



# SSM St. Clare Health Center St. Louis County, MO

Technical Report III

Christopher Brandmeier

Advisor: Dr. Linda Hanagan

# Agenda

- General Information and Location
- Floor Plans and Loading
- Typical Bay Geometry
- Floor Systems
  - Composite Steel Framing (Original)
  - Ordinary Steel Framing
  - Two-Way Slab System
  - One-Way Slab System (with intermediate beams)
  - One-Way Slab System (without intermediate beams)
- System Comparison
- Decision Matrix, Criteria
- Conclusion, Questions

# SSM St. Clare Health Center

**Full Height:** 90 feet

**Number of Stories:** 6

**Size:** 427,000 GSF

**Cost:** \$223.5 million

**Dates of Construction:** Sept. 2006 – March 2009

**Project Delivery Method:** Integrated “Lean” Project Delivery

**Owner:** SSM Health Care, St. Louis

**Owner’s Program Manager:** Hammes Company

**Architect of Record:** HGA Architects and Engineers

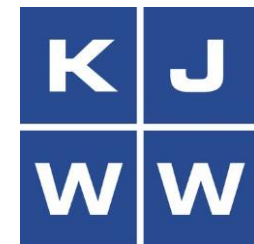
**Associate Architect:** Mackey Mitchel Associates

