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Structural Design Option
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Spring Run Assisted Living
10/31/2005

Technical Assignment 2

Executive Summary

Technical Assignment 2 is the pro-con structural study of alternate floor systems. The purpose of this report is to pick various other floor systems other then the one provided and compare the advantages and disadvantages of them. Many different factors are going to be taken into consideration. Some of these factors include; cost, weight, ease of construction, floor-to-floor height, fire ratings, material benefits, and structural benefits. The alternative floor systems are chosen based on typically used systems in low-rise multi dwelling units.

The 6 alternate floor systems analyzed are:

Existing – Hollow core precast planks.

1. Non-composite beam with composite metal deck and slab
2. Open web steel joists with composite metal deck and slab
3. Precast pre-stressed double tees (with interior bearing wall removed)
4. Precast pre-stressed double tees (with existing bay size)
5. One way concrete joist system (with interior bearing wall removed)
6. One way concrete joist system (with existing bay size)

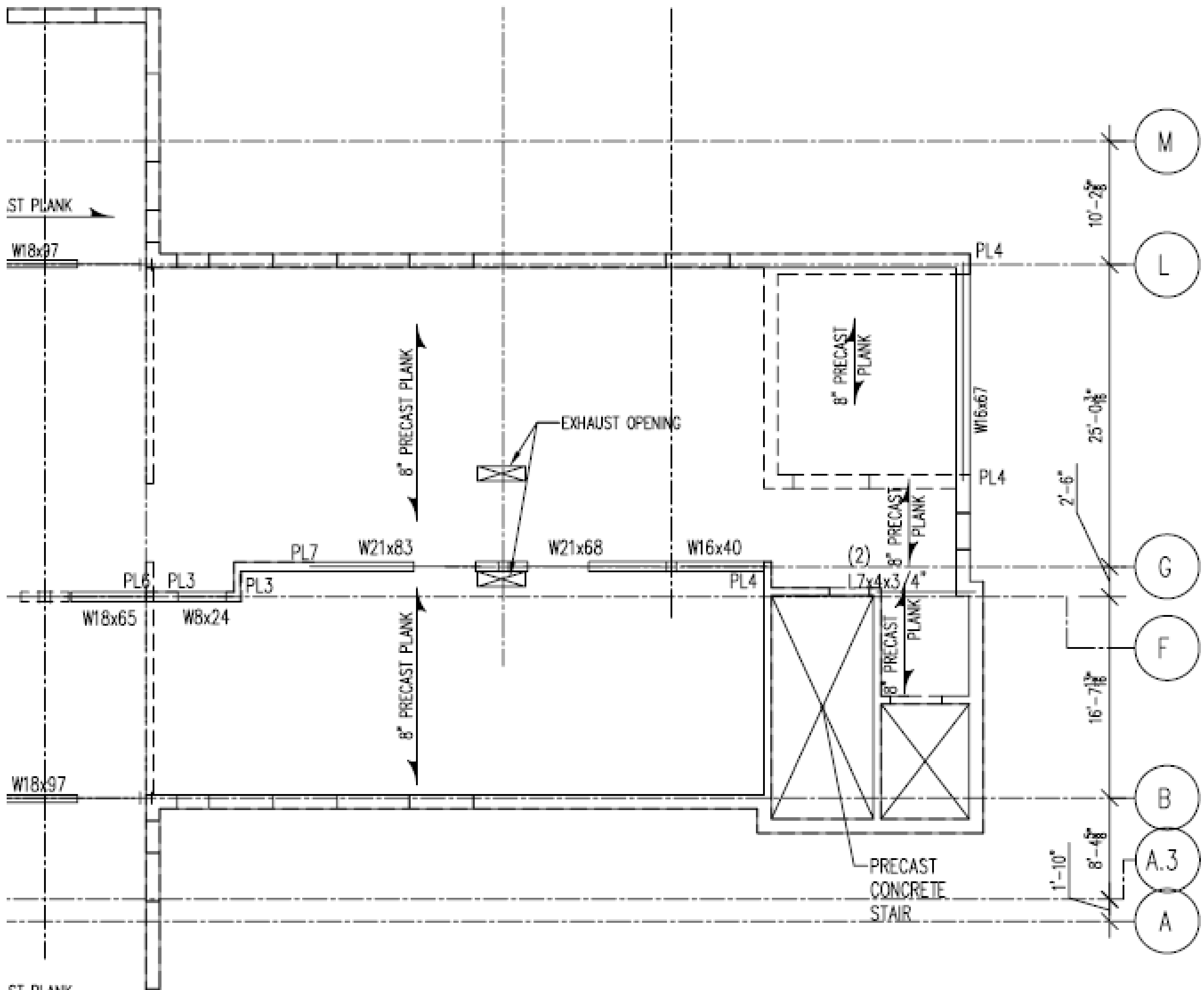
It was concluded that the existing floor system is the most efficient for the building design because of the follow:

1. Fire rating was not achieved by systems 1 and 2
2. All the alternate systems increase the building height.
3. System 5 had a much higher dead load for the slab.
4. System 2 may have large vibrations which will affect serviceability.

2 Existing Floor System

Technical Assignment 2 is the pro-con structural study of alternate floor systems. The purpose of this report is to pick various other floor systems other then the one provided and compare the advantages and disadvantages of them. Many different factors are going to be taken into consideration. Some of these factors include; cost, weight, ease of construction, floor-to-floor height, fire ratings, material benefits, and structural benefits. The alternative floor systems are chosen based on typically used systems in low-rise multi dwelling units.

The chosen alternate floor systems are going to be analyzed for a typical bay within the existing building. They will then be compared to the existing designed floor system and an analysis of whether further investigation into the use of those floor systems will be feasible.



