David Lee
AE 481W
Structural Option

Advisor: Andres Lepage
URS Office Building
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STRUCTURAL TECHNICAL REPORT 2

Pro-Con Structural Study of Alternate Floor System

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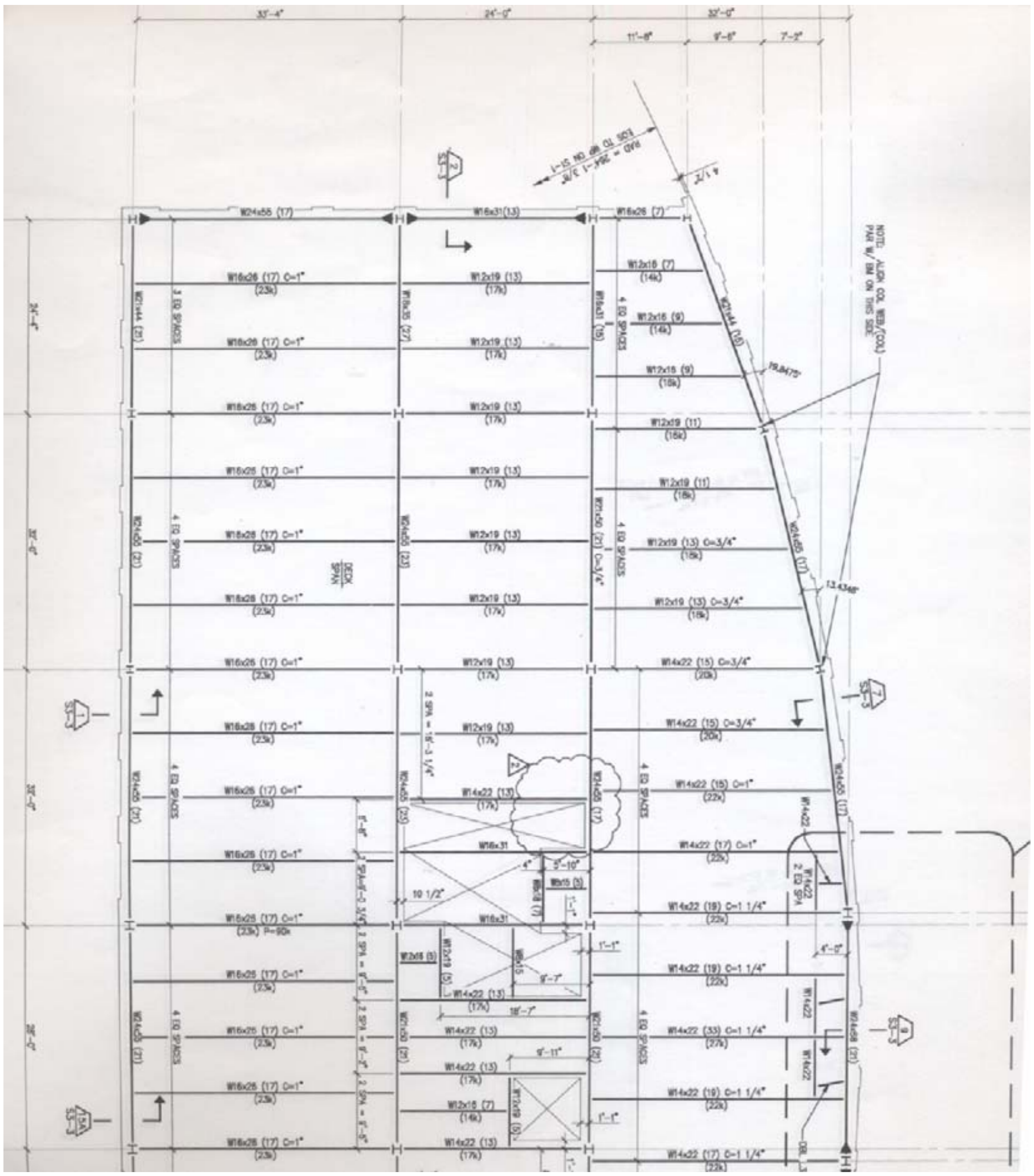
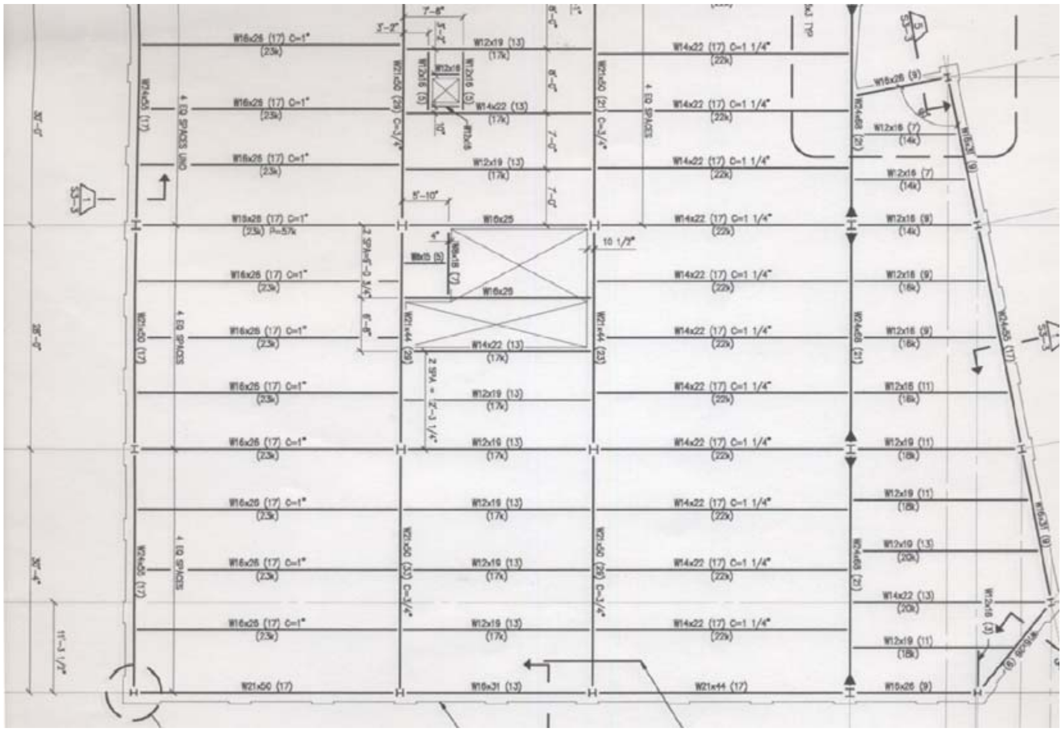
Current Condition

