20	0.0042	0.007	0.0033	5.9
Floor 8	26	20	0.0042	0.0073	0.0033	5.9	26	20	0.0042	0.0073	0.0033	5.9	26	20	0.0042	0.0073	0.0033	5.9
Floor 7	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9
Floor 6	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9
Floor 5	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9
Floor 4	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9	26	20	0.0042	0.0083	0.0033	5.9
Floor 3	26	20	0.0042	0.0081	0.0033	5.9	26	20	0.0042	0.0081	0.0033	5.9	26	20	0.0042	0.0081	0.0033	5.9
Floor 2	26	20	0.0048	0.0083	0.0033	5.9	26	20	0.0048	0.0083	0.0033	5.9	26	20	0.0048	0.0083	0.0033	5.9

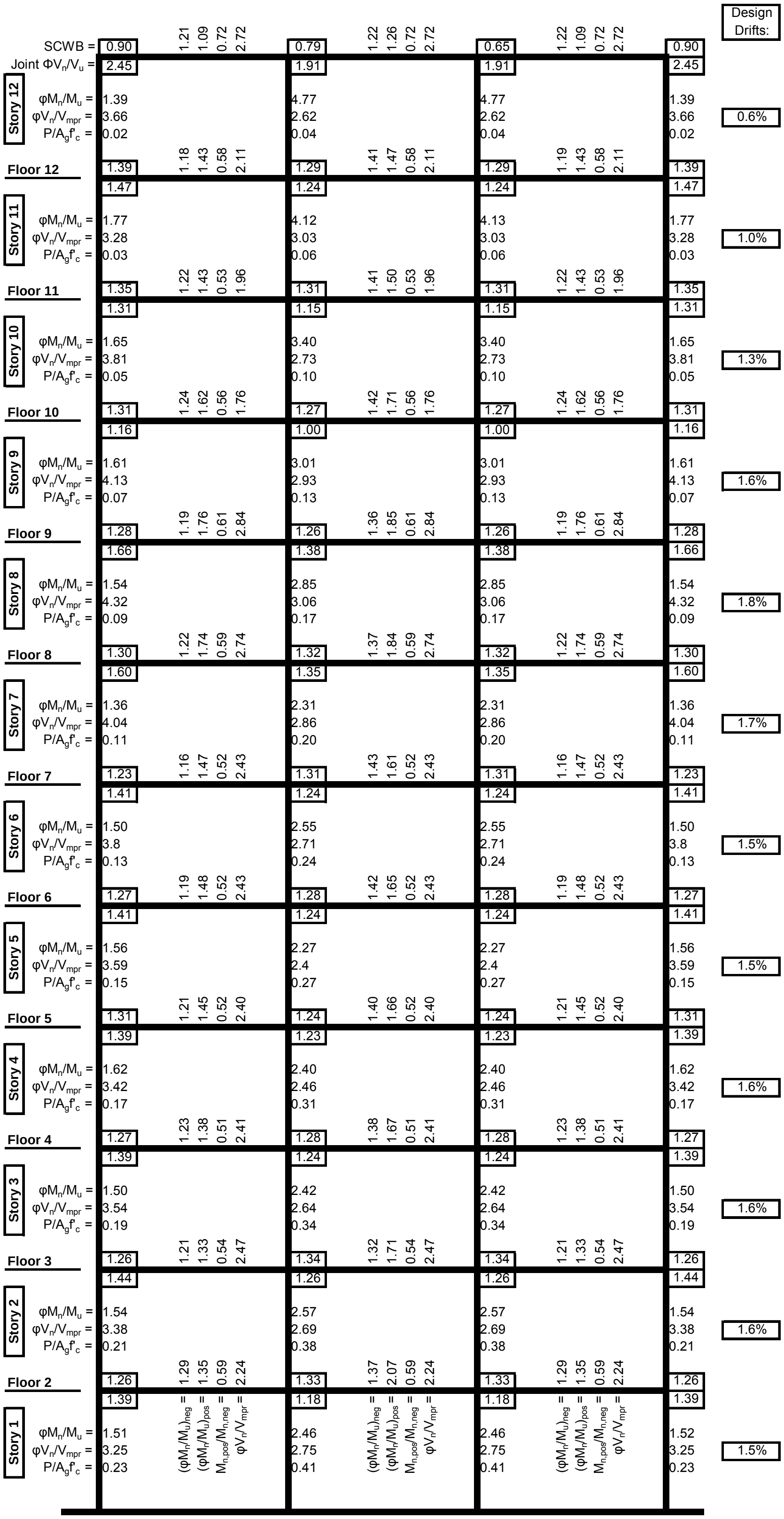
Grade beam column height (in) = 24

Basement column height (in) = 20

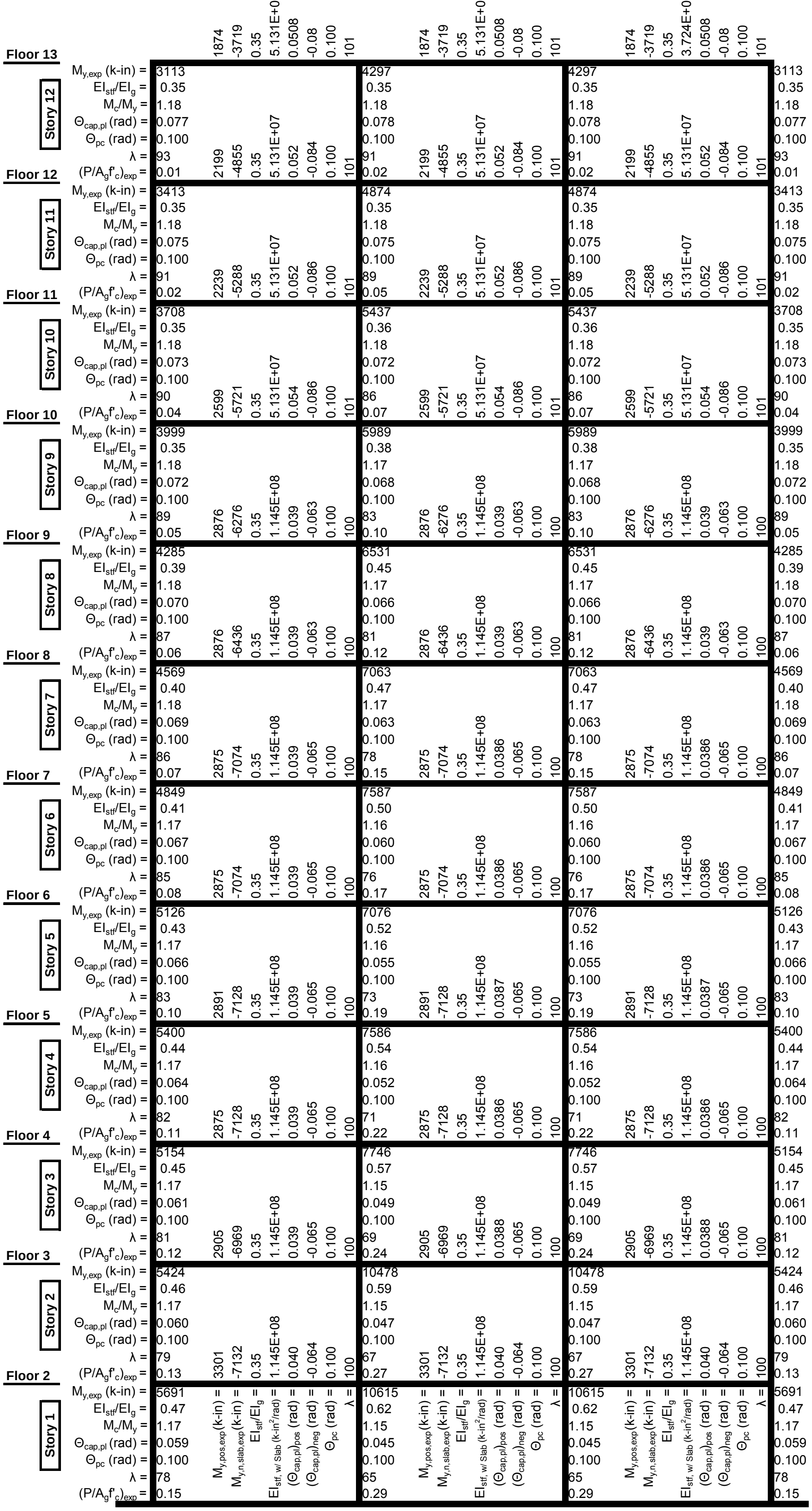
Design base shear = 0.023 g, 232 k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	8.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	8.0	ksi

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Story	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_gf'_c)_{exp}$ =
Story 12	3113	0.35	1.18	0.077	0.100	93	0.01
	4297	0.35	1.18	0.078	0.100	91	0.02
	4297	0.35	1.18	0.078	0.100	91	0.02
	3113	0.35	1.18	0.077	0.100	93	0.01
Story 11	3413	0.35	1.18	0.075	0.100	91	0.02
	4874	0.35	1.18	0.075	0.100	89	0.05
	4874	0.35	1.18	0.075	0.100	89	0.05
	3413	0.35	1.18	0.075	0.100	91	0.02
Story 10	3708	0.35	1.18	0.073	0.100	90	0.04
	5437	0.36	1.18	0.072	0.100	86	0.07
	5437	0.36	1.18	0.072	0.100	86	0.07
	3708	0.35	1.18	0.073	0.100	90	0.04
Story 9	3999	0.35	1.18	0.072	0.100	89	0.05
	5989	0.38	1.17	0.068	0.100	83	0.10
	5989	0.38	1.17	0.068	0.100	83	0.10
	3999	0.35	1.18	0.072	0.100	89	0.05
Story 8	4285	0.39	1.18	0.070	0.100	87	0.06
	6531	0.45	1.17	0.066	0.100	81	0.12
	6531	0.45	1.17	0.066	0.100	81	0.12
	4285	0.39	1.18	0.070	0.100	87	0.06
Story 7	4569	0.40	1.18	0.069	0.100	86	0.07
	7063	0.47	1.17	0.063	0.100	78	0.15
	7063	0.47	1.17	0.063	0.100	78	0.15
	4569	0.40	1.18	0.069	0.100	86	0.07
Story 6	4849	0.41	1.17	0.067	0.100	85	0.08
	7587	0.50	1.16	0.060	0.100	76	0.17
	7587	0.50	1.16	0.060	0.100	76	0.17
	4849	0.41	1.17	0.067	0.100	85	0.08
Story 5	5126	0.43	1.17	0.066	0.100	83	0.10
	7076	0.52	1.16	0.055	0.100	73	0.19
	7076	0.52	1.16	0.055	0.100	73	0.19
	5126	0.43	1.17	0.066	0.100	83	0.10
Story 4	5400	0.44	1.17	0.064	0.100	82	0.11
	7586	0.54	1.16	0.052	0.100	71	0.22
	7586	0.54	1.16	0.052	0.100	71	0.22
	5400	0.44	1.17	0.064	0.100	82	0.11
Story 3	5154	0.45	1.17	0.061	0.100	81	0.12
	7746	0.57	1.15	0.049	0.100	69	0.24
	7746	0.57	1.15	0.049	0.100	69	0.24
	5154	0.45	1.17	0.061	0.100	81	0.12
Story 2	5424	0.46	1.17	0.060	0.100	79	0.13
	10478	0.59	1.15	0.047	0.100	67	0.27
	10478	0.59	1.15	0.047	0.100	67	0.27
	5424	0.46	1.17	0.060	0.100	79	0.13
Story 1	5691	0.47	1.17	0.059	0.100	78	0.15
	10615	0.62	1.15	0.045	0.100	65	0.29
	10615	0.62	1.15	0.045	0.100	65	0.29
	5691	0.47	1.17	0.059	0.100	78	0.15

Floor	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	1874	-3719	0.35	5.131E+07	0.0508	-0.08	0.100	101
	1874	-3719	0.35	5.131E+07	0.0508	-0.08	0.100	101
	1874	-3719	0.35	3.724E+07	0.0508	-0.08	0.100	101
Floor 12	2199	-4855	0.35	5.131E+07	0.052	-0.084	0.100	101
	2199	-4855	0.35	5.131E+07	0.052	-0.084	0.100	101
	2199	-4855	0.35	5.131E+07	0.052	-0.084	0.100	101
Floor 11	2239	-5288	0.35	5.131E+07	0.052	-0.086	0.100	101
	2239	-5288	0.35	5.131E+07	0.052	-0.086	0.100	101
	2239	-5288	0.35	5.131E+07	0.052	-0.086	0.100	101
Floor 10	2599	-5721	0.35	5.131E+07	0.054	-0.086	0.100	101
	2599	-5721	0.35	5.131E+07	0.054	-0.086	0.100	101
	2599	-5721	0.35	5.131E+07	0.054	-0.086	0.100	101
Floor 9	2876	-6276	0.35	1.145E+08	0.039	-0.063	0.100	100
	2876	-6276	0.35	1.145E+08	0.039	-0.063	0.100	100
	2876	-6276	0.35	1.145E+08	0.039	-0.063	0.100	100
Floor 8	2876	-6436	0.35	1.145E+08	0.039	-0.063	0.100	100
	2876	-6436	0.35	1.145E+08	0.039	-0.063	0.100	100
	2876	-6436	0.35	1.145E+08	0.039	-0.063	0.100	100
Floor 7	2875	-7074	0.35	1.145E+08	0.039	-0.065	0.100	100
	2875	-7074	0.35	1.145E+08	0.0386	-0.065	0.100	100
	2875	-7074	0.35	1.145E+08	0.0386	-0.065	0.100	100
Floor 6	2875	-7074	0.35	1.145E+08	0.039	-0.065	0.100	100
	2875	-7074	0.35	1.145E+08	0.0386	-0.065	0.100	100
	2875	-7074	0.35	1.145E+08	0.0386	-0.065	0.100	100
Floor 5	2891	-7128	0.35	1.145E+08	0.039	-0.065	0.100	100
	2891	-7128	0.35	1.145E+08	0.0387	-0.065	0.100	100
	2891	-7128	0.35	1.145E+08	0.0387	-0.065	0.100	100
Floor 4	2875	-7128	0.35	1.145E+08	0.039	-0.065	0.100	100
	2875	-7128	0.35	1.145E+08	0.0386	-0.065	0.100	100
	2875	-7128	0.35	1.145E+08	0.0386	-0.065	0.100	100
Floor 3	2905	-6969	0.35	1.145E+08	0.039	-0.065	0.100	100
	2905	-6969	0.35	1.145E+08	0.0388	-0.065	0.100	100
	2905	-6969	0.35	1.145E+08	0.0388	-0.065	0.100	100
Floor 2	3301	-7132	0.35	1.145E+08	0.040	-0.064	0.100	100
	3301	-7132	0.35	1.145E+08	0.040	-0.064	0.100	100
	3301	-7132	0.35	1.145E+08	0.040	-0.064	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.40 T_2= 0.81 T_3 = 0.48

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2012
Number of Stories: 12
Fundamental Period (sec): 1.99

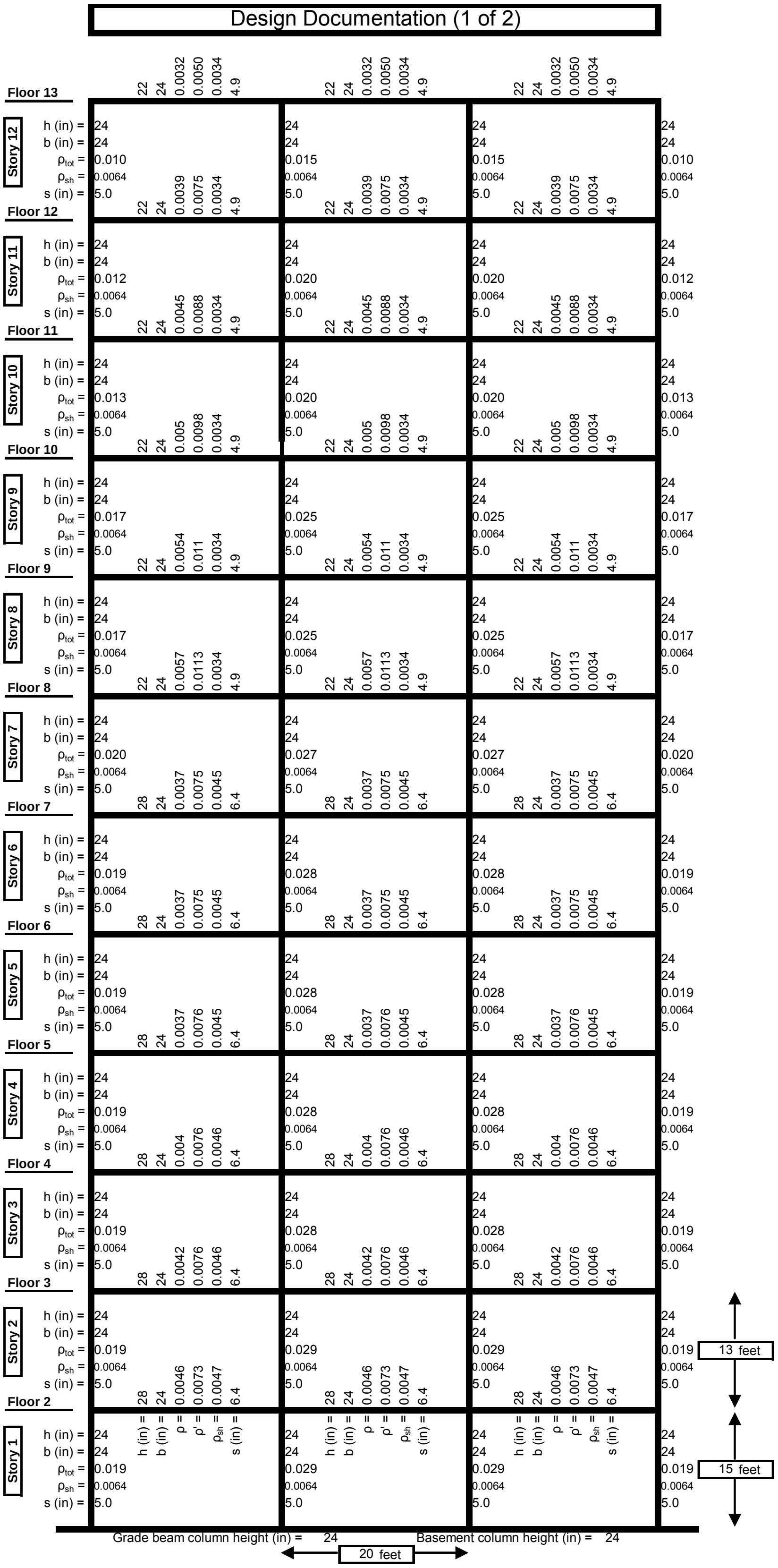
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2012 SCWB=1.5

Compared to the baseline 12 story, this build simply have more reinforcement in the columns. Both positive and negative bending strength were controlled by strength demands. Few additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). All column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Story 12	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.015	0.015	0.010
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 11	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.020	0.020	0.012
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 10	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.020	0.020	0.013
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 9	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.017	0.025	0.025	0.017
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 8	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.017	0.025	0.025	0.017
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 7	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.020	0.027	0.027	0.020
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 6	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.028	0.028	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 5	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.028	0.028	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 4	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.028	0.028	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 3	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.028	0.028	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 2	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.029	0.029	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0
Story 1	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.019	0.029	0.029	0.019
	ρ_{sh} =	0.0064	0.0064	0.0064	0.0064
	s (in) =	5.0	5.0	5.0	5.0

Floor 13	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.0032	0.0032	0.0032
	ρ' =	0.0050	0.0050	0.0050
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 12	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.0039	0.0039	0.0039
	ρ' =	0.0075	0.0075	0.0075
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 11	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.0045	0.0045	0.0045
	ρ' =	0.0088	0.0088	0.0088
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 10	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.005	0.005	0.005
	ρ' =	0.0098	0.0098	0.0098
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 9	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.0054	0.0054	0.0054
	ρ' =	0.011	0.011	0.011
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 8	h (in) =	22	22	22
	b (in) =	24	24	24
	ρ =	0.0057	0.0057	0.0057
	ρ' =	0.0113	0.0113	0.0113
	ρ_{sh} =	0.0034	0.0034	0.0034
	s (in) =	4.9	4.9	4.9
Floor 7	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.0037	0.0037	0.0037
	ρ' =	0.0075	0.0075	0.0075
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.4	6.4	6.4
Floor 6	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.0037	0.0037	0.0037
	ρ' =	0.0075	0.0075	0.0075
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.4	6.4	6.4
Floor 5	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.0037	0.0037	0.0037
	ρ' =	0.0076	0.0076	0.0076
	ρ_{sh} =	0.0045	0.0045	0.0045
	s (in) =	6.4	6.4	6.4
Floor 4	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.004	0.004	0.004
	ρ' =	0.0076	0.0076	0.0076
	ρ_{sh} =	0.0046	0.0046	0.0046
	s (in) =	6.4	6.4	6.4
Floor 3	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.0042	0.0042	0.0042
	ρ' =	0.0076	0.0076	0.0076
	ρ_{sh} =	0.0046	0.0046	0.0046
	s (in) =	6.4	6.4	6.4
Floor 2	h (in) =	28	28	28
	b (in) =	24	24	24
	ρ =	0.0046	0.0046	0.0046
	ρ' =	0.0073	0.0073	0.0073
	ρ_{sh} =	0.0047	0.0047	0.0047
	s (in) =	6.4	6.4	6.4

Grade beam column height (in) = 24

Basement column height (in) = 24

Design base shear =	0.044 g,	232 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	5.0 ksi

Design Documentation (2 of 2)

									Design Drifts:
	SCWB =	1.00	1.14 1.11 0.65 7.29	0.91	1.19 1.26 0.65 7.29	0.74	1.14 1.11 0.65 7.29	0.91	
	Joint $\Phi V_n/V_u$ =	3.07		2.49		2.49		3.07	
Story 12	$\varphi M_n/M_u$ =	1.45		3.46		3.49		1.31	
	$\varphi V_n/V_{mpr}$ =	2.44		1.73		1.74		2.58	0.7%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 12		1.55	1.14 1.37 0.53 3.82	1.62	1.33 1.47 0.53 3.82	1.63	1.14 1.37 0.53 3.82	1.46	
		1.76		1.55		1.55		1.76	
Story 11	$\varphi M_n/M_u$ =	1.97		3.81		3.79		1.92	
	$\varphi V_n/V_{mpr}$ =	2.02		1.31		1.32		2.21	1.1%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 11		1.50	1.15 1.43 0.52 2.98	1.63	1.31 1.54 0.52 2.98	1.63	1.15 1.43 0.52 2.98	1.46	
		1.51		1.33		1.33		1.51	
Story 10	$\varphi M_n/M_u$ =	1.78		2.84		2.86		1.73	
	$\varphi V_n/V_{mpr}$ =	1.9		1.32		1.32		2.01	1.4%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 10		1.62	1.13 1.46 0.52 2.54	1.66	1.29 1.55 0.52 2.54	1.67	1.13 1.46 0.52 2.54	1.60	
		1.33		1.17		1.17		1.33	
Story 9	$\varphi M_n/M_u$ =	2.00		2.84		2.86		2.00	
	$\varphi V_n/V_{mpr}$ =	1.75		1.25		1.26		1.84	1.7%
	$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 9		1.63	1.17 1.45 0.51 2.17	1.67	1.33 1.58 0.51 2.17	1.68	1.17 1.45 0.51 2.17	1.70	
		1.16		1.03		1.03		1.16	
Story 8	$\varphi M_n/M_u$ =	1.73		2.46		2.46		1.87	
	$\varphi V_n/V_{mpr}$ =	2.08		1.42		1.43		2	1.9%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 8		1.73	1.16 1.46 0.52 2.08	1.68	1.30 1.57 0.52 2.08	1.68	1.17 1.46 0.52 2.08	1.83	
		1.13		1.00		1.00		1.13	
Story 7	$\varphi M_n/M_u$ =	1.71		2.05		2.05		1.77	
	$\varphi V_n/V_{mpr}$ =	1.77		1.35		1.35		1.7	1.8%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 7		1.52	1.14 1.25 0.51 1.16	1.50	1.34 1.32 0.51 1.16	1.50	1.14 1.26 0.51 1.16	1.58	
		1.38		1.23		1.23		1.38	
Story 6	$\varphi M_n/M_u$ =	1.66		2.16		2.17		1.72	
	$\varphi V_n/V_{mpr}$ =	1.9		1.3		1.31		1.85	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 6		1.50	1.15 1.25 0.51 1.16	1.54	1.32 1.31 0.51 1.16	1.54	1.15 1.25 0.51 1.16	1.52	
		1.38		1.23		1.23		1.38	
Story 5	$\varphi M_n/M_u$ =	1.73		2.16		2.17		1.70	
	$\varphi V_n/V_{mpr}$ =	1.85		1.28		1.28		1.8	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 5		1.51	1.15 1.17 0.50 1.15	1.53	1.31 1.27 0.50 1.15	1.53	1.15 1.17 0.50 1.15	1.49	
		1.36		1.22		1.22		1.36	
Story 4	$\varphi M_n/M_u$ =	1.67		2.09		2.09		1.65	
	$\varphi V_n/V_{mpr}$ =	1.87		1.31		1.3		1.9	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 4		1.51	1.15 1.16 0.53 1.15	1.50	1.29 1.33 0.53 1.15	1.51	1.15 1.16 0.53 1.15	1.49	
		1.36		1.19		1.19		1.36	
Story 3	$\varphi M_n/M_u$ =	1.71		2.11		2.12		1.69	
	$\varphi V_n/V_{mpr}$ =	1.82		1.28		1.28		1.85	1.6%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 3		1.51	1.16 1.18 0.57 1.15	1.50	1.28 1.40 0.57 1.15	1.51	1.16 1.18 0.57 1.15	1.49	
		1.36		1.17		1.17		1.36	
Story 2	$\varphi M_n/M_u$ =	1.64		2.11		2.12		1.61	
	$\varphi V_n/V_{mpr}$ =	1.92		1.25		1.25		1.91	1.7%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 2		1.52	1.17 1.20 0.63 1.16	1.51	1.29 1.66 0.63 1.16	1.51	1.18 1.20 0.63 1.16	1.51	
		1.41	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.16	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.16	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.41	
Story 1	$\varphi M_n/M_u$ =	1.26		1.89		1.89		1.27	
	$\varphi V_n/V_{mpr}$ =	1.9		1.25		1.25		1.9	1.5%
	$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	

Modeling Documentation (1 of 1)

Story	Column line	$M_{y,exp}$ (k-in)	EI_{stf}/EI_g	M_c/M_y	$\Theta_{cap,pl}$ (rad)	Θ_{pc} (rad)	λ	$(P/A_gf'_c)_{exp}$
Story 12	1	3794	0.35	1.21	0.061	0.100	98	0.01
Story 12	2	5786	0.35	1.21	0.062	0.100	96	0.03
Story 12	3	5786	0.35	1.21	0.062	0.100	96	0.03
Story 12	4	3794	0.35	1.21	0.061	0.100	98	0.01
Story 11	1	4812	0.35	1.21	0.061	0.100	96	0.03
Story 11	2	8093	0.35	1.20	0.062	0.100	93	0.05
Story 11	3	8093	0.35	1.20	0.062	0.100	93	0.05
Story 11	4	4812	0.35	1.21	0.061	0.100	96	0.03
Story 10	1	5493	0.35	1.20	0.060	0.100	95	0.04
Story 10	2	8772	0.35	1.20	0.059	0.100	90	0.08
Story 10	3	8772	0.35	1.20	0.059	0.100	90	0.08
Story 10	4	5493	0.35	1.20	0.060	0.100	95	0.04
Story 9	1	7131	0.35	1.20	0.060	0.100	93	0.05
Story 9	2	11031	0.35	1.19	0.058	0.100	87	0.11
Story 9	3	11031	0.35	1.19	0.058	0.100	87	0.11
Story 9	4	7131	0.35	1.20	0.060	0.100	93	0.05
Story 8	1	7474	0.35	1.20	0.059	0.100	92	0.07
Story 8	2	11684	0.40	1.19	0.056	0.100	84	0.13
Story 8	3	11684	0.40	1.19	0.056	0.100	84	0.13
Story 8	4	7474	0.35	1.20	0.059	0.100	92	0.07
Story 7	1	8772	0.35	1.20	0.059	0.100	90	0.08
Story 7	2	12806	0.43	1.19	0.054	0.100	81	0.16
Story 7	3	12806	0.43	1.19	0.054	0.100	81	0.16
Story 7	4	8772	0.35	1.20	0.059	0.100	90	0.08
Story 6	1	8628	0.36	1.20	0.057	0.100	88	0.09
Story 6	2	13761	0.46	1.18	0.051	0.100	78	0.19
Story 6	3	13761	0.46	1.18	0.051	0.100	78	0.19
Story 6	4	8628	0.36	1.20	0.057	0.100	88	0.09
Story 5	1	9120	0.38	1.19	0.056	0.100	87	0.11
Story 5	2	14550	0.48	1.18	0.049	0.096	75	0.22
Story 5	3	14550	0.48	1.18	0.049	0.096	75	0.22
Story 5	4	9120	0.38	1.19	0.056	0.100	87	0.11
Story 4	1	9370	0.39	1.19	0.054	0.100	85	0.12
Story 4	2	15014	0.51	1.18	0.047	0.088	73	0.24
Story 4	3	15014	0.51	1.18	0.047	0.088	73	0.24
Story 4	4	9370	0.39	1.19	0.054	0.100	85	0.12
Story 3	1	9856	0.40	1.19	0.053	0.100	84	0.13
Story 3	2	15791	0.54	1.17	0.045	0.080	70	0.27
Story 3	3	15791	0.54	1.17	0.045	0.080	70	0.27
Story 3	4	9856	0.40	1.19	0.053	0.100	84	0.13
Story 2	1	9943	0.42	1.19	0.052	0.100	82	0.15
Story 2	2	16641	0.56	1.17	0.043	0.073	68	0.30
Story 2	3	16641	0.56	1.17	0.043	0.073	68	0.30
Story 2	4	9943	0.42	1.19	0.052	0.100	82	0.15
Story 1	1	10265	0.43	1.19	0.050	0.100	81	0.16
Story 1	2	17977	0.59	1.17	0.041	0.066	65	0.32
Story 1	3	17977	0.59	1.17	0.041	0.066	65	0.32
Story 1	4	10265	0.43	1.19	0.050	0.100	81	0.16

Floor	Bay	$M_{y,pos,exp}$(k-in)	$M_{y,n,slab,exp}$(k-in)	EI_{stf}/EI_g	$EI_{stf, w/ Slab}$ (k-in^2/rad)	$(\Theta_{cap,pl})_{pos}$ (rad)	$(\Theta_{cap,pl})_{neg}$ (rad)	Θ_{pc} (rad)	λ
Floor 13	1	1839	-4089	0.35	7.428E+07	0.0407	-0.068	0.100	100
Floor 13	2	1839	-4089	0.35	7.428E+07	0.0407	-0.068	0.100	100
Floor 13	3	1839	-4089	0.35	3.724E+07	0.0407	-0.068	0.100	100
Floor 12	1	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
Floor 12	2	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
Floor 12	3	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
Floor 11	1	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
Floor 11	2	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
Floor 11	3	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
Floor 10	1	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
Floor 10	2	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
Floor 10	3	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
Floor 9	1	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
Floor 9	2	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
Floor 9	3	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
Floor 8	1	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
Floor 8	2	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
Floor 8	3	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
Floor 7	1	3639	-8835	0.35	1.522E+08	0.041	-0.068	0.100	99
Floor 7	2	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 7	3	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 6	1	3639	-8835	0.35	1.522E+08	0.041	-0.068	0.100	99
Floor 6	2	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 6	3	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 5	1	3619	-8911	0.35	1.522E+08	0.041	-0.068	0.100	99
Floor 5	2	3619	-8911	0.35	1.522E+08	0.0411	-0.068	0.100	99
Floor 5	3	3619	-8911	0.35	1.522E+08	0.0411	-0.068	0.100	99
Floor 4	1	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
Floor 4	2	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
Floor 4	3	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
Floor 3	1	4113	-8917	0.35	1.522E+08	0.043	-0.067	0.100	99
Floor 3	2	4113	-8917	0.35	1.522E+08	0.0429	-0.067	0.100	99
Floor 3	3	4113	-8917	0.35	1.522E+08	0.0429	-0.067	0.100	99
Floor 2	1	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99
Floor 2	2	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99
Floor 2	3	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.99 T_2= 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2013
Number of Stories: 12
Fundamental Period (sec): 1.97

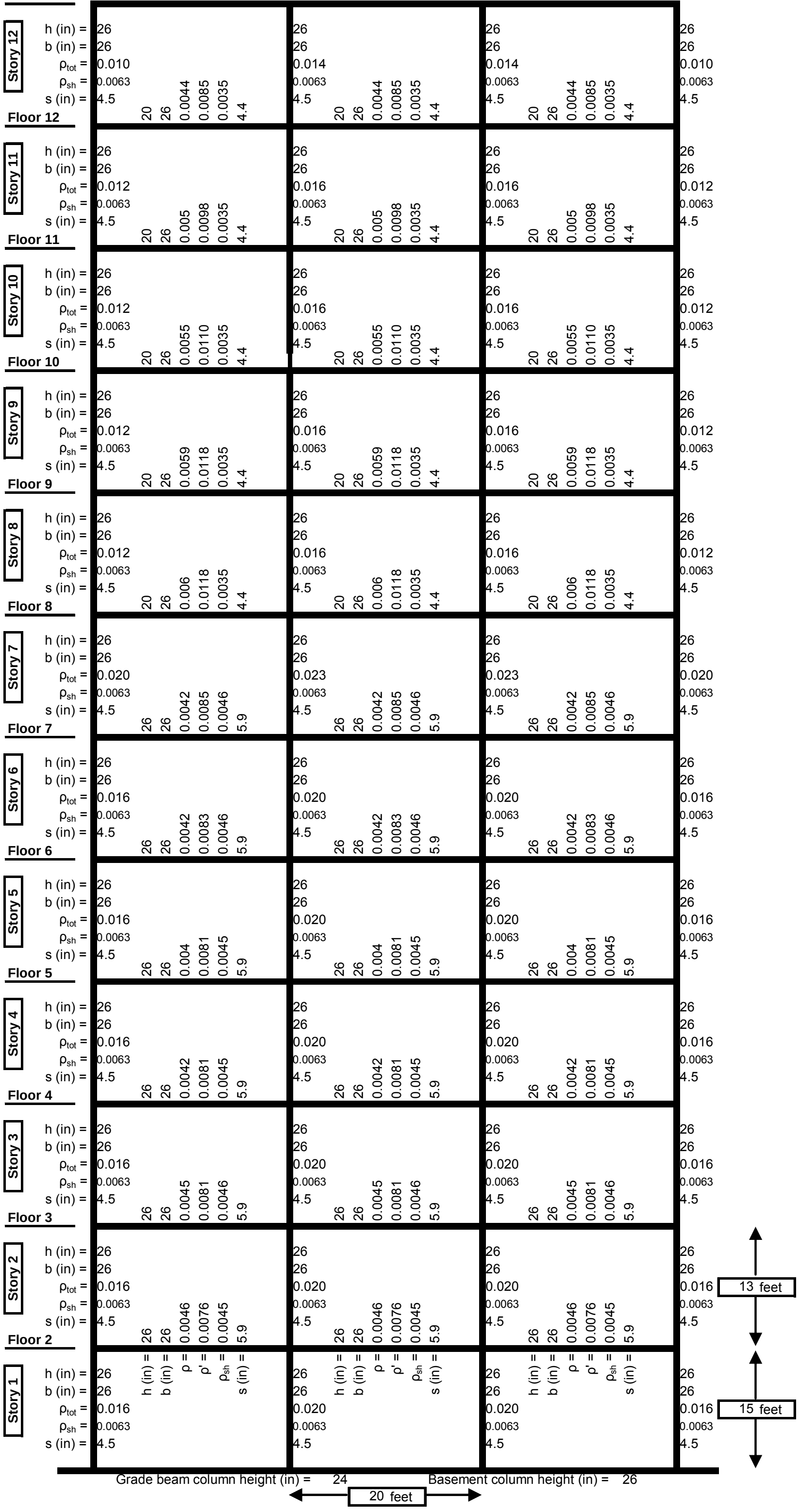
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2013 SCWB=2.0

Simply adding more reinforcements in the column was insufficient to obtain SCWB=2.0 from the baseline design. Thus, columns were made larger. However, after the columns were larger inter story drift and joint shear was too conservative, so beams were sized down, until joint shear controls. Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 21 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 6 by strength demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). All column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Story	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	26	26	0.010	0.0063	4.5	26	26	0.014	0.0063	4.5	26	26	0.014	0.0063	4.5	26	26	0.010	0.0063	4.5
Story 11	26	26	0.012	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.012	0.0063	4.5
Story 10	26	26	0.012	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.012	0.0063	4.5
Story 9	26	26	0.012	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.012	0.0063	4.5
Story 8	26	26	0.012	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.016	0.0063	4.5	26	26	0.012	0.0063	4.5
Story 7	26	26	0.020	0.0063	4.5	26	26	0.023	0.0063	4.5	26	26	0.023	0.0063	4.5	26	26	0.020	0.0063	4.5
Story 6	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5
Story 5	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5
Story 4	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5
Story 3	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5
Story 2	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5
Story 1	26	26	0.016	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.020	0.0063	4.5	26	26	0.016	0.0063	4.5

Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	20	26	0.0039	0.0060	0.0035	4.4	20	26	0.0039	0.0060	0.0035	4.4	20	26	0.0039	0.0060	0.0035	4.4
Floor 12	20	26	0.0044	0.0085	0.0035	4.4	20	26	0.0044	0.0085	0.0035	4.4	20	26	0.0044	0.0085	0.0035	4.4
Floor 11	20	26	0.005	0.0098	0.0035	4.4	20	26	0.005	0.0098	0.0035	4.4	20	26	0.005	0.0098	0.0035	4.4
Floor 10	20	26	0.0055	0.0110	0.0035	4.4	20	26	0.0055	0.0110	0.0035	4.4	20	26	0.0055	0.0110	0.0035	4.4
Floor 9	20	26	0.0059	0.0118	0.0035	4.4	20	26	0.0059	0.0118	0.0035	4.4	20	26	0.0059	0.0118	0.0035	4.4
Floor 8	20	26	0.006	0.0118	0.0035	4.4	20	26	0.006	0.0118	0.0035	4.4	20	26	0.006	0.0118	0.0035	4.4
Floor 7	26	26	0.0042	0.0085	0.0046	5.9	26	26	0.0042	0.0085	0.0046	5.9	26	26	0.0042	0.0085	0.0046	5.9
Floor 6	26	26	0.0042	0.0083	0.0046	5.9	26	26	0.0042	0.0083	0.0046	5.9	26	26	0.0042	0.0083	0.0046	5.9
Floor 5	26	26	0.004	0.0081	0.0045	5.9	26	26	0.004	0.0081	0.0045	5.9	26	26	0.004	0.0081	0.0045	5.9
Floor 4	26	26	0.0042	0.0081	0.0045	5.9	26	26	0.0042	0.0081	0.0045	5.9	26	26	0.0042	0.0081	0.0045	5.9
Floor 3	26	26	0.0045	0.0081	0.0046	5.9	26	26	0.0045	0.0081	0.0046	5.9	26	26	0.0045	0.0081	0.0046	5.9
Floor 2	26	26	0.0046	0.0076	0.0045	5.9	26	26	0.0046	0.0076	0.0045	5.9	26	26	0.0046	0.0076	0.0045	5.9

Grade beam column height (in) = 24

Basement column height (in) = 26

Design base shear = 0.044 g, 232 k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi

Design Documentation (2 of 2)

								Design Drifts:
SCWB =	1.28		1.19		0.99		1.28	
(beam, roof) (φMn/Mu)neg =		1.16		1.23		1.16		
(φMn/Mu)pos =		1.22		1.34		1.22		
Mn,pos/Mn,neg =		0.66		0.66		0.66		
φVn/Vmpr =		5.77		5.77		5.77		
Joint ΦVn/Vu =	2.94		2.38		2.38		2.94	
Story 12 φMn/Mu =	1.72		4.18		4.18		1.73	
φVn/Vmpr =	2.13		1.48		1.48		2.13	0.8%
P/Agf'c =	0.02		0.03		0.03		0.02	
Floor 12 (φMn/Mu)neg =		1.17		1.33		1.18		
(φMn/Mu)pos =		1.39		1.47		1.39		
Mn,pos/Mn,neg =		0.53		0.53		0.53		
φVn/Vmpr =		3.61		3.61		3.61		
SCWB =	2.18		2.11		2.11		2.18	
Joint ΦVn/Vu =	1.82		1.60		1.60		1.82	
Story 11 φMn/Mu =	2.63		4.18		4.18		2.63	
φVn/Vmpr =	1.67		1.72		1.72		1.67	1.1%
P/Agf'c =	0.03		0.06		0.06		0.03	
Floor 11 (φMn/Mu)neg =		1.17		1.30		1.17		
(φMn/Mu)pos =		1.42		1.53		1.42		
Mn,pos/Mn,neg =		0.52		0.52		0.52		
φVn/Vmpr =		2.93		2.93		2.93		
SCWB =	2.20		2.11		2.11		2.20	
Joint ΦVn/Vu =	1.59		1.40		1.40		1.59	
Story 10 φMn/Mu =	2.38		3.67		3.67		2.38	
φVn/Vmpr =	2.18		1.59		1.59		2.18	1.5%
P/Agf'c =	0.05		0.09		0.09		0.05	
Floor 10 (φMn/Mu)neg =		1.17		1.30		1.17		
(φMn/Mu)pos =		1.44		1.53		1.44		
Mn,pos/Mn,neg =		0.51		0.51		0.51		
φVn/Vmpr =		2.50		2.50		2.50		
SCWB =	2.06		2.03		2.03		2.06	
Joint ΦVn/Vu =	1.38		1.23		1.23		1.38	
Story 9 φMn/Mu =	2.36		3.32		3.32		2.36	
φVn/Vmpr =	2.4		1.74		1.74		2.4	1.8%
P/Agf'c =	0.07		0.12		0.12		0.07	
Floor 9 (φMn/Mu)neg =		1.16		1.28		1.16		
(φMn/Mu)pos =		1.45		1.55		1.45		
Mn,pos/Mn,neg =		0.52		0.52		0.52		
φVn/Vmpr =		2.27		2.27		2.27		
SCWB =	2.01		2.02		2.02		2.01	
Joint ΦVn/Vu =	1.28		1.13		1.13		1.28	
Story 8 φMn/Mu =	1.99		2.92		2.92		1.98	
φVn/Vmpr =	2.54		1.84		1.84		2.54	2.0%
P/Agf'c =	0.09		0.16		0.16		0.09	
Floor 8 (φMn/Mu)neg =		1.16		1.26		1.16		
(φMn/Mu)pos =		1.44		1.55		1.45		
Mn,pos/Mn,neg =		0.52		0.52		0.52		
φVn/Vmpr =		2.26		2.26		2.26		
SCWB =	2.60		2.44		2.44		2.60	
Joint ΦVn/Vu =	1.28		1.13		1.13		1.28	
Story 7 φMn/Mu =	2.38		2.74		2.75		2.38	
φVn/Vmpr =	1.73		1.41		1.41		1.73	1.8%
P/Agf'c =	0.11		0.19		0.19		0.11	
Floor 7 (φMn/Mu)neg =		1.16		1.36		1.16		
(φMn/Mu)pos =		1.22		1.29		1.22		
Mn,pos/Mn,neg =		0.51		0.51		0.51		
φVn/Vmpr =		1.16		1.16		1.16		
SCWB =	2.18		2.04		2.04		2.18	
Joint ΦVn/Vu =	1.40		1.25		1.25		1.40	
Story 6 φMn/Mu =	2.29		2.78		2.78		2.29	
φVn/Vmpr =	1.93		1.5		1.5		1.93	1.5%
P/Agf'c =	0.13		0.22		0.22		0.13	
Floor 6 (φMn/Mu)neg =		1.17		1.34		1.17		
(φMn/Mu)pos =		1.28		1.34		1.28		
Mn,pos/Mn,neg =		0.52		0.52		0.52		
φVn/Vmpr =		1.16		1.16		1.16		
SCWB =	2.07		2.04		2.04		2.07	
Joint ΦVn/Vu =	1.45		1.28		1.28		1.45	
Story 5 φMn/Mu =	2.33		2.91		2.91		2.33	
φVn/Vmpr =	1.85		1.44		1.44		1.85	1.5%
P/Agf'c =	0.15		0.26		0.26		0.15	
Floor 5 (φMn/Mu)neg =		1.15		1.30		1.15		
(φMn/Mu)pos =		1.18		1.25		1.18		
Mn,pos/Mn,neg =		0.50		0.50		0.50		
φVn/Vmpr =		1.15		1.15		1.15		
SCWB =	2.13		2.18		2.18		2.13	
Joint ΦVn/Vu =	1.48		1.32		1.32		1.48	
Story 4 φMn/Mu =	2.35		2.98		2.98		2.35	
φVn/Vmpr =	1.79		1.3		1.3		1.79	1.6%
P/Agf'c =	0.18		0.29		0.29		0.18	
Floor 4 (φMn/Mu)neg =		1.15		1.29		1.15		
(φMn/Mu)pos =		1.19		1.30		1.19		
Mn,pos/Mn,neg =		0.53		0.53		0.53		
φVn/Vmpr =		1.15		1.15		1.15		
SCWB =	2.16		2.22		2.22		2.16	
Joint ΦVn/Vu =	1.48		1.29		1.29		1.48	
Story 3 φMn/Mu =	2.38		3.07		3.08		2.38	
φVn/Vmpr =	1.73		1.32		1.32		1.73	1.6%
P/Agf'c =	0.20		0.32		0.32		0.20	
Floor 3 (φMn/Mu)neg =		1.17		1.28		1.17		
(φMn/Mu)pos =		1.20		1.38		1.21		
Mn,pos/Mn,neg =		0.57		0.57		0.57		
φVn/Vmpr =		1.15		1.15		1.15		
SCWB =	2.19		2.26		2.26		2.19	
Joint ΦVn/Vu =	1.48		1.26		1.26		1.48	
Story 2 φMn/Mu =	2.35		3.09		3.09		2.35	
φVn/Vmpr =	1.68		1.35		1.35		1.68	1.6%
P/Agf'c =	0.22		0.36		0.36		0.22	
Floor 2 (φMn/Mu)neg =		1.16		1.25		1.16		
(φMn/Mu)pos =		1.18		1.55		1.18		
Mn,pos/Mn,neg =		0.61		0.61		0.61		
φVn/Vmpr =		1.16		1.16		1.16		
SCWB =	2.34		2.41		2.41		2.34	
Joint ΦVn/Vu =	1.57		1.31		1.31		1.57	
Story 1 φMn/Mu =	1.84		2.86		2.86		1.84	
φVn/Vmpr =	1.63		1.37		1.37		1.63	1.3%
P/Agf'c =	0.24		0.39		0.39		0.24	

Modeling Documentation (1 of 1)

Story	Column line	$M_{y,exp}$ (k-in)	EI_{stf}/EI_g	M_c/M_y	$\Theta_{cap,pl}$ (rad)	Θ_{pc} (rad)	λ	$(P/A_gf'_c)_{exp}$
Story 12	1	4840	0.35	1.21	0.064	0.100	108	0.01
Story 12	2	6933	0.35	1.21	0.065	0.100	107	0.02
Story 12	3	6933	0.35	1.21	0.065	0.100	107	0.02
Story 12	4	4840	0.35	1.21	0.064	0.100	108	0.01
Story 11	1	6087	0.35	1.21	0.064	0.100	107	0.02
Story 11	2	8540	0.35	1.20	0.063	0.100	103	0.05
Story 11	3	8540	0.35	1.20	0.063	0.100	103	0.05
Story 11	4	6087	0.35	1.21	0.064	0.100	107	0.02
Story 10	1	6477	0.35	1.21	0.062	0.100	105	0.03
Story 10	2	9289	0.35	1.20	0.061	0.100	100	0.07
Story 10	3	9289	0.35	1.20	0.061	0.100	100	0.07
Story 10	4	6477	0.35	1.21	0.062	0.100	105	0.03
Story 9	1	6862	0.35	1.20	0.061	0.100	103	0.05
Story 9	2	10025	0.35	1.20	0.058	0.100	97	0.09
Story 9	3	10025	0.35	1.20	0.058	0.100	97	0.09
Story 9	4	6862	0.35	1.20	0.061	0.100	103	0.05
Story 8	1	7242	0.35	1.20	0.060	0.100	102	0.06
Story 8	2	10749	0.36	1.19	0.056	0.100	95	0.11
Story 8	3	10749	0.36	1.19	0.056	0.100	95	0.11
Story 8	4	7242	0.35	1.20	0.060	0.100	102	0.06
Story 7	1	10957	0.35	1.20	0.063	0.100	100	0.07
Story 7	2	14362	0.38	1.19	0.057	0.100	92	0.14
Story 7	3	14362	0.38	1.19	0.057	0.100	92	0.14
Story 7	4	10957	0.35	1.20	0.063	0.100	100	0.07
Story 6	1	9659	0.35	1.20	0.059	0.100	99	0.08
Story 6	2	13614	0.41	1.19	0.053	0.100	89	0.16
Story 6	3	13614	0.41	1.19	0.053	0.100	89	0.16
Story 6	4	9659	0.35	1.20	0.059	0.100	99	0.08
Story 5	1	10025	0.35	1.20	0.058	0.100	97	0.09
Story 5	2	14307	0.43	1.18	0.051	0.100	86	0.18
Story 5	3	14307	0.43	1.18	0.051	0.100	86	0.18
Story 5	4	10025	0.35	1.20	0.058	0.100	97	0.09
Story 4	1	10388	0.35	1.20	0.057	0.100	96	0.10
Story 4	2	14993	0.45	1.18	0.048	0.099	84	0.21
Story 4	3	14993	0.45	1.18	0.048	0.099	84	0.21
Story 4	4	10388	0.35	1.20	0.057	0.100	96	0.10
Story 3	1	10749	0.36	1.19	0.056	0.100	95	0.11
Story 3	2	15671	0.47	1.18	0.046	0.091	81	0.23
Story 3	3	15671	0.47	1.18	0.046	0.091	81	0.23
Story 3	4	10749	0.36	1.19	0.056	0.100	95	0.11
Story 2	1	11107	0.37	1.19	0.055	0.100	93	0.13
Story 2	2	16342	0.50	1.17	0.045	0.084	79	0.25
Story 2	3	16342	0.50	1.17	0.045	0.084	79	0.25
Story 2	4	11107	0.37	1.19	0.055	0.100	93	0.13
Story 1	1	11462	0.38	1.19	0.053	0.100	92	0.14
Story 1	2	17006	0.52	1.17	0.043	0.078	77	0.28
Story 1	3	17006	0.52	1.17	0.043	0.078	77	0.28
Story 1	4	11462	0.38	1.19	0.053	0.100	92	0.14

Floor	Bay	$M_{y,pos,exp}$(k-in)	$M_{y,n,slab,exp}$(k-in)	EI_{stf}/EI_g	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad)	$(\Theta_{cap,pl})_{pos}$ (rad)	$(\Theta_{cap,pl})_{neg}$ (rad)	Θ_{pc} (rad)	λ
Floor 13	1	1917	-4043	0.35	5.695E+07	0.0442	-0.071	0.100	101
Floor 13	2	1917	-4043	0.35	5.695E+07	0.0442	-0.071	0.100	101
Floor 13	3	1917	-4043	0.35	3.724E+07	0.0442	-0.071	0.100	101
Floor 12	1	2151	-5190	0.35	5.695E+07	0.044	-0.074	0.100	101
Floor 12	2	2151	-5190	0.35	5.695E+07	0.044	-0.074	0.100	101
Floor 12	3	2151	-5190	0.35	5.695E+07	0.044	-0.074	0.100	101
Floor 11	1	2442	-5758	0.35	5.695E+07	0.046	-0.074	0.100	101
Floor 11	2	2442	-5758	0.35	5.695E+07	0.046	-0.074	0.100	101
Floor 11	3	2442	-5758	0.35	5.695E+07	0.046	-0.074	0.100	101
Floor 10	1	2676	-6324	0.35	5.695E+07	0.046	-0.075	0.100	101
Floor 10	2	2676	-6324	0.35	5.695E+07	0.046	-0.075	0.100	101
Floor 10	3	2676	-6324	0.35	5.695E+07	0.046	-0.075	0.100	101
Floor 9	1	2885	-6662	0.35	5.695E+07	0.047	-0.076	0.100	101
Floor 9	2	2885	-6662	0.35	5.695E+07	0.047	-0.076	0.100	101
Floor 9	3	2885	-6662	0.35	5.695E+07	0.047	-0.076	0.100	101
Floor 8	1	2897	-6662	0.35	5.695E+07	0.047	-0.075	0.100	101
Floor 8	2	2897	-6662	0.35	5.695E+07	0.047	-0.075	0.100	101
Floor 8	3	2897	-6662	0.35	5.695E+07	0.047	-0.075	0.100	101
Floor 7	1	3758	-8944	0.35	1.269E+08	0.044	-0.072	0.100	100
Floor 7	2	3758	-8944	0.35	1.269E+08	0.0442	-0.072	0.100	100
Floor 7	3	3758	-8944	0.35	1.269E+08	0.0442	-0.072	0.100	100
Floor 6	1	3759	-8737	0.35	1.269E+08	0.044	-0.071	0.100	100
Floor 6	2	3759	-8737	0.35	1.269E+08	0.0441	-0.071	0.100	100
Floor 6	3	3759	-8737	0.35	1.269E+08	0.0441	-0.071	0.100	100
Floor 5	1	3541	-8598	0.35	1.269E+08	0.043	-0.071	0.100	100
Floor 5	2	3541	-8598	0.35	1.269E+08	0.0431	-0.071	0.100	100
Floor 5	3	3541	-8598	0.35	1.269E+08	0.0431	-0.071	0.100	100
Floor 4	1	3759	-8600	0.35	1.269E+08	0.044	-0.070	0.100	100
Floor 4	2	3759	-8600	0.35	1.269E+08	0.044	-0.070	0.100	100
Floor 4	3	3759	-8600	0.35	1.269E+08	0.044	-0.070	0.100	100
Floor 3	1	3994	-8602	0.35	1.269E+08	0.045	-0.070	0.100	100
Floor 3	2	3994	-8602	0.35	1.269E+08	0.0449	-0.070	0.100	100
Floor 3	3	3994	-8602	0.35	1.269E+08	0.0449	-0.070	0.100	100
Floor 2	1	4076	-8186	0.35	1.269E+08	0.045	-0.068	0.100	100
Floor 2	2	4076	-8186	0.35	1.269E+08	0.045	-0.068	0.100	100
Floor 2	3	4076	-8186	0.35	1.269E+08	0.045	-0.068	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.97 T_2= 0.67 T_3 = 0.38

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2014

Number of Stories: 12

Fundamental Period (sec): 1.97

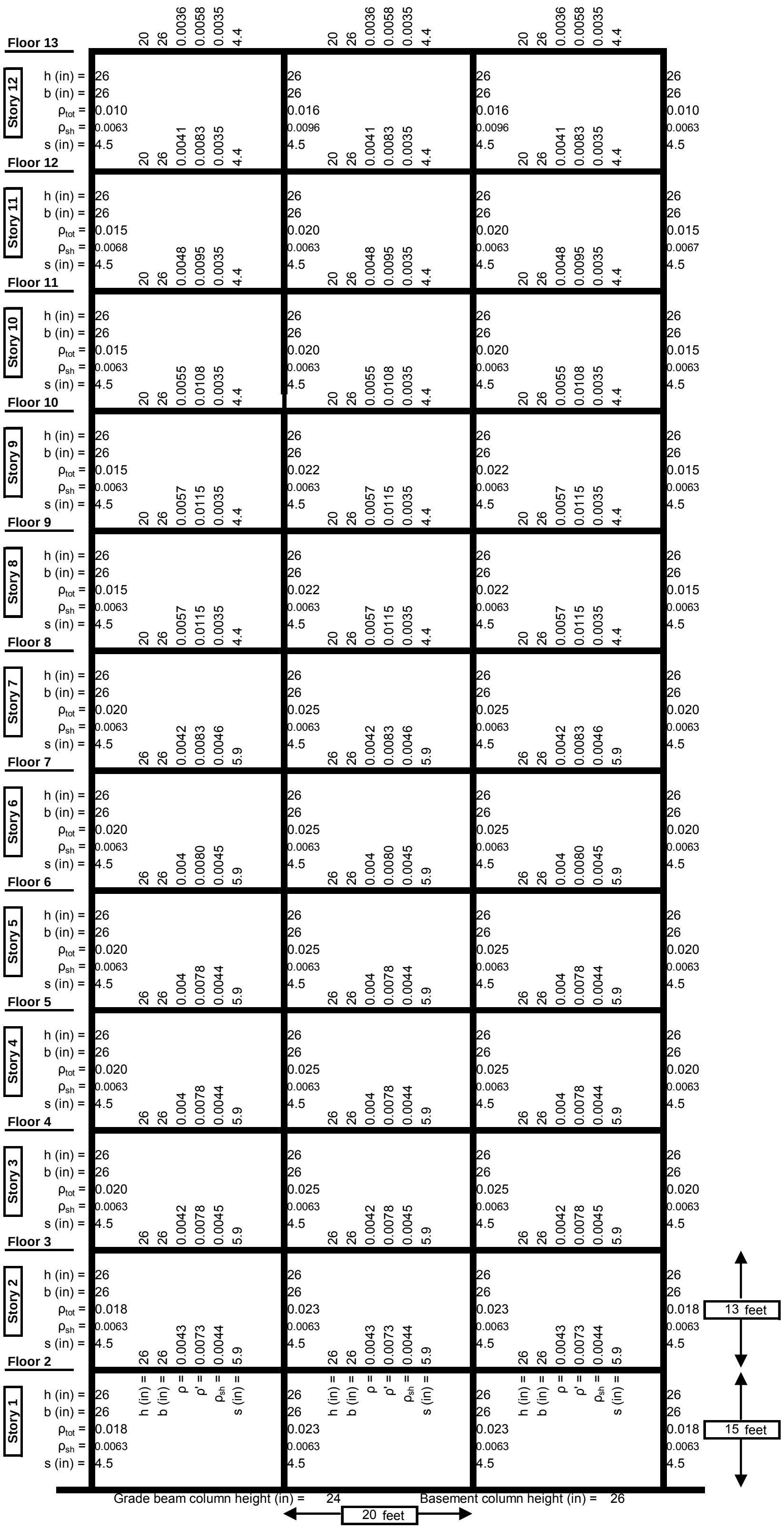
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2014 SCWB=2.5

Simply adding more reinforcements in the column from the 2013 was sufficient to obtain SCWB=2.5. In this design drift controlled over joint shear. Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Column flexural strengths were controlled by the strong-column weak-beam ratio. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). All column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Columns

	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	26	26	0.010	0.0063	4.5
	26	26	0.016	0.0096	4.5
	26	26	0.016	0.0096	4.5
	26	26	0.010	0.0063	4.5
Story 11	26	26	0.015	0.0068	4.5
	26	26	0.020	0.0063	4.5
	26	26	0.020	0.0063	4.5
	26	26	0.015	0.0067	4.5
Story 10	26	26	0.015	0.0063	4.5
	26	26	0.020	0.0063	4.5
	26	26	0.020	0.0063	4.5
	26	26	0.015	0.0063	4.5
Story 9	26	26	0.015	0.0063	4.5
	26	26	0.022	0.0063	4.5
	26	26	0.022	0.0063	4.5
	26	26	0.015	0.0063	4.5
Story 8	26	26	0.015	0.0063	4.5
	26	26	0.022	0.0063	4.5
	26	26	0.022	0.0063	4.5
	26	26	0.015	0.0063	4.5
Story 7	26	26	0.020	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.020	0.0063	4.5
Story 6	26	26	0.020	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.020	0.0063	4.5
Story 5	26	26	0.020	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.020	0.0063	4.5
Story 4	26	26	0.020	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.020	0.0063	4.5
Story 3	26	26	0.020	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.025	0.0063	4.5
	26	26	0.020	0.0063	4.5
Story 2	26	26	0.018	0.0063	4.5
	26	26	0.023	0.0063	4.5
	26	26	0.023	0.0063	4.5
	26	26	0.018	0.0063	4.5
Story 1	26	26	0.018	0.0063	4.5
	26	26	0.023	0.0063	4.5
	26	26	0.023	0.0063	4.5
	26	26	0.018	0.0063	4.5

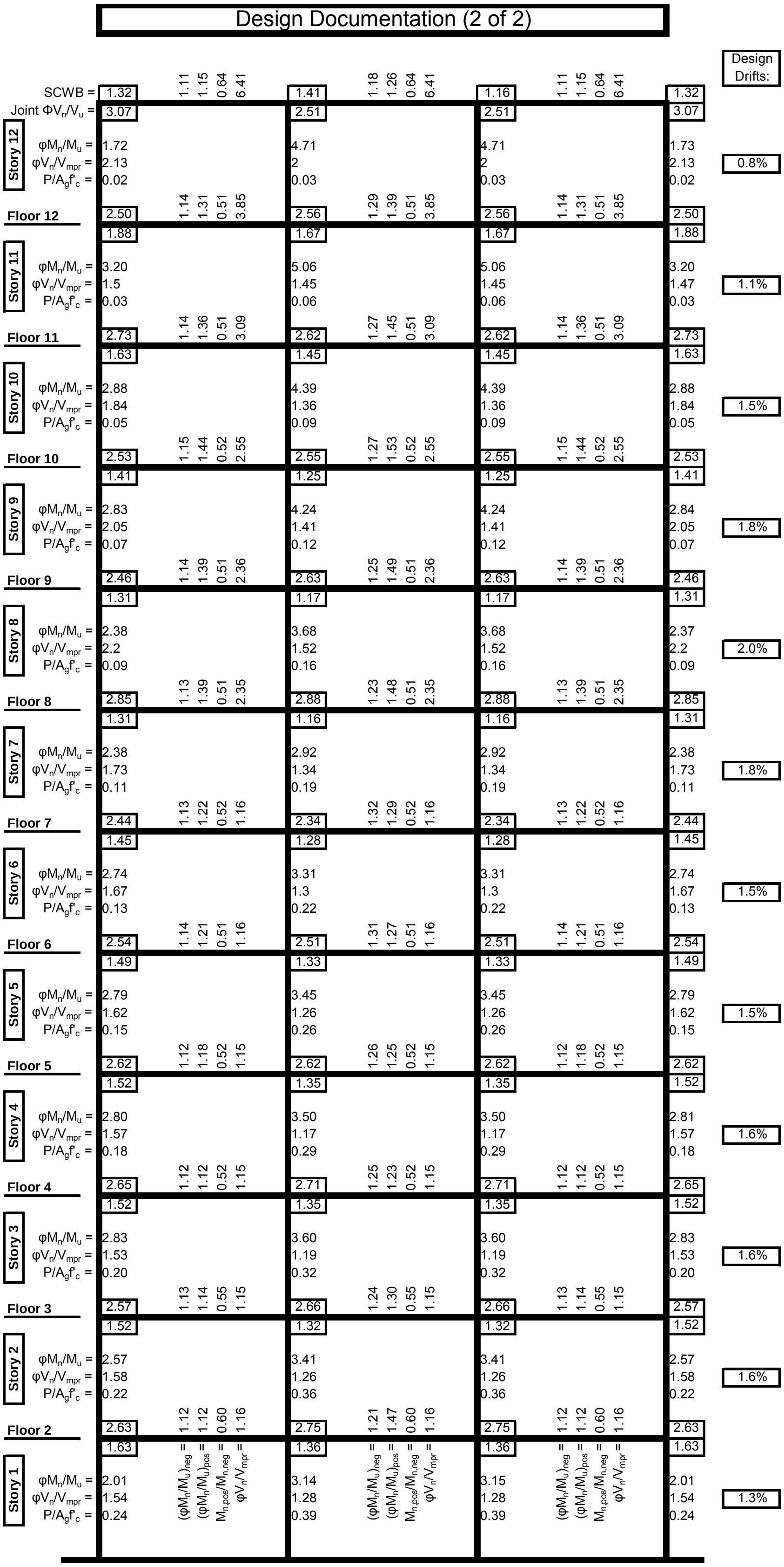
Beams

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	20	26	0.0036	0.0058	0.0035	4.4
	20	26	0.0036	0.0058	0.0035	4.4
	20	26	0.0036	0.0058	0.0035	4.4
Floor 12	20	26	0.0041	0.0083	0.0035	4.4
	20	26	0.0041	0.0083	0.0035	4.4
	20	26	0.0041	0.0083	0.0035	4.4
Floor 11	20	26	0.0048	0.0095	0.0035	4.4
	20	26	0.0048	0.0095	0.0035	4.4
	20	26	0.0048	0.0095	0.0035	4.4
Floor 10	20	26	0.0055	0.0108	0.0035	4.4
	20	26	0.0055	0.0108	0.0035	4.4
	20	26	0.0055	0.0108	0.0035	4.4
Floor 9	20	26	0.0057	0.0115	0.0035	4.4
	20	26	0.0057	0.0115	0.0035	4.4
	20	26	0.0057	0.0115	0.0035	4.4
Floor 8	20	26	0.0057	0.0115	0.0035	4.4
	20	26	0.0057	0.0115	0.0035	4.4
	20	26	0.0057	0.0115	0.0035	4.4
Floor 7	26	26	0.0042	0.0083	0.0046	5.9
	26	26	0.0042	0.0083	0.0046	5.9
	26	26	0.0042	0.0083	0.0046	5.9
Floor 6	26	26	0.004	0.0080	0.0045	5.9
	26	26	0.004	0.0080	0.0045	5.9
	26	26	0.004	0.0080	0.0045	5.9
Floor 5	26	26	0.004	0.0078	0.0044	5.9
	26	26	0.004	0.0078	0.0044	5.9
	26	26	0.004	0.0078	0.0044	5.9
Floor 4	26	26	0.004	0.0078	0.0044	5.9
	26	26	0.004	0.0078	0.0044	5.9
	26	26	0.004	0.0078	0.0044	5.9
Floor 3	26	26	0.0042	0.0078	0.0045	5.9
	26	26	0.0042	0.0078	0.0045	5.9
	26	26	0.0042	0.0078	0.0045	5.9
Floor 2	26	26	0.0043	0.0073	0.0044	5.9
	26	26	0.0043	0.0073	0.0044	5.9
	26	26	0.0043	0.0073	0.0044	5.9

Grade beam column height (in) = 24

Basement column height (in) = 26

Design base shear =	0.044	g,	232	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi



Design Documentation (2 of 2)

SCWB =	1.32	1.11 1.15 0.64 6.41	1.41	1.18 1.26 0.64 6.41	1.16	1.11 1.15 0.64 6.41	1.32	Design Drifts:
Joint $\Phi V_n/V_u$ =	3.07		2.51		2.51		3.07	
Story 12 $\varphi M_n/M_u$ =	1.72		4.71		4.71		1.73	
$\varphi V_n/V_{mpr}$ =	2.13		2		2		2.13	0.8%
$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
Floor 12	2.50	1.14 1.31 0.51 3.85	2.56	1.29 1.39 0.51 3.85	2.56	1.14 1.31 0.51 3.85	2.50	
	1.88		1.67		1.67		1.88	
Story 11 $\varphi M_n/M_u$ =	3.20		5.06		5.06		3.20	
$\varphi V_n/V_{mpr}$ =	1.5		1.45		1.45		1.47	1.1%
$P/A_g f'_c$ =	0.03		0.06		0.06		0.03	
Floor 11	2.73	1.14 1.36 0.51 3.09	2.62	1.27 1.45 0.51 3.09	2.62	1.14 1.36 0.51 3.09	2.73	
	1.63		1.45		1.45		1.63	
Story 10 $\varphi M_n/M_u$ =	2.88		4.39		4.39		2.88	
$\varphi V_n/V_{mpr}$ =	1.84		1.36		1.36		1.84	1.5%
$P/A_g f'_c$ =	0.05		0.09		0.09		0.05	
Floor 10	2.53	1.15 1.44 0.52 2.55	2.55	1.27 1.53 0.52 2.55	2.55	1.15 1.44 0.52 2.55	2.53	
	1.41		1.25		1.25		1.41	
Story 9 $\varphi M_n/M_u$ =	2.83		4.24		4.24		2.84	
$\varphi V_n/V_{mpr}$ =	2.05		1.41		1.41		2.05	1.8%
$P/A_g f'_c$ =	0.07		0.12		0.12		0.07	
Floor 9	2.46	1.14 1.39 0.51 2.36	2.63	1.25 1.49 0.51 2.36	2.63	1.14 1.39 0.51 2.36	2.46	
	1.31		1.17		1.17		1.31	
Story 8 $\varphi M_n/M_u$ =	2.38		3.68		3.68		2.37	
$\varphi V_n/V_{mpr}$ =	2.2		1.52		1.52		2.2	2.0%
$P/A_g f'_c$ =	0.09		0.16		0.16		0.09	
Floor 8	2.85	1.13 1.39 0.51 2.35	2.88	1.23 1.48 0.51 2.35	2.88	1.13 1.39 0.51 2.35	2.85	
	1.31		1.16		1.16		1.31	
Story 7 $\varphi M_n/M_u$ =	2.38		2.92		2.92		2.38	
$\varphi V_n/V_{mpr}$ =	1.73		1.34		1.34		1.73	1.8%
$P/A_g f'_c$ =	0.11		0.19		0.19		0.11	
Floor 7	2.44	1.13 1.22 0.52 1.16	2.34	1.32 1.29 0.52 1.16	2.34	1.13 1.22 0.52 1.16	2.44	
	1.45		1.28		1.28		1.45	
Story 6 $\varphi M_n/M_u$ =	2.74		3.31		3.31		2.74	
$\varphi V_n/V_{mpr}$ =	1.67		1.3		1.3		1.67	1.5%
$P/A_g f'_c$ =	0.13		0.22		0.22		0.13	
Floor 6	2.54	1.14 1.21 0.51 1.16	2.51	1.31 1.27 0.51 1.16	2.51	1.14 1.21 0.51 1.16	2.54	
	1.49		1.33		1.33		1.49	
Story 5 $\varphi M_n/M_u$ =	2.79		3.45		3.45		2.79	
$\varphi V_n/V_{mpr}$ =	1.62		1.26		1.26		1.62	1.5%
$P/A_g f'_c$ =	0.15		0.26		0.26		0.15	
Floor 5	2.62	1.12 1.18 0.52 1.15	2.62	1.26 1.25 0.52 1.15	2.62	1.12 1.18 0.52 1.15	2.62	
	1.52		1.35		1.35		1.52	
Story 4 $\varphi M_n/M_u$ =	2.80		3.50		3.50		2.81	
$\varphi V_n/V_{mpr}$ =	1.57		1.17		1.17		1.57	1.6%
$P/A_g f'_c$ =	0.18		0.29		0.29		0.18	
Floor 4	2.65	1.12 1.12 0.52 1.15	2.71	1.25 1.23 0.52 1.15	2.71	1.12 1.12 0.52 1.15	2.65	
	1.52		1.35		1.35		1.52	
Story 3 $\varphi M_n/M_u$ =	2.83		3.60		3.60		2.83	
$\varphi V_n/V_{mpr}$ =	1.53		1.19		1.19		1.53	1.6%
$P/A_g f'_c$ =	0.20		0.32		0.32		0.20	
Floor 3	2.57	1.13 1.14 0.55 1.15	2.66	1.24 1.30 0.55 1.15	2.66	1.13 1.14 0.55 1.15	2.57	
	1.52		1.32		1.32		1.52	
Story 2 $\varphi M_n/M_u$ =	2.57		3.41		3.41		2.57	
$\varphi V_n/V_{mpr}$ =	1.58		1.26		1.26		1.58	1.6%
$P/A_g f'_c$ =	0.22		0.36		0.36		0.22	
Floor 2	2.63	1.12 1.12 0.60 1.16	2.75	1.21 1.47 0.60 1.16	2.75	1.12 1.12 0.60 1.16	2.63	
	1.63		1.36		1.36		1.63	
Story 1 $\varphi M_n/M_u$ =	2.01	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	3.14	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	3.15	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	2.01	
$\varphi V_n/V_{mpr}$ =	1.54		1.28		1.28		1.54	1.3%
$P/A_g f'_c$ =	0.24		0.39		0.39		0.24	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	4840	7777	7777	4840
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.064	0.078	0.078	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	107	107	108
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	7356	10215	10215	7356
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.067	0.065	0.065	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	103	103	107
	$(P/A_gf'_c)_{exp}$ =	0.02	0.05	0.05	0.02
Story 10	$M_{y,exp}$ (k-in) =	7740	10957	10957	7740
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.064	0.063	0.063	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	100	100	105
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 9	$M_{y,exp}$ (k-in) =	8121	12519	12519	8121
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.063	0.061	0.061	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	97	97	103
	$(P/A_gf'_c)_{exp}$ =	0.05	0.09	0.09	0.05
Story 8	$M_{y,exp}$ (k-in) =	8498	13238	13238	8498
	EI_{stf}/EI_g =	0.35	0.36	0.36	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.061	0.059	0.059	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	95	95	102
	$(P/A_gf'_c)_{exp}$ =	0.06	0.11	0.11	0.06
Story 7	$M_{y,exp}$ (k-in) =	10957	15192	15192	10957
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.063	0.058	0.058	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	92	92	100
	$(P/A_gf'_c)_{exp}$ =	0.07	0.14	0.14	0.07
Story 6	$M_{y,exp}$ (k-in) =	11324	15893	15893	11324
	EI_{stf}/EI_g =	0.35	0.41	0.41	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.061	0.055	0.055	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	89	89	99
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 5	$M_{y,exp}$ (k-in) =	11688	16586	16586	11688
	EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.060	0.053	0.053	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	86	86	97
	$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 4	$M_{y,exp}$ (k-in) =	12049	17272	17272	12049
	EI_{stf}/EI_g =	0.35	0.45	0.45	0.35
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.059	0.051	0.051	0.059
	Θ_{pc} (rad) =	0.100	0.099	0.099	0.100
	λ =	96	84	84	96
	$(P/A_gf'_c)_{exp}$ =	0.10	0.21	0.21	0.10
Story 3	$M_{y,exp}$ (k-in) =	12408	17952	17952	12408
	EI_{stf}/EI_g =	0.36	0.47	0.47	0.36
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.058	0.049	0.049	0.058
	Θ_{pc} (rad) =	0.100	0.091	0.091	0.100
	λ =	95	81	81	95
	$(P/A_gf'_c)_{exp}$ =	0.11	0.23	0.23	0.11
Story 2	$M_{y,exp}$ (k-in) =	11936	17794	17794	11936
	EI_{stf}/EI_g =	0.37	0.50	0.50	0.37
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.055	0.046	0.046	0.055
	Θ_{pc} (rad) =	0.100	0.084	0.084	0.100
	λ =	93	79	79	93
	$(P/A_gf'_c)_{exp}$ =	0.13	0.25	0.25	0.13
Story 1	$M_{y,exp}$ (k-in) =	12290	18461	18461	12290
	EI_{stf}/EI_g =	0.38	0.52	0.52	0.38
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.054	0.044	0.044	0.054
	Θ_{pc} (rad) =	0.100	0.078	0.078	0.100
	λ =	92	77	77	92
	$(P/A_gf'_c)_{exp}$ =	0.14	0.28	0.28	0.14