Section of Structural Floor Plan to be Analyzed

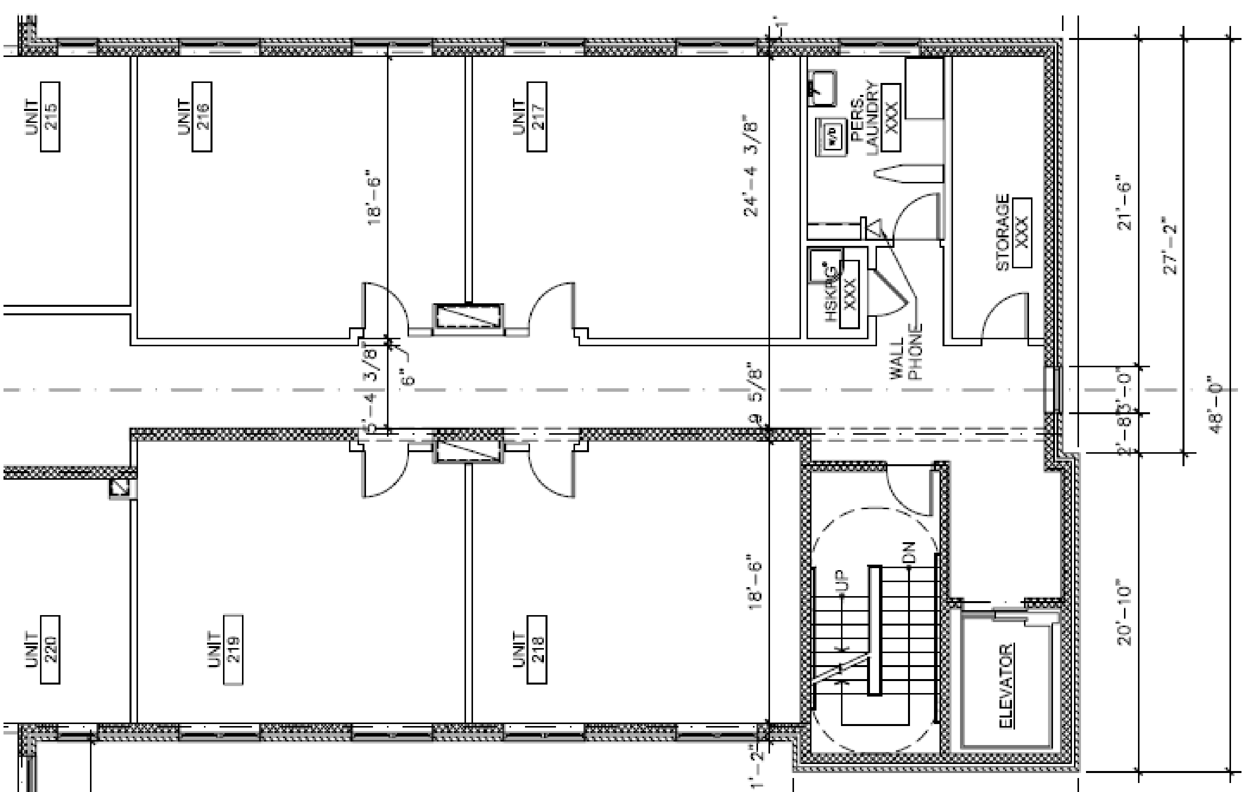
The existing floor system is 8” Hollow Core Pre-Cast Concrete Planks. Where the plank is used as flooring, an additional 2” of topping will be added. Where the plank is used as the roof structure, no additional topping will be added. The concrete used in the pre-cast planks must reach a compressive strength of no less then 5000 psi after 28 days of curing. Where the planks meet a load bearing wall or a lintel, the plank is to be grouted solid as to make a connection to transfer lateral loads.

Live Loads (acquired from ASCE 7-02 Table 4.1)

Corridors – First floor......100 PSF
Others..............40 PSF
Lobbies.............................100 PSF
Mechanical Rooms...........150 PSF
Storage (Light).................125 PSF
Dwelling Units...................40 PSF
Partitions............................20 PSF

Dead - Loads

Plank w/o Topping.............63 PSF
Plank w/ Topping...............88 PSF
HVAC..................................5 PSF
Ceiling.................................2 PSF
Framing..............................10 PSF
Misc.....................................3 PSF



Units 216 Through 219 will be Analyzed

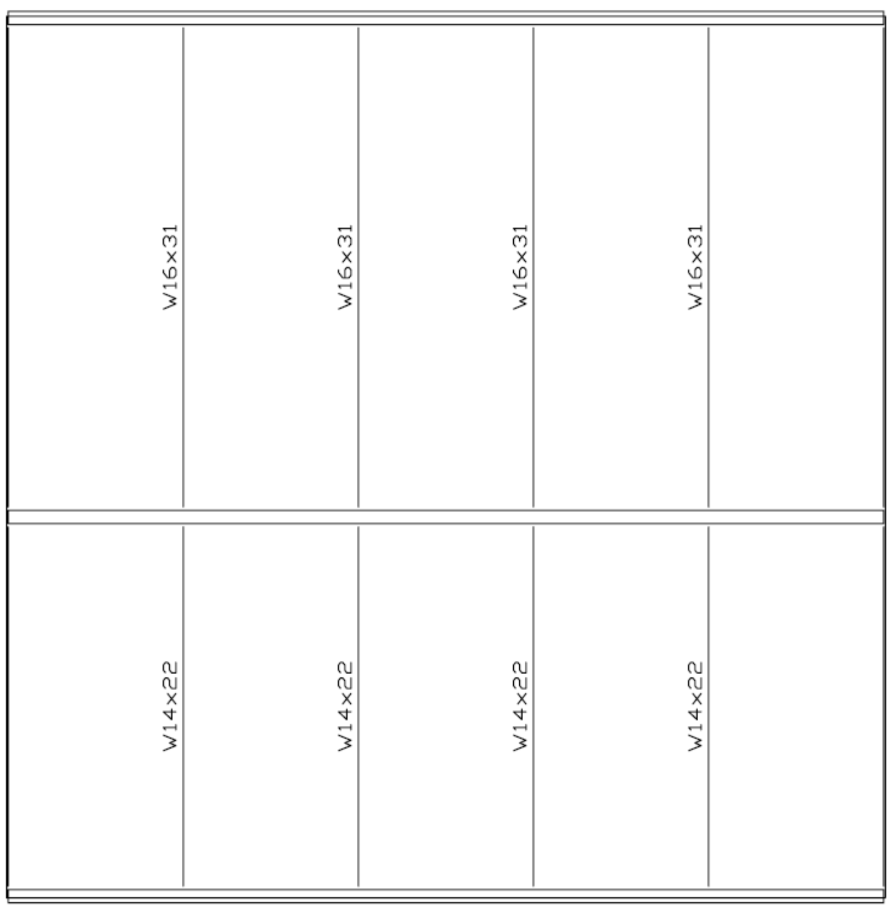
3 Alternative Floor Systems

There are numerous types of different floor systems which could have been selected and analyzed for this report. However, many of these systems would be impractical. Systems such as a two-way concrete slab can not be used in the current bearing wall plan and would require that bearing walls be placed thus that they provide a ratio of roughly 2 to 1 bays or less.

3.1 Alternative Floor System #1 Non-Composite Steel Beam with Composite Concrete Slab and Metal Decking

The first alternative floor system is a non-composite steel beam system with a composite concrete slab and metal deck floor system. Through wheeling deck products, a 1.5 SB Light Weight floor system was chosen. This floor system will have 20 gauge metal decking, 4" of total slab thickness, and welded wire fabric of 6 x 6 - w1.4 x w1.4.