**Structural Engineers:** HGA Architects and Engineers

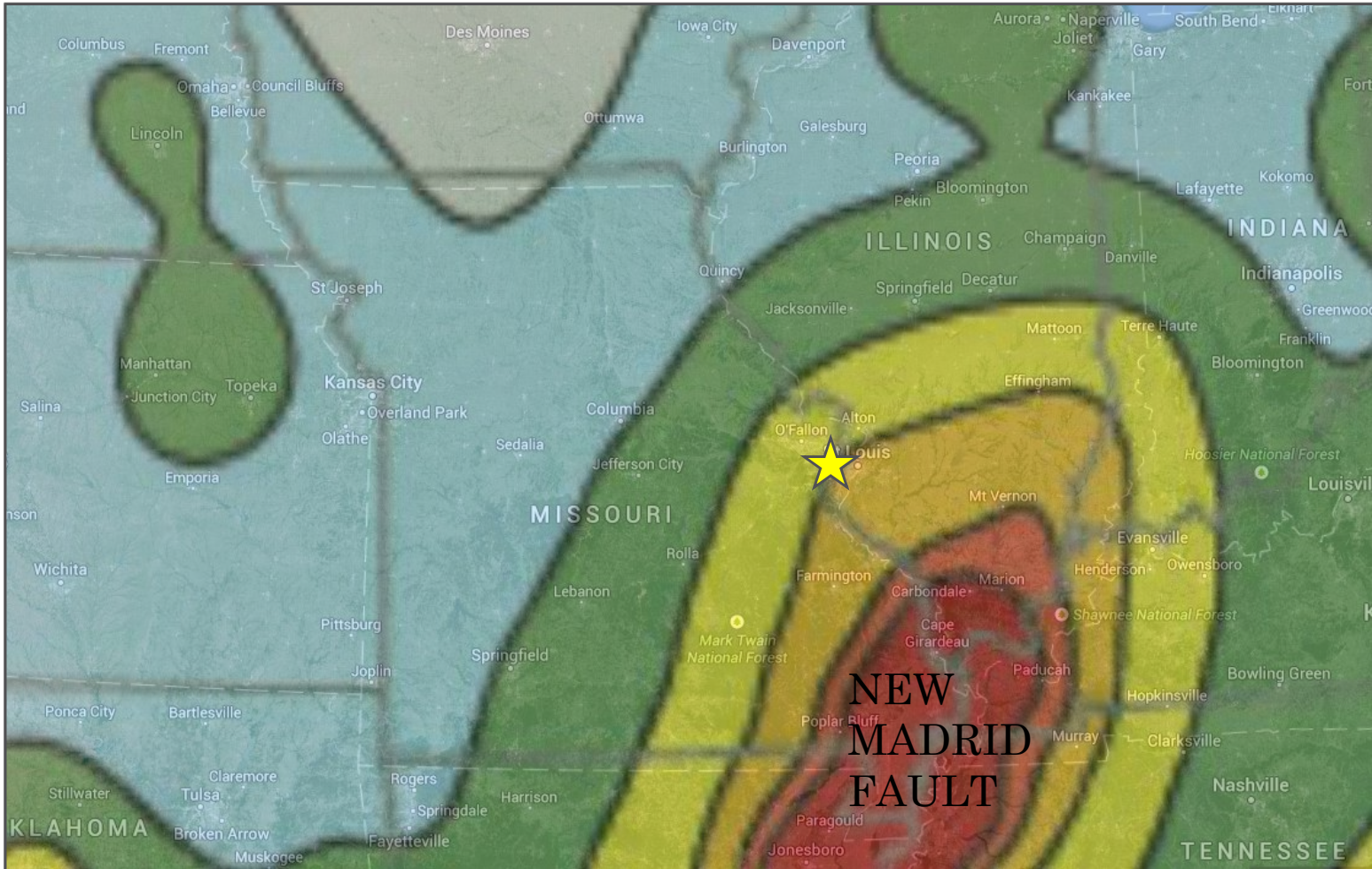
**MEP Engineers:** KJWW Engineering

**Construction Manager:** Alberici Construction

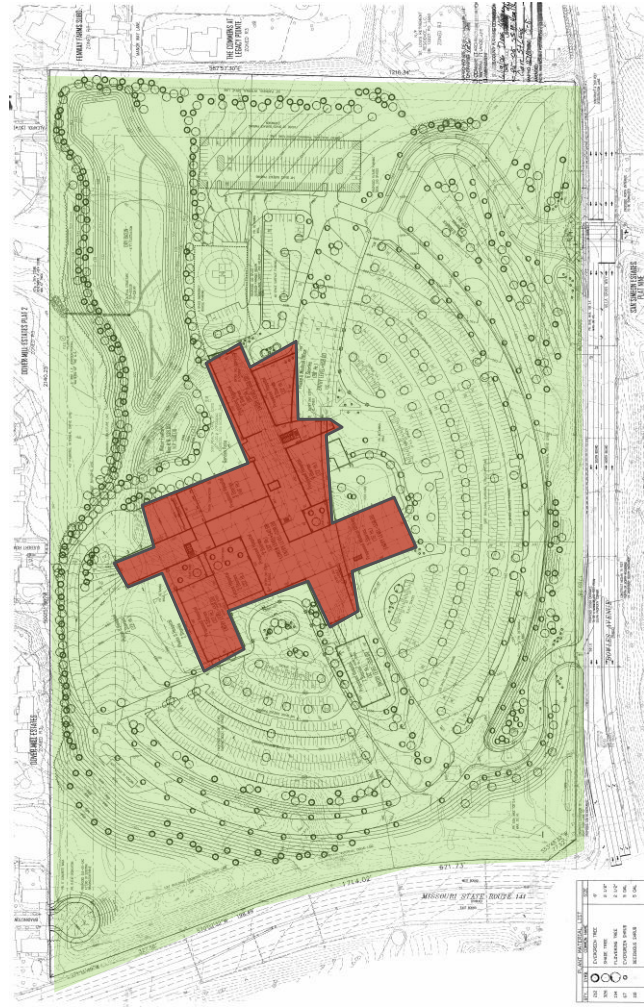
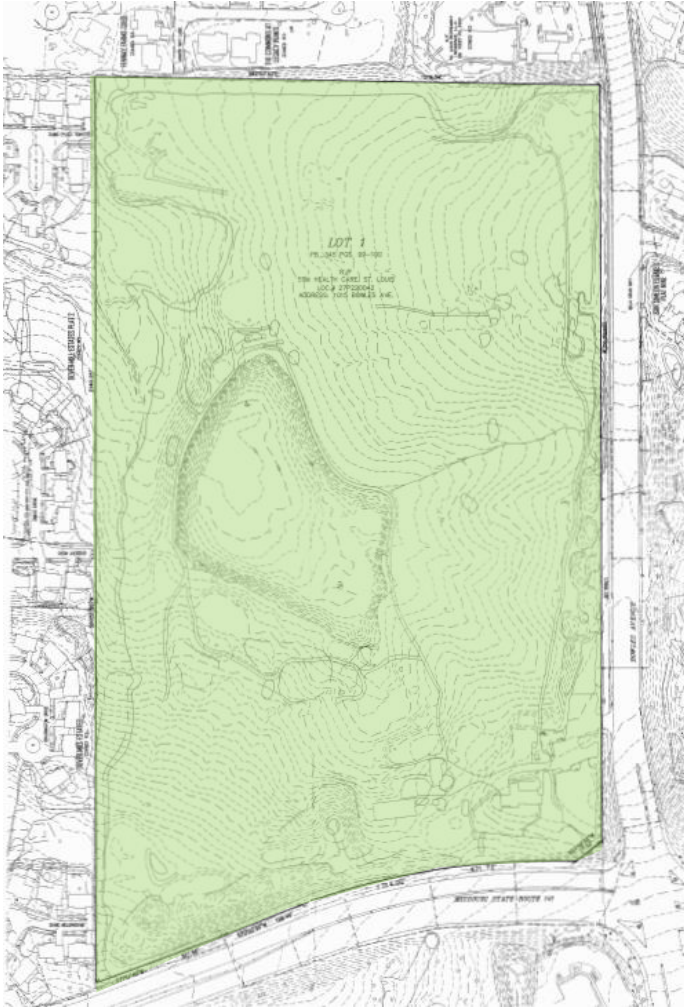
**Elevator Consultants:** Lerch, Bates & Associates Inc.