Floor 13	$M_{y,pos,exp}$(k-in) =	1798	1798	1798
	$M_{y,n,slab,exp}$(k-in) =	-3928	-3928	-3928
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0436	0.0436	0.0436
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 12	$M_{y,pos,exp}$(k-in) =	2033	2033	2033
	$M_{y,n,slab,exp}$(k-in) =	-5076	-5076	-5076
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 11	$M_{y,pos,exp}$(k-in) =	2324	2324	2324
	$M_{y,n,slab,exp}$(k-in) =	-5645	-5645	-5645
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 10	$M_{y,pos,exp}$(k-in) =	2677	2677	2677
	$M_{y,n,slab,exp}$(k-in) =	-6211	-6211	-6211
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 9	$M_{y,pos,exp}$(k-in) =	2768	2768	2768
	$M_{y,n,slab,exp}$(k-in) =	-6549	-6549	-6549
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.076	-0.076	-0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 8	$M_{y,pos,exp}$(k-in) =	2779	2779	2779
	$M_{y,n,slab,exp}$(k-in) =	-6549	-6549	-6549
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.076	-0.076	-0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 7	$M_{y,pos,exp}$(k-in) =	3759	3759	3759
	$M_{y,n,slab,exp}$(k-in) =	-8737	-8737	-8737
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0441	0.0441
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 6	$M_{y,pos,exp}$(k-in) =	3542	3542	3542
	$M_{y,n,slab,exp}$(k-in) =	-8527	-8527	-8527
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.0431	0.0431
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 5	$M_{y,pos,exp}$(k-in) =	3542	3542	3542
	$M_{y,n,slab,exp}$(k-in) =	-8390	-8390	-8390
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$(k-in) =	3542	3542	3542
	$M_{y,n,slab,exp}$(k-in) =	-8390	-8390	-8390
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$(k-in) =	3777	3777	3777
	$M_{y,n,slab,exp}$(k-in) =	-8392	-8392	-8392
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 2	$M_{y,pos,exp}$(k-in) =	3859	3859	3859
	$M_{y,n,slab,exp}$(k-in) =	-7976	-7976	-7976
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.97 T_2 = 0.67 T_3 = 0.38

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2015
Number of Stories: 12
Fundamental Period (sec): 1.59

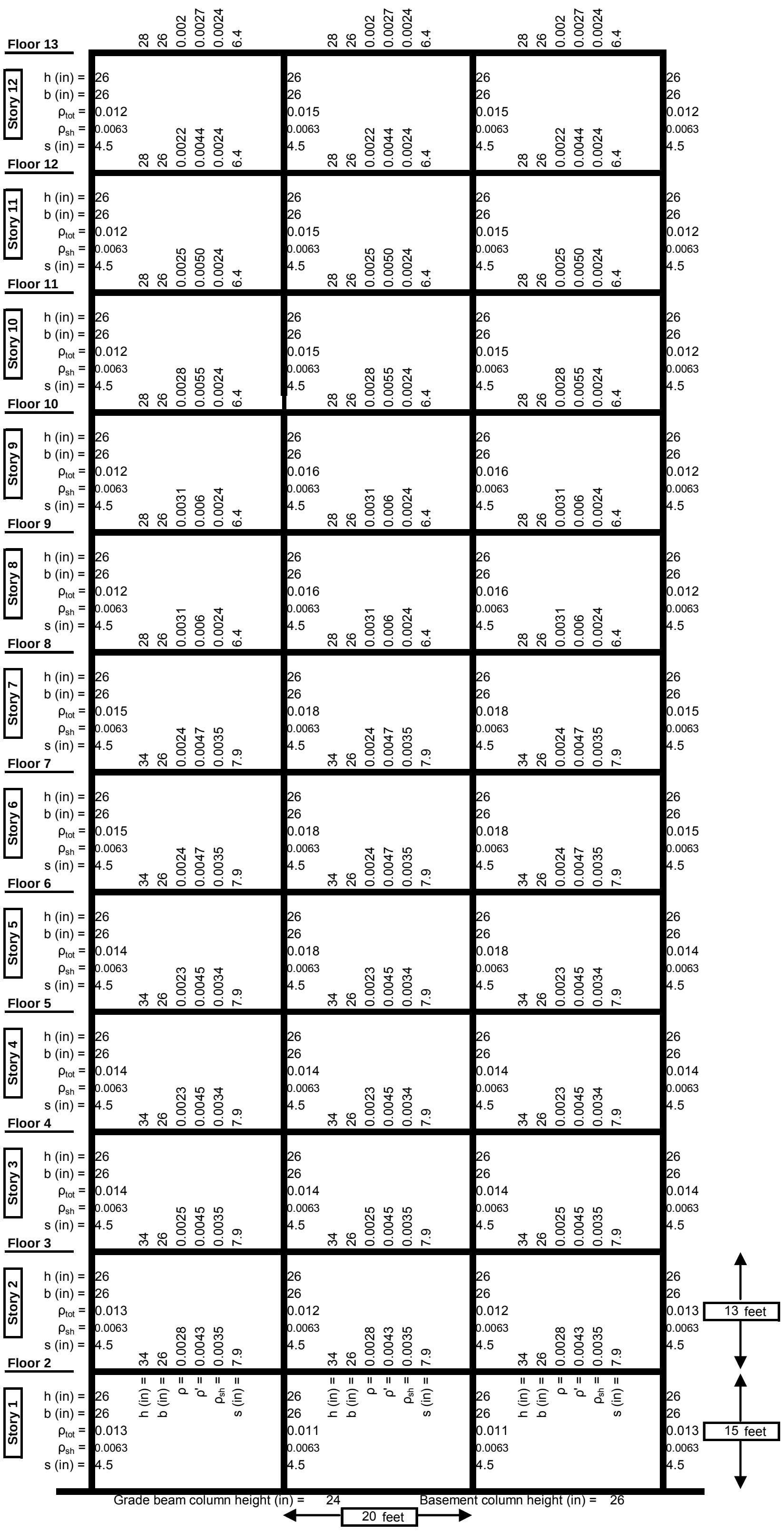
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2015 Drift Limit = 0.01

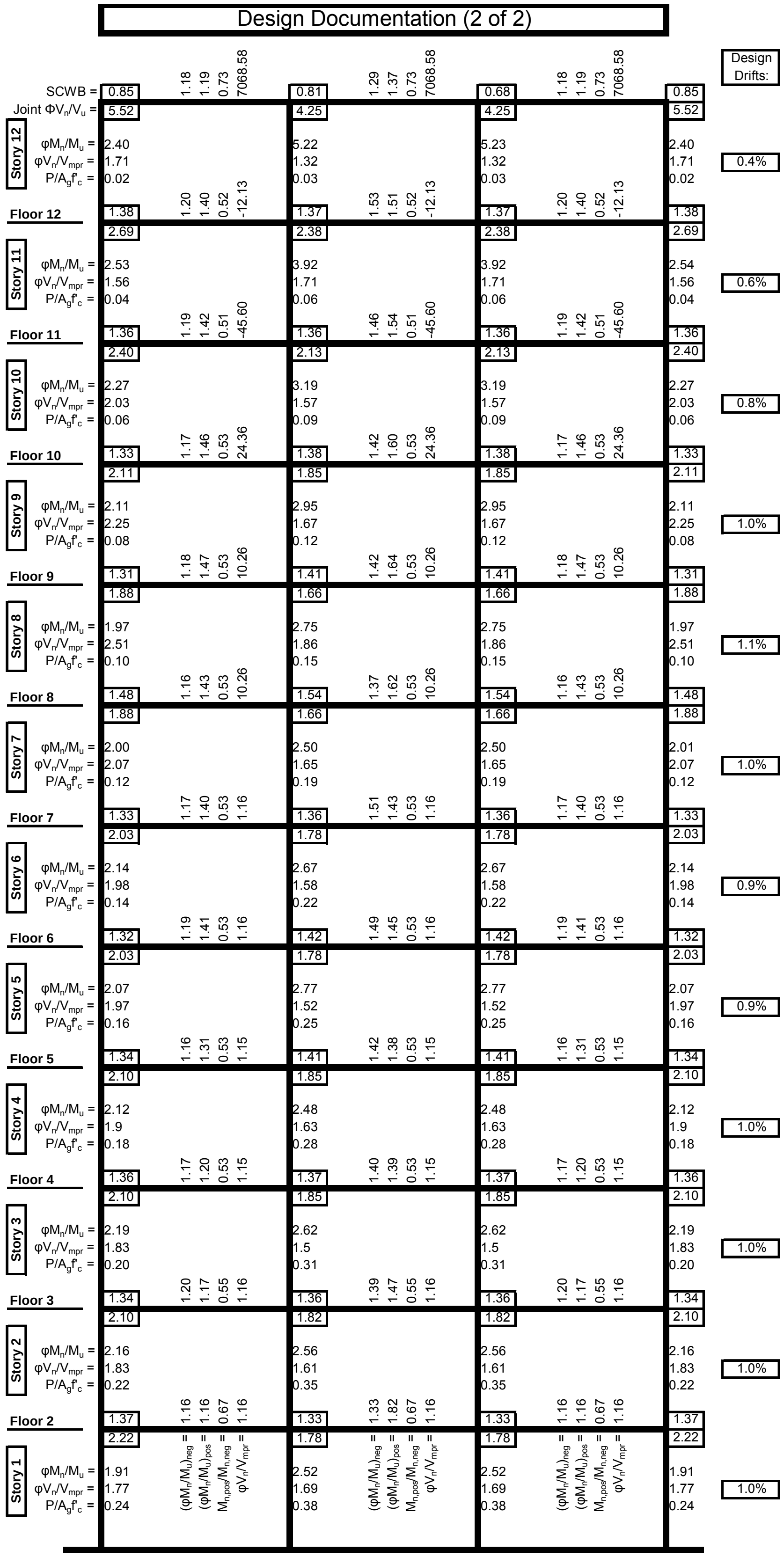
To decrease the drift from the baseline design, beams were made larger as well as columns (a little bit larger). Positive bending strength was controlled by strength demand. Negative bending strength was controlled by min reinforcement requirement, since beams were made large to control drift. *NOTE: However, the minimum reinforcement requirement was ignored for the purpose changing 1 variable in the sensitivity analysis.* Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the positive and negative strength ratio for the same floor and to meet the minimum positive to negative ratio requirement. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 5 by strength demand. *Minimum column reinforcement ratio is ignored for the purpose of sensitivity analysis.* Most beam stirrups were controlled by the capacity shear design. All column stirrups were controlled by the minimum confinement requirement. Joint shear did not control since beams were large for stiffness.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.044 g,	232 k	
f'_c beams = 5.0 ksi		$f'_{c,cols,upper}$ = 5.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 5.0 ksi	


Design Documentation (2 of 2)
Design Drifts:
1.18 1.19 0.73 7068.58
1.29 1.37 0.73 7068.58
1.18 1.19 0.73 7068.58
SCWB = 0.85 0.81 0.68 0.85
Joint ΦVn/Vu = 5.52 4.25 4.25 5.52
Story 12
φMn/Mu = 2.40 5.22 5.23 2.40
φVn/Vmpr = 1.71 1.32 1.32 1.71
P/Agf'c = 0.02 0.03 0.03 0.02
0.4%
1.20 1.40 0.52 -12.13
1.53 1.51 0.52 -12.13
1.20 1.40 0.52 -12.13
Floor 12
1.38 1.37 1.37 1.38
2.69 2.38 2.38 2.69
Story 11
φMn/Mu = 2.53 3.92 3.92 2.54
φVn/Vmpr = 1.56 1.71 1.71 1.56
P/Agf'c = 0.04 0.06 0.06 0.04
0.6%
1.19 1.42 0.51 -45.60
1.46 1.54 0.51 -45.60
1.19 1.42 0.51 -45.60
Floor 11
1.36 1.36 1.36 1.36
2.40 2.13 2.13 2.40
Story 10
φMn/Mu = 2.27 3.19 3.19 2.27
φVn/Vmpr = 2.03 1.57 1.57 2.03
P/Agf'c = 0.06 0.09 0.09 0.06
0.8%
1.17 1.46 0.53 24.36
1.42 1.60 0.53 24.36
1.17 1.46 0.53 24.36
Floor 10
1.33 1.38 1.38 1.33
2.11 1.85 1.85 2.11
Story 9
φMn/Mu = 2.11 2.95 2.95 2.11
φVn/Vmpr = 2.25 1.67 1.67 2.25
P/Agf'c = 0.08 0.12 0.12 0.08
1.0%
1.18 1.47 0.53 10.26
1.42 1.64 0.53 10.26
1.18 1.47 0.53 10.26
Floor 9
1.31 1.41 1.41 1.31
1.88 1.66 1.66 1.88
Story 8
φMn/Mu = 1.97 2.75 2.75 1.97
φVn/Vmpr = 2.51 1.86 1.86 2.51
P/Agf'c = 0.10 0.15 0.15 0.10
1.1%
1.16 1.43 0.53 10.26
1.37 1.62 0.53 10.26
1.16 1.43 0.53 10.26
Floor 8
1.48 1.54 1.54 1.48
1.88 1.66 1.66 1.88
Story 7
φMn/Mu = 2.00 2.50 2.50 2.01
φVn/Vmpr = 2.07 1.65 1.65 2.07
P/Agf'c = 0.12 0.19 0.19 0.12
1.0%
1.17 1.40 0.53 1.16
1.51 1.43 0.53 1.16
1.17 1.40 0.53 1.16
Floor 7
1.33 1.36 1.36 1.33
2.03 1.78 1.78 2.03
Story 6
φMn/Mu = 2.14 2.67 2.67 2.14
φVn/Vmpr = 1.98 1.58 1.58 1.98
P/Agf'c = 0.14 0.22 0.22 0.14
0.9%
1.19 1.41 0.53 1.16
1.49 1.45 0.53 1.16
1.19 1.41 0.53 1.16
Floor 6
1.32 1.42 1.42 1.32
2.03 1.78 1.78 2.03
Story 5
φMn/Mu = 2.07 2.77 2.77 2.07
φVn/Vmpr = 1.97 1.52 1.52 1.97
P/Agf'c = 0.16 0.25 0.25 0.16
0.9%
1.16 1.31 0.53 1.15
1.42 1.38 0.53 1.15
1.16 1.31 0.53 1.15
Floor 5
1.34 1.41 1.41 1.34
2.10 1.85 1.85 2.10
Story 4
φMn/Mu = 2.12 2.48 2.48 2.12
φVn/Vmpr = 1.9 1.63 1.63 1.9
P/Agf'c = 0.18 0.28 0.28 0.18
1.0%
1.17 1.20 0.53 1.15
1.40 1.39 0.53 1.15
1.17 1.20 0.53 1.15
Floor 4
1.36 1.37 1.37 1.36
2.10 1.85 1.85 2.10
Story 3
φMn/Mu = 2.19 2.62 2.62 2.19
φVn/Vmpr = 1.83 1.5 1.5 1.83
P/Agf'c = 0.20 0.31 0.31 0.20
1.0%
1.20 1.17 0.55 1.16
1.39 1.47 0.55 1.16
1.20 1.17 0.55 1.16
Floor 3
1.34 1.36 1.36 1.34
2.10 1.82 1.82 2.10
Story 2
φMn/Mu = 2.16 2.56 2.56 2.16
φVn/Vmpr = 1.83 1.61 1.61 1.83
P/Agf'c = 0.22 0.35 0.35 0.22
1.0%
1.16 1.16 0.67 1.16
1.33 1.82 0.67 1.16
1.16 1.16 0.67 1.16
Floor 2
1.37 1.33 1.33 1.37
2.22 1.78 1.78 2.22
Story 1
φMn/Mu = 1.91 2.52 2.52 1.91
φVn/Vmpr = 1.77 1.69 1.69 1.77
P/Agf'c = 0.24 0.38 0.38 0.24
1.0%
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	5693	7356	7356	5693
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.065	0.065	0.065	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	107	107	108
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	6087	8121	8121	6087
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.064	0.063	0.063	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	103	103	107
	$(P/A_g f'_c)_{exp}$ =	0.02	0.05	0.05	0.02
Story 10	$M_{y,exp}$ (k-in) =	6477	8872	8872	6477
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.062	0.060	0.060	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	100	100	105
	$(P/A_g f'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 9	$M_{y,exp}$ (k-in) =	6862	10025	10025	6862
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.061	0.058	0.058	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	97	97	103
	$(P/A_g f'_c)_{exp}$ =	0.05	0.09	0.09	0.05
Story 8	$M_{y,exp}$ (k-in) =	7242	10749	10749	7242
	EI_{stf}/EI_g =	0.35	0.36	0.36	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.060	0.056	0.056	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	95	95	102
	$(P/A_g f'_c)_{exp}$ =	0.06	0.11	0.11	0.06
Story 7	$M_{y,exp}$ (k-in) =	8872	12290	12290	8872
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.060	0.054	0.054	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	92	92	100
	$(P/A_g f'_c)_{exp}$ =	0.07	0.14	0.14	0.07
Story 6	$M_{y,exp}$ (k-in) =	9242	12993	12993	9242
	EI_{stf}/EI_g =	0.35	0.41	0.41	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.059	0.052	0.052	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	89	89	99
	$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 5	$M_{y,exp}$ (k-in) =	9193	13686	13686	9193
	EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.057	0.050	0.050	0.057
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	86	86	97
	$(P/A_g f'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 4	$M_{y,exp}$ (k-in) =	9558	12717	12717	9558
	EI_{stf}/EI_g =	0.35	0.45	0.45	0.35
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.056	0.046	0.046	0.056
	Θ_{pc} (rad) =	0.100	0.099	0.099	0.100
	λ =	96	84	84	96
	$(P/A_g f'_c)_{exp}$ =	0.10	0.21	0.21	0.10
Story 3	$M_{y,exp}$ (k-in) =	9919	13394	13394	9919
	EI_{stf}/EI_g =	0.36	0.47	0.47	0.36
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.055	0.044	0.044	0.055
	Θ_{pc} (rad) =	0.100	0.091	0.091	0.100
	λ =	95	81	81	95
	$(P/A_g f'_c)_{exp}$ =	0.11	0.23	0.23	0.11
Story 2	$M_{y,exp}$ (k-in) =	9864	13236	13236	9864
	EI_{stf}/EI_g =	0.37	0.50	0.50	0.37
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.053	0.042	0.042	0.053
	Θ_{pc} (rad) =	0.100	0.084	0.084	0.100
	λ =	93	79	79	93
	$(P/A_g f'_c)_{exp}$ =	0.13	0.25	0.25	0.13
Story 1	$M_{y,exp}$ (k-in) =	10220	13483	13483	10220
	EI_{stf}/EI_g =	0.38	0.52	0.52	0.38
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.052	0.040	0.040	0.052
	Θ_{pc} (rad) =	0.100	0.078	0.078	0.100
	λ =	92	77	77	92
	$(P/A_g f'_c)_{exp}$ =	0.14	0.28	0.28	0.14

		$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13		2112	-4379	0.35	1.574E+08	0.0327	-0.046	0.084	99
		2112	-4379	0.35	1.574E+08	0.0327	-0.046	0.084	99
		2112	-4379	0.35	3.724E+07	0.0327	-0.046	0.084	99
Floor 12		2388	-6097	0.35	1.574E+08	0.032	-0.049	0.084	99
		2388	-6097	0.35	1.574E+08	0.032	-0.049	0.084	99
		2388	-6097	0.35	1.574E+08	0.032	-0.049	0.084	99
Floor 11		2648	-6648	0.35	1.574E+08	0.032	-0.049	0.084	99
		2648	-6648	0.35	1.574E+08	0.032	-0.049	0.084	99
		2648	-6648	0.35	1.574E+08	0.032	-0.049	0.084	99
Floor 10		2993	-7148	0.35	1.574E+08	0.033	-0.049	0.084	99
		2993	-7148	0.35	1.574E+08	0.033	-0.049	0.084	99
		2993	-7148	0.35	1.574E+08	0.033	-0.049	0.084	99
Floor 9		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
Floor 8		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
		3252	-7647	0.35	1.574E+08	0.033	-0.049	0.084	99
Floor 7		3955	-9386	0.35	2.727E+08	0.037	-0.056	0.100	110
		3955	-9386	0.35	2.727E+08	0.0373	-0.056	0.100	110
		3955	-9386	0.35	2.727E+08	0.0373	-0.056	0.100	110
Floor 6		3955	-9386	0.35	2.727E+08	0.037	-0.056	0.100	110
		3955	-9386	0.35	2.727E+08	0.0373	-0.056	0.100	110
		3955	-9386	0.35	2.727E+08	0.0373	-0.056	0.100	110
Floor 5		3822	-9132	0.35	2.727E+08	0.035	-0.053	0.100	106
		3822	-9132	0.35	2.727E+08	0.0353	-0.053	0.100	106
		3822	-9132	0.35	2.727E+08	0.0353	-0.053	0.100	106
Floor 4		3822	-9132	0.35	2.727E+08	0.035	-0.053	0.100	106
		3822	-9132	0.35	2.727E+08	0.0353	-0.053	0.100	106
		3822	-9132	0.35	2.727E+08	0.0353	-0.053	0.100	106
Floor 3		4008	-9133	0.35	2.727E+08	0.036	-0.053	0.100	106
		4008	-9133	0.35	2.727E+08	0.0359	-0.053	0.100	106
		4008	-9133	0.35	2.727E+08	0.0359	-0.053	0.100	106
Floor 2		4606	-8753	0.35	2.727E+08	0.039	-0.053	0.100	110
		4606	-8753	0.35	2.727E+08	0.039	-0.053	0.100	110
		4606	-8753	0.35	2.727E+08	0.039	-0.053	0.100	110

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.59 T_2 = 0.54 T_3 = 0.31

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2017
Number of Stories: 12
Fundamental Period (sec): 2.20

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

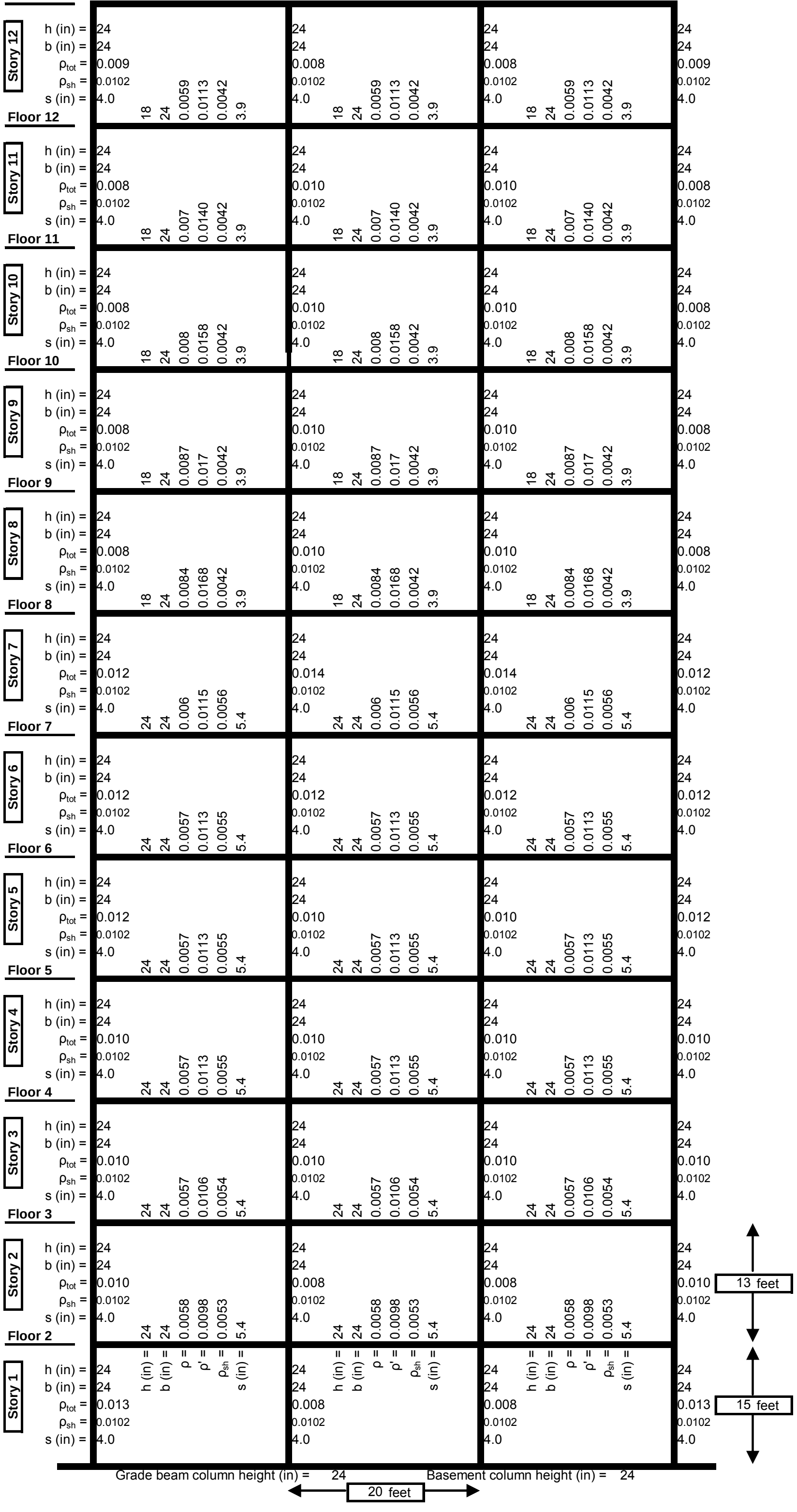
2017 Drift Limit = 0.03

Note: in order to reach high drift and have design not be overly concretive in strength for the benefit of the sensitivity analysis, the minimum steel reinforcement requirement in the concrete column is neglected, such that SCWB ratio is not too high and conservative. In attempting to increase the drift from the baseline design, beams were made smaller. The SCWB came out to be between 1.9 – 1.46 and max limit at 2.9%.

Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the positive and negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 6 by strength demand (note again min reinforcement is not applied). Beam stirrups were controlled by the capacity shear design and minimum requirement. All column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Beams (each bay, left to right):

Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	18	24	0.005	0.0080	0.0042	3.9	18	24	0.005	0.0080	0.0042	3.9	18	24	0.005	0.0080	0.0042	3.9
Floor 12	18	24	0.0059	0.0113	0.0042	3.9	18	24	0.0059	0.0113	0.0042	3.9	18	24	0.0059	0.0113	0.0042	3.9
Floor 11	18	24	0.007	0.0140	0.0042	3.9	18	24	0.007	0.0140	0.0042	3.9	18	24	0.007	0.0140	0.0042	3.9
Floor 10	18	24	0.008	0.0158	0.0042	3.9	18	24	0.008	0.0158	0.0042	3.9	18	24	0.008	0.0158	0.0042	3.9
Floor 9	18	24	0.0087	0.017	0.0042	3.9	18	24	0.0087	0.017	0.0042	3.9	18	24	0.0087	0.017	0.0042	3.9
Floor 8	18	24	0.0084	0.0168	0.0042	3.9	18	24	0.0084	0.0168	0.0042	3.9	18	24	0.0084	0.0168	0.0042	3.9
Floor 7	24	24	0.006	0.0115	0.0056	5.4	24	24	0.006	0.0115	0.0056	5.4	24	24	0.006	0.0115	0.0056	5.4
Floor 6	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4
Floor 5	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4
Floor 4	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4	24	24	0.0057	0.0113	0.0055	5.4
Floor 3	24	24	0.0057	0.0106	0.0054	5.4	24	24	0.0057	0.0106	0.0054	5.4	24	24	0.0057	0.0106	0.0054	5.4
Floor 2	24	24	0.0058	0.0098	0.0053	5.4	24	24	0.0058	0.0098	0.0053	5.4	24	24	0.0058	0.0098	0.0053	5.4

Columns (each column line, left to right):

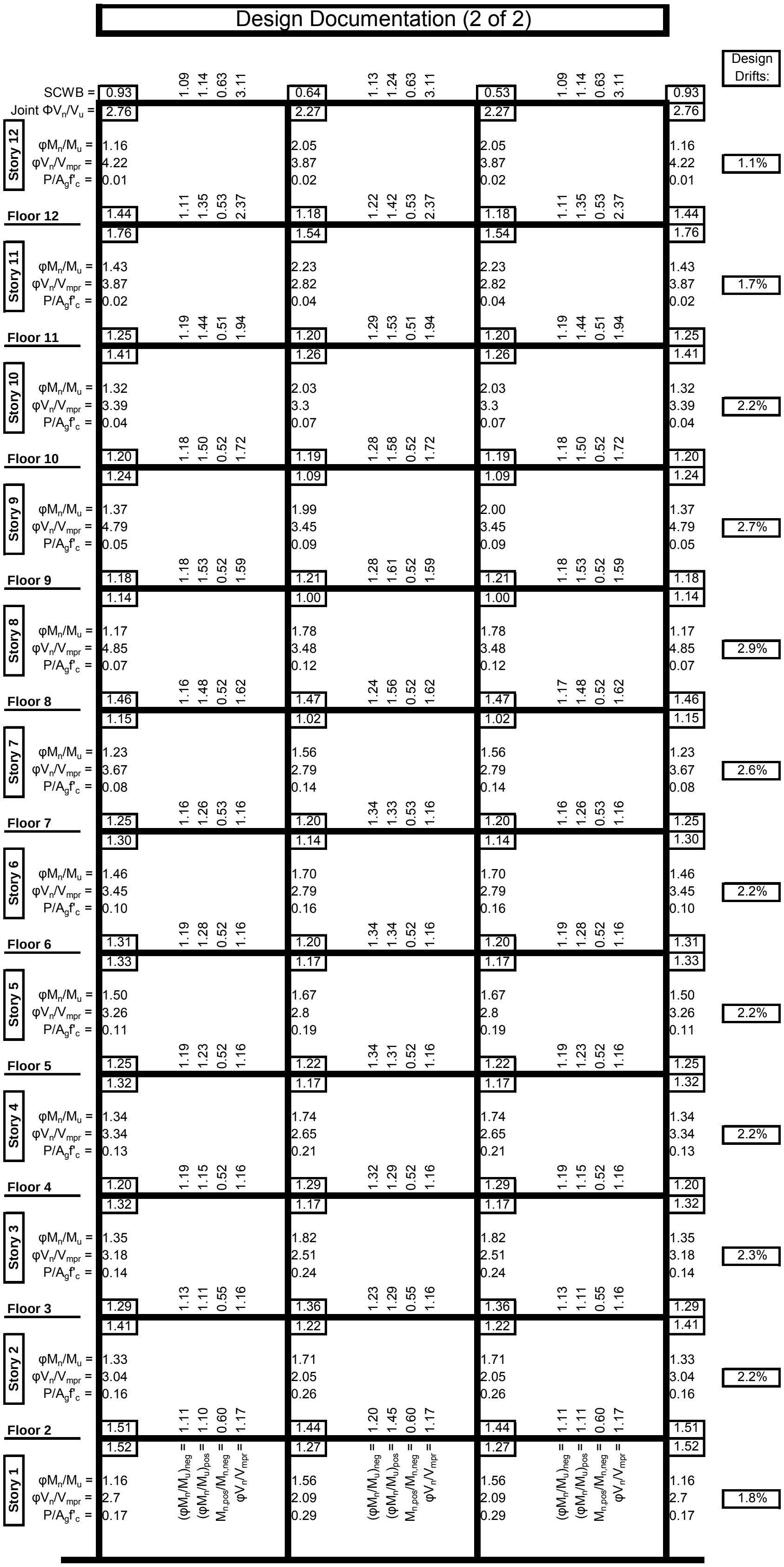
Story 12	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.009	0.008	0.008	0.009
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 11	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.008	0.010	0.010	0.008
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 10	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.008	0.010	0.010	0.008
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 9	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.008	0.010	0.010	0.008
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 8	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.008	0.010	0.010	0.008
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 7	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.014	0.014	0.012
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 6	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.012	0.012	0.012
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 5	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.010	0.010	0.012
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 4	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 3	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 2	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.008	0.008	0.010
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0
Story 1	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.008	0.008	0.013
	ρ_{sh} =	0.0102	0.0102	0.0102	0.0102
	s (in) =	4.0	4.0	4.0	4.0

Grade beam column height (in) = 24

Basement column height (in) = 24

Design base shear =	0.044	g,	232	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	8.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	8.0	ksi

Design Documentation (2 of 2)



	SCWB =	0.93	1.09 1.14 0.63 3.11	0.64	1.13 1.24 0.63 3.11	0.53	1.09 1.14 0.63 3.11	0.93	Design Drifts:
	Joint $\Phi V_n/V_u$ =	2.76		2.27		2.27		2.76	
Story 12	$\varphi M_n/M_u$ =	1.16		2.05		2.05		1.16	
	$\varphi V_n/V_{mpr}$ =	4.22		3.87		3.87		4.22	1.1%
	$P/A_gf'_c$ =	0.01		0.02		0.02		0.01	
Floor 12		1.44	1.11 1.35 0.53 2.37	1.18	1.22 1.42 0.53 2.37	1.18	1.11 1.35 0.53 2.37	1.44	
		1.76		1.54		1.54		1.76	
Story 11	$\varphi M_n/M_u$ =	1.43		2.23		2.23		1.43	
	$\varphi V_n/V_{mpr}$ =	3.87		2.82		2.82		3.87	1.7%
	$P/A_gf'_c$ =	0.02		0.04		0.04		0.02	
Floor 11		1.25	1.19 1.44 0.51 1.94	1.20	1.29 1.53 0.51 1.94	1.20	1.19 1.44 0.51 1.94	1.25	
		1.41		1.26		1.26		1.41	
Story 10	$\varphi M_n/M_u$ =	1.32		2.03		2.03		1.32	
	$\varphi V_n/V_{mpr}$ =	3.39		3.3		3.3		3.39	2.2%
	$P/A_gf'_c$ =	0.04		0.07		0.07		0.04	
Floor 10		1.20	1.18 1.50 0.52 1.72	1.19	1.28 1.58 0.52 1.72	1.19	1.18 1.50 0.52 1.72	1.20	
		1.24		1.09		1.09		1.24	
Story 9	$\varphi M_n/M_u$ =	1.37		1.99		2.00		1.37	
	$\varphi V_n/V_{mpr}$ =	4.79		3.45		3.45		4.79	2.7%
	$P/A_gf'_c$ =	0.05		0.09		0.09		0.05	
Floor 9		1.18	1.18 1.53 0.52 1.59	1.21	1.28 1.61 0.52 1.59	1.21	1.18 1.53 0.52 1.59	1.18	
		1.14		1.00		1.00		1.14	
Story 8	$\varphi M_n/M_u$ =	1.17		1.78		1.78		1.17	
	$\varphi V_n/V_{mpr}$ =	4.85		3.48		3.48		4.85	2.9%
	$P/A_gf'_c$ =	0.07		0.12		0.12		0.07	
Floor 8		1.46	1.16 1.48 0.52 1.62	1.47	1.24 1.56 0.52 1.62	1.47	1.17 1.48 0.52 1.62	1.46	
		1.15		1.02		1.02		1.15	
Story 7	$\varphi M_n/M_u$ =	1.23		1.56		1.56		1.23	
	$\varphi V_n/V_{mpr}$ =	3.67		2.79		2.79		3.67	2.6%
	$P/A_gf'_c$ =	0.08		0.14		0.14		0.08	
Floor 7		1.25	1.16 1.26 0.53 1.16	1.20	1.34 1.33 0.53 1.16	1.20	1.16 1.26 0.53 1.16	1.25	
		1.30		1.14		1.14		1.30	
Story 6	$\varphi M_n/M_u$ =	1.46		1.70		1.70		1.46	
	$\varphi V_n/V_{mpr}$ =	3.45		2.79		2.79		3.45	2.2%
	$P/A_gf'_c$ =	0.10		0.16		0.16		0.10	
Floor 6		1.31	1.19 1.28 0.52 1.16	1.20	1.34 1.34 0.52 1.16	1.20	1.19 1.28 0.52 1.16	1.31	
		1.33		1.17		1.17		1.33	
Story 5	$\varphi M_n/M_u$ =	1.50		1.67		1.67		1.50	
	$\varphi V_n/V_{mpr}$ =	3.26		2.8		2.8		3.26	2.2%
	$P/A_gf'_c$ =	0.11		0.19		0.19		0.11	
Floor 5		1.25	1.19 1.23 0.52 1.16	1.22	1.34 1.31 0.52 1.16	1.22	1.19 1.23 0.52 1.16	1.25	
		1.32		1.17		1.17		1.32	
Story 4	$\varphi M_n/M_u$ =	1.34		1.74		1.74		1.34	
	$\varphi V_n/V_{mpr}$ =	3.34		2.65		2.65		3.34	2.2%
	$P/A_gf'_c$ =	0.13		0.21		0.21		0.13	
Floor 4		1.20	1.19 1.15 0.52 1.16	1.29	1.32 1.29 0.52 1.16	1.29	1.19 1.15 0.52 1.16	1.20	
		1.32		1.17		1.17		1.32	
Story 3	$\varphi M_n/M_u$ =	1.35		1.82		1.82		1.35	
	$\varphi V_n/V_{mpr}$ =	3.18		2.51		2.51		3.18	2.3%
	$P/A_gf'_c$ =	0.14		0.24		0.24		0.14	
Floor 3		1.29	1.13 1.11 0.55 1.16	1.36	1.23 1.29 0.55 1.16	1.36	1.13 1.11 0.55 1.16	1.29	
		1.41		1.22		1.22		1.41	
Story 2	$\varphi M_n/M_u$ =	1.33		1.71		1.71		1.33	
	$\varphi V_n/V_{mpr}$ =	3.04		2.05		2.05		3.04	2.2%
	$P/A_gf'_c$ =	0.16		0.26		0.26		0.16	
Floor 2		1.51	1.11 1.10 0.60 1.17	1.44	1.20 1.45 0.60 1.17	1.44	1.11 1.11 0.60 1.17	1.51	
		1.52	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.27	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.27	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.52	
Story 1	$\varphi M_n/M_u$ =	1.16		1.56		1.56		1.16	
	$\varphi V_n/V_{mpr}$ =	2.7		2.09		2.09		2.7	1.8%
	$P/A_gf'_c$ =	0.17		0.29		0.29		0.17	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	3328	3539	3539	3328
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.071	0.069	0.069	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	109	109	110
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	3539	4930	4930	3539
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.069	0.068	0.068	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	106	106	109
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 10	$M_{y,exp}$ (k-in) =	3911	5643	5643	3911
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.068	0.066	0.066	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	104	104	108
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 9	$M_{y,exp}$ (k-in) =	4277	6339	6339	4277
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.067	0.064	0.064	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	102	102	106
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 8	$M_{y,exp}$ (k-in) =	4639	7022	7022	4639
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.066	0.062	0.062	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	100	100	105
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 7	$M_{y,exp}$ (k-in) =	6288	8965	8965	6288
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.067	0.062	0.062	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	104	97	97	104
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 6	$M_{y,exp}$ (k-in) =	6636	8986	8986	6636
	EI_{stf}/EI_g =	0.35	0.39	0.39	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.066	0.059	0.059	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	95	95	103
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 5	$M_{y,exp}$ (k-in) =	6981	9000	9000	6981
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.065	0.057	0.057	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	93	93	102
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 4	$M_{y,exp}$ (k-in) =	6682	9639	9639	6682
	EI_{stf}/EI_g =	0.35	0.42	0.42	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.063	0.055	0.055	0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	101	91	91	101
	$(P/A_gf'_c)_{exp}$ =	0.08	0.15	0.15	0.08
Story 3	$M_{y,exp}$ (k-in) =	7022	10270	10270	7022
	EI_{stf}/EI_g =	0.35	0.44	0.44	0.35
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.062	0.053	0.053	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	89	89	100
	$(P/A_gf'_c)_{exp}$ =	0.08	0.17	0.17	0.08
Story 2	$M_{y,exp}$ (k-in) =	7359	10260	10260	7359
	EI_{stf}/EI_g =	0.36	0.45	0.45	0.36
	M_c/M_y =	1.17	1.16	1.16	1.17
	$\Theta_{cap,pl}$ (rad) =	0.061	0.051	0.051	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	87	87	99
	$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 1	$M_{y,exp}$ (k-in) =	8488	10875	10875	8488
	EI_{stf}/EI_g =	0.37	0.47	0.47	0.37
	M_c/M_y =	1.17	1.16	1.16	1.17
	$\Theta_{cap,pl}$ (rad) =	0.062	0.049	0.049	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	85	85	97
	$(P/A_gf'_c)_{exp}$ =	0.10	0.20	0.20	0.10

Floor 13	$M_{y,pos,exp}$(k-in) =	1761	1761	1761
	$M_{y,n,slab,exp}$(k-in) =	-3747	-3747	-3747
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0514	0.0514	0.0514
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.082	-0.082	-0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 12	$M_{y,pos,exp}$(k-in) =	2064	2064	2064
	$M_{y,n,slab,exp}$(k-in) =	-4808	-4808	-4808
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.902E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.053	0.053	0.053
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.086	-0.086	-0.086
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 11	$M_{y,pos,exp}$(k-in) =	2437	2437	2437
	$M_{y,n,slab,exp}$(k-in) =	-5697	-5697	-5697
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.902E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.088	-0.088	-0.088
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 10	$M_{y,pos,exp}$(k-in) =	2770	2770	2770
	$M_{y,n,slab,exp}$(k-in) =	-6259	-6259	-6259
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.902E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.057	0.057	0.057
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.089	-0.089	-0.089
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 9	$M_{y,pos,exp}$(k-in) =	3001	3001	3001
	$M_{y,n,slab,exp}$(k-in) =	-6659	-6659	-6659
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.902E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.058	0.058
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.090	-0.090	-0.090
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 8	$M_{y,pos,exp}$(k-in) =	2918	2918	2918
	$M_{y,n,slab,exp}$(k-in) =	-6579	-6579	-6579
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	3.902E+07	3.902E+07	3.902E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.057	0.057	0.057
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.090	-0.090	-0.090
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	101	101	101
Floor 7	$M_{y,pos,exp}$(k-in) =	4074	4074	4074
	$M_{y,n,slab,exp}$(k-in) =	-9020	-9020	-9020
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.053	0.053	0.053
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 6	$M_{y,pos,exp}$(k-in) =	3908	3908	3908
	$M_{y,n,slab,exp}$(k-in) =	-8861	-8861	-8861
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.052	0.0521	0.0521
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.082	-0.082	-0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 5	$M_{y,pos,exp}$(k-in) =	3894	3894	3894
	$M_{y,n,slab,exp}$(k-in) =	-8914	-8914	-8914
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.052	0.0521	0.0521
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$(k-in) =	3894	3894	3894
	$M_{y,n,slab,exp}$(k-in) =	-8914	-8914	-8914
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.052	0.0521	0.0521
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$(k-in) =	3909	3909	3909
	$M_{y,n,slab,exp}$(k-in) =	-8440	-8440	-8440
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.052	0.052	0.052
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.081	-0.081	-0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 2	$M_{y,pos,exp}$(k-in) =	3971	3971	3971
	$M_{y,n,slab,exp}$(k-in) =	-7965	-7965	-7965
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	9.678E+07	9.678E+07	9.678E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.052	0.052	0.052
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.078	-0.078	-0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.20 T_2= 0.74 T_3 = 0.43

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2018
Number of Stories: 12
Fundamental Period (sec): 2.64

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

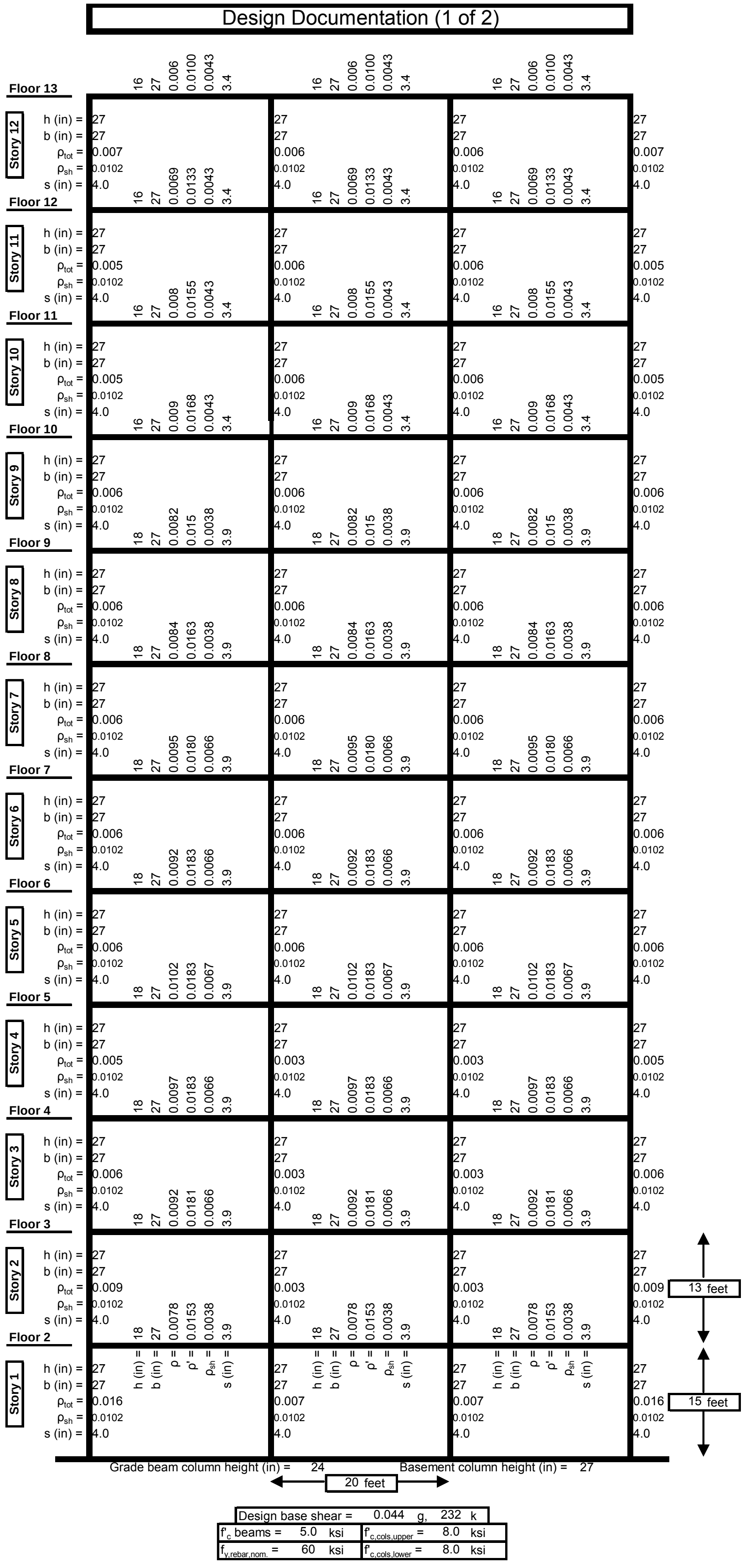
2018 Drift unlimited

Note: in order to reach high drift and have design not be overly concretive in strength for the benefit of the sensitivity analysis, the minimum steel reinforcement requirement in the concrete column is neglected. In this design drift does not control. Beam sizes were reduced until beams were controlled by flexural (beams exceeds the maximum allowable steel reinforcement). Eventually with the min beam size that would still be strong enough for bending and column strength large enough for joint shear, the max inter-story drift came out to be 3.62%.

Both positive and negative bending strength were controlled by max reinforced ratio. Few additional beam reinforcements in 10 bays were added to alter beam design to use same rho and rhoPrime in each floor. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 6 by strength demand. Less than ½ of the Beam stirrups were controlled by the capacity shear design and most others by minimum reinforcement requirement. All column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	27	27	0.007	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.007	0.0102	4.0
Story 11	27	27	0.005	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.005	0.0102	4.0
Story 10	27	27	0.005	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.005	0.0102	4.0
Story 9	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 8	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 7	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 6	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 5	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 4	27	27	0.005	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.005	0.0102	4.0
Story 3	27	27	0.006	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.006	0.0102	4.0
Story 2	27	27	0.009	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.003	0.0102	4.0
	27	27	0.009	0.0102	4.0
Story 1	27	27	0.016	0.0102	4.0
	27	27	0.007	0.0102	4.0
	27	27	0.007	0.0102	4.0
	27	27	0.016	0.0102	4.0

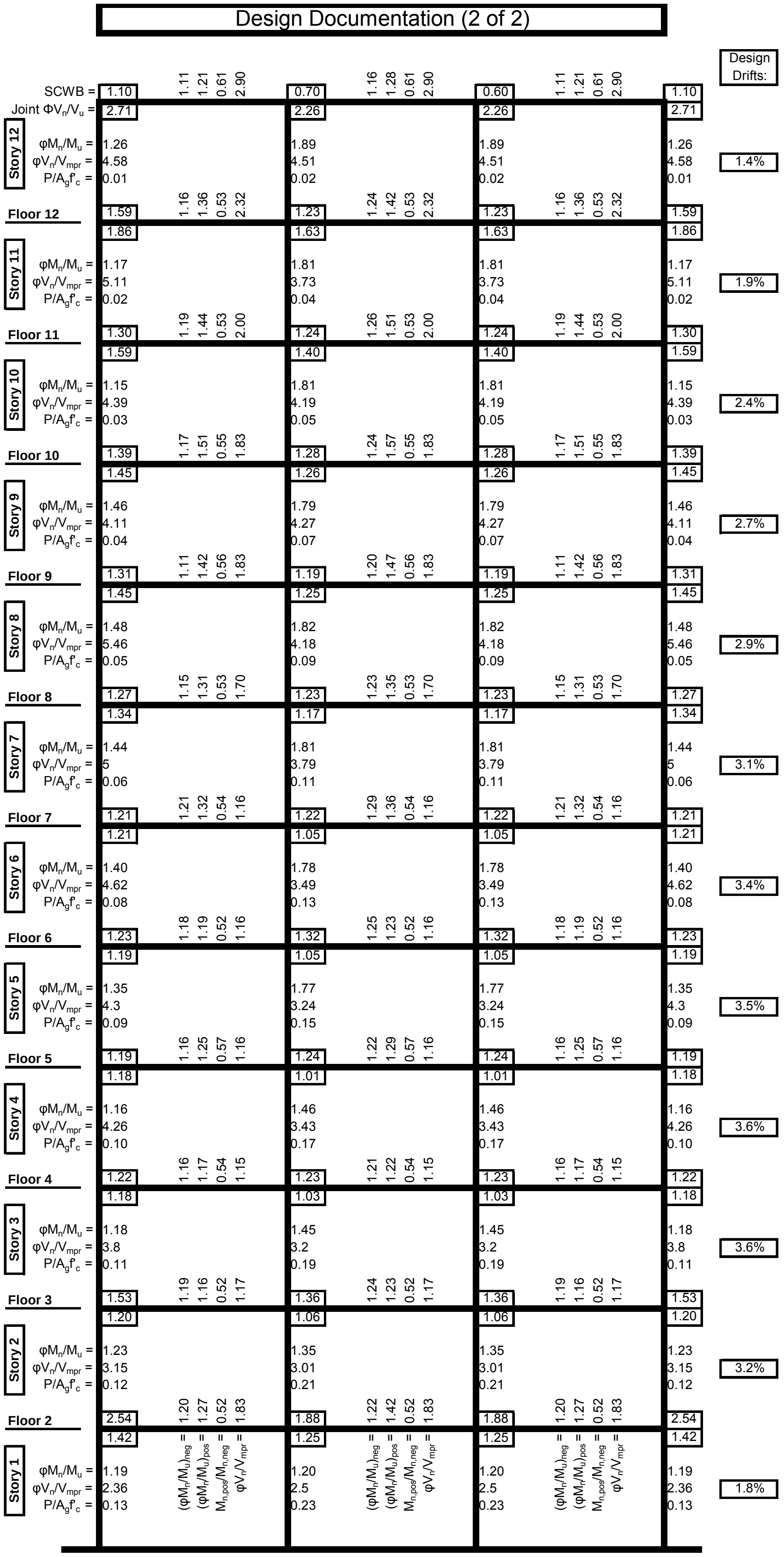
	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	16	27	0.006	0.0100	0.0043	3.4
	16	27	0.006	0.0100	0.0043	3.4
	16	27	0.006	0.0100	0.0043	3.4
Floor 12	16	27	0.0069	0.0133	0.0043	3.4
	16	27	0.0069	0.0133	0.0043	3.4
	16	27	0.0069	0.0133	0.0043	3.4
Floor 11	16	27	0.008	0.0155	0.0043	3.4
	16	27	0.008	0.0155	0.0043	3.4
	16	27	0.008	0.0155	0.0043	3.4
Floor 10	16	27	0.009	0.0168	0.0043	3.4
	16	27	0.009	0.0168	0.0043	3.4
	16	27	0.009	0.0168	0.0043	3.4
Floor 9	18	27	0.0082	0.015	0.0038	3.9
	18	27	0.0082	0.015	0.0038	3.9
	18	27	0.0082	0.015	0.0038	3.9
Floor 8	18	27	0.0084	0.0163	0.0038	3.9
	18	27	0.0084	0.0163	0.0038	3.9
	18	27	0.0084	0.0163	0.0038	3.9
Floor 7	18	27	0.0095	0.0180	0.0066	3.9
	18	27	0.0095	0.0180	0.0066	3.9
	18	27	0.0095	0.0180	0.0066	3.9
Floor 6	18	27	0.0092	0.0183	0.0066	3.9
	18	27	0.0092	0.0183	0.0066	3.9
	18	27	0.0092	0.0183	0.0066	3.9
Floor 5	18	27	0.0102	0.0183	0.0067	3.9
	18	27	0.0102	0.0183	0.0067	3.9
	18	27	0.0102	0.0183	0.0067	3.9
Floor 4	18	27	0.0097	0.0183	0.0066	3.9
	18	27	0.0097	0.0183	0.0066	3.9
	18	27	0.0097	0.0183	0.0066	3.9
Floor 3	18	27	0.0092	0.0181	0.0066	3.9
	18	27	0.0092	0.0181	0.0066	3.9
	18	27	0.0092	0.0181	0.0066	3.9
Floor 2	18	27	0.0078	0.0153	0.0038	3.9
	18	27	0.0078	0.0153	0.0038	3.9
	18	27	0.0078	0.0153	0.0038	3.9

Grade beam column height (in) = 24

Basement column height (in) = 27

Design base shear = 0.044 g, 232 k

f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	8.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	8.0 ksi


Design Documentation (2 of 2)
Design Drifts:
1.11 1.21 0.61 2.90 | 1.16 1.28 0.61 2.90 | 1.11 1.21 0.61 2.90
SCWB = 1.10 | 0.70 | 0.60 | 1.10
Joint ΦVn/Vu = 2.71 | 2.26 | 2.26 | 2.71
Story 12
φMn/Mu = 1.26 | 1.89 | 1.89 | 1.26
φVn/Vmpr = 4.58 | 4.51 | 4.51 | 4.58
P/Agf'c = 0.01 | 0.02 | 0.02 | 0.01
1.4%
1.16 1.36 0.53 2.32 | 1.24 1.42 0.53 2.32 | 1.16 1.36 0.53 2.32
Floor 12
1.59 | 1.23 | 1.23 | 1.59
1.86 | 1.63 | 1.63 | 1.86
Story 11
φMn/Mu = 1.17 | 1.81 | 1.81 | 1.17
φVn/Vmpr = 5.11 | 3.73 | 3.73 | 5.11
P/Agf'c = 0.02 | 0.04 | 0.04 | 0.02
1.9%
1.19 1.44 0.53 2.00 | 1.26 1.51 0.53 2.00 | 1.19 1.44 0.53 2.00
Floor 11
1.30 | 1.24 | 1.24 | 1.30
1.59 | 1.40 | 1.40 | 1.59
Story 10
φMn/Mu = 1.15 | 1.81 | 1.81 | 1.15
φVn/Vmpr = 4.39 | 4.19 | 4.19 | 4.39
P/Agf'c = 0.03 | 0.05 | 0.05 | 0.03
2.4%
1.17 1.51 0.55 1.83 | 1.24 1.57 0.55 1.83 | 1.17 1.51 0.55 1.83
Floor 10
1.39 | 1.28 | 1.28 | 1.39
1.45 | 1.26 | 1.26 | 1.45
Story 9
φMn/Mu = 1.46 | 1.79 | 1.79 | 1.46
φVn/Vmpr = 4.11 | 4.27 | 4.27 | 4.11
P/Agf'c = 0.04 | 0.07 | 0.07 | 0.04
2.7%
1.11 1.42 0.56 1.83 | 1.20 1.47 0.56 1.83 | 1.11 1.42 0.56 1.83
Floor 9
1.31 | 1.19 | 1.19 | 1.31
1.45 | 1.25 | 1.25 | 1.45
Story 8
φMn/Mu = 1.48 | 1.82 | 1.82 | 1.48
φVn/Vmpr = 5.46 | 4.18 | 4.18 | 5.46
P/Agf'c = 0.05 | 0.09 | 0.09 | 0.05
2.9%
1.15 1.31 0.53 1.70 | 1.23 1.35 0.53 1.70 | 1.15 1.31 0.53 1.70
Floor 8
1.27 | 1.23 | 1.23 | 1.27
1.34 | 1.17 | 1.17 | 1.34
Story 7
φMn/Mu = 1.44 | 1.81 | 1.81 | 1.44
φVn/Vmpr = 5 | 3.79 | 3.79 | 5
P/Agf'c = 0.06 | 0.11 | 0.11 | 0.06
3.1%
1.21 1.32 0.54 1.16 | 1.29 1.36 0.54 1.16 | 1.21 1.32 0.54 1.16
Floor 7
1.21 | 1.22 | 1.22 | 1.21
1.21 | 1.05 | 1.05 | 1.21
Story 6
φMn/Mu = 1.40 | 1.78 | 1.78 | 1.40
φVn/Vmpr = 4.62 | 3.49 | 3.49 | 4.62
P/Agf'c = 0.08 | 0.13 | 0.13 | 0.08
3.4%
1.18 1.19 0.52 1.16 | 1.25 1.23 0.52 1.16 | 1.18 1.19 0.52 1.16
Floor 6
1.23 | 1.32 | 1.32 | 1.23
1.19 | 1.05 | 1.05 | 1.19
Story 5
φMn/Mu = 1.35 | 1.77 | 1.77 | 1.35
φVn/Vmpr = 4.3 | 3.24 | 3.24 | 4.3
P/Agf'c = 0.09 | 0.15 | 0.15 | 0.09
3.5%
1.16 1.25 0.57 1.16 | 1.22 1.29 0.57 1.16 | 1.16 1.25 0.57 1.16
Floor 5
1.19 | 1.24 | 1.24 | 1.19
1.18 | 1.01 | 1.01 | 1.18
Story 4
φMn/Mu = 1.16 | 1.46 | 1.46 | 1.16
φVn/Vmpr = 4.26 | 3.43 | 3.43 | 4.26
P/Agf'c = 0.10 | 0.17 | 0.17 | 0.10
3.6%
1.16 1.17 0.54 1.15 | 1.21 1.22 0.54 1.15 | 1.16 1.17 0.54 1.15
Floor 4
1.22 | 1.23 | 1.23 | 1.22
1.18 | 1.03 | 1.03 | 1.18
Story 3
φMn/Mu = 1.18 | 1.45 | 1.45 | 1.18
φVn/Vmpr = 3.8 | 3.2 | 3.2 | 3.8
P/Agf'c = 0.11 | 0.19 | 0.19 | 0.11
3.6%
1.19 1.16 0.52 1.17 | 1.24 1.23 0.52 1.17 | 1.19 1.16 0.52 1.17
Floor 3
1.53 | 1.36 | 1.36 | 1.53
1.20 | 1.06 | 1.06 | 1.20
Story 2
φMn/Mu = 1.23 | 1.35 | 1.35 | 1.23
φVn/Vmpr = 3.15 | 3.01 | 3.01 | 3.15
P/Agf'c = 0.12 | 0.21 | 0.21 | 0.12
3.2%
1.20 1.27 0.52 1.83 | 1.22 1.42 0.52 1.83 | 1.20 1.27 0.52 1.83
Floor 2
2.54 | 1.88 | 1.88 | 2.54
1.42 | 1.25 | 1.25 | 1.42
(φMn/Mu)neg = | (φMn/Mu)pos = | Mn,pos/Mn,neg = | φVn/Vmpr =
Story 1
φMn/Mu = 1.19 | 1.20 | 1.20 | 1.19
φVn/Vmpr = 2.36 | 2.5 | 2.5 | 2.36
P/Agf'c = 0.13 | 0.23 | 0.23 | 0.13
1.8%

Modeling Documentation (1 of 1)

Floor 13

$M_{y,pos,exp}$(k-in) =	1789	1789	1789
$M_{y,n,slab,exp}$(k-in) =	-3746	-3746	-3746
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	2.745E+07	2.745E+07	3.724E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0559	0.0559	0.0559
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.088	-0.088	-0.088
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	102	102	102

Story 12

$M_{y,exp}$ (k-in) =	4004	3946	3946	4004
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.070	0.069	0.069	0.070
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	116	115	115	116
$(P/A_gf'_c)_{exp}$ =	0.01	0.01	0.01	0.01

Floor 12

$M_{y,pos,exp}$(k-in) =	2043	2043	2043
$M_{y,n,slab,exp}$(k-in) =	-4640	-4640	-4640
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	2.745E+07	2.745E+07	2.745E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.057	0.057	0.057
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.091	-0.091	-0.091
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	102	102	102

Story 11

$M_{y,exp}$ (k-in) =	3455	4796	4796	3455
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.18	1.18	1.18
$\Theta_{cap,pl}$ (rad) =	0.068	0.067	0.067	0.068
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	115	113	113	115
$(P/A_gf'_c)_{exp}$ =	0.01	0.03	0.03	0.01

Floor 11

$M_{y,pos,exp}$(k-in) =	2357	2357	2357
$M_{y,n,slab,exp}$(k-in) =	-5253	-5253	-5253
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	2.745E+07	2.745E+07	2.745E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.059	0.059	0.059
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.093	-0.093	-0.093
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	102	102	102

Story 10

$M_{y,exp}$ (k-in) =	3886	5624	5624	3886
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.18	1.18	1.18
$\Theta_{cap,pl}$ (rad) =	0.067	0.065	0.065	0.067
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	114	111	111	114
$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02

Floor 10

$M_{y,pos,exp}$(k-in) =	2637	2637	2637
$M_{y,n,slab,exp}$(k-in) =	-5591	-5591	-5591
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	2.745E+07	2.745E+07	2.745E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.061	0.061	0.061
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.094	-0.094	-0.094
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	102	102	102

Story 9

$M_{y,exp}$ (k-in) =	4796	6434	6434	4796
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.18	1.18	1.18
$\Theta_{cap,pl}$ (rad) =	0.067	0.064	0.064	0.067
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	113	109	109	113
$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03

Floor 9

$M_{y,pos,exp}$(k-in) =	3191	3191	3191
$M_{y,n,slab,exp}$(k-in) =	-6655	-6655	-6655
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.083	-0.083	-0.083
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 8

$M_{y,exp}$ (k-in) =	5213	7227	7227	5213
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.18	1.18	1.18
$\Theta_{cap,pl}$ (rad) =	0.066	0.062	0.062	0.066
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	112	107	107	112
$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03

Floor 8

$M_{y,pos,exp}$(k-in) =	3284	3284	3284
$M_{y,n,slab,exp}$(k-in) =	-7106	-7106	-7106
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.084	-0.084	-0.084
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 7

$M_{y,exp}$ (k-in) =	5624	8005	8005	5624
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.18	1.18	1.18
$\Theta_{cap,pl}$ (rad) =	0.065	0.061	0.061	0.065
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	111	106	106	111
$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04

Floor 7

$M_{y,pos,exp}$(k-in) =	3673	3673	3673
$M_{y,n,slab,exp}$(k-in) =	-7736	-7736	-7736
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.071	0.0706	0.0706
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.106	-0.106	-0.106
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 6

$M_{y,exp}$ (k-in) =	6031	8770	8770	6031
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.065	0.059	0.059	0.065
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	110	104	104	110
$(P/A_gf'_c)_{exp}$ =	0.05	0.09	0.09	0.05

Floor 6

$M_{y,pos,exp}$(k-in) =	3579	3579	3579
$M_{y,n,slab,exp}$(k-in) =	-7825	-7825	-7825
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.070	0.07	0.07
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.107	-0.107	-0.107
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 5

$M_{y,exp}$ (k-in) =	6434	9523	9523	6434
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.064	0.058	0.058	0.064
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	109	102	102	109
$(P/A_gf'_c)_{exp}$ =	0.05	0.11	0.11	0.05

Floor 5

$M_{y,pos,exp}$(k-in) =	3945	3945	3945
$M_{y,n,slab,exp}$(k-in) =	-7858	-7858	-7858
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.073	0.0727	0.0727
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.106	-0.106	-0.106
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 4

$M_{y,exp}$ (k-in) =	6357	8862	8862	6357
EI_{stf}/EI_g =	0.35	0.36	0.36	0.35
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.063	0.055	0.055	0.063
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	108	100	100	108
$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06

Floor 4

$M_{y,pos,exp}$(k-in) =	3759	3759	3759
$M_{y,n,slab,exp}$(k-in) =	-7857	-7857	-7857
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.071	0.0711	0.0711
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.106	-0.106	-0.106
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 3

$M_{y,exp}$ (k-in) =	7227	9596	9596	7227
EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.062	0.054	0.054	0.062
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	107	99	99	107
$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07

Floor 3

$M_{y,pos,exp}$(k-in) =	3579	3579	3579
$M_{y,n,slab,exp}$(k-in) =	-7766	-7766	-7766
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.070	0.0701	0.0701
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.107	-0.107	-0.107
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 2

$M_{y,exp}$ (k-in) =	9034	10320	10320	9034
EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
M_c/M_y =	1.18	1.17	1.17	1.18
$\Theta_{cap,pl}$ (rad) =	0.063	0.052	0.052	0.063
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	107	97	97	107
$(P/A_gf'_c)_{exp}$ =	0.07	0.15	0.15	0.07

Floor 2

$M_{y,pos,exp}$(k-in) =	3055	3055	3055
$M_{y,n,slab,exp}$(k-in) =	-6776	-6776	-6776
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.108E+07	4.108E+07	4.108E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.054	0.054	0.054
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.084	-0.084	-0.084
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 1

$M_{y,exp}$ (k-in) =	12713	12899	12899	12713
EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
M_c/M_y =	1.18	1.16	1.16	1.18
$\Theta_{cap,pl}$ (rad) =	0.066	0.053	0.053	0.066
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	106	95	95	106
$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.64 T_2= 0.86 T_3 = 0.49

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

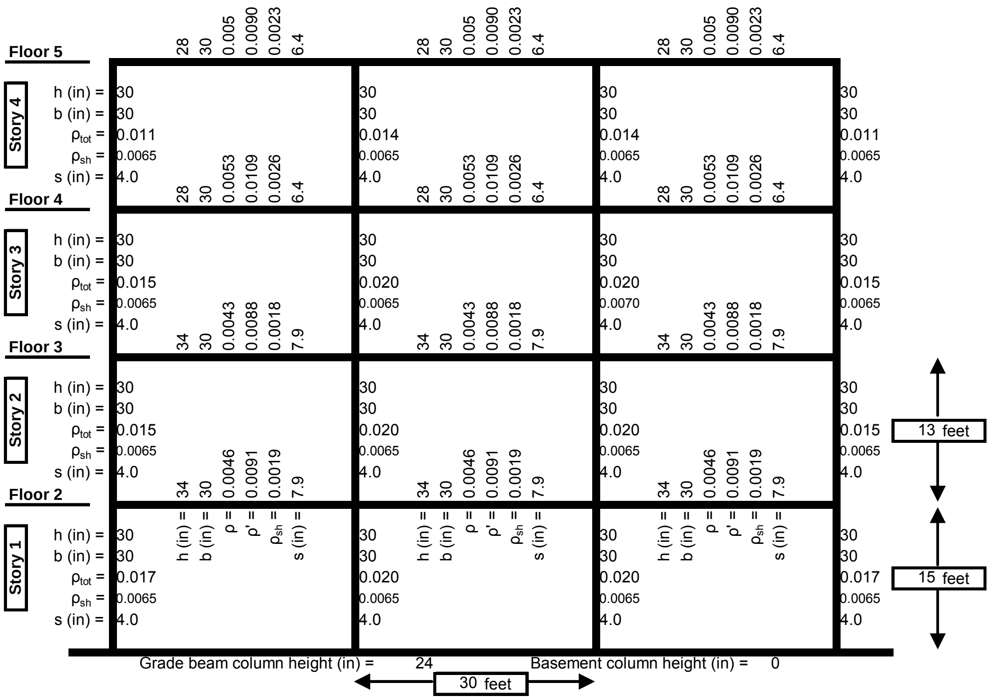
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2020
Number of Stories: 4
Fundamental Period (sec): 0.77

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2020 R=5.33
Compared to the baseline design, beam sizes were increased to meet the stronger lateral load, due to a lower R value. As in baseline design, joint shear controlled the beam depth more than drift. Both negative and positive flexural beam strength were controlled by strength demands. Few additional beam reinforcements in four bays were added to alter beam design to use same rho and rhoPrime for each level. Three bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 2 by strength demand. All beam stirrups were controlled by the capacity shear design. Most column stirrups were controlled by the capacity shear design while one column was controlled by minimum confinement requirements.