RAM Structural System was used to size the new beams. There are two lengths of beams used; the first beam is 19' in length and the second is 25' in length. The spacing of the beams is 8'-10". The shorter spanned beam is going to be a W12x19 while the longer spanned beam is to be a W16x26. The RAM model can be seen below:



Alternative Floor System #1 Non-composite Beam with Composite Concrete Slab and Metal Deck

Advantages and Disadvantages:

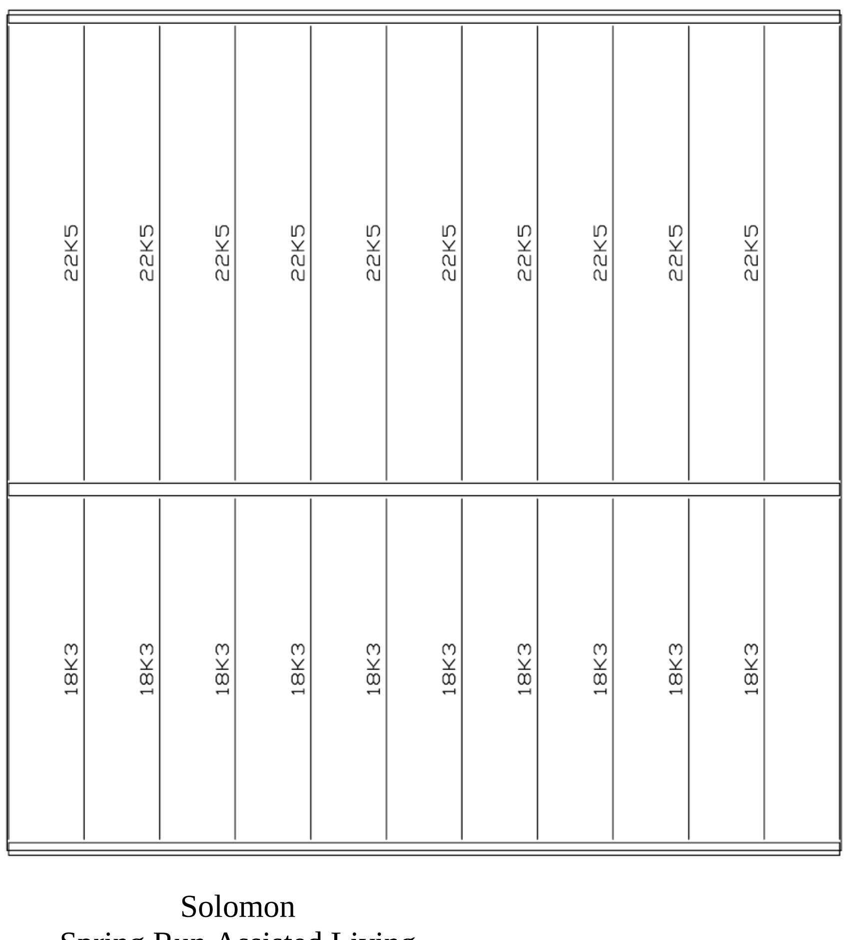
Using beams to support the new floor system will require that spray-on fireproofing be provided on any steel member to achieve the necessary 2 hr fire rating within the building. If beams are going to be used in the current wall design bearing plates must be inserted into the existing load bearing masonry walls. Although unlikely because of the use of the building, vibrations may play a role in the feasibility of this system. Using a beam system will be much lighter then using the existing system. The decking, which was originally provided as a structural component, will dub as a way to suspend the ACT ceiling. The dead load of the system is less than that of the original and thus the foundation can be reduced or left alone.

3.2 Alternative Floor System #2 Open Web Steel Joists with Composite Concrete Slab and Metal Decking

Instead of large bulky beams spanning such short distances, the option of using open web steel joists is going to be analyzed. The same decking and concrete slab can be used as in alternative floor system 1. This is a wheeling deck, 1.5 SB light weight floor system. This will be of 20 gauge steel and have a total slab thickness of 4”. Also, welded wire fabric of size, 6 x 6 – w1.4 x w1.4 will be used.

RAM Structural System was used to size the joists. The two lengths of the joists will be 19’ and 25’. The sizes needed are 18K3 and 22K5 respectively. The RAM model can be seen below. Spacing will be provided at 4’-0” O.C.

Alternative Floor System #2
Open Web Steel Joists with Composite Concrete Slab and Metal Deck

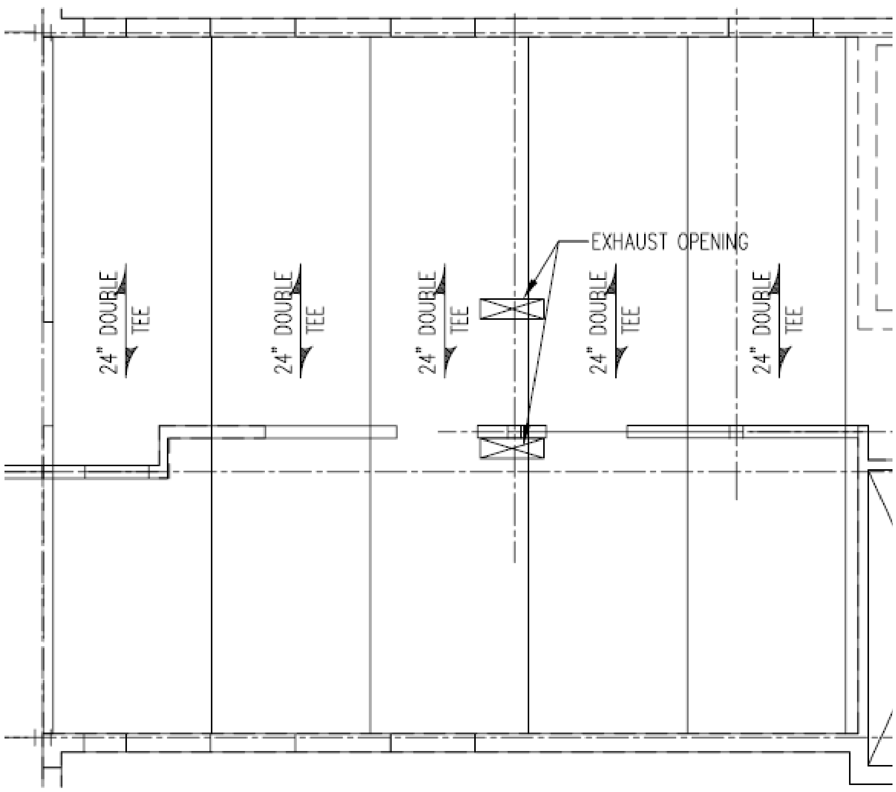


Advantages and Disadvantages:

Using joists to support the new floor system will require that spray-on fireproofing be provided on any steel member to achieve the necessary 2 hr fire rating within the building. Due to a joist floor system, the vibrations may play a key role in this alternatives feasibility. This new system will make dead loads much less and therefore the foundations may be reduced and lower cost. The ACT ceiling may be suspended from this new decking system.

3.3 Alternative Floor Systems #3 and #4
Pre-stressed Double Tee Topped 10'-0" x 24"
(44' Span)

Although the existing design of the building is precast concrete, it is hollow core planks which are slightly heavier then the Double Tee Topped 10'-0" x 24' precast concrete. Using a Double Tee allows for extremely large clear spans along with higher allowable loading. PCI design handbook is used to select the Double Tee based on superimposed service loads. The actual Double Tee selected is the Spancrete 10DT24 – C148H series.



This shows the layout of the Double Tees and only the width and span length would change for the 8'-0" Double Tees. The span direction would remain constant.

Pre-stressed Double Tee Topped 8'-0" x 20"
(25' Span and 19' Span)

This is the same type as floor system #3 except that the span of the Tee's is going to be decreased as to lessen the depth. The actual Double tee selected for this option is the Spancrete 8DT20 – C48h series.