The 5 story, 100,000 square foot URS Office Building currently employs slab on grade and composite slabs for the upper floors. Composite slabs consist of wide flange structural steel working compositely with the galvanized 20 gage 2” floor deck and 3-1/4” concrete. Headed studs ¾”ϕ x 4” are spaced evenly across the steel members to achieve composite action. The typical bays are 32’x 33’ and second through fifth floor has identical layout.



Typical Floor Plan



Typical Floor Plan

LOADS

Loads are calculated by design parameters given in ASCE 7-05 in conjunction with 2003 IBC. Dead load will be calculated according to the actual weight of the permanent building components. Live load will be directly taken out of 2003 IBC.

Dead Loads (PSF) – actual weight of the permanent building components

- Structural Steel ------ 6.5 PSF
- Metal Deck ----------- 3 PSF
- Concrete -------------- 43 PSF
- MEP ------------------- 15 PSF
- Partition --------------- 20 PSF

- Total Dead Load ----- 87.5 PSF

Live Loads (PSF) – from 2003 IBC: Table 1607.1

- Roof Snow ----------- 25 PSF
- Office Floor ---------- 50 PSF
- Corridor --------------- 100 PSF
- Lobby ----------------- 100 PSF
- Retail ------------------ 100 PSF
- Penthouse Floor ------ 250 PSF
- Mechanical Unit ----- 150 PSF + weight of equipment

The above loads were calculated and utilized in technical assignment 1 to check member size and adequacy of design. The same loads will be used to design alternate floor systems. However the design aids employed define allowable load as total load minus self weight. Therefore the self weight of the member of the alternate system does not have to be assumed and checked. Dead load used to calculate the alternate systems was 35 PSF or MEP (15 PSF) plus partition (20 PSF) loads. Live load of 50 PSF was used for the office floor.

REFERENCE MATERIAL

DESIGN AIDS

- CRSI CONCRETE DESIGN HANDBOOK (2002)
- MANUAL OF STEEL CONSTRUCTION LRFD 3RD EDITION
- PCI DESIGN HANDBOOK 5TH EDITION (1999)
- POST-TENSIONED CONCRETE DESIGN WORKBOOK
- UNITED STEEL DECK DESIGN MANUAL AND CATALOG OF PRODUCTS

COST DATA

- RS MEANS ASSEMBLIES COST DATA 31ST ANNUAL EDITION (2006)
- RS MEANS BUILDING CONSTRUCTION COST DATA 64TH ANNUAL EDITION (2006)

ORIGINAL FLOOR SYSTEM

COMPOSITE FLOOR SYSTEM

Analysis of the composite floor system was performed both in RAM and by hand calculation. Hand calculation was done with the aid of the Steel Manual. Both analysis results were in agreement with the construction document. Below in *Figure 1* is the largest bay which is 32'x 33'4". Typical girders are W24x55 and typical beams are W16x26. Measuring from the top of concrete to the bottom of structural steel, depth was found to be 23.6". Self weight was calculated 50 PSF and according to RS Means cost was found to be $20 per square foot. If cost of fireproofing is accounted for, the total cost would be $20.80 per square foot.