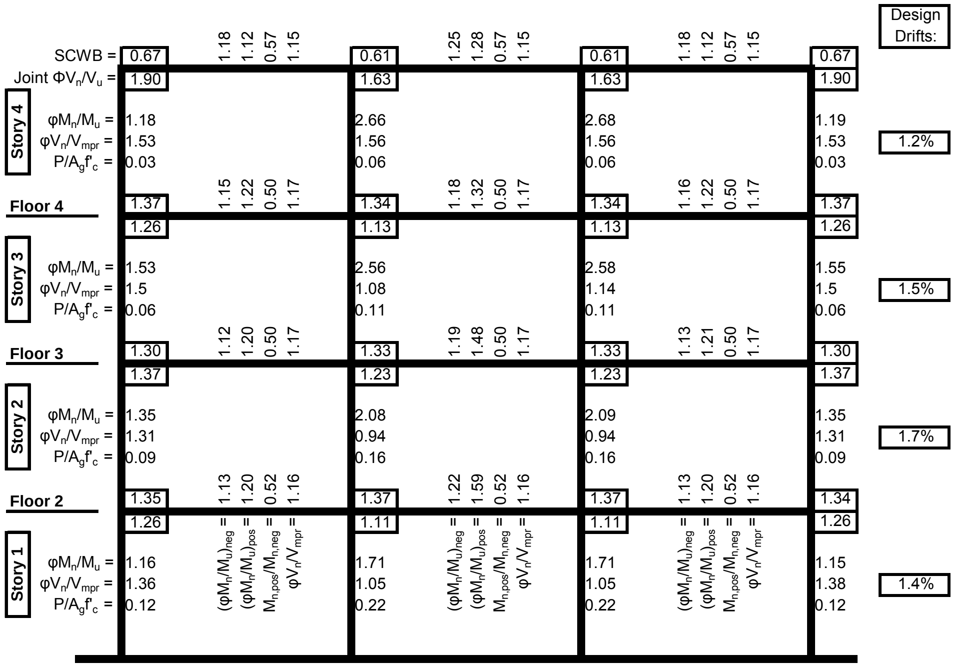
DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)

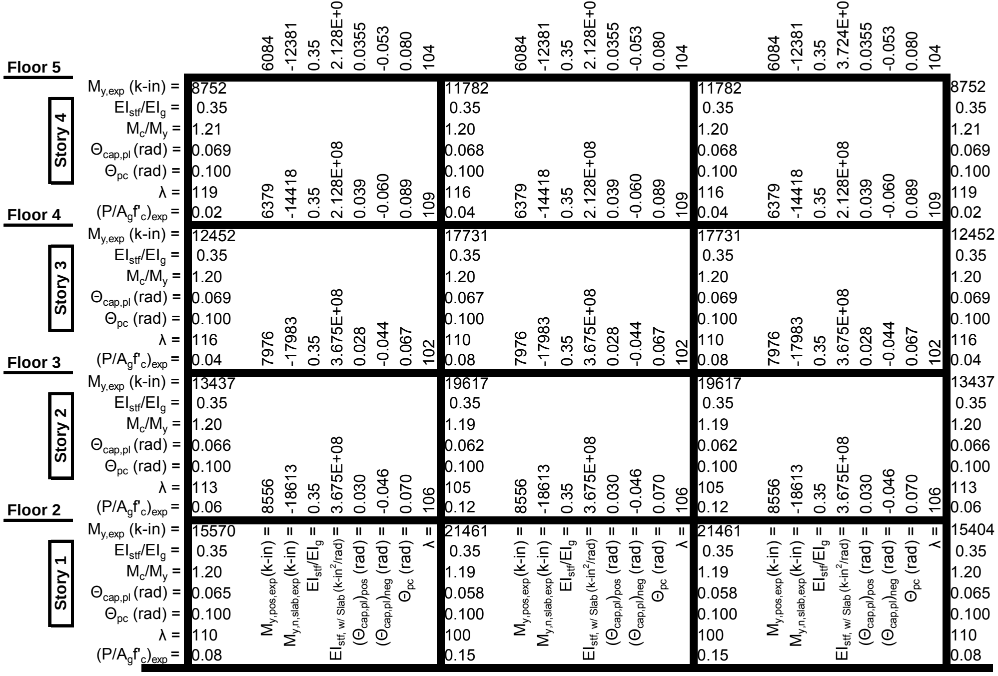


Design base shear =	0.139 g,	290 k			
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.77 T_2= 0.25 T_3 = 0.14

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2021
Number of Stories: 12
Fundamental Period (sec): 1.97

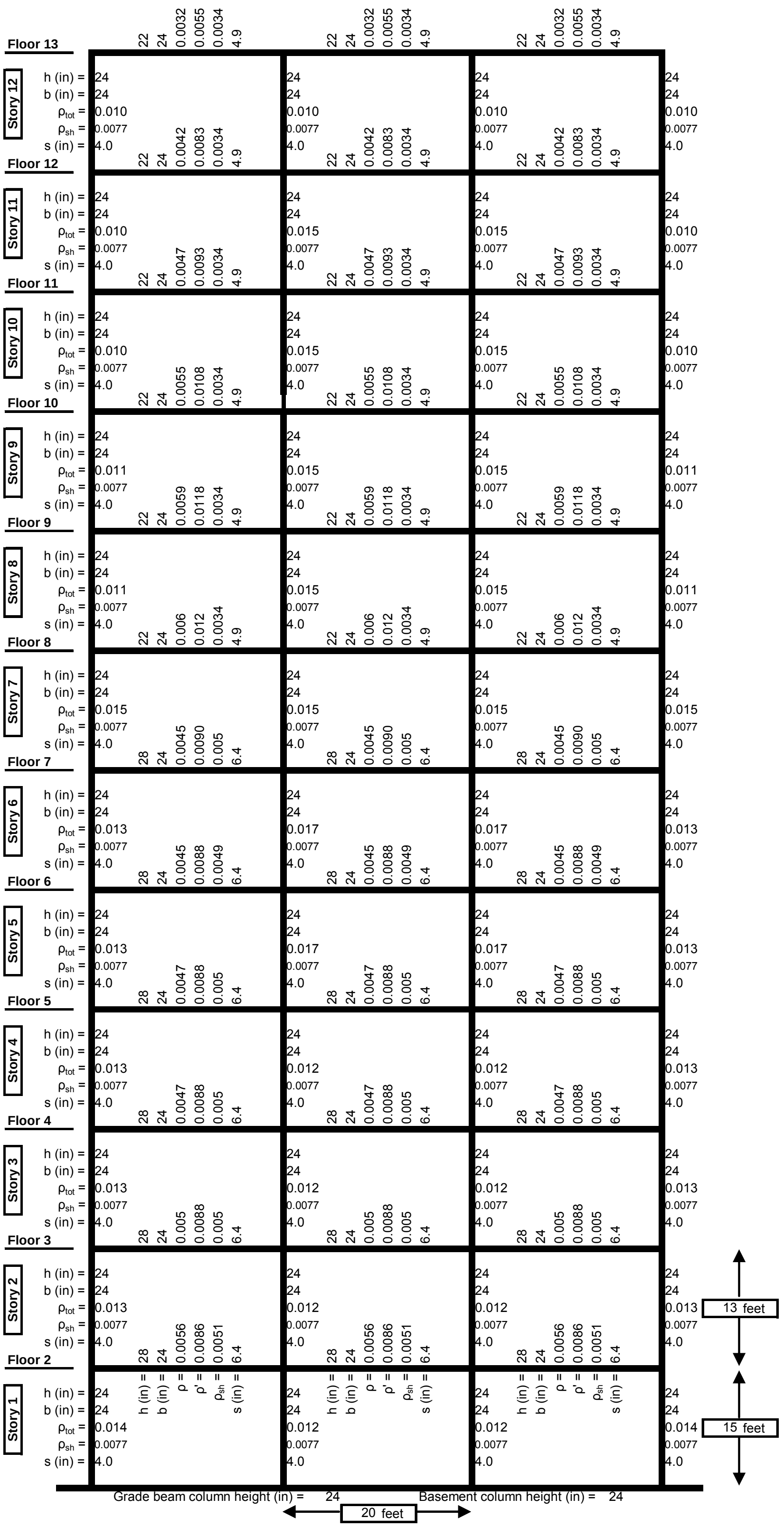
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2021 R=5.33

First from the baseline design, a larger lateral force was applied. After the preliminary analysis only joint shear was insufficient. After few iterations between sizes and column concrete strength, it was found that by using same geometry with a higher concrete strength was perfect for this design. Both positive and negative bending strengths were controlled by strength demand. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 2 by strength demand. Beam stirrups were controlled by both the capacity shear design and min reinforcement requirement. Column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Floor	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)	h (in)	b (in)	ρ	ρ'	ρ_{sh}	s (in)
Floor 13	22	24	0.0032	0.0055	0.0034	4.9	22	24	0.0032	0.0055	0.0034	4.9	22	24	0.0032	0.0055	0.0034	4.9
Floor 12	22	24	0.0042	0.0083	0.0034	4.9	22	24	0.0042	0.0083	0.0034	4.9	22	24	0.0042	0.0083	0.0034	4.9
Floor 11	22	24	0.0047	0.0093	0.0034	4.9	22	24	0.0047	0.0093	0.0034	4.9	22	24	0.0047	0.0093	0.0034	4.9
Floor 10	22	24	0.0055	0.0108	0.0034	4.9	22	24	0.0055	0.0108	0.0034	4.9	22	24	0.0055	0.0108	0.0034	4.9
Floor 9	22	24	0.0059	0.0118	0.0034	4.9	22	24	0.0059	0.0118	0.0034	4.9	22	24	0.0059	0.0118	0.0034	4.9
Floor 8	22	24	0.006	0.012	0.0034	4.9	22	24	0.006	0.012	0.0034	4.9	22	24	0.006	0.012	0.0034	4.9
Floor 7	28	24	0.0045	0.0090	0.005	6.4	28	24	0.0045	0.0090	0.005	6.4	28	24	0.0045	0.0090	0.005	6.4
Floor 6	28	24	0.0045	0.0088	0.0049	6.4	28	24	0.0045	0.0088	0.0049	6.4	28	24	0.0045	0.0088	0.0049	6.4
Floor 5	28	24	0.0047	0.0088	0.005	6.4	28	24	0.0047	0.0088	0.005	6.4	28	24	0.0047	0.0088	0.005	6.4
Floor 4	28	24	0.0047	0.0088	0.005	6.4	28	24	0.0047	0.0088	0.005	6.4	28	24	0.0047	0.0088	0.005	6.4
Floor 3	28	24	0.005	0.0088	0.005	6.4	28	24	0.005	0.0088	0.005	6.4	28	24	0.005	0.0088	0.005	6.4
Floor 2	28	24	0.0056	0.0086	0.0051	6.4	28	24	0.0056	0.0086	0.0051	6.4	28	24	0.0056	0.0086	0.0051	6.4

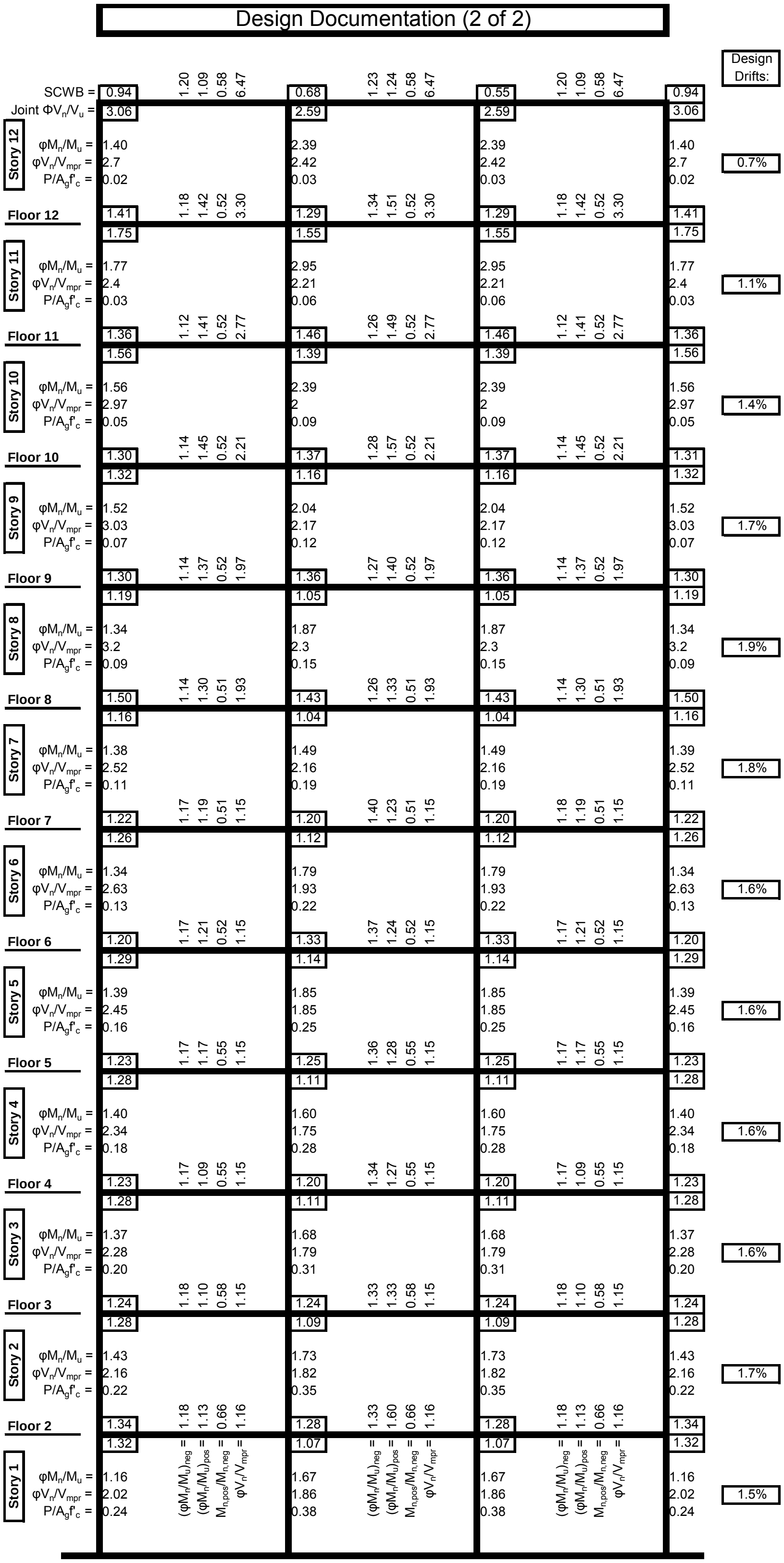
Story					
Story 12	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 11	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.015	0.015	0.010
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 10	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.015	0.015	0.010
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 9	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.011	0.015	0.015	0.011
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 8	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.011	0.015	0.015	0.011
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 7	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.015	0.015	0.015	0.015
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 6	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.017	0.017	0.013
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 5	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.017	0.017	0.013
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 4	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.012	0.012	0.013
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 3	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.012	0.012	0.013
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 2	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.013	0.012	0.012	0.013
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0
Story 1	h (in) =	24	24	24	24
	b (in) =	24	24	24	24
	ρ_{tot} =	0.014	0.012	0.012	0.014
	ρ_{sh} =	0.0077	0.0077	0.0077	0.0077
	s (in) =	4.0	4.0	4.0	4.0

Grade beam column height (in) = 24

Basement column height (in) = 24

Design base shear = 0.053 g, 232 k

f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	6.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	6.0 ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.94 | 0.68 | 0.55 | 0.94
1.20 1.09 0.58 6.47 | 1.23 1.24 0.58 6.47 | 1.20 1.09 0.58 6.47
Joint ΦVn/Vu = 3.06 | 2.59 | 2.59 | 3.06
Story 12
φMn/Mu = 1.40 | 2.39 | 2.39 | 1.40
φVn/Vmpr = 2.7 | 2.42 | 2.42 | 2.7
P/Agf'c = 0.02 | 0.03 | 0.03 | 0.02
0.7%
Floor 12
1.18 1.42 0.52 3.30 | 1.34 1.51 0.52 3.30 | 1.18 1.42 0.52 3.30
1.41 | 1.29 | 1.29 | 1.41
1.75 | 1.55 | 1.55 | 1.75
Story 11
φMn/Mu = 1.77 | 2.95 | 2.95 | 1.77
φVn/Vmpr = 2.4 | 2.21 | 2.21 | 2.4
P/Agf'c = 0.03 | 0.06 | 0.06 | 0.03
1.1%
Floor 11
1.12 1.41 0.52 2.77 | 1.26 1.49 0.52 2.77 | 1.12 1.41 0.52 2.77
1.36 | 1.46 | 1.46 | 1.36
1.56 | 1.39 | 1.39 | 1.56
Story 10
φMn/Mu = 1.56 | 2.39 | 2.39 | 1.56
φVn/Vmpr = 2.97 | 2 | 2 | 2.97
P/Agf'c = 0.05 | 0.09 | 0.09 | 0.05
1.4%
Floor 10
1.14 1.45 0.52 2.21 | 1.28 1.57 0.52 2.21 | 1.14 1.45 0.52 2.21
1.30 | 1.37 | 1.37 | 1.31
1.32 | 1.16 | 1.16 | 1.32
Story 9
φMn/Mu = 1.52 | 2.04 | 2.04 | 1.52
φVn/Vmpr = 3.03 | 2.17 | 2.17 | 3.03
P/Agf'c = 0.07 | 0.12 | 0.12 | 0.07
1.7%
Floor 9
1.14 1.37 0.52 1.97 | 1.27 1.40 0.52 1.97 | 1.14 1.37 0.52 1.97
1.30 | 1.36 | 1.36 | 1.30
1.19 | 1.05 | 1.05 | 1.19
Story 8
φMn/Mu = 1.34 | 1.87 | 1.87 | 1.34
φVn/Vmpr = 3.2 | 2.3 | 2.3 | 3.2
P/Agf'c = 0.09 | 0.15 | 0.15 | 0.09
1.9%
Floor 8
1.14 1.30 0.51 1.93 | 1.26 1.33 0.51 1.93 | 1.14 1.30 0.51 1.93
1.50 | 1.43 | 1.43 | 1.50
1.16 | 1.04 | 1.04 | 1.16
Story 7
φMn/Mu = 1.38 | 1.49 | 1.49 | 1.39
φVn/Vmpr = 2.52 | 2.16 | 2.16 | 2.52
P/Agf'c = 0.11 | 0.19 | 0.19 | 0.11
1.8%
Floor 7
1.17 1.19 0.51 1.15 | 1.40 1.23 0.51 1.15 | 1.18 1.19 0.51 1.15
1.22 | 1.20 | 1.20 | 1.22
1.26 | 1.12 | 1.12 | 1.26
Story 6
φMn/Mu = 1.34 | 1.79 | 1.79 | 1.34
φVn/Vmpr = 2.63 | 1.93 | 1.93 | 2.63
P/Agf'c = 0.13 | 0.22 | 0.22 | 0.13
1.6%
Floor 6
1.17 1.21 0.52 1.15 | 1.37 1.24 0.52 1.15 | 1.17 1.21 0.52 1.15
1.20 | 1.33 | 1.33 | 1.20
1.29 | 1.14 | 1.14 | 1.29
Story 5
φMn/Mu = 1.39 | 1.85 | 1.85 | 1.39
φVn/Vmpr = 2.45 | 1.85 | 1.85 | 2.45
P/Agf'c = 0.16 | 0.25 | 0.25 | 0.16
1.6%
Floor 5
1.17 1.17 0.55 1.15 | 1.36 1.28 0.55 1.15 | 1.17 1.17 0.55 1.15
1.23 | 1.25 | 1.25 | 1.23
1.28 | 1.11 | 1.11 | 1.28
Story 4
φMn/Mu = 1.40 | 1.60 | 1.60 | 1.40
φVn/Vmpr = 2.34 | 1.75 | 1.75 | 2.34
P/Agf'c = 0.18 | 0.28 | 0.28 | 0.18
1.6%
Floor 4
1.17 1.09 0.55 1.15 | 1.34 1.27 0.55 1.15 | 1.17 1.09 0.55 1.15
1.23 | 1.20 | 1.20 | 1.23
1.28 | 1.11 | 1.11 | 1.28
Story 3
φMn/Mu = 1.37 | 1.68 | 1.68 | 1.37
φVn/Vmpr = 2.28 | 1.79 | 1.79 | 2.28
P/Agf'c = 0.20 | 0.31 | 0.31 | 0.20
1.6%
Floor 3
1.18 1.10 0.58 1.15 | 1.33 1.33 0.58 1.15 | 1.18 1.10 0.58 1.15
1.24 | 1.24 | 1.24 | 1.24
1.28 | 1.09 | 1.09 | 1.28
Story 2
φMn/Mu = 1.43 | 1.73 | 1.73 | 1.43
φVn/Vmpr = 2.16 | 1.82 | 1.82 | 2.16
P/Agf'c = 0.22 | 0.35 | 0.35 | 0.22
1.7%
Floor 2
1.18 1.13 0.66 1.16 | 1.33 1.60 0.66 1.16 | 1.18 1.13 0.66 1.16
1.34 | 1.28 | 1.28 | 1.34
1.32 | 1.07 | 1.07 | 1.32
Story 1
φMn/Mu = 1.16 | 1.67 | 1.67 | 1.16
φVn/Vmpr = 2.02 | 1.86 | 1.86 | 2.02
P/Agf'c = 0.24 | 0.38 | 0.38 | 0.24
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
1.5%

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	3807	4176	4176	3807
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.069	0.067	0.067	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	108	108	110
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	4176	6513	6513	4176
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.067	0.067	0.067	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	105	105	108
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 10	$M_{y,exp}$ (k-in) =	4539	7205	7205	4539
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.066	0.065	0.065	0.066
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	102	102	106
	$(P/A_g f'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 9	$M_{y,exp}$ (k-in) =	5221	7883	7883	5221
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.065	0.062	0.062	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	99	99	105
	$(P/A_g f'_c)_{exp}$ =	0.04	0.09	0.09	0.04
Story 8	$M_{y,exp}$ (k-in) =	5573	8549	8549	5573
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.064	0.060	0.060	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	96	96	103
	$(P/A_g f'_c)_{exp}$ =	0.06	0.11	0.11	0.06
Story 7	$M_{y,exp}$ (k-in) =	7205	9204	9204	7205
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.065	0.057	0.057	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	93	93	102
	$(P/A_g f'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 6	$M_{y,exp}$ (k-in) =	6745	10483	10483	6745
	EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.062	0.056	0.056	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	91	91	100
	$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 5	$M_{y,exp}$ (k-in) =	7244	11118	11118	7244
	EI_{stf}/EI_g =	0.36	0.45	0.45	0.36
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.061	0.054	0.054	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	88	88	99
	$(P/A_g f'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 4	$M_{y,exp}$ (k-in) =	7580	10162	10162	7580
	EI_{stf}/EI_g =	0.37	0.47	0.47	0.37
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.060	0.049	0.049	0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	97	85	85	97
	$(P/A_g f'_c)_{exp}$ =	0.10	0.20	0.20	0.10
Story 3	$M_{y,exp}$ (k-in) =	7753	10781	10781	7753
	EI_{stf}/EI_g =	0.38	0.49	0.49	0.38
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.058	0.047	0.047	0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	96	83	83	96
	$(P/A_g f'_c)_{exp}$ =	0.11	0.22	0.22	0.11
Story 2	$M_{y,exp}$ (k-in) =	8242	11393	11393	8242
	EI_{stf}/EI_g =	0.39	0.51	0.51	0.39
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.058	0.046	0.046	0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	95	81	81	95
	$(P/A_g f'_c)_{exp}$ =	0.12	0.25	0.25	0.12
Story 1	$M_{y,exp}$ (k-in) =	8887	11997	11997	8887
	EI_{stf}/EI_g =	0.40	0.54	0.54	0.40
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.057	0.044	0.044	0.057
	Θ_{pc} (rad) =	0.100	0.095	0.095	0.100
	λ =	93	78	78	93
	$(P/A_g f'_c)_{exp}$ =	0.13	0.27	0.27	0.13

Floor 13	$M_{y,pos,exp}$(k-in) =	1804	1804	1804
	$M_{y,n,slab,exp}$(k-in) =	-4356	-4356	-4356
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0402	0.0402	0.0402
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.069	-0.069	-0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 12	$M_{y,pos,exp}$(k-in) =	2351	2351	2351
	$M_{y,n,slab,exp}$(k-in) =	-5808	-5808	-5808
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 11	$M_{y,pos,exp}$(k-in) =	2624	2624	2624
	$M_{y,n,slab,exp}$(k-in) =	-6332	-6332	-6332
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 10	$M_{y,pos,exp}$(k-in) =	3076	3076	3076
	$M_{y,n,slab,exp}$(k-in) =	-7116	-7116	-7116
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 9	$M_{y,pos,exp}$(k-in) =	3316	3316	3316
	$M_{y,n,slab,exp}$(k-in) =	-7635	-7635	-7635
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 8	$M_{y,pos,exp}$(k-in) =	3329	3329	3329
	$M_{y,n,slab,exp}$(k-in) =	-7765	-7765	-7765
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 7	$M_{y,pos,exp}$(k-in) =	4349	4349	4349
	$M_{y,n,slab,exp}$(k-in) =	-10197	-10197	-10197
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0441	0.0441
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 6	$M_{y,pos,exp}$(k-in) =	4349	4349	4349
	$M_{y,n,slab,exp}$(k-in) =	-9972	-9972	-9972
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0441	0.0441
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 5	$M_{y,pos,exp}$(k-in) =	4565	4565	4565
	$M_{y,n,slab,exp}$(k-in) =	-10051	-10051	-10051
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0448	0.0448
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 4	$M_{y,pos,exp}$(k-in) =	4565	4565	4565
	$M_{y,n,slab,exp}$(k-in) =	-10051	-10051	-10051
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0448	0.0448
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 3	$M_{y,pos,exp}$(k-in) =	4821	4821	4821
	$M_{y,n,slab,exp}$(k-in) =	-10055	-10055	-10055
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.0456	0.0456
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 2	$M_{y,pos,exp}$(k-in) =	5379	5379	5379
	$M_{y,n,slab,exp}$(k-in) =	-9836	-9836	-9836
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.048	0.048	0.048
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.97 T_2 = 0.67 T_3 = 0.38

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

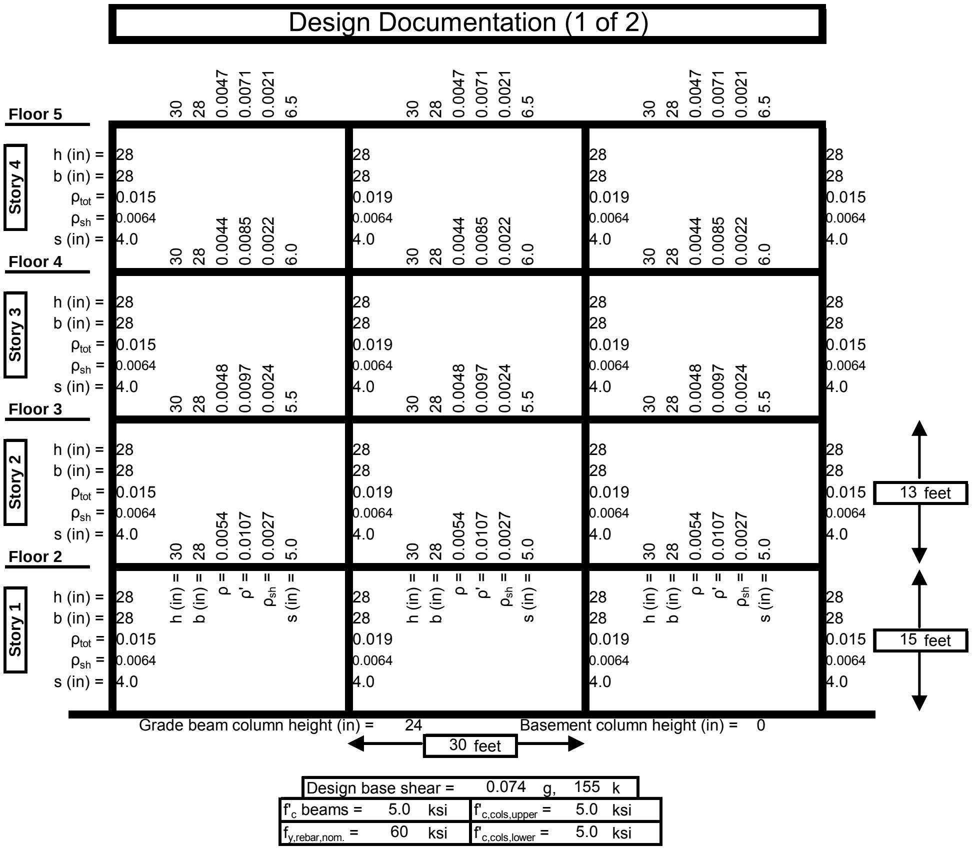
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2022
Number of Stories: 4
Fundamental Period (sec): 0.91

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

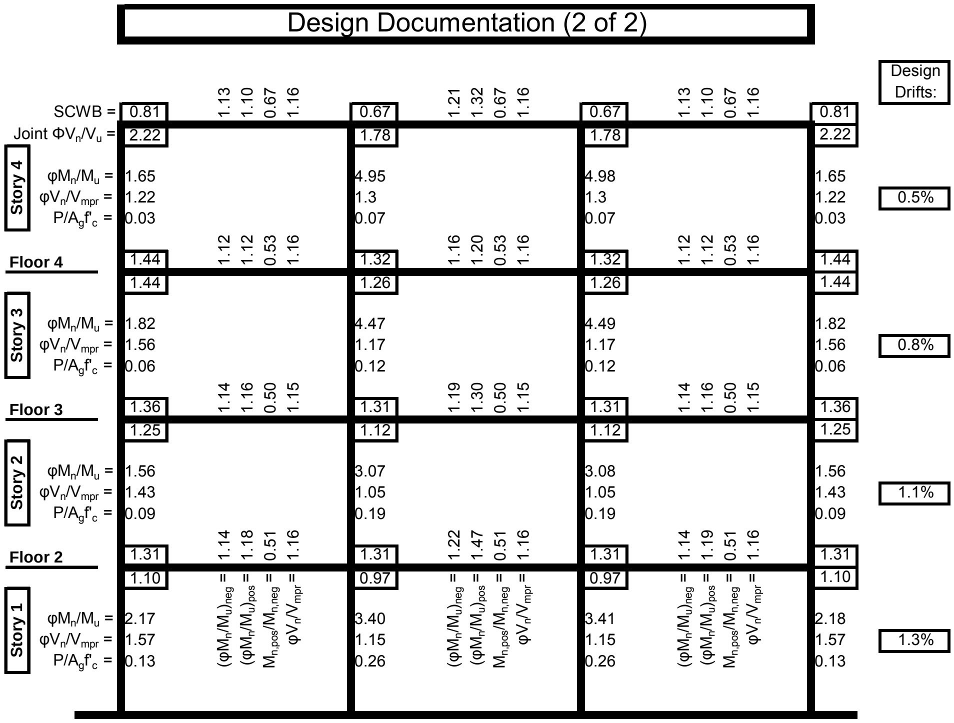
2022 R=10

This design was an add-on after the majority of the design—as it can be seen from the design number 2022. In this design, beam and column sizes were controlled by joint shear demand, where drift was only at 1.27%. Both negative and positive flexural beam strength was controlled by strength demands. More reinforcements were added to beams in four bays in order make consistent reinforcement for each floor. Six beams had additional reinforcement added to meet the minimum positive and negative ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. All beam stirrups were controlled by the capacity shear design. All of column stirrups were controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

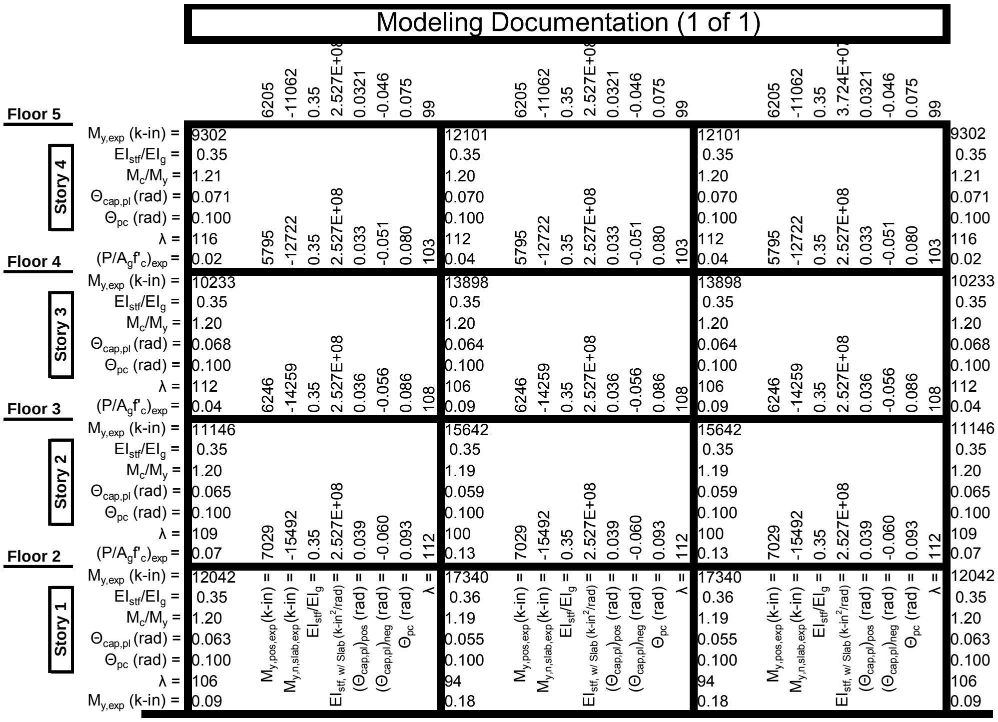

Design Documentation (1 of 2)
Floor 5
30 28 0.0047 0.0071 0.0021 6.5
30 28 0.0047 0.0071 0.0021 6.5
30 28 0.0047 0.0071 0.0021 6.5
Story 4
h (in) = 28 / 28 / 28 / 28
b (in) = 28 / 28 / 28 / 28
ρtot = 0.015 / 0.019 / 0.019 / 0.015
ρsh = 0.0064 / 0.0064 / 0.0064 / 0.0064
s (in) = 4.0 / 4.0 / 4.0 / 4.0
Floor 4
30 28 0.0044 0.0085 0.0022 6.0
30 28 0.0044 0.0085 0.0022 6.0
30 28 0.0044 0.0085 0.0022 6.0
Story 3
h (in) = 28 / 28 / 28 / 28
b (in) = 28 / 28 / 28 / 28
ρtot = 0.015 / 0.019 / 0.019 / 0.015
ρsh = 0.0064 / 0.0064 / 0.0064 / 0.0064
s (in) = 4.0 / 4.0 / 4.0 / 4.0
Floor 3
30 28 0.0048 0.0097 0.0024 5.5
30 28 0.0048 0.0097 0.0024 5.5
30 28 0.0048 0.0097 0.0024 5.5
Story 2
h (in) = 28 / 28 / 28 / 28
b (in) = 28 / 28 / 28 / 28
ρtot = 0.015 / 0.019 / 0.019 / 0.015
ρsh = 0.0064 / 0.0064 / 0.0064 / 0.0064
s (in) = 4.0 / 4.0 / 4.0 / 4.0
13 feet
Floor 2
30 28 0.0054 0.0107 0.0027 5.0
30 28 0.0054 0.0107 0.0027 5.0
30 28 0.0054 0.0107 0.0027 5.0
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 28 / 28 / 28 / 28
b (in) = 28 / 28 / 28 / 28
ρtot = 0.015 / 0.019 / 0.019 / 0.015
ρsh = 0.0064 / 0.0064 / 0.0064 / 0.0064
s (in) = 4.0 / 4.0 / 4.0 / 4.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.074 g, 155 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi

Design Documentation (2 of 2)



	Column 1	Beam bay 1	Column 2	Beam bay 2	Column 3	Beam bay 3	Column 4	Design Drifts:
SCWB =	0.81	1.13 1.10 0.67 1.16	0.67	1.21 1.32 0.67 1.16	0.67	1.13 1.10 0.67 1.16	0.81	
Joint $\Phi V_n/V_u$ =	2.22		1.78		1.78		2.22	
Story 4 $\varphi M_n/M_u$ =	1.65		4.95		4.98		1.65	
$\varphi V_n/V_{mpr}$ =	1.22		1.3		1.3		1.22	0.5%
$P/A_gf'_c$ =	0.03		0.07		0.07		0.03	
Floor 4	1.44	1.12 1.12 0.53 1.16	1.32	1.16 1.20 0.53 1.16	1.32	1.12 1.12 0.53 1.16	1.44	
	1.44		1.26		1.26		1.44	
Story 3 $\varphi M_n/M_u$ =	1.82		4.47		4.49		1.82	
$\varphi V_n/V_{mpr}$ =	1.56		1.17		1.17		1.56	0.8%
$P/A_gf'_c$ =	0.06		0.12		0.12		0.06	
Floor 3	1.36	1.14 1.16 0.50 1.15	1.31	1.19 1.30 0.50 1.15	1.31	1.14 1.16 0.50 1.15	1.36	
	1.25		1.12		1.12		1.25	
Story 2 $\varphi M_n/M_u$ =	1.56		3.07		3.08		1.56	
$\varphi V_n/V_{mpr}$ =	1.43		1.05		1.05		1.43	1.1%
$P/A_gf'_c$ =	0.09		0.19		0.19		0.09	
Floor 2	1.31	1.14 1.18 0.51 1.16	1.31	1.22 1.47 0.51 1.16	1.31	1.14 1.19 0.51 1.16	1.31	
	1.10	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	0.97	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	0.97	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.10	
Story 1 $\varphi M_n/M_u$ =	2.17		3.40		3.41		2.18	
$\varphi V_n/V_{mpr}$ =	1.57		1.15		1.15		1.57	1.3%
$P/A_gf'_c$ =	0.13		0.26		0.26		0.13	

Modeling Documentation (1 of 1)



	Column 1	Beam bay 1	Column 2	Beam bay 2	Column 3	Beam bay 3	Column 4
Floor 5		6205 -11062 0.35 2.527E+08 0.0321 -0.046 0.075 99		6205 -11062 0.35 2.527E+08 0.0321 -0.046 0.075 99		6205 -11062 0.35 3.724E+07 0.0321 -0.046 0.075 99	
Story 4 $M_{y,exp}$ (k-in) =	9302		12101		12101		9302
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.21		1.20		1.20		1.21
$\Theta_{cap,pl}$ (rad) =	0.071		0.070		0.070		0.071
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	116		112		112		116
$(P/A_gf'_c)_{exp}$ =	0.02		0.04		0.04		0.02
Floor 4		5795 -12722 0.35 2.527E+08 0.033 -0.051 0.080 103		5795 -12722 0.35 2.527E+08 0.033 -0.051 0.080 103		5795 -12722 0.35 2.527E+08 0.033 -0.051 0.080 103	
Story 3 $M_{y,exp}$ (k-in) =	10233		13898		13898		10233
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.20		1.20		1.20		1.20
$\Theta_{cap,pl}$ (rad) =	0.068		0.064		0.064		0.068
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	112		106		106		112
$(P/A_gf'_c)_{exp}$ =	0.04		0.09		0.09		0.04
Floor 3		6246 -14259 0.35 2.527E+08 0.036 -0.056 0.086 108		6246 -14259 0.35 2.527E+08 0.036 -0.056 0.086 108		6246 -14259 0.35 2.527E+08 0.036 -0.056 0.086 108	
Story 2 $M_{y,exp}$ (k-in) =	11146		15642		15642		11146
EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
M_c/M_y =	1.20		1.19		1.19		1.20
$\Theta_{cap,pl}$ (rad) =	0.065		0.059		0.059		0.065
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	109		100		100		109
$(P/A_gf'_c)_{exp}$ =	0.07		0.13		0.13		0.07
Floor 2		7029 -15492 0.35 2.527E+08 0.039 -0.060 0.093 112		7029 -15492 0.35 2.527E+08 0.039 -0.060 0.093 112		7029 -15492 0.35 2.527E+08 0.039 -0.060 0.093 112	
Story 1 $M_{y,exp}$ (k-in) =	12042	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	17340	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	17340	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	12042
EI_{stf}/EI_g =	0.35		0.36		0.36		0.35
M_c/M_y =	1.20		1.19		1.19		1.20
$\Theta_{cap,pl}$ (rad) =	0.063		0.055		0.055		0.063
Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
λ =	106		94		94		106
$M_{y,exp}$ (k-in) =	0.09		0.18		0.18		0.09

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.91 T_2 = 0.29 T_3 = 0.16

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

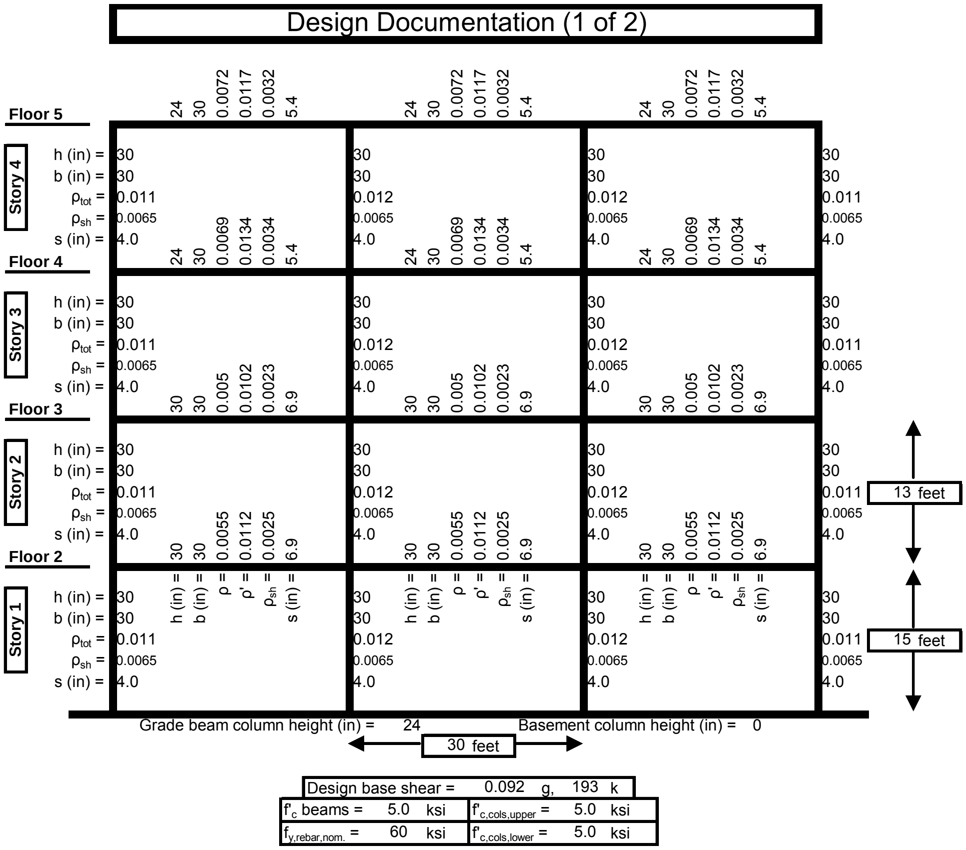
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2023
Number of Stories: 4
Fundamental Period (sec): 0.86

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2023 SCWB=1.0

From the baseline deign to satisfy a lower SCWB ratio wasn't hard. Keeping the same sizes by simply reducing column reinforcement were able to get us sufficient SCWB. Like the baseline design, beam depths were controlled by joint shear. Both negative and positive flexural beam strength was controlled by strength demands. About six bays have reinforcement added to keep reinforcement constant for each level, and to meet the positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio, except two. 3 beam stirrups were controlled by the capacity shear design except 6 by min requirement. Column stirrups were controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
24 30 0.0072 0.0117 0.0032 5.4
24 30 0.0072 0.0117 0.0032 5.4
24 30 0.0072 0.0117 0.0032 5.4
Story 4
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρ_{tot} = 0.011 | 0.012 | 0.012 | 0.011
ρ_{sh} = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 4
24 30 0.0069 0.0134 0.0034 5.4
24 30 0.0069 0.0134 0.0034 5.4
24 30 0.0069 0.0134 0.0034 5.4
Story 3
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρ_{tot} = 0.011 | 0.012 | 0.012 | 0.011
ρ_{sh} = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
Floor 3
30 30 0.005 0.0102 0.0023 6.9
30 30 0.005 0.0102 0.0023 6.9
30 30 0.005 0.0102 0.0023 6.9
Story 2
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρ_{tot} = 0.011 | 0.012 | 0.012 | 0.011
ρ_{sh} = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
13 feet
Floor 2
30 30 0.0055 0.0112 0.0025 6.9
30 30 0.0055 0.0112 0.0025 6.9
30 30 0.0055 0.0112 0.0025 6.9
h (in) = b (in) = ρ = ρ' = ρ_{sh} = s (in) =
Story 1
h (in) = 30 | 30 | 30 | 30
b (in) = 30 | 30 | 30 | 30
ρ_{tot} = 0.011 | 0.012 | 0.012 | 0.011
ρ_{sh} = 0.0065 | 0.0065 | 0.0065 | 0.0065
s (in) = 4.0 | 4.0 | 4.0 | 4.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi

Design Documentation (2 of 2)

Floor		Column 1	Bay 1	Column 2	Bay 2	Column 3	Bay 3	Column 4
Roof	SCWB =	0.74		0.57		0.57		0.74
Roof	Joint $\Phi V_n/V_u$ =	1.57		1.30		1.30		1.57
Roof	$(\varphi M_n/M_u)_{neg}$ =		1.17		1.23		1.17	
Roof	$(\varphi M_n/M_u)_{pos}$ =		1.16		1.27		1.16	
Roof	$M_{n,pos}/M_{n,neg}$ =		0.63		0.63		0.63	
Roof	$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16	
Floor 4	SCWB =	1.36		1.15		1.15		1.36
Floor 4	Joint $\Phi V_n/V_u$ =	1.15		1.01		1.01		1.15
Floor 4	$(\varphi M_n/M_u)_{neg}$ =		1.16		1.18		1.16	
Floor 4	$(\varphi M_n/M_u)_{pos}$ =		1.17		1.21		1.17	
Floor 4	$M_{n,pos}/M_{n,neg}$ =		0.53		0.53		0.53	
Floor 4	$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16	
Floor 3	SCWB =	1.13		1.04		1.04		1.13
Floor 3	Joint $\Phi V_n/V_u$ =	1.27		1.14		1.14		1.27
Floor 3	$(\varphi M_n/M_u)_{neg}$ =		1.17		1.21		1.17	
Floor 3	$(\varphi M_n/M_u)_{pos}$ =		1.24		1.43		1.24	
Floor 3	$M_{n,pos}/M_{n,neg}$ =		0.50		0.50		0.50	
Floor 3	$\varphi V_n/V_{mpr}$ =		1.17		1.17		1.17	
Floor 2	SCWB =	1.09		1.07		1.07		1.09
Floor 2	Joint $\Phi V_n/V_u$ =	1.12		1.00		1.00		1.12
Floor 2	$(\varphi M_n/M_u)_{neg}$ =		1.17		1.25		1.18	
Floor 2	$(\varphi M_n/M_u)_{pos}$ =		1.24		1.52		1.24	
Floor 2	$M_{n,pos}/M_{n,neg}$ =		0.50		0.50		0.50	
Floor 2	$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16	

Story		Column 1	Column 2	Column 3	Column 4	Design Drifts:
Story 4	$\varphi M_n/M_u$ =	1.17	2.99	3.00	1.17	0.8%
Story 4	$\varphi V_n/V_{mpr}$ =	1.6	1.81	1.81	1.6	
Story 4	$P/A_g f'_c$ =	0.03	0.06	0.06	0.03	
Story 3	$\varphi M_n/M_u$ =	1.37	2.55	2.57	1.39	1.0%
Story 3	$\varphi V_n/V_{mpr}$ =	1.99	1.57	1.57	1.99	
Story 3	$P/A_g f'_c$ =	0.05	0.11	0.11	0.05	
Story 2	$\varphi M_n/M_u$ =	1.34	2.18	2.18	1.35	1.2%
Story 2	$\varphi V_n/V_{mpr}$ =	1.7	1.3	1.3	1.7	
Story 2	$P/A_g f'_c$ =	0.08	0.16	0.16	0.08	
Story 1	$\varphi M_n/M_u$ =	1.71	2.57	2.57	1.72	1.4%
Story 1	$\varphi V_n/V_{mpr}$ =	1.85	1.39	1.39	1.85	
Story 1	$P/A_g f'_c$ =	0.11	0.22	0.22	0.11	

Modeling Documentation (1 of 1)

Floor		Bay 1	Bay 2	Bay 3
Floor 5	$M_{y,pos,exp}$(k-in) =	6062	6062	6062
Floor 5	$M_{y,n,slab,exp}$(k-in) =	-11077	-11077	-11077
Floor 5	EI_{stf}/EI_g =	0.35	0.35	0.35
Floor 5	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.354E+08	1.354E+08	3.724E+07
Floor 5	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0452	0.0452	0.0452
Floor 5	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.064	-0.064	-0.064
Floor 5	Θ_{pc} (rad) =	0.100	0.100	0.100
Floor 5	λ =	100	100	100
Floor 4	$M_{y,pos,exp}$(k-in) =	5856	5856	5856
Floor 4	$M_{y,n,slab,exp}$(k-in) =	-12453	-12453	-12453
Floor 4	EI_{stf}/EI_g =	0.35	0.35	0.35
Floor 4	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.354E+08	1.354E+08	1.354E+08
Floor 4	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
Floor 4	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Floor 4	Θ_{pc} (rad) =	0.100	0.100	0.100
Floor 4	λ =	100	100	100
Floor 3	$M_{y,pos,exp}$(k-in) =	7024	7024	7024
Floor 3	$M_{y,n,slab,exp}$(k-in) =	-15861	-15861	-15861
Floor 3	EI_{stf}/EI_g =	0.35	0.35	0.35
Floor 3	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.591E+08	2.591E+08	2.591E+08
Floor 3	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.035	0.035	0.035
Floor 3	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
Floor 3	Θ_{pc} (rad) =	0.082	0.082	0.082
Floor 3	λ =	108	108	108
Floor 2	$M_{y,pos,exp}$(k-in) =	7712	7712	7712
Floor 2	$M_{y,n,slab,exp}$(k-in) =	-17177	-17177	-17177
Floor 2	EI_{stf}/EI_g =	0.35	0.35	0.35
Floor 2	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.591E+08	2.591E+08	2.591E+08
Floor 2	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.039	0.039	0.039
Floor 2	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.059	-0.059	-0.059
Floor 2	Θ_{pc} (rad) =	0.088	0.088	0.088
Floor 2	λ =	112	112	112

Story		Column 1	Column 2	Column 3	Column 4
Story 4	$M_{y,exp}$ (k-in) =	8583	10441	10441	8583
Story 4	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
Story 4	M_c/M_y =	1.21	1.20	1.20	1.21
Story 4	$\Theta_{cap,pl}$ (rad) =	0.069	0.067	0.067	0.069
Story 4	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
Story 4	λ =	119	116	116	119
Story 4	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 3	$M_{y,exp}$ (k-in) =	9602	12412	12412	9602
Story 3	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
Story 3	M_c/M_y =	1.20	1.20	1.20	1.20
Story 3	$\Theta_{cap,pl}$ (rad) =	0.066	0.063	0.063	0.066
Story 3	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
Story 3	λ =	116	110	110	116
Story 3	$(P/A_g f'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 2	$M_{y,exp}$ (k-in) =	10601	14317	14317	10601
Story 2	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
Story 2	M_c/M_y =	1.20	1.19	1.19	1.20
Story 2	$\Theta_{cap,pl}$ (rad) =	0.064	0.058	0.058	0.064
Story 2	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
Story 2	λ =	113	105	105	113
Story 2	$(P/A_g f'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 1	$M_{y,exp}$ (k-in) =	11580	16168	16168	11580
Story 1	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
Story 1	M_c/M_y =	1.20	1.19	1.19	1.20
Story 1	$\Theta_{cap,pl}$ (rad) =	0.062	0.054	0.054	0.062
Story 1	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
Story 1	λ =	110	100	100	110
Story 1	$(P/A_g f'_c)_{exp}$ =	0.08	0.15	0.15	0.08

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.85 T_2= 0.27 T_3= 0.15

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2024

Number of Stories: 4

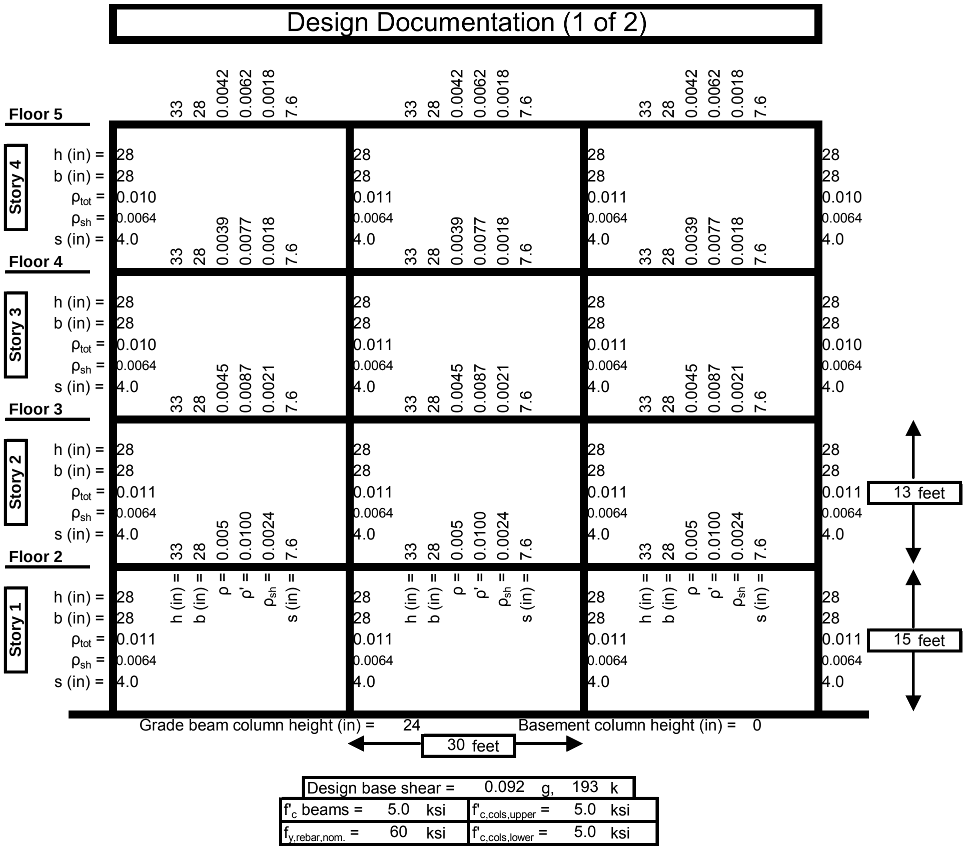
Fundamental Period (sec): 0.85

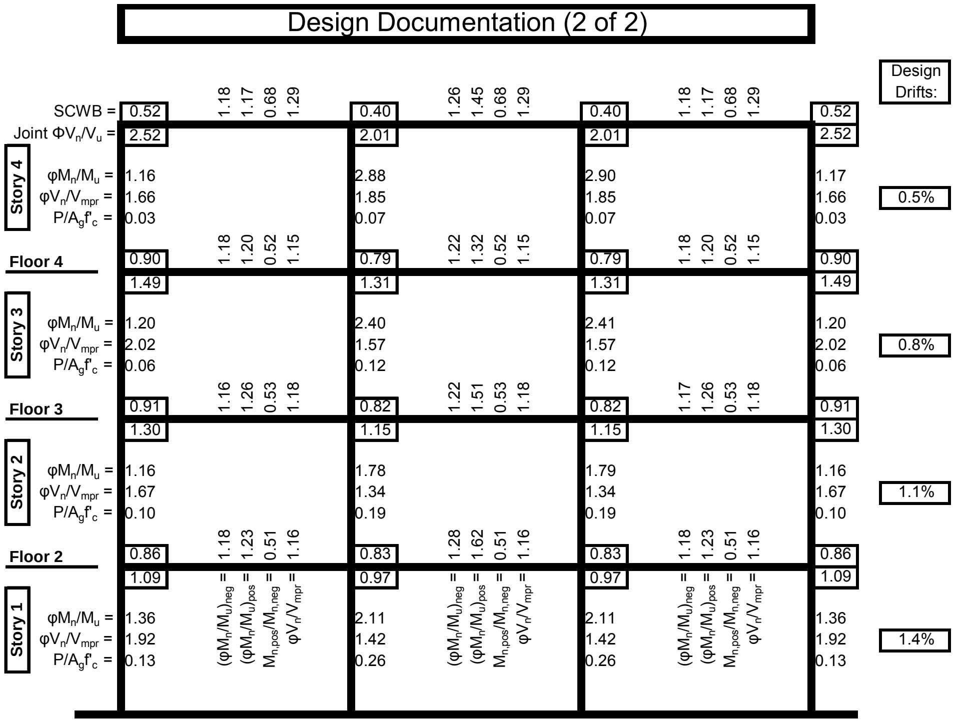
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

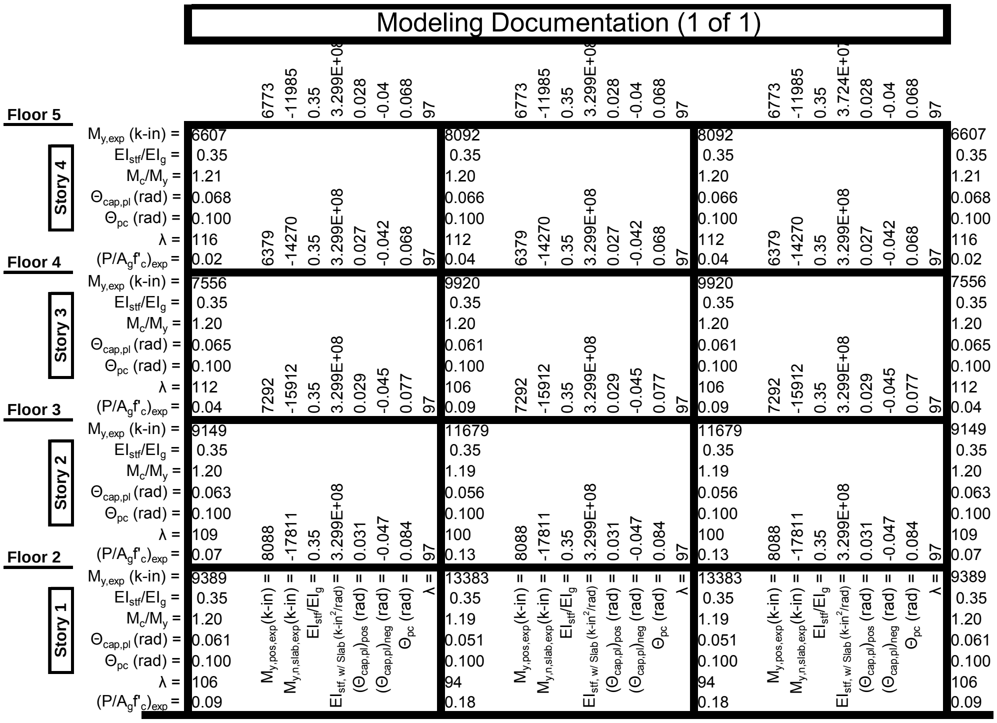
2024 SCWB=0.8

From the 2023 deign to satisfy a lower SCWB, columns were made smaller. Again, beam depths were controlled by joint shear. Both negative and positive flexural beam strength was controlled by strength demands. Few bays have reinforcement added to keep reinforcement constant for each level, and to meet the positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio, except for two. Half of beam stirrups were controlled by the capacity shear design, half by minimum requirement. All column stirrups were controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
33
28
0.0042
0.0062
0.0018
7.6
Story 4
h (in) = 28
b (in) = 28
ρtot = 0.010
ρsh = 0.0064
s (in) = 4.0
28
28
0.011
0.0064
4.0
0.010
33
28
0.0039
0.0077
0.0018
7.6
Floor 4
Story 3
0.0045
0.0087
0.0021
Floor 3
Story 2
0.005
0.0100
0.0024
Floor 2
Story 1
0.011
h (in) =
b (in) =
ρ =
ρ' =
ρsh =
s (in) =
13 feet
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi





Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.85 T_2 = 0.27 T_3 = 0.15

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

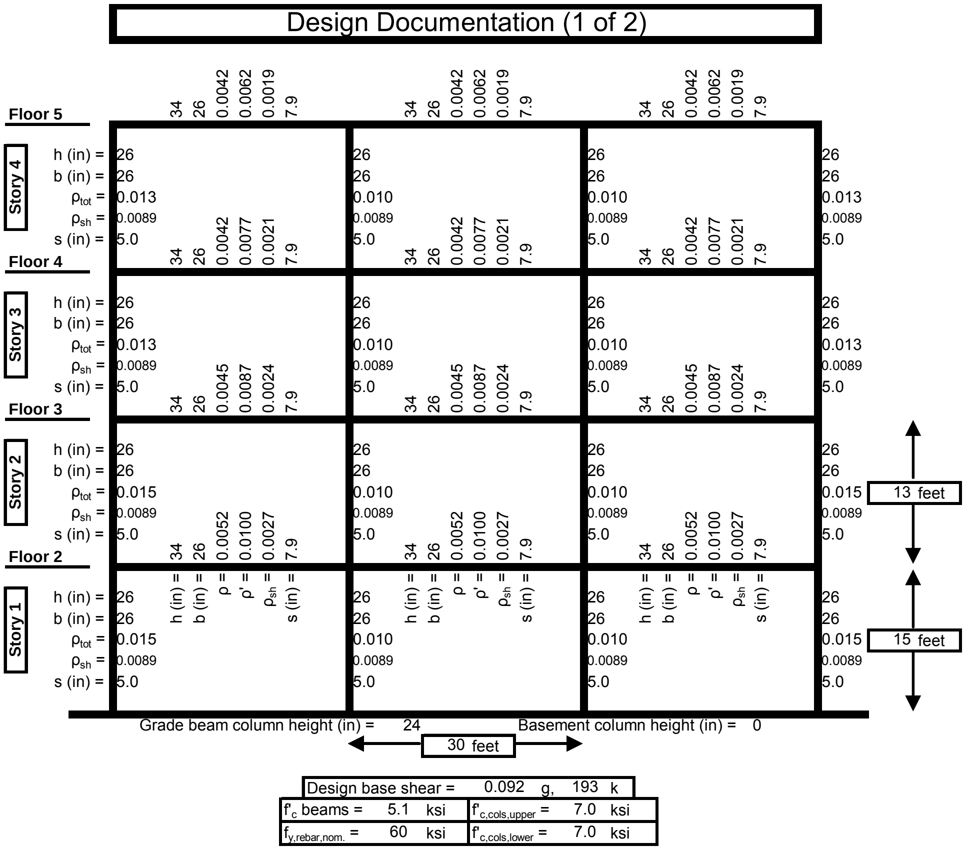
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2025
Number of Stories: 4
Fundamental Period (sec): 0.87

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

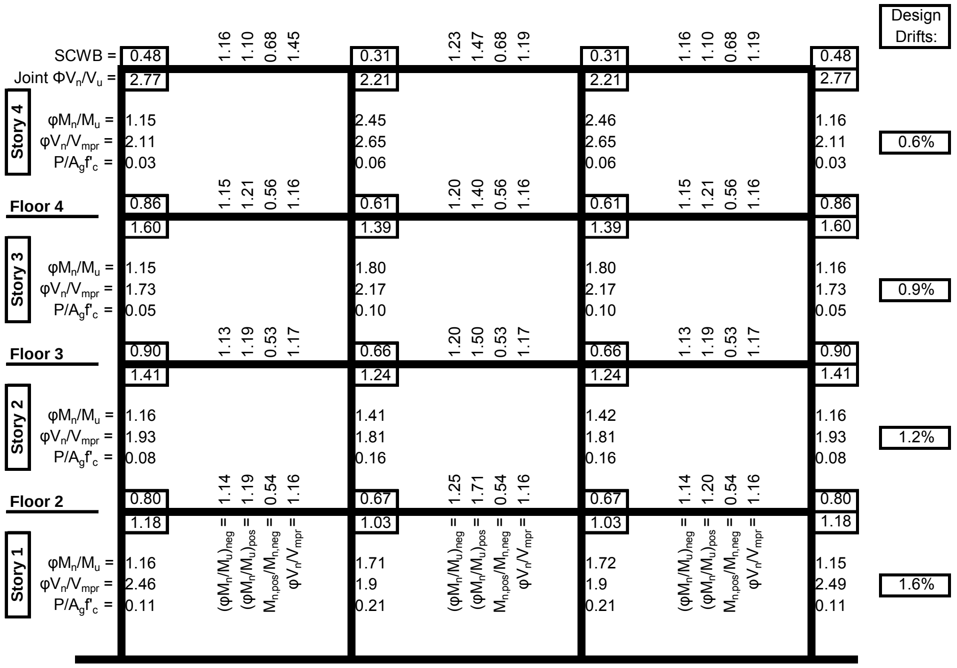
2025 SCWB=0.6

Simply making the columns sizes smaller and making beams larger (columns 26”, beams 34”) weren’t enough to satisfy low SCWB and sufficient joint shear force. Hence, strong concrete strength were use to meet the joint shear strength. Both negative and positive flexural beam strength was controlled by strength demands. Few bays have reinforcement added to keep reinforcement constant for each level, and to meet the positive/negative requirement ratio. Exterior column flexural strengths were controlled by the flexural demand, where as the interior columns by the strong-column weak-beam ratio. Most of beam stirrups were controlled by the capacity shear design, rest by minimum requirement. All column stirrups were controlled by minimum confinement requirements.