Advantages and Disadvantages:
Precast members have many benefits including higher quality control and short onsite erection time. This particular type of floor system will require some additional type of fire protection because the slab thickness is not as great as it needs to be. This system is also less (but still rather similar) than that of the existing and therefore the foundations should be left alone. A way to join this floor system with the shear walls will need to be acquired as to pick up the shear from wind and seismic loading. Floor system 2 will allow for the interior load-bearing wall to be removed and converted to a lightweight partition. This will decrease the load on the foundations.

3.4 Alternative Floor System #5 and #6

One Way Concrete Joists
(44' Span)
(25' Span and 19' Span)

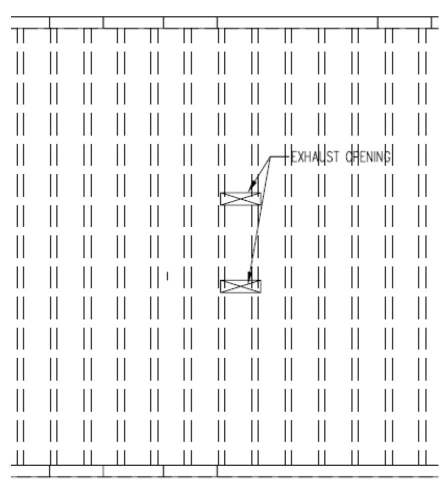
Using concrete joists systems along with a 4.5" slab, a 2 hour fire rating can be achieved. Using the loads mentioned earlier in this report and load factors of 1.4 for dead loads and 1.7 for live loads and CRSI Design Handbook 2002 edition, a One Way Concrete Joist system was chosen for both the 44' Span and the combination of a 25' span and a 19' span.

(44' Span)

Using the CRSI Design Handbook 2002 edition the following one way concrete joist system was chosen.

40" Forms + 8" Ribs @ 48" c.c.
18" Deep Ribs + 4.5" Top Slab = 22.5" Total Depth
Total weight = 403psf

Top Bars.....................#6 bars @ 11" o.c.
Bottom Bars ....1 # 8 bar
Stirrups.......................#3 Stirrups @ 10" c.c. up to 146" away from the face of the support

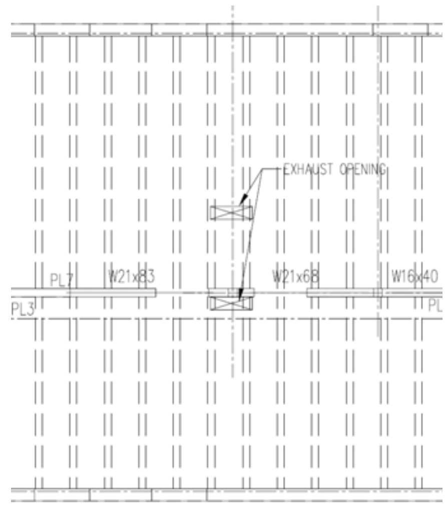


Layout for One Way Concrete Joist System with 25' Span and 19' Span

(25’ Span and 19’ Span)

Using the CRSI Design Handbook 2002 edition the following one way concrete joist system was chosen.

30” Forms + 6” Ribs @ 36” c.c.
10” Deep Ribs + 3.0” Top Slab = 13” Total Depth
Total weight = 80psf
*Form work is the same for both spans



Layout for One Way Concrete Joist System with 25’ Span and 19’ Span

19’ Span

Top Bars.....................#4 bars @ 12” o.c.
Bottom Bars ....1 # 5 bar

25’ Span

Top Bars.....................#5 bars @ 12” o.c.
Bottom Bars ....1 # 6 bar

Advantages and Disadvantages:
The weight of the 44’ span is so great, the foundations will most likely need to be recalculated. This could also affect the walls which the floor system is being supported by. The 19’ span and 25’ span have a lower weight then that of the existing system but not by much so the foundations should be able to be left alone. Floor to floor height will surely increase with either of these new systems and both will also delay onsite construction time.

4 Conclusion

Alternative System		Depth (in)	Building Height Increase	Wt./Area (psf)	Impact on Fire Rating	Amount of Possible Vibrations	Impact on Foundation	Investigate Further
Existing	Hollow Core Precast Plank	8	N/A	88	N/A	Very Little	N/A	N/A
1	Non-Composite Beam w/ Composite Deck and Slab	20	Yes 3’	~25	Steel Needs to be Fireproofed	Little	Decrease of Foundation Possible	Yes
2	Open Web Steel Joists w/ Composite Deck and Slab	26	Yes 4.5’	~25	Steel Needs to be Fireproofed	Large Amount	Decrease of Foundation Possible	No
3	Double Tee 44’ Span	24	Yes 4’	~80	None	Very Little	Increase Foundation Because of Removal of Wall	No
4	Double Tee 25’ Span and 19’ Span	20	Yes 3’	~75	None	Very Little	None	No
5	One-way Concrete Joist System 44’ Span	22.5	Yes 3.625’	~403	None	Very Little	Increase Foundation for Larger Load and Removal of Wall	No
6	One-way Concrete Joist System 25’ Span and 19’ Span	13	Yes 1.25’	~80	None	Very Little	None	Yes

After analysis of several other possible systems for Spring Run Assisted Living have lead to the conclusion that the existing system is the most efficient. The existing system meets the modular for the masonry walls, meets fire code and transfers little vibrations. The only other system which is comparable to the existing is really the one way concrete joist system but it does not fall into the CMU modular. The other benefit that the hollow core pre-cast plank has over the one way concrete joist system is that it does not require long erection time. The precast can be prepared offsite and brought to site ready for erection. Waiting for concrete to cure on site will not only delay future work, but also the day of a pour for concrete must be coordinated with the weather. This does not happen with the hollowcore precast concrete planks.

APPENDIX A
DECKING AND SLAB SELECTION (ALT SYSTEMS 1 AND 2)