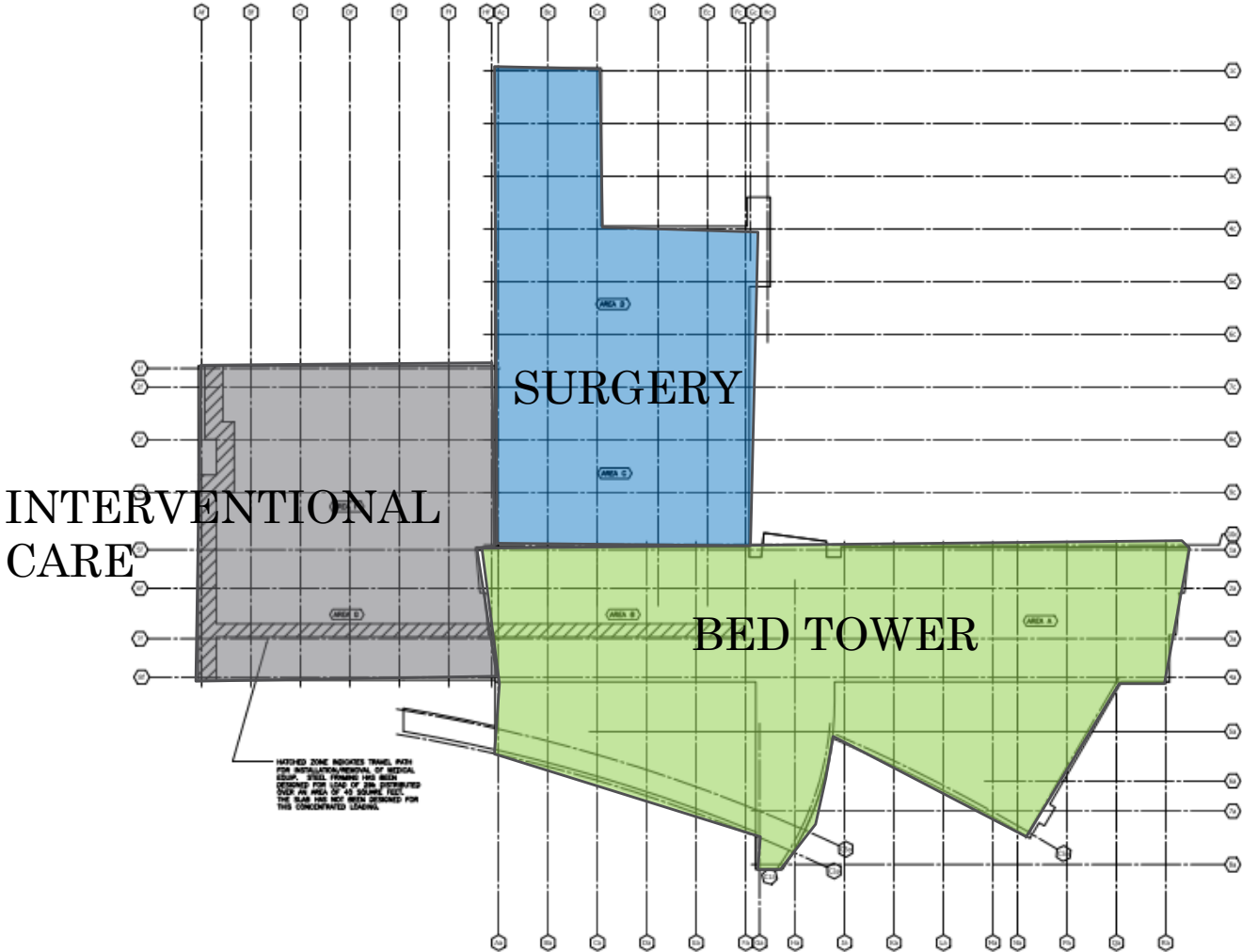
# Location



# Site



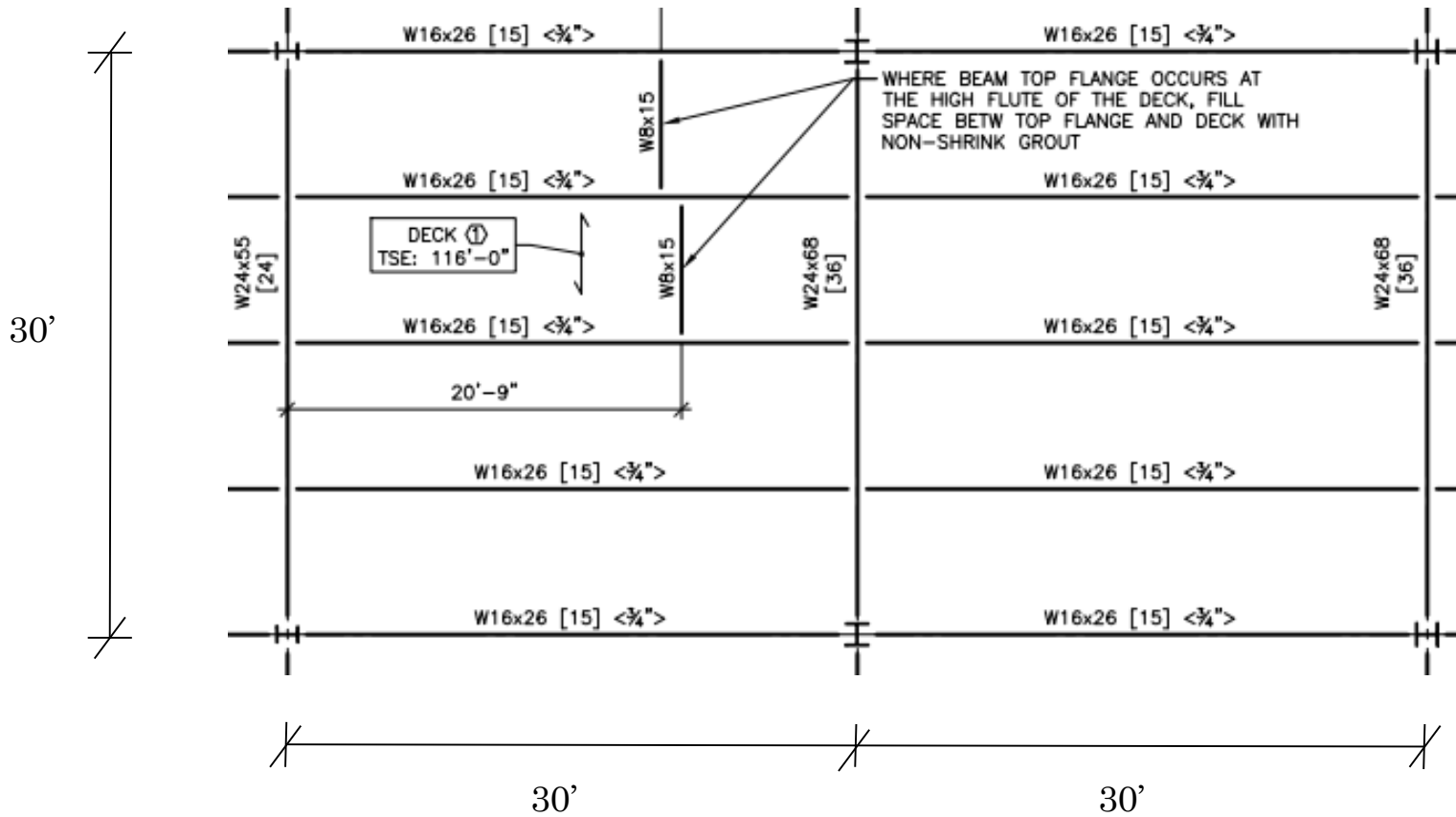
# Expansion Joint Separations



# Bed Tower



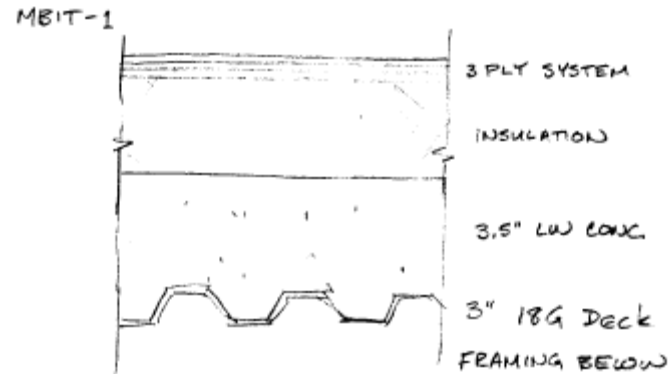
# Typical Bay



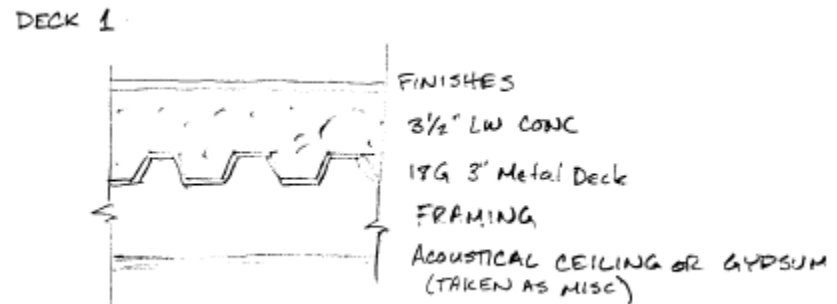


# Gravity Load Conditions

- Live Load
  - 80 psf – Corridor
  - 60 psf – Operating Room
  - 20 psf – Movable partitions
- Dead Load
  - Same floor assembly throughout
  - 64 psf – Hospital Floor
  - 70 psf – Hospital Roof
- Façade Load
  - 51 psf – Brick Cavity Wall
  - 25 psf – Glazing
  - Approximately 30% glazing