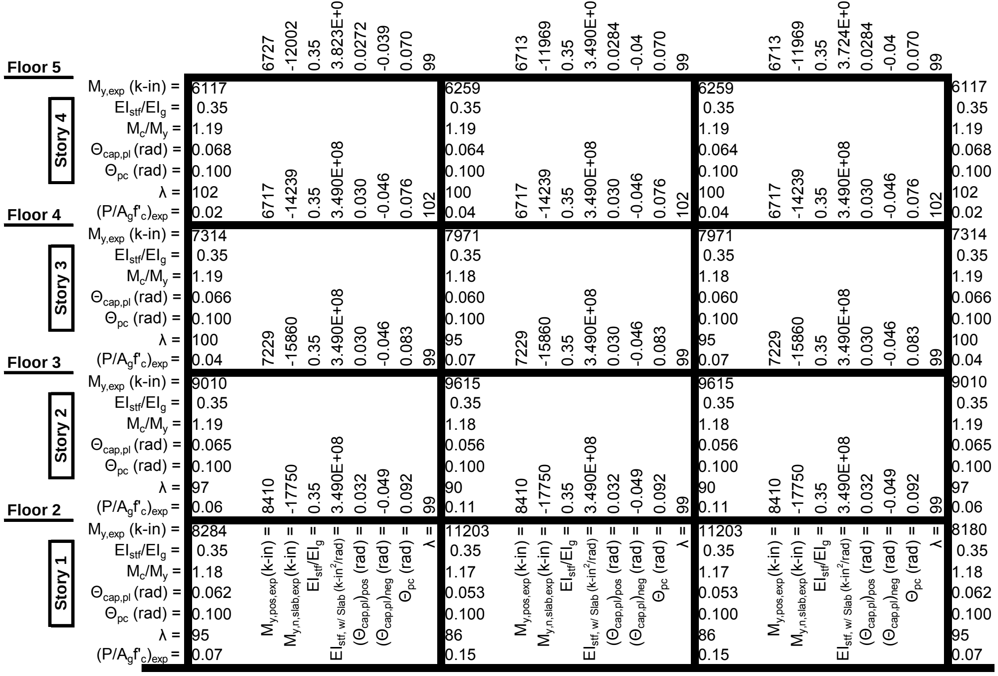
DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
34 26 0.0042 0.0062 0.0019 7.9
Story 4
h (in) = 26 26 26 26
b (in) = 26 26 26 26
ρtot = 0.013 0.010 0.010 0.013
ρsh = 0.0089 0.0089 0.0089 0.0089
s (in) = 5.0 5.0 5.0 5.0
Floor 4
34 26 0.0042 0.0077 0.0021 7.9
Story 3
h (in) = 26 26 26 26
b (in) = 26 26 26 26
ρtot = 0.013 0.010 0.010 0.013
ρsh = 0.0089 0.0089 0.0089 0.0089
s (in) = 5.0 5.0 5.0 5.0
Floor 3
34 26 0.0045 0.0087 0.0024 7.9
Story 2
h (in) = 26 26 26 26
b (in) = 26 26 26 26
ρtot = 0.015 0.010 0.010 0.015
ρsh = 0.0089 0.0089 0.0089 0.0089
s (in) = 5.0 5.0 5.0 5.0
Floor 2
34 26 0.0052 0.0100 0.0027 7.9
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 26 26 26 26
b (in) = 26 26 26 26
ρtot = 0.015 0.010 0.010 0.015
ρsh = 0.0089 0.0089 0.0089 0.0089
s (in) = 5.0 5.0 5.0 5.0
13 feet
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.1 ksi
f'c,cols,upper = 7.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 7.0 ksi

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.87 T_2 = 0.27 T_3 = 0.15

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

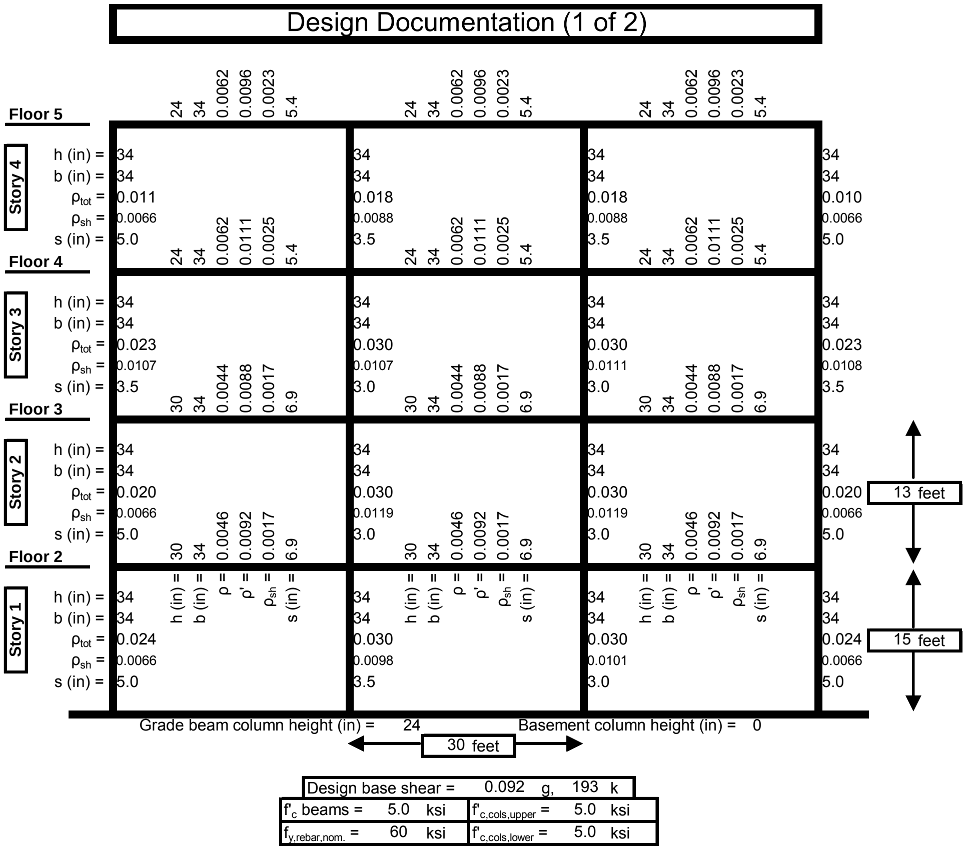
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2027
Number of Stories: 4
Fundamental Period (sec): 0.85

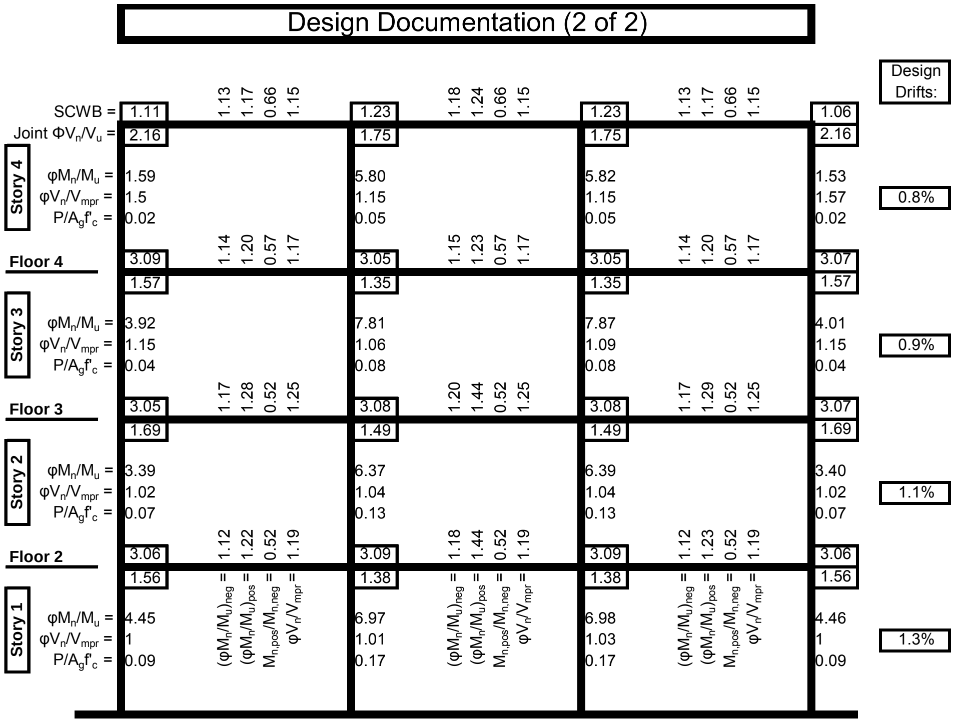
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

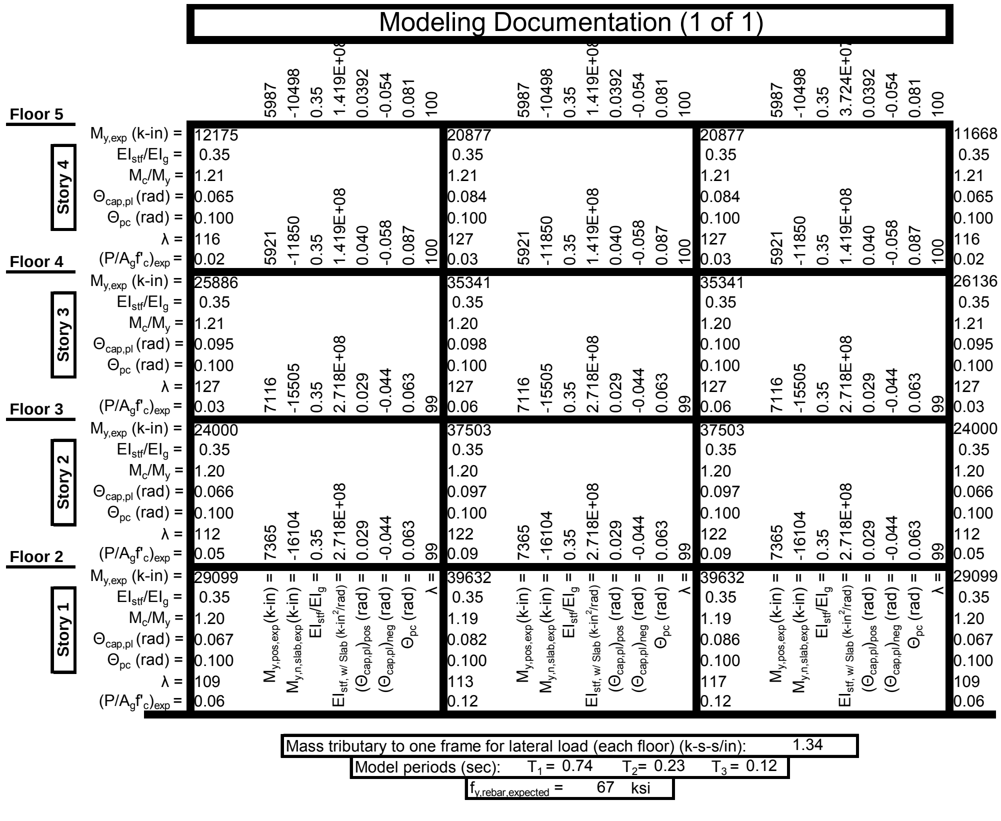
2027 SCWB=3.0

Compared to the 2007 design, column sizes were increased to meet strong-column weak-beam ratio (>3.0). Both negative and positive flexural beam strength was controlled by strength demands. Few additional beam reinforcements in four beans were added to alter beam design to use same rho and rhoPrime. Two floors had additional reinforcement added to meet the minimum positive/negative strength ratio. All column flexural strengths were controlled by the strong-column weak-beam ratio. Six beam stirrups and six columns were controlled by the capacity shear design, and the rest controlled by minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 5
Floor 4
Floor 3
Floor 2
Story 4
Story 3
Story 2
Story 1
h (in) =
b (in) =
ρtot =
ρsh =
s (in) =
Story 4 columns: 34 34 0.011 0.0066 5.0 | 34 34 0.018 0.0088 3.5 | 34 34 0.018 0.0088 3.5 | 34 34 0.010 0.0066 5.0
Story 3 columns: 34 34 0.023 0.0107 3.5 | 34 34 0.030 0.0107 3.0 | 34 34 0.030 0.0111 3.0 | 34 34 0.023 0.0108 3.5
Story 2 columns: 34 34 0.020 0.0066 5.0 | 34 34 0.030 0.0119 3.0 | 34 34 0.030 0.0119 3.0 | 34 34 0.020 0.0066 5.0
Story 1 columns: 34 34 0.024 0.0066 5.0 | 34 34 0.030 0.0098 3.5 | 34 34 0.030 0.0101 3.0 | 34 34 0.024 0.0066 5.0
Floor 5 beams: 24 34 0.0062 0.0096 0.0023 5.4
Floor 4 beams: 24 34 0.0062 0.0111 0.0025 5.4
Floor 3 beams: 30 34 0.0044 0.0088 0.0017 6.9
Floor 2 beams: 30 34 0.0046 0.0092 0.0017 6.9
h (in) =
b (in) =
ρ =
ρ' =
ρsh =
s (in) =
13 feet
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 0
30 feet
Design base shear = 0.092 g, 193 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 1.11
Joint ΦVn/Vu = 2.16
1.13 1.17 0.66 1.15
1.23 1.75
1.18 1.24 0.66 1.15
1.23 1.75
1.13 1.17 0.66 1.15
1.06 2.16
Story 4
φMn/Mu = 1.59 5.80 5.82 1.53
φVn/Vmpr = 1.5 1.15 1.15 1.57
P/Agf'c = 0.02 0.05 0.05 0.02
0.8%
Floor 4
3.09 1.57
1.14 1.20 0.57 1.17
3.05 1.35
1.15 1.23 0.57 1.17
3.05 1.35
1.14 1.20 0.57 1.17
3.07 1.57
Story 3
φMn/Mu = 3.92 7.81 7.87 4.01
φVn/Vmpr = 1.15 1.06 1.09 1.15
P/Agf'c = 0.04 0.08 0.08 0.04
0.9%
Floor 3
3.05 1.69
1.17 1.28 0.52 1.25
3.08 1.49
1.20 1.44 0.52 1.25
3.08 1.49
1.17 1.29 0.52 1.25
3.07 1.69
Story 2
φMn/Mu = 3.39 6.37 6.39 3.40
φVn/Vmpr = 1.02 1.04 1.04 1.02
P/Agf'c = 0.07 0.13 0.13 0.07
1.1%
Floor 2
3.06 1.56
1.12 1.22 0.52 1.19
3.09 1.38
1.18 1.44 0.52 1.19
3.09 1.38
1.12 1.23 0.52 1.19
3.06 1.56
Story 1
φMn/Mu = 4.45 6.97 6.98 4.46
φVn/Vmpr = 1 1.01 1.03 1
P/Agf'c = 0.09 0.17 0.17 0.09
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
1.3%


Modeling Documentation (1 of 1)
Floor 5
5987 -10498 0.35 1.419E+08 0.0392 -0.054 0.081 100
5987 -10498 0.35 1.419E+08 0.0392 -0.054 0.081 100
5987 -10498 0.35 3.724E+07 0.0392 -0.054 0.081 100
Story 4
My,exp (k-in) = 12175 20877 20877 11668
EIstf/EIg = 0.35 0.35 0.35 0.35
Mc/My = 1.21 1.21 1.21 1.21
Θcap,pl (rad) = 0.065 0.084 0.084 0.065
Θpc (rad) = 0.100 0.100 0.100 0.100
λ = 116 127 127 116
(P/Agf'c)exp = 0.02 0.03 0.03 0.02
Floor 4
5921 -11850 0.35 1.419E+08 0.040 -0.058 0.087 100
Story 3
My,exp (k-in) = 25886 35341 35341 26136
EIstf/EIg = 0.35 0.35 0.35 0.35
Mc/My = 1.21 1.20 1.20 1.21
Θcap,pl (rad) = 0.095 0.098 0.100 0.095
Θpc (rad) = 0.100 0.100 0.100 0.100
λ = 127 127 127 127
(P/Agf'c)exp = 0.03 0.06 0.06 0.03
Floor 3
7116 -15505 0.35 2.718E+08 0.029 -0.044 0.063 99
Story 2
My,exp (k-in) = 24000 37503 37503 24000
EIstf/EIg = 0.35 0.35 0.35 0.35
Mc/My = 1.20 1.20 1.20 1.20
Θcap,pl (rad) = 0.066 0.097 0.097 0.066
Θpc (rad) = 0.100 0.100 0.100 0.100
λ = 112 122 122 112
(P/Agf'c)exp = 0.05 0.09 0.09 0.05
Floor 2
7365 -16104 0.35 2.718E+08 0.029 -0.044 0.063 99
Story 1
My,exp (k-in) = 29099 39632 39632 29099
EIstf/EIg = 0.35 0.35 0.35 0.35
Mc/My = 1.20 1.19 1.19 1.20
Θcap,pl (rad) = 0.067 0.082 0.086 0.067
Θpc (rad) = 0.100 0.100 0.100 0.100
λ = 109 113 117 109
(P/Agf'c)exp = 0.06 0.12 0.12 0.06
My,pos,exp(k-in) =
My,n,slab,exp(k-in) =
EIstf/EIg =
EIstf, w/ Slab (k-in²/rad) =
(Θcap,pl)pos (rad) =
(Θcap,pl)neg (rad) =
Θpc (rad) =
λ =
Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34
Model periods (sec): T1 = 0.74 T2 = 0.23 T3 = 0.12
fy,rebar,expected = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2028

Number of Stories: 12

Fundamental Period (sec): 2.27

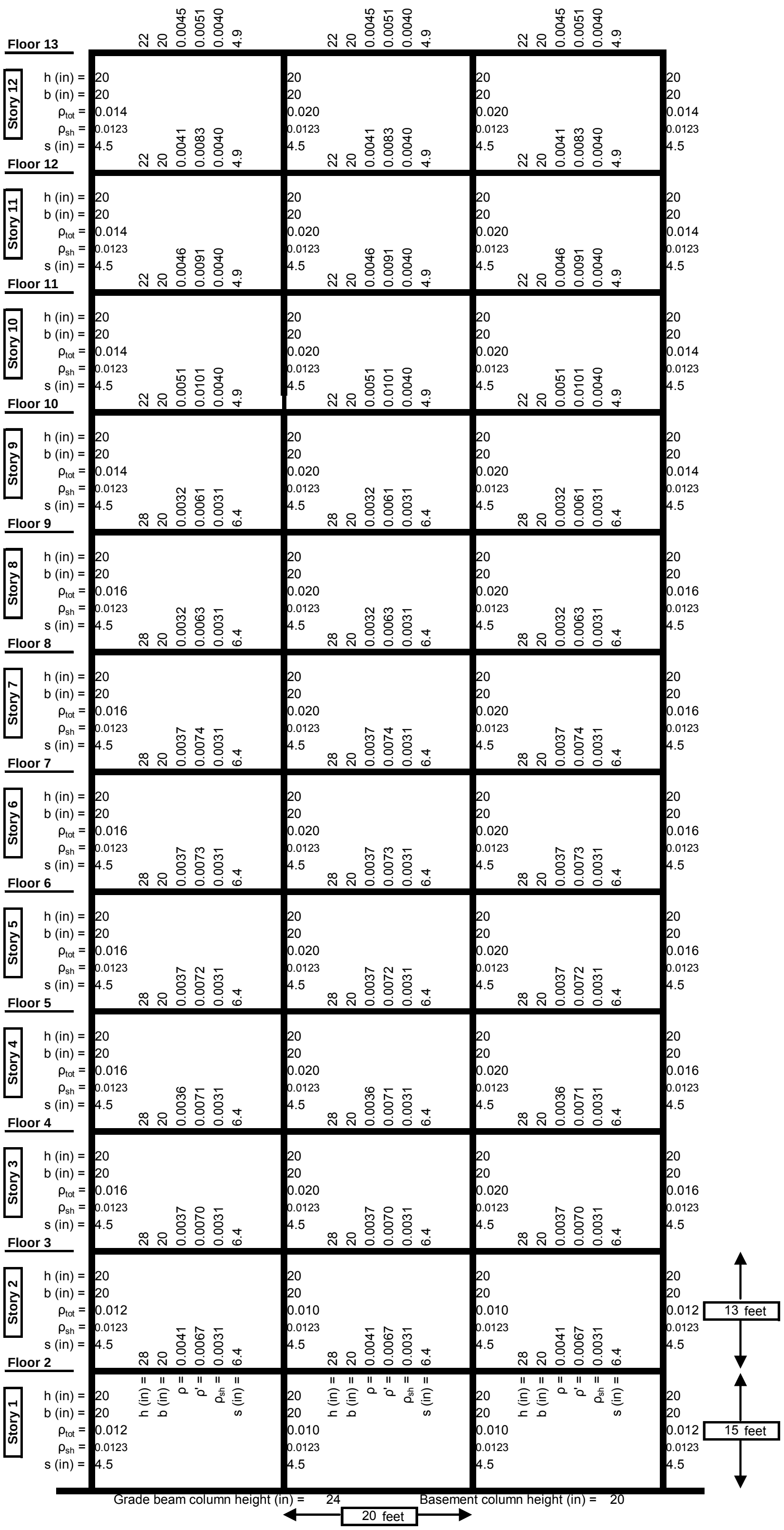
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Note: In order to see the effects of design strength changes the minimum base shear demand from eqn 9.5.5.2.1-3 was not imposed in this design.

From the baseline design, beam sizes were reduced as the lateral demand is reduced from larger R value. Since joint shear controlled, a higher concrete strength was used. Positive beam bending strength was controlled by strength demands. 12 negative bending strength is controlled by minimum reinforcement requirement, the rest by strength demand. The beam is made large for stiffness, thus controlled by min requirement. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the minimum positive/negative strength ratio. Column strength governed by SCWB ratio. Both beam and column stirrups were controlled by the minimum confinement requirements.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	22	20	0.0045	0.0051	0.0040	4.9
Floor 12	22	20	0.0041	0.0083	0.0040	4.9
Floor 11	22	20	0.0046	0.0091	0.0040	4.9
Floor 10	22	20	0.0051	0.0101	0.0040	4.9
Floor 9	28	20	0.0032	0.0061	0.0031	6.4
Floor 8	28	20	0.0032	0.0063	0.0031	6.4
Floor 7	28	20	0.0037	0.0074	0.0031	6.4
Floor 6	28	20	0.0037	0.0073	0.0031	6.4
Floor 5	28	20	0.0037	0.0072	0.0031	6.4
Floor 4	28	20	0.0036	0.0071	0.0031	6.4
Floor 3	28	20	0.0037	0.0070	0.0031	6.4
Floor 2	28	20	0.0041	0.0067	0.0031	6.4

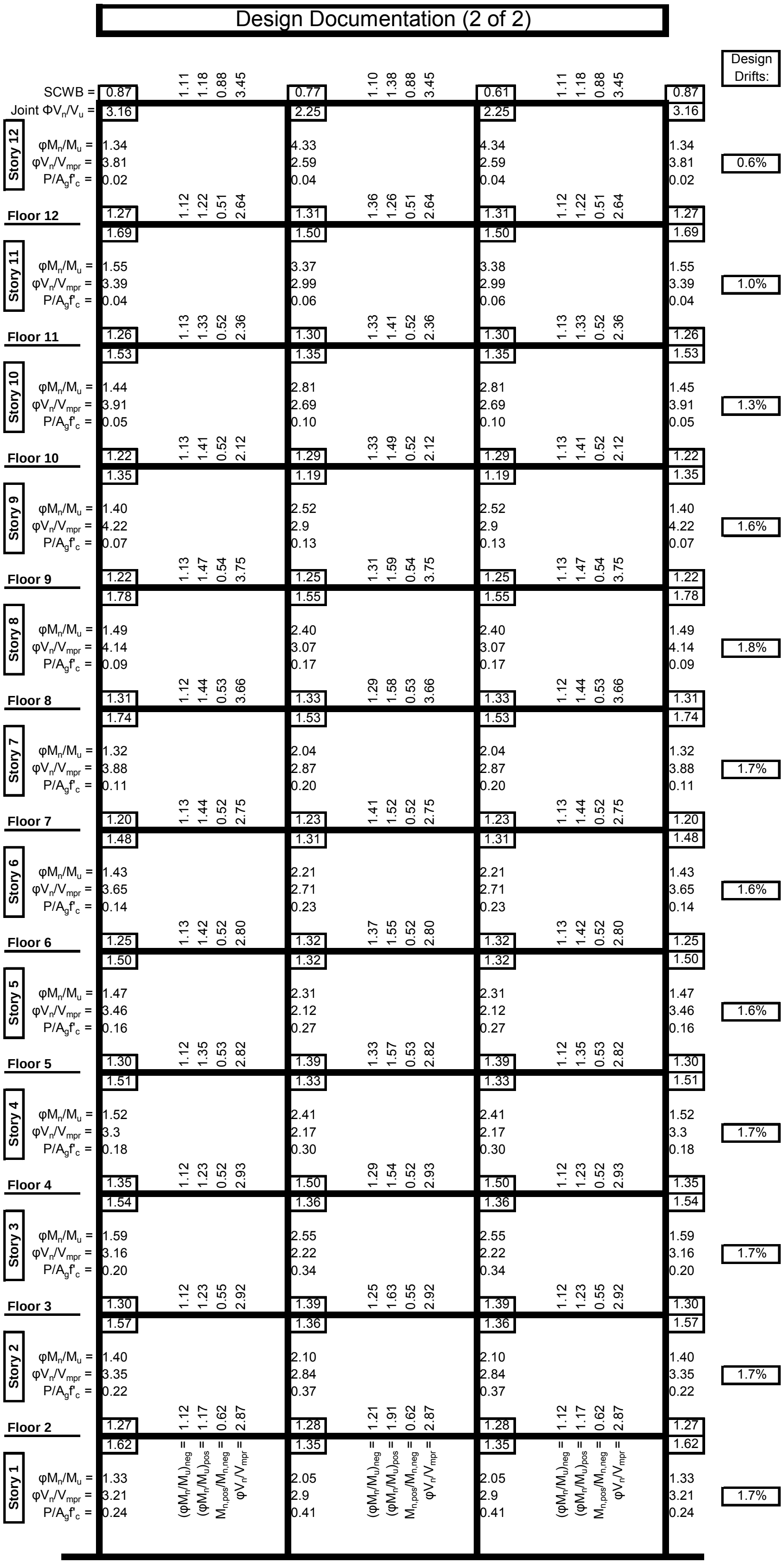
Story 12	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.014	0.020	0.020	0.014
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 11	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.014	0.020	0.020	0.014
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 10	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.014	0.020	0.020	0.014
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 9	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.014	0.020	0.020	0.014
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 8	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 7	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 6	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 5	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 4	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 3	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.016	0.020	0.020	0.016
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 2	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.012	0.010	0.010	0.012
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5
Story 1	h (in) =	20	20	20	20
	b (in) =	20	20	20	20
	ρ_{tot} =	0.012	0.010	0.010	0.012
	ρ_{sh} =	0.0123	0.0123	0.0123	0.0123
	s (in) =	4.5	4.5	4.5	4.5

Grade beam column height (in) = 24

Basement column height (in) = 20

Design base shear = 0.028 g, 232 k

f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	8.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	8.0 ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.87 0.77 0.61 0.87
Joint ΦVn/Vu = 3.16 2.25 2.25 3.16
1.11 1.18 0.88 3.45
1.10 1.38 0.88 3.45
1.11 1.18 0.88 3.45
Story 12
φMn/Mu = 1.34 4.33 4.34 1.34
φVn/Vmpr = 3.81 2.59 2.59 3.81
P/Agf'c = 0.02 0.04 0.04 0.02
0.6%
1.12 1.22 0.51 2.64
1.36 1.26 0.51 2.64
1.12 1.22 0.51 2.64
Floor 12
1.27 1.31 1.31 1.27
1.69 1.50 1.50 1.69
Story 11
φMn/Mu = 1.55 3.37 3.38 1.55
φVn/Vmpr = 3.39 2.99 2.99 3.39
P/Agf'c = 0.04 0.06 0.06 0.04
1.0%
1.13 1.33 0.52 2.36
1.33 1.41 0.52 2.36
1.13 1.33 0.52 2.36
Floor 11
1.26 1.30 1.30 1.26
1.53 1.35 1.35 1.53
Story 10
φMn/Mu = 1.44 2.81 2.81 1.45
φVn/Vmpr = 3.91 2.69 2.69 3.91
P/Agf'c = 0.05 0.10 0.10 0.05
1.3%
1.13 1.41 0.52 2.12
1.33 1.49 0.52 2.12
1.13 1.41 0.52 2.12
Floor 10
1.22 1.29 1.29 1.22
1.35 1.19 1.19 1.35
Story 9
φMn/Mu = 1.40 2.52 2.52 1.40
φVn/Vmpr = 4.22 2.9 2.9 4.22
P/Agf'c = 0.07 0.13 0.13 0.07
1.6%
1.13 1.47 0.54 3.75
1.31 1.59 0.54 3.75
1.13 1.47 0.54 3.75
Floor 9
1.22 1.25 1.25 1.22
1.78 1.55 1.55 1.78
Story 8
φMn/Mu = 1.49 2.40 2.40 1.49
φVn/Vmpr = 4.14 3.07 3.07 4.14
P/Agf'c = 0.09 0.17 0.17 0.09
1.8%
1.12 1.44 0.53 3.66
1.29 1.58 0.53 3.66
1.12 1.44 0.53 3.66
Floor 8
1.31 1.33 1.33 1.31
1.74 1.53 1.53 1.74
Story 7
φMn/Mu = 1.32 2.04 2.04 1.32
φVn/Vmpr = 3.88 2.87 2.87 3.88
P/Agf'c = 0.11 0.20 0.20 0.11
1.7%
1.13 1.44 0.52 2.75
1.41 1.52 0.52 2.75
1.13 1.44 0.52 2.75
Floor 7
1.20 1.23 1.23 1.20
1.48 1.31 1.31 1.48
Story 6
φMn/Mu = 1.43 2.21 2.21 1.43
φVn/Vmpr = 3.65 2.71 2.71 3.65
P/Agf'c = 0.14 0.23 0.23 0.14
1.6%
1.13 1.42 0.52 2.80
1.37 1.55 0.52 2.80
1.13 1.42 0.52 2.80
Floor 6
1.25 1.32 1.32 1.25
1.50 1.32 1.32 1.50
Story 5
φMn/Mu = 1.47 2.31 2.31 1.47
φVn/Vmpr = 3.46 2.12 2.12 3.46
P/Agf'c = 0.16 0.27 0.27 0.16
1.6%
1.12 1.35 0.53 2.82
1.33 1.57 0.53 2.82
1.12 1.35 0.53 2.82
Floor 5
1.30 1.39 1.39 1.30
1.51 1.33 1.33 1.51
Story 4
φMn/Mu = 1.52 2.41 2.41 1.52
φVn/Vmpr = 3.3 2.17 2.17 3.3
P/Agf'c = 0.18 0.30 0.30 0.18
1.7%
1.12 1.23 0.52 2.93
1.29 1.54 0.52 2.93
1.12 1.23 0.52 2.93
Floor 4
1.35 1.50 1.50 1.35
1.54 1.36 1.36 1.54
Story 3
φMn/Mu = 1.59 2.55 2.55 1.59
φVn/Vmpr = 3.16 2.22 2.22 3.16
P/Agf'c = 0.20 0.34 0.34 0.20
1.7%
1.12 1.23 0.55 2.92
1.25 1.63 0.55 2.92
1.12 1.23 0.55 2.92
Floor 3
1.30 1.39 1.39 1.30
1.57 1.36 1.36 1.57
Story 2
φMn/Mu = 1.40 2.10 2.10 1.40
φVn/Vmpr = 3.35 2.84 2.84 3.35
P/Agf'c = 0.22 0.37 0.37 0.22
1.7%
1.12 1.17 0.62 2.87
1.21 1.91 0.62 2.87
1.12 1.17 0.62 2.87
Floor 2
1.27 1.28 1.28 1.27
1.62 1.35 1.35 1.62
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
Story 1
φMn/Mu = 1.33 2.05 2.05 1.33
φVn/Vmpr = 3.21 2.9 2.9 3.21
P/Agf'c = 0.24 0.41 0.41 0.24
1.7%

Modeling Documentation (1 of 1)

Floor 13	$M_{y,pos,exp}$(k-in) =		2106		2106		2106	
	$M_{y,n,slab,exp}$(k-in) =		-3674		-3674		-3674	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		6.927E+07		6.927E+07		3.724E+07	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.0467		0.0467		0.0467	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.07		-0.07		-0.07	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		100		100		100	
Story 12	$M_{y,exp}$ (k-in) =	2934		4297		4297		2934
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.18		1.18		1.18		1.18
	$\Theta_{cap,pl}$ (rad) =	0.076		0.078		0.078		0.076
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	93		91		91		93
	$(P/A_g f'_c)_{exp}$ =	0.01		0.02		0.02		0.01
Floor 12	$M_{y,pos,exp}$(k-in) =		1944		1944		1944	
	$M_{y,n,slab,exp}$(k-in) =		-5047		-5047		-5047	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		6.927E+07		6.927E+07		6.927E+07	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.044		0.044		0.044	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.078		-0.078		-0.078	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		100		100		100	
Story 11	$M_{y,exp}$ (k-in) =	3235		4874		4874		3235
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.18		1.18		1.18		1.18
	$\Theta_{cap,pl}$ (rad) =	0.074		0.075		0.075		0.074
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	91		89		89		91
	$(P/A_g f'_c)_{exp}$ =	0.02		0.05		0.05		0.02
Floor 11	$M_{y,pos,exp}$(k-in) =		2167		2167		2167	
	$M_{y,n,slab,exp}$(k-in) =		-5428		-5428		-5428	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		6.927E+07		6.927E+07		6.927E+07	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.045		0.045		0.045	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.078		-0.078		-0.078	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		100		100		100	
Story 10	$M_{y,exp}$ (k-in) =	3531		5437		5437		3531
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.18		1.18		1.18		1.18
	$\Theta_{cap,pl}$ (rad) =	0.073		0.072		0.072		0.073
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	90		86		86		90
	$(P/A_g f'_c)_{exp}$ =	0.04		0.07		0.07		0.04
Floor 10	$M_{y,pos,exp}$(k-in) =		2394		2394		2394	
	$M_{y,n,slab,exp}$(k-in) =		-5863		-5863		-5863	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		6.927E+07		6.927E+07		6.927E+07	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.046		0.046		0.046	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.078		-0.078		-0.078	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		100		100		100	
Story 9	$M_{y,exp}$ (k-in) =	3823		5989		5989		3823
	EI_{stf}/EI_g =	0.35		0.38		0.38		0.35
	M_c/M_y =	1.18		1.17		1.17		1.18
	$\Theta_{cap,pl}$ (rad) =	0.071		0.068		0.068		0.071
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	89		83		83		89
	$(P/A_g f'_c)_{exp}$ =	0.05		0.10		0.10		0.05
Floor 9	$M_{y,pos,exp}$(k-in) =		2620		2620		2620	
	$M_{y,n,slab,exp}$(k-in) =		-6600		-6600		-6600	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.035		0.035	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 8	$M_{y,exp}$ (k-in) =	4460		6531		6531		4460
	EI_{stf}/EI_g =	0.39		0.45		0.45		0.39
	M_c/M_y =	1.18		1.17		1.17		1.18
	$\Theta_{cap,pl}$ (rad) =	0.071		0.066		0.066		0.071
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	87		81		81		87
	$(P/A_g f'_c)_{exp}$ =	0.06		0.12		0.12		0.06
Floor 8	$M_{y,pos,exp}$(k-in) =		2620		2620		2620	
	$M_{y,n,slab,exp}$(k-in) =		-6694		-6694		-6694	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.035		0.035	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 7	$M_{y,exp}$ (k-in) =	4743		7063		7063		4743
	EI_{stf}/EI_g =	0.40		0.47		0.47		0.40
	M_c/M_y =	1.18		1.17		1.17		1.18
	$\Theta_{cap,pl}$ (rad) =	0.069		0.063		0.063		0.069
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	86		78		78		86
	$(P/A_g f'_c)_{exp}$ =	0.07		0.15		0.15		0.07
Floor 7	$M_{y,pos,exp}$(k-in) =		3016		3016		3016	
	$M_{y,n,slab,exp}$(k-in) =		-7548		-7548		-7548	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.0353		0.0353	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 6	$M_{y,exp}$ (k-in) =	5022		7587		7587		5022
	EI_{stf}/EI_g =	0.41		0.50		0.50		0.41
	M_c/M_y =	1.17		1.16		1.16		1.17
	$\Theta_{cap,pl}$ (rad) =	0.068		0.060		0.060		0.068
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	85		76		76		85
	$(P/A_g f'_c)_{exp}$ =	0.08		0.17		0.17		0.08
Floor 6	$M_{y,pos,exp}$(k-in) =		3016		3016		3016	
	$M_{y,n,slab,exp}$(k-in) =		-7454		-7454		-7454	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.0354		0.0354	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 5	$M_{y,exp}$ (k-in) =	5298		8103		8103		5298
	EI_{stf}/EI_g =	0.43		0.52		0.52		0.43
	M_c/M_y =	1.17		1.16		1.16		1.17
	$\Theta_{cap,pl}$ (rad) =	0.066		0.057		0.057		0.066
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	83		73		73		83
	$(P/A_g f'_c)_{exp}$ =	0.10		0.19		0.19		0.10
Floor 5	$M_{y,pos,exp}$(k-in) =		3016		3016		3016	
	$M_{y,n,slab,exp}$(k-in) =		-7424		-7424		-7424	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.0354		0.0354	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 4	$M_{y,exp}$ (k-in) =	5572		8611		8611		5572
	EI_{stf}/EI_g =	0.44		0.54		0.54		0.44
	M_c/M_y =	1.17		1.16		1.16		1.17
	$\Theta_{cap,pl}$ (rad) =	0.065		0.055		0.055		0.065
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	82		71		71		82
	$(P/A_g f'_c)_{exp}$ =	0.11		0.22		0.22		0.11
Floor 4	$M_{y,pos,exp}$(k-in) =		2917		2917		2917	
	$M_{y,n,slab,exp}$(k-in) =		-7328		-7328		-7328	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.035		0.0351		0.0351	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.060		-0.060		-0.060	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 3	$M_{y,exp}$ (k-in) =	5843		9114		9114		5843
	EI_{stf}/EI_g =	0.45		0.57		0.57		0.45
	M_c/M_y =	1.17		1.15		1.15		1.17
	$\Theta_{cap,pl}$ (rad) =	0.063		0.052		0.052		0.063
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	81		69		69		81
	$(P/A_g f'_c)_{exp}$ =	0.12		0.24		0.24		0.12
Floor 3	$M_{y,pos,exp}$(k-in) =		3033		3033		3033	
	$M_{y,n,slab,exp}$(k-in) =		-7235		-7235		-7235	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.036		0.0355		0.0355	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.059		-0.059		-0.059	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 2	$M_{y,exp}$ (k-in) =	5424		9961		9961		5424
	EI_{stf}/EI_g =	0.46		0.59		0.59		0.46
	M_c/M_y =	1.17		1.15		1.15		1.17
	$\Theta_{cap,pl}$ (rad) =	0.060		0.046		0.046		0.060
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	79		67		67		79
	$(P/A_g f'_c)_{exp}$ =	0.13		0.27		0.27		0.13
Floor 2	$M_{y,pos,exp}$(k-in) =		3305		3305		3305	
	$M_{y,n,slab,exp}$(k-in) =		-7049		-7049		-7049	
	EI_{stf}/EI_g =		0.35		0.35		0.35	
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =		1.419E+08		1.419E+08		1.419E+08	
	$(\Theta_{cap,pl})_{pos}$ (rad) =		0.036		0.036		0.036	
	$(\Theta_{cap,pl})_{neg}$ (rad) =		-0.058		-0.058		-0.058	
	Θ_{pc} (rad) =		0.100		0.100		0.100	
	λ =		99		99		99	
Story 1	$M_{y,exp}$ (k-in) =	5691		10129		10129		5691
	EI_{stf}/EI_g =	0.47		0.62		0.62		0.47
	M_c/M_y =	1.17		1.15		1.15		1.17
	$\Theta_{cap,pl}$ (rad) =	0.059		0.044		0.044		0.059
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	78		65		65		78
	$(P/A_g f'_c)_{exp}$ =	0.15		0.29		0.29		0.15

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.27 T_2 = 0.77 T_3 = 0.45

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

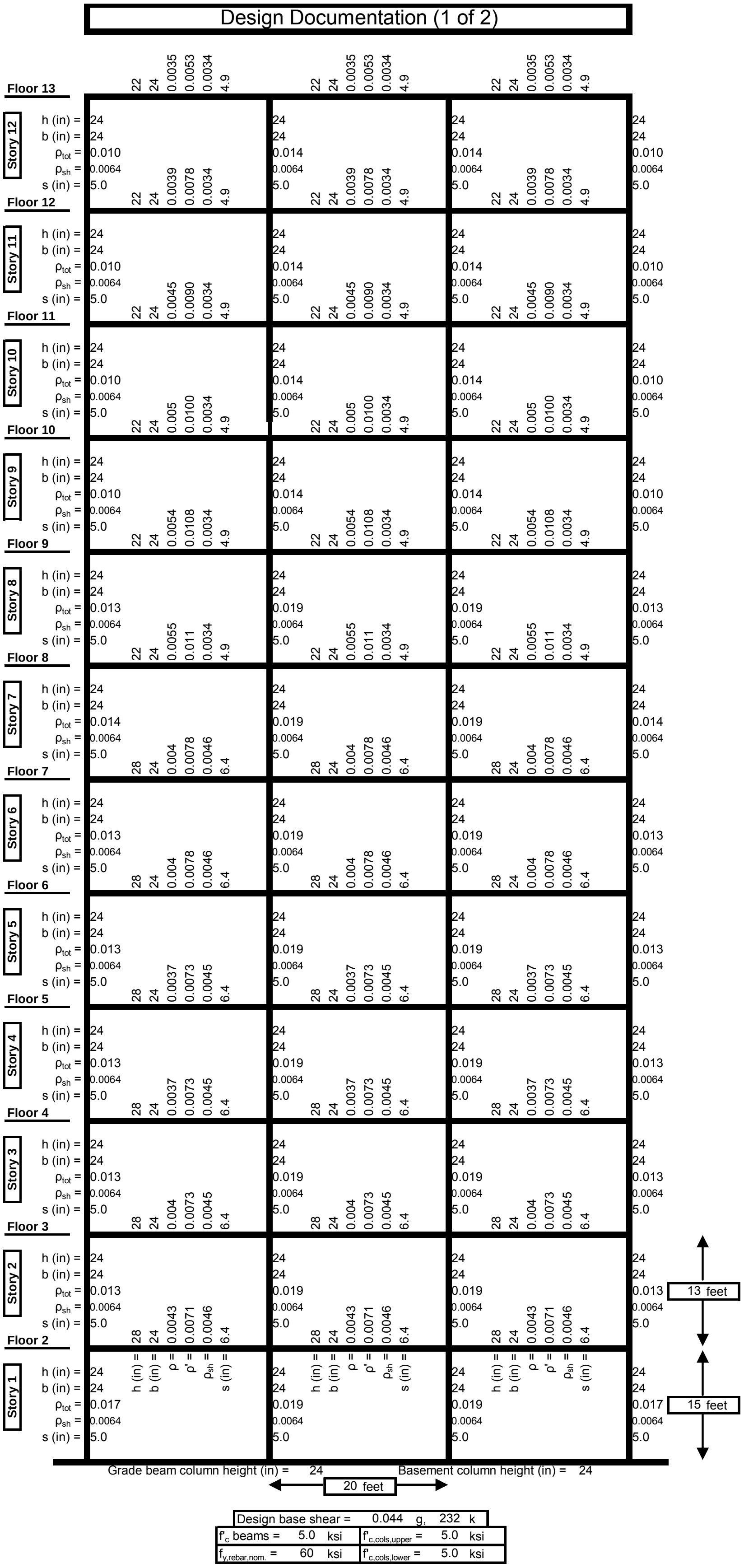
Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2029
Number of Stories: 12
Fundamental Period (sec): 1.99

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

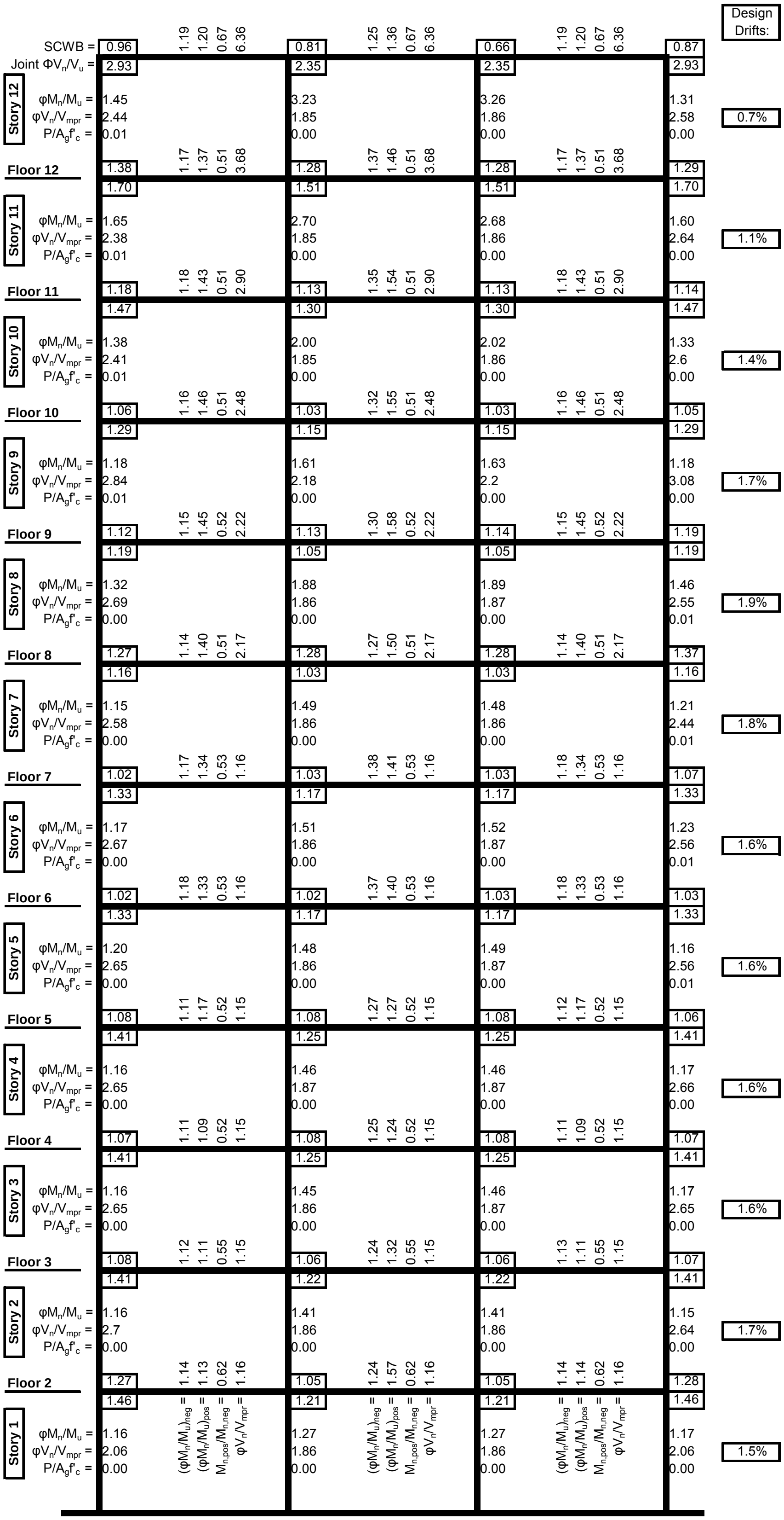
2029 SCWB=1.0

Simply using less reinforcements in the column from the baseline design was sufficient to obtain SCWB=1.0. Like the baseline, joint shear and drift controls this design—joint shear more dominate. Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 5 by flexural demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). Column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES


Design Documentation (1 of 2)
Floor 13
22 24 0.0035 0.0053 0.0034 4.9
Story 12
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.010 0.014 0.014 0.010
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 12
22 24 0.0039 0.0078 0.0034 4.9
Story 11
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.010 0.014 0.014 0.010
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 11
22 24 0.0045 0.0090 0.0034 4.9
Story 10
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.010 0.014 0.014 0.010
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 10
22 24 0.005 0.0100 0.0034 4.9
Story 9
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.010 0.014 0.014 0.010
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 9
22 24 0.0054 0.0108 0.0034 4.9
Story 8
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 8
22 24 0.0055 0.011 0.0034 4.9
Story 7
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.014 0.019 0.019 0.014
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 7
28 24 0.004 0.0078 0.0046 6.4
Story 6
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 6
28 24 0.004 0.0078 0.0046 6.4
Story 5
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 5
28 24 0.0037 0.0073 0.0045 6.4
Story 4
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 4
28 24 0.0037 0.0073 0.0045 6.4
Story 3
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
Floor 3
28 24 0.004 0.0073 0.0045 6.4
Story 2
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.013 0.019 0.019 0.013
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
13 feet
Floor 2
28 24 0.0043 0.0071 0.0046 6.4
h (in) = b (in) = ρ = ρ' = ρsh = s (in) =
Story 1
h (in) = 24 24 24 24
b (in) = 24 24 24 24
ρtot = 0.017 0.019 0.019 0.017
ρsh = 0.0064 0.0064 0.0064 0.0064
s (in) = 5.0 5.0 5.0 5.0
15 feet
Grade beam column height (in) = 24
Basement column height (in) = 24
20 feet
Design base shear = 0.044 g, 232 k
f'c beams = 5.0 ksi
f'c,cols,upper = 5.0 ksi
fy,rebar,nom. = 60 ksi
f'c,cols,lower = 5.0 ksi

Design Documentation (2 of 2)



Story	φMn/Mu =	φVn/Vmpr =	P/Agf'c =	φMn/Mu =	φVn/Vmpr =	P/Agf'c =	φMn/Mu =	φVn/Vmpr =	P/Agf'c =	φMn/Mu =	φVn/Vmpr =	P/Agf'c =	Design Drifts:
Story 12	1.45	2.44	0.01	3.23	1.85	0.00	3.26	1.86	0.00	1.31	2.58	0.00	0.7%
Story 11	1.65	2.38	0.01	2.70	1.85	0.00	2.68	1.86	0.00	1.60	2.64	0.00	1.1%
Story 10	1.38	2.41	0.01	2.00	1.85	0.00	2.02	1.86	0.00	1.33	2.6	0.00	1.4%
Story 9	1.18	2.84	0.01	1.61	2.18	0.00	1.63	2.2	0.00	1.18	3.08	0.00	1.7%
Story 8	1.32	2.69	0.00	1.88	1.86	0.00	1.89	1.87	0.00	1.46	2.55	0.01	1.9%
Story 7	1.15	2.58	0.00	1.49	1.86	0.00	1.48	1.86	0.00	1.21	2.44	0.01	1.8%
Story 6	1.17	2.67	0.00	1.51	1.86	0.00	1.52	1.87	0.00	1.23	2.56	0.01	1.6%
Story 5	1.20	2.65	0.00	1.48	1.86	0.00	1.49	1.87	0.00	1.16	2.56	0.01	1.6%
Story 4	1.16	2.65	0.00	1.46	1.87	0.00	1.46	1.87	0.00	1.17	2.66	0.00	1.6%
Story 3	1.16	2.65	0.00	1.45	1.86	0.00	1.46	1.87	0.00	1.17	2.65	0.00	1.6%
Story 2	1.16	2.7	0.00	1.41	1.86	0.00	1.41	1.86	0.00	1.15	2.64	0.00	1.7%
Story 1	1.16	2.06	0.00	1.27	1.86	0.00	1.27	1.86	0.00	1.17	2.06	0.00	1.5%

Floor	SCWB =	SCWB =	SCWB =	SCWB =	Joint ΦVn/Vu =	Joint ΦVn/Vu =	Joint ΦVn/Vu =	Joint ΦVn/Vu =
	0.96	0.81	0.66	0.87	2.93	2.35	2.35	2.93
Floor 12	1.38	1.28	1.28	1.29	1.70	1.51	1.51	1.70
Floor 11	1.18	1.13	1.13	1.14	1.47	1.30	1.30	1.47
Floor 10	1.06	1.03	1.03	1.05	1.29	1.15	1.15	1.29
Floor 9	1.12	1.13	1.14	1.19	1.19	1.05	1.05	1.19
Floor 8	1.27	1.28	1.28	1.37	1.16	1.03	1.03	1.16
Floor 7	1.02	1.03	1.03	1.07	1.33	1.17	1.17	1.33
Floor 6	1.02	1.02	1.03	1.03	1.33	1.17	1.17	1.33
Floor 5	1.08	1.08	1.08	1.06	1.41	1.25	1.25	1.41
Floor 4	1.07	1.08	1.08	1.07	1.41	1.25	1.25	1.41
Floor 3	1.08	1.06	1.06	1.07	1.41	1.22	1.22	1.41
Floor 2	1.27	1.05	1.05	1.28	1.46	1.21	1.21	1.46

Floor	(φMn/Mu)neg =	(φMn/Mu)pos =	Mn,pos/Mn,neg =	φVn/Vmpr =	(φMn/Mu)neg =	(φMn/Mu)pos =	Mn,pos/Mn,neg =	φVn/Vmpr =	(φMn/Mu)neg =	(φMn/Mu)pos =	Mn,pos/Mn,neg =	φVn/Vmpr =
	1.19	1.20	0.67	6.36	1.25	1.36	0.67	6.36	1.19	1.20	0.67	6.36
Floor 12	1.17	1.37	0.51	3.68	1.37	1.46	0.51	3.68	1.17	1.37	0.51	3.68
Floor 11	1.18	1.43	0.51	2.90	1.35	1.54	0.51	2.90	1.18	1.43	0.51	2.90
Floor 10	1.16	1.46	0.51	2.48	1.32	1.55	0.51	2.48	1.16	1.46	0.51	2.48
Floor 9	1.15	1.45	0.52	2.22	1.30	1.58	0.52	2.22	1.15	1.45	0.52	2.22
Floor 8	1.14	1.40	0.51	2.17	1.27	1.50	0.51	2.17	1.14	1.40	0.51	2.17
Floor 7	1.17	1.34	0.53	1.16	1.38	1.41	0.53	1.16	1.18	1.34	0.53	1.16
Floor 6	1.18	1.33	0.53	1.16	1.37	1.40	0.53	1.16	1.18	1.33	0.53	1.16
Floor 5	1.11	1.17	0.52	1.15	1.27	1.27	0.52	1.15	1.12	1.17	0.52	1.15
Floor 4	1.11	1.09	0.52	1.15	1.25	1.24	0.52	1.15	1.11	1.09	0.52	1.15
Floor 3	1.12	1.11	0.55	1.15	1.24	1.32	0.55	1.15	1.13	1.11	0.55	1.15
Floor 2	1.14	1.13	0.62	1.16	1.24	1.57	0.62	1.16	1.14	1.14	0.62	1.16

Modeling Documentation (1 of 1)

Floor 13

$M_{y,pos,exp}$(k-in) =	1977	1977	1977
$M_{y,n,slab,exp}$(k-in) =	-4223	-4223	-4223
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	3.724E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0413	0.0413	0.0413
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.067	-0.067	-0.067
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 12

$M_{y,exp}$ (k-in) =	3794	5462	5462	3794
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.061	0.062	0.062	0.061
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	98	96	96	98
$(P/A_g f'_c)_{exp}$ =	0.01	0.03	0.03	0.01

Floor 12

$M_{y,pos,exp}$(k-in) =	2196	2196	2196
$M_{y,n,slab,exp}$(k-in) =	-5545	-5545	-5545
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.041	0.041	0.041
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 11

$M_{y,exp}$ (k-in) =	4160	6166	6166	4160
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.20	1.20	1.21
$\Theta_{cap,pl}$ (rad) =	0.060	0.059	0.059	0.060
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	96	93	93	96
$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03

Floor 11

$M_{y,pos,exp}$(k-in) =	2533	2533	2533
$M_{y,n,slab,exp}$(k-in) =	-6201	-6201	-6201
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 10

$M_{y,exp}$ (k-in) =	4521	6854	6854	4521
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.20	1.20	1.20
$\Theta_{cap,pl}$ (rad) =	0.059	0.056	0.056	0.059
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	95	90	90	95
$(P/A_g f'_c)_{exp}$ =	0.04	0.08	0.08	0.04

Floor 10

$M_{y,pos,exp}$(k-in) =	2804	2804	2804
$M_{y,n,slab,exp}$(k-in) =	-6724	-6724	-6724
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 9

$M_{y,exp}$ (k-in) =	4876	7527	7527	4876
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.057	0.053	0.053	0.057
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	93	87	87	93
$(P/A_g f'_c)_{exp}$ =	0.05	0.11	0.11	0.05

Floor 9

$M_{y,pos,exp}$(k-in) =	3046	3046	3046
$M_{y,n,slab,exp}$(k-in) =	-7115	-7115	-7115
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 8

$M_{y,exp}$ (k-in) =	6191	9777	9777	6191
EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.057	0.053	0.053	0.057
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	92	84	84	92
$(P/A_g f'_c)_{exp}$ =	0.07	0.13	0.13	0.07

Floor 8

$M_{y,pos,exp}$(k-in) =	3059	3059	3059
$M_{y,n,slab,exp}$(k-in) =	-7245	-7245	-7245
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	7.428E+07	7.428E+07	7.428E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 7

$M_{y,exp}$ (k-in) =	6694	10424	10424	6694
EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.056	0.050	0.050	0.056
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	90	81	81	90
$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08

Floor 7

$M_{y,pos,exp}$(k-in) =	3876	3876	3876
$M_{y,n,slab,exp}$(k-in) =	-9064	-9064	-9064
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.0421	0.0421
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 6

$M_{y,exp}$ (k-in) =	6873	11062	11062	6873
EI_{stf}/EI_g =	0.36	0.46	0.46	0.36
M_c/M_y =	1.20	1.18	1.18	1.20
$\Theta_{cap,pl}$ (rad) =	0.054	0.048	0.048	0.054
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	88	78	78	88
$(P/A_g f'_c)_{exp}$ =	0.09	0.19	0.19	0.09

Floor 6

$M_{y,pos,exp}$(k-in) =	3876	3876	3876
$M_{y,n,slab,exp}$(k-in) =	-9064	-9064	-9064
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.0421	0.0421
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 5

$M_{y,exp}$ (k-in) =	7208	11691	11691	7208
EI_{stf}/EI_g =	0.38	0.48	0.48	0.38
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.053	0.046	0.046	0.053
Θ_{pc} (rad) =	0.100	0.096	0.096	0.100
λ =	87	75	75	87
$(P/A_g f'_c)_{exp}$ =	0.11	0.22	0.22	0.11

Floor 5

$M_{y,pos,exp}$(k-in) =	3619	3619	3619
$M_{y,n,slab,exp}$(k-in) =	-8685	-8685	-8685
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.041	0.0411	0.0411
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 4

$M_{y,exp}$ (k-in) =	7541	12313	12313	7621
EI_{stf}/EI_g =	0.39	0.51	0.51	0.39
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.052	0.044	0.044	0.052
Θ_{pc} (rad) =	0.100	0.088	0.088	0.100
λ =	85	73	73	85
$(P/A_g f'_c)_{exp}$ =	0.12	0.24	0.24	0.12

Floor 4

$M_{y,pos,exp}$(k-in) =	3619	3619	3619
$M_{y,n,slab,exp}$(k-in) =	-8685	-8685	-8685
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.041	0.0411	0.0411
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 3

$M_{y,exp}$ (k-in) =	7870	12927	12927	7950
EI_{stf}/EI_g =	0.40	0.54	0.54	0.40
M_c/M_y =	1.19	1.17	1.17	1.19
$\Theta_{cap,pl}$ (rad) =	0.050	0.041	0.041	0.051
Θ_{pc} (rad) =	0.100	0.080	0.080	0.100
λ =	84	70	70	84
$(P/A_g f'_c)_{exp}$ =	0.13	0.27	0.27	0.13

Floor 3

$M_{y,pos,exp}$(k-in) =	3876	3876	3876
$M_{y,n,slab,exp}$(k-in) =	-8688	-8688	-8688
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.067	-0.067	-0.067
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 2

$M_{y,exp}$ (k-in) =	8197	13534	13534	8276
EI_{stf}/EI_g =	0.42	0.56	0.56	0.42
M_c/M_y =	1.19	1.17	1.17	1.19
$\Theta_{cap,pl}$ (rad) =	0.049	0.039	0.039	0.049
Θ_{pc} (rad) =	0.100	0.073	0.073	0.100
λ =	82	68	68	82
$(P/A_g f'_c)_{exp}$ =	0.15	0.30	0.30	0.15

Floor 2

$M_{y,pos,exp}$(k-in) =	4202	4202	4202
$M_{y,n,slab,exp}$(k-in) =	-8464	-8464	-8464
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.522E+08	1.522E+08	1.522E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.066	-0.066	-0.066
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	99	99	99

Story 1

$M_{y,exp}$ (k-in) =	9789	15090	15090	9789
EI_{stf}/EI_g =	0.43	0.59	0.59	0.43
M_c/M_y =	1.19	1.17	1.17	1.19
$\Theta_{cap,pl}$ (rad) =	0.050	0.038	0.038	0.050
Θ_{pc} (rad) =	0.100	0.066	0.066	0.100
λ =	81	65	65	81
$(P/A_g f'_c)_{exp}$ =	0.16	0.32	0.32	0.16

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.99 T_2 = 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2030
Number of Stories: 12
Fundamental Period (sec): 1.99

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2030 SCWB=0.8

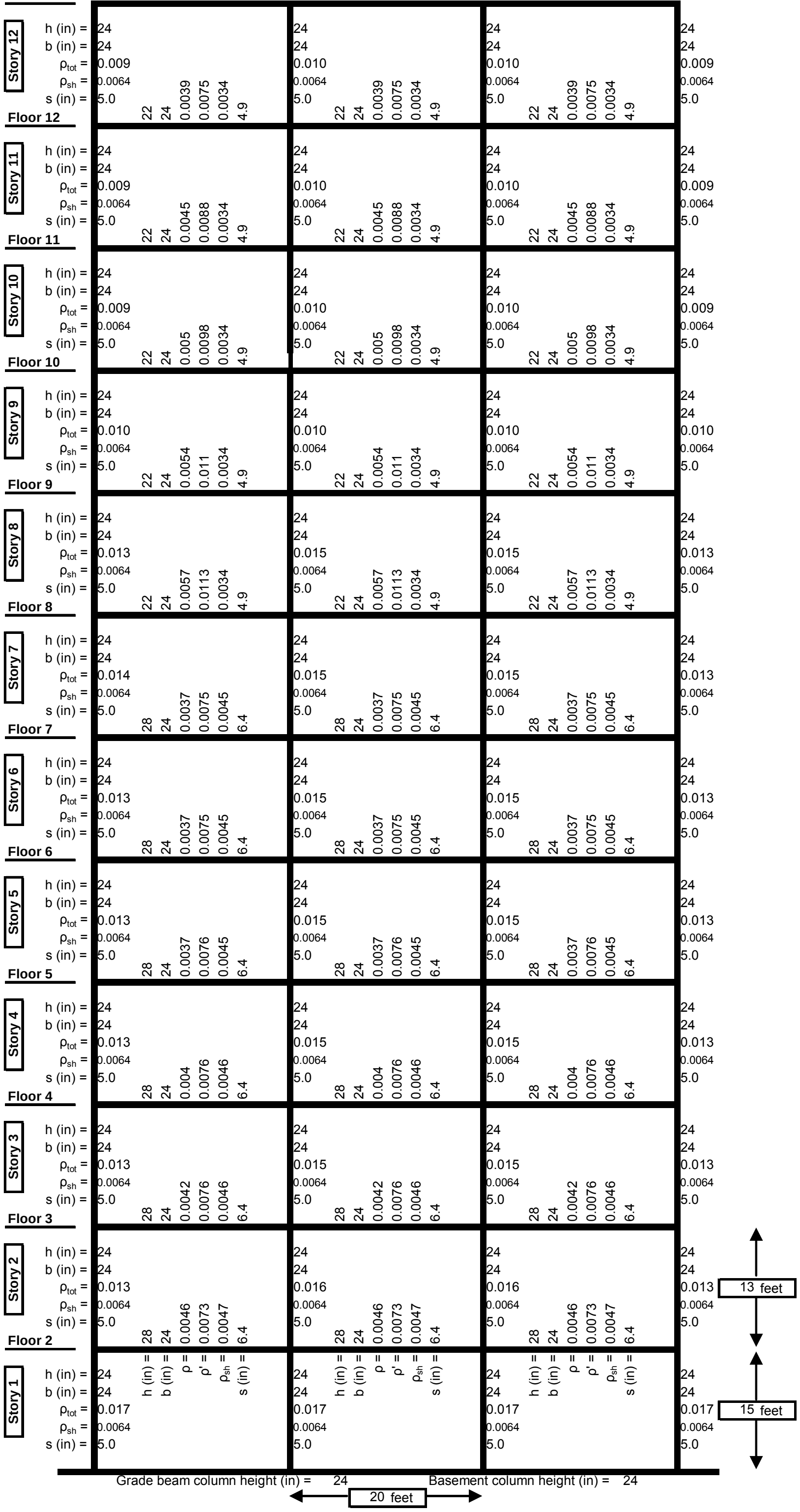
Note: for the purpose of sensitivity analysis, this design ignores the minimum requirement ratio in the columns. Furthermore, the beam and column sizes were kept as in 2029, where only the column reinforcement are make less dense to reach smaller SCWB ratio. Reason: By making column sizes smaller, beam sizes would have to be larger to satisfy drift; and my making beam sizes larger, minimum reinforcement requirement in the beam will be imposed.

Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Few column flexural strengths were controlled by the strong-column weak-beam ratio, 28 columns (mostly exterior columns) by flexural demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). Column stirrups were controlled by the minimum confinement requirement.

Note: Design for smaller SCWB were done but ignored for analysis because majority of the columns in this design (2030) were already controlled by flexural strength. Thus, even by making a less SCWB requirement will not increase capacity performance, and will analysis result will be misleading.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)

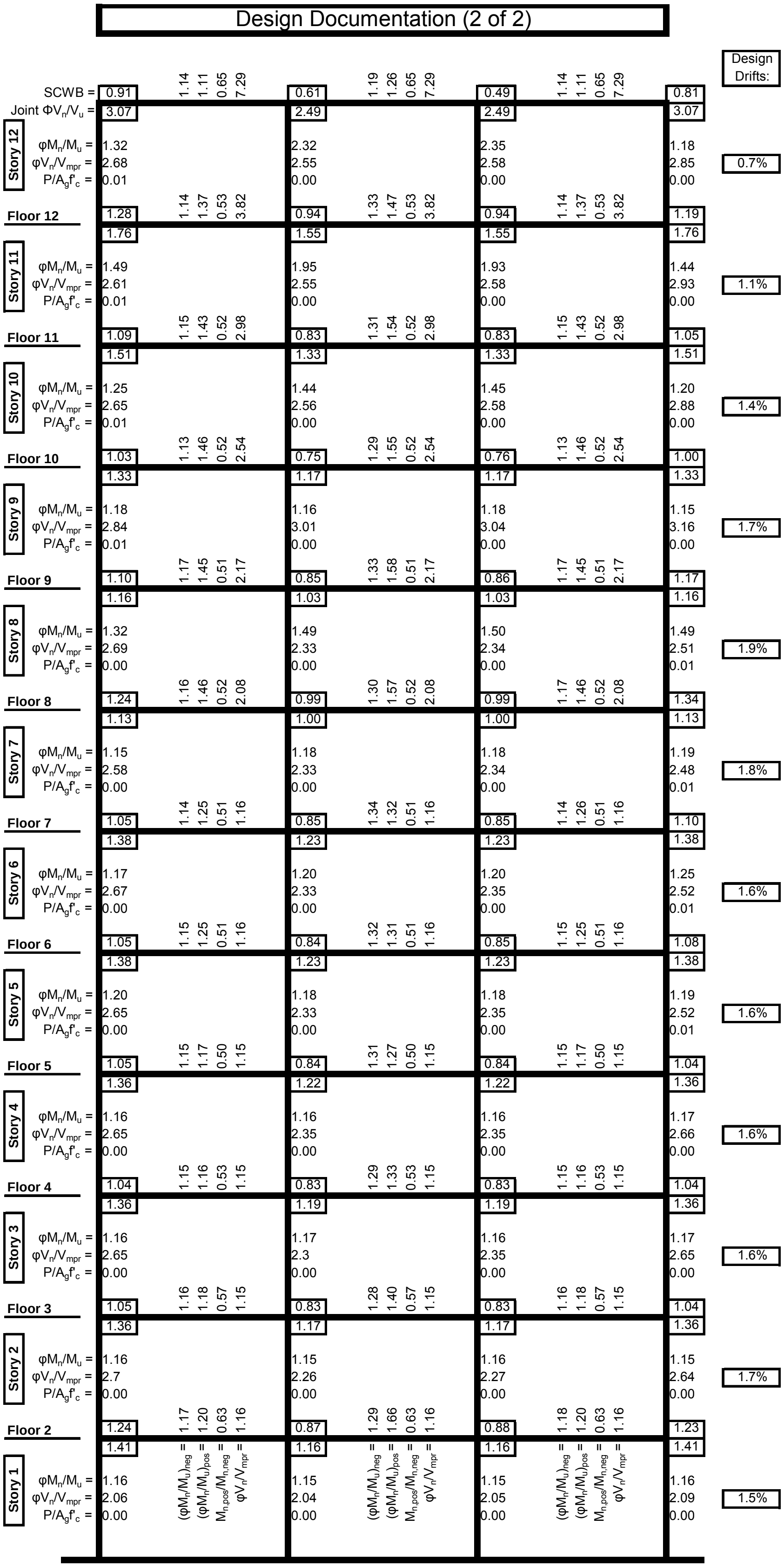


	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	24	24	0.009	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.009	0.0064	5.0
Story 11	24	24	0.009	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.009	0.0064	5.0
Story 10	24	24	0.009	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.009	0.0064	5.0
Story 9	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
	24	24	0.010	0.0064	5.0
Story 8	24	24	0.013	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 7	24	24	0.014	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 6	24	24	0.013	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 5	24	24	0.013	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 4	24	24	0.013	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 3	24	24	0.013	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.015	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 2	24	24	0.013	0.0064	5.0
	24	24	0.016	0.0064	5.0
	24	24	0.016	0.0064	5.0
	24	24	0.013	0.0064	5.0
Story 1	24	24	0.017	0.0064	5.0
	24	24	0.017	0.0064	5.0
	24	24	0.017	0.0064	5.0
	24	24	0.017	0.0064	5.0

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	22	24	0.0032	0.0050	0.0034	4.9
	22	24	0.0032	0.0050	0.0034	4.9
	22	24	0.0032	0.0050	0.0034	4.9
Floor 12	22	24	0.0039	0.0075	0.0034	4.9
	22	24	0.0039	0.0075	0.0034	4.9
	22	24	0.0039	0.0075	0.0034	4.9
Floor 11	22	24	0.0045	0.0088	0.0034	4.9
	22	24	0.0045	0.0088	0.0034	4.9
	22	24	0.0045	0.0088	0.0034	4.9
Floor 10	22	24	0.005	0.0098	0.0034	4.9
	22	24	0.005	0.0098	0.0034	4.9
	22	24	0.005	0.0098	0.0034	4.9
Floor 9	22	24	0.0054	0.011	0.0034	4.9
	22	24	0.0054	0.011	0.0034	4.9
	22	24	0.0054	0.011	0.0034	4.9
Floor 8	22	24	0.0057	0.0113	0.0034	4.9
	22	24	0.0057	0.0113	0.0034	4.9
	22	24	0.0057	0.0113	0.0034	4.9
Floor 7	28	24	0.0037	0.0075	0.0045	6.4
	28	24	0.0037	0.0075	0.0045	6.4
	28	24	0.0037	0.0075	0.0045	6.4
Floor 6	28	24	0.0037	0.0075	0.0045	6.4
	28	24	0.0037	0.0075	0.0045	6.4
	28	24	0.0037	0.0075	0.0045	6.4
Floor 5	28	24	0.0037	0.0076	0.0045	6.4
	28	24	0.0037	0.0076	0.0045	6.4
	28	24	0.0037	0.0076	0.0045	6.4
Floor 4	28	24	0.004	0.0076	0.0046	6.4
	28	24	0.004	0.0076	0.0046	6.4
	28	24	0.004	0.0076	0.0046	6.4
Floor 3	28	24	0.0042	0.0076	0.0046	6.4
	28	24	0.0042	0.0076	0.0046	6.4
	28	24	0.0042	0.0076	0.0046	6.4
Floor 2	28	24	0.0046	0.0073	0.0047	6.4
	28	24	0.0046	0.0073	0.0047	6.4
	28	24	0.0046	0.0073	0.0047	6.4

Design base shear = 0.044 g, 232 k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi



Design Documentation (2 of 2)

								Design Drifts:
SCWB =	0.91	1.14 1.11 0.65 7.29	0.61	1.19 1.26 0.65 7.29	0.49	1.14 1.11 0.65 7.29	0.81	
Joint $\Phi V_n/V_u$ =	3.07		2.49		2.49		3.07	
Story 12 $\varphi M_n/M_u$ =	1.32		2.32		2.35		1.18	
$\varphi V_n/V_{mpr}$ =	2.68		2.55		2.58		2.85	0.7%
$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 12	1.28	1.14 1.37 0.53 3.82	0.94	1.33 1.47 0.53 3.82	0.94	1.14 1.37 0.53 3.82	1.19	
	1.76		1.55		1.55		1.76	
Story 11 $\varphi M_n/M_u$ =	1.49		1.95		1.93		1.44	
$\varphi V_n/V_{mpr}$ =	2.61		2.55		2.58		2.93	1.1%
$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 11	1.09	1.15 1.43 0.52 2.98	0.83	1.31 1.54 0.52 2.98	0.83	1.15 1.43 0.52 2.98	1.05	
	1.51		1.33		1.33		1.51	
Story 10 $\varphi M_n/M_u$ =	1.25		1.44		1.45		1.20	
$\varphi V_n/V_{mpr}$ =	2.65		2.56		2.58		2.88	1.4%
$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 10	1.03	1.13 1.46 0.52 2.54	0.75	1.29 1.55 0.52 2.54	0.76	1.13 1.46 0.52 2.54	1.00	
	1.33		1.17		1.17		1.33	
Story 9 $\varphi M_n/M_u$ =	1.18		1.16		1.18		1.15	
$\varphi V_n/V_{mpr}$ =	2.84		3.01		3.04		3.16	1.7%
$P/A_g f'_c$ =	0.01		0.00		0.00		0.00	
Floor 9	1.10	1.17 1.45 0.51 2.17	0.85	1.33 1.58 0.51 2.17	0.86	1.17 1.45 0.51 2.17	1.17	
	1.16		1.03		1.03		1.16	
Story 8 $\varphi M_n/M_u$ =	1.32		1.49		1.50		1.49	
$\varphi V_n/V_{mpr}$ =	2.69		2.33		2.34		2.51	1.9%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 8	1.24	1.16 1.46 0.52 2.08	0.99	1.30 1.57 0.52 2.08	0.99	1.17 1.46 0.52 2.08	1.34	
	1.13		1.00		1.00		1.13	
Story 7 $\varphi M_n/M_u$ =	1.15		1.18		1.18		1.19	
$\varphi V_n/V_{mpr}$ =	2.58		2.33		2.34		2.48	1.8%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 7	1.05	1.14 1.25 0.51 1.16	0.85	1.34 1.32 0.51 1.16	0.85	1.14 1.26 0.51 1.16	1.10	
	1.38		1.23		1.23		1.38	
Story 6 $\varphi M_n/M_u$ =	1.17		1.20		1.20		1.25	
$\varphi V_n/V_{mpr}$ =	2.67		2.33		2.35		2.52	1.6%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 6	1.05	1.15 1.25 0.51 1.16	0.84	1.32 1.31 0.51 1.16	0.85	1.15 1.25 0.51 1.16	1.08	
	1.38		1.23		1.23		1.38	
Story 5 $\varphi M_n/M_u$ =	1.20		1.18		1.18		1.19	
$\varphi V_n/V_{mpr}$ =	2.65		2.33		2.35		2.52	1.6%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.01	
Floor 5	1.05	1.15 1.17 0.50 1.15	0.84	1.31 1.27 0.50 1.15	0.84	1.15 1.17 0.50 1.15	1.04	
	1.36		1.22		1.22		1.36	
Story 4 $\varphi M_n/M_u$ =	1.16		1.16		1.16		1.17	
$\varphi V_n/V_{mpr}$ =	2.65		2.35		2.35		2.66	1.6%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 4	1.04	1.15 1.16 0.53 1.15	0.83	1.29 1.33 0.53 1.15	0.83	1.15 1.16 0.53 1.15	1.04	
	1.36		1.19		1.19		1.36	
Story 3 $\varphi M_n/M_u$ =	1.16		1.17		1.16		1.17	
$\varphi V_n/V_{mpr}$ =	2.65		2.3		2.35		2.65	1.6%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 3	1.05	1.16 1.18 0.57 1.15	0.83	1.28 1.40 0.57 1.15	0.83	1.16 1.18 0.57 1.15	1.04	
	1.36		1.17		1.17		1.36	
Story 2 $\varphi M_n/M_u$ =	1.16		1.15		1.16		1.15	
$\varphi V_n/V_{mpr}$ =	2.7		2.26		2.27		2.64	1.7%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	
Floor 2	1.24	1.17 1.20 0.63 1.16	0.87	1.29 1.66 0.63 1.16	0.88	1.18 1.20 0.63 1.16	1.23	
	1.41	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.16	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.16	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.41	
Story 1 $\varphi M_n/M_u$ =	1.16		1.15		1.15		1.16	
$\varphi V_n/V_{mpr}$ =	2.06		2.04		2.05		2.09	1.5%
$P/A_g f'_c$ =	0.00		0.00		0.00		0.00	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	3465	4160	4160	3465
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.061	0.060	0.060	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	98	96	96	98
	$(P/A_g f'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 11	$M_{y,exp}$ (k-in) =	3833	4876	4876	3833
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.059	0.057	0.057	0.059
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	96	93	93	96
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 10	$M_{y,exp}$ (k-in) =	4195	5572	5572	4195
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.058	0.054	0.054	0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	95	90	90	95
	$(P/A_g f'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 9	$M_{y,exp}$ (k-in) =	4876	6252	6252	4795
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.057	0.052	0.052	0.057
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	93	87	87	93
	$(P/A_g f'_c)_{exp}$ =	0.05	0.11	0.11	0.05
Story 8	$M_{y,exp}$ (k-in) =	6191	8506	8506	6271
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.057	0.051	0.051	0.057
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	92	84	84	92
	$(P/A_g f'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 7	$M_{y,exp}$ (k-in) =	6694	9155	9155	6614
	EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.056	0.049	0.049	0.056
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	90	81	81	90
	$(P/A_g f'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 6	$M_{y,exp}$ (k-in) =	6873	9794	9794	6953
	EI_{stf}/EI_g =	0.36	0.46	0.46	0.36
	M_c/M_y =	1.20	1.18	1.18	1.20
	$\Theta_{cap,pl}$ (rad) =	0.054	0.046	0.046	0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	88	78	78	88
	$(P/A_g f'_c)_{exp}$ =	0.09	0.19	0.19	0.09
Story 5	$M_{y,exp}$ (k-in) =	7208	10423	10423	7288
	EI_{stf}/EI_g =	0.38	0.48	0.48	0.38
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.053	0.044	0.044	0.053
	Θ_{pc} (rad) =	0.100	0.096	0.096	0.100
	λ =	87	75	75	87
	$(P/A_g f'_c)_{exp}$ =	0.11	0.22	0.22	0.11
Story 4	$M_{y,exp}$ (k-in) =	7541	11044	11044	7621
	EI_{stf}/EI_g =	0.39	0.51	0.51	0.39
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.052	0.042	0.042	0.052
	Θ_{pc} (rad) =	0.100	0.088	0.088	0.100
	λ =	85	73	73	85
	$(P/A_g f'_c)_{exp}$ =	0.12	0.24	0.24	0.12
Story 3	$M_{y,exp}$ (k-in) =	7870	11736	11657	7950
	EI_{stf}/EI_g =	0.40	0.54	0.54	0.40
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.050	0.040	0.040	0.051
	Θ_{pc} (rad) =	0.100	0.080	0.080	0.100
	λ =	84	70	70	84
	$(P/A_g f'_c)_{exp}$ =	0.13	0.27	0.27	0.13
Story 2	$M_{y,exp}$ (k-in) =	8197	12421	12421	8276
	EI_{stf}/EI_g =	0.42	0.56	0.56	0.42
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.049	0.038	0.038	0.049
	Θ_{pc} (rad) =	0.100	0.073	0.073	0.100
	λ =	82	68	68	82
	$(P/A_g f'_c)_{exp}$ =	0.15	0.30	0.30	0.15
Story 1	$M_{y,exp}$ (k-in) =	9789	14552	14552	9710
	EI_{stf}/EI_g =	0.43	0.59	0.59	0.43
	M_c/M_y =	1.19	1.17	1.17	1.19
	$\Theta_{cap,pl}$ (rad) =	0.050	0.037	0.037	0.050
	Θ_{pc} (rad) =	0.100	0.066	0.066	0.100
	λ =	81	65	65	81
	$(P/A_g f'_c)_{exp}$ =	0.16	0.32	0.32	0.16