1.5 SB Lightweight

Wheeling Composite Deck

115 pcf Lightweight Concrete

Total Slab Depth D / Wt. Conc. / Area Conc.	Gage	Maximum Unshored Clear Spans: Single Span	Double Span	Triple Span	Composite Properties: Iavg in⁴/ft	Sc in³/ft	Superimposed Live Loads - psf: No Studs — Span - Feet and Inches: 6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"
	22	6'-3"	8'-5"	8'-6"	2.916	0.848	394	333	284	244	212	185	163	144	127	110	96	84
4"	20	7'-4"	9'-5"	9'-11"	3.163	1.002	400	397	339	293	254	223	190	161	138	120	104	91
28.8 psf	18	7'-9"	10'-1"	10'-5"	3.580	1.274	400	400	348	297	259	226	199	176	157	135	118	103
20.6 in²	16	9'-1"	11'-4"	11'-8"	3.965	1.543	400	400	345	297	259	226	199	176	157	135	118	103
	22	6'-0"	8'-0"	8'-1"	4.159	1.044	400	400	351	302	262	229	202	178	158	141	126	113
4-1/2"	20	6'-11"	9'-3"	9'-5"	4.563	1.235	400	400	400	362	315	276	243	216	192	170	148	130
33.6 psf	18	7'-4"	9'-7"	9'-11"	5.082	1.573	400	400	400	369	321	281	248	220	196	175	157	141
24.8 in²	16	8'-7"	10'-9"	11'-2"	5.621	1.911	400	400	400	369	321	281	248	220	196	175	157	141
	22	5'-10"	7'-10"	7'-11"	4.882	1.144	400	400	385	332	288	252	222	196	174	156	139	125
4-3/4"	20	6'-9"	9'-1"	9'-2"	5.298	1.355	400	400	400	398	346	304	268	237	212	189	170	152
36.0 psf	18	7'-2"	9'-5"	9'-9"	5.967	1.727	400	400	400	400	353	310	273	242	216	193	173	156
27.0 in²	16	8'-4"	10'-7"	10'-11"	6.596	2.102	400	400	400	400	353	310	273	242	216	193	173	156
	22	5'-8"	7'-8"	7'-9"	5.704	1.246	400	400	400	362	315	275	242	214	191	170	152	137
5"	20	6'-7"	8'-10"	9'-0"	6.167	1.477	400	400	400	400	378	332	293	260	231	207	186	168
38.4 psf	18	7'-0"	9'-3"	9'-6"	6.946	1.885	400	400	400	400	386	339	299	265	236	211	190	171
34.1 in²	16	8'-2"	10'-4"	10'-8"	7.675	2.296	400	400	400	400	386	339	299	265	236	211	190	171
	22	5'-4"	7'-2"	7'-4"	8.655	1.568	400	400	400	400	386	346	305	270	240	215	193	173
5-3/4"	20	6'-2"	8'-4"	8'-6"	9.337	1.861	400	400	400	400	400	400	369	328	292	262	235	212
45.6 psf	18	6'-7"	8'-8"	9'-0"	10.483	2.379	400	400	400	400	400	400	378	336	300	268	241	218
38.7 in²	16	7'-8"	9'-9"	10'-1"	11.572	2.899	400	400	400	400	400	400	378	336	300	268	241	218

D, Wc, Ac	Gage	Single Span	Double Span	Triple Span	Stud Factors 2' o.c.	3' o.c.	Superimposed Live Loads - psf: Studs @ 1'-0" O.C. — Span - Feet and Inches: 6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"
	22	6'-3"	8'-5"	8'-6"	0.87	0.80	400	400	372	303	249	208	175	149	128	110	96	84
4"	20	7'-4"	9'-9"	9'-11"	0.83	0.78	400	400	400	328	270	225	190	161	138	120	104	91
28.8 psf	18	7'-9"	10'-1"	10'-5"	0.81	0.76	400	400	400	371	306	255	215	183	157	136	118	103
20.6 in²	16	9'-1"	11'-3"	11'-8"	0.78	0.74	400	400	400	400	339	283	238	202	174	150	130	114
	22	6'-0"	8'-0"	8'-1"	0.88	0.81	400	400	400	400	356	296	250	212	182	157	137	120
4-1/2"	20	6'-11"	9'-3"	9'-5"	0.84	0.79	400	400	400	400	385	321	270	230	197	170	148	130
33.6 psf	18	7'-4"	9'-7"	9'-11"	0.82	0.77	400	400	400	400	400	362	305	259	222	192	167	146
24.8 in²	16	8'-7"	10'-9"	11'-2"	0.79	0.75	400	400	400	400	400	400	338	287	246	213	185	162
	22	5'-10"	7'-10"	7'-11"	0.88	0.82	400	400	400	400	400	349	294	250	214	185	161	141
4-3/4"	20	6'-9"	9'-1"	9'-2"	0.85	0.80	400	400	400	400	400	377	318	270	232	200	174	152
36.0 psf	18	7'-2"	9'-5"	9'-9"	0.83	0.78	400	400	400	400	400	400	358	305	261	226	198	172
27.0 in²	16	8'-4"	10'-6"	10'-11"	0.80	0.76	400	400	400	400	400	400	396	337	289	249	217	190
	22	5'-8"	7'-8"	7'-9"	0.88	0.83	400	400	400	400	400	400	343	291	250	216	188	164
5"	20	6'-7"	8'-10"	9'-0"	0.85	0.81	400	400	400	400	400	400	370	315	270	233	203	178
38.4 psf	18	7'-0"	9'-3"	9'-6"	0.83	0.79	400	400	400	400	400	400	400	355	304	263	228	200
34.1 in²	16	8'-2"	10'-4"	10'-8"	0.80	0.77	400	400	400	400	400	400	400	392	336	290	252	221
	22	5'-4"	7'-3"	7'-4"	0.90	0.84	400	400	400	400	400	400	400	380	339	305	274	248
5-3/4"	20	6'-2"	8'-4"	8'-6"	0.87	0.82	400	400	400	400	400	400	400	400	400	353	307	269
45.6 psf	18	6'-7"	8'-8"	9'-0"	0.85	0.80	400	400	400	400	400	400	400	400	400	390	345	302
38.7 in²	16	7'-8"	9'-9"	10'-1"	0.82	0.78	400	400	400	400	400	400	400	400	400	400	381	333

1) Refer to the Design Notes, Note 7 for information on live load limits for fire-rated construction. See Page CD-3.
2) If stud spacing exceeds 1'-0" o.c., reduce live load by applicable stud factor listed above for actual stud spacing.
3) If welded wire fabric is not used, the live loads should be reduced by 10%.

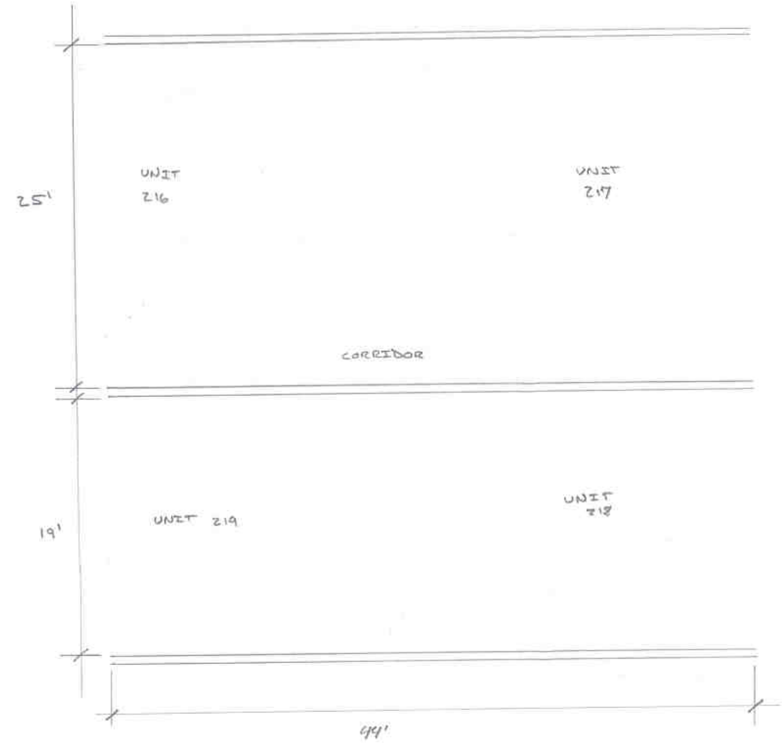
APPENDIX B
WWF SELECTION (ALT SYSTEMS 1 AND 2)