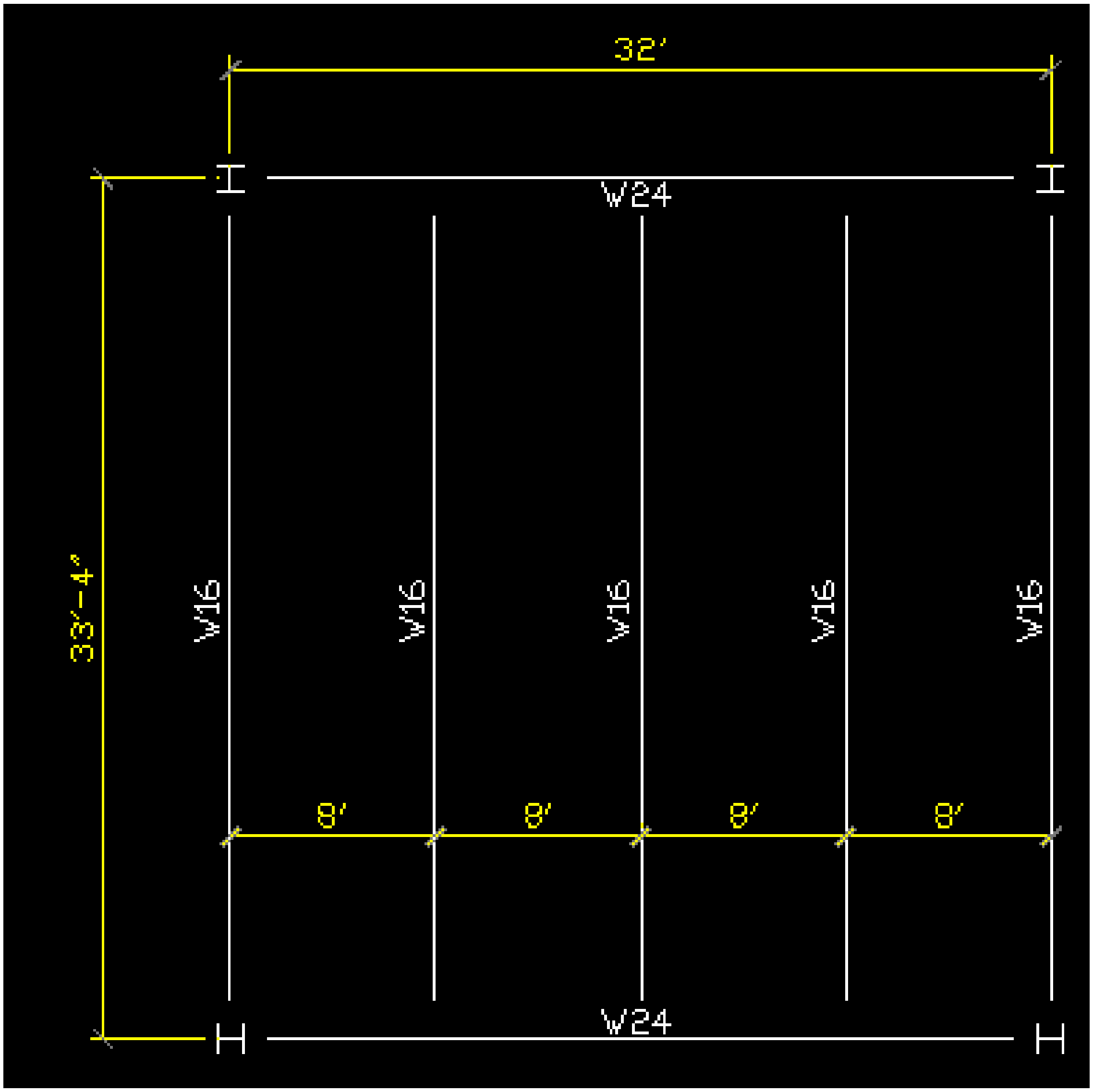


Figure 1

Current floor system draws the best of concrete and steel. Relatively low self weight compared to concrete construction and added stiffness are some of the advantages of composite floor system. Reduction in steel tonnage compared to non-composite system is possible and total floor depth is satisfactory. Disadvantages are the issues of fire rating and constructability. The structural steel members must be fire-proofed which is time consuming and costly. Also composite construction is labor intensive.

ALTERNATE SYSTEM 1

COMPOSITE FLOOR SYSTEM – DIFFERENT BEAM SPACING

Under equal loading condition, typical bay had two filler beams instead of three (see *Figure 2*). With the help of the steel manual hand calculation was performed and new member sizes were W24x55 for the girder and W16x31 for the beams. The floor depth was essentially equal to the original system and self weight was approximately the same as original system. For composite construction, RS Means determines cost per square foot depending on bay size. Beam spacing does not contribute to construction cost due to the way charts are made. Although cost reduction is not indicated on RS Means, due to savings on labor cost due to less member being erected, larger spacing of the filler beams will reduce cost.