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	1839	-4089	0.35	7.428E+07	0.0407	-0.068	0.100	100
	1839	-4089	0.35	7.428E+07	0.0407	-0.068	0.100	100
	1839	-4089	0.35	3.724E+07	0.0407	-0.068	0.100	100
Floor 12	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
	2197	-5414	0.35	7.428E+07	0.041	-0.070	0.100	100
Floor 11	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
	2533	-6071	0.35	7.428E+07	0.043	-0.070	0.100	100
Floor 10	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
	2805	-6594	0.35	7.428E+07	0.043	-0.071	0.100	100
Floor 9	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
	3046	-7245	0.35	7.428E+07	0.044	-0.072	0.100	100
Floor 8	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
	3195	-7376	0.35	7.428E+07	0.045	-0.071	0.100	100
Floor 7	3639	-8835	0.35	1.522E+08	0.041	-0.068	0.100	99
	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 6	3639	-8835	0.35	1.522E+08	0.041	-0.068	0.100	99
	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
	3639	-8835	0.35	1.522E+08	0.0412	-0.068	0.100	99
Floor 5	3619	-8911	0.35	1.522E+08	0.041	-0.068	0.100	99
	3619	-8911	0.35	1.522E+08	0.0411	-0.068	0.100	99
	3619	-8911	0.35	1.522E+08	0.0411	-0.068	0.100	99
Floor 4	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
	3856	-8914	0.35	1.522E+08	0.042	-0.068	0.100	99
Floor 3	4113	-8917	0.35	1.522E+08	0.043	-0.067	0.100	99
	4113	-8917	0.35	1.522E+08	0.0429	-0.067	0.100	99
	4113	-8917	0.35	1.522E+08	0.0429	-0.067	0.100	99
Floor 2	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99
	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99
	4438	-8693	0.35	1.522E+08	0.044	-0.066	0.100	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.99 T_2 = 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2033
Number of Stories: 12
Fundamental Period (sec): 1.97

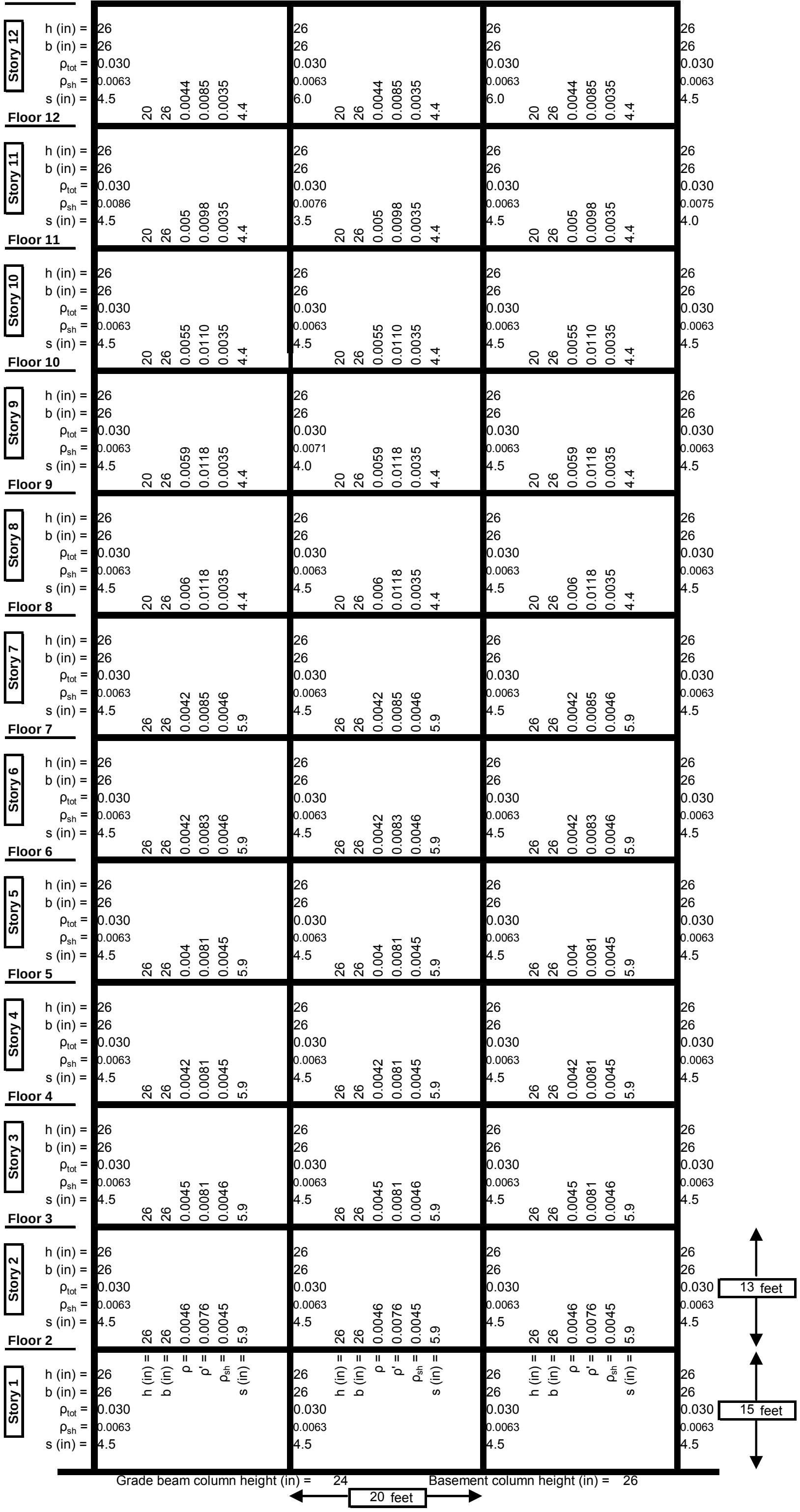
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2033 SCWB=3.0

Simply adding more reinforcements in the column from the 2014 was sufficient to obtain SCWB=3.0. Drift controls this design. Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. Then 24 bays had additional reinforcement added to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except 1 by flexural demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). Most column stirrups were controlled by the minimum confinement requirement, four by shear demand.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Columns:

	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	6.0	26	26	0.030	0.0063	6.0	26	26	0.030	0.0063	4.5
Story 11	26	26	0.030	0.0086	4.5	26	26	0.030	0.0076	3.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0075	4.0
Story 10	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 9	26	26	0.030	0.0063	4.5	26	26	0.030	0.0071	4.0	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 8	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 7	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 6	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 4	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 3	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 2	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5
Story 1	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5	26	26	0.030	0.0063	4.5

Beams:

	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	20	26	0.0039	0.0060	0.0035	4.4	20	26	0.0039	0.0060	0.0035	4.4	20	26	0.0039	0.0060	0.0035	4.4
Floor 12	20	26	0.0044	0.0085	0.0035	4.4	20	26	0.0044	0.0085	0.0035	4.4	20	26	0.0044	0.0085	0.0035	4.4
Floor 11	20	26	0.005	0.0098	0.0035	4.4	20	26	0.005	0.0098	0.0035	4.4	20	26	0.005	0.0098	0.0035	4.4
Floor 10	20	26	0.0055	0.0110	0.0035	4.4	20	26	0.0055	0.0110	0.0035	4.4	20	26	0.0055	0.0110	0.0035	4.4
Floor 9	20	26	0.0059	0.0118	0.0035	4.4	20	26	0.0059	0.0118	0.0035	4.4	20	26	0.0059	0.0118	0.0035	4.4
Floor 8	20	26	0.006	0.0118	0.0035	4.4	20	26	0.006	0.0118	0.0035	4.4	20	26	0.006	0.0118	0.0035	4.4
Floor 7	26	26	0.0042	0.0085	0.0046	5.9	26	26	0.0042	0.0085	0.0046	5.9	26	26	0.0042	0.0085	0.0046	5.9
Floor 6	26	26	0.0042	0.0083	0.0046	5.9	26	26	0.0042	0.0083	0.0046	5.9	26	26	0.0042	0.0083	0.0046	5.9
Floor 5	26	26	0.004	0.0081	0.0045	5.9	26	26	0.004	0.0081	0.0045	5.9	26	26	0.004	0.0081	0.0045	5.9
Floor 4	26	26	0.0042	0.0081	0.0045	5.9	26	26	0.0042	0.0081	0.0045	5.9	26	26	0.0042	0.0081	0.0045	5.9
Floor 3	26	26	0.0045	0.0081	0.0046	5.9	26	26	0.0045	0.0081	0.0046	5.9	26	26	0.0045	0.0081	0.0046	5.9
Floor 2	26	26	0.0046	0.0076	0.0045	5.9	26	26	0.0046	0.0076	0.0045	5.9	26	26	0.0046	0.0076	0.0045	5.9

Grade beam column height (in) = 24

Basement column height (in) = 26

Design base shear = 0.044 g, 232 k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	5.0	ksi

Design Documentation (2 of 2)

								Design Drifts:
SCWB =	1.28		0.89		0.98		1.28	
Joint $\Phi V_n/V_u$ =	2.94		2.38		2.38		2.94	
$(\varphi M_n/M_u)_{neg}$ =		1.16		1.23		1.16		
$(\varphi M_n/M_u)_{pos}$ =		1.22		1.34		1.22		
$M_{n,pos}/M_{n,neg}$ =		0.66		0.66		0.66		
$\varphi V_n/V_{mpr}$ =		5.77		5.77		5.77		
Story 12 $\varphi M_n/M_u$ =	1.72		3.12		4.12		1.73	
$\varphi V_n/V_{mpr}$ =	2.13		1.93		1.5		2.13	0.8%
$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
Floor 12 $(\varphi M_n/M_u)_{neg}$ =		1.17		1.33		1.18		
$(\varphi M_n/M_u)_{pos}$ =		1.39		1.47		1.39		
$M_{n,pos}/M_{n,neg}$ =		0.53		0.53		0.53		
$\varphi V_n/V_{mpr}$ =		3.61		3.61		3.61		
SCWB =	3.47		3.05		3.01		3.12	
Joint $\Phi V_n/V_u$ =	1.82		1.60		1.60		1.82	
Story 11 $\varphi M_n/M_u$ =	5.44		8.49		7.51		4.68	
$\varphi V_n/V_{mpr}$ =	1.15		1.01		1		1.15	1.1%
$P/A_g f'_c$ =	0.03		0.06		0.06		0.03	
Floor 11 $(\varphi M_n/M_u)_{neg}$ =		1.17		1.30		1.17		
$(\varphi M_n/M_u)_{pos}$ =		1.42		1.53		1.42		
$M_{n,pos}/M_{n,neg}$ =		0.52		0.52		0.52		
$\varphi V_n/V_{mpr}$ =		2.93		2.93		2.93		
SCWB =	3.19		3.01		3.00		3.00	
Joint $\Phi V_n/V_u$ =	1.59		1.40		1.40		1.59	
Story 10 $\varphi M_n/M_u$ =	2.04		3.13		3.89		2.30	
$\varphi V_n/V_{mpr}$ =	2.48		1.82		1.51		2.25	1.5%
$P/A_g f'_c$ =	0.05		0.09		0.09		0.05	
Floor 10 $(\varphi M_n/M_u)_{neg}$ =		1.17		1.30		1.17		
$(\varphi M_n/M_u)_{pos}$ =		1.44		1.53		1.44		
$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
$\varphi V_n/V_{mpr}$ =		2.50		2.50		2.50		
SCWB =	3.15		3.00		3.01		3.01	
Joint $\Phi V_n/V_u$ =	1.38		1.23		1.23		1.38	
Story 9 $\varphi M_n/M_u$ =	5.13		6.84		6.23		4.58	
$\varphi V_n/V_{mpr}$ =	1.21		0.99		1		1.35	1.8%
$P/A_g f'_c$ =	0.07		0.12		0.12		0.07	
Floor 9 $(\varphi M_n/M_u)_{neg}$ =		1.16		1.28		1.16		
$(\varphi M_n/M_u)_{pos}$ =		1.45		1.55		1.45		
$M_{n,pos}/M_{n,neg}$ =		0.52		0.52		0.52		
$\varphi V_n/V_{mpr}$ =		2.27		2.27		2.27		
SCWB =	3.04		3.01		3.00		2.99	
Joint $\Phi V_n/V_u$ =	1.28		1.13		1.13		1.28	
Story 8 $\varphi M_n/M_u$ =	1.72		2.76		3.24		2.08	
$\varphi V_n/V_{mpr}$ =	2.83		1.93		1.69		2.44	2.0%
$P/A_g f'_c$ =	0.09		0.16		0.16		0.09	
Floor 8 $(\varphi M_n/M_u)_{neg}$ =		1.16		1.26		1.16		
$(\varphi M_n/M_u)_{pos}$ =		1.44		1.55		1.45		
$M_{n,pos}/M_{n,neg}$ =		0.52		0.52		0.52		
$\varphi V_n/V_{mpr}$ =		2.26		2.26		2.26		
SCWB =	3.03		3.00		3.01		3.02	
Joint $\Phi V_n/V_u$ =	1.28		1.13		1.13		1.28	
Story 7 $\varphi M_n/M_u$ =	3.22		3.94		3.63		2.93	
$\varphi V_n/V_{mpr}$ =	1.34		1.04		1.11		1.45	1.8%
$P/A_g f'_c$ =	0.11		0.19		0.19		0.11	
Floor 7 $(\varphi M_n/M_u)_{neg}$ =		1.16		1.36		1.16		
$(\varphi M_n/M_u)_{pos}$ =		1.22		1.29		1.22		
$M_{n,pos}/M_{n,neg}$ =		0.51		0.51		0.51		
$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	3.01		3.01		3.00		3.00	
Joint $\Phi V_n/V_u$ =	1.40		1.25		1.25		1.40	
Story 6 $\varphi M_n/M_u$ =	3.22		4.20		4.52		3.53	
$\varphi V_n/V_{mpr}$ =	1.47		1.06		0.99		1.36	1.5%
$P/A_g f'_c$ =	0.13		0.22		0.22		0.13	
Floor 6 $(\varphi M_n/M_u)_{neg}$ =		1.17		1.34		1.17		
$(\varphi M_n/M_u)_{pos}$ =		1.28		1.34		1.28		
$M_{n,pos}/M_{n,neg}$ =		0.52		0.52		0.52		
$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	3.01		3.01		3.01		3.01	
Joint $\Phi V_n/V_u$ =	1.45		1.28		1.28		1.45	
Story 5 $\varphi M_n/M_u$ =	3.50		4.20		3.88		3.19	
$\varphi V_n/V_{mpr}$ =	1.35		1.07		1.14		1.46	1.5%
$P/A_g f'_c$ =	0.15		0.26		0.26		0.15	
Floor 5 $(\varphi M_n/M_u)_{neg}$ =		1.15		1.30		1.15		
$(\varphi M_n/M_u)_{pos}$ =		1.18		1.25		1.18		
$M_{n,pos}/M_{n,neg}$ =		0.50		0.50		0.50		
$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	3.01		3.00		2.99		2.99	
Joint $\Phi V_n/V_u$ =	1.48		1.32		1.32		1.48	
Story 4 $\varphi M_n/M_u$ =	3.12		3.91		4.20		3.37	
$\varphi V_n/V_{mpr}$ =	1.45		1.08		1.03		1.36	1.6%
$P/A_g f'_c$ =	0.18		0.29		0.29		0.18	
Floor 4 $(\varphi M_n/M_u)_{neg}$ =		1.15		1.29		1.15		
$(\varphi M_n/M_u)_{pos}$ =		1.19		1.30		1.19		
$M_{n,pos}/M_{n,neg}$ =		0.53		0.53		0.53		
$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	3.00		3.00		3.00		3.00	
Joint $\Phi V_n/V_u$ =	1.48		1.29		1.29		1.48	
Story 3 $\varphi M_n/M_u$ =	3.45		4.26		3.98		3.19	
$\varphi V_n/V_{mpr}$ =	1.32		1.05		1.11		1.4	1.6%
$P/A_g f'_c$ =	0.20		0.32		0.32		0.20	
Floor 3 $(\varphi M_n/M_u)_{neg}$ =		1.17		1.28		1.17		
$(\varphi M_n/M_u)_{pos}$ =		1.20		1.38		1.21		
$M_{n,pos}/M_{n,neg}$ =		0.57		0.57		0.57		
$\varphi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	3.00		3.01		3.00		2.99	
Joint $\Phi V_n/V_u$ =	1.48		1.26		1.26		1.48	
Story 2 $\varphi M_n/M_u$ =	3.04		3.94		4.20		3.26	
$\varphi V_n/V_{mpr}$ =	1.4		1.13		1.08		1.33	1.6%
$P/A_g f'_c$ =	0.22		0.36		0.36		0.22	
Floor 2 $(\varphi M_n/M_u)_{neg}$ =		1.16		1.25		1.16		
$(\varphi M_n/M_u)_{pos}$ =		1.18		1.55		1.18		
$M_{n,pos}/M_{n,neg}$ =		0.61		0.61		0.61		
$\varphi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	3.00		3.02		3.02		3.00	
Joint $\Phi V_n/V_u$ =	1.57		1.31		1.31		1.57	
Story 1 $\varphi M_n/M_u$ =	2.35		3.52		3.29		2.18	
$\varphi V_n/V_{mpr}$ =	1.38		1.18		1.24		1.45	1.3%
$P/A_g f'_c$ =	0.24		0.39		0.39		0.24	

Modeling Documentation (1 of 1)

13

$M_{y,pos,exp}$(k-in) =	1917	1917	1917
$M_{y,n,slab,exp}$(k-in) =	-4043	-4043	-4043
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	3.724E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0442	0.0442	0.0442
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 12

$M_{y,exp}$ (k-in) =	4840	5239	6828	4840
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.075	0.066	0.066	0.075
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	108	92	92	108
$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01

12

$M_{y,pos,exp}$(k-in) =	2151	2151	2151
$M_{y,n,slab,exp}$(k-in) =	-5190	-5190	-5190
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 11

$M_{y,exp}$ (k-in) =	12289	16788	14911	10614
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.20	1.20	1.21
$\Theta_{cap,pl}$ (rad) =	0.084	0.082	0.071	0.082
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	107	114	103	112
$(P/A_gf'_c)_{exp}$ =	0.02	0.05	0.05	0.02

11

$M_{y,pos,exp}$(k-in) =	2442	2442	2442
$M_{y,n,slab,exp}$(k-in) =	-5758	-5758	-5758
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 10

$M_{y,exp}$ (k-in) =	5632	8037	9810	6266
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.20	1.20	1.21
$\Theta_{cap,pl}$ (rad) =	0.072	0.068	0.068	0.072
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	105	100	100	105
$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03

10

$M_{y,pos,exp}$(k-in) =	2676	2676	2676
$M_{y,n,slab,exp}$(k-in) =	-6324	-6324	-6324
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 9

$M_{y,exp}$ (k-in) =	14181	19589	17924	12721
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.20	1.20	1.20	1.20
$\Theta_{cap,pl}$ (rad) =	0.071	0.071	0.065	0.071
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	103	102	97	103
$(P/A_gf'_c)_{exp}$ =	0.05	0.09	0.09	0.05

9

$M_{y,pos,exp}$(k-in) =	2885	2885	2885
$M_{y,n,slab,exp}$(k-in) =	-6662	-6662	-6662
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.076	-0.076	-0.076
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 8

$M_{y,exp}$ (k-in) =	6403	10230	11786	7557
EI_{stf}/EI_g =	0.35	0.36	0.36	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.069	0.062	0.062	0.069
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	102	95	95	102
$(P/A_gf'_c)_{exp}$ =	0.06	0.11	0.11	0.06

8

$M_{y,pos,exp}$(k-in) =	2897	2897	2897
$M_{y,n,slab,exp}$(k-in) =	-6662	-6662	-6662
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	5.695E+07	5.695E+07	5.695E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	101	101	101

Story 7

$M_{y,exp}$ (k-in) =	14497	19968	18513	13248
EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.068	0.060	0.060	0.068
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	100	92	92	100
$(P/A_gf'_c)_{exp}$ =	0.07	0.14	0.14	0.07

7

$M_{y,pos,exp}$(k-in) =	3758	3758	3758
$M_{y,n,slab,exp}$(k-in) =	-8944	-8944	-8944
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0442	0.0442
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 6

$M_{y,exp}$ (k-in) =	13092	19733	21085	14236
EI_{stf}/EI_g =	0.35	0.41	0.41	0.35
M_c/M_y =	1.20	1.19	1.19	1.20
$\Theta_{cap,pl}$ (rad) =	0.067	0.057	0.057	0.067
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	99	89	89	99
$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08

6

$M_{y,pos,exp}$(k-in) =	3759	3759	3759
$M_{y,n,slab,exp}$(k-in) =	-8737	-8737	-8737
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0441	0.0441
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 5

$M_{y,exp}$ (k-in) =	14285	19804	18453	13142
EI_{stf}/EI_g =	0.35	0.43	0.43	0.35
M_c/M_y =	1.20	1.18	1.18	1.20
$\Theta_{cap,pl}$ (rad) =	0.065	0.055	0.055	0.065
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	97	86	86	97
$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09

5

$M_{y,pos,exp}$(k-in) =	3541	3541	3541
$M_{y,n,slab,exp}$(k-in) =	-8598	-8598	-8598
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.0431	0.0431
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 4

$M_{y,exp}$ (k-in) =	13191	19037	20284	14126
EI_{stf}/EI_g =	0.35	0.45	0.45	0.35
M_c/M_y =	1.20	1.18	1.18	1.20
$\Theta_{cap,pl}$ (rad) =	0.064	0.053	0.053	0.064
Θ_{pc} (rad) =	0.100	0.099	0.099	0.100
λ =	96	84	84	96
$(P/A_gf'_c)_{exp}$ =	0.10	0.21	0.21	0.10

4

$M_{y,pos,exp}$(k-in) =	3759	3759	3759
$M_{y,n,slab,exp}$(k-in) =	-8600	-8600	-8600
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 3

$M_{y,exp}$ (k-in) =	14691	20862	19614	13757
EI_{stf}/EI_g =	0.36	0.47	0.47	0.36
M_c/M_y =	1.19	1.18	1.18	1.19
$\Theta_{cap,pl}$ (rad) =	0.062	0.051	0.051	0.062
Θ_{pc} (rad) =	0.100	0.091	0.091	0.100
λ =	95	81	81	95
$(P/A_gf'_c)_{exp}$ =	0.11	0.23	0.23	0.11

3

$M_{y,pos,exp}$(k-in) =	3994	3994	3994
$M_{y,n,slab,exp}$(k-in) =	-8602	-8602	-8602
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0449	0.0449
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 2

$M_{y,exp}$ (k-in) =	13698	20185	21330	14527
EI_{stf}/EI_g =	0.37	0.50	0.50	0.37
M_c/M_y =	1.19	1.17	1.17	1.19
$\Theta_{cap,pl}$ (rad) =	0.061	0.049	0.049	0.061
Θ_{pc} (rad) =	0.100	0.084	0.084	0.100
λ =	93	79	79	93
$(P/A_gf'_c)_{exp}$ =	0.13	0.25	0.25	0.13

2

$M_{y,pos,exp}$(k-in) =	4076	4076	4076
$M_{y,n,slab,exp}$(k-in) =	-8186	-8186	-8186
EI_{stf}/EI_g =	0.35	0.35	0.35
$EI_{stf, w/ Slab}$ (k-in^2/rad) =	1.269E+08	1.269E+08	1.269E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 1

$M_{y,exp}$ (k-in) =	13948	20333	19189	13119
EI_{stf}/EI_g =	0.38	0.52	0.52	0.38
M_c/M_y =	1.19	1.17	1.17	1.19
$\Theta_{cap,pl}$ (rad) =	0.060	0.047	0.047	0.060
Θ_{pc} (rad) =	0.100	0.078	0.078	0.100
λ =	92	77	77	92
$(P/A_gf'_c)_{exp}$ =	0.14	0.28	0.28	0.14

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.97 T_2 = 0.67 T_3 = 0.38

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2034
Number of Stories: 4
Fundamental Period (sec): 0.87

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

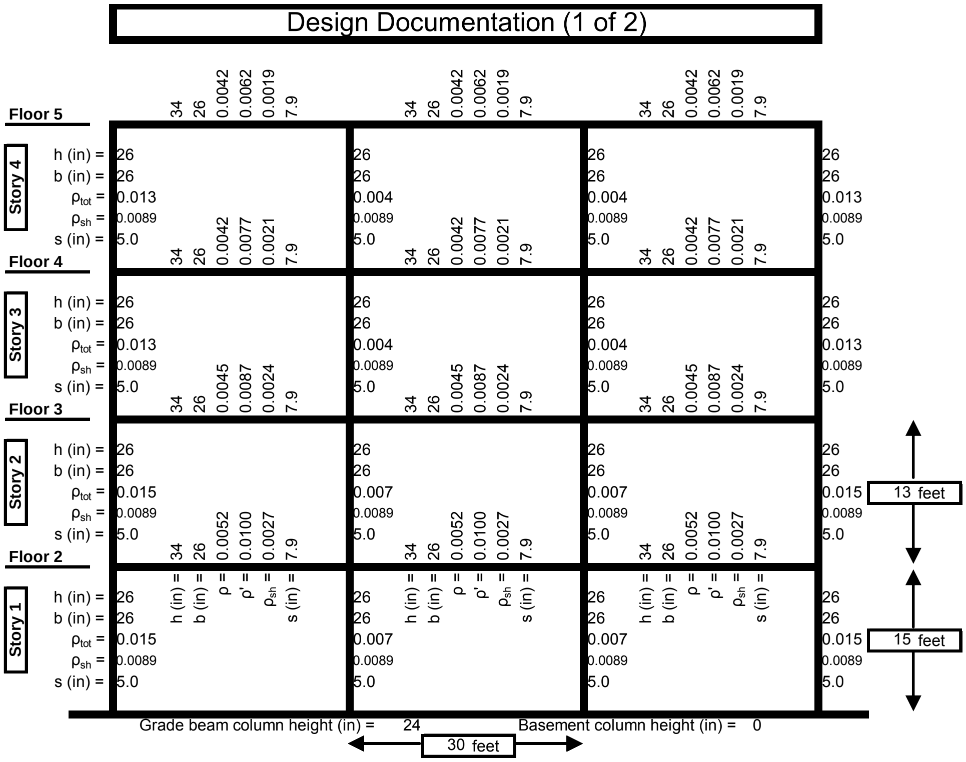
2034 SCWB=0.4

Note: for the purpose of sensitivity analysis, this design ignores the minimum requirement ratio in the columns. Furthermore, the beam and column sizes were kept as in design 2025, where only the column reinforcement are make less dense to reach smaller SCWB ratio. Reason: By making column sizes smaller, beam sizes would have to be larger to satisfy drift.

Both positive and negative bending strength were controlled by strength demands. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the minimum positive/negative strength ratio. All column flexural strengths were controlled by flexural strength demand. Beam stirrups were controlled by the capacity shear design and minimum requirement (half-half). Column stirrups were controlled by the minimum confinement requirement.

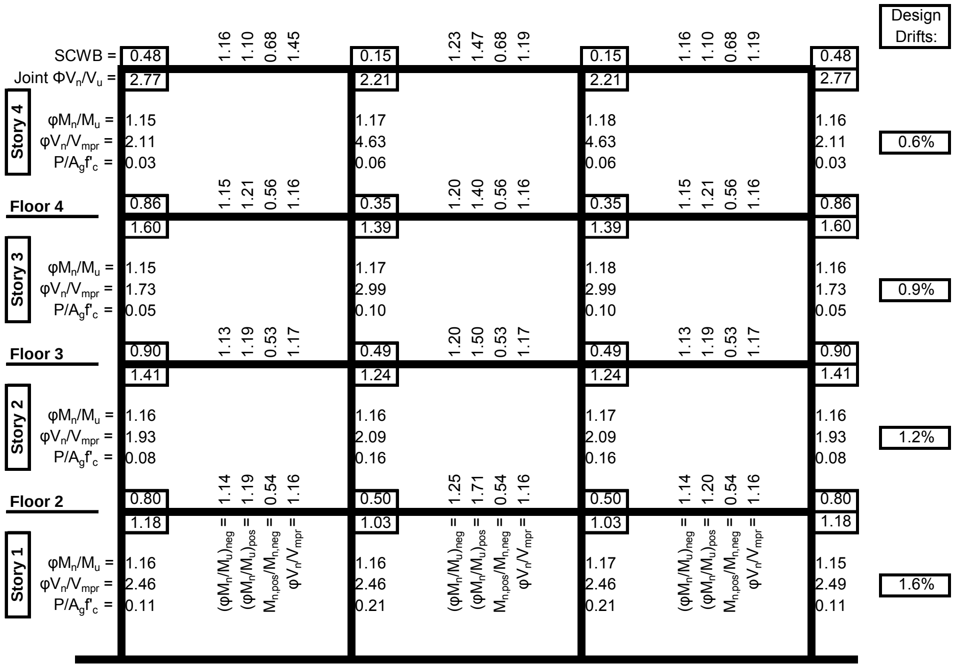
Note: Design for smaller SCWB were done but ignored for analysis because majority of the columns in this design (2034) were already controlled by flexural strength. Thus, even by making a less SCWB requirement will not increase capacity performance, and will analysis result will be misleading.

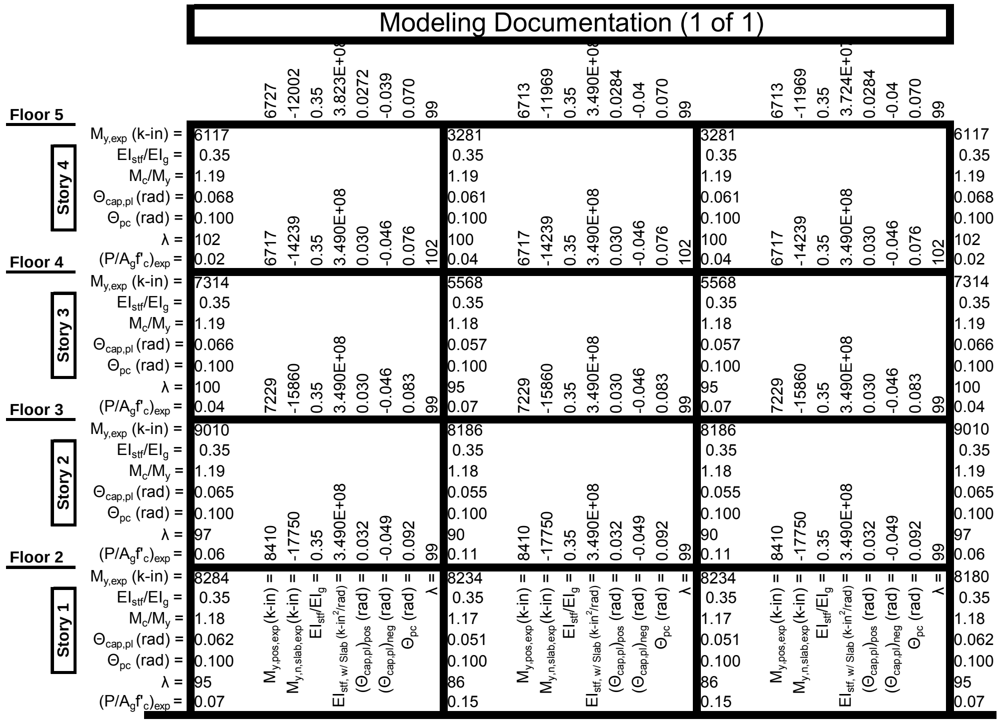
DESIGN AND MODELING DOCUMENTATION FIGURES



Design base shear =	ralLoadin g,	193	k
f'_c beams = 5.1 ksi		$f'_{c,cols,upper}$ = 7.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 7.0 ksi	

Design Documentation (2 of 2)





Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.34

Model periods (sec): T_1 = 0.87 T_2 = 0.27 T_3 = 0.15

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2051

Number of Stories: 4

Fundamental Period (sec): 0.54

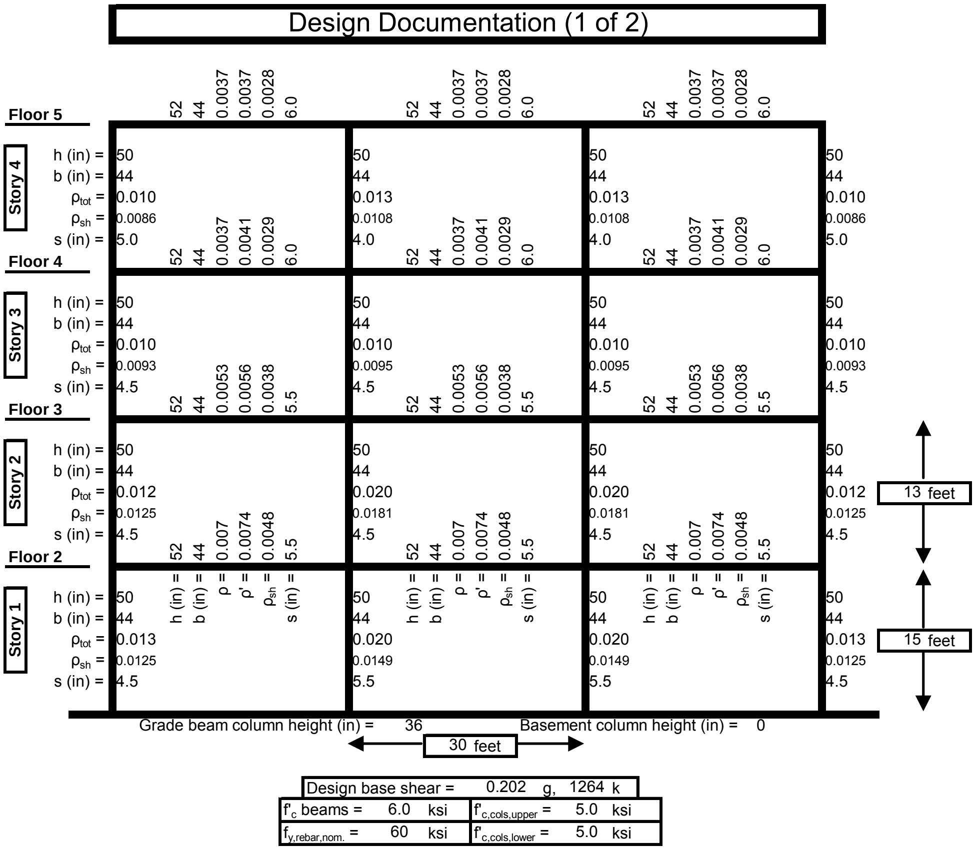
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2051 Perimeter Frame, R=4

Note: this design contains very large element sizes in order to satisfy drift under a extremely large lateral force.

The beam and column sizes were controlled by drift limits, caused by large lateral force demand due to the low R value. Both negative and positive flexural beam strength was controlled by strength demands, but then additional steel was added to 9 bays to meet the minimum reinforcement requirements (this was needed due to large beam sizes). Column flexural strengths were primarily controlled by the strong-column weak-beam ratio. In upper story exterior columns, the minimum longitudinal reinforcement ratio controlled (due to the large member sizes to control drift in lower stories) and caused the columns to be stronger. This could have been avoided by reducing column sizes in upper stories; we did not do this because the practitioner reviewing our designs said this would not be consistent with current practice. Beam stirrups were controlled by both minimum requirements and by the capacity shear design—half-half. Most of column stirrups were controlled by both minimum confinement requirements and 12 columns had added stirrups for capacity shear demand. Joint shear did not control design because elements were already large due to drift demands.

DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)

			1.79 2.18 1.00 1.16		2.00 2.84 1.00 1.16		1.85 2.27 1.00 1.16	Design Drifts:
	SCWB =	1.07		0.74		0.74		1.07	
	Joint $\Phi V_n/V_u$ =	11.59		7.25		7.25		11.59	
Story 4	$\varphi M_n/M_u$ =	3.03		3.28		3.32		3.10	
	$\varphi V_n/V_{mpr}$ =	1.15		1.15		1.15		1.15	0.7%
	$P/A_g f'_c$ =	0.01		0.01		0.01		0.01	
			1.15 1.22 0.91 1.15		1.28 1.41 0.91 1.15		1.17 1.26 0.91 1.15		
Floor 4		1.92		1.31		1.31		1.92	
		3.35		2.20		2.20		3.35	
Story 3	$\varphi M_n/M_u$ =	2.35		1.51		1.53		2.37	
	$\varphi V_n/V_{mpr}$ =	1.16		1.15		1.15		1.15	1.2%
	$P/A_g f'_c$ =	0.02		0.02		0.02		0.02	
			1.12 1.17 0.94 1.16		1.27 1.38 0.94 1.16		1.14 1.20 0.94 1.16		
Floor 3		1.54		1.29		1.30		1.55	
		2.45		1.58		1.58		2.45	
Story 2	$\varphi M_n/M_u$ =	2.36		1.99		2.01		2.42	
	$\varphi V_n/V_{mpr}$ =	1.21		1.16		1.16		1.22	1.5%
	$P/A_g f'_c$ =	0.04		0.03		0.03		0.04	
			1.15 1.16 0.94 1.16		1.38 1.45 0.94 1.16		1.16 1.17 0.94 1.16		
Floor 2		1.28		1.29		1.30		1.28	
		1.63		1.06		1.06		1.63	
			$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		
Story 1	$\varphi M_n/M_u$ =	1.17		2.10		2.12		1.16	
	$\varphi V_n/V_{mpr}$ =	1.58		1.16		1.16		1.61	2.0%
	$P/A_g f'_c$ =	0.06		0.05		0.05		0.06	

Modeling Documentation (1 of 1)

			25057 -28663 0.35 1.515E+09 0.0387 -0.041 0.096 129		25057 -28663 0.35 1.515E+09 0.0387 -0.041 0.096 129		25057 -28663 0.35 3.724E+0 0.0387 -0.041 0.096 129	
Floor 5								
Story 4	$M_{y,exp}$ (k-in) =	31915		40363		40363		31915
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.21		1.21		1.21		1.21
	$\Theta_{cap,pl}$ (rad) =	0.074		0.088		0.088		0.074
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	133		139		139		133
	$(P/A_g f'_c)_{exp}$ =	0.00	25072 -31291 0.35 1.515E+09 0.039 -0.043 0.099 129	0.01	25072 -31291 0.35 1.515E+09 0.039 -0.043 0.099 129	0.01	25072 -31291 0.35 1.515E+09 0.039 -0.043 0.099 129	0.00
Floor 4								
Story 3	$M_{y,exp}$ (k-in) =	32801		35313		35313		32801
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.21		1.21		1.21		1.21
	$\Theta_{cap,pl}$ (rad) =	0.078		0.078		0.078		0.078
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	136		134		134		136
	$(P/A_g f'_c)_{exp}$ =	0.01	35448 -41192 0.35 1.515E+09 0.046 -0.050 0.100 132	0.02	35448 -41192 0.35 1.515E+09 0.046 -0.050 0.100 132	0.02	35448 -41192 0.35 1.515E+09 0.046 -0.050 0.100 132	0.01
Floor 3								
Story 2	$M_{y,exp}$ (k-in) =	40479		67106		67106		40479
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.21		1.21		1.21		1.21
	$\Theta_{cap,pl}$ (rad) =	0.089		0.109		0.109		0.089
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	135		133		133		135
	$(P/A_g f'_c)_{exp}$ =	0.01	46683 -53334 0.35 1.515E+09 0.052 -0.056 0.100 132	0.02	46683 -53334 0.35 1.515E+09 0.052 -0.056 0.100 132	0.02	46683 -53334 0.35 1.515E+09 0.052 -0.056 0.100 132	0.01
Floor 2								
Story 1	$M_{y,exp}$ (k-in) =	44360	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	67282	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	67282	$M_{y,pos,exp}$(k-in) = $M_{y,n,slab,exp}$(k-in) = EI_{stf}/EI_g = $EI_{stf,\ w/\ Slab}$ (k-in^2/rad) = $(\Theta_{cap,pl})_{pos}$ (rad) = $(\Theta_{cap,pl})_{neg}$ (rad) = Θ_{pc} (rad) = λ =	43607
	EI_{stf}/EI_g =	0.35		0.35		0.35		0.35
	M_c/M_y =	1.21		1.21		1.21		1.21
	$\Theta_{cap,pl}$ (rad) =	0.089		0.092		0.092		0.089
	Θ_{pc} (rad) =	0.100		0.100		0.100		0.100
	λ =	134		125		125		134
	$(P/A_g f'_c)_{exp}$ =	0.02		0.03		0.03		0.02

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 4.03

Model periods (sec): T_1 = 0.54 T_2 = 0.16 T_3 = 0.08

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2052
Number of Stories: 4
Fundamental Period (sec): 1.15

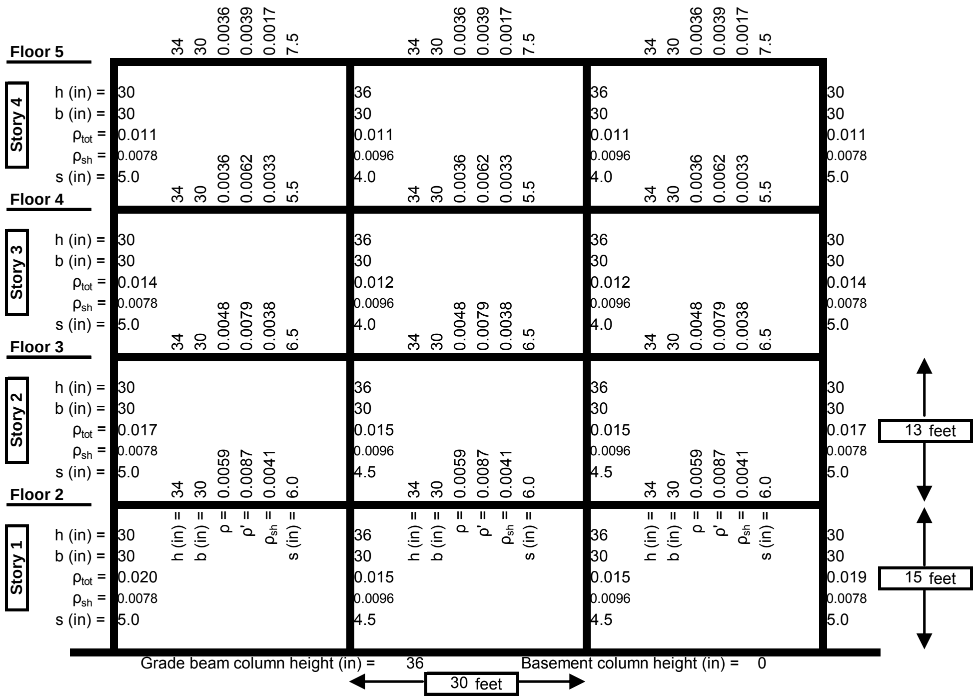
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2052 Perimeter Frame, R=12

The column size and beam depth were controlled by joint shear demand; drift did not control the design. Both negative and positive flexural beam strength was controlled by strength demands. More reinforcements were added to beams in four bays in order make consistent reinforcement for each floor, and few beams had additional reinforcement added to meet the minimum positive and negative ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, except the two exterior columns at the bottom story were controlled by strength demands. All beam stirrups were controlled by the capacity shear design. All of column stirrups were controlled by minimum confinement requirements, except 2.

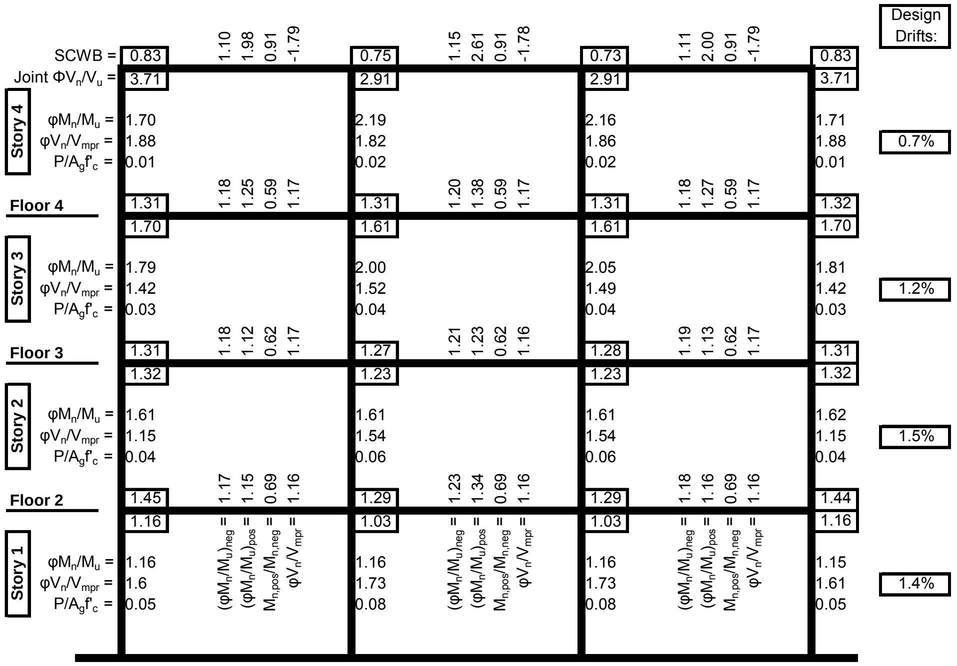
DESIGN AND MODELING DOCUMENTATION FIGURES

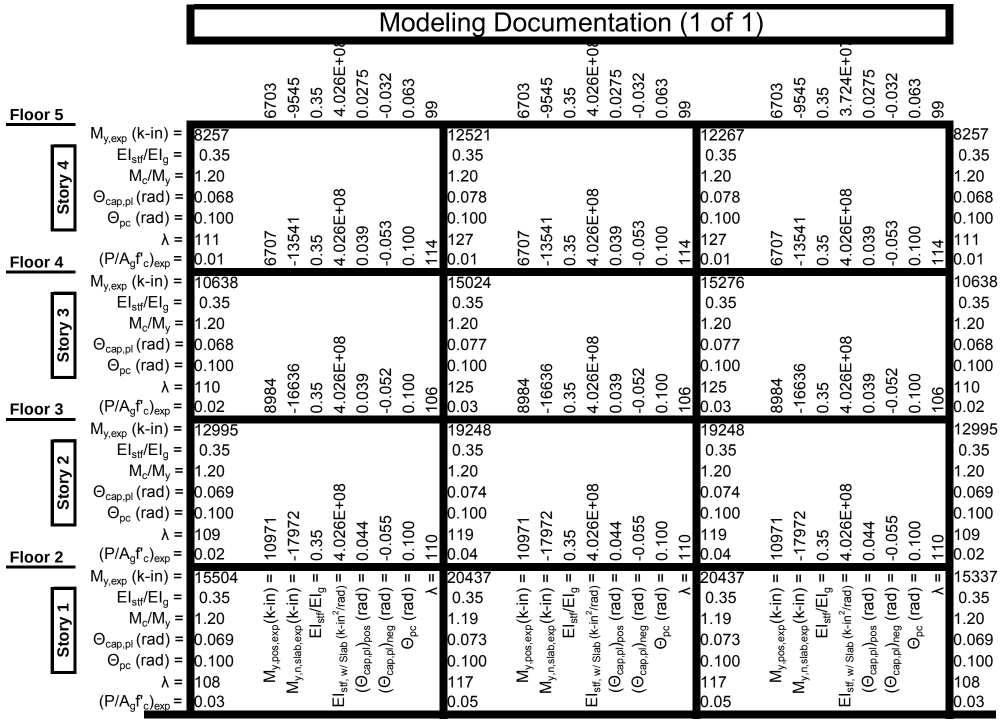
Design Documentation (1 of 2)



Design base shear =	0.062 g,	386 k	
f'c beams = 6.0 ksi		f'c,cols,upper =	6.0 ksi
fy,rebar,nom. = 60 ksi		f'c,cols,lower =	6.0 ksi

Design Documentation (2 of 2)





Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 4.03

Model periods (sec): T_1 = 1.15 T_2 = 0.36 T_3 = 0.19

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2053

Number of Stories: 12

Fundamental Period (sec): 1.50

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

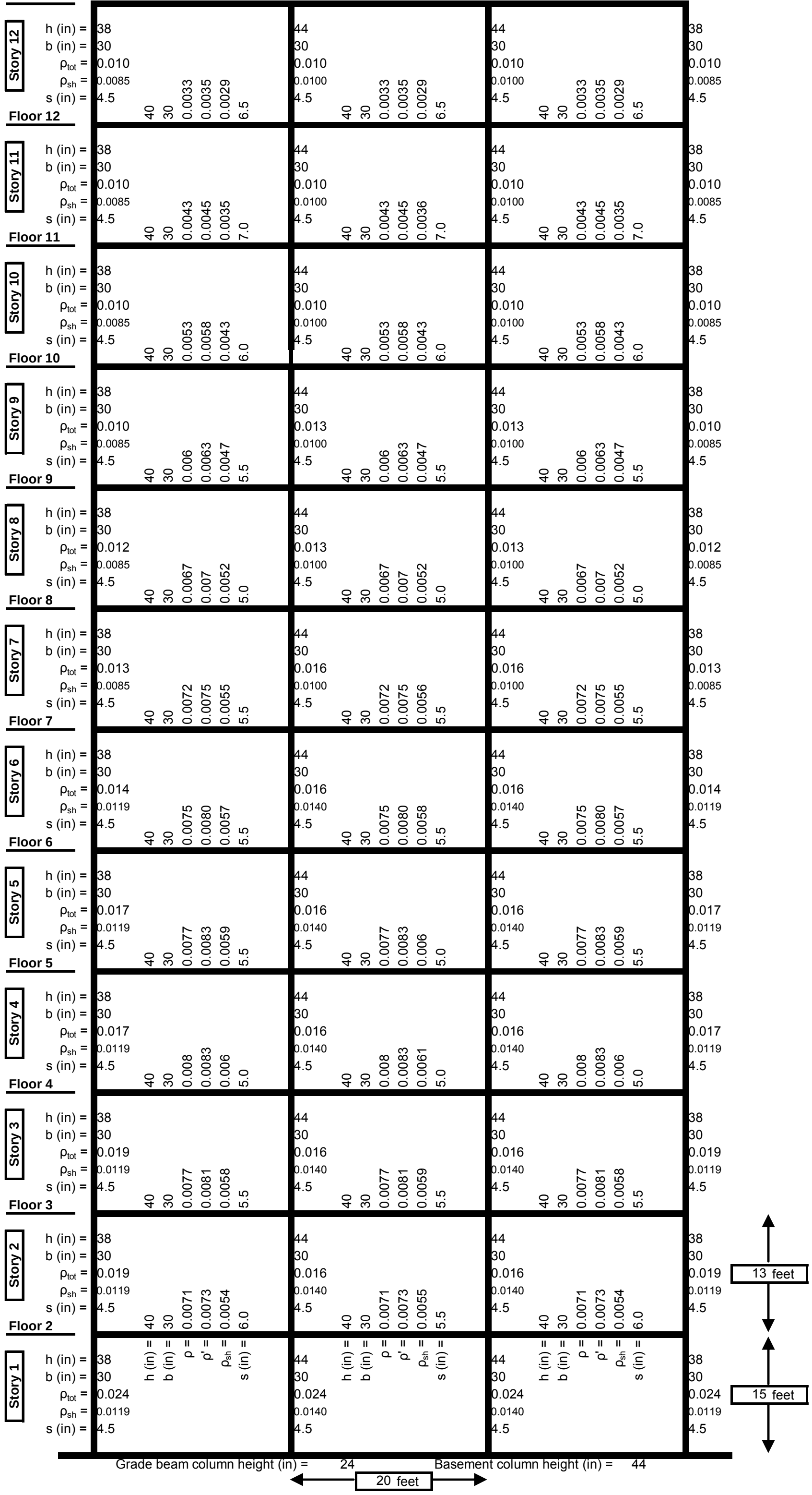
2053 Perimeter Frame, R=4

From the baseline design, beam and column sizes were made lager as the lateral demand is larger from smaller R value. Joint shear controls and made columns larger. Most positive bending strengths were controlled by primarily strength demand, 6 bays had min reinforcement imposed. Negative bending strengths were controlled by strength demands, except 3. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor. Most column flexural strengths were controlled by the strong-column weak-beam ratio, but the bottom story columns were controlled by flexural demands. Beam stirrups were controlled by both the capacity shear design and min reinforcement requirement. Column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Columns (h (in), b (in), ρ_{tot}, ρ_{sh}, s (in)):

Story	Column 1	Column 2	Column 3	Column 4
Story 12	38 30 0.010 0.0085 4.5	44 30 0.010 0.0100 4.5	44 30 0.010 0.0100 4.5	38 30 0.010 0.0085 4.5
Story 11	38 30 0.010 0.0085 4.5	44 30 0.010 0.0100 4.5	44 30 0.010 0.0100 4.5	38 30 0.010 0.0085 4.5
Story 10	38 30 0.010 0.0085 4.5	44 30 0.010 0.0100 4.5	44 30 0.010 0.0100 4.5	38 30 0.010 0.0085 4.5
Story 9	38 30 0.010 0.0085 4.5	44 30 0.013 0.0100 4.5	44 30 0.013 0.0100 4.5	38 30 0.010 0.0085 4.5
Story 8	38 30 0.012 0.0085 4.5	44 30 0.013 0.0100 4.5	44 30 0.013 0.0100 4.5	38 30 0.012 0.0085 4.5
Story 7	38 30 0.013 0.0085 4.5	44 30 0.016 0.0100 4.5	44 30 0.016 0.0100 4.5	38 30 0.013 0.0085 4.5
Story 6	38 30 0.014 0.0119 4.5	44 30 0.016 0.0140 4.5	44 30 0.016 0.0140 4.5	38 30 0.014 0.0119 4.5
Story 5	38 30 0.017 0.0119 4.5	44 30 0.016 0.0140 4.5	44 30 0.016 0.0140 4.5	38 30 0.017 0.0119 4.5
Story 4	38 30 0.017 0.0119 4.5	44 30 0.016 0.0140 4.5	44 30 0.016 0.0140 4.5	38 30 0.017 0.0119 4.5
Story 3	38 30 0.019 0.0119 4.5	44 30 0.016 0.0140 4.5	44 30 0.016 0.0140 4.5	38 30 0.019 0.0119 4.5
Story 2	38 30 0.019 0.0119 4.5	44 30 0.016 0.0140 4.5	44 30 0.016 0.0140 4.5	38 30 0.019 0.0119 4.5
Story 1	38 30 0.024 0.0119 4.5	44 30 0.024 0.0140 4.5	44 30 0.024 0.0140 4.5	38 30 0.024 0.0119 4.5

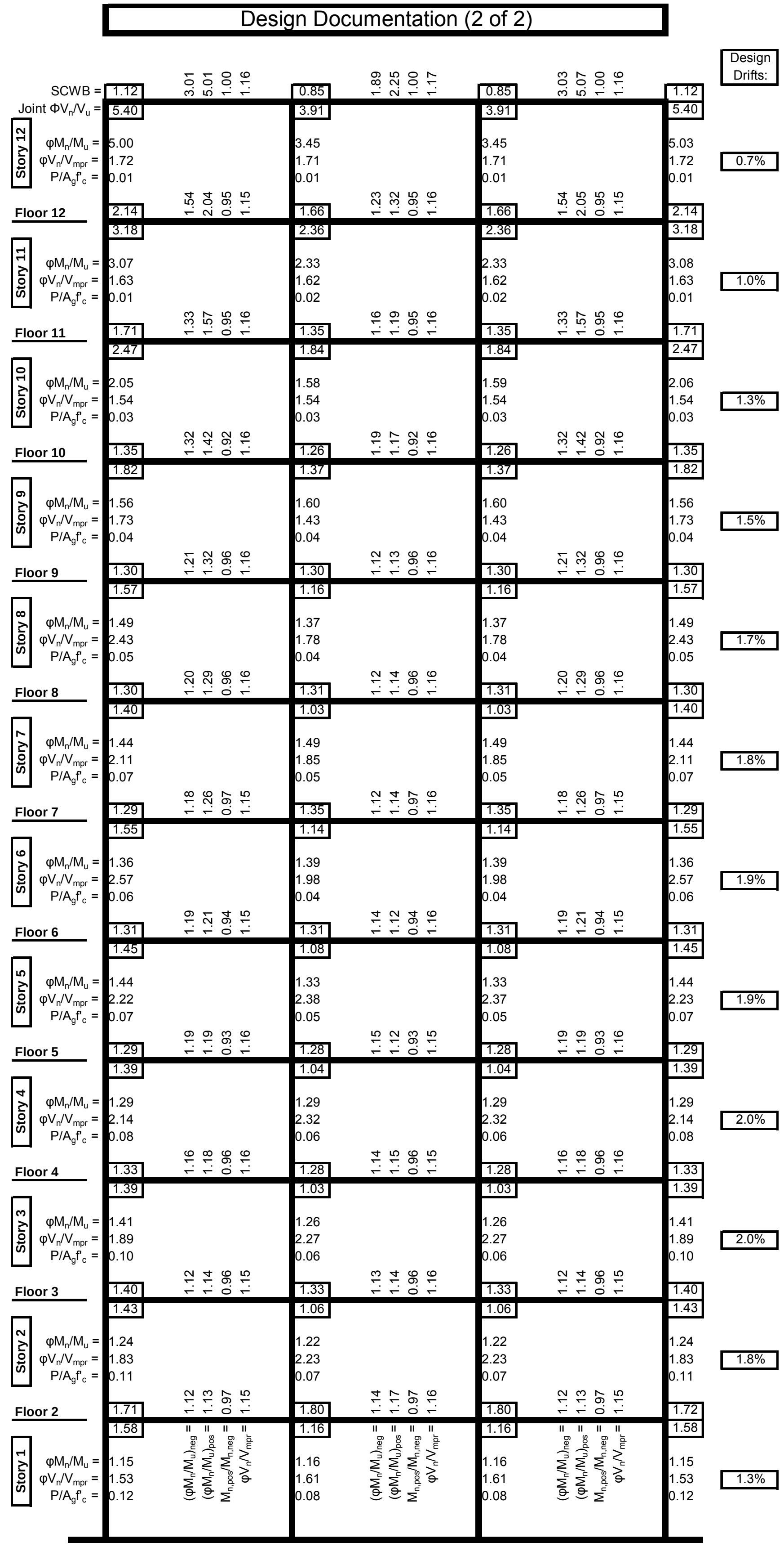
Beams (h (in), b (in), ρ, ρ', ρ_{sh}, s (in)):

Floor	Bay 1	Bay 2	Bay 3
Floor 13	40 30 0.0033 0.0033 0.0028 7.0	40 30 0.0033 0.0033 0.0029 6.5	40 30 0.0033 0.0033 0.0028 7.0
Floor 12	40 30 0.0033 0.0035 0.0029 6.5	40 30 0.0033 0.0035 0.0029 6.5	40 30 0.0033 0.0035 0.0029 6.5
Floor 11	40 30 0.0043 0.0045 0.0035 7.0	40 30 0.0043 0.0045 0.0036 7.0	40 30 0.0043 0.0045 0.0035 7.0
Floor 10	40 30 0.0053 0.0058 0.0043 6.0	40 30 0.0053 0.0058 0.0043 6.0	40 30 0.0053 0.0058 0.0043 6.0
Floor 9	40 30 0.006 0.0063 0.0047 5.5	40 30 0.006 0.0063 0.0047 5.5	40 30 0.006 0.0063 0.0047 5.5
Floor 8	40 30 0.0067 0.007 0.0052 5.0	40 30 0.0067 0.007 0.0052 5.0	40 30 0.0067 0.007 0.0052 5.0
Floor 7	40 30 0.0072 0.0075 0.0055 5.5	40 30 0.0072 0.0075 0.0056 5.5	40 30 0.0072 0.0075 0.0055 5.5
Floor 6	40 30 0.0075 0.0080 0.0057 5.5	40 30 0.0075 0.0080 0.0058 5.5	40 30 0.0075 0.0080 0.0057 5.5
Floor 5	40 30 0.0077 0.0083 0.0059 5.5	40 30 0.0077 0.0083 0.006 5.0	40 30 0.0077 0.0083 0.0059 5.5
Floor 4	40 30 0.008 0.0083 0.006 5.0	40 30 0.008 0.0083 0.0061 5.0	40 30 0.008 0.0083 0.006 5.0
Floor 3	40 30 0.0077 0.0081 0.0058 5.5	40 30 0.0077 0.0081 0.0059 5.5	40 30 0.0077 0.0081 0.0058 5.5
Floor 2	40 30 0.0071 0.0073 0.0054 6.0	40 30 0.0071 0.0073 0.0055 5.5	40 30 0.0071 0.0073 0.0054 6.0

Grade beam column height (in) = 24

Basement column height (in) = 44

Design base shear =	0.079 g,	663 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	7.0 ksi



Design Documentation (2 of 2)

		3.01 5.01 1.00 1.16		1.89 2.25 1.00 1.17		3.03 5.07 1.00 1.16		Design Drifts:
SCWB =	1.12		0.85		0.85		1.12	
Joint $\Phi V_n/V_u$ =	5.40		3.91		3.91		5.40	
Story 12 $\varphi M_n/M_u$ =	5.00		3.45		3.45		5.03	
$\varphi V_n/V_{mpr}$ =	1.72		1.71		1.71		1.72	0.7%
$P/A_g f'_c$ =	0.01		0.01		0.01		0.01	
		1.54 2.04 0.95 1.15		1.23 1.32 0.95 1.16		1.54 2.05 0.95 1.15		
Floor 12	2.14		1.66		1.66		2.14	
	3.18		2.36		2.36		3.18	
Story 11 $\varphi M_n/M_u$ =	3.07		2.33		2.33		3.08	
$\varphi V_n/V_{mpr}$ =	1.63		1.62		1.62		1.63	1.0%
$P/A_g f'_c$ =	0.01		0.02		0.02		0.01	
		1.33 1.57 0.95 1.16		1.16 1.19 0.95 1.16		1.33 1.57 0.95 1.16		
Floor 11	1.71		1.35		1.35		1.71	
	2.47		1.84		1.84		2.47	
Story 10 $\varphi M_n/M_u$ =	2.05		1.58		1.59		2.06	
$\varphi V_n/V_{mpr}$ =	1.54		1.54		1.54		1.54	1.3%
$P/A_g f'_c$ =	0.03		0.03		0.03		0.03	
		1.32 1.42 0.92 1.16		1.19 1.17 0.92 1.16		1.32 1.42 0.92 1.16		
Floor 10	1.35		1.26		1.26		1.35	
	1.82		1.37		1.37		1.82	
Story 9 $\varphi M_n/M_u$ =	1.56		1.60		1.60		1.56	
$\varphi V_n/V_{mpr}$ =	1.73		1.43		1.43		1.73	1.5%
$P/A_g f'_c$ =	0.04		0.04		0.04		0.04	
		1.21 1.32 0.96 1.16		1.12 1.13 0.96 1.16		1.21 1.32 0.96 1.16		
Floor 9	1.30		1.30		1.30		1.30	
	1.57		1.16		1.16		1.57	
Story 8 $\varphi M_n/M_u$ =	1.49		1.37		1.37		1.49	
$\varphi V_n/V_{mpr}$ =	2.43		1.78		1.78		2.43	1.7%
$P/A_g f'_c$ =	0.05		0.04		0.04		0.05	
		1.20 1.29 0.96 1.16		1.12 1.14 0.96 1.16		1.20 1.29 0.96 1.16		
Floor 8	1.30		1.31		1.31		1.30	
	1.40		1.03		1.03		1.40	
Story 7 $\varphi M_n/M_u$ =	1.44		1.49		1.49		1.44	
$\varphi V_n/V_{mpr}$ =	2.11		1.85		1.85		2.11	1.8%
$P/A_g f'_c$ =	0.07		0.05		0.05		0.07	
		1.18 1.26 0.97 1.15		1.12 1.14 0.97 1.16		1.18 1.26 0.97 1.15		
Floor 7	1.29		1.35		1.35		1.29	
	1.55		1.14		1.14		1.55	
Story 6 $\varphi M_n/M_u$ =	1.36		1.39		1.39		1.36	
$\varphi V_n/V_{mpr}$ =	2.57		1.98		1.98		2.57	1.9%
$P/A_g f'_c$ =	0.06		0.04		0.04		0.06	
		1.19 1.21 0.94 1.15		1.14 1.12 0.94 1.16		1.19 1.21 0.94 1.15		
Floor 6	1.31		1.31		1.31		1.31	
	1.45		1.08		1.08		1.45	
Story 5 $\varphi M_n/M_u$ =	1.44		1.33		1.33		1.44	
$\varphi V_n/V_{mpr}$ =	2.22		2.38		2.37		2.23	1.9%
$P/A_g f'_c$ =	0.07		0.05		0.05		0.07	
		1.19 1.19 0.93 1.16		1.15 1.12 0.93 1.15		1.19 1.19 0.93 1.16		
Floor 5	1.29		1.28		1.28		1.29	
	1.39		1.04		1.04		1.39	
Story 4 $\varphi M_n/M_u$ =	1.29		1.29		1.29		1.29	
$\varphi V_n/V_{mpr}$ =	2.14		2.32		2.32		2.14	2.0%
$P/A_g f'_c$ =	0.08		0.06		0.06		0.08	
		1.16 1.18 0.96 1.16		1.14 1.15 0.96 1.15		1.16 1.18 0.96 1.16		
Floor 4	1.33		1.28		1.28		1.33	
	1.39		1.03		1.03		1.39	
Story 3 $\varphi M_n/M_u$ =	1.41		1.26		1.26		1.41	
$\varphi V_n/V_{mpr}$ =	1.89		2.27		2.27		1.89	2.0%
$P/A_g f'_c$ =	0.10		0.06		0.06		0.10	
		1.12 1.14 0.96 1.15		1.13 1.14 0.96 1.16		1.12 1.14 0.96 1.15		
Floor 3	1.40		1.33		1.33		1.40	
	1.43		1.06		1.06		1.43	
Story 2 $\varphi M_n/M_u$ =	1.24		1.22		1.22		1.24	
$\varphi V_n/V_{mpr}$ =	1.83		2.23		2.23		1.83	1.8%
$P/A_g f'_c$ =	0.11		0.07		0.07		0.11	
		1.12 1.13 0.97 1.15		1.14 1.17 0.97 1.16		1.12 1.13 0.97 1.15		
Floor 2	1.71		1.80		1.80		1.72	
	1.58		1.16		1.16		1.58	
		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =		
Story 1 $\varphi M_n/M_u$ =	1.15		1.16		1.16		1.15	
$\varphi V_n/V_{mpr}$ =	1.53		1.61		1.61		1.53	1.3%
$P/A_g f'_c$ =	0.12		0.08		0.08		0.12	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	12061	16808	16808	12061
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.077	0.082	0.082	0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	127	132	132	127
	$(P/A_g f'_c)_{exp}$ =	0.00	0.01	0.01	0.00
Story 11	$M_{y,exp}$ (k-in) =	12359	17497	17497	12359
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.076	0.081	0.081	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	126	131	131	126
	$(P/A_g f'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 10	$M_{y,exp}$ (k-in) =	12656	18180	18180	12656
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.076	0.080	0.080	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	126	130	130	126
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 9	$M_{y,exp}$ (k-in) =	12952	23539	23539	12952
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.075	0.081	0.081	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	125	129	129	125
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 8	$M_{y,exp}$ (k-in) =	15239	24204	24204	15239
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.076	0.080	0.080	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	125	128	128	125
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 7	$M_{y,exp}$ (k-in) =	17232	29526	29526	17232
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.076	0.081	0.081	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	127	127	124
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 6	$M_{y,exp}$ (k-in) =	18740	30317	30317	18740
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.087	0.087	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	125	128	128	125
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 5	$M_{y,exp}$ (k-in) =	21581	30974	30974	21581
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.083	0.086	0.086	0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	127	127	124
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 4	$M_{y,exp}$ (k-in) =	21867	31628	31628	21867
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.085	0.085	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	127	127	124
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 3	$M_{y,exp}$ (k-in) =	24981	32279	32279	24981
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.084	0.085	0.085	0.084
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	126	126	124
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 2	$M_{y,exp}$ (k-in) =	25263	32926	32926	25263
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.083	0.084	0.084	0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	123	125	125	123
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 1	$M_{y,exp}$ (k-in) =	31190	46347	46347	31190
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.087	0.089	0.089	0.087
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	123	125	125	123
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03

Floor 13	$M_{y,pos,exp}$(k-in) =	8790	8790	8790
	$M_{y,n,slab,exp}$(k-in) =	-10578	-10578	-10578
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0368	0.0385	0.0368
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.04	-0.042	-0.04
	Θ_{pc} (rad) =	0.096	0.098	0.096
	λ =	111	115	111
Floor 12	$M_{y,pos,exp}$(k-in) =	8792	8792	8792
	$M_{y,n,slab,exp}$(k-in) =	-11053	-11053	-11053
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.038	0.038	0.038
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.042	-0.043	-0.042
	Θ_{pc} (rad) =	0.098	0.099	0.098
	λ =	115	115	115
Floor 11	$M_{y,pos,exp}$(k-in) =	11210	11210	11210
	$M_{y,n,slab,exp}$(k-in) =	-13618	-13618	-13618
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.041	0.041	0.041
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.045	-0.044
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	111	111	111
Floor 10	$M_{y,pos,exp}$(k-in) =	13786	13786	13786
	$M_{y,n,slab,exp}$(k-in) =	-16805	-16805	-16805
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.048	0.048	0.048
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	118	118	118
Floor 9	$M_{y,pos,exp}$(k-in) =	15627	15627	15627
	$M_{y,n,slab,exp}$(k-in) =	-18085	-18085	-18085
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.053	0.053	0.053
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.057	-0.057	-0.057
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	122	122	122
Floor 8	$M_{y,pos,exp}$(k-in) =	17545	17545	17545
	$M_{y,n,slab,exp}$(k-in) =	-19993	-19993	-19993
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.058	0.058
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.062	-0.062	-0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	126	126	126
Floor 7	$M_{y,pos,exp}$(k-in) =	18875	18875	18875
	$M_{y,n,slab,exp}$(k-in) =	-21265	-21265	-21265
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.0583	0.0579
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.061	-0.062	-0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	122	122	122
Floor 6	$M_{y,pos,exp}$(k-in) =	19519	19519	19519
	$M_{y,n,slab,exp}$(k-in) =	-22526	-22526	-22526
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.059	0.0593	0.0589
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.063	-0.063	-0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	122	122	122
Floor 5	$M_{y,pos,exp}$(k-in) =	20106	20106	20106
	$M_{y,n,slab,exp}$(k-in) =	-23371	-23371	-23371
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.060	0.0625	0.0599
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.064	-0.067	-0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	122	126	122
Floor 4	$M_{y,pos,exp}$(k-in) =	20736	20736	20736
	$M_{y,n,slab,exp}$(k-in) =	-23380	-23380	-23380
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.063	0.0635	0.0633
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.067	-0.067	-0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	126	126	126
Floor 3	$M_{y,pos,exp}$(k-in) =	20152	20152	20152
	$M_{y,n,slab,exp}$(k-in) =	-22747	-22747	-22747
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.060	0.0602	0.0598
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.063	-0.064	-0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	122	122	122
Floor 2	$M_{y,pos,exp}$(k-in) =	18476	18476	18476
	$M_{y,n,slab,exp}$(k-in) =	-20845	-20845	-20845
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf, w/ Slab}$ (k-in^2/rad) =	4.568E+08	4.568E+08	4.568E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.058	0.055
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.061	-0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	118	122	118