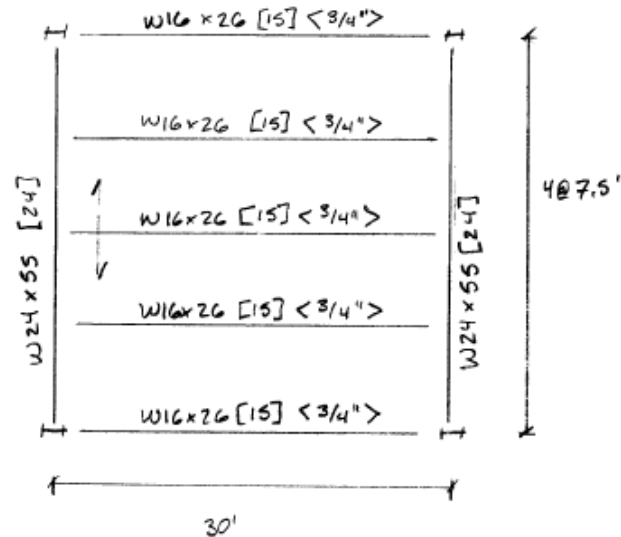
Roof Section



Floor Section

# Composite Steel Framing

- Deck: 3VLI18
  - 3 Span = 14.75' > 7.5'
- Beam: W16x26
  - 166 kft > 79.1 kft
  - 0.48
- Girder: W24x55
  - 574 kft > 250.6 kft
  - 0.44
- Column:
  - Interior: W14x90
    - 979 k > 815 k
    - 0.83
  - Exterior: W14x61
    - 514 k > 505.5 k = Pu
    - 0.98

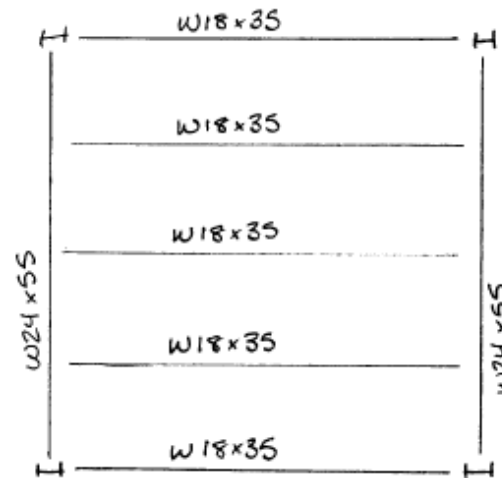


DECK: 3", 18G DECK w/ 3/2" LW CONC TOPPING  
2 HR FIRE RATING  
TYP.

- 50 ksi steel
- 3500 psi concrete

# Non-Composite Steel Framing

- No camber
- Slightly heavier members
- Deck achieves same fire rating
- Same max depth



DECK: 3VL1 2022 DECK w/ 3/2" LW CONC  
2 HR FIRE RATING  
TYP

50 ksi steel  
3500 psi concrete (LW)