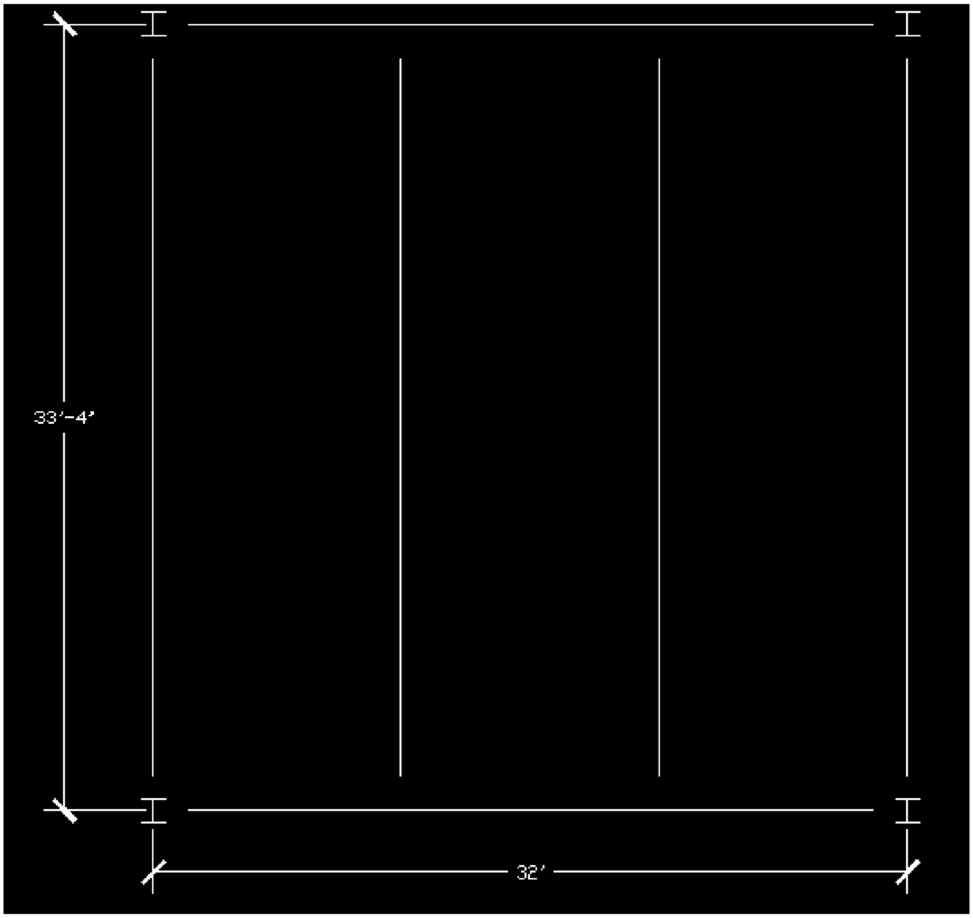


Figure 2

This modified composite system still has the advantages of the original system. Along with the aforementioned advantages, larger spacing of filler beams will reduce construction cost and increase constructability. A possible drawback is the vibration problem. Adequacy of the current deck size was checked and 20 gage steel deck can still be used for this floor system (see appendix D).

ALTERNATE SYSTEM 2

WAFFLE SLAB

Using the CRSI design handbook, waffle slab (see *Figure 3*) was designed and selected as the second alternative to the original floor system. Typical bay of 32'x 32' was used along with live load of 50 PSF and dead load of 35 PSF. These loads were factored to find adequate reinforcing of a waffle flat slab with 30"x 30" voids with 6" ribs @ 36". Depth of 13", self weight of 95 PSF was calculated. Price RS Means indicated was $20.35 per square foot.

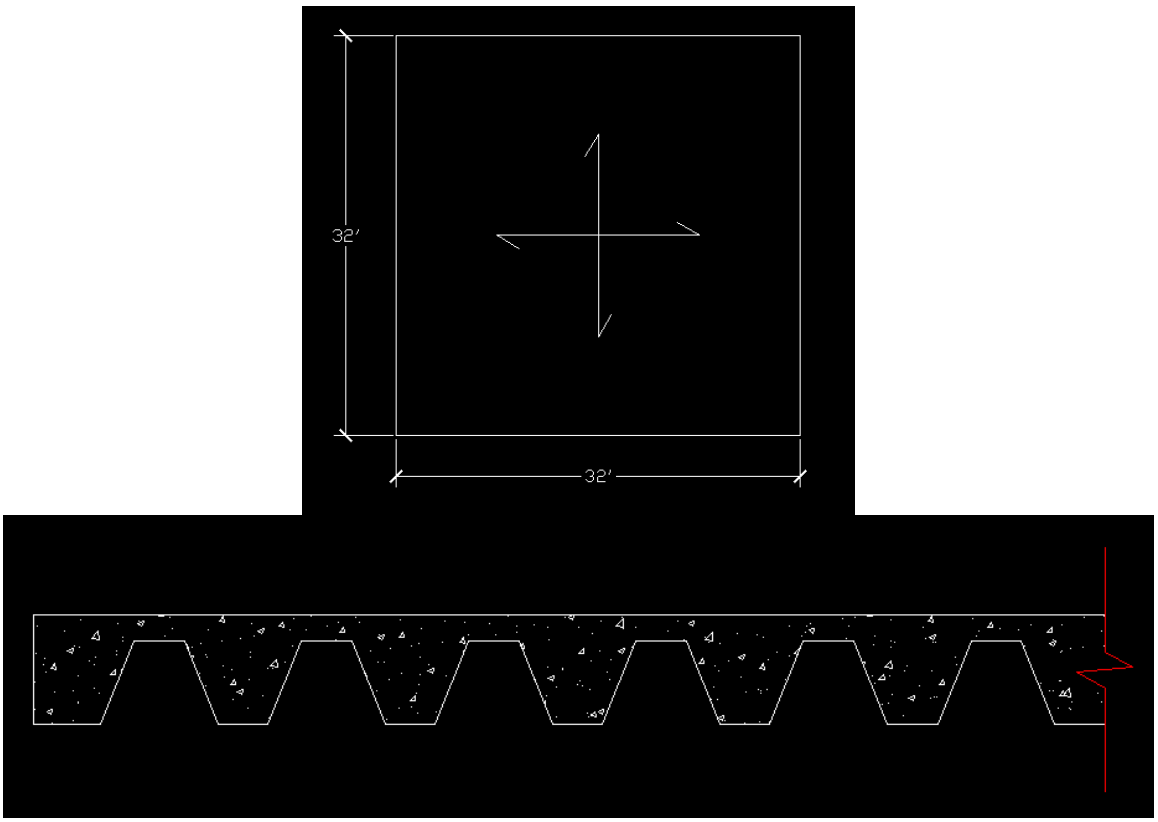


Figure 3

An advantage offered by the waffle slab is its floor depth. Having reduced more than 10" of total floor depth could result in higher floor to ceiling height or reduce building height leading to reduced cost. Also the price per square foot compared to the original system is reduced. Greatest concern is the significant increase in self weight. This added load could increase member sizes and even affect the foundation.

ALTERNATE SYSTEM 3

HOLLOW CORE

PCI design handbook was referenced to design the hollow core planks (see *Figure 4*). The hollow core planks were designed to span 32’ and carry total service load of 85 PSF. 4’x 8” light weight concrete hollow core with 2” topping was selected for the third alternate floor system. Six number 8 straight (68-S) strands were used to span 32’. The 8” member and 2” topping add to 10” of total depth. 68 PSF is the self weight of the hollow core plus the topping. And cost of this floor system is $21.30 per square foot.