Concrete Volume and Welded Wire Fabric

DECK DEPTH	TOTAL SLAB DEPTH	CONCRETE VOLUME		RECOMMENDED WELDED WIRE FABRIC
		C.U. YD/ 100 SQ. FT	C.U. FT/ SQ. FT.	
1-1/2"	4"	0.93	0.252	6 x 6 - W1.4 x W1.4
	4-1/2"	1.08	0.293	6 x 6 - W1.4 x W1.4
	4-3/4"	1.16	0.314	6 x 6 - W1.4 x W1.4
	5"	1.24	0.335	6 x 6 - W2.1 x W2.1
	5-1/2"	1.39	0.376	6 x 6 - W2.1 x W2.1
	5-3/4"	1.47	0.397	6 x 6 - W2.1 x W2.1
	6"	1.55	0.418	6 x 6 - W2.1 x W2.1
2"	4-1/2"	1.08	0.292	6 x 6 - W1.4 x W1.4
	5"	1.23	0.333	6 x 6 - W1.4 x W1.4
	5-1/4"	1.31	0.354	6 x 6 - W1.4 x W1.4
	5-1/2"	1.39	0.375	6 x 6 - W2.1 x W2.1
	6"	1.54	0.417	6 x 6 - W2.1 x W2.1
	6-1/4"	1.62	0.438	6 x 6 - W2.1 x W2.1
	6-1/2"	1.70	0.458	6 x 6 - W2.1 x W2.1
3"	5-1/2"	1.23	0.333	6 x 6 - W1.4 x W1.4
	6"	1.39	0.375	6 x 6 - W1.4 x W1.4
	6-1/4"	1.47	0.396	6 x 6 - W1.4 x W1.4
	6-1/2"	1.54	0.417	6 x 6 - W2.1 x W2.1
	7"	1.70	0.458	6 x 6 - W2.1 x W2.1
	7-1/4"	1.77	0.479	6 x 6 - W2.1 x W2.1
	7-1/2"	1.85	0.500	6 x 6 - W2.1 x W2.1

ALT FLOOR SYSTEM 1

NON-COMPOSITE STEEL BEAM
W/ COMPOSITE CONCRETE SLAB AND METAL DECK



LOADS (FACTORED)

LL → 40 PSF CORRIDOR / DWELLING UNIT
20 PSF PARTITION
60 PSF x 1.6 = 96 PSF

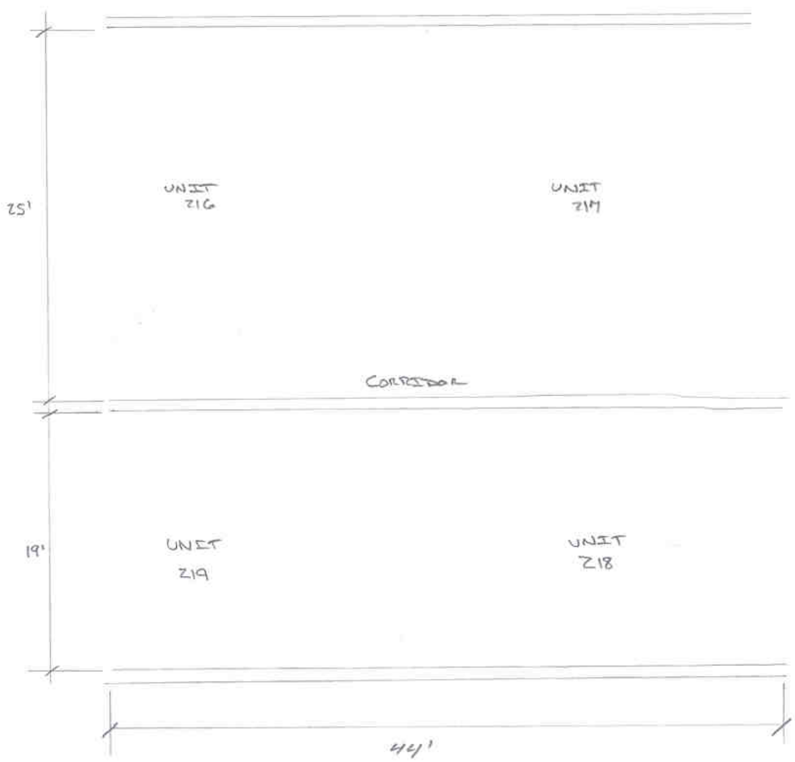
DL → 28.8 PSF [1.5 SB LIGHTWEIGHT CONCRETE AND DECKING] (20 GAUGE)
5 PSF HVAC
2 PSF CEILING
10 PSF FRAMING
6.7 PSF MISC
60.0 PSF x 1.2 = 72 PSF

USE W 12x19 W/ 5 EQ. SPACES - SHORTER BAY
USE W 16 x 26 W/ 5 EQ SPACES - LONGER BAY

WHEELING DECK PRODUCTS:
- DECKING - 1.5 SB LIGHTWEIGHT
- SLAB TOTAL DEPTH = 4" WWF = 6x6 + W1.4 x W1.4
- 2 HR FIRE RATING W/ SPRAY ON FIRE PROOFING
- 1 HR " " W/O " " " "

ALT FLOOR SYSTEM 2

JOISTS W/ COMPOSITE CONCRETE SLAB AND MTL. DECK



LOADS (FACTORED)

LL → 40 PSF CORRIDOR / DWELLING UNIT
20 PSF PARTITION
60 PSF × 1.6 = 96 PSF

DL → 28.8 PSF [1.5 SB LIGHTWEIGHT CONCRETE AND 20 GAUGE DECKING]
5 PSF HVAC
2 PSF CEILING
10 PSF FRAMING
6.7 PSF MISC.
60 PSF × 1.2 = 72 PSF