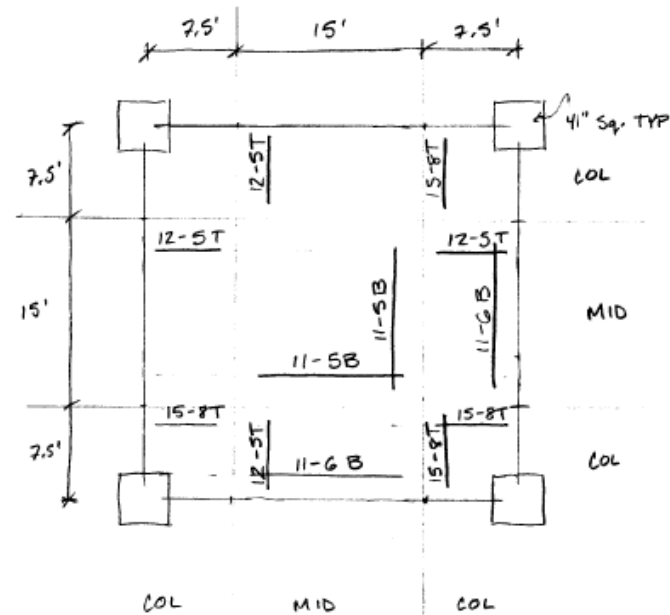
# Two-Way Slab System

FLAT PLATE SYSTEM (WITHOUT SHEARHEADS)													SQUARE EDGE PANEL						SQUARE INTERIOR PANEL						$f'_c = 4,000$ psi Grade 60 Bars		
SPAN c-c Col. 1 $l_1 = l_2$	Factored Superim- posed Load	(1) Min. Square Column			Total Panel Moments			Reinforcing Bars						End Panel			(2) Span c-c (ft)	(3) Load (psf)	(1) Min. Sq. Col. (in.)	Reinforcing Bars				Steel (psf)			
		(in.)	$\gamma_f$	-M Ext.	+M Int.	-M 1st Int.	Each Column Strip		Each Middle Strip		Steel (psf)			Column Strip		Middle Strip				Location of Panel							
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C	Top	Bottom				Top	Bottom	I	IE	IC			
10 in. = TOTAL THICKNESS OF SLAB													0.833 c.f./s.f.						10 in. = TOTAL THICKNESS OF SLAB						0.833 c.f./s.f.		
26	50	20	0.791	102	204	275	12-#5 4	11-#5	13-#6	10-#5	10-#5	2.59	2.61	2.55	26	50	14	17-#5	10-#5	10-#5	10-#5	2.60	2.62	2.64			
26	100	25	0.723	123	247	332	12-#5 4	13-#5	12-#7	10-#5	10-#5	2.84	2.85	2.79	26	100	19	15-#6	10-#5	10-#5	10-#5	2.85	2.87	2.89			
26	150	29	0.696	143	286	385	13-#5 4	11-#6	14-#7	10-#5	10-#5	3.11	3.13	3.13	26	150	25	13-#7	10-#5	10-#5	10-#5	3.06	3.09	3.11			
26	200	34	0.617	161	322	434	14-#5 3	9-#7	12-#8	11-#5	10-#5	3.46	3.48	3.61	26	200	30	12-#8	12-#5	10-#5	10-#5	3.49	3.49	3.49			
26	250	38	0.658	178	355	478	16-#5 5	10-#7	17-#7	9-#6	11-#5	3.81	3.84	4.05	26	250	36	13-#8	9-#6	10-#5	10-#5	3.73	3.74	3.75			
26	300	45	0.610	188	376	507	12-#6 2	14-#6	14-#6	13-#5	11-#5	3.99	4.02	4.20	26	300	45	13-#8	13-#5	10-#5	10-#5	3.78	3.82	3.86			
26	350	52	0.609	196	392	528	17-#5 2	9-#8	15-#8	10-#6	12-#5	4.32	4.37	4.43	26	350	55	14-#8	10-#6	11-#5	10-#5	4.09	4.14	4.19			
27	50	22	0.760	113	227	305	12-#5 4	12-#5	20-#5	10-#5	10-#5	2.60	2.62	2.61	27	50	16	14-#6	10-#5	10-#5	10-#5	2.66	2.66	2.65			
27	100	27	0.710	137	274	369	12-#5 5	11-#6	13-#7	10-#5	10-#5	2.92	2.93	2.91	27	100	21	13-#7	10-#5	10-#5	10-#5	2.93	2.93	2.93			
27	150	32	0.639	159	317	427	14-#5 3	9-#7	12-#8	11-#5	10-#5	3.26	3.28	3.29	27	150	27	19-#6	12-#5	10-#5	10-#5	3.18	3.22	3.26			
27	200	36	0.671	179	358	481	16-#5 5	10-#7	14-#8	9-#6	11-#5	3.69	3.74	3.93	27	200	33	13-#8	9-#6	10-#5	10-#5	3.58	3.62	3.66			
27	250	43	0.610	193	386	520	12-#6 2	11-#7	15-#8	10-#6	12-#5	4.04	4.10	4.26	27	250	42	14-#8	10-#6	11-#5	10-#5	3.87	3.91	3.95			
27	300	51	0.609	204	407	548	13-#6 1	9-#8	16-#8	10-#6	12-#5	4.24	4.31	4.55	27	300	52	14-#8	11-#6	11-#5	10-#5	4.03	4.10	4.18			
27	350	58	0.608	212	423	570	19-#5 1	12-#7	16-#8	11-#6	9-#6	4.47	4.52	4.72	27	350	63	15-#8	11-#6	12-#5	10-#5	4.26	4.30	4.35			