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 1.50 T_2 = 0.49 T_3 = 0.28

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2054

Number of Stories: 12

Fundamental Period (sec): 2.84

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

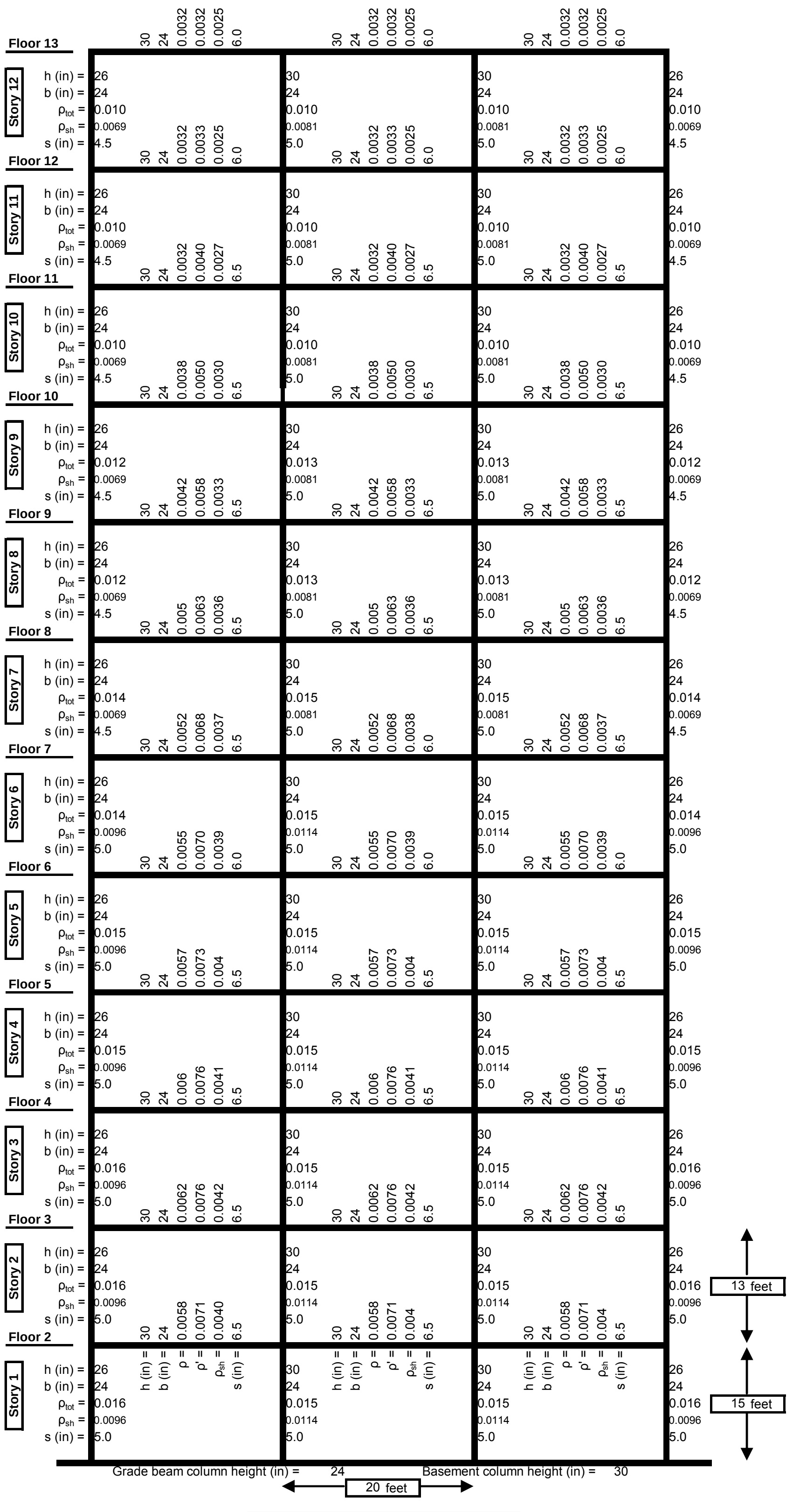
2054 Perimeter Frame, R=12

From the baseline design, beam and column sizes were made lager as the lateral demand is larger from smaller R value. Joint shear controls thus columns larger. Positive and negative bending strengths were controlled by primarily strength demand, 6 bays had min reinforcement imposed. Additional beam reinforcements were added to alter beam design to use same rho and rhoPrime in each floor and to meet the minimum positive/negative strength ratio. Most column flexural strengths were controlled by the strong-column weak-beam ratio, 8 by strength demand. Beam stirrups were controlled by both the capacity shear design and min reinforcement requirement. Column stirrups were controlled by the minimum confinement requirement.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Columns (h (in) =, b (in) =, ρ_{tot} =, ρ_{sh} =, s (in) =):

Story		Column line 1	Column line 2	Column line 3	Column line 4
Story 12	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 11	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 10	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 9	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.013	0.013	0.012
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 8	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.012	0.013	0.013	0.012
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 7	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.014	0.015	0.015	0.014
	ρ_{sh} =	0.0069	0.0081	0.0081	0.0069
	s (in) =	4.5	5.0	5.0	4.5
Story 6	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.014	0.015	0.015	0.014
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0
Story 5	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.015	0.015	0.015	0.015
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0
Story 4	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.015	0.015	0.015	0.015
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0
Story 3	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.016	0.015	0.015	0.016
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0
Story 2	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.016	0.015	0.015	0.016
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0
Story 1	h (in) =	26	30	30	26
	b (in) =	24	24	24	24
	ρ_{tot} =	0.016	0.015	0.015	0.016
	ρ_{sh} =	0.0096	0.0114	0.0114	0.0096
	s (in) =	5.0	5.0	5.0	5.0

Beams (h (in) =, b (in) =, ρ =, ρ' =, ρ_{sh} =, s (in) =):

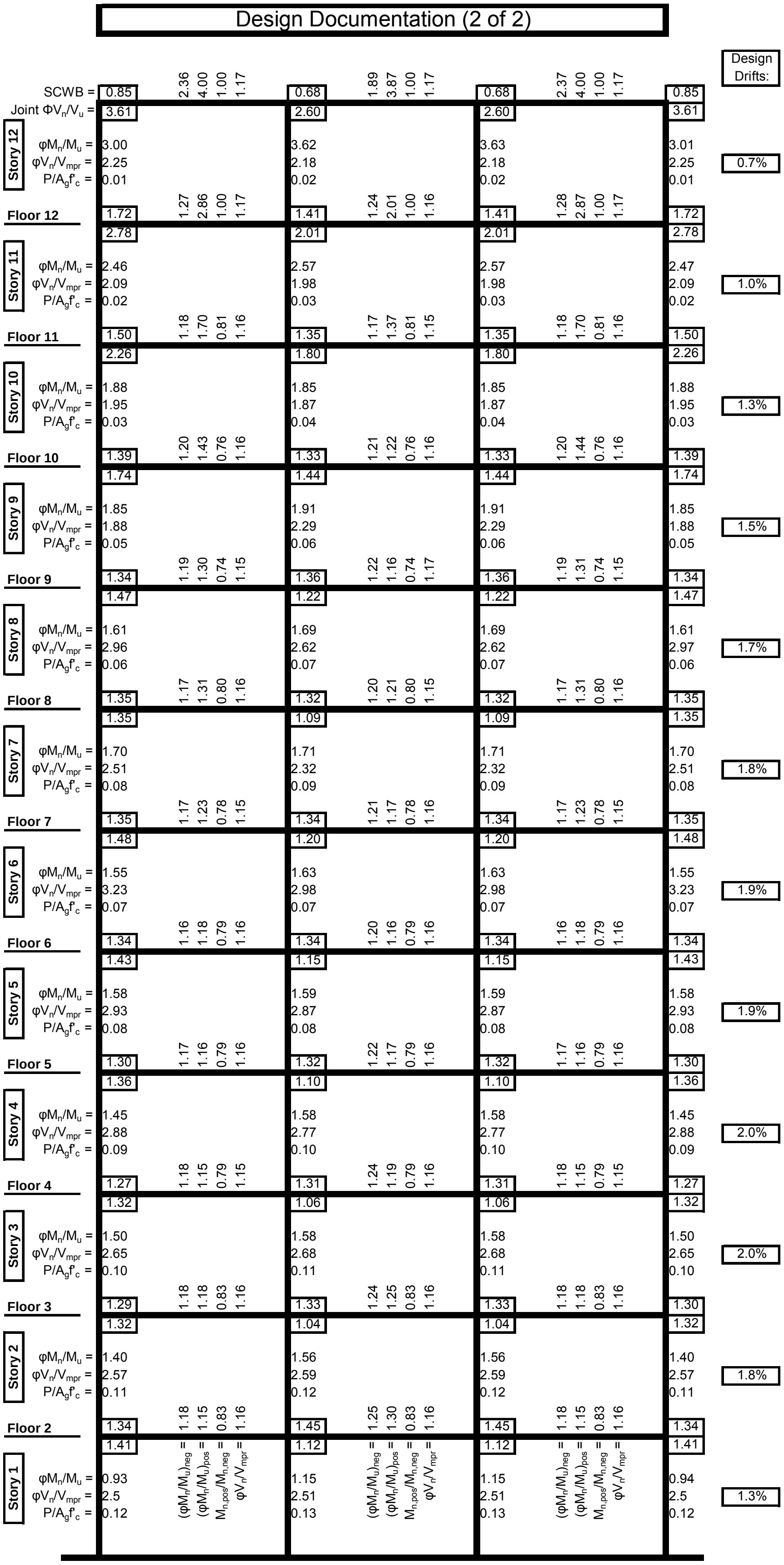
Floor		Bay 1	Bay 2	Bay 3
Floor 13	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0032	0.0032	0.0032
	ρ' =	0.0032	0.0032	0.0032
	ρ_{sh} =	0.0025	0.0025	0.0025
	s (in) =	6.0	6.0	6.0
Floor 12	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0032	0.0032	0.0032
	ρ' =	0.0033	0.0033	0.0033
	ρ_{sh} =	0.0025	0.0025	0.0025
	s (in) =	6.0	6.0	6.0
Floor 11	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0032	0.0032	0.0032
	ρ' =	0.0040	0.0040	0.0040
	ρ_{sh} =	0.0027	0.0027	0.0027
	s (in) =	6.5	6.5	6.5
Floor 10	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0038	0.0038	0.0038
	ρ' =	0.0050	0.0050	0.0050
	ρ_{sh} =	0.0030	0.0030	0.0030
	s (in) =	6.5	6.5	6.5
Floor 9	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0042	0.0042	0.0042
	ρ' =	0.0058	0.0058	0.0058
	ρ_{sh} =	0.0033	0.0033	0.0033
	s (in) =	6.5	6.5	6.5
Floor 8	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.005	0.005	0.005
	ρ' =	0.0063	0.0063	0.0063
	ρ_{sh} =	0.0036	0.0036	0.0036
	s (in) =	6.5	6.5	6.5
Floor 7	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0052	0.0052	0.0052
	ρ' =	0.0068	0.0068	0.0068
	ρ_{sh} =	0.0037	0.0038	0.0037
	s (in) =	6.5	6.0	6.5
Floor 6	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0055	0.0055	0.0055
	ρ' =	0.0070	0.0070	0.0070
	ρ_{sh} =	0.0039	0.0039	0.0039
	s (in) =	6.0	6.0	6.0
Floor 5	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0057	0.0057	0.0057
	ρ' =	0.0073	0.0073	0.0073
	ρ_{sh} =	0.004	0.004	0.004
	s (in) =	6.5	6.5	6.5
Floor 4	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.006	0.006	0.006
	ρ' =	0.0076	0.0076	0.0076
	ρ_{sh} =	0.0041	0.0041	0.0041
	s (in) =	6.5	6.5	6.5
Floor 3	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0062	0.0062	0.0062
	ρ' =	0.0076	0.0076	0.0076
	ρ_{sh} =	0.0042	0.0042	0.0042
	s (in) =	6.5	6.5	6.5
Floor 2	h (in) =	30	30	30
	b (in) =	24	24	24
	ρ =	0.0058	0.0058	0.0058
	ρ' =	0.0071	0.0071	0.0071
	ρ_{sh} =	0.0040	0.004	0.004
	s (in) =	6.5	6.5	6.5

Grade beam column height (in) = 24

Basement column height (in) = 30

Design base shear =	0.023 g, 196 k		
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	7.0 ksi

Design Documentation (2 of 2)



									Design Drifts:
			2.36		1.89		2.37		
			4.00		3.87		4.00		
			1.00		1.00		1.00		
			1.17		1.17		1.17		
	SCWB =	0.85		0.68		0.68		0.85	
	Joint $\Phi V_n/V_u$ =	3.61		2.60		2.60		3.61	
Story 12	$\phi M_n/M_u$ =	3.00		3.62		3.63		3.01	
	$\phi V_n/V_{mpr}$ =	2.25		2.18		2.18		2.25	0.7%
	$P/A_g f'_c$ =	0.01		0.02		0.02		0.01	
			1.27		1.24		1.28		
			2.86		2.01		2.87		
			1.00		1.00		1.00		
			1.17		1.16		1.17		
Floor 12		1.72		1.41		1.41		1.72	
		2.78		2.01		2.01		2.78	
Story 11	$\phi M_n/M_u$ =	2.46		2.57		2.57		2.47	
	$\phi V_n/V_{mpr}$ =	2.09		1.98		1.98		2.09	1.0%
	$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
			1.18		1.17		1.18		
			1.70		1.37		1.70		
			0.81		0.81		0.81		
			1.16		1.15		1.16		
Floor 11		1.50		1.35		1.35		1.50	
		2.26		1.80		1.80		2.26	
Story 10	$\phi M_n/M_u$ =	1.88		1.85		1.85		1.88	
	$\phi V_n/V_{mpr}$ =	1.95		1.87		1.87		1.95	1.3%
	$P/A_g f'_c$ =	0.03		0.04		0.04		0.03	
			1.20		1.21		1.20		
			1.43		1.22		1.44		
			0.76		0.76		0.76		
			1.16		1.16		1.16		
Floor 10		1.39		1.33		1.33		1.39	
		1.74		1.44		1.44		1.74	
Story 9	$\phi M_n/M_u$ =	1.85		1.91		1.91		1.85	
	$\phi V_n/V_{mpr}$ =	1.88		2.29		2.29		1.88	1.5%
	$P/A_g f'_c$ =	0.05		0.06		0.06		0.05	
			1.19		1.22		1.19		
			1.30		1.16		1.31		
			0.74		0.74		0.74		
			1.15		1.17		1.15		
Floor 9		1.34		1.36		1.36		1.34	
		1.47		1.22		1.22		1.47	
Story 8	$\phi M_n/M_u$ =	1.61		1.69		1.69		1.61	
	$\phi V_n/V_{mpr}$ =	2.96		2.62		2.62		2.97	1.7%
	$P/A_g f'_c$ =	0.06		0.07		0.07		0.06	
			1.17		1.20		1.17		
			1.31		1.21		1.31		
			0.80		0.80		0.80		
			1.16		1.15		1.16		
Floor 8		1.35		1.32		1.32		1.35	
		1.35		1.09		1.09		1.35	
Story 7	$\phi M_n/M_u$ =	1.70		1.71		1.71		1.70	
	$\phi V_n/V_{mpr}$ =	2.51		2.32		2.32		2.51	1.8%
	$P/A_g f'_c$ =	0.08		0.09		0.09		0.08	
			1.17		1.21		1.17		
			1.23		1.17		1.23		
			0.78		0.78		0.78		
			1.15		1.16		1.15		
Floor 7		1.35		1.34		1.34		1.35	
		1.48		1.20		1.20		1.48	
Story 6	$\phi M_n/M_u$ =	1.55		1.63		1.63		1.55	
	$\phi V_n/V_{mpr}$ =	3.23		2.98		2.98		3.23	1.9%
	$P/A_g f'_c$ =	0.07		0.07		0.07		0.07	
			1.16		1.20		1.16		
			1.18		1.16		1.18		
			0.79		0.79		0.79		
			1.16		1.16		1.16		
Floor 6		1.34		1.34		1.34		1.34	
		1.43		1.15		1.15		1.43	
Story 5	$\phi M_n/M_u$ =	1.58		1.59		1.59		1.58	
	$\phi V_n/V_{mpr}$ =	2.93		2.87		2.87		2.93	1.9%
	$P/A_g f'_c$ =	0.08		0.08		0.08		0.08	
			1.17		1.22		1.17		
			1.16		1.17		1.16		
			0.79		0.79		0.79		
			1.16		1.16		1.16		
Floor 5		1.30		1.32		1.32		1.30	
		1.36		1.10		1.10		1.36	
Story 4	$\phi M_n/M_u$ =	1.45		1.58		1.58		1.45	
	$\phi V_n/V_{mpr}$ =	2.88		2.77		2.77		2.88	2.0%
	$P/A_g f'_c$ =	0.09		0.10		0.10		0.09	
			1.18		1.24		1.18		
			1.15		1.19		1.15		
			0.79		0.79		0.79		
			1.15		1.16		1.15		
Floor 4		1.27		1.31		1.31		1.27	
		1.32		1.06		1.06		1.32	
Story 3	$\phi M_n/M_u$ =	1.50		1.58		1.58		1.50	
	$\phi V_n/V_{mpr}$ =	2.65		2.68		2.68		2.65	2.0%
	$P/A_g f'_c$ =	0.10		0.11		0.11		0.10	
			1.18		1.24		1.18		
			1.18		1.25		1.18		
			0.83		0.83		0.83		
			1.16		1.16		1.16		
Floor 3		1.29		1.33		1.33		1.30	
		1.32		1.04		1.04		1.32	
Story 2	$\phi M_n/M_u$ =	1.40		1.56		1.56		1.40	
	$\phi V_n/V_{mpr}$ =	2.57		2.59		2.59		2.57	1.8%
	$P/A_g f'_c$ =	0.11		0.12		0.12		0.11	
			1.18		1.25		1.18		
			1.15		1.30		1.15		
			0.83		0.83		0.83		
			1.16		1.16		1.16		
Floor 2		1.34		1.45		1.45		1.34	
		1.41		1.12		1.12		1.41	
			$(\phi M_n/M_u)_{neg}$ =		$(\phi M_n/M_u)_{neg}$ =		$(\phi M_n/M_u)_{neg}$ =		
			$(\phi M_n/M_u)_{pos}$ =		$(\phi M_n/M_u)_{pos}$ =		$(\phi M_n/M_u)_{pos}$ =		
			$M_{n,pos}/M_{n,neg}$ =		$M_{n,pos}/M_{n,neg}$ =		$M_{n,pos}/M_{n,neg}$ =		
			$\phi V_n/V_{mpr}$ =		$\phi V_n/V_{mpr}$ =		$\phi V_n/V_{mpr}$ =		
Story 1	$\phi M_n/M_u$ =	0.93		1.15		1.15		0.94	
	$\phi V_n/V_{mpr}$ =	2.5		2.51		2.51		2.5	1.3%
	$P/A_g f'_c$ =	0.12		0.13		0.13		0.12	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	4297	6090	6090	4297
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.070	0.072	0.072	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	111	111	109
	$(P/A_gf'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 11	$M_{y,exp}$ (k-in) =	4499	6687	6687	4499
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.069	0.071	0.071	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	109	109	108
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 10	$M_{y,exp}$ (k-in) =	4698	7008	7008	4698
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.069	0.069	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	108	108	107
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 9	$M_{y,exp}$ (k-in) =	5679	9067	9067	5679
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.069	0.069	0.069	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	106	106	106
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 8	$M_{y,exp}$ (k-in) =	5874	9507	9507	5874
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.068	0.068	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	105	105	105
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 7	$M_{y,exp}$ (k-in) =	6942	10743	10743	6942
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.069	0.068	0.068	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	103	103	105
	$(P/A_gf'_c)_{exp}$ =	0.04	0.06	0.06	0.04
Story 6	$M_{y,exp}$ (k-in) =	7083	11252	11252	7083
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.070	0.073	0.073	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	105	105	100
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 5	$M_{y,exp}$ (k-in) =	7761	11685	11685	7761
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.071	0.072	0.072	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	100	104	104	100
	$(P/A_gf'_c)_{exp}$ =	0.04	0.06	0.06	0.04
Story 4	$M_{y,exp}$ (k-in) =	7758	12115	12115	7758
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.070	0.071	0.071	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	103	103	99
	$(P/A_gf'_c)_{exp}$ =	0.04	0.07	0.07	0.04
Story 3	$M_{y,exp}$ (k-in) =	8432	12542	12542	8432
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.070	0.070	0.070	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	99	102	102	99
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 2	$M_{y,exp}$ (k-in) =	8621	12966	12966	8621
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.069	0.069	0.069	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	98	101	101	98
	$(P/A_gf'_c)_{exp}$ =	0.05	0.08	0.08	0.05
Story 1	$M_{y,exp}$ (k-in) =	8809	13386	13386	8809
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.069	0.068	0.068	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	98	100	100	98
	$(P/A_gf'_c)_{exp}$ =	0.05	0.09	0.09	0.05

Floor 13	$M_{y,pos,exp}$(k-in) =	3686	3686	3686
	$M_{y,n,slab,exp}$(k-in) =	-4961	-4961	-4961
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0375	0.0375	0.0375
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.043	-0.043	-0.043
	Θ_{pc} (rad) =	0.088	0.088	0.088
	λ =	103	103	103
Floor 12	$M_{y,pos,exp}$(k-in) =	3686	3686	3686
	$M_{y,n,slab,exp}$(k-in) =	-4971	-4971	-4971
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.037	0.037	0.037
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.043	-0.043	-0.043
	Θ_{pc} (rad) =	0.088	0.088	0.088
	λ =	103	103	103
Floor 11	$M_{y,pos,exp}$(k-in) =	3686	3686	3686
	$M_{y,n,slab,exp}$(k-in) =	-5788	-5788	-5788
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.036	0.036	0.036
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.044	-0.044
	Θ_{pc} (rad) =	0.093	0.093	0.093
	λ =	99	99	99
Floor 10	$M_{y,pos,exp}$(k-in) =	4249	4249	4249
	$M_{y,n,slab,exp}$(k-in) =	-6873	-6873	-6873
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.038	0.038	0.038
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.047	-0.047	-0.047
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 9	$M_{y,pos,exp}$(k-in) =	4768	4768	4768
	$M_{y,n,slab,exp}$(k-in) =	-7683	-7683	-7683
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.039	0.039	0.039
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.049	-0.049	-0.049
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 8	$M_{y,pos,exp}$(k-in) =	5591	5591	5591
	$M_{y,n,slab,exp}$(k-in) =	-8224	-8224	-8224
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.050	-0.050	-0.050
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 7	$M_{y,pos,exp}$(k-in) =	5889	5889	5889
	$M_{y,n,slab,exp}$(k-in) =	-8761	-8761	-8761
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.0444	0.0424
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.051	-0.053	-0.051
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	103	99
Floor 6	$M_{y,pos,exp}$(k-in) =	6162	6162	6162
	$M_{y,n,slab,exp}$(k-in) =	-9031	-9031	-9031
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0452	0.0452
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 5	$M_{y,pos,exp}$(k-in) =	6413	6413	6413
	$M_{y,n,slab,exp}$(k-in) =	-9390	-9390	-9390
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.0443	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 4	$M_{y,pos,exp}$(k-in) =	6686	6686	6686
	$M_{y,n,slab,exp}$(k-in) =	-9659	-9659	-9659
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.0448
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 3	$M_{y,pos,exp}$(k-in) =	6980	6980	6980
	$M_{y,n,slab,exp}$(k-in) =	-9661	-9661	-9661
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.0458	0.0458
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 2	$M_{y,pos,exp}$(k-in) =	6537	6537	6537
	$M_{y,n,slab,exp}$(k-in) =	-9124	-9124	-9124
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.854E+08	1.854E+08	1.854E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.052	-0.052	-0.052
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.84 T_2 = 0.94 T_3 = 0.54

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2055

Number of Stories: 12

Fundamental Period (sec): 2.01

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

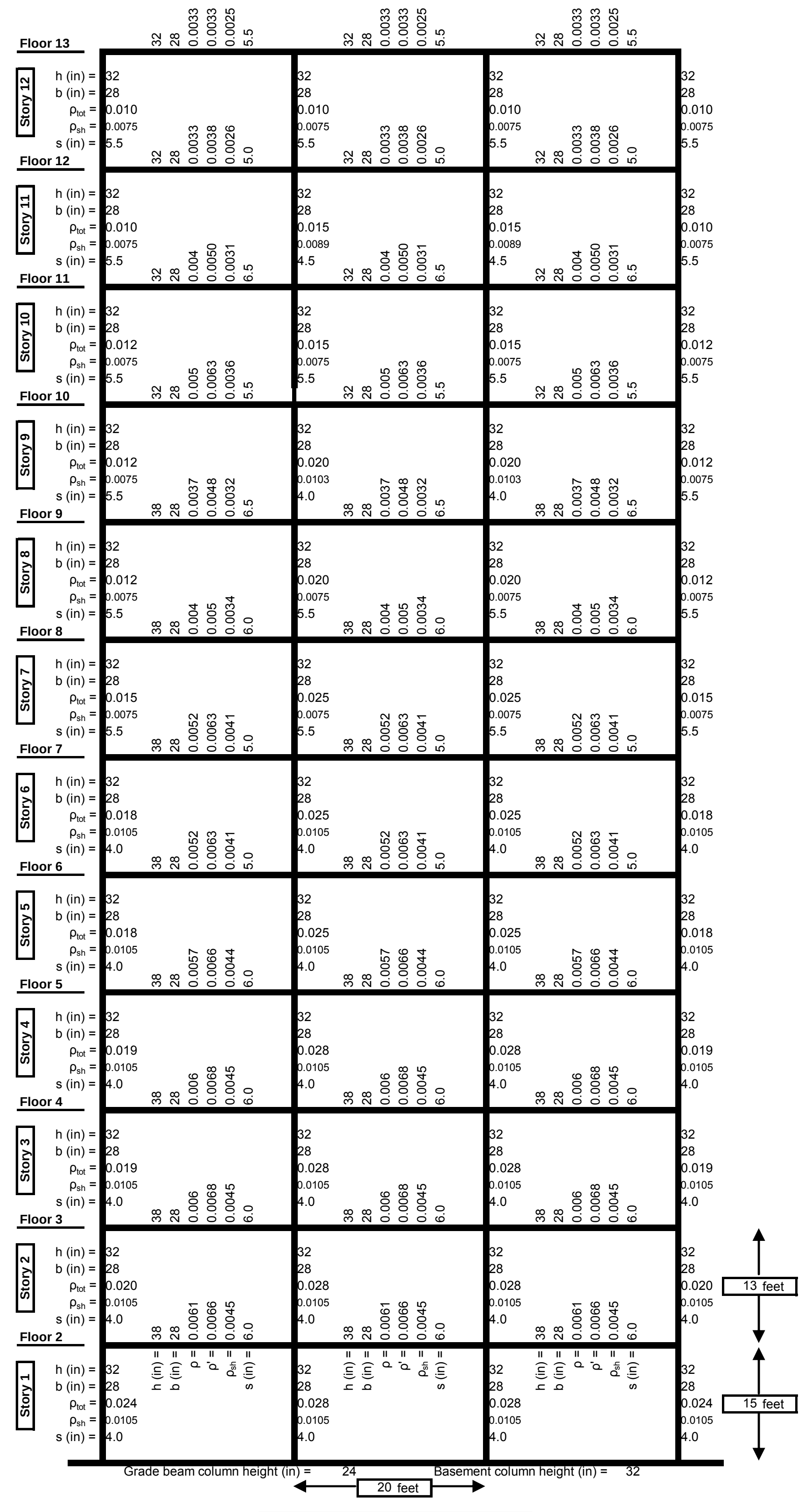
2055 Perimeter Frame, SCWB=1.5

Compared to the baseline 12 story, this build simply have more reinforcement in the columns. Both positive and negative beam bending strength were controlled by strength demands, except for 3 beams. Few additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. All column flexural strengths were controlled by the strong-column weak-beam ratio except for 4 outer columns by flexural and few columns at the upper floors of the building by minimum requirement. Beam stirrups were controlled by the capacity shear design and minimum requirement (36 by demand). Column stirrups were controlled by the capacity shear design and minimum requirement (4 by demand). As in the baseline design, joint shear controls the beam and column sizes.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Story	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	32	28	0.010	0.0075	5.5
	32	28	0.010	0.0075	5.5
	32	28	0.010	0.0075	5.5
	32	28	0.010	0.0075	5.5
Story 11	32	28	0.010	0.0075	5.5
	32	28	0.015	0.0089	4.5
	32	28	0.015	0.0089	4.5
	32	28	0.010	0.0075	5.5
Story 10	32	28	0.012	0.0075	5.5
	32	28	0.015	0.0075	5.5
	32	28	0.015	0.0075	5.5
	32	28	0.012	0.0075	5.5
Story 9	32	28	0.012	0.0075	5.5
	32	28	0.020	0.0103	4.0
	32	28	0.020	0.0103	4.0
	32	28	0.012	0.0075	5.5
Story 8	32	28	0.012	0.0075	5.5
	32	28	0.020	0.0075	5.5
	32	28	0.020	0.0075	5.5
	32	28	0.012	0.0075	5.5
Story 7	32	28	0.015	0.0075	5.5
	32	28	0.025	0.0075	5.5
	32	28	0.025	0.0075	5.5
	32	28	0.015	0.0075	5.5
Story 6	32	28	0.018	0.0105	4.0
	32	28	0.025	0.0105	4.0
	32	28	0.025	0.0105	4.0
	32	28	0.018	0.0105	4.0
Story 5	32	28	0.018	0.0105	4.0
	32	28	0.025	0.0105	4.0
	32	28	0.025	0.0105	4.0
	32	28	0.018	0.0105	4.0
Story 4	32	28	0.019	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.019	0.0105	4.0
Story 3	32	28	0.019	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.019	0.0105	4.0
Story 2	32	28	0.020	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.020	0.0105	4.0
Story 1	32	28	0.024	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.028	0.0105	4.0
	32	28	0.024	0.0105	4.0

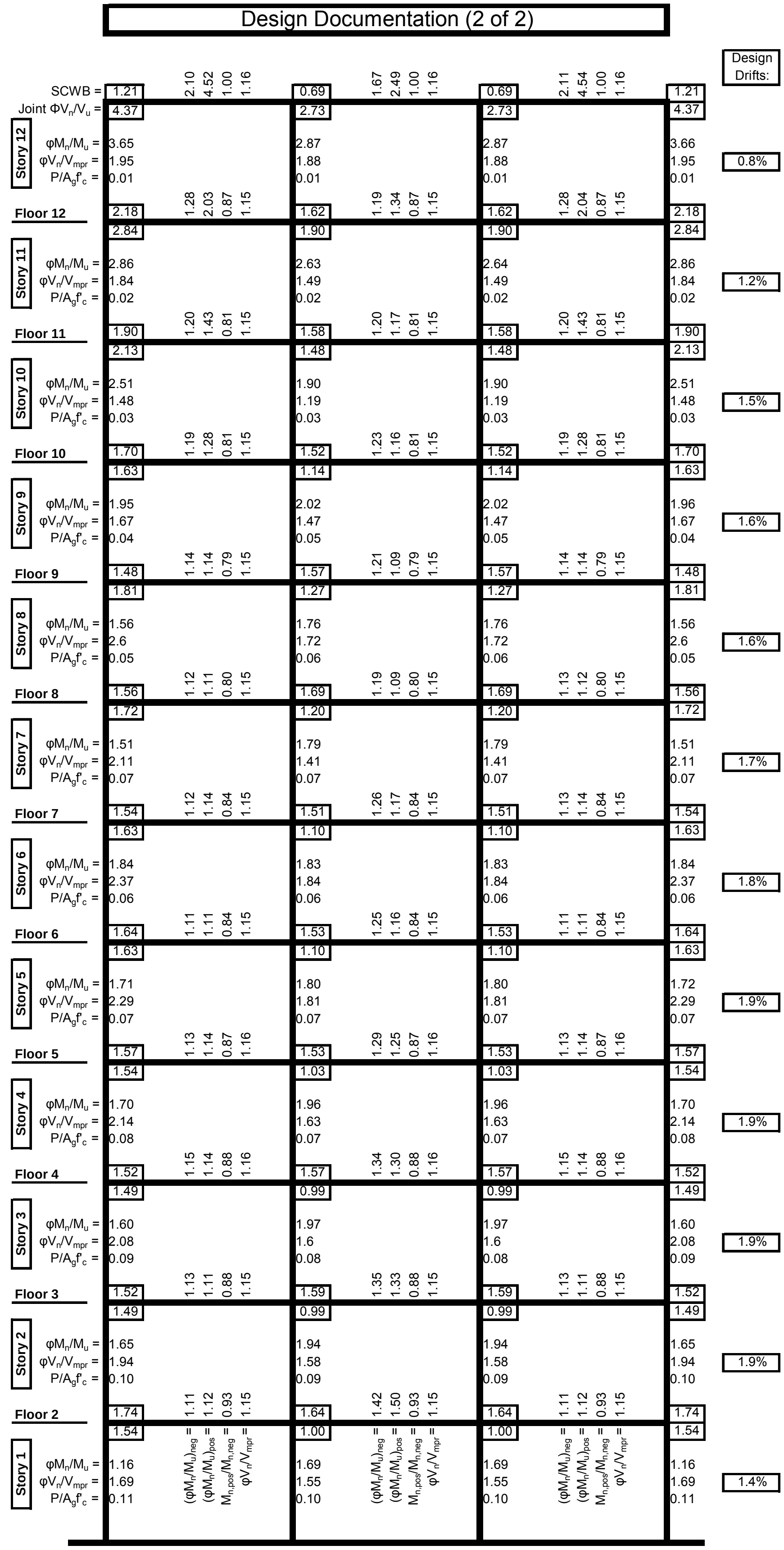
Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	32	28	0.0033	0.0033	0.0025	5.5
	32	28	0.0033	0.0033	0.0025	5.5
	32	28	0.0033	0.0033	0.0025	5.5
Floor 12	32	28	0.0033	0.0038	0.0026	5.0
	32	28	0.0033	0.0038	0.0026	5.0
	32	28	0.0033	0.0038	0.0026	5.0
Floor 11	32	28	0.004	0.0050	0.0031	6.5
	32	28	0.004	0.0050	0.0031	6.5
	32	28	0.004	0.0050	0.0031	6.5
Floor 10	32	28	0.005	0.0063	0.0036	5.5
	32	28	0.005	0.0063	0.0036	5.5
	32	28	0.005	0.0063	0.0036	5.5
Floor 9	38	28	0.0037	0.0048	0.0032	6.5
	38	28	0.0037	0.0048	0.0032	6.5
	38	28	0.0037	0.0048	0.0032	6.5
Floor 8	38	28	0.004	0.005	0.0034	6.0
	38	28	0.004	0.005	0.0034	6.0
	38	28	0.004	0.005	0.0034	6.0
Floor 7	38	28	0.0052	0.0063	0.0041	5.0
	38	28	0.0052	0.0063	0.0041	5.0
	38	28	0.0052	0.0063	0.0041	5.0
Floor 6	38	28	0.0052	0.0063	0.0041	5.0
	38	28	0.0052	0.0063	0.0041	5.0
	38	28	0.0052	0.0063	0.0041	5.0
Floor 5	38	28	0.0057	0.0066	0.0044	6.0
	38	28	0.0057	0.0066	0.0044	6.0
	38	28	0.0057	0.0066	0.0044	6.0
Floor 4	38	28	0.006	0.0068	0.0045	6.0
	38	28	0.006	0.0068	0.0045	6.0
	38	28	0.006	0.0068	0.0045	6.0
Floor 3	38	28	0.006	0.0068	0.0045	6.0
	38	28	0.006	0.0068	0.0045	6.0
	38	28	0.006	0.0068	0.0045	6.0
Floor 2	38	28	0.0061	0.0066	0.0045	6.0
	38	28	0.0061	0.0066	0.0045	6.0
	38	28	0.0061	0.0066	0.0045	6.0

Grade beam column height (in) = 24

Basement column height (in) = 32

Design base shear =	0.044 g,	368 k	
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	7.0 ksi

Design Documentation (2 of 2)



								Design Drifts:
$(\phi M_n/M_u)_{neg}$ =		2.10		1.67		2.11		
$(\phi M_n/M_u)_{pos}$ =		4.52		2.49		4.54		
$M_{n,pos}/M_{n,neg}$ =		1.00		1.00		1.00		
$\phi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	1.21		0.69		0.69		1.21	
Joint $\Phi V_n/V_u$ =	4.37		2.73		2.73		4.37	
Story 12 $\phi M_n/M_u$ =	3.65		2.87		2.87		3.66	
$\phi V_n/V_{mpr}$ =	1.95		1.88		1.88		1.95	0.8%
$P/A_gf'_c$ =	0.01		0.01		0.01		0.01	
Floor 12 $(\phi M_n/M_u)_{neg}$ =		1.28		1.19		1.28		
$(\phi M_n/M_u)_{pos}$ =		2.03		1.34		2.04		
$M_{n,pos}/M_{n,neg}$ =		0.87		0.87		0.87		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	2.18		1.62		1.62		2.18	
Joint $\Phi V_n/V_u$ =	2.84		1.90		1.90		2.84	
Story 11 $\phi M_n/M_u$ =	2.86		2.63		2.64		2.86	
$\phi V_n/V_{mpr}$ =	1.84		1.49		1.49		1.84	1.2%
$P/A_gf'_c$ =	0.02		0.02		0.02		0.02	
Floor 11 $(\phi M_n/M_u)_{neg}$ =		1.20		1.20		1.20		
$(\phi M_n/M_u)_{pos}$ =		1.43		1.17		1.43		
$M_{n,pos}/M_{n,neg}$ =		0.81		0.81		0.81		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.90		1.58		1.58		1.90	
Joint $\Phi V_n/V_u$ =	2.13		1.48		1.48		2.13	
Story 10 $\phi M_n/M_u$ =	2.51		1.90		1.90		2.51	
$\phi V_n/V_{mpr}$ =	1.48		1.19		1.19		1.48	1.5%
$P/A_gf'_c$ =	0.03		0.03		0.03		0.03	
Floor 10 $(\phi M_n/M_u)_{neg}$ =		1.19		1.23		1.19		
$(\phi M_n/M_u)_{pos}$ =		1.28		1.16		1.28		
$M_{n,pos}/M_{n,neg}$ =		0.81		0.81		0.81		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.70		1.52		1.52		1.70	
Joint $\Phi V_n/V_u$ =	1.63		1.14		1.14		1.63	
Story 9 $\phi M_n/M_u$ =	1.95		2.02		2.02		1.96	
$\phi V_n/V_{mpr}$ =	1.67		1.47		1.47		1.67	1.6%
$P/A_gf'_c$ =	0.04		0.05		0.05		0.04	
Floor 9 $(\phi M_n/M_u)_{neg}$ =		1.14		1.21		1.14		
$(\phi M_n/M_u)_{pos}$ =		1.14		1.09		1.14		
$M_{n,pos}/M_{n,neg}$ =		0.79		0.79		0.79		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.48		1.57		1.57		1.48	
Joint $\Phi V_n/V_u$ =	1.81		1.27		1.27		1.81	
Story 8 $\phi M_n/M_u$ =	1.56		1.76		1.76		1.56	
$\phi V_n/V_{mpr}$ =	2.6		1.72		1.72		2.6	1.6%
$P/A_gf'_c$ =	0.05		0.06		0.06		0.05	
Floor 8 $(\phi M_n/M_u)_{neg}$ =		1.12		1.19		1.13		
$(\phi M_n/M_u)_{pos}$ =		1.11		1.09		1.12		
$M_{n,pos}/M_{n,neg}$ =		0.80		0.80		0.80		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.56		1.69		1.69		1.56	
Joint $\Phi V_n/V_u$ =	1.72		1.20		1.20		1.72	
Story 7 $\phi M_n/M_u$ =	1.51		1.79		1.79		1.51	
$\phi V_n/V_{mpr}$ =	2.11		1.41		1.41		2.11	1.7%
$P/A_gf'_c$ =	0.07		0.07		0.07		0.07	
Floor 7 $(\phi M_n/M_u)_{neg}$ =		1.12		1.26		1.13		
$(\phi M_n/M_u)_{pos}$ =		1.14		1.17		1.14		
$M_{n,pos}/M_{n,neg}$ =		0.84		0.84		0.84		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.54		1.51		1.51		1.54	
Joint $\Phi V_n/V_u$ =	1.63		1.10		1.10		1.63	
Story 6 $\phi M_n/M_u$ =	1.84		1.83		1.83		1.84	
$\phi V_n/V_{mpr}$ =	2.37		1.84		1.84		2.37	1.8%
$P/A_gf'_c$ =	0.06		0.06		0.06		0.06	
Floor 6 $(\phi M_n/M_u)_{neg}$ =		1.11		1.25		1.11		
$(\phi M_n/M_u)_{pos}$ =		1.11		1.16		1.11		
$M_{n,pos}/M_{n,neg}$ =		0.84		0.84		0.84		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.64		1.53		1.53		1.64	
Joint $\Phi V_n/V_u$ =	1.63		1.10		1.10		1.63	
Story 5 $\phi M_n/M_u$ =	1.71		1.80		1.80		1.72	
$\phi V_n/V_{mpr}$ =	2.29		1.81		1.81		2.29	1.9%
$P/A_gf'_c$ =	0.07		0.07		0.07		0.07	
Floor 5 $(\phi M_n/M_u)_{neg}$ =		1.13		1.29		1.13		
$(\phi M_n/M_u)_{pos}$ =		1.14		1.25		1.14		
$M_{n,pos}/M_{n,neg}$ =		0.87		0.87		0.87		
$\phi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	1.57		1.53		1.53		1.57	
Joint $\Phi V_n/V_u$ =	1.54		1.03		1.03		1.54	
Story 4 $\phi M_n/M_u$ =	1.70		1.96		1.96		1.70	
$\phi V_n/V_{mpr}$ =	2.14		1.63		1.63		2.14	1.9%
$P/A_gf'_c$ =	0.08		0.07		0.07		0.08	
Floor 4 $(\phi M_n/M_u)_{neg}$ =		1.15		1.34		1.15		
$(\phi M_n/M_u)_{pos}$ =		1.14		1.30		1.14		
$M_{n,pos}/M_{n,neg}$ =		0.88		0.88		0.88		
$\phi V_n/V_{mpr}$ =		1.16		1.16		1.16		
SCWB =	1.52		1.57		1.57		1.52	
Joint $\Phi V_n/V_u$ =	1.49		0.99		0.99		1.49	
Story 3 $\phi M_n/M_u$ =	1.60		1.97		1.97		1.60	
$\phi V_n/V_{mpr}$ =	2.08		1.6		1.6		2.08	1.9%
$P/A_gf'_c$ =	0.09		0.08		0.08		0.09	
Floor 3 $(\phi M_n/M_u)_{neg}$ =		1.13		1.35		1.13		
$(\phi M_n/M_u)_{pos}$ =		1.11		1.33		1.11		
$M_{n,pos}/M_{n,neg}$ =		0.88		0.88		0.88		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.52		1.59		1.59		1.52	
Joint $\Phi V_n/V_u$ =	1.49		0.99		0.99		1.49	
Story 2 $\phi M_n/M_u$ =	1.65		1.94		1.94		1.65	
$\phi V_n/V_{mpr}$ =	1.94		1.58		1.58		1.94	1.9%
$P/A_gf'_c$ =	0.10		0.09		0.09		0.10	
Floor 2 $(\phi M_n/M_u)_{neg}$ =		1.11		1.42		1.11		
$(\phi M_n/M_u)_{pos}$ =		1.12		1.50		1.12		
$M_{n,pos}/M_{n,neg}$ =		0.93		0.93		0.93		
$\phi V_n/V_{mpr}$ =		1.15		1.15		1.15		
SCWB =	1.74		1.64		1.64		1.74	
Joint $\Phi V_n/V_u$ =	1.54		1.00		1.00		1.54	
Story 1 $\phi M_n/M_u$ =	1.16		1.69		1.69		1.16	
$\phi V_n/V_{mpr}$ =	1.69		1.55		1.55		1.69	1.4%
$P/A_gf'_c$ =	0.11		0.10		0.10		0.11	

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Floor 13	$M_{y,pos,exp}$(k-in) =	4981	4981	4981
	$M_{y,n,slab,exp}$(k-in) =	-6358	-6358	-6358
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0389	0.0389	0.0389
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.044	-0.044
	Θ_{pc} (rad) =	0.086	0.086	0.086
	λ =	111	111	111
Floor 12	$M_{y,pos,exp}$(k-in) =	4981	4981	4981
	$M_{y,n,slab,exp}$(k-in) =	-7079	-7079	-7079
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.040	0.040	0.040
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.047	-0.047	-0.047
	Θ_{pc} (rad) =	0.089	0.089	0.089
	λ =	116	116	116
Floor 11	$M_{y,pos,exp}$(k-in) =	6082	6082	6082
	$M_{y,n,slab,exp}$(k-in) =	-8908	-8908	-8908
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.039	0.039	0.039
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.046	-0.046	-0.046
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	103	103	103
Floor 10	$M_{y,pos,exp}$(k-in) =	7562	7562	7562
	$M_{y,n,slab,exp}$(k-in) =	-10728	-10728	-10728
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	111	111	111
Floor 9	$M_{y,pos,exp}$(k-in) =	8230	8230	8230
	$M_{y,n,slab,exp}$(k-in) =	-12091	-12091	-12091
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.039	0.039	0.039
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.047	-0.047	-0.047
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	112	112	112
Floor 8	$M_{y,pos,exp}$(k-in) =	8771	8771	8771
	$M_{y,n,slab,exp}$(k-in) =	-12624	-12624	-12624
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.049	-0.049	-0.049
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 7	$M_{y,pos,exp}$(k-in) =	11506	11506	11506
	$M_{y,n,slab,exp}$(k-in) =	-15282	-15282	-15282
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.0507	0.0507
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	123	123	123
Floor 6	$M_{y,pos,exp}$(k-in) =	11506	11506	11506
	$M_{y,n,slab,exp}$(k-in) =	-15282	-15282	-15282
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.0507	0.0507
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	123	123	123
Floor 5	$M_{y,pos,exp}$(k-in) =	12531	12531	12531
	$M_{y,n,slab,exp}$(k-in) =	-15995	-15995	-15995
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0486	0.0486
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 4	$M_{y,pos,exp}$(k-in) =	13066	13066	13066
	$M_{y,n,slab,exp}$(k-in) =	-16525	-16525	-16525
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.0496	0.0496
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 3	$M_{y,pos,exp}$(k-in) =	13111	13111	13111
	$M_{y,n,slab,exp}$(k-in) =	-16526	-16526	-16526
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.0496	0.0496
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 2	$M_{y,pos,exp}$(k-in) =	13306	13306	13306
	$M_{y,n,slab,exp}$(k-in) =	-16004	-16004	-16004
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.050	0.050
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116

Story 12	$M_{y,exp}$ (k-in) =	7808	8058	8058	7808
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.067	0.067	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	110	110	110
	$(P/A_gf'_c)_{exp}$ =	0.00	0.01	0.01	0.00
Story 11	$M_{y,exp}$ (k-in) =	8058	12190	12190	8058
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.067	0.080	0.080	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	117	117	110
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 10	$M_{y,exp}$ (k-in) =	9766	12669	12669	9766
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.068	0.068	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	107	107	109
	$(P/A_gf'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 9	$M_{y,exp}$ (k-in) =	10010	16751	16751	10010
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.067	0.088	0.088	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	119	119	109
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 8	$M_{y,exp}$ (k-in) =	10254	17218	17218	10254
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.067	0.069	0.069	0.067
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	105	105	108
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 7	$M_{y,exp}$ (k-in) =	12669	21275	21275	12669
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.068	0.070	0.070	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	104	104	107
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 6	$M_{y,exp}$ (k-in) =	15149	21835	21835	15149
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.084	0.084	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	121	118	118	121
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 5	$M_{y,exp}$ (k-in) =	15387	22295	22295	15387
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.083	0.083	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	121	117	117	121
	$(P/A_gf'_c)_{exp}$ =	0.02	0.05	0.05	0.02
Story 4	$M_{y,exp}$ (k-in) =	16347	24907	24907	16347
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.084	0.084	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	116	116	120
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 3	$M_{y,exp}$ (k-in) =	16583	25361	25361	16583
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.081	0.083	0.083	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	115	115	120
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 2	$M_{y,exp}$ (k-in) =	17719	25814	25814	17719
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.082	0.082	0.082	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	114	114	119
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 1	$M_{y,exp}$ (k-in) =	20653	26264	26264	20653
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.084	0.081	0.081	0.084
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	113	113	119
	$(P/A_gf'_c)_{exp}$ =	0.04	0.07	0.07	0.04

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.01 T_2 = 0.68 T_3 = 0.39

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2056
Number of Stories: 12
Fundamental Period (sec): 2.01

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2056 Perimeter Frame, SCWB=2.0
Compared to the baseline 12 story, this build simply have more reinforcement in the columns. Both positive and negative bending strength were controlled by strength demands, except for 3 elements. Few additional beam reinforcements in 12 bays were added to alter beam design to use same rho and rhoPrime in each floor. All column flexural strengths were controlled by the strong-column weak-beam ratio except for 4 lower outer columns and 8 upper columns. Beam stirrups were controlled by the capacity shear design and minimum requirement (36 by demand). Column stirrups were controlled by the capacity shear design and minimum requirement (4 by demand). As in the baseline design, joint shear controls the beam and column sizes.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)

Story	Column line	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	1	36	28	0.010	0.0086	5.5
Story 12	2	36	28	0.010	0.0086	5.5
Story 12	3	36	28	0.010	0.0086	5.5
Story 12	4	36	28	0.010	0.0086	5.5
Story 11	1	36	28	0.013	0.0086	5.5
Story 11	2	36	28	0.015	0.0102	4.5
Story 11	3	36	28	0.015	0.0102	4.5
Story 11	4	36	28	0.013	0.0086	5.5
Story 10	1	36	28	0.013	0.0086	5.5
Story 10	2	36	28	0.015	0.0086	5.5
Story 10	3	36	28	0.015	0.0086	5.5
Story 10	4	36	28	0.013	0.0086	5.5
Story 9	1	36	28	0.015	0.0086	5.5
Story 9	2	36	28	0.022	0.0105	4.5
Story 9	3	36	28	0.022	0.0105	4.5
Story 9	4	36	28	0.015	0.0086	5.5
Story 8	1	36	28	0.015	0.0086	5.5
Story 8	2	36	28	0.022	0.0086	5.5
Story 8	3	36	28	0.022	0.0086	5.5
Story 8	4	36	28	0.015	0.0086	5.5
Story 7	1	36	28	0.015	0.0086	5.5
Story 7	2	36	28	0.022	0.0086	5.5
Story 7	3	36	28	0.022	0.0086	5.5
Story 7	4	36	28	0.015	0.0086	5.5
Story 6	1	36	28	0.015	0.0120	4.5
Story 6	2	36	28	0.022	0.0120	4.5
Story 6	3	36	28	0.022	0.0120	4.5
Story 6	4	36	28	0.015	0.0120	4.5
Story 5	1	36	28	0.018	0.0120	4.5
Story 5	2	36	28	0.026	0.0120	4.5
Story 5	3	36	28	0.026	0.0120	4.5
Story 5	4	36	28	0.018	0.0120	4.5
Story 4	1	36	28	0.018	0.0120	4.5
Story 4	2	36	28	0.026	0.0120	4.5
Story 4	3	36	28	0.026	0.0120	4.5
Story 4	4	36	28	0.018	0.0120	4.5
Story 3	1	36	28	0.018	0.0120	4.5
Story 3	2	36	28	0.026	0.0120	4.5
Story 3	3	36	28	0.026	0.0120	4.5
Story 3	4	36	28	0.018	0.0120	4.5
Story 2	1	36	28	0.018	0.0120	4.5
Story 2	2	36	28	0.026	0.0120	4.5
Story 2	3	36	28	0.026	0.0120	4.5
Story 2	4	36	28	0.018	0.0120	4.5
Story 1	1	36	28	0.022	0.0120	4.5
Story 1	2	36	28	0.026	0.0120	4.5
Story 1	3	36	28	0.026	0.0120	4.5
Story 1	4	36	28	0.022	0.0120	4.5

Floor	Bay	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	1	28	28	0.0032	0.0032	0.0023	5.5
Floor 13	2	28	28	0.0032	0.0032	0.0023	5.5
Floor 13	3	28	28	0.0032	0.0032	0.0023	5.5
Floor 12	1	28	28	0.0033	0.0045	0.0026	5.0
Floor 12	2	28	28	0.0033	0.0045	0.0026	5.0
Floor 12	3	28	28	0.0033	0.0045	0.0026	5.0
Floor 11	1	28	28	0.0045	0.0058	0.0031	6.0
Floor 11	2	28	28	0.0045	0.0058	0.0031	6.0
Floor 11	3	28	28	0.0045	0.0058	0.0031	6.0
Floor 10	1	28	28	0.0055	0.0065	0.0035	5.5
Floor 10	2	28	28	0.0055	0.0065	0.0035	5.5
Floor 10	3	28	28	0.0055	0.0065	0.0035	5.5
Floor 9	1	34	28	0.0052	0.0063	0.0039	5.0
Floor 9	2	34	28	0.0052	0.0063	0.0039	5.0
Floor 9	3	34	28	0.0052	0.0063	0.0039	5.0
Floor 8	1	34	28	0.0057	0.0065	0.0041	5.0
Floor 8	2	34	28	0.0057	0.0065	0.0041	5.0
Floor 8	3	34	28	0.0057	0.0065	0.0041	5.0
Floor 7	1	34	28	0.006	0.0070	0.0043	4.5
Floor 7	2	34	28	0.006	0.0070	0.0043	4.5
Floor 7	3	34	28	0.006	0.0070	0.0043	4.5
Floor 6	1	34	28	0.0062	0.0075	0.0045	4.5
Floor 6	2	34	28	0.0062	0.0075	0.0045	4.5
Floor 6	3	34	28	0.0062	0.0075	0.0045	4.5
Floor 5	1	34	28	0.0067	0.0078	0.0047	5.5
Floor 5	2	34	28	0.0067	0.0078	0.0047	5.5
Floor 5	3	34	28	0.0067	0.0078	0.0047	5.5
Floor 4	1	34	28	0.007	0.0078	0.0047	5.5
Floor 4	2	34	28	0.007	0.0078	0.0047	5.5
Floor 4	3	34	28	0.007	0.0078	0.0047	5.5
Floor 3	1	34	28	0.007	0.0078	0.0048	5.5
Floor 3	2	34	28	0.007	0.0078	0.0048	5.5
Floor 3	3	34	28	0.007	0.0078	0.0048	5.5
Floor 2	1	34	28	0.0063	0.0073	0.0044	6.0
Floor 2	2	34	28	0.0063	0.0073	0.0044	6.0
Floor 2	3	34	28	0.0063	0.0073	0.0044	6.0

13 feet

15 feet

Grade beam column height (in) = 24

Basement column height (in) = 36

20 feet

Design base shear =	0.044 g,	368 k		
f'_c beams =	5.0 ksi	$f'_{c,cols,upper}$ =	5.0 ksi	
$f_{y,rebar,nom.}$ =	60 ksi	$f'_{c,cols,lower}$ =	7.0 ksi	

Design Documentation (2 of 2)

								Design Drifts:
SCWB =	2.04	1.38 2.96 1.00 1.17	1.19	1.24 1.84 1.00 1.17	1.19	1.39 2.97 1.00 1.17	2.04	
Joint $\Phi V_n/V_u$ =	5.12		3.20		3.20		5.12	
Story 12 $\phi M_n/M_u$ =	3.59		2.79		2.80		3.60	
$\phi V_n/V_{mpr}$ =	2.03		1.97		1.97		2.03	0.9%
$P/A_g f'_c$ =	0.01		0.01		0.01		0.01	
Floor 12	3.63	1.22 1.42 0.73 1.17	2.53	1.15 1.11 0.73 1.17	2.53	1.22 1.42 0.73 1.17	3.63	
	2.92		2.12		2.12		2.92	
Story 11 $\phi M_n/M_u$ =	3.60		3.40		3.40		3.60	
$\phi V_n/V_{mpr}$ =	1.52		1.56		1.56		1.52	1.2%
$P/A_g f'_c$ =	0.01		0.02		0.02		0.01	
Floor 11	3.36	1.15 1.29 0.79 1.15	2.41	1.14 1.11 0.79 1.15	2.41	1.15 1.30 0.79 1.15	3.36	
	2.28		1.60		1.60		2.28	
Story 10 $\phi M_n/M_u$ =	3.48		2.69		2.69		3.48	
$\phi V_n/V_{mpr}$ =	1.46		1.26		1.26		1.46	1.6%
$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
Floor 10	3.18	1.12 1.29 0.85 1.16	2.59	1.11 1.14 0.85 1.16	2.59	1.12 1.29 0.85 1.16	3.18	
	1.96		1.33		1.33		1.96	
Story 9 $\phi M_n/M_u$ =	2.49		2.44		2.44		2.51	
$\phi V_n/V_{mpr}$ =	1.52		1.27		1.27		1.52	1.6%
$P/A_g f'_c$ =	0.03		0.04		0.04		0.03	
Floor 9	2.29	1.13 1.19 0.84 1.16	2.12	1.18 1.11 0.84 1.16	2.12	1.13 1.20 0.84 1.16	2.29	
	1.69		1.15		1.15		1.69	
Story 8 $\phi M_n/M_u$ =	2.55		2.39		2.39		2.55	
$\phi V_n/V_{mpr}$ =	1.71		1.57		1.57		1.71	1.6%
$P/A_g f'_c$ =	0.05		0.05		0.05		0.05	
Floor 8	2.17	1.12 1.22 0.88 1.16	2.03	1.16 1.15 0.88 1.16	2.03	1.12 1.22 0.88 1.16	2.17	
	1.62		1.08		1.08		1.62	
Story 7 $\phi M_n/M_u$ =	2.28		2.25		2.25		2.29	
$\phi V_n/V_{mpr}$ =	2.16		1.54		1.54		2.16	1.7%
$P/A_g f'_c$ =	0.06		0.06		0.06		0.06	
Floor 7	1.99	1.12 1.16 0.86 1.16	1.95	1.18 1.13 0.86 1.16	1.95	1.12 1.16 0.86 1.16	1.99	
	1.78		1.20		1.20		1.78	
Story 6 $\phi M_n/M_u$ =	2.06		2.13		2.13		2.07	
$\phi V_n/V_{mpr}$ =	2.78		2.02		2.02		2.78	1.8%
$P/A_g f'_c$ =	0.05		0.05		0.05		0.05	
Floor 6	2.05	1.14 1.12 0.84 1.16	2.03	1.21 1.13 0.84 1.16	2.03	1.14 1.12 0.84 1.16	2.05	
	1.67		1.14		1.14		1.67	
Story 5 $\phi M_n/M_u$ =	2.33		2.37		2.37		2.34	
$\phi V_n/V_{mpr}$ =	2.32		1.74		1.74		2.32	1.9%
$P/A_g f'_c$ =	0.06		0.06		0.06		0.06	
Floor 5	2.12	1.14 1.14 0.86 1.15	2.10	1.23 1.18 0.86 1.15	2.10	1.15 1.14 0.86 1.15	2.12	
	1.59		1.07		1.07		1.59	
Story 4 $\phi M_n/M_u$ =	2.17		2.32		2.32		2.17	
$\phi V_n/V_{mpr}$ =	2.25		1.71		1.71		2.25	1.9%
$P/A_g f'_c$ =	0.07		0.07		0.07		0.07	
Floor 4	2.06	1.12 1.14 0.89 1.15	2.09	1.22 1.21 0.89 1.15	2.09	1.12 1.14 0.89 1.15	2.06	
	1.59		1.05		1.05		1.59	
Story 3 $\phi M_n/M_u$ =	1.99		2.29		2.29		1.99	
$\phi V_n/V_{mpr}$ =	2.19		1.68		1.68		2.19	1.9%
$P/A_g f'_c$ =	0.08		0.07		0.07		0.08	
Floor 3	2.00	1.13 1.14 0.90 1.16	2.11	1.25 1.25 0.90 1.16	2.11	1.13 1.14 0.90 1.16	2.00	
	1.59		1.05		1.05		1.59	
Story 2 $\phi M_n/M_u$ =	1.77		2.19		2.19		1.77	
$\phi V_n/V_{mpr}$ =	2.13		1.66		1.66		2.13	1.8%
$P/A_g f'_c$ =	0.09		0.08		0.08		0.09	
Floor 2	2.31	1.17 1.13 0.87 1.15	2.31	1.34 1.32 0.87 1.15	2.31	1.17 1.13 0.87 1.15	2.31	
	1.70	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.14	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.14	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.70	
Story 1 $\phi M_n/M_u$ =	1.15		1.72		1.72		1.15	
$\phi V_n/V_{mpr}$ =	1.83		1.63		1.63		1.83	1.2%
$P/A_g f'_c$ =	0.10		0.09		0.09		0.10	

Modeling Documentation (1 of 1)

Story	Column line	$M_{y,exp}$ (k-in) =	EI_{stf}/EI_g =	M_c/M_y =	$\Theta_{cap,pl}$ (rad) =	Θ_{pc} (rad) =	λ =	$(P/A_g f'_c)_{exp}$ =
Story 12	1	10049	0.35	1.21	0.072	0.100	116	0.00
	2	10331	0.35	1.21	0.071	0.100	116	0.01
	3	10331	0.35	1.21	0.071	0.100	116	0.01
	4	10049	0.35	1.21	0.072	0.100	116	0.00
Story 11	1	13173	0.35	1.21	0.073	0.100	116	0.01
	2	15607	0.35	1.21	0.084	0.100	123	0.02
	3	15607	0.35	1.21	0.084	0.100	123	0.02
	4	13173	0.35	1.21	0.073	0.100	116	0.01
Story 10	1	13449	0.35	1.21	0.073	0.100	115	0.01
	2	16150	0.35	1.21	0.072	0.100	113	0.02
	3	16150	0.35	1.21	0.072	0.100	113	0.02
	4	13449	0.35	1.21	0.073	0.100	115	0.01
Story 9	1	15137	0.35	1.21	0.073	0.100	115	0.02
	2	23243	0.35	1.21	0.088	0.100	120	0.03
	3	23243	0.35	1.21	0.088	0.100	120	0.03
	4	15137	0.35	1.21	0.073	0.100	115	0.02
Story 8	1	15409	0.35	1.21	0.072	0.100	114	0.02
	2	23770	0.35	1.20	0.074	0.100	111	0.04
	3	23770	0.35	1.20	0.074	0.100	111	0.04
	4	15409	0.35	1.21	0.072	0.100	114	0.02
Story 7	1	15680	0.35	1.21	0.072	0.100	113	0.02
	2	24293	0.35	1.20	0.073	0.100	110	0.05
	3	24293	0.35	1.20	0.073	0.100	110	0.05
	4	15680	0.35	1.21	0.072	0.100	113	0.02
Story 6	1	16028	0.35	1.19	0.082	0.100	122	0.02
	2	24927	0.35	1.19	0.084	0.100	119	0.04
	3	24927	0.35	1.19	0.084	0.100	119	0.04
	4	16028	0.35	1.19	0.082	0.100	122	0.02
Story 5	1	19354	0.35	1.19	0.084	0.100	122	0.02
	2	29185	0.35	1.19	0.086	0.100	118	0.04
	3	29185	0.35	1.19	0.086	0.100	118	0.04
	4	19354	0.35	1.19	0.084	0.100	122	0.02
Story 4	1	19623	0.35	1.19	0.083	0.100	121	0.02
	2	29704	0.35	1.19	0.085	0.100	117	0.05
	3	29704	0.35	1.19	0.085	0.100	117	0.05
	4	19623	0.35	1.19	0.083	0.100	121	0.02
Story 3	1	19891	0.35	1.19	0.083	0.100	121	0.03
	2	30221	0.35	1.19	0.084	0.100	117	0.05
	3	30221	0.35	1.19	0.084	0.100	117	0.05
	4	19891	0.35	1.19	0.083	0.100	121	0.03
Story 2	1	20158	0.35	1.19	0.082	0.100	120	0.03
	2	30736	0.35	1.19	0.083	0.100	116	0.06
	3	30736	0.35	1.19	0.083	0.100	116	0.06
	4	20158	0.35	1.19	0.082	0.100	120	0.03
Story 1	1	23933	0.35	1.19	0.084	0.100	120	0.03
	2	31248	0.35	1.19	0.083	0.100	115	0.07
	3	31248	0.35	1.19	0.083	0.100	115	0.07
	4	23933	0.35	1.19	0.084	0.100	120	0.03

Floor	Bay	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 13	1	3672	-4845	0.35	1.625E+08	0.0381	-0.043	0.083	104
	2	3672	-4845	0.35	1.625E+08	0.0381	-0.043	0.083	104
	3	3672	-4845	0.35	3.724E+07	0.0381	-0.043	0.083	104
Floor 12	1	3714	-6242	0.35	1.625E+08	0.040	-0.050	0.092	109
	2	3714	-6242	0.35	1.625E+08	0.040	-0.050	0.092	109
	3	3714	-6242	0.35	1.625E+08	0.040	-0.050	0.092	109
Floor 11	1	5095	-7597	0.35	1.625E+08	0.041	-0.049	0.100	99
	2	5095	-7597	0.35	1.625E+08	0.041	-0.049	0.100	99
	3	5095	-7597	0.35	1.625E+08	0.041	-0.049	0.100	99
Floor 10	1	6180	-8409	0.35	1.625E+08	0.046	-0.053	0.100	104
	2	6180	-8409	0.35	1.625E+08	0.046	-0.053	0.100	104
	3	6180	-8409	0.35	1.625E+08	0.046	-0.053	0.100	104
Floor 9	1	9002	-12159	0.35	2.820E+08	0.049	-0.057	0.100	118
	2	9002	-12159	0.35	2.820E+08	0.049	-0.057	0.100	118
	3	9002	-12159	0.35	2.820E+08	0.049	-0.057	0.100	118
Floor 8	1	9841	-12578	0.35	2.820E+08	0.051	-0.057	0.100	118
	2	9841	-12578	0.35	2.820E+08	0.051	-0.057	0.100	118
	3	9841	-12578	0.35	2.820E+08	0.051	-0.057	0.100	118
Floor 7	1	10298	-13405	0.35	2.820E+08	0.054	-0.062	0.100	123
	2	10298	-13405	0.35	2.820E+08	0.0544	-0.062	0.100	123
	3	10298	-13405	0.35	2.820E+08	0.0544	-0.062	0.100	123
Floor 6	1	10719	-14230	0.35	2.820E+08	0.055	-0.063	0.100	123
	2	10719	-14230	0.35	2.820E+08	0.0555	-0.063	0.100	123
	3	10719	-14230	0.35	2.820E+08	0.0555	-0.063	0.100	123
Floor 5	1	11520	-14788	0.35	2.820E+08	0.053	-0.059	0.100	114
	2	11520	-14788	0.35	2.820E+08	0.0529	-0.059	0.100	114
	3	11520	-14788	0.35	2.820E+08	0.0529	-0.059	0.100	114
Floor 4	1	11936	-14793	0.35	2.820E+08	0.054	-0.059	0.100	114
	2	11936	-14793	0.35	2.820E+08	0.0536	-0.059	0.100	114
	3	11936	-14793	0.35	2.820E+08	0.0536	-0.059	0.100	114
Floor 3	1	11971	-14793	0.35	2.820E+08	0.054	-0.060	0.100	114
	2	11971	-14793	0.35	2.820E+08	0.0539	-0.060	0.100	114
	3	11971	-14793	0.35	2.820E+08	0.0539	-0.060	0.100	114
Floor 2	1	10874	-13961	0.35	2.820E+08	0.049	-0.055	0.100	110
	2	10874	-13961	0.35	2.820E+08	0.049	-0.055	0.100	110
	3	10874	-13961	0.35	2.820E+08	0.049	-0.055	0.100	110

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.01 T_2= 0.67 T_3 = 0.38

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2057
Number of Stories: 12
Fundamental Period (sec): 1.90

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

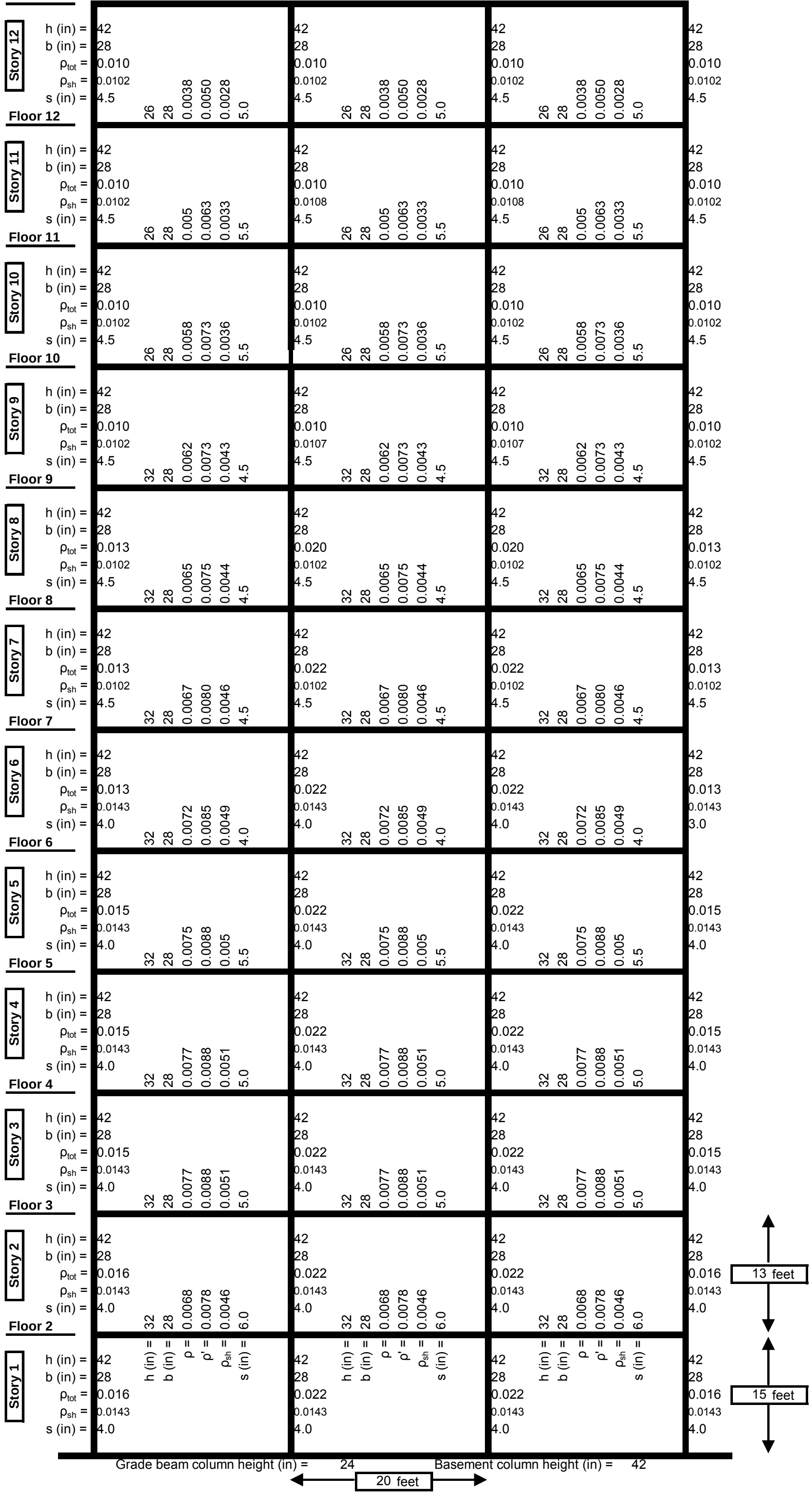
2057 Perimeter Frame, SCWB=2.5

Initial column sizes were increased due to SCWB requirements as increasing column reinforcement was not sufficient, due to the maximum allowable reinforcement ratio. Both positive and negative bending strength were controlled by strength demands. Few additional beam reinforcements in 15 bays were added to alter beam design to use same rho and rhoPrime in each floor. All column flexural strengths were controlled by the strong-column weak-beam ratio, except 2 lower exterior columns and 8 upper columns by minimum requirement. Beam stirrups were controlled by the capacity shear design and minimum requirement (34 by demand). Column stirrups were controlled by the capacity shear design and minimum requirement (4 by demand). As in the baseline design, joint shear controls the beam and column sizes.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	26	28	0.0032	0.0035	0.0024	5.5
Floor 12	26	28	0.0038	0.0050	0.0028	5.0
Floor 11	26	28	0.005	0.0063	0.0033	5.5
Floor 10	26	28	0.0058	0.0073	0.0036	5.5
Floor 9	32	28	0.0062	0.0073	0.0043	4.5
Floor 8	32	28	0.0065	0.0075	0.0044	4.5
Floor 7	32	28	0.0067	0.0080	0.0046	4.5
Floor 6	32	28	0.0072	0.0085	0.0049	4.0
Floor 5	32	28	0.0075	0.0088	0.005	5.5
Floor 4	32	28	0.0077	0.0088	0.0051	5.0
Floor 3	32	28	0.0077	0.0088	0.0051	5.0
Floor 2	32	28	0.0068	0.0078	0.0046	6.0