USE 18K3 @ 4'-0" O.C. SHORTER BAY
USE 22K5 @ 4'-0" O.C. LONGER BAY

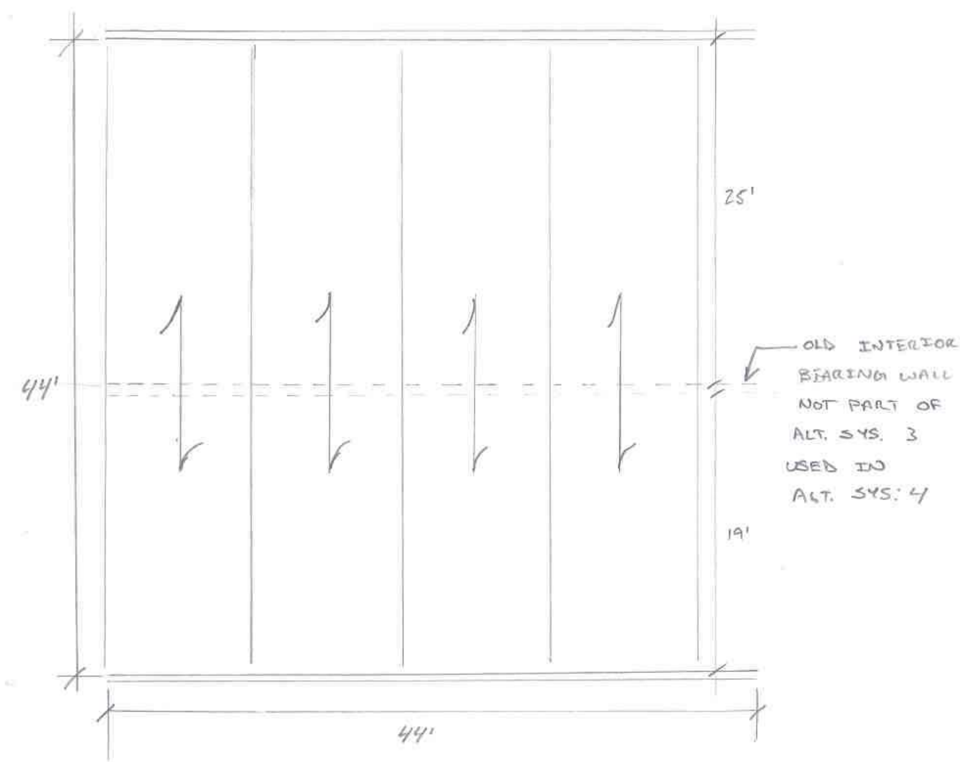
WHEELING DECK PRODUCTS {
- DECKING - 1.5 SB LIGHTWEIGHT
- SLAB TOTAL DEPTH = 4" WWF - 6x6 - W1.4xW1.4
- 2 HR. FIRE RATING W/ SPRAY ON FIRE PROOFING
- 1 HR. " " W/O " " " "

ALT FLOOR SYSTEM 3 & 4

DOUBLE TEE PLANKS AT 44' SPAN & 25' SPAN + 19' SPAN
(REMOVAL OF INTERIOR BEARING WALL CAN
BE USED BECAUSE OF POSSIBLE SPAN LENGTHS)

SUPERIMPOSED LOADING
LIVE LOAD → 40 PSF CORRIDOR/DWELLING UNIT
20 PSF PARTITION LOAD
60 PSF · 1.7 = 102 PSF
DEAD LOAD → 5 PSF HVAC
2 PSF CEILING
10 PSF FRAMING
8 PSF MISC.
25 PSF · 1.4 = 35 PSF
TOTAL = 137 PSF

USE A 10DT24-C148H SERIES FOR 44' SPAN
USE A 8DT20-C48H SERIES FOR 25' & 19' SPANS



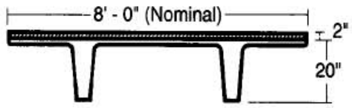
APPENDIX F
DOUBLE TEE SELECTION (ALT SYSTEM 3)

SPANCRETE

1.4 Double tee load tables
8'-0" x 20" Double tee topped

1.0 Double Tees

Issued 10/94



2 Inch Bonded Structural Topping
Dead Load Weight of Tee with Topping = 75 psf

SECTION PROPERTIES

A = 517 in.^{2} Y_t = 5.87 in.
I = 17,697 in.^{4} Y_b = 16.13 in.

ϕM_n ft - k	237	345	447	542
SERIES	8DT20-C48H	8DT20-C68H	8DT20-C88H	8DT20-C108H
Span in Feet	ALLOWABLE SUPERIMPOSED LOAD IN POUNDS PER SQUARE FOOT			
20	297			
22	235			
24	187			
26	150	248		
28	120	205	283	
30	97	170	238	
32	77	142	202	
34	61	118	169	
36	48	99	141	
38	36	80	117	
40		63	97	121
42		49	80	102
44		37	65	85
46			52	70
48			40	57
50				45
52				35

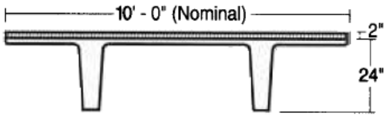
1"-1 1/2" Camber   1 1/2" or More Camber

SPANCRETE

1.4 Double tee load tables
10'-0" x 24" Double tee topped

1.0 Double Tees

Issued 10/94



2 Inch Bonded Structural Topping
Dead Load Weight of Tee with Topping = 80 psf

SECTION PROPERTIES

A = 701 in.^{2}
I = 38,176 in.^{4}
Y_t = 7.31 in.
Y_b = 16.69 in.

ϕM_n ft - k	423	552	675	792	903	1039
SERIES	10DT24-C68H	10DT24-C88H	10DT24-C108H	10DT24-C128H	10DT24-C148H	10DT24-C168H
Span In Feet	ALLOWABLE SUPERIMPOSED LOAD IN POUNDS PER SQUARE FOOT					
24	290					
26	237					
28	195	275				
30	161	231	291			
32	133	195	248	299		
34	110	165	212	257		
36	91	139	181	221		
38	75	118	156	189		
40	61	100	134	161		
42	49	84	113	138	155	
44	38	71	94	117	133	
46		57	79	99	113	
48		45	64	83	96	
50			52	70	82	
52			41	57	68	81
54				46	57	68
56					46	57

1" - 1 1/2" Camber
1 1/2" or More Camber

ALT FLOOR SYSTEM 5 & 6
ONE WAY CONCRETE JOISTS
LOADING

LL - 40 PSF DWELLING UNIT / CORRIDOR
20 PSF PARTIONS
60 PSF · 1.7 = 102 PSF

DL - 5 PSF HVAC
2 PSF CEILING
10 PSF FRAMING
8 PSF MISC
25 PSF · 1.4 = 35 PSF

TOTAL W_U = 137 PSF

[5]
FOR 44' SPAN, END SPAN
Pg. 8-62

USE 40" FORMS + 8" RIBS @ 48" o.c.
18" DEEP RIB + 4.5" TOP SLAB = 22.5" TOTAL DEPTH

TOP BARS #6 @ 11.0" o.c.