28	50	24	0.743	126	252	339	13-#5 4	13-#5	16-#6	10-#5	10-#5	2.64	2.65	2.63	28	50	17	15-#6	10-#5	10-#5	10-#5	2.63	2.65	2.66			
28	100	29	0.698	151	303	407	13-#5 5	16-#5	15-#7	11-#5	10-#5	3.01	3.03	3.07	28	100	24	14-#7	11-#5	10-#5	10-#5	3.00	3.02	3.04			
28	150	34	0.686	175	350	472	15-#5 6	10-#7	13-#8	12-#5	10-#5	3.42	3.44	3.54	28	150	30	13-#8	13-#5	10-#5	10-#5	3.43	3.43	3.43			
28	200	41	0.611	195	390	525	17-#5 4	11-#7	15-#8	10-#6	12-#5	3.88	3.90	4.03	28	200	37	14-#8	10-#6	11-#5	10-#5	3.70	3.74	3.78			
28	250	48	0.609	209	418	563	13-#6 1	12-#7	16-#8	11-#6	12-#5	4.19	4.24	4.46	28	250	49	15-#8	11-#6	12-#5	10-#5	4.02	4.06	4.09			
28	300	56	0.608	220	440	592	19-#5 3	10-#8	17-#8	11-#6	13-#5	4.40	4.47	4.68	28	300	60	15-#8	11-#6	12-#5	10-#5	4.08	4.15	4.23			
28	350	64	0.607	229	457	616	20-#5 1	10-#8	18-#8	16-#5	10-#6	4.67	4.75	4.93	28	350	70	16-#8	16-#5	12-#5	11-#5	4.33	4.42	4.52			
29	50	26	0.711	139	277	373	13-#5 4	11-#6	13-#7	11-#5	11-#5	2.85	2.86	2.85	29	50	19	13-#7	11-#5	11-#5	11-#5	2.90	2.89	2.89			
29	100	32	0.674	167	333	448	15-#5 5	10-#7	13-#8	12-#5	11-#5	3.29	3.32	3.38	29	100	26	15-#7	12-#5	11-#5	11-#5	3.15	3.19	3.24			
29	150	37	0.638	192	385	518	17-#5 4	20-#5	15-#8	10-#6	11-#5	3.71	3.74	3.82	29	150	33	14-#8	10-#6	11-#5	11-#5	3.62	3.65	3.68			
29	200	45	0.610	212	423	570	19-#5 3	12-#7	16-#8	11-#6	13-#5	4.07	4.12	4.31	29	200	43	15-#8	11-#6	12-#5	11-#5	3.92	3.96	4.00			
29	250	54	0.608	226	451	607	14-#6 3	10-#8	17-#8	16-#5	13-#5	4.34	4.39	4.55	29	250	55	16-#8	16-#5	12-#5	11-#5	4.10	4.14	4.18			
29	300	63	0.607	236	472	635	15-#6 0	11-#8	18-#8	12-#6	10-#6	4.72	4.77	4.94	29	300	67	17-#8	12-#6	13-#5	11-#5	4.40	4.45	4.49			
29	350	71	0.607	245	490	659	16-#6 0	11-#8	19-#8	17-#5	11-#6	4.90	4.97	5.18	29	350	78	17-#8	12-#6	13-#5	11-#5	4.46	4.55	4.65			
30	50	28	0.724	152	305	410	14-#5 6	16-#5	15-#7	11-#5	11-#5	2.92	2.94	2.90	30	50	21	14-#7	11-#5	11-#5	11-#5	2.89	2.91	2.92			
30	100	34	0.665	183	366	492	16-#5 5	14-#6	14-#8	13-#5	11-#5	3.37	3.42	3.55	30	100	28	17-#7	13-#5	11-#5	11-#5	3.29	3.32	3.34			
30	150	41	0.663	210	420	565	19-#5 6	12-#7	16-#8	11-#6	13-#5	3.96	3.97	4.00	30	150	36	15-#8	11-#6	12-#5	11-#5	3.76	3.79	3.83			
30	200	50	0.609	228	457	615	20-#5 5	10-#8	18-#8	16-#5	10-#6	4.19	4.26	4.44	30	200	49	16-#8	16-#5	13-#5	11-#5	3.96	4.03	4.10			
30	250	60	0.608	242	484	652	15-#6 3	11-#8	19-#8	12-#6	10-#6	4.57	4.64	4.81	30	250	62	17-#8	12-#6	13-#5	11-#5	4.22	4.29	4.36			
30	300	69	0.607	254	507	683	16-#6 2	11-#8	20-#8	10-#7	11-#6	4.93	4.99	5.25	30	300	74	18-#8	10-#7	10-#6	12-#5	4.64	4.72	4.79			
30	350	78	0.606	262	523	704	23-#5 1	10-#9	20-#8	10-#7	11-#6	5.16	5.23	5.60	30	350	86	18-#8	10-#7	10-#6	12-#5	4.70	4.78	4.86			