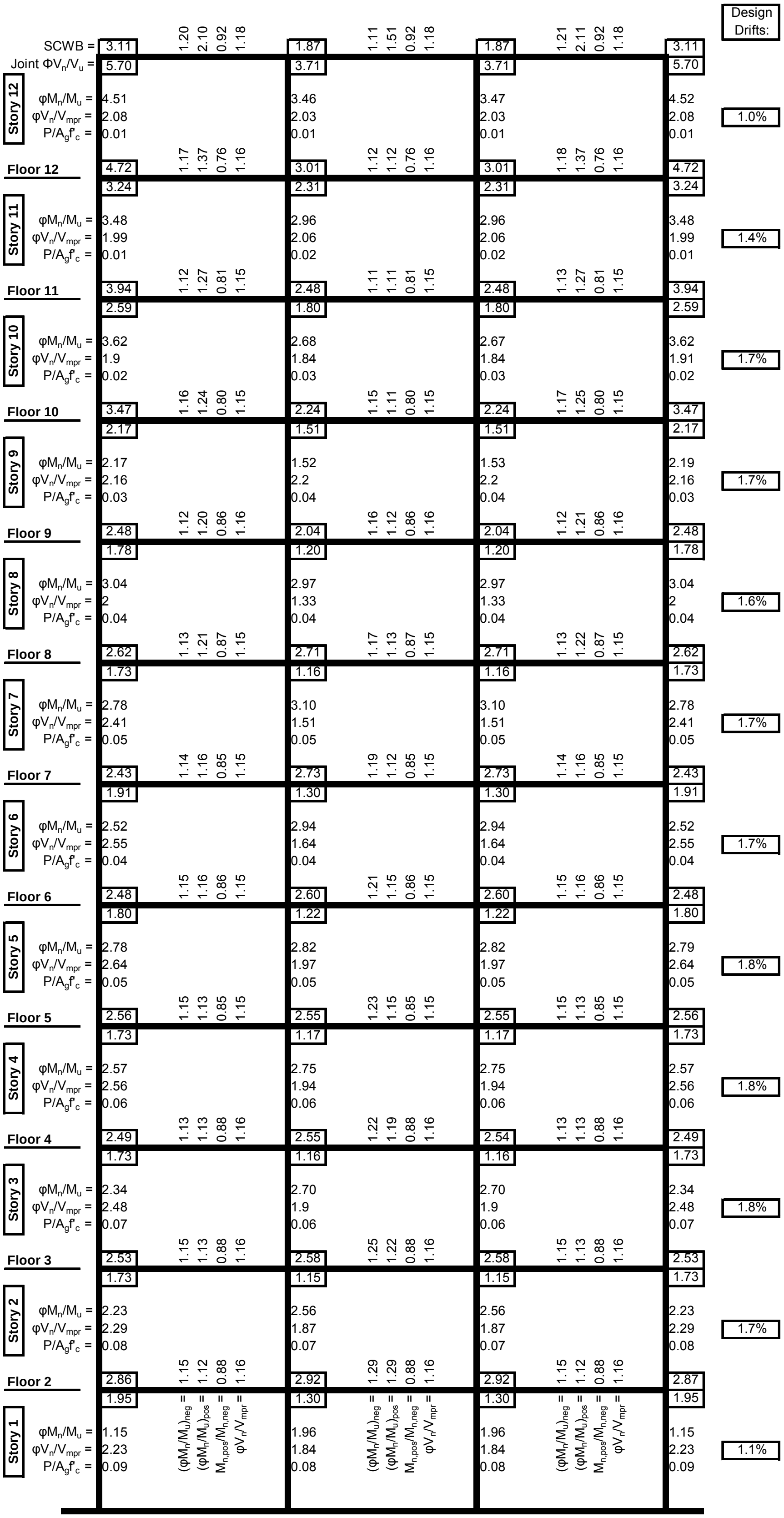
Story	Column	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	1	42	28	0.010	0.0102	4.5
	2	42	28	0.010	0.0102	4.5
	3	42	28	0.010	0.0102	4.5
	4	42	28	0.010	0.0102	4.5
Story 11	1	42	28	0.010	0.0102	4.5
	2	42	28	0.010	0.0108	4.5
	3	42	28	0.010	0.0108	4.5
	4	42	28	0.010	0.0102	4.5
Story 10	1	42	28	0.010	0.0102	4.5
	2	42	28	0.010	0.0102	4.5
	3	42	28	0.010	0.0102	4.5
	4	42	28	0.010	0.0102	4.5
Story 9	1	42	28	0.010	0.0102	4.5
	2	42	28	0.010	0.0107	4.5
	3	42	28	0.010	0.0107	4.5
	4	42	28	0.010	0.0102	4.5
Story 8	1	42	28	0.013	0.0102	4.5
	2	42	28	0.020	0.0102	4.5
	3	42	28	0.020	0.0102	4.5
	4	42	28	0.013	0.0102	4.5
Story 7	1	42	28	0.013	0.0102	4.5
	2	42	28	0.022	0.0102	4.5
	3	42	28	0.022	0.0102	4.5
	4	42	28	0.013	0.0102	4.5
Story 6	1	42	28	0.013	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.013	0.0143	3.0
Story 5	1	42	28	0.015	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.015	0.0143	4.0
Story 4	1	42	28	0.015	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.015	0.0143	4.0
Story 3	1	42	28	0.015	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.015	0.0143	4.0
Story 2	1	42	28	0.016	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.016	0.0143	4.0
Story 1	1	42	28	0.016	0.0143	4.0
	2	42	28	0.022	0.0143	4.0
	3	42	28	0.022	0.0143	4.0
	4	42	28	0.016	0.0143	4.0

Grade beam column height (in) = 24

Basement column height (in) = 42

Design base shear =	0.044	g,	368	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	7.0	ksi

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	13946	14276	14276	13946
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.083	0.082	0.082	0.083
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	131	130	130	131
	$(P/A_g f'_c)_{exp}$ =	0.00	0.01	0.01	0.00
Story 11	$M_{y,exp}$ (k-in) =	14276	14932	14932	14276
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.082	0.083	0.083	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	130	129	129	130
	$(P/A_g f'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 10	$M_{y,exp}$ (k-in) =	14605	15583	15583	14605
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.082	0.080	0.080	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	130	128	128	130
	$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 9	$M_{y,exp}$ (k-in) =	14932	16227	16227	14932
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.081	0.081	0.081	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	129	127	127	129
	$(P/A_g f'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 8	$M_{y,exp}$ (k-in) =	18559	29986	29986	18559
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.21	1.21	1.21
	$\Theta_{cap,pl}$ (rad) =	0.082	0.085	0.085	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	129	126	126	129
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 7	$M_{y,exp}$ (k-in) =	18879	33224	33224	18879
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.21	1.20	1.20	1.21
	$\Theta_{cap,pl}$ (rad) =	0.082	0.085	0.085	0.082
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	128	125	125	128
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 6	$M_{y,exp}$ (k-in) =	19287	33971	33971	19287
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.090	0.094	0.094	0.096
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	132	129	129	140
	$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 5	$M_{y,exp}$ (k-in) =	22903	34589	34589	22903
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.091	0.093	0.093	0.091
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	132	129	129	132
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 4	$M_{y,exp}$ (k-in) =	23221	35203	35203	23221
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.091	0.093	0.093	0.091
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	132	128	128	132
	$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 3	$M_{y,exp}$ (k-in) =	23539	35815	35815	23539
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.091	0.092	0.092	0.091
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	131	127	127	131
	$(P/A_g f'_c)_{exp}$ =	0.02	0.05	0.05	0.02
Story 2	$M_{y,exp}$ (k-in) =	25497	36425	36425	25497
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.091	0.091	0.091	0.091
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	131	126	126	131
	$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 1	$M_{y,exp}$ (k-in) =	25812	37032	37032	25812
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.091	0.090	0.090	0.091
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	130	126	126	130
	$(P/A_g f'_c)_{exp}$ =	0.03	0.06	0.06	0.03

Floor 13	$M_{y,pos,exp}$(k-in) =	3093	3093	3093
	$M_{y,n,slab,exp}$(k-in) =	-4420	-4420	-4420
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.310E+08	1.310E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0377	0.0377	0.0377
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.044	-0.044
	Θ_{pc} (rad) =	0.084	0.084	0.084
	λ =	100	100	100
Floor 12	$M_{y,pos,exp}$(k-in) =	3620	3620	3620
	$M_{y,n,slab,exp}$(k-in) =	-5831	-5831	-5831
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.310E+08	1.310E+08	1.310E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.041	0.041	0.041
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.051	-0.051	-0.051
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	105	105	105
Floor 11	$M_{y,pos,exp}$(k-in) =	4785	4785	4785
	$M_{y,n,slab,exp}$(k-in) =	-6976	-6976	-6976
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.310E+08	1.310E+08	1.310E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.052	-0.052	-0.052
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 10	$M_{y,pos,exp}$(k-in) =	5471	5471	5471
	$M_{y,n,slab,exp}$(k-in) =	-7886	-7886	-7886
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.310E+08	1.310E+08	1.310E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	100	100	100
Floor 9	$M_{y,pos,exp}$(k-in) =	9354	9354	9354
	$M_{y,n,slab,exp}$(k-in) =	-12183	-12183	-12183
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.062	-0.062	-0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	120	120	120
Floor 8	$M_{y,pos,exp}$(k-in) =	9721	9721	9721
	$M_{y,n,slab,exp}$(k-in) =	-12546	-12546	-12546
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.056	0.056	0.056
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.063	-0.063	-0.063
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	120	120	120
Floor 7	$M_{y,pos,exp}$(k-in) =	10119	10119	10119
	$M_{y,n,slab,exp}$(k-in) =	-13267	-13267	-13267
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.057	0.0567	0.0567
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.064	-0.064	-0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	120	120	120
Floor 6	$M_{y,pos,exp}$(k-in) =	10851	10851	10851
	$M_{y,n,slab,exp}$(k-in) =	-13991	-13991	-13991
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.061	0.0609	0.0609
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.069	-0.069	-0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	125	125	125
Floor 5	$M_{y,pos,exp}$(k-in) =	11187	11187	11187
	$M_{y,n,slab,exp}$(k-in) =	-14473	-14473	-14473
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.062	-0.062	-0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	111	111	111
Floor 4	$M_{y,pos,exp}$(k-in) =	11549	11549	11549
	$M_{y,n,slab,exp}$(k-in) =	-14478	-14478	-14478
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.0582	0.0582
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.065	-0.065	-0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 3	$M_{y,pos,exp}$(k-in) =	11580	11580	11580
	$M_{y,n,slab,exp}$(k-in) =	-14478	-14478	-14478
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.0582	0.0582
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.065	-0.065	-0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 2	$M_{y,pos,exp}$(k-in) =	10255	10255	10255
	$M_{y,n,slab,exp}$(k-in) =	-13032	-13032	-13032
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.051	0.051
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.057	-0.057	-0.057
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	107	107	107

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 1.90 T_2 = 0.63 T_3 = 0.35

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2058
Number of Stories: 12
Fundamental Period (sec): 1.84

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

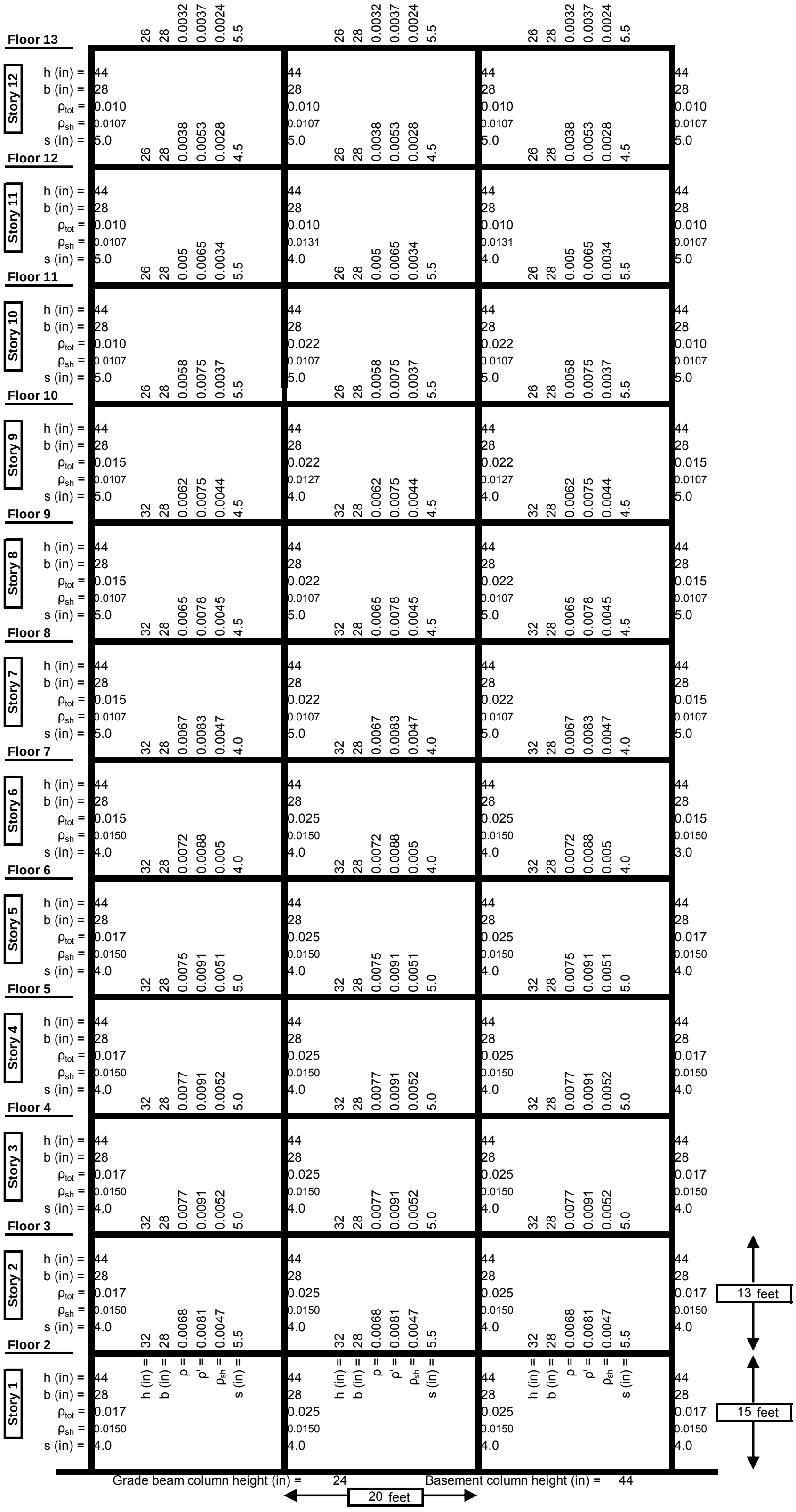
2058 Perimeter Frame, SCWB=3.0

Initial column sizes were increased due to SCWB requirements as increasing column reinforcement was not sufficient. Both positive and negative bending strength were controlled by strength demands. Few additional beam reinforcements in 15 bays were added to alter beam design to use same rho and rhoPrime in each floor. All column flexural strengths were controlled by the strong-column weak-beam ratio, except 8 upper columns by minimum requirement. Beam stirrups were controlled by the capacity shear design and minimum requirement (36 by demand). Column stirrups were controlled by the capacity shear design and minimum requirement (4 by demand). As in the baseline design, joint shear controls the beam and column sizes.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Floor 13

h (in) =	26	26	26
b (in) =	28	28	28
ρ =	0.0032	0.0032	0.0032
ρ' =	0.0037	0.0037	0.0037
ρ_{sh} =	0.0024	0.0024	0.0024
s (in) =	5.5	5.5	5.5

Story 12

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.010	0.010	0.010	0.010
ρ_{sh} =	0.0107	0.0107	0.0107	0.0107
s (in) =	5.0	5.0	5.0	5.0

Floor 12

h (in) =	26	26	26
b (in) =	28	28	28
ρ =	0.0038	0.0038	0.0038
ρ' =	0.0053	0.0053	0.0053
ρ_{sh} =	0.0028	0.0028	0.0028
s (in) =	4.5	4.5	4.5

Story 11

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.010	0.010	0.010	0.010
ρ_{sh} =	0.0107	0.0131	0.0131	0.0107
s (in) =	5.0	4.0	4.0	5.0

Floor 11

h (in) =	26	26	26
b (in) =	28	28	28
ρ =	0.005	0.005	0.005
ρ' =	0.0065	0.0065	0.0065
ρ_{sh} =	0.0034	0.0034	0.0034
s (in) =	5.5	5.5	5.5

Story 10

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.010	0.022	0.022	0.010
ρ_{sh} =	0.0107	0.0107	0.0107	0.0107
s (in) =	5.0	5.0	5.0	5.0

Floor 10

h (in) =	26	26	26
b (in) =	28	28	28
ρ =	0.0058	0.0058	0.0058
ρ' =	0.0075	0.0075	0.0075
ρ_{sh} =	0.0037	0.0037	0.0037
s (in) =	5.5	5.5	5.5

Story 9

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.015	0.022	0.022	0.015
ρ_{sh} =	0.0107	0.0127	0.0127	0.0107
s (in) =	5.0	4.0	4.0	5.0

Floor 9

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0062	0.0062	0.0062
ρ' =	0.0075	0.0075	0.0075
ρ_{sh} =	0.0044	0.0044	0.0044
s (in) =	4.5	4.5	4.5

Story 8

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.015	0.022	0.022	0.015
ρ_{sh} =	0.0107	0.0107	0.0107	0.0107
s (in) =	5.0	5.0	5.0	5.0

Floor 8

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0065	0.0065	0.0065
ρ' =	0.0078	0.0078	0.0078
ρ_{sh} =	0.0045	0.0045	0.0045
s (in) =	4.5	4.5	4.5

Story 7

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.015	0.022	0.022	0.015
ρ_{sh} =	0.0107	0.0107	0.0107	0.0107
s (in) =	5.0	5.0	5.0	5.0

Floor 7

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0067	0.0067	0.0067
ρ' =	0.0083	0.0083	0.0083
ρ_{sh} =	0.0047	0.0047	0.0047
s (in) =	4.0	4.0	4.0

Story 6

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.015	0.025	0.025	0.015
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	3.0

Floor 6

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0072	0.0072	0.0072
ρ' =	0.0088	0.0088	0.0088
ρ_{sh} =	0.005	0.005	0.005
s (in) =	4.0	4.0	4.0

Story 5

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.017	0.025	0.025	0.017
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	4.0

Floor 5

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0075	0.0075	0.0075
ρ' =	0.0091	0.0091	0.0091
ρ_{sh} =	0.0051	0.0051	0.0051
s (in) =	5.0	5.0	5.0

Story 4

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.017	0.025	0.025	0.017
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	4.0

Floor 4

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0077	0.0077	0.0077
ρ' =	0.0091	0.0091	0.0091
ρ_{sh} =	0.0052	0.0052	0.0052
s (in) =	5.0	5.0	5.0

Story 3

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.017	0.025	0.025	0.017
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	4.0

Floor 3

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0077	0.0077	0.0077
ρ' =	0.0091	0.0091	0.0091
ρ_{sh} =	0.0052	0.0052	0.0052
s (in) =	5.0	5.0	5.0

Story 2

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.017	0.025	0.025	0.017
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	4.0

Floor 2

h (in) =	32	32	32
b (in) =	28	28	28
ρ =	0.0068	0.0068	0.0068
ρ' =	0.0081	0.0081	0.0081
ρ_{sh} =	0.0047	0.0047	0.0047
s (in) =	5.5	5.5	5.5

Story 1

h (in) =	44	44	44	44
b (in) =	28	28	28	28
ρ_{tot} =	0.017	0.025	0.025	0.017
ρ_{sh} =	0.0150	0.0150	0.0150	0.0150
s (in) =	4.0	4.0	4.0	4.0

Grade beam column height (in) = 24

Basement column height (in) = 44

Design base shear =	0.044	g,	368	k			
f'_c beams =	5.0	ksi			$f'_{c,cols,upper}$ =	5.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi			$f'_{c,cols,lower}$ =	7.0	ksi

Design Documentation (2 of 2)

	SCWB =				Joint $\Phi V_n/V_u$ =				$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =	$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =	$(\varphi M_n/M_u)_{neg}$ =	$(\varphi M_n/M_u)_{pos}$ =	$M_{n,pos}/M_{n,neg}$ =	$\varphi V_n/V_{mpr}$ =
	3.26	2.00	2.00	3.26	5.57	3.75	3.75	5.57	1.29	2.10	0.86	1.17	1.19	1.51	0.86	1.17	1.29	2.11	0.86	1.17
Floor 12	5.01	3.24	3.23	5.01	3.23	2.35	2.35	3.23	1.23	1.37	0.72	1.15	1.17	1.12	0.72	1.15	1.23	1.37	0.72	1.15
Floor 11	4.21	4.14	4.14	4.21	2.61	1.84	1.84	2.61	1.17	1.27	0.78	1.17	1.15	1.11	0.78	1.17	1.17	1.27	0.78	1.17
Floor 10	4.62	5.00	5.00	4.63	2.20	1.56	1.56	2.20	1.20	1.24	0.77	1.16	1.18	1.11	0.77	1.16	1.21	1.25	0.77	1.16
Floor 9	3.54	3.14	3.13	3.54	1.81	1.24	1.24	1.81	1.15	1.20	0.84	1.16	1.20	1.12	0.84	1.16	1.16	1.21	0.84	1.16
Floor 8	3.39	3.07	3.07	3.39	1.75	1.19	1.19	1.75	1.17	1.21	0.84	1.15	1.21	1.13	0.84	1.15	1.17	1.22	0.84	1.15
Floor 7	3.16	3.14	3.14	3.16	1.94	1.34	1.34	1.94	1.17	1.16	0.82	1.15	1.22	1.12	0.82	1.15	1.17	1.16	0.82	1.15
Floor 6	3.14	3.17	3.17	3.15	1.83	1.25	1.25	1.83	1.18	1.16	0.83	1.15	1.24	1.15	0.83	1.15	1.18	1.16	0.83	1.15
Floor 5	3.17	3.10	3.10	3.17	1.77	1.21	1.21	1.77	1.18	1.13	0.83	1.15	1.26	1.15	0.83	1.15	1.18	1.13	0.83	1.15
Floor 4	3.10	3.09	3.09	3.10	1.77	1.19	1.19	1.77	1.16	1.13	0.86	1.16	1.25	1.19	0.86	1.16	1.16	1.13	0.86	1.16
Floor 3	3.03	3.12	3.12	3.03	1.77	1.19	1.19	1.77	1.18	1.13	0.86	1.16	1.29	1.22	0.86	1.16	1.18	1.13	0.86	1.16
Floor 2	3.27	3.53	3.53	3.27	1.98	1.34	1.34	1.98	1.18	1.12	0.85	1.16	1.33	1.29	0.85	1.16	1.18	1.12	0.85	1.16

	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	$\varphi M_n/M_u$ =	$\varphi V_n/V_{mpr}$ =	$P/A_g f'_c$ =	Design Drifts:
Story 12	4.98	2.09	0.01	3.82	2.04	0.01	3.83	2.04	0.01	4.99	2.09	0.01	1.0%
Story 11	3.84	2	0.01	3.26	2.38	0.02	3.26	2.38	0.02	3.84	2	0.01	1.4%
Story 10	3.99	1.92	0.02	6.11	0.93	0.03	6.10	0.93	0.03	4.00	1.92	0.02	1.7%
Story 9	3.56	1.54	0.03	3.43	1.28	0.03	3.44	1.28	0.03	3.59	1.54	0.03	1.7%
Story 8	4.03	1.74	0.04	3.57	1.23	0.04	3.57	1.23	0.04	4.03	1.74	0.04	1.6%
Story 7	3.70	1.67	0.05	3.41	1.51	0.05	3.41	1.51	0.05	3.70	1.67	0.05	1.7%
Story 6	3.37	2.25	0.04	3.63	1.48	0.04	3.63	1.48	0.04	3.37	2.25	0.04	1.7%
Story 5	3.52	1.97	0.05	3.48	1.45	0.05	3.48	1.45	0.05	3.53	1.97	0.05	1.8%
Story 4	3.27	2.34	0.06	3.38	1.74	0.05	3.38	1.74	0.05	3.28	2.34	0.06	1.8%
Story 3	3.00	2.28	0.07	3.32	1.72	0.06	3.32	1.72	0.06	3.00	2.28	0.07	1.8%
Story 2	2.61	2.22	0.07	3.14	1.69	0.07	3.14	1.69	0.07	2.61	2.22	0.07	1.7%
Story 1	1.35	2.17	0.08	2.41	1.67	0.07	2.41	1.67	0.07	1.35	2.17	0.08	1.1%

Modeling Documentation (1 of 1)

Floor 13

$M_{y,pos,exp}$(k-in) =	3092	3092	3092
$M_{y,n,slab,exp}$(k-in) =	-4651	-4651	-4651
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.310E+08	1.310E+08	3.724E+07
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0376	0.0376	0.0376
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.045	-0.045	-0.045
Θ_{pc} (rad) =	0.086	0.086	0.086
λ =	100	100	100

Story 12

$M_{y,exp}$ (k-in) =	15388	15734	15734	15388
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.082	0.081	0.081	0.082
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	129	128	128	129
$(P/A_g f'_c)_{exp}$ =	0.00	0.01	0.01	0.00

Floor 12

$M_{y,pos,exp}$(k-in) =	3620	3620	3620
$M_{y,n,slab,exp}$(k-in) =	-6060	-6060	-6060
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.310E+08	1.310E+08	1.310E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
Θ_{pc} (rad) =	0.097	0.097	0.097
λ =	110	110	110

Story 11

$M_{y,exp}$ (k-in) =	15734	16422	16422	15734
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.081	0.093	0.093	0.081
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	128	134	134	128
$(P/A_g f'_c)_{exp}$ =	0.01	0.01	0.01	0.01

Floor 11

$M_{y,pos,exp}$(k-in) =	4785	4785	4785
$M_{y,n,slab,exp}$(k-in) =	-7203	-7203	-7203
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.310E+08	1.310E+08	1.310E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 10

$M_{y,exp}$ (k-in) =	16079	34560	34560	16079
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.081	0.087	0.087	0.081
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	128	126	126	128
$(P/A_g f'_c)_{exp}$ =	0.01	0.02	0.02	0.01

Floor 10

$M_{y,pos,exp}$(k-in) =	5471	5471	5471
$M_{y,n,slab,exp}$(k-in) =	-8113	-8113	-8113
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.310E+08	1.310E+08	1.310E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.056	-0.056	-0.056
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	100	100	100

Story 9

$M_{y,exp}$ (k-in) =	23720	35214	35214	23720
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.083	0.099	0.099	0.083
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	127	132	132	127
$(P/A_g f'_c)_{exp}$ =	0.01	0.03	0.03	0.01

Floor 9

$M_{y,pos,exp}$(k-in) =	9356	9356	9356
$M_{y,n,slab,exp}$(k-in) =	-12542	-12542	-12542
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.055	0.055	0.055
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.063	-0.063	-0.063
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	120	120	120

Story 8

$M_{y,exp}$ (k-in) =	24055	35865	35865	24055
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.21	1.21	1.21
$\Theta_{cap,pl}$ (rad) =	0.083	0.085	0.085	0.083
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	127	124	124	127
$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02

Floor 8

$M_{y,pos,exp}$(k-in) =	9722	9722	9722
$M_{y,n,slab,exp}$(k-in) =	-12905	-12905	-12905
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.056	0.056	0.056
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.064	-0.064	-0.064
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	120	120	120

Story 7

$M_{y,exp}$ (k-in) =	24389	36513	36513	24389
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.21	1.20	1.20	1.21
$\Theta_{cap,pl}$ (rad) =	0.083	0.084	0.084	0.083
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	126	123	123	126
$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02

Floor 7

$M_{y,pos,exp}$(k-in) =	10121	10121	10121
$M_{y,n,slab,exp}$(k-in) =	-13625	-13625	-13625
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.059	0.0592	0.0592
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.068	-0.068	-0.068
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	125	125	125

Story 6

$M_{y,exp}$ (k-in) =	24824	41645	41645	24824
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.094	0.099	0.099	0.101
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	134	131	131	142
$(P/A_g f'_c)_{exp}$ =	0.02	0.03	0.03	0.02

Floor 6

$M_{y,pos,exp}$(k-in) =	10853	10853	10853
$M_{y,n,slab,exp}$(k-in) =	-14348	-14348	-14348
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.061	0.0612	0.0612
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	125	125	125

Story 5

$M_{y,exp}$ (k-in) =	28069	42291	42291	28069
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.095	0.098	0.098	0.095
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	134	130	130	134
$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02

Floor 5

$M_{y,pos,exp}$(k-in) =	11189	11189	11189
$M_{y,n,slab,exp}$(k-in) =	-14830	-14830	-14830
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.057	0.0574	0.0574
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.066	-0.066	-0.066
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	116	116	116

Story 4

$M_{y,exp}$ (k-in) =	28402	42935	42935	28402
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.095	0.097	0.097	0.095
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	133	130	130	133
$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02

Floor 4

$M_{y,pos,exp}$(k-in) =	11552	11552	11552
$M_{y,n,slab,exp}$(k-in) =	-14835	-14835	-14835
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.0584	0.0584
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.066	-0.066	-0.066
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	116	116	116

Story 3

$M_{y,exp}$ (k-in) =	28734	43576	43576	28734
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.094	0.097	0.097	0.094
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	133	129	129	133
$(P/A_g f'_c)_{exp}$ =	0.02	0.04	0.04	0.02

Floor 3

$M_{y,pos,exp}$(k-in) =	11582	11582	11582
$M_{y,n,slab,exp}$(k-in) =	-14835	-14835	-14835
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.058	0.0584	0.0584
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.066	-0.066	-0.066
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	116	116	116

Story 2

$M_{y,exp}$ (k-in) =	29065	44214	44214	29065
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.094	0.096	0.096	0.094
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	132	128	128	132
$(P/A_g f'_c)_{exp}$ =	0.02	0.05	0.05	0.02

Floor 2

$M_{y,pos,exp}$(k-in) =	10257	10257	10257
$M_{y,n,slab,exp}$(k-in) =	-13390	-13390	-13390
EI_{stf}/EI_g	0.35	0.35	0.35
$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
$(\Theta_{cap,pl})_{pos}$ (rad) =	0.053	0.053	0.053
$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.060	-0.060	-0.060
Θ_{pc} (rad) =	0.100	0.100	0.100
λ =	111	111	111

Story 1

$M_{y,exp}$ (k-in) =	29395	44851	44851	29395
EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
M_c/M_y =	1.19	1.19	1.19	1.19
$\Theta_{cap,pl}$ (rad) =	0.093	0.095	0.095	0.093
Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
λ =	132	127	127	132
$(P/A_g f'_c)_{exp}$ =	0.03	0.05	0.05	0.03

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 1.84 T_2 = 0.61 T_3 = 0.34

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2060
Number of Stories: 12
Fundamental Period (sec): 2.00

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

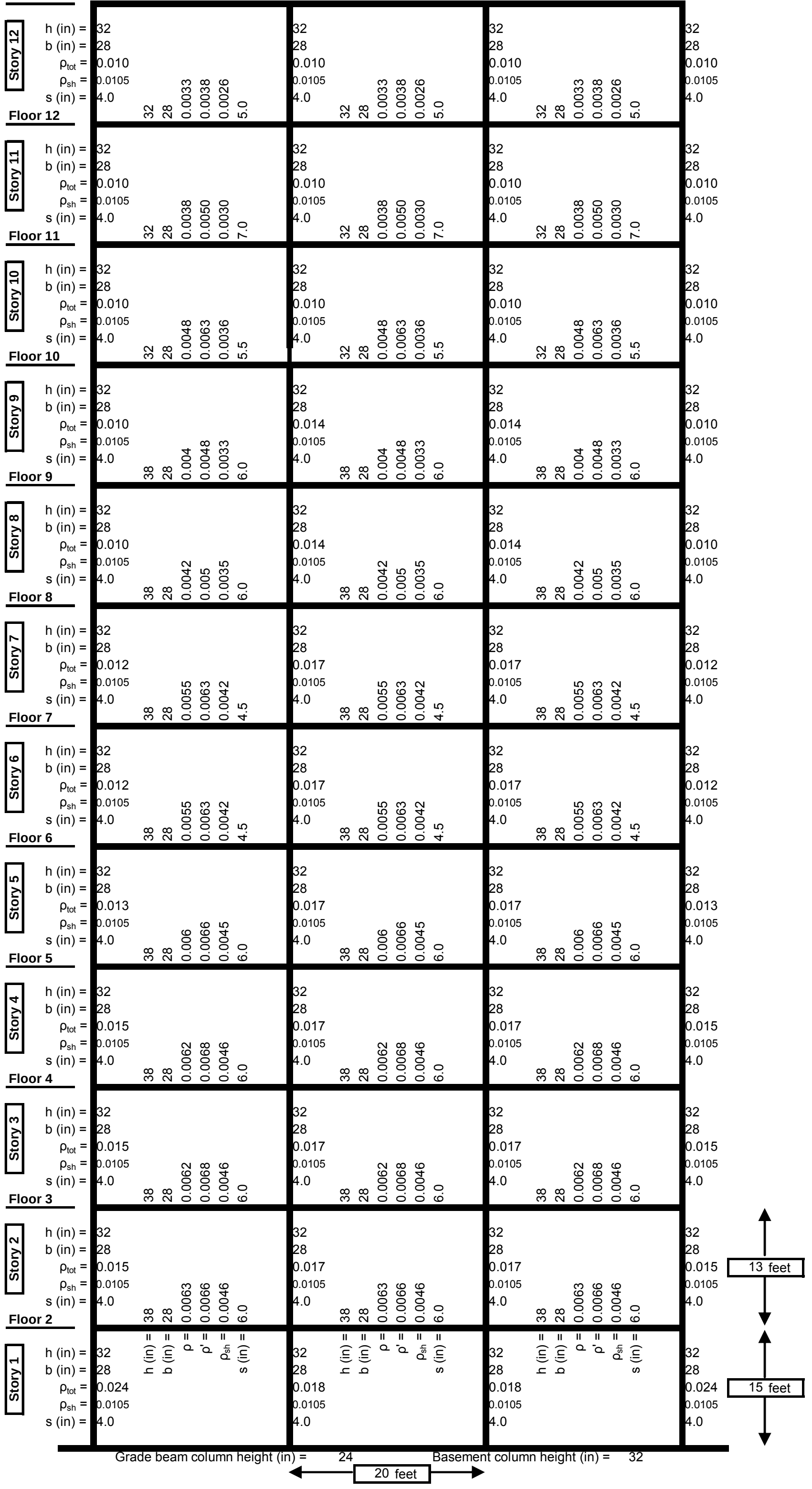
2060 Perimeter Frame, SCWB=0.9
Note: We chose the SCWB=0.9 value for this design because this is the point that flexural controls over SCWB for a significant number of the columns in the frame. In another words, this is virtually the lowest SCWB ratio we can design for without flexural controlling for all columns in the frame.

Column and beam sizes were kept the same as the baseline design. Simply reducing the reinforcement was enough to meet the SCWB ratio desired. Both positive and negative bending strength were controlled by strength demands, except 3 by strength minimum requirements. Few additional beam reinforcements in 14 bays were added to alter beam design to use same rho and rhoPrime in each floor. All column flexural strengths were controlled by the strong-column weak-beam ratio, except for top 4 story's columns by minimum requirement (again most columns were very close to being flexural controlled). Beam stirrups were controlled by the capacity shear design and minimum requirement (36 by demand). Column stirrups were controlled by the minimum requirement. As in the baseline design, joint shear controls the beam and column sizes.

DESIGN AND MODELING DOCUMENTATION

FIGURES

Design Documentation (1 of 2)



Story 12	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 11	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 10	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.010	0.010	0.010	0.010
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 9	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.010	0.014	0.014	0.010
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 8	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.010	0.014	0.014	0.010
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 7	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.012	0.017	0.017	0.012
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 6	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.012	0.017	0.017	0.012
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 5	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.013	0.017	0.017	0.013
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 4	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.015	0.017	0.017	0.015
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 3	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.015	0.017	0.017	0.015
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 2	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.015	0.017	0.017	0.015
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0
Story 1	h (in) =	32	32	32	32
	b (in) =	28	28	28	28
	ρ_{tot} =	0.024	0.018	0.018	0.024
	ρ_{sh} =	0.0105	0.0105	0.0105	0.0105
	s (in) =	4.0	4.0	4.0	4.0

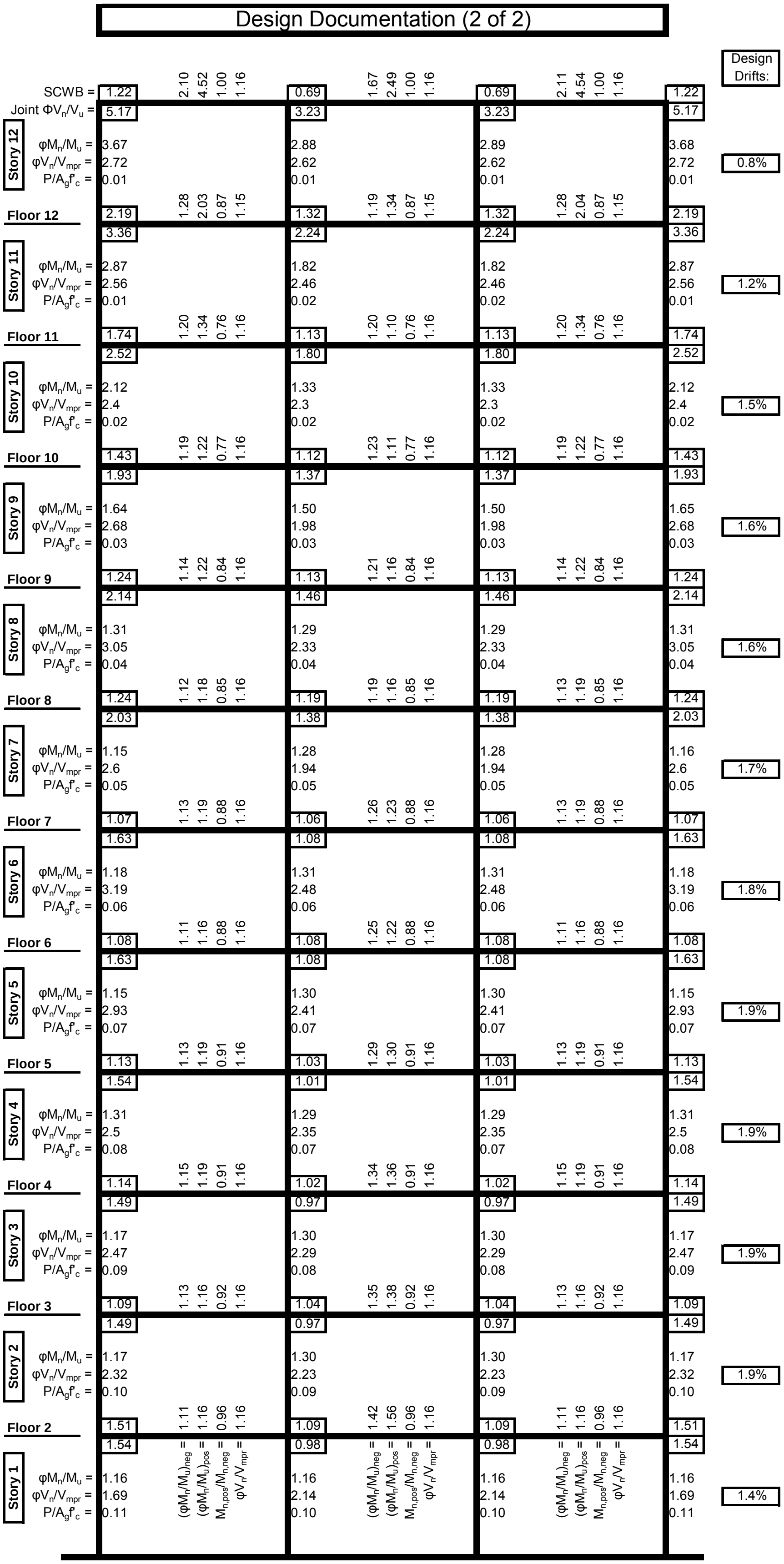
	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	32	28	0.0033	0.0033	0.0025	5.5
	32	28	0.0033	0.0033	0.0025	5.5
	32	28	0.0033	0.0033	0.0025	5.5
Floor 12	32	28	0.0033	0.0038	0.0026	5.0
	32	28	0.0033	0.0038	0.0026	5.0
	32	28	0.0033	0.0038	0.0026	5.0
Floor 11	32	28	0.0038	0.0050	0.0030	7.0
	32	28	0.0038	0.0050	0.0030	7.0
	32	28	0.0038	0.0050	0.0030	7.0
Floor 10	32	28	0.0048	0.0063	0.0036	5.5
	32	28	0.0048	0.0063	0.0036	5.5
	32	28	0.0048	0.0063	0.0036	5.5
Floor 9	38	28	0.004	0.0048	0.0033	6.0
	38	28	0.004	0.0048	0.0033	6.0
	38	28	0.004	0.0048	0.0033	6.0
Floor 8	38	28	0.0042	0.005	0.0035	6.0
	38	28	0.0042	0.005	0.0035	6.0
	38	28	0.0042	0.005	0.0035	6.0
Floor 7	38	28	0.0055	0.0063	0.0042	4.5
	38	28	0.0055	0.0063	0.0042	4.5
	38	28	0.0055	0.0063	0.0042	4.5
Floor 6	38	28	0.0055	0.0063	0.0042	4.5
	38	28	0.0055	0.0063	0.0042	4.5
	38	28	0.0055	0.0063	0.0042	4.5
Floor 5	38	28	0.006	0.0066	0.0045	6.0
	38	28	0.006	0.0066	0.0045	6.0
	38	28	0.006	0.0066	0.0045	6.0
Floor 4	38	28	0.0062	0.0068	0.0046	6.0
	38	28	0.0062	0.0068	0.0046	6.0
	38	28	0.0062	0.0068	0.0046	6.0
Floor 3	38	28	0.0062	0.0068	0.0046	6.0
	38	28	0.0062	0.0068	0.0046	6.0
	38	28	0.0062	0.0068	0.0046	6.0
Floor 2	38	28	0.0063	0.0066	0.0046	6.0
	38	28	0.0063	0.0066	0.0046	6.0
	38	28	0.0063	0.0066	0.0046	6.0

Grade beam column height (in) = 24

Basement column height (in) = 32

Design base shear =	0.044 g,	368 k	
f'_c beams = 5.0 ksi		$f'_{c,cols,upper}$ = 7.0 ksi	
$f_{y,rebar,nom.}$ = 60 ksi		$f'_{c,cols,lower}$ = 7.0 ksi	

Design Documentation (2 of 2)



Modeling Documentation (1 of 1)

Floor 13	$M_{y,pos,exp}$ (k-in) =	4981	4981	4981
	$M_{y,n,slab,exp}$ (k-in) =	-6358	-6358	-6358
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	3.724E+07
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0389	0.0389	0.0389
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.044	-0.044
	Θ_{pc} (rad) =	0.086	0.086	0.086
	λ =	111	111	111
Floor 12	$M_{y,pos,exp}$ (k-in) =	4981	4981	4981
	$M_{y,n,slab,exp}$ (k-in) =	-7079	-7079	-7079
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.040	0.040	0.040
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.047	-0.047	-0.047
	Θ_{pc} (rad) =	0.089	0.089	0.089
	λ =	116	116	116
Floor 11	$M_{y,pos,exp}$ (k-in) =	5712	5712	5712
	$M_{y,n,slab,exp}$ (k-in) =	-8906	-8906	-8906
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.036	0.036	0.036
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.044	-0.044	-0.044
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 10	$M_{y,pos,exp}$ (k-in) =	7194	7194	7194
	$M_{y,n,slab,exp}$ (k-in) =	-10725	-10725	-10725
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	2.379E+08	2.379E+08	2.379E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	111	111	111
Floor 9	$M_{y,pos,exp}$ (k-in) =	8769	8769	8769
	$M_{y,n,slab,exp}$ (k-in) =	-12095	-12095	-12095
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.042	0.042	0.042
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.049	-0.049	-0.049
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 8	$M_{y,pos,exp}$ (k-in) =	9308	9308	9308
	$M_{y,n,slab,exp}$ (k-in) =	-12628	-12628	-12628
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.049	-0.049	-0.049
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 7	$M_{y,pos,exp}$ (k-in) =	12039	12039	12039
	$M_{y,n,slab,exp}$ (k-in) =	-15287	-15287	-15287
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.054	0.0539	0.0539
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.060	-0.060	-0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	127	127	127
Floor 6	$M_{y,pos,exp}$ (k-in) =	12039	12039	12039
	$M_{y,n,slab,exp}$ (k-in) =	-15287	-15287	-15287
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.054	0.0539	0.0539
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.060	-0.060	-0.060
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	127	127	127
Floor 5	$M_{y,pos,exp}$ (k-in) =	13062	13062	13062
	$M_{y,n,slab,exp}$ (k-in) =	-16001	-16001	-16001
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.0496	0.0496
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 4	$M_{y,pos,exp}$ (k-in) =	13597	13597	13597
	$M_{y,n,slab,exp}$ (k-in) =	-16532	-16532	-16532
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.0506	0.0506
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 3	$M_{y,pos,exp}$ (k-in) =	13642	13642	13642
	$M_{y,n,slab,exp}$ (k-in) =	-16532	-16532	-16532
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.0506	0.0506
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.055	-0.055	-0.055
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116
Floor 2	$M_{y,pos,exp}$ (k-in) =	13836	13836	13836
	$M_{y,n,slab,exp}$ (k-in) =	-16010	-16010	-16010
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	3.838E+08	3.838E+08	3.838E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.051	0.051	0.051
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.054	-0.054	-0.054
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	116	116	116

Story 12	$M_{y,exp}$ (k-in) =	7844	8097	8097	7844
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.080	0.079	0.079	0.080
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	124	124	124
	$(P/A_gf'_c)_{exp}$ =	0.00	0.01	0.01	0.00
Story 11	$M_{y,exp}$ (k-in) =	8097	8598	8598	8097
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.079	0.078	0.078	0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	124	123	123	124
	$(P/A_gf'_c)_{exp}$ =	0.01	0.01	0.01	0.01
Story 10	$M_{y,exp}$ (k-in) =	8348	9095	9095	8348
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.079	0.077	0.077	0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	123	122	122	123
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 9	$M_{y,exp}$ (k-in) =	8598	12673	12673	8598
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.079	0.079	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	123	121	121	123
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 8	$M_{y,exp}$ (k-in) =	8847	12972	12972	8847
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.078	0.078	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	122	120	120	122
	$(P/A_gf'_c)_{exp}$ =	0.02	0.03	0.03	0.02
Story 7	$M_{y,exp}$ (k-in) =	10189	15612	15612	10189
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.079	0.079	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	122	119	119	122
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 6	$M_{y,exp}$ (k-in) =	10616	16081	16081	10616
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.078	0.078	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	121	118	118	121
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 5	$M_{y,exp}$ (k-in) =	11404	16547	16547	11404
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.077	0.077	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	121	117	117	121
	$(P/A_gf'_c)_{exp}$ =	0.02	0.05	0.05	0.02
Story 4	$M_{y,exp}$ (k-in) =	13456	17010	17010	13456
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.079	0.077	0.077	0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	116	116	120
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 3	$M_{y,exp}$ (k-in) =	13333	17470	17470	13333
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.076	0.076	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	120	115	115	120
	$(P/A_gf'_c)_{exp}$ =	0.03	0.06	0.06	0.03
Story 2	$M_{y,exp}$ (k-in) =	14113	17928	17928	14113
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.078	0.075	0.075	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	114	114	119
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 1	$M_{y,exp}$ (k-in) =	20653	18741	18741	20653
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.084	0.074	0.074	0.084
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	119	113	113	119
	$(P/A_gf'_c)_{exp}$ =	0.04	0.07	0.07	0.04

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 1.79

Model periods (sec): T_1 = 2.00 T_2= 0.67 T_3= 0.38

$f_{y,rebar,expected}$= 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2061

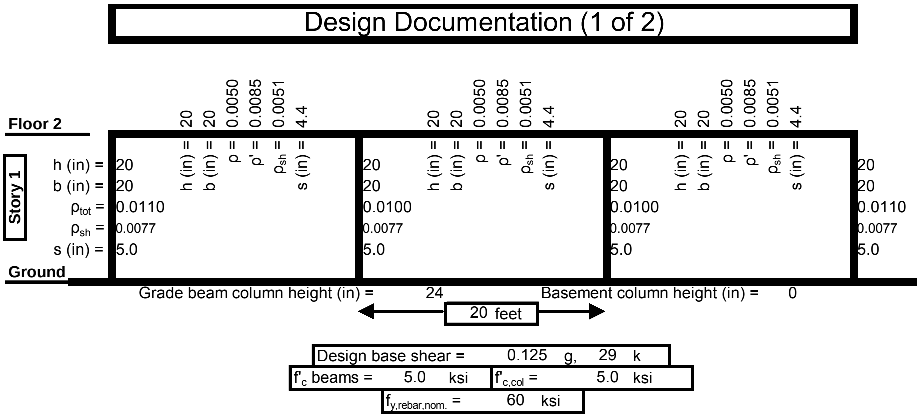
Number of Stories: 1

Fundamental Period (sec): 0.42

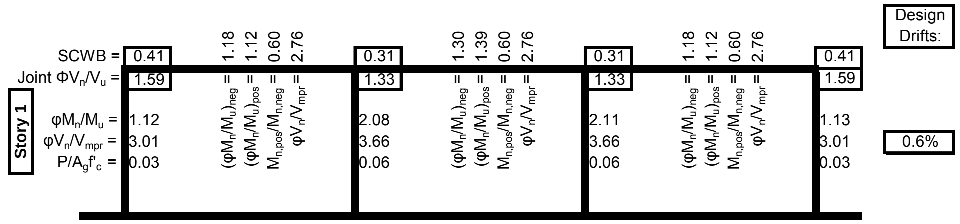
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Column size is designed to satisfy joint shear requirements. Beams strength were controlled by force demand, but one beams had additional reinforcement added to keep the same rho ratio between the floors. Exterior column strengths are controlled by flexural demands and interior by columns controlled by minimum the reinforcement requirement. The columns could not be made smaller than 20” because of the joint bond requirements of 20*db; 20” is the smallest dimension allowable for a #8 rebar. Beam stirrups were controlled by the minimum requirement. The column stirrups were controlled by confinement requirement.

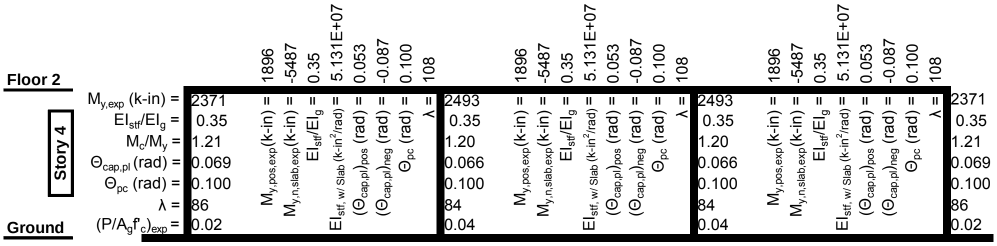
DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.42 T_2 = 0.40 T_3 = 0.03

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2062

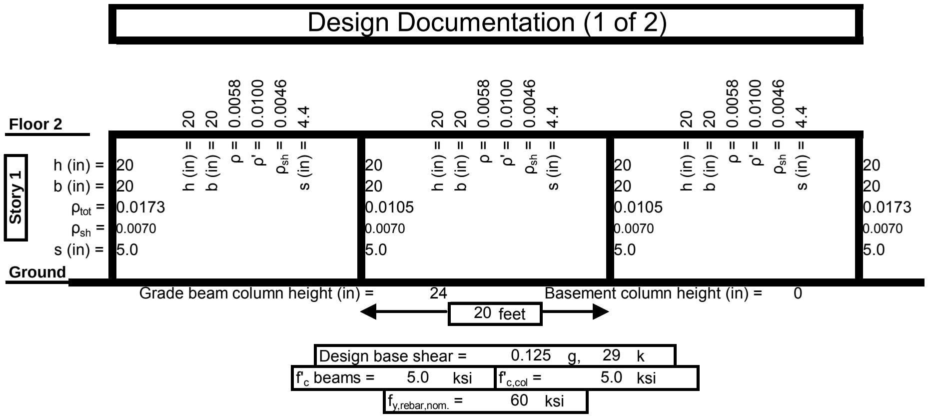
Number of Stories: 1

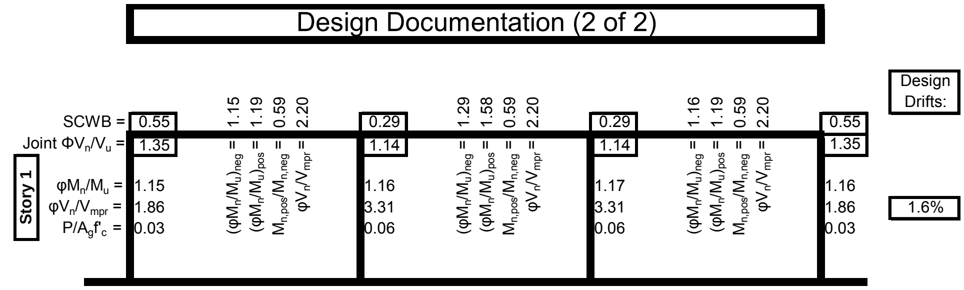
Fundamental Period (sec): 0.42

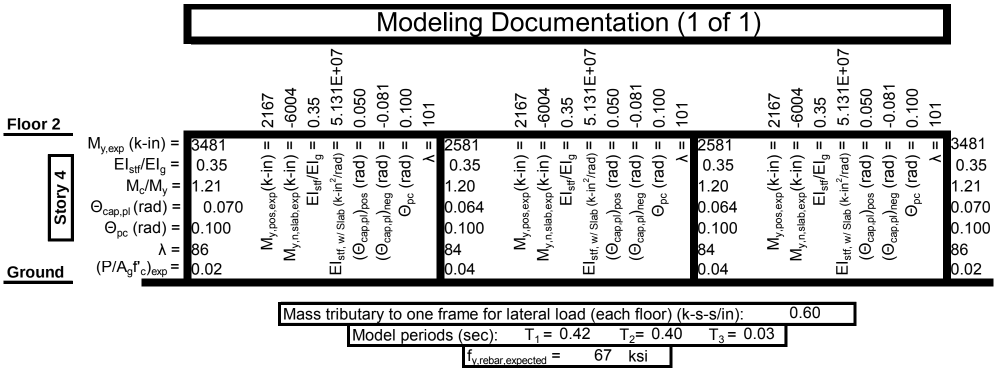
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Column size is designed to satisfy joint shear requirements. Beams strength were controlled by force demand, but one beams had additional reinforcement added to keep the same rho ratio between the floors. Exterior column strengths are controlled by flexural demands and interior by columns controlled by minimum the reinforcement requirement. The columns could not be made smaller than 20” because of the joint bond requirements of 20*db; 20” is the smallest dimension allowable for a #8 rebar. Beam stirrups were controlled by the minimum requirement. The column stirrups were controlled by confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES




Design Documentation (2 of 2)
Design Drifts:
1.6%
Story 1
SCWB = 0.55 | 0.29 | 0.29 | 0.55
Joint ΦVn/Vu = 1.35 | 1.14 | 1.14 | 1.35
φMn/Mu = 1.15 | 1.16 | 1.17 | 1.16
φVn/Vmpr = 1.86 | 3.31 | 3.31 | 1.86
P/Agf'c = 0.03 | 0.06 | 0.06 | 0.03
(φMn/Mu)neg = 1.15 | 1.29 | 1.16
(φMn/Mu)pos = 1.19 | 1.58 | 1.19
Mn,pos/Mn,neg = 0.59 | 0.59 | 0.59
φVn/Vmpr = 2.20 | 2.20 | 2.20


Modeling Documentation (1 of 1)
Floor 2
Story 4
Ground
My,exp (k-in) = 3481 | 2581 | 2581 | 3481
EIstf/EIg = 0.35 | 0.35 | 0.35 | 0.35
Mc/My = 1.21 | 1.20 | 1.20 | 1.21
Θcap,pl (rad) = 0.070 | 0.064 | 0.064 | 0.070
Θpc (rad) = 0.100 | 0.100 | 0.100 | 0.100
λ = 86 | 84 | 84 | 86
(P/Agf'c)exp = 0.02 | 0.04 | 0.04 | 0.02
My,pos,exp (k-in) = 2167 | 2167 | 2167
My,n,slab,exp (k-in) = -6004 | -6004 | -6004
EIstf/EIg = 0.35 | 0.35 | 0.35
EIstf, w/ Slab (k-in²/rad) = 5.131E+07 | 5.131E+07 | 5.131E+07
(Θcap,pl)pos (rad) = 0.050 | 0.050 | 0.050
(Θcap,pl)neg (rad) = -0.081 | -0.081 | -0.081
Θpc (rad) = 0.100 | 0.100 | 0.100
λ = 101 | 101 | 101
Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60
Model periods (sec): T1 = 0.42 T2 = 0.40 T3 = 0.03
fy,rebar,expected = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2063

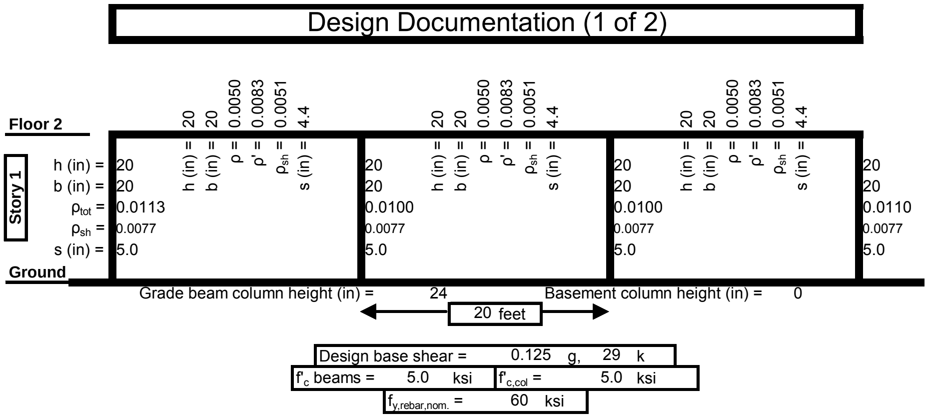
Number of Stories: 1

Fundamental Period (sec): 0.43

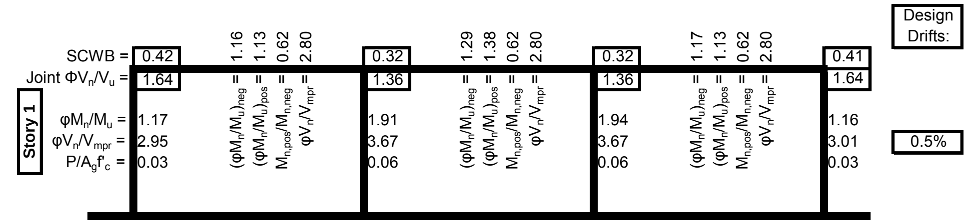
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

This design is not too much different form the 2061 design. Column size is designed to satisfy joint shear requirements. Beams strength were controlled by force demand, but one beams had additional reinforcement added to keep the same rho ratio between the floors. Exterior column strengths are controlled by flexural demands and interior by columns controlled by minimum the reinforcement requirement. The columns could not be made smaller than 20” because of the joint bond requirements of 20*db; 20” is the smallest dimension allowable for a #8 rebar. Beam stirrups were controlled by the minimum requirement. The column stirrups were controlled by confinement requirement.

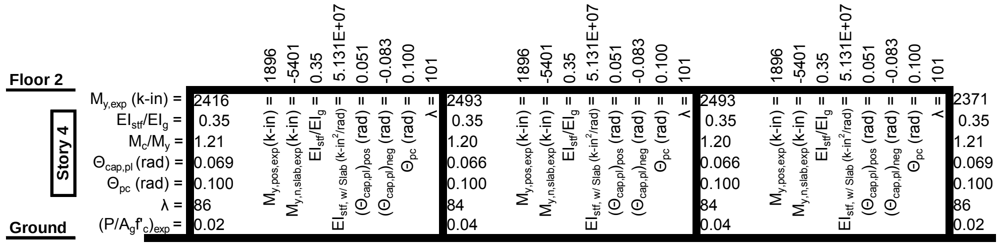
DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 0.42 T_2 = 0.40 T_3 = 0.03

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2064

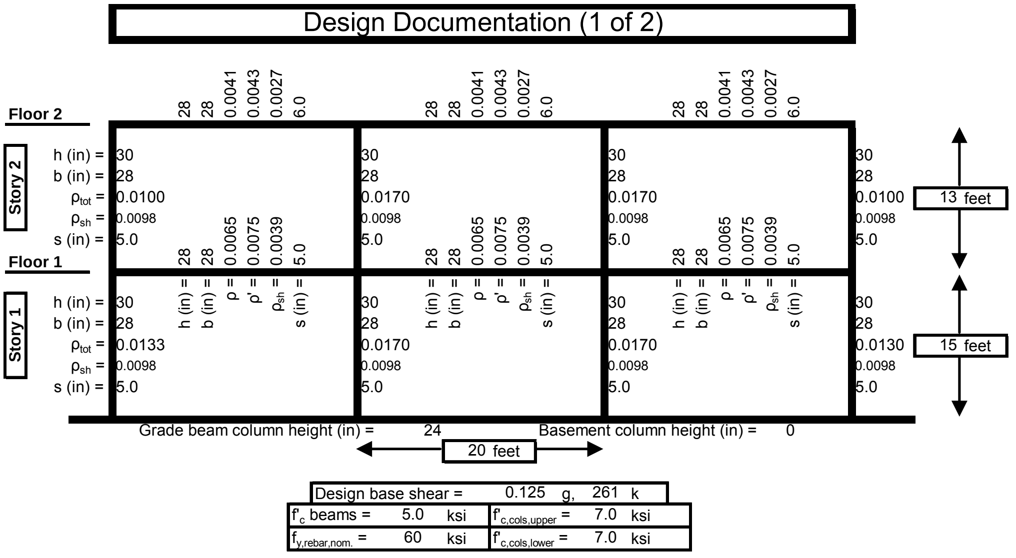
Number of Stories: 2

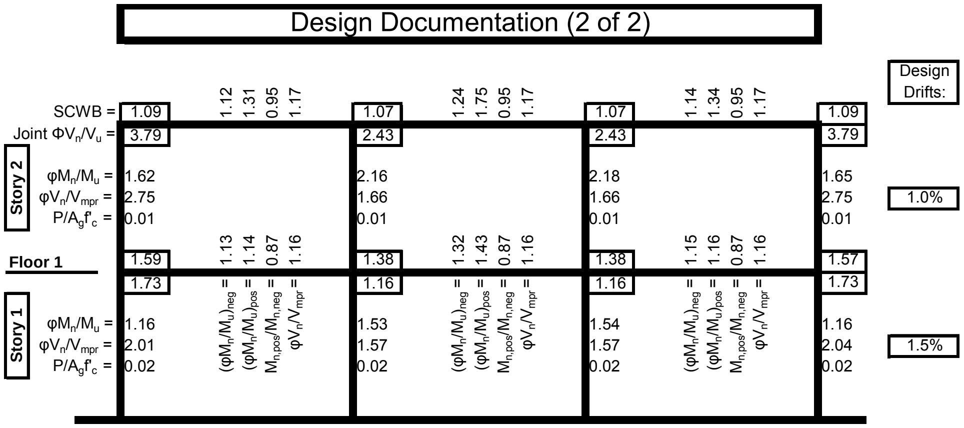
Fundamental Period (sec): 0.66

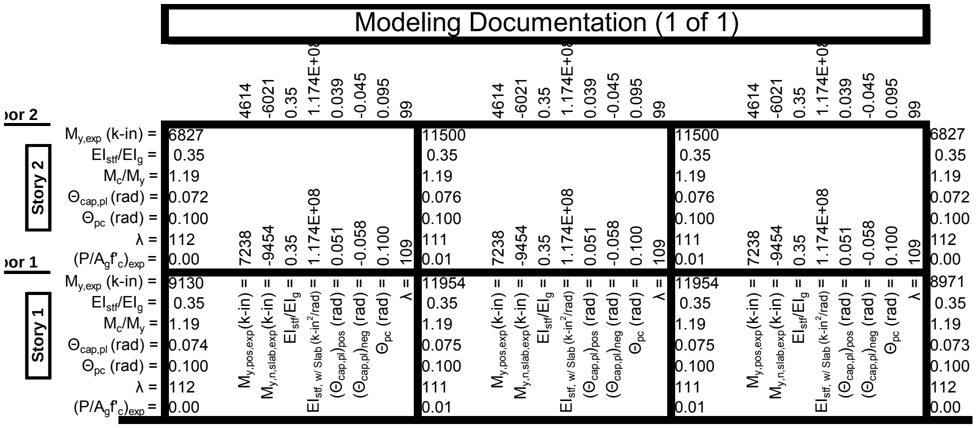
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

Column size concrete strength are designed to satisfy joint shear requirements, specifically the column widths were increased to increase column area. Beams strength were controlled by force demand, but four beams had additional reinforcement added to keep the same rho ratio between the floors. Column strengths are controlled by SCWB except two exterior lower columns that were controlled by flexural demands and two upper story exterior columns controlled by minimum the reinforcement requirement. Beam stirrups were controlled by the minimum requirement. The column stirrups were controlled by confinement requirement.