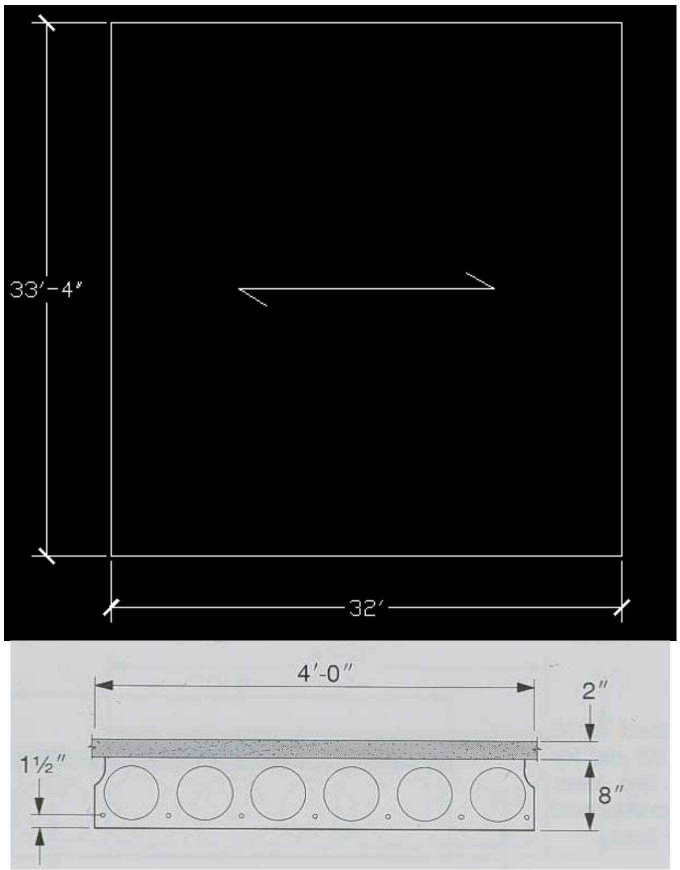


Figure 4

Using the hollow core offers many advantages. First and foremost, hollow core planks can reduce construction time. Added to possible reduction in construction time are very small floor depth and the option to run MEP through the hollowed out areas of concrete. Ease of construction is another positive for this system due to its prefabrication. A downside is the increase in self weight. This added weight may require redesign of the foundation systems.

ALTERNATE SYSTEM 4

DOUBLE TEE

The fourth floor system investigated was the double tee (see *Figure 5*). With the aid of PCI design handbook, 8'x 24" light weight concrete double tee with 2" topping was selected. 4 number 8 straight strands were used to span 32'. 24" member with 2" topping made the total floor depth 26" and total self weight added up to 65 PSF. The cost of construction was $20.38 per square foot.

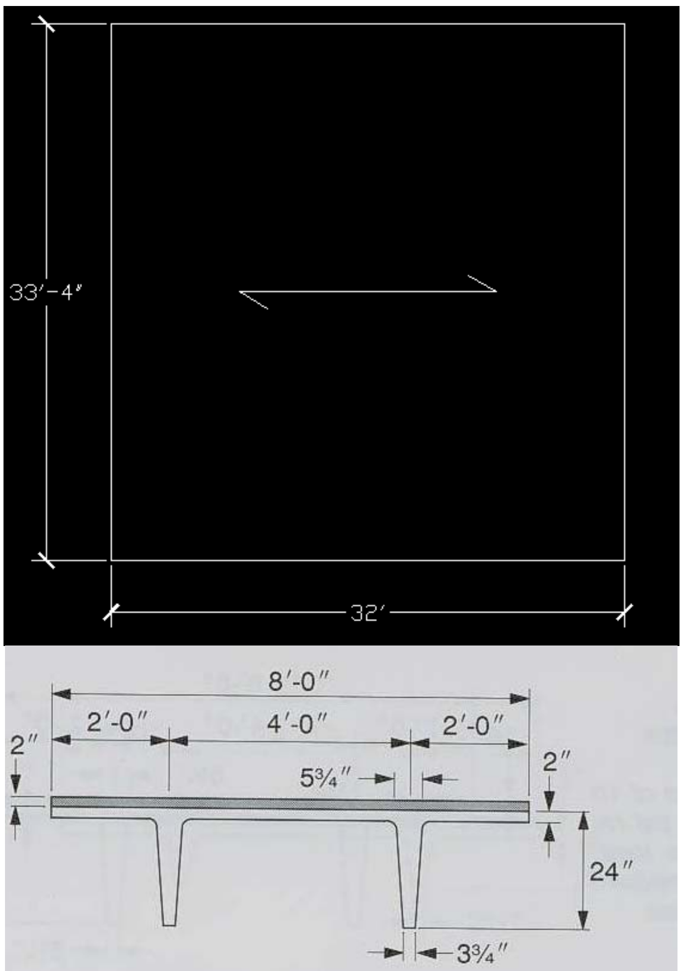


Figure 5

The double tee is a cost effective alternative to the original construction. Being a prefabricated member, erection time can be reduced. The major downfall to this system is the 26" floor depth compared to the original 23.6" floor depth. Also the added self weight requires foundation design check.

ALTERNATE SYSTEM 5

POST TENSIONED SLAB

Post tensioned two-way flat slab was considered a possible alternative floor system (see *Figure 6*). Design of the slab was according to the post-tensioned concrete design handbook by Atlas Prestressing Corp. Bay size of 32'x 32' was selected and the thickness of slab for the span was 8.5". Calculated self weight of the slab is 106 PSF. According to RS Means, cost of this floor system is $20.25 per square foot.