BOTTOM BARS 1 #8

STIR #3 @ 10" c.c. UP TO 146" FROM FACE OF SUPPORT

[6] FOR 19' SPAN & 25' SPAN
Pg. 8-21

USE 30" FORMS + 6" RIBS @ 36" o.c.
10" DEEP RIB + 3.0" TOP SLAB = 13" TOTAL DEPTH

19' SPAN TOP BARS #4 @ 12" c.c.
BOTTOM BARS 1 #5

25' SPAN TOP BARS #5 @ 12" c.c.
BOTTOM BARS 1 #6

APPENDIX I
ONE-WAY CONCRETE JOIST SYSTEM SELECTION (ALT SYSTEM 5)

WIDE MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	11.5	10.5	9.5	11.0	9.5		8.5	5.0	7.0	8.0	7.0	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	.72	1.18	1.33	1.66	1.87		.64	.64	.64	.64	.64	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32′-0″ (3)	142	610	736	979	1177	4.000	463	1144	1327	1680	1969	2.461
STIR	#3- 38	#3-111	#3-122	#3-138	#3-134		#3- 66	#3-117	#3-124	#3-137	#4-144	
33′-0″	100	540	658	887	1073	4.523	402	1042	1214	1546	1818	2.784
STIR	3- 33	#3-111	#3-123	#3-140	#3-142		#3- 64	#3-118	#3-126	#3-140	#3-147	
34′-0″	61	476	587	802	978	5.097	346	949	1111	1424	1680	3.137
STIR	#3- 28	#3-111	#3-123	#3-141	#3-151		#3- 62	#3-119	#3-128	#3-142	#3-149	
35′-0″		417	522	725	892	5.724	294	864	1016	1312	1554	3.522
STIR		#3-110	#3-123	#3-142	#3-154		S#3- 60	#3-120	#3-129	#3-124	#3-152	
36′-0″		363	463	655	812	6.407	247	785	930	1209	1437	3.942
STIR		#3-110	#3-123	#3-143	#3-156		#3- 57	#3-121	#3-130	#3-131	#3-155	
37′-0″		314	408	590	738	7.149	204	713	850	1114	1331	4.399
STIR		#3-109	#3-123	#3-144	#3-157		#3- 54	#3-121	#3-131	#3-139	#3-157	
38′-0″		268	357	530	671	7.953	164	647	777	1027	1232	4.894
STIR		#3-108	#3-123	#3-145	#3-159		#3- 51	#3-122	#3-132	#3-146	#3-159	
39′-0″		226	311	474	608	8.824	127	586	709	947	1141	5.430
STIR		#3-106	#3-122	#3-146	#3-160		#3- 47	#3-122	#3-133	#3-150	#3-162	
40′-0″		187	267	423	550	9.765	93	529	646	872	1057	6.009
STIR		#3-105	#3-121	#3-146	#3-161		#3- 43	#3-122	#3-134	#3-151	#3-144	
41′-0″		151	227	375	496	10.778	61	476	587	803	979	6.633
STIR		#3-103	#3-120	#3-146	#3-162		#3- 39	#3-122	#3-134	#3-153	#3-151	
42′-0″		117	190	331	447	11.869	32	427	533	738	906	7.304
STIR		#3-101	#3-119	#3-147	#3-163		#3- 35	#3-122	#3-135	#3-154	#3-158	
43′-0″		86	155	290	400	13.040		381	483	679	839	8.025
STIR		#3- 98	#3-118	#3-147	#3-164			#3-121	#3-135	#3-155	#3-166	
44′-0″		57	123	252	357	14.296		339	436	623	776	8.798
STIR		#3- 96	#3-116	#3-146	#3-164			#3-121	#3-135	#3-156	#3-169	
PROPERTIES FOR DESIGN (CONCRETE .67 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	.83	1.42	1.57	1.92	2.22		1.13	1.92	2.13	2.64	3.02	
ACTUAL STEEL %	.414	.704	.779	.958	1.109		.559	.951	1.057	1.317	1.505	
EFF. DEPTH, IN.	20.75	20.69	20.69	20.63	20.63		20.75	20.75	20.69	20.63	20.63	
– ICR/IGR	.119	.181	.196	.227	.253		.152	.230	.247	.287	.315	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	.71	1.19	1.32	1.58	1.79		.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	.342	.575	.638	.768	.871		.342	.575	.638	.768	.871	
EFF. DEPTH, IN.	20.72	20.64	20.63	20.50	20.46		20.72	20.64	20.63	20.50	20.46	
+ICR/IGR	.125	.200	.220	.255	.284		.125	.200	.220	.255	.284	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Table 8-3.
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

APPENDIX J

ONE-WAY CONCRETE JOIST SYSTEM SELECTION (ALT SYSTEM 6)

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS		30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)											f'_c = 4,000 psi f_y = 60,000 psi
10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth													
TOP BARS	Size @	# 4 12	# 4 12	# 4 9.5	# 5 12	# 5 10	End Span Defl. Coeff. (3)	# 4 12	# 4 11.5	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		.58	.69	.86	1.05	1.25		.63	.74	.95	1.18	1.46	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		180	251	309*	317*	328*	1.006	215	301	358*	365*	374*	.619
		0	0	322	404	478*		0	0	404	508	570*	
18'-0"		151	214	278	288*	297*	1.264	182	259	328*	334*	342*	.778
		0	0	0	351	425		0	0	351	444	525*	
19'-0"		127	184	241	263*	271*	1.569	155	224	301*	307*	314*	.966
		0	0	0	306	373		0	0	306	390	481*	
20'-0"		106	157	209	241*	248*	1.926	131	194	268	284*	289*	1.185
		0	0	0	268	328		0	0	0	343	429	
21'-0"		88	135	182	221*	228*	2.342	111	168	235	263*	267*	1.441
		0	0	0	235	290		0	0	0	303	381	
22'-0"		73	115	158	204*	210*	2.820	94	145	207	244*	248*	1.736
		0	0	0	207	256		0	0	0	269	340	
23'-0"		59	98	137	182	194*	3.369	78	126	182	227*	231*	2.073
		0	0	0	0	227		0	0	0	239	303	
24'-0"		48	83	119	160	180*	3.995	65	108	160	212*	215*	2.458
		0	0	0	0	202		0	0	0	0	272	
25'-0"			70	103	141	167*	4.703	53	93	141	189	201*	2.894
			0	0	0	179		0	0	0	0	244	
26'-0"			58	89	124	156*	5.502	43	80	123	168	188*	3.386
			0	0	0	159		0	0	0	0	219	
27'-0"			48	76	108	141	6.398	68	108	150	176*		3.938
			0	0	0	0		0	0	0	197		
28'-0"				65	95	125	7.400		57	95	133	166*	4.554
				0	0	0			0	0	0	177	
29'-0"				54	82	111	8.516		47	82	118	156*	5.240
				0	0	0			0	0	0	159	
30'-0"				45	71	98	9.752			71	105	143	6.001
				0	0	0				0	0	0	

(1) For gross section properties, see Table 8-1.
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE .41 CF/SF) (4)											
NEGATIVE MOMENT											
STEEL AREA (SQ. IN.)	60	.60	.76	.93	1.12		.60	.63	.85	1.03	1.31
STEEL % (UNIFORM)	.73	.73	.92	1.14	1.37		.73	.76	1.03	1.25	1.61
(TAPERED)	.43	.43	.54	.66	.80		.43	.44	.60	.73	.94
EFF. DEPTH, IN.	11.8	11.8	11.8	11.7	11.7		11.8	11.8	11.8	11.8	11.7
– ICR/IGR	.179	.179	.214	.246	.280		.179	.185	.232	.268	.314
POSITIVE MOMENT											
STEEL AREA (SQ. IN.)	.40	.51	.62	.75	.88		.31	.40	.51	.62	.75
STEEL %	.09	.12	.15	.18	.21		.07	.09	.12	.15	.18
EFF. DEPTH, IN.	11.8	11.7	11.7	11.6	11.6		11.8	11.8	11.7	11.7	11.6
+ICR/IGR	.162	.200	.239	.280	.323		.128	.162	.200	.239	.280