CONCRETE REINFORCING STEEL INSTITUTE

# Two-Way Slab System (Cont.)

- Initial sizing from CRSI
- Use DDM
- 10" thick slab
- 24" max depth
- 41" Columns!
- 4 hour fire rating



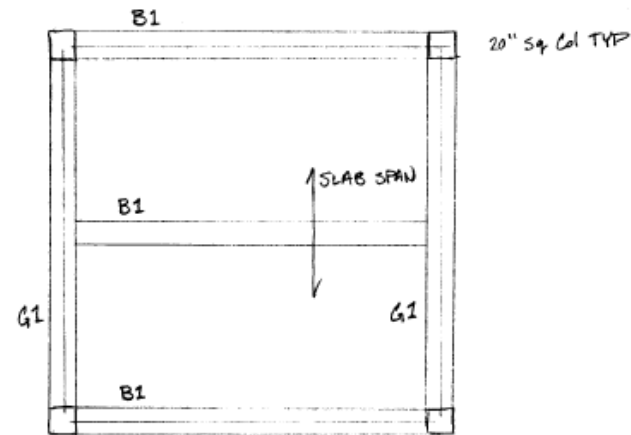
NOTE: All reinforcement sizing was evaluated based on CRSI TABLES

SPAN: 30' x 30'  
SUPERIMPOSED LOAD: 150 psf

4000 psi NW concrete  
60,000 psi steel

# One Way Slab System -with Intermediate Beams

- Span only 15'
- 7.5" thick slab



B1: 20" x 20"

(G) #9 bottom reinforcement, no T action assumed  
#4 stirrups @ 10" o.c.

G1: 20" x 24"

(G) #10 bottom reinforcement, no T action assumed

SLAB: 7.5" SLAB

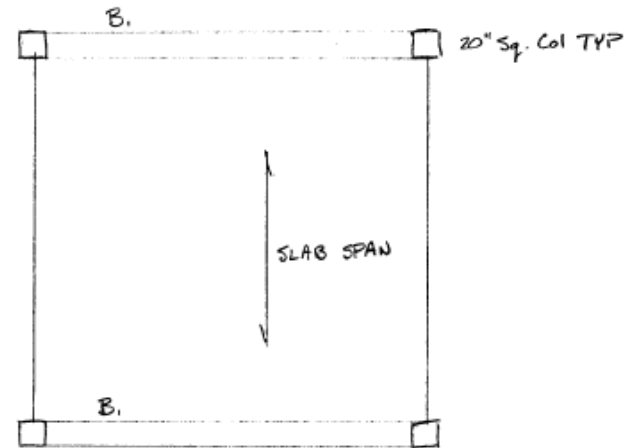
#4 bars @ 6" o.c.

Thermal/Cracking  
#4 bars @ 12" o.c.

4000 psi NW concrete  
60 ksi steel

# One Way Slab System -without Intermediate Beams

- 13" slab
- 24" max depth
- 50" wide beams



B<sub>1</sub>: 50" x 24"

(2) #10 bottom reinforcement, no T action assumed

SLAB: 13" one way flat slab

#9 bars @ 12" O.C.

Thermal/Cracking

#5 bars @ 12" O.C.

4,000 psi NW concrete

60 ksi steel

# System Comparison

Criteria	Composite Steel Framing	Non-Composite Steel Framing	2 Way Flat Plate Slab	1 Way Slab with Intermediate	1 Way Slab
Weight (psf)	53.5	49.5	124.4	127.4	165.3
Depth	24"	24"	10"	24"	24"
Cost	\$14.25 / SF	\$13.43 / SF	\$11.25 / SF	\$13.67 / SF	\$11.72 / SF
Fire Protection	None	None	None	None	None
Fire Rating	2 Hr	2 Hr	4 Hr	4 Hr	4 Hr
Environmental Impact (lbCO <sub>2</sub> /lb)	9107.6	8744.7	6209.7	6349.6	8239.7

## • References

- RS Means 2002
- “Fire and Concrete Structures” (2008 ASCE). D. Bilow.
- “Embodied Carbon of Steel Versus Concrete Buildings” (2013 Cundall). D. Clark and D. Bradley
- Vulcraft Steel Deck Catalogue (2008)



# Decision Matrix

Criteria	Importance Factor	Composite Steel Framing	Non-Composite Steel Framing	2 Way Flat Plate Slab	1 Way Slab with Intermediate	1 Way Slab
Cost	1.50	-1	0	1	0	1
Environmental Impact	1.50	-1	-1	1	1	1
Constructibility	1.00	2	2	2	0	0
Durability	1.00	1	1	1	1	1
Fire Resistivity	1.00	1	1	2	2	2
Weight	0.75	2	2	1	1	0
Vibration Susceptibility	0.75	-1	0	1	1	1
Detailing Intensity (Seismic)	0.50	1	1	-2	-2	-2
		2.25	4.5	8.5	5	5.75

# Thank you.

- Questions?