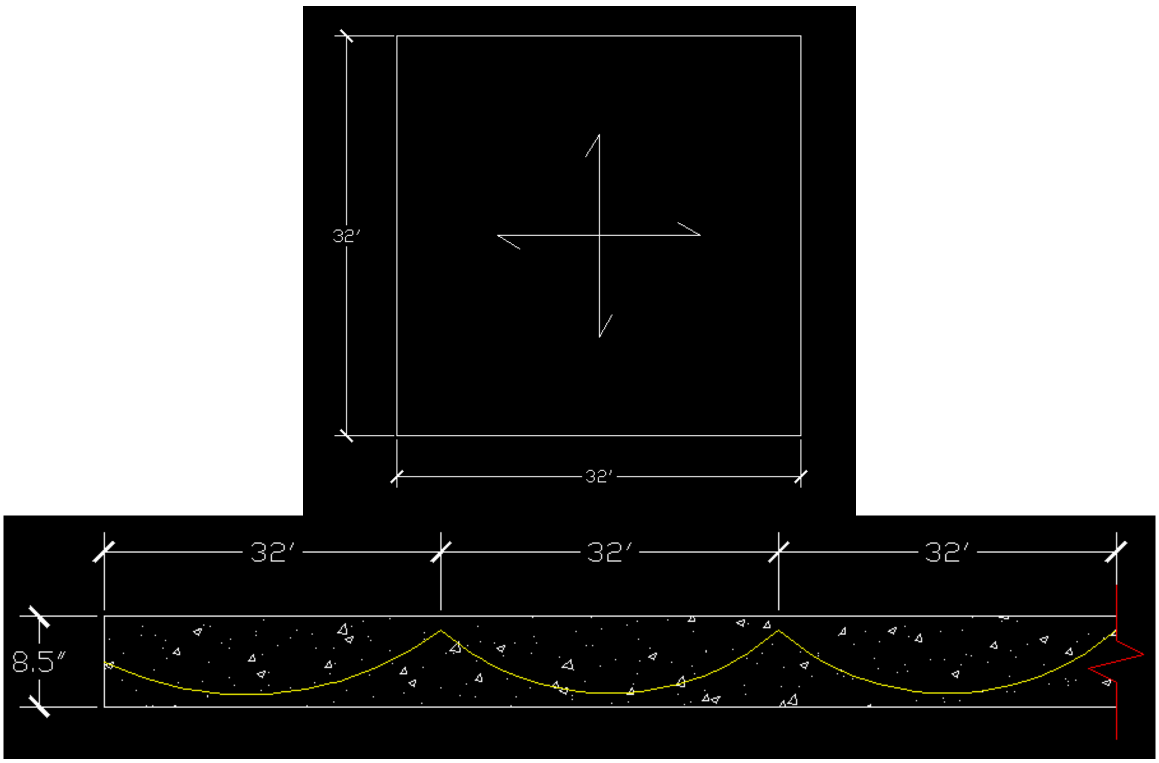


Figure 6

Post tensioned slab is found to have the least cost per square foot of construction. Add advantage to the cost is significant reduction in floor depth. Thickness of the slab being only 8.5", building height could be dramatically reduced. Reduction in building height will save cladding cost, cost of heating and cooling, and the cost of wires and pipes throughout the building. Large increase in self weight is a concern. Also for post-tensioned slab, the building would be designed as a concrete structure. Therefore redesign of foundation can be expected.

COMPARISON CHART

SYSTEMS	DEPTH (inch)	SELF WEIGHT (PSF)	COST ($/SF) material + labor
ORIGINAL composite	23.6	50	20.80 13.90 + 6.10 + 0.80*
ALTERNATIVE 1 change in beam spacing	23.8	50	20.80** 13.90 + 6.10 + 0.80*
ALTERNATIVE 2 waffle slab	13	95	20.35 10.65 + 9.70
ALTERNATIVE 3 hollow core	10	68	21.30 16.10 + 5.20
ALTERNATIVE 4 double tee	26	65	20.38 15.90 + 4.48
ALTERNATIVE 5 post tension	8.5	106	20.25 11.54 + 8.71

*Cost of fireproofing
**Although not indicated in RS Means the change in beam spacing should lead to reduced labor cost

CONSIDERATIONS

Various systems were considered in alternative floor system analysis. Few systems that were not included in the written report but shown in the appendix were non-composite floor system and multi-span one way joist. Weighing the improvement versus the downside led to their exclusion in this report. Increase in cost and floor depth without much in return made the non-composite system very unappealing alternative. On site curing leading to increase in construction time along with significant increase in the self weight discounted the one way joist.