DESIGN AND MODELING DOCUMENTATION FIGURES







Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 2.69

Model periods (sec): T_1 = 0.66 T_2 = 0.18 T_3 = 0.05

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2065
Number of Stories: 8
Fundamental Period (sec): 1.57

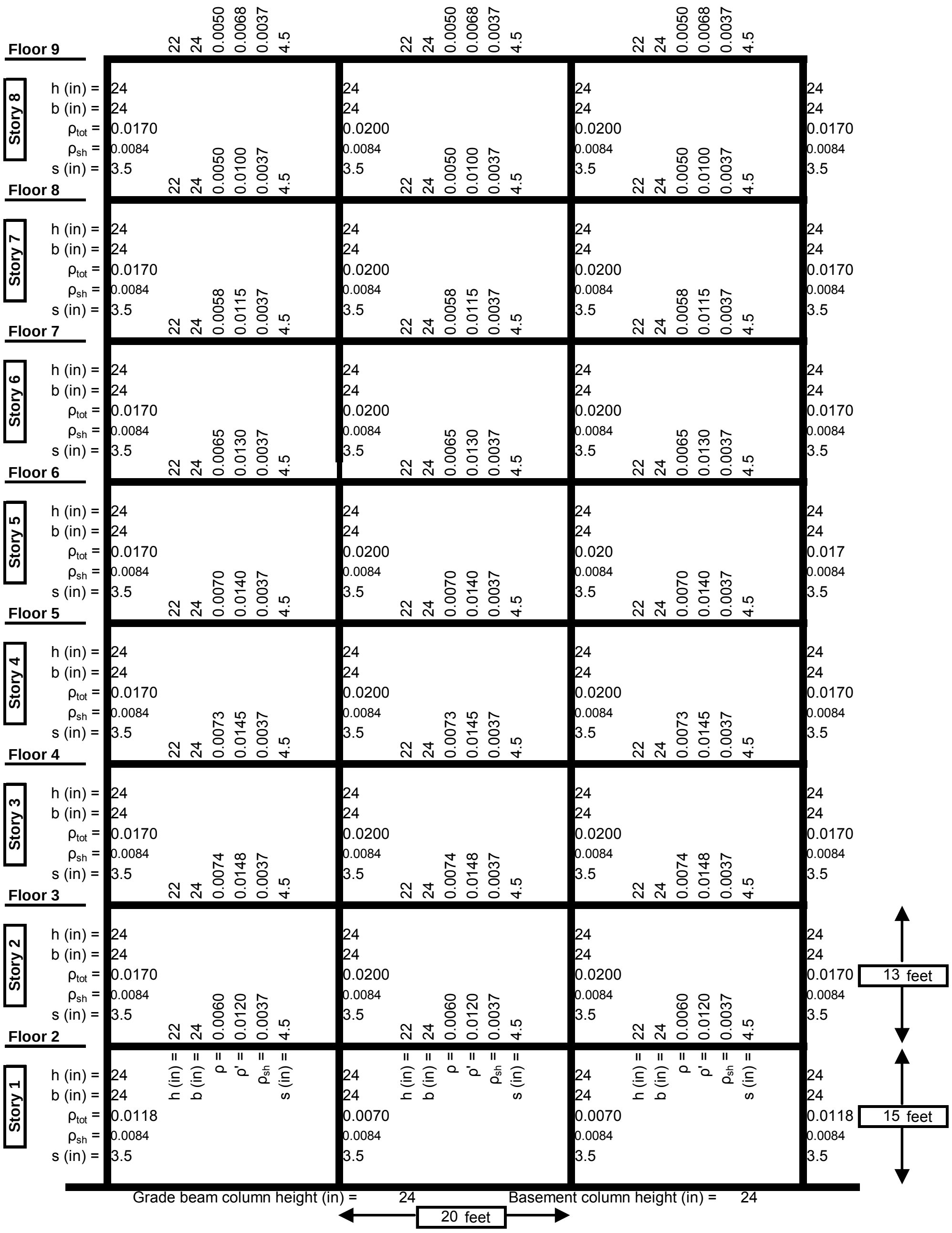
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2065 Perimeter Frame, 65% Weak Story in first story only

This design was created using design ID 1023 as the baseline. Design ID 1023 had the first two stories weak, and this design is intended to have only the first story weak. Therefore, to make this design, we strengthened the second story columns and the first above ground beam. We based the 65% ratio of story strengths on the strengths computed only from the columns of the first and second stories, assuming both column ends hinged. Even with the weak story, this design is fully code conforming. The bottom story exterior columns were controlled by flexural.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.050	g,	94	k

f'_c beams =	6.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	8.0	ksi

Design Documentation (2 of 2)

								Design Drifts:
SCWB =	0.93	1.77 1.73 0.75 5.75	0.78	1.67 2.01 0.75 5.75	0.78	1.77 1.73 0.75 5.75	0.93	
Joint $\Phi V_n/V_u$ =	2.50		1.91		1.91		2.50	
Story 8 $\varphi M_n/M_u$ =	2.68		6.77		6.78		2.68	
$\varphi V_n/V_{mpr}$ =	1.87		1.52		1.52		1.87	0.6%
$P/A_g f'_c$ =	0.02		0.03		0.03		0.02	
Floor 8	1.49	1.73 1.86 0.51 3.45	1.36	1.87 1.95 0.51 3.45	1.36	1.73 1.86 0.51 3.45	1.49	
	1.45		1.29		1.29		1.45	
Story 7 $\varphi M_n/M_u$ =	3.36		5.28		5.28		3.37	
$\varphi V_n/V_{mpr}$ =	1.75		1.89		1.89		1.75	0.9%
$P/A_g f'_c$ =	0.03		0.06		0.06		0.03	
Floor 7	1.41	1.73 2.00 0.51 2.70	1.31	1.85 2.14 0.51 2.70	1.31	1.73 2.00 0.51 2.70	1.41	
	1.26		1.12		1.12		1.26	
Story 6 $\varphi M_n/M_u$ =	2.90		4.31		4.31		2.90	
$\varphi V_n/V_{mpr}$ =	1.63		1.75		1.75		1.63	1.3%
$P/A_g f'_c$ =	0.05		0.09		0.09		0.05	
Floor 6	1.34	1.74 2.06 0.51 0.72	1.26	1.86 2.21 0.51 0.72	1.26	1.74 2.06 0.51 0.72	1.34	
	1.09		0.97		0.97		1.09	
Story 5 $\varphi M_n/M_u$ =	2.66		3.70		3.70		2.67	
$\varphi V_n/V_{mpr}$ =	2.46		1.93		1.93		2.46	1.5%
$P/A_g f'_c$ =	0.07		0.13		0.13		0.07	
Floor 5	1.31	1.74 2.04 0.51 0.69	1.26	1.85 2.25 0.51 0.69	1.26	1.74 2.04 0.51 0.69	1.31	
	1.15		1.02		1.02		1.15	
Story 4 $\varphi M_n/M_u$ =	2.54		3.44		3.44		2.54	
$\varphi V_n/V_{mpr}$ =	2.76		2.15		2.15		2.76	1.7%
$P/A_g f'_c$ =	0.06		0.12		0.12		0.06	
Floor 4	1.31	1.72 1.99 0.51 0.68	1.30	1.82 2.25 0.51 0.68	1.30	1.72 1.99 0.51 0.68	1.31	
	1.11		0.99		0.99		1.11	
Story 3 $\varphi M_n/M_u$ =	2.44		3.37		3.37		2.44	
$\varphi V_n/V_{mpr}$ =	2.64		2.04		2.04		2.64	1.8%
$P/A_g f'_c$ =	0.08		0.14		0.14		0.08	
Floor 3	1.32	1.74 1.98 0.51 0.67	1.34	1.81 2.25 0.51 0.67	1.34	1.74 1.98 0.51 0.67	1.32	
	1.09		0.97		0.97		1.09	
Story 2 $\varphi M_n/M_u$ =	2.36		3.04		3.04		2.36	
$\varphi V_n/V_{mpr}$ =	2.53		1.95		1.95		2.53	1.8%
$P/A_g f'_c$ =	0.09		0.17		0.17		0.09	
Floor 2	1.37	1.51 1.56 0.51 2.52	1.32	1.59 1.97 0.51 2.52	1.32	1.51 1.56 0.51 2.52	1.37	
	1.34		1.19		1.19		1.34	
Story 1 $\varphi M_n/M_u$ =	1.15	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.89	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.89	$(\varphi M_n/M_u)_{neg}$ = $(\varphi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\varphi V_n/V_{mpr}$ =	1.15	
$\varphi V_n/V_{mpr}$ =	2.95		2.68		2.68		2.95	1.4%
$P/A_g f'_c$ =	0.11		0.19		0.19		0.11	

Modeling Documentation (1 of 1)

Story 8	$M_{y,exp}$ (k-in) =	6098	7426	7426	6098
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.081	0.081	0.081	0.081
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	116	114	114	116
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 7	$M_{y,exp}$ (k-in) =	6455	8122	8122	6455
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.079	0.078	0.078	0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	114	111	111	114
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 6	$M_{y,exp}$ (k-in) =	6808	8806	8806	6808
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.078	0.075	0.075	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	112	107	107	112
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 5	$M_{y,exp}$ (k-in) =	7157	9478	9478	7157
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.076	0.072	0.072	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	111	104	104	111
	$(P/A_gf'_c)_{exp}$ =	0.04	0.09	0.09	0.04
Story 4	$M_{y,exp}$ (k-in) =	7550	10212	10212	7550
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.18	1.18	1.18	1.18
	$\Theta_{cap,pl}$ (rad) =	0.070	0.067	0.067	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	111	105	105	111
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 3	$M_{y,exp}$ (k-in) =	7897	10873	10873	7897
	EI_{stf}/EI_g =	0.35	0.37	0.37	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.069	0.065	0.065	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	103	103	110
	$(P/A_gf'_c)_{exp}$ =	0.05	0.10	0.10	0.05
Story 2	$M_{y,exp}$ (k-in) =	8241	11525	11525	8241
	EI_{stf}/EI_g =	0.35	0.39	0.39	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.068	0.063	0.063	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	109	101	101	109
	$(P/A_gf'_c)_{exp}$ =	0.06	0.12	0.12	0.06
Story 1	$M_{y,exp}$ (k-in) =	6901	8050	8050	6901
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.064	0.055	0.055	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	98	98	107
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07

	$M_{y,pos,exp}$(k-in) =	$M_{y,n,slab,exp}$(k-in) =	EI_{stf}/EI_g =	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	$(\Theta_{cap,pl})_{pos}$ (rad) =	$(\Theta_{cap,pl})_{neg}$ (rad) =	Θ_{pc} (rad) =	λ =
Floor 9	2817	-6453	0.35	8.137E+07	0.044	-0.065	0.100	100
	2817	-6453	0.35	8.137E+07	0.044	-0.065	0.100	100
	2817	-6453	0.35	8.137E+07	0.044	-0.065	0.100	100
Floor 8	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
	2813	-8142	0.35	8.137E+07	0.043	-0.070	0.100	100
Floor 7	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
	3220	-8919	0.35	8.137E+07	0.044	-0.071	0.100	100
Floor 6	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
	3626	-9693	0.35	8.137E+07	0.045	-0.072	0.100	100
Floor 5	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
	3896	-10208	0.35	8.137E+07	0.046	-0.072	0.100	100
Floor 4	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
	4030	-10465	0.35	8.137E+07	0.046	-0.073	0.100	100
Floor 3	4098	-10594	0.35	8.137E+07	0.047	-0.073	0.100	100
	4098	-10594	0.35	8.137E+07	0.0467	-0.073	0.100	100
	4098	-10594	0.35	8.137E+07	0.0467	-0.073	0.100	100
Floor 2	3355	-9177	0.35	8.137E+07	0.045	-0.071	0.100	100
	3355	-9177	0.35	8.137E+07	0.045	-0.071	0.100	100
	3355	-9177	0.35	8.137E+07	0.045	-0.071	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.57 T_2 = 0.51 T_3 = 0.29

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2066
Number of Stories: 8
Fundamental Period (sec): 1.71

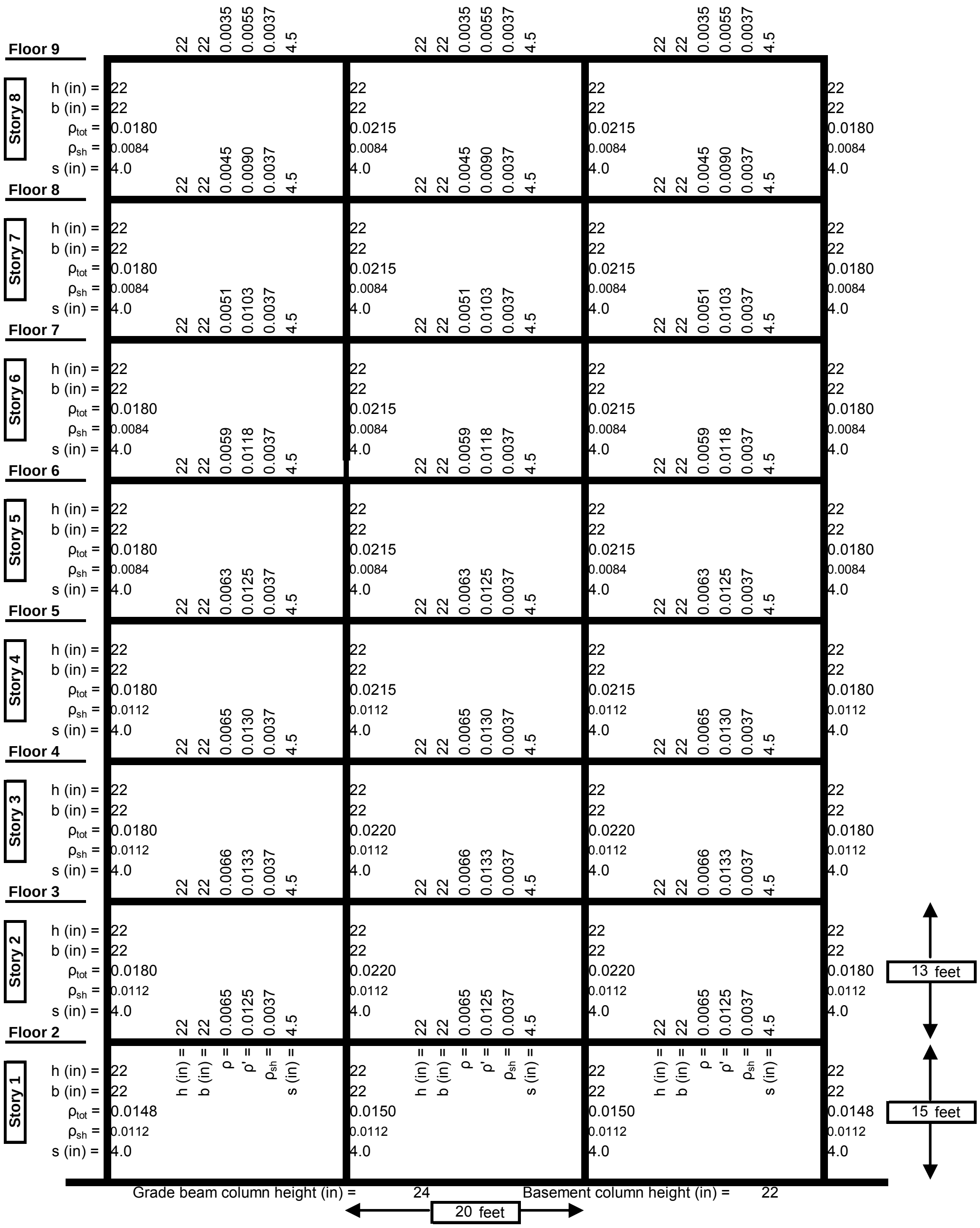
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2066 Perimeter Frame, 80% Weak Story in first story only

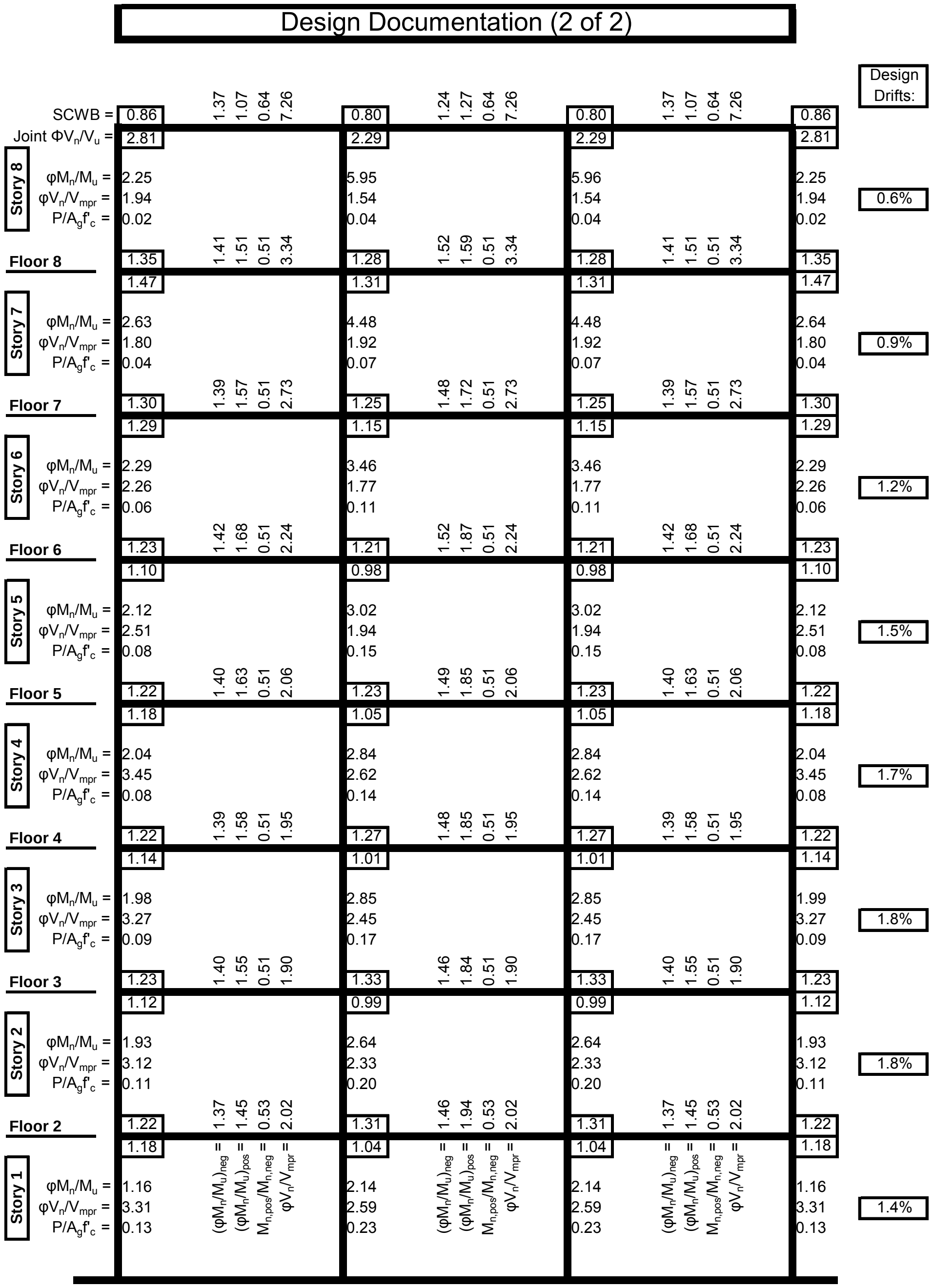
This design was created using design ID 1024 as the baseline. Design ID 1024 had the first two stories weak, and this design is intended to have only the first story weak. Therefore, to make this design, we strengthened the second story columns and the first above ground beam. We based the 80% ratio of story strengths on the strengths computed only from the columns of the first and second stories, assuming both column ends hinged. Even with the weak story, this design is fully code conforming. The bottom story exterior columns were controlled by flexural.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.050	g,	94	k	
f'_c beams =	6.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	8.0	ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB =
Joint ΦVn/Vu =
0.86 0.80 0.80 0.86
2.81 2.29 2.29 2.81
1.37 1.07 0.64 7.26
1.24 1.27 0.64 7.26
1.37 1.07 0.64 7.26
Story 8
φMn/Mu = 2.25 5.95 5.96 2.25
φVn/Vmpr = 1.94 1.54 1.54 1.94
P/Agf'c = 0.02 0.04 0.04 0.02
0.6%
1.41 1.51 0.51 3.34
1.52 1.59 0.51 3.34
1.41 1.51 0.51 3.34
Floor 8
1.35 1.28 1.28 1.35
1.47 1.31 1.31 1.47
Story 7
φMn/Mu = 2.63 4.48 4.48 2.64
φVn/Vmpr = 1.80 1.92 1.92 1.80
P/Agf'c = 0.04 0.07 0.07 0.04
0.9%
1.39 1.57 0.51 2.73
1.48 1.72 0.51 2.73
1.39 1.57 0.51 2.73
Floor 7
1.30 1.25 1.25 1.30
1.29 1.15 1.15 1.29
Story 6
φMn/Mu = 2.29 3.46 3.46 2.29
φVn/Vmpr = 2.26 1.77 1.77 2.26
P/Agf'c = 0.06 0.11 0.11 0.06
1.2%
1.42 1.68 0.51 2.24
1.52 1.87 0.51 2.24
1.42 1.68 0.51 2.24
Floor 6
1.23 1.21 1.21 1.23
1.10 0.98 0.98 1.10
Story 5
φMn/Mu = 2.12 3.02 3.02 2.12
φVn/Vmpr = 2.51 1.94 1.94 2.51
P/Agf'c = 0.08 0.15 0.15 0.08
1.5%
1.40 1.63 0.51 2.06
1.49 1.85 0.51 2.06
1.40 1.63 0.51 2.06
Floor 5
1.22 1.23 1.23 1.22
1.18 1.05 1.05 1.18
Story 4
φMn/Mu = 2.04 2.84 2.84 2.04
φVn/Vmpr = 3.45 2.62 2.62 3.45
P/Agf'c = 0.08 0.14 0.14 0.08
1.7%
1.39 1.58 0.51 1.95
1.48 1.85 0.51 1.95
1.39 1.58 0.51 1.95
Floor 4
1.22 1.27 1.27 1.22
1.14 1.01 1.01 1.14
Story 3
φMn/Mu = 1.98 2.85 2.85 1.99
φVn/Vmpr = 3.27 2.45 2.45 3.27
P/Agf'c = 0.09 0.17 0.17 0.09
1.8%
1.40 1.55 0.51 1.90
1.46 1.84 0.51 1.90
1.40 1.55 0.51 1.90
Floor 3
1.23 1.33 1.33 1.23
1.12 0.99 0.99 1.12
Story 2
φMn/Mu = 1.93 2.64 2.64 1.93
φVn/Vmpr = 3.12 2.33 2.33 3.12
P/Agf'c = 0.11 0.20 0.20 0.11
1.8%
1.37 1.45 0.53 2.02
1.46 1.94 0.53 2.02
1.37 1.45 0.53 2.02
Floor 2
1.22 1.31 1.31 1.22
1.18 1.04 1.04 1.18
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
Story 1
φMn/Mu = 1.16 2.14 2.14 1.16
φVn/Vmpr = 3.31 2.59 2.59 3.31
P/Agf'c = 0.13 0.23 0.23 0.13
1.4%

Modeling Documentation (1 of 1)

Story	$M_{y,exp}$ (k-in)	EI_{stf}/EI_g	M_c/M_y	$\Theta_{cap,pl}$ (rad)	Θ_{pc} (rad)	λ	$(P/A_g f'_c)_{exp}$
Story 8	4889	0.35	1.20	0.078	0.100	105	0.01
	6059	0.35	1.20	0.079	0.100	103	0.03
	6059	0.35	1.20	0.079	0.100	103	0.03
	4889	0.35	1.20	0.078	0.100	105	0.01
Story 7	5213	0.35	1.20	0.077	0.100	103	0.03
	6689	0.35	1.19	0.075	0.100	99	0.05
	6689	0.35	1.19	0.075	0.100	99	0.05
	5213	0.35	1.20	0.077	0.100	103	0.03
Story 6	5533	0.35	1.20	0.075	0.100	101	0.04
	7307	0.35	1.19	0.071	0.100	96	0.08
	7307	0.35	1.19	0.071	0.100	96	0.08
	5533	0.35	1.20	0.075	0.100	101	0.04
Story 5	5849	0.35	1.19	0.073	0.100	99	0.05
	7914	0.36	1.19	0.068	0.100	93	0.11
	7914	0.36	1.19	0.068	0.100	93	0.11
	5849	0.35	1.19	0.073	0.100	99	0.05
Story 4	6204	0.35	1.18	0.076	0.100	100	0.05
	8576	0.40	1.17	0.071	0.100	93	0.10
	8576	0.40	1.17	0.071	0.100	93	0.10
	6204	0.35	1.18	0.076	0.100	100	0.05
Story 3	6518	0.36	1.18	0.074	0.100	98	0.06
	9290	0.42	1.17	0.069	0.100	91	0.12
	9290	0.42	1.17	0.069	0.100	91	0.12
	6518	0.36	1.18	0.074	0.100	98	0.06
Story 2	6828	0.37	1.18	0.073	0.100	97	0.07
	9877	0.44	1.17	0.066	0.100	89	0.14
	9877	0.44	1.17	0.066	0.100	89	0.14
	6828	0.37	1.18	0.073	0.100	97	0.07
Story 1	6360	0.38	1.18	0.070	0.100	96	0.08
	8800	0.46	1.16	0.060	0.100	86	0.16
	8800	0.46	1.16	0.060	0.100	86	0.16
	6360	0.38	1.18	0.070	0.100	96	0.08

Floor	$M_{y,pos,exp}$(k-in)	$M_{y,n,slab,exp}$(k-in)	EI_{stf}/EI_g	$EI_{stf, w/ Slab}$ (k-in^2/rad)	$(\Theta_{cap,pl})_{pos}$ (rad)	$(\Theta_{cap,pl})_{neg}$ (rad)	Θ_{pc} (rad)	λ
Floor 9	1828	-5532	0.35	7.863E+07	0.0406	-0.068	0.100	100
	1828	-5532	0.35	7.863E+07	0.0406	-0.068	0.100	100
	1828	-5532	0.35	7.863E+07	0.0406	-0.068	0.100	100
Floor 8	2329	-7205	0.35	7.863E+07	0.042	-0.071	0.100	100
	2329	-7205	0.35	7.863E+07	0.042	-0.071	0.100	100
	2329	-7205	0.35	7.863E+07	0.042	-0.071	0.100	100
Floor 7	2641	-7799	0.35	7.863E+07	0.043	-0.071	0.100	100
	2641	-7799	0.35	7.863E+07	0.043	-0.071	0.100	100
	2641	-7799	0.35	7.863E+07	0.043	-0.071	0.100	100
Floor 6	3014	-8510	0.35	7.863E+07	0.044	-0.072	0.100	100
	3014	-8510	0.35	7.863E+07	0.044	-0.072	0.100	100
	3014	-8510	0.35	7.863E+07	0.044	-0.072	0.100	100
Floor 5	3200	-8864	0.35	7.863E+07	0.045	-0.072	0.100	100
	3200	-8864	0.35	7.863E+07	0.045	-0.072	0.100	100
	3200	-8864	0.35	7.863E+07	0.045	-0.072	0.100	100
Floor 4	3324	-9101	0.35	7.863E+07	0.045	-0.072	0.100	100
	3324	-9101	0.35	7.863E+07	0.045	-0.072	0.100	100
	3324	-9101	0.35	7.863E+07	0.045	-0.072	0.100	100
Floor 3	3385	-9219	0.35	7.863E+07	0.045	-0.073	0.100	100
	3385	-9219	0.35	7.863E+07	0.0454	-0.073	0.100	100
	3385	-9219	0.35	7.863E+07	0.0454	-0.073	0.100	100
Floor 2	3324	-8866	0.35	7.863E+07	0.045	-0.072	0.100	100
	3324	-8866	0.35	7.863E+07	0.045	-0.072	0.100	100
	3324	-8866	0.35	7.863E+07	0.045	-0.072	0.100	100

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.71 T_2 = 0.56 T_3 = 0.32

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2067
Number of Stories: 12
Fundamental Period (sec): 1.92

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

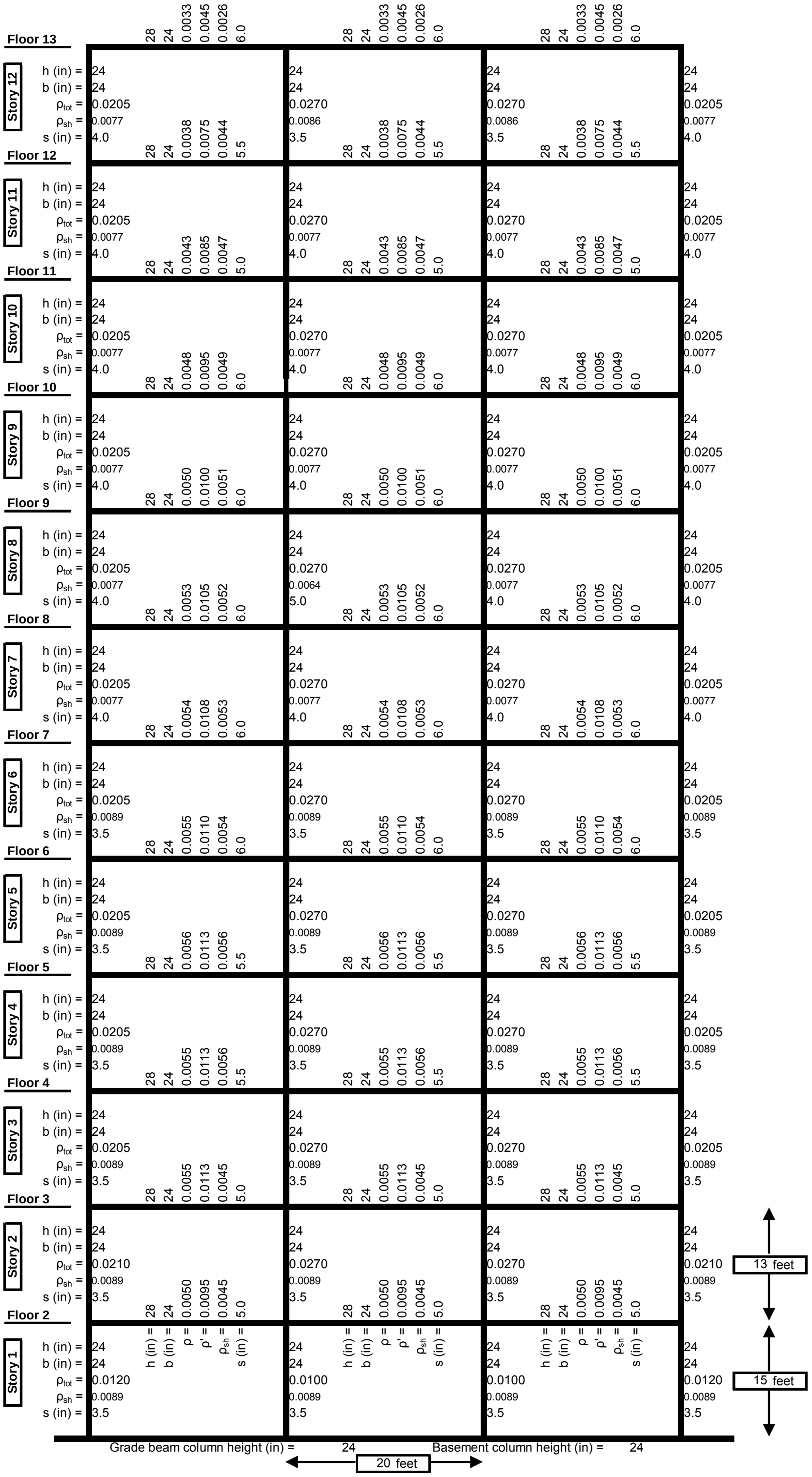
2067 Perimeter Frame, 65% Weak Story in first story only

This design was created using design ID 1017 as the baseline. Design ID 1017 had the first two stories weak, and this design is intended to have only the first story weak. Therefore, to make this design, we strengthened the second story columns and the first above ground beam. We based the 65% ratio of story strengths on the strengths computed only from the columns of the first and second stories, assuming both column ends hinged. Even with the weak story, this design is fully code conforming. The bottom story exterior columns were controlled by flexural.

Design 2067 ends up being about 30% stronger than 1017 because the second story was strengthened in the effort to make only the first story weak. During the pushover, the second story contributed to the yield mechanism, so the additional strength in that story increased the yield base shear strength.

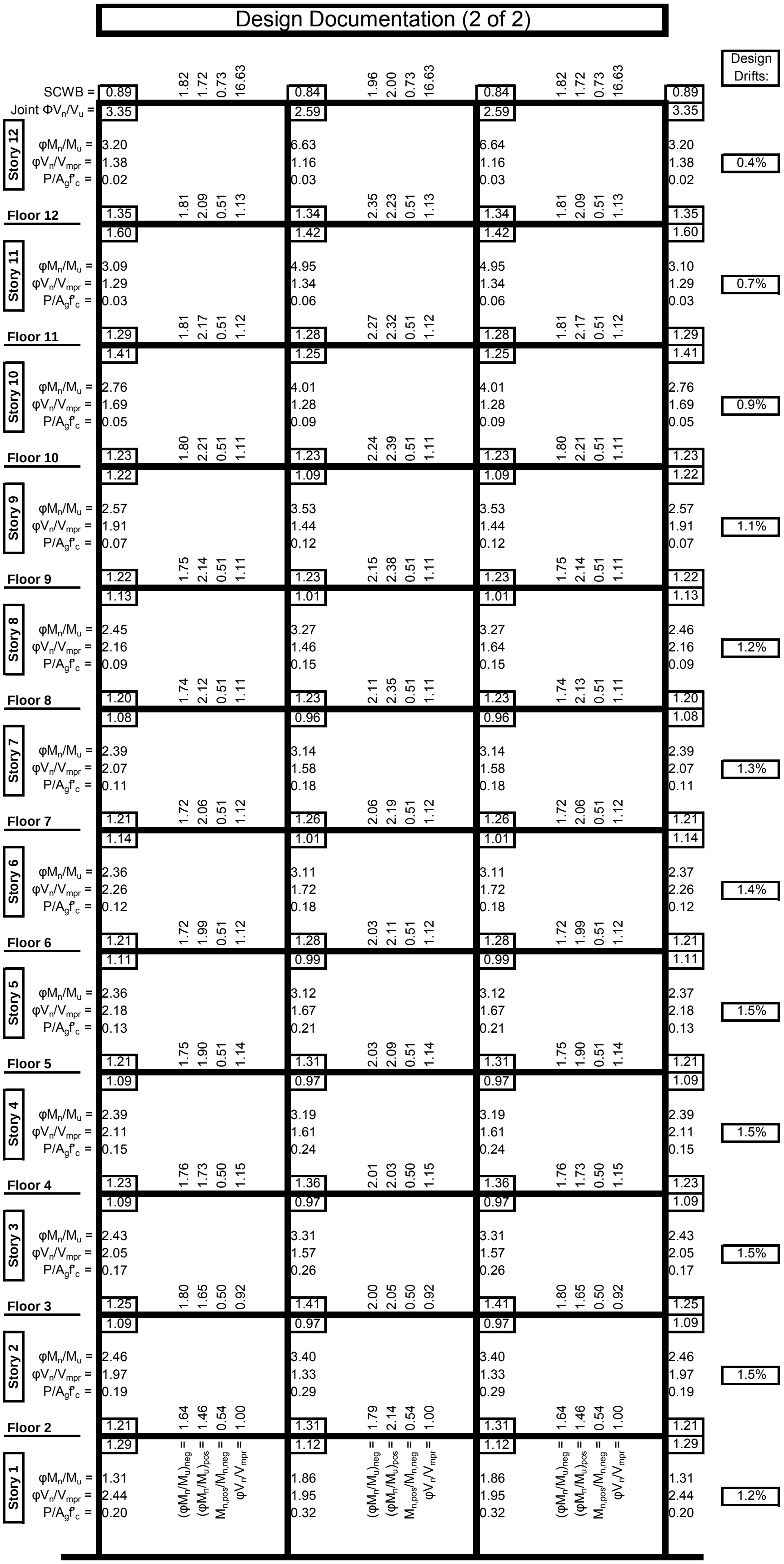
DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Design base shear =	0.044	g,	123	k

f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	7.0	ksi


Design Documentation (2 of 2)
Design Drifts:
SCWB = 0.89 | 0.84 | 0.84 | 0.89
Joint ΦVn/Vu = 3.35 | 2.59 | 2.59 | 3.35
1.82 1.72 0.73 16.63 | 1.96 2.00 0.73 16.63 | 1.82 1.72 0.73 16.63
Story 12
φMn/Mu = 3.20 | 6.63 | 6.64 | 3.20
φVn/Vmpr = 1.38 | 1.16 | 1.16 | 1.38
P/Agf'c = 0.02 | 0.03 | 0.03 | 0.02
0.4%
1.81 2.09 0.51 1.13 | 2.35 2.23 0.51 1.13 | 1.81 2.09 0.51 1.13
Floor 12
1.35 | 1.34 | 1.34 | 1.35
1.60 | 1.42 | 1.42 | 1.60
Story 11
φMn/Mu = 3.09 | 4.95 | 4.95 | 3.10
φVn/Vmpr = 1.29 | 1.34 | 1.34 | 1.29
P/Agf'c = 0.03 | 0.06 | 0.06 | 0.03
0.7%
1.81 2.17 0.51 1.12 | 2.27 2.32 0.51 1.12 | 1.81 2.17 0.51 1.12
Floor 11
1.29 | 1.28 | 1.28 | 1.29
1.41 | 1.25 | 1.25 | 1.41
Story 10
φMn/Mu = 2.76 | 4.01 | 4.01 | 2.76
φVn/Vmpr = 1.69 | 1.28 | 1.28 | 1.69
P/Agf'c = 0.05 | 0.09 | 0.09 | 0.05
0.9%
1.80 2.21 0.51 1.11 | 2.24 2.39 0.51 1.11 | 1.80 2.21 0.51 1.11
Floor 10
1.23 | 1.23 | 1.23 | 1.23
1.22 | 1.09 | 1.09 | 1.22
Story 9
φMn/Mu = 2.57 | 3.53 | 3.53 | 2.57
φVn/Vmpr = 1.91 | 1.44 | 1.44 | 1.91
P/Agf'c = 0.07 | 0.12 | 0.12 | 0.07
1.1%
1.75 2.14 0.51 1.11 | 2.15 2.38 0.51 1.11 | 1.75 2.14 0.51 1.11
Floor 9
1.22 | 1.23 | 1.23 | 1.22
1.13 | 1.01 | 1.01 | 1.13
Story 8
φMn/Mu = 2.45 | 3.27 | 3.27 | 2.46
φVn/Vmpr = 2.16 | 1.46 | 1.64 | 2.16
P/Agf'c = 0.09 | 0.15 | 0.15 | 0.09
1.2%
1.74 2.12 0.51 1.11 | 2.11 2.35 0.51 1.11 | 1.74 2.13 0.51 1.11
Floor 8
1.20 | 1.23 | 1.23 | 1.20
1.08 | 0.96 | 0.96 | 1.08
Story 7
φMn/Mu = 2.39 | 3.14 | 3.14 | 2.39
φVn/Vmpr = 2.07 | 1.58 | 1.58 | 2.07
P/Agf'c = 0.11 | 0.18 | 0.18 | 0.11
1.3%
1.72 2.06 0.51 1.12 | 2.06 2.19 0.51 1.12 | 1.72 2.06 0.51 1.12
Floor 7
1.21 | 1.26 | 1.26 | 1.21
1.14 | 1.01 | 1.01 | 1.14
Story 6
φMn/Mu = 2.36 | 3.11 | 3.11 | 2.37
φVn/Vmpr = 2.26 | 1.72 | 1.72 | 2.26
P/Agf'c = 0.12 | 0.18 | 0.18 | 0.12
1.4%
1.72 1.99 0.51 1.12 | 2.03 2.11 0.51 1.12 | 1.72 1.99 0.51 1.12
Floor 6
1.21 | 1.28 | 1.28 | 1.21
1.11 | 0.99 | 0.99 | 1.11
Story 5
φMn/Mu = 2.36 | 3.12 | 3.12 | 2.37
φVn/Vmpr = 2.18 | 1.67 | 1.67 | 2.18
P/Agf'c = 0.13 | 0.21 | 0.21 | 0.13
1.5%
1.75 1.90 0.51 1.14 | 2.03 2.09 0.51 1.14 | 1.75 1.90 0.51 1.14
Floor 5
1.21 | 1.31 | 1.31 | 1.21
1.09 | 0.97 | 0.97 | 1.09
Story 4
φMn/Mu = 2.39 | 3.19 | 3.19 | 2.39
φVn/Vmpr = 2.11 | 1.61 | 1.61 | 2.11
P/Agf'c = 0.15 | 0.24 | 0.24 | 0.15
1.5%
1.76 1.73 0.50 1.15 | 2.01 2.03 0.50 1.15 | 1.76 1.73 0.50 1.15
Floor 4
1.23 | 1.36 | 1.36 | 1.23
1.09 | 0.97 | 0.97 | 1.09
Story 3
φMn/Mu = 2.43 | 3.31 | 3.31 | 2.43
φVn/Vmpr = 2.05 | 1.57 | 1.57 | 2.05
P/Agf'c = 0.17 | 0.26 | 0.26 | 0.17
1.5%
1.80 1.65 0.50 0.92 | 2.00 2.05 0.50 0.92 | 1.80 1.65 0.50 0.92
Floor 3
1.25 | 1.41 | 1.41 | 1.25
1.09 | 0.97 | 0.97 | 1.09
Story 2
φMn/Mu = 2.46 | 3.40 | 3.40 | 2.46
φVn/Vmpr = 1.97 | 1.33 | 1.33 | 1.97
P/Agf'c = 0.19 | 0.29 | 0.29 | 0.19
1.5%
1.64 1.46 0.54 1.00 | 1.79 2.14 0.54 1.00 | 1.64 1.46 0.54 1.00
Floor 2
1.21 | 1.31 | 1.31 | 1.21
1.29 | 1.12 | 1.12 | 1.29
(φMn/Mu)neg =
(φMn/Mu)pos =
Mn,pos/Mn,neg =
φVn/Vmpr =
Story 1
φMn/Mu = 1.31 | 1.86 | 1.86 | 1.31
φVn/Vmpr = 2.44 | 1.95 | 1.95 | 2.44
P/Agf'c = 0.20 | 0.32 | 0.32 | 0.20
1.2%

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	7234	9681	9681	7234
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.078	0.088	0.088	0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	110	114	114	110
	$(P/A_gf'_c)_{exp}$ =	0.01	0.02	0.02	0.01
Story 11	$M_{y,exp}$ (k-in) =	7587	10367	10367	7587
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.077	0.078	0.078	0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	108	105	105	108
	$(P/A_gf'_c)_{exp}$ =	0.02	0.04	0.04	0.02
Story 10	$M_{y,exp}$ (k-in) =	7936	11043	11043	7936
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.075	0.075	0.075	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	102	102	106
	$(P/A_gf'_c)_{exp}$ =	0.03	0.07	0.07	0.03
Story 9	$M_{y,exp}$ (k-in) =	8282	11709	11709	8282
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.074	0.072	0.072	0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	99	99	105
	$(P/A_gf'_c)_{exp}$ =	0.04	0.09	0.09	0.04
Story 8	$M_{y,exp}$ (k-in) =	8625	12366	12366	8625
	EI_{stf}/EI_g =	0.35	0.38	0.38	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.072	0.060	0.069	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	86	96	103
	$(P/A_gf'_c)_{exp}$ =	0.06	0.11	0.11	0.06
Story 7	$M_{y,exp}$ (k-in) =	8965	13015	13015	8965
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.071	0.066	0.066	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	93	93	102
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 6	$M_{y,exp}$ (k-in) =	9334	13705	13705	9334
	EI_{stf}/EI_g =	0.35	0.40	0.40	0.35
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.075	0.070	0.070	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	107	98	98	107
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 5	$M_{y,exp}$ (k-in) =	9671	14343	14343	9671
	EI_{stf}/EI_g =	0.35	0.42	0.42	0.35
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.073	0.067	0.067	0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	106	96	96	106
	$(P/A_gf'_c)_{exp}$ =	0.08	0.15	0.15	0.08
Story 4	$M_{y,exp}$ (k-in) =	10005	14975	14975	10005
	EI_{stf}/EI_g =	0.36	0.44	0.44	0.36
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.072	0.065	0.065	0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	105	94	94	105
	$(P/A_gf'_c)_{exp}$ =	0.09	0.17	0.17	0.09
Story 3	$M_{y,exp}$ (k-in) =	10337	15601	15601	10337
	EI_{stf}/EI_g =	0.37	0.46	0.46	0.37
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.071	0.063	0.063	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	103	91	91	103
	$(P/A_gf'_c)_{exp}$ =	0.10	0.19	0.19	0.10
Story 2	$M_{y,exp}$ (k-in) =	10825	16220	16220	10825
	EI_{stf}/EI_g =	0.38	0.48	0.48	0.38
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.070	0.060	0.060	0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	102	89	89	102
	$(P/A_gf'_c)_{exp}$ =	0.11	0.21	0.21	0.11
Story 1	$M_{y,exp}$ (k-in) =	8293	11440	11440	8293
	EI_{stf}/EI_g =	0.39	0.50	0.50	0.39
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.064	0.051	0.051	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	101	87	87	101
	$(P/A_gf'_c)_{exp}$ =	0.12	0.23	0.23	0.12

Floor 13	$M_{y,pos,exp}$(k-in) =	3175	3175	3175
	$M_{y,n,slab,exp}$(k-in) =	-8021	-8021	-8021
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.0336	0.0336	0.0336
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.052	-0.052	-0.052
	Θ_{pc} (rad) =	0.089	0.089	0.089
	λ =	99	99	99
Floor 12	$M_{y,pos,exp}$(k-in) =	3648	3648	3648
	$M_{y,n,slab,exp}$(k-in) =	-10732	-10732	-10732
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.043	0.043	0.043
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.070	-0.070	-0.070
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 11	$M_{y,pos,exp}$(k-in) =	4121	4121	4121
	$M_{y,n,slab,exp}$(k-in) =	-11633	-11633	-11633
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 10	$M_{y,pos,exp}$(k-in) =	4594	4594	4594
	$M_{y,n,slab,exp}$(k-in) =	-12532	-12532	-12532
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.044	0.044	0.044
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 9	$M_{y,pos,exp}$(k-in) =	4830	4830	4830
	$M_{y,n,slab,exp}$(k-in) =	-12981	-12981	-12981
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.045	0.045
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.072	-0.072	-0.072
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 8	$M_{y,pos,exp}$(k-in) =	5065	5065	5065
	$M_{y,n,slab,exp}$(k-in) =	-13429	-13429	-13429
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.073	-0.073	-0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 7	$M_{y,pos,exp}$(k-in) =	5183	5183	5183
	$M_{y,n,slab,exp}$(k-in) =	-13653	-13653	-13653
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0469	0.0469
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 6	$M_{y,pos,exp}$(k-in) =	5301	5301	5301
	$M_{y,n,slab,exp}$(k-in) =	-13877	-13877	-13877
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0474	0.0474
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.074	-0.074	-0.074
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	99	99	99
Floor 5	$M_{y,pos,exp}$(k-in) =	5418	5418	5418
	$M_{y,n,slab,exp}$(k-in) =	-14101	-14101	-14101
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.0501	0.0501
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.078	-0.078	-0.078
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 4	$M_{y,pos,exp}$(k-in) =	5301	5301	5301
	$M_{y,n,slab,exp}$(k-in) =	-14098	-14098	-14098
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.050	0.05	0.05
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 3	$M_{y,pos,exp}$(k-in) =	5301	5301	5301
	$M_{y,n,slab,exp}$(k-in) =	-14098	-14098	-14098
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.048	0.0476	0.0476
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.075	-0.075	-0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 2	$M_{y,pos,exp}$(k-in) =	4830	4830	4830
	$M_{y,n,slab,exp}$(k-in) =	-12537	-12537	-12537
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in²/rad) =	1.522E+08	1.522E+08	1.522E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.047	0.047
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.073	-0.073	-0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 1.92 T_2 = 0.63 T_3 = 0.37

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC
Building Design ID: 2068
Number of Stories: 12
Fundamental Period (sec): 2.09

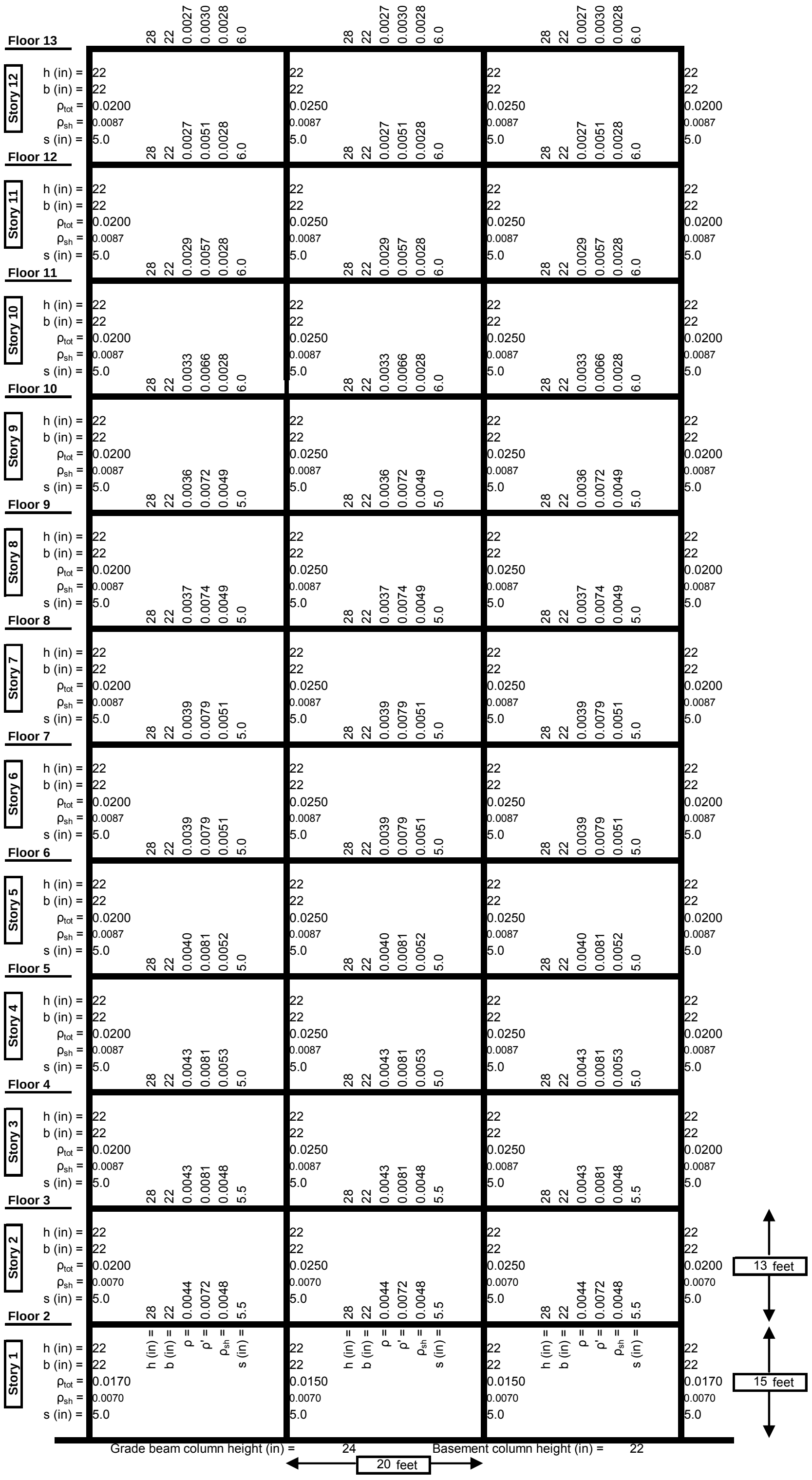
SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

2068 Perimeter Frame, 80% Weak Story in first story only

This design was created using design ID 1018 as the baseline. Design ID 1018 had the first two stories weak, and this design is intended to have only the first story weak. Therefore, to make this design, we strengthened the second story columns and the first above ground beam. We based the 80% ratio of story strengths on the strengths computed only from the columns of the first and second stories, assuming both column ends hinged. Even with the weak story, this design is fully code conforming. The bottom story exterior columns were controlled by flexural.

DESIGN AND MODELING DOCUMENTATION FIGURES

Design Documentation (1 of 2)



Story	h (in) =	b (in) =	ρ_{tot} =	ρ_{sh} =	s (in) =
Story 12	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 11	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 10	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 9	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 8	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 7	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 6	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 5	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 4	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 3	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0087 0.0087 0.0087 0.0087	5.0 5.0 5.0 5.0
Story 2	22 22 22 22	22 22 22 22	0.0200 0.0250 0.0250 0.0200	0.0070 0.0070 0.0070 0.0070	5.0 5.0 5.0 5.0
Story 1	22 22 22 22	22 22 22 22	0.0170 0.0150 0.0150 0.0170	0.0070 0.0070 0.0070 0.0070	5.0 5.0 5.0 5.0

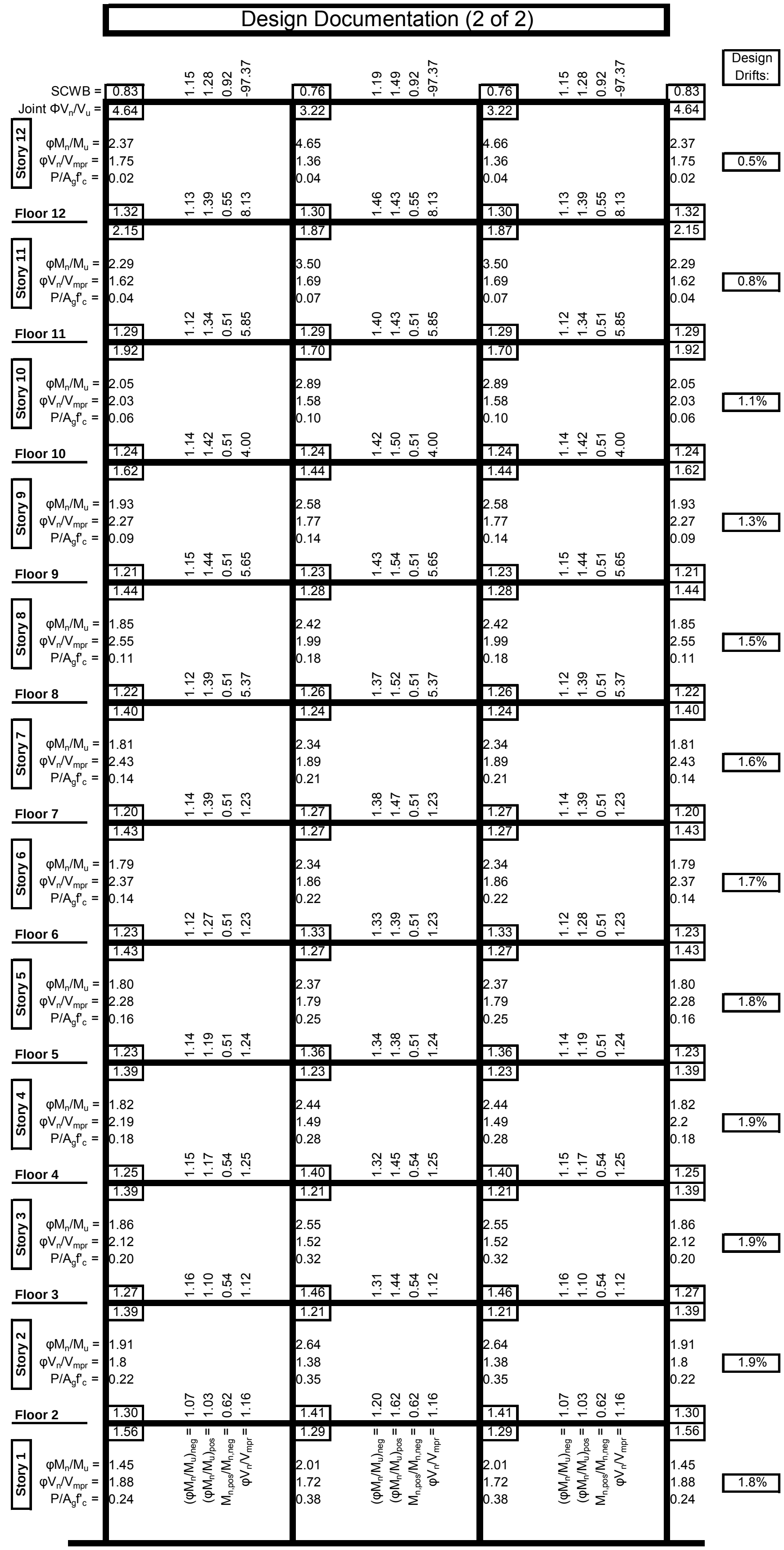
Floor	h (in) =	b (in) =	ρ =	ρ' =	ρ_{sh} =	s (in) =
Floor 13	28 28 28	22 22 22	0.0027 0.0027 0.0027	0.0030 0.0030 0.0030	0.0028 0.0028 0.0028	6.0 6.0 6.0
Floor 12	28 28 28	22 22 22	0.0027 0.0027 0.0027	0.0051 0.0051 0.0051	0.0028 0.0028 0.0028	6.0 6.0 6.0
Floor 11	28 28 28	22 22 22	0.0029 0.0029 0.0029	0.0057 0.0057 0.0057	0.0028 0.0028 0.0028	6.0 6.0 6.0
Floor 10	28 28 28	22 22 22	0.0033 0.0033 0.0033	0.0066 0.0066 0.0066	0.0028 0.0028 0.0028	6.0 6.0 6.0
Floor 9	28 28 28	22 22 22	0.0036 0.0036 0.0036	0.0072 0.0072 0.0072	0.0049 0.0049 0.0049	5.0 5.0 5.0
Floor 8	28 28 28	22 22 22	0.0037 0.0037 0.0037	0.0074 0.0074 0.0074	0.0049 0.0049 0.0049	5.0 5.0 5.0
Floor 7	28 28 28	22 22 22	0.0039 0.0039 0.0039	0.0079 0.0079 0.0079	0.0051 0.0051 0.0051	5.0 5.0 5.0
Floor 6	28 28 28	22 22 22	0.0039 0.0039 0.0039	0.0079 0.0079 0.0079	0.0051 0.0051 0.0051	5.0 5.0 5.0
Floor 5	28 28 28	22 22 22	0.0040 0.0040 0.0040	0.0081 0.0081 0.0081	0.0052 0.0052 0.0052	5.0 5.0 5.0
Floor 4	28 28 28	22 22 22	0.0043 0.0043 0.0043	0.0081 0.0081 0.0081	0.0053 0.0053 0.0053	5.0 5.0 5.0
Floor 3	28 28 28	22 22 22	0.0043 0.0043 0.0043	0.0081 0.0081 0.0081	0.0048 0.0048 0.0048	5.5 5.5 5.5
Floor 2	28 28 28	22 22 22	0.0044 0.0044 0.0044	0.0072 0.0072 0.0072	0.0048 0.0048 0.0048	5.5 5.5 5.5

Grade beam column height (in) = 24

Basement column height (in) = 22

Design base shear =	0.044	g,	123	k	
f'_c beams =	5.0	ksi	$f'_{c,cols,upper}$ =	6.0	ksi
$f_{y,rebar,nom.}$ =	60	ksi	$f'_{c,cols,lower}$ =	7.0	ksi

Design Documentation (2 of 2)



									Design Drifts:
	SCWB =	0.83	1.15 1.28 0.92 -97.37	0.76	1.19 1.49 0.92 -97.37	0.76	1.15 1.28 0.92 -97.37	0.83	
	Joint $\Phi V_n/V_u$ =	4.64		3.22		3.22		4.64	
Story 12	$\phi M_n/M_u$ =	2.37		4.65		4.66		2.37	
	$\phi V_n/V_{mpr}$ =	1.75		1.36		1.36		1.75	0.5%
	$P/A_gf'_c$ =	0.02		0.04		0.04		0.02	
Floor 12		1.32	1.13 1.39 0.55 8.13	1.30	1.46 1.43 0.55 8.13	1.30	1.13 1.39 0.55 8.13	1.32	
		2.15		1.87		1.87		2.15	
Story 11	$\phi M_n/M_u$ =	2.29		3.50		3.50		2.29	
	$\phi V_n/V_{mpr}$ =	1.62		1.69		1.69		1.62	0.8%
	$P/A_gf'_c$ =	0.04		0.07		0.07		0.04	
Floor 11		1.29	1.12 1.34 0.51 5.85	1.29	1.40 1.43 0.51 5.85	1.29	1.12 1.34 0.51 5.85	1.29	
		1.92		1.70		1.70		1.92	
Story 10	$\phi M_n/M_u$ =	2.05		2.89		2.89		2.05	
	$\phi V_n/V_{mpr}$ =	2.03		1.58		1.58		2.03	1.1%
	$P/A_gf'_c$ =	0.06		0.10		0.10		0.06	
Floor 10		1.24	1.14 1.42 0.51 4.00	1.24	1.42 1.50 0.51 4.00	1.24	1.14 1.42 0.51 4.00	1.24	
		1.62		1.44		1.44		1.62	
Story 9	$\phi M_n/M_u$ =	1.93		2.58		2.58		1.93	
	$\phi V_n/V_{mpr}$ =	2.27		1.77		1.77		2.27	1.3%
	$P/A_gf'_c$ =	0.09		0.14		0.14		0.09	
Floor 9		1.21	1.15 1.44 0.51 5.65	1.23	1.43 1.54 0.51 5.65	1.23	1.15 1.44 0.51 5.65	1.21	
		1.44		1.28		1.28		1.44	
Story 8	$\phi M_n/M_u$ =	1.85		2.42		2.42		1.85	
	$\phi V_n/V_{mpr}$ =	2.55		1.99		1.99		2.55	1.5%
	$P/A_gf'_c$ =	0.11		0.18		0.18		0.11	
Floor 8		1.22	1.12 1.39 0.51 5.37	1.26	1.37 1.52 0.51 5.37	1.26	1.12 1.39 0.51 5.37	1.22	
		1.40		1.24		1.24		1.40	
Story 7	$\phi M_n/M_u$ =	1.81		2.34		2.34		1.81	
	$\phi V_n/V_{mpr}$ =	2.43		1.89		1.89		2.43	1.6%
	$P/A_gf'_c$ =	0.14		0.21		0.21		0.14	
Floor 7		1.20	1.14 1.39 0.51 1.23	1.27	1.38 1.47 0.51 1.23	1.27	1.14 1.39 0.51 1.23	1.20	
		1.43		1.27		1.27		1.43	
Story 6	$\phi M_n/M_u$ =	1.79		2.34		2.34		1.79	
	$\phi V_n/V_{mpr}$ =	2.37		1.86		1.86		2.37	1.7%
	$P/A_gf'_c$ =	0.14		0.22		0.22		0.14	
Floor 6		1.23	1.12 1.27 0.51 1.23	1.33	1.33 1.39 0.51 1.23	1.33	1.12 1.28 0.51 1.23	1.23	
		1.43		1.27		1.27		1.43	
Story 5	$\phi M_n/M_u$ =	1.80		2.37		2.37		1.80	
	$\phi V_n/V_{mpr}$ =	2.28		1.79		1.79		2.28	1.8%
	$P/A_gf'_c$ =	0.16		0.25		0.25		0.16	
Floor 5		1.23	1.14 1.19 0.51 1.24	1.36	1.34 1.38 0.51 1.24	1.36	1.14 1.19 0.51 1.24	1.23	
		1.39		1.23		1.23		1.39	
Story 4	$\phi M_n/M_u$ =	1.82		2.44		2.44		1.82	
	$\phi V_n/V_{mpr}$ =	2.19		1.49		1.49		2.2	1.9%
	$P/A_gf'_c$ =	0.18		0.28		0.28		0.18	
Floor 4		1.25	1.15 1.17 0.54 1.25	1.40	1.32 1.45 0.54 1.25	1.40	1.15 1.17 0.54 1.25	1.25	
		1.39		1.21		1.21		1.39	
Story 3	$\phi M_n/M_u$ =	1.86		2.55		2.55		1.86	
	$\phi V_n/V_{mpr}$ =	2.12		1.52		1.52		2.12	1.9%
	$P/A_gf'_c$ =	0.20		0.32		0.32		0.20	
Floor 3		1.27	1.16 1.10 0.54 1.12	1.46	1.31 1.44 0.54 1.12	1.46	1.16 1.10 0.54 1.12	1.27	
		1.39		1.21		1.21		1.39	
Story 2	$\phi M_n/M_u$ =	1.91		2.64		2.64		1.91	
	$\phi V_n/V_{mpr}$ =	1.8		1.38		1.38		1.8	1.9%
	$P/A_gf'_c$ =	0.22		0.35		0.35		0.22	
Floor 2		1.30	1.07 1.03 0.62 1.16	1.41	1.20 1.62 0.62 1.16	1.41	1.07 1.03 0.62 1.16	1.30	
		1.56	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.29	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.29	$(\phi M_n/M_u)_{neg}$ = $(\phi M_n/M_u)_{pos}$ = $M_{n,pos}/M_{n,neg}$ = $\phi V_n/V_{mpr}$ =	1.56	
Story 1	$\phi M_n/M_u$ =	1.45		2.01		2.01		1.45	
	$\phi V_n/V_{mpr}$ =	1.88		1.72		1.72		1.88	1.8%
	$P/A_gf'_c$ =	0.24		0.38		0.38		0.24	

Modeling Documentation (1 of 1)

Story 12	$M_{y,exp}$ (k-in) =	5375	6903	6903	5375
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.20	1.20	1.20
	$\Theta_{cap,pl}$ (rad) =	0.076	0.078	0.078	0.076
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	93	91	91	93
	$(P/A_gf'_c)_{exp}$ =	0.01	0.03	0.03	0.01
Story 11	$M_{y,exp}$ (k-in) =	5697	7528	7528	5697
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.075	0.074	0.074	0.075
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	91	88	88	91
	$(P/A_gf'_c)_{exp}$ =	0.03	0.05	0.05	0.03
Story 10	$M_{y,exp}$ (k-in) =	6015	8143	8143	6015
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.20	1.19	1.19	1.20
	$\Theta_{cap,pl}$ (rad) =	0.073	0.071	0.071	0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	90	85	85	90
	$(P/A_gf'_c)_{exp}$ =	0.04	0.08	0.08	0.04
Story 9	$M_{y,exp}$ (k-in) =	6329	8747	8747	6329
	EI_{stf}/EI_g =	0.35	0.35	0.35	0.35
	M_c/M_y =	1.19	1.19	1.19	1.19
	$\Theta_{cap,pl}$ (rad) =	0.071	0.067	0.067	0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	88	82	82	88
	$(P/A_gf'_c)_{exp}$ =	0.05	0.11	0.11	0.05
Story 8	$M_{y,exp}$ (k-in) =	6641	9341	9341	6641
	EI_{stf}/EI_g =	0.36	0.43	0.43	0.36
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.069	0.064	0.064	0.069
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	87	79	79	87
	$(P/A_gf'_c)_{exp}$ =	0.07	0.13	0.13	0.07
Story 7	$M_{y,exp}$ (k-in) =	6949	9927	9927	6949
	EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
	M_c/M_y =	1.19	1.18	1.18	1.19
	$\Theta_{cap,pl}$ (rad) =	0.068	0.061	0.061	0.068
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	85	77	77	85
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 6	$M_{y,exp}$ (k-in) =	7282	10549	10549	7282
	EI_{stf}/EI_g =	0.38	0.46	0.46	0.38
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.065	0.058	0.058	0.065
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	85	77	77	85
	$(P/A_gf'_c)_{exp}$ =	0.08	0.16	0.16	0.08
Story 5	$M_{y,exp}$ (k-in) =	7587	11125	11125	7587
	EI_{stf}/EI_g =	0.39	0.48	0.48	0.39
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.064	0.056	0.056	0.064
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	84	74	74	84
	$(P/A_gf'_c)_{exp}$ =	0.09	0.18	0.18	0.09
Story 4	$M_{y,exp}$ (k-in) =	7889	11693	11693	7889
	EI_{stf}/EI_g =	0.40	0.50	0.50	0.40
	M_c/M_y =	1.18	1.17	1.17	1.18
	$\Theta_{cap,pl}$ (rad) =	0.062	0.054	0.054	0.062
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	83	72	72	83
	$(P/A_gf'_c)_{exp}$ =	0.10	0.21	0.21	0.10
Story 3	$M_{y,exp}$ (k-in) =	8189	12255	12255	8189
	EI_{stf}/EI_g =	0.41	0.52	0.52	0.41
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.061	0.051	0.051	0.061
	Θ_{pc} (rad) =	0.100	0.100	0.100	0.100
	λ =	81	70	70	81
	$(P/A_gf'_c)_{exp}$ =	0.11	0.23	0.23	0.11
Story 2	$M_{y,exp}$ (k-in) =	8486	12811	12811	8486
	EI_{stf}/EI_g =	0.42	0.55	0.55	0.42
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.055	0.045	0.045	0.055
	Θ_{pc} (rad) =	0.100	0.093	0.093	0.100
	λ =	80	68	68	80
	$(P/A_gf'_c)_{exp}$ =	0.13	0.25	0.25	0.13
Story 1	$M_{y,exp}$ (k-in) =	8070	10988	10988	8070
	EI_{stf}/EI_g =	0.43	0.57	0.57	0.43
	M_c/M_y =	1.18	1.16	1.16	1.18
	$\Theta_{cap,pl}$ (rad) =	0.052	0.040	0.040	0.052
	Θ_{pc} (rad) =	0.100	0.085	0.085	0.100
	λ =	79	66	66	79
	$(P/A_gf'_c)_{exp}$ =	0.14	0.27	0.27	0.14

Floor 13	$M_{y,pos,exp}$(k-in) =	2463	2463	2463
	$M_{y,n,slab,exp}$(k-in) =	-6375	-6375	-6375
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.053	-0.053	-0.053
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 12	$M_{y,pos,exp}$(k-in) =	2460	2460	2460
	$M_{y,n,slab,exp}$(k-in) =	-8146	-8146	-8146
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.033	0.033	0.033
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.057	-0.057	-0.057
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 11	$M_{y,pos,exp}$(k-in) =	2575	2575	2575
	$M_{y,n,slab,exp}$(k-in) =	-8674	-8674	-8674
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.033	0.033	0.033
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 10	$M_{y,pos,exp}$(k-in) =	2947	2947	2947
	$M_{y,n,slab,exp}$(k-in) =	-9379	-9379	-9379
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.034	0.034	0.034
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.058	-0.058	-0.058
	Θ_{pc} (rad) =	0.096	0.096	0.096
	λ =	99	99	99
Floor 9	$M_{y,pos,exp}$(k-in) =	3224	3224	3224
	$M_{y,n,slab,exp}$(k-in) =	-9906	-9906	-9906
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.077	-0.077	-0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 8	$M_{y,pos,exp}$(k-in) =	3317	3317	3317
	$M_{y,n,slab,exp}$(k-in) =	-10082	-10082	-10082
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.077	-0.077	-0.077
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 7	$M_{y,pos,exp}$(k-in) =	3501	3501	3501
	$M_{y,n,slab,exp}$(k-in) =	-10432	-10432	-10432
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0472	0.0472
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 6	$M_{y,pos,exp}$(k-in) =	3501	3501	3501
	$M_{y,n,slab,exp}$(k-in) =	-10432	-10432	-10432
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.047	0.0472	0.0472
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 5	$M_{y,pos,exp}$(k-in) =	3594	3594	3594
	$M_{y,n,slab,exp}$(k-in) =	-10608	-10608	-10608
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.048	0.0478	0.0478
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 4	$M_{y,pos,exp}$(k-in) =	3778	3778	3778
	$M_{y,n,slab,exp}$(k-in) =	-10611	-10611	-10611
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.049	0.0488	0.0488
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.079	-0.079	-0.079
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	109	109	109
Floor 3	$M_{y,pos,exp}$(k-in) =	3778	3778	3778
	$M_{y,n,slab,exp}$(k-in) =	-10611	-10611	-10611
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.045	0.0449	0.0449
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.073	-0.073	-0.073
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104
Floor 2	$M_{y,pos,exp}$(k-in) =	3908	3908	3908
	$M_{y,n,slab,exp}$(k-in) =	-9897	-9897	-9897
	EI_{stf}/EI_g =	0.35	0.35	0.35
	$EI_{stf,\ w/\ Slab}$ (k-in^2/rad) =	1.471E+08	1.471E+08	1.471E+08
	$(\Theta_{cap,pl})_{pos}$ (rad) =	0.046	0.046	0.046
	$(\Theta_{cap,pl})_{neg}$ (rad) =	-0.071	-0.071	-0.071
	Θ_{pc} (rad) =	0.100	0.100	0.100
	λ =	104	104	104

Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 0.60

Model periods (sec): T_1 = 2.09 T_2 = 0.69 T_3 = 0.40

$f_{y,rebar,expected}$ = 67 ksi

STRUCTURAL DESIGN AND MODELING SUMMARY

Building Type: Special RC Frame, designed per 2003 IBC

Building Design ID: 2069

Number of Stories: 1

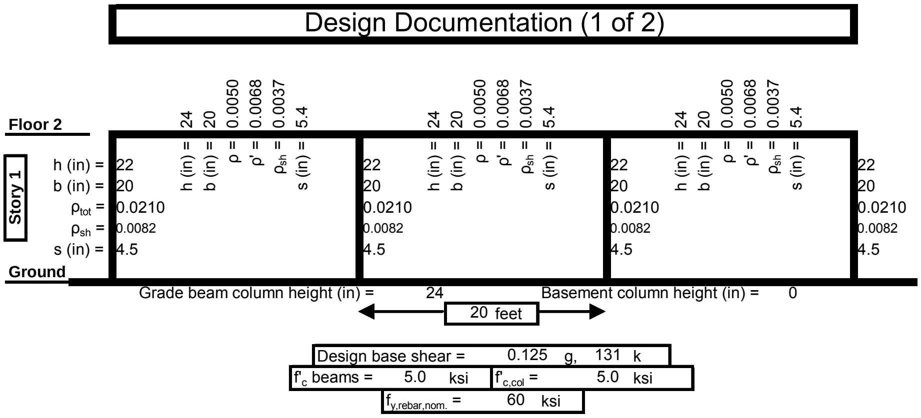
Fundamental Period (sec): 0.71

SUMMARY OF DESIGN DECISIONS AND WHAT CONTROLLED DESIGN

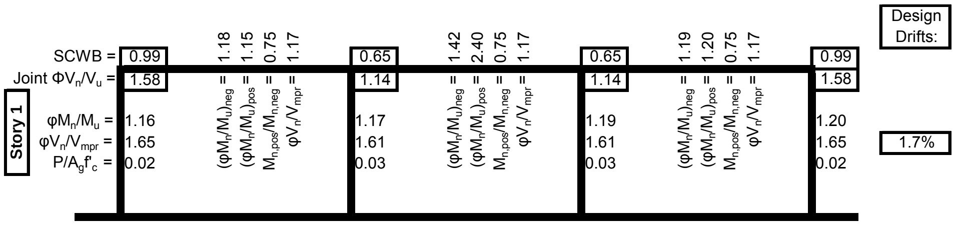
Sizes are controlled by both drift and joint shear, but more drift than joint shear. Beams strength were controlled by force demand, but one beams had additional reinforcement added to keep the same rho ratio between the floors. Column strengths are controlled by flexural demands. Beam stirrups were controlled by the minimum requirement. The column stirrups were controlled by confinement requirement.

The fundamental period is so high for this building because elements are relatively small and the building is a perimeter frame system. The relatively small element sizes from the fact that lateral forces and joint shear demands are smaller compared to taller buildings of this type.

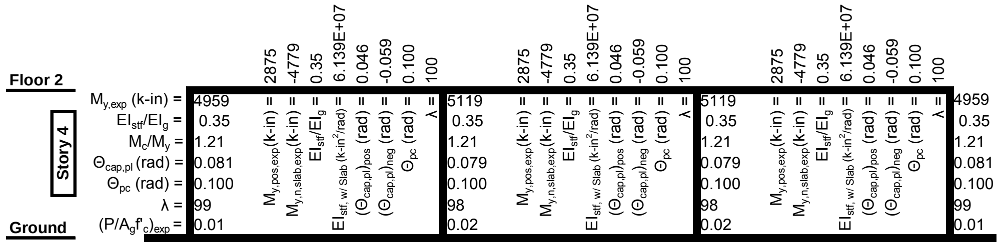
DESIGN AND MODELING DOCUMENTATION FIGURES



Design Documentation (2 of 2)



Modeling Documentation (1 of 1)



Mass tributary to one frame for lateral load (each floor) (k-s-s/in): 2.69

Model periods (sec): T_1 = 0.71 T_2 = 0.42 T_3 = 0.05

$f_{y,rebar,expected}$ = 67 ksi