Conclusion

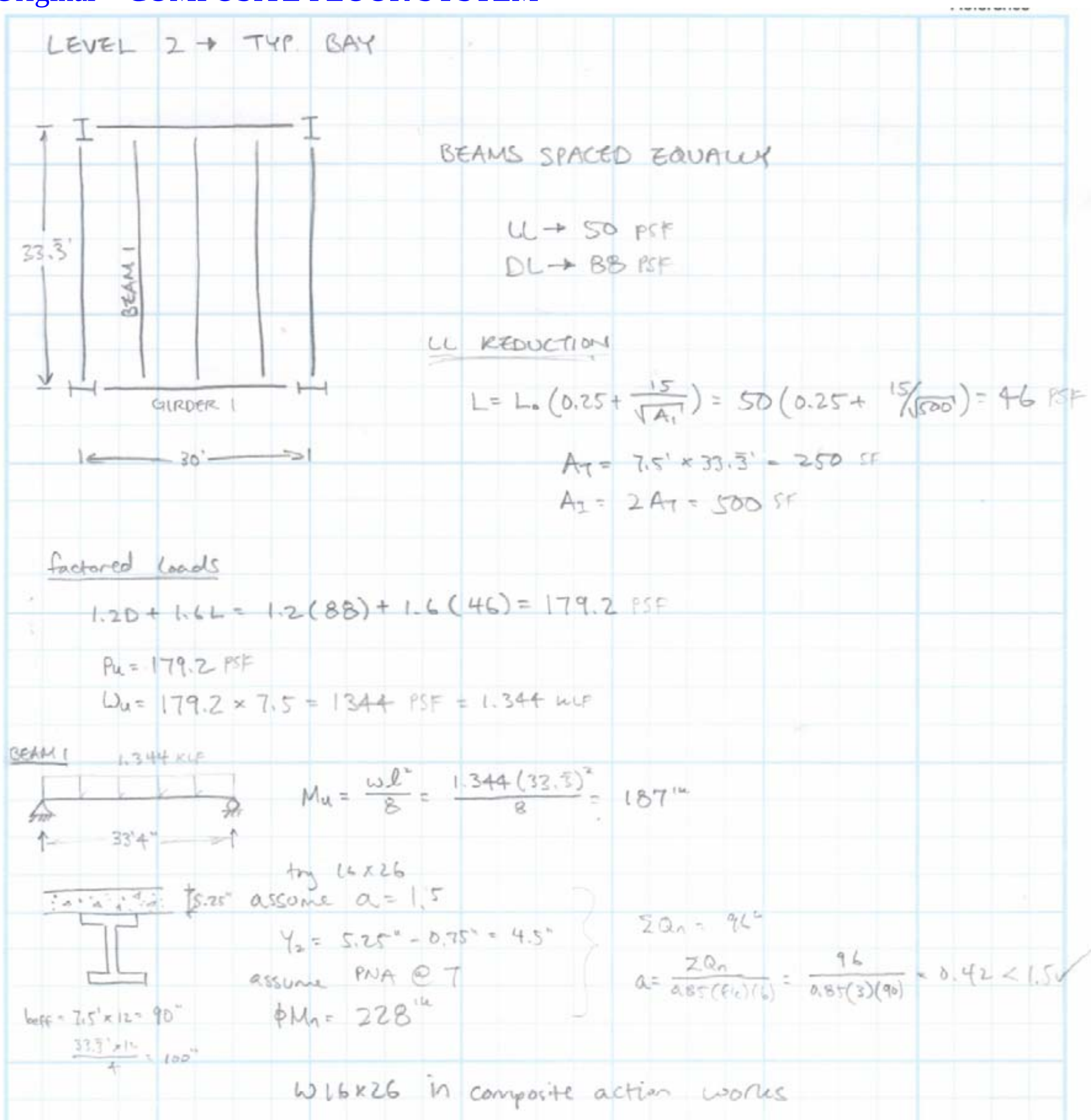
Of the alternative systems reported in this document, two systems will not be considered for further analysis. The waffle slab is not a viable option due to drastic increase in self weight. Almost doubling the self weight will lead to increase in member size and may necessitate redesign of the foundation. Also the double tee will not be pursued due to its increase in floor depth.

Although vibration was not considered in this preliminary design, the change in beams spacing offered a cost effective alternative floor system. The deck currently employed was found to be adequate. If floor vibration is in the acceptable range, this floor system would be worth pursuing. The hollow core may offer a substantial reduction in construction time and prefabrication increases the ease of construction. Hence hollow core is another viable alternative. Post-tension offers cost savings and the reduced floor depth makes it an attractive alternative. With the knowledge of its performance, current system is an efficient and reliable floor system.

APPENDICES

APPENDIX A: CALCULATIONS

Original – COMPOSITE FLOOR SYSTEM



LEVEL 2 → TYP. BAY

BEAMS SPACED EQUALLY

LL → 50 PSF
DL → 88 PSF

LL REDUCTION

$L = L_o(0.25 + \frac{15}{\sqrt{A_I}}) = 50(0.25 + 15/\sqrt{500}) = 46$ PSF

$A_T = 7.5' \times 33.\bar{3}' = 250$ SF
$A_I = 2A_T = 500$ SF

factored loads

$1.2D + 1.6L = 1.2(88) + 1.6(46) = 179.2$ PSF

$P_u = 179.2$ PSF
$W_u = 179.2 \times 7.5 = 1344$ PSF $= 1.344$ KLF

$M_u = \frac{wl^2}{8} = \frac{1.344(33.\bar{3})^2}{8} = 187^{'k}$

try 16x26
assume $a = 1.5$
$Y_2 = 5.25" - 0.75" = 4.5"$
assume PNA @ T
$\phi M_n = 228^{'k}$

$\Sigma Q_n = 96^k$

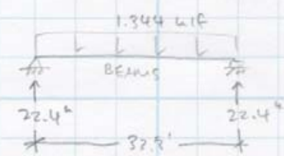
$a = \frac{\Sigma Q_n}{0.85(f'_c)(b)} = \frac{96}{0.85(3)(90)} = 0.42 < 1.5$ ✓

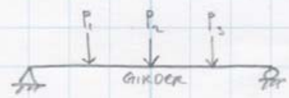
$b_{eff} = 7.5' \times 12 = 90"$
$\frac{33.3' \times 12}{4} = 100"$

W16x26 in composite action works

Original – COMPOSITE FLOOR SYSTEM

GIRDER 1

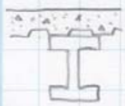




$P_1 = P_2 = P_3 = 44.8^k$

assume equal load from beams in next bay

$$M_u = \frac{P_2 l}{4} + \frac{P_1 bx}{l} + \frac{P_3 bx}{l} = \frac{44.8(30)}{4} + \frac{44.8(7.5)(15)}{30} + \frac{44.8(7.5)(15)}{30} = 672^{'k}$$



try 24x55
assume a = 1.5
$Y_2 = 4.5''$
assume PNA @ 7
$\phi M_n = 678^{'k}$

$\Sigma Q_n = 204^k$

$$a = \frac{204}{0.85(3)(90)} = 0.89 < 1.5 ✓$$

$b_{eff} = 33.3' \times 12 = 400''$

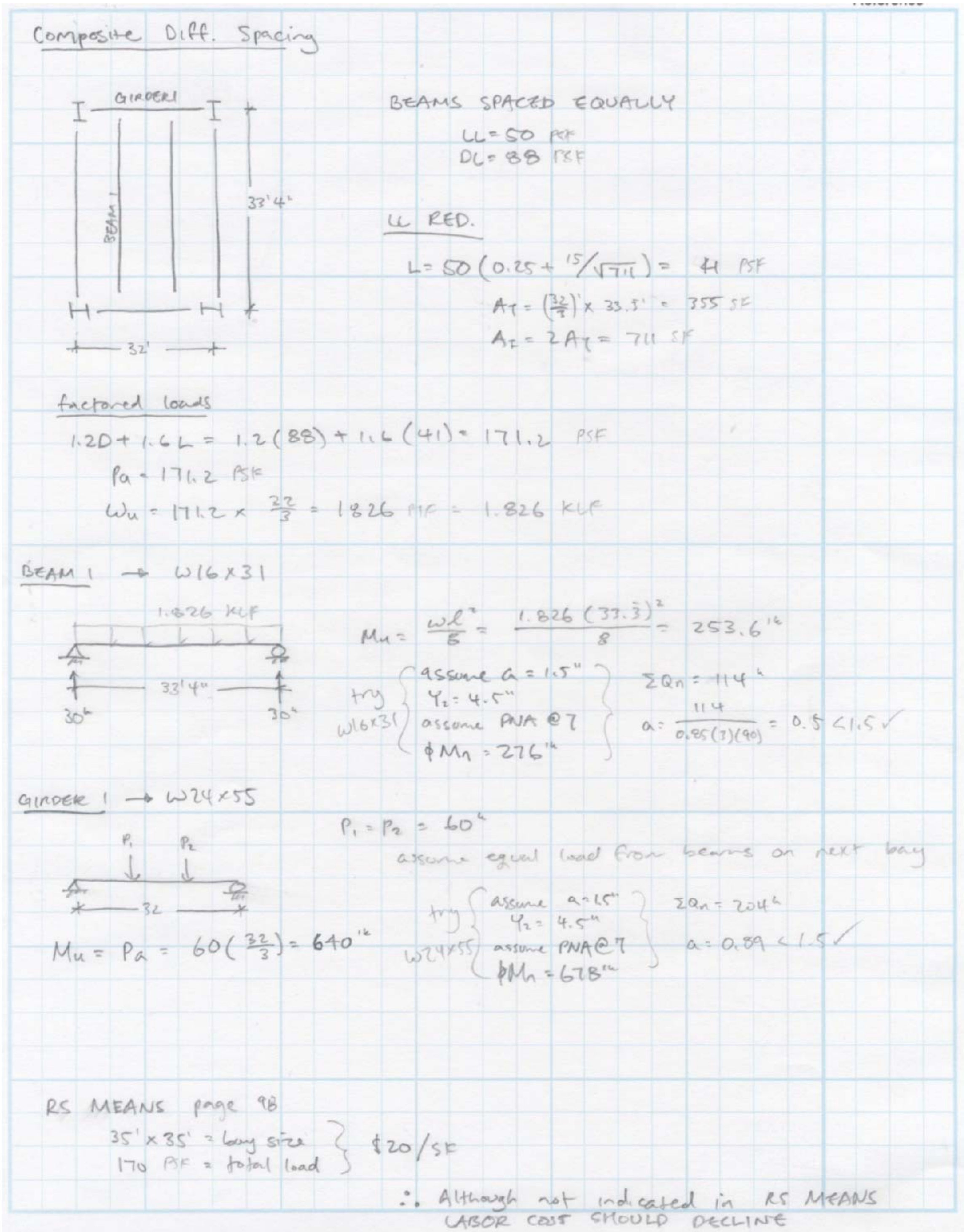
$= \frac{30' \times 12}{4} = 90''$

W 24x55 in composite action works

∴ From loads calculated composite beam and girders are adequate. The sizes chosen are also resonable.

RS MEANS page 98
35'x35' = bay size
170 PSF = total load
} \$20/SF

Alternative 1 – CHANGE IN BEAM SPACING



Composite Diff. Spacing

BEAMS SPACED EQUALLY

LL = 50 PSF
DL = 88 PSF

LL RED.

$L = 50\left(0.25 + 15/\sqrt{711}\right) = 41$ PSF

$A_T = \left(\frac{32}{3}\right) \times 33.3' = 355$ SF

$A_I = 2A_T = 711$ SF

factored loads

$1.2D + 1.6L = 1.2(88) + 1.6(41) = 171.2$ PSF

$P_a = 171.2$ PSF

$\omega_u = 171.2 \times \frac{32}{3} = 1826$ PLF $= 1.826$ KLF

BEAM 1 → W16x31

$M_u = \frac{wl^2}{8} = \frac{1.826(33.\bar{3})^2}{8} = 253.6'^k$

try W16x31 { assume a = 1.5", Y_2 = 4.5", assume PNA @ 7, $\phi M_n = 276'^k$ }

$\Sigma Q_n = 114^k$

$a = \frac{114}{0.85(3)(90)} = 0.5 < 1.5$ ✓

GIRDER 1 → W24x55

$P_1 = P_2 = 60^k$

assume equal load from beams on next bay

$M_u = P_a = 60\left(\frac{32}{3}\right) = 640'^k$

try W24x55 { assume a = 1.5", Y_2 = 4.5", assume PNA @ 7, $\phi M_n = 678'^k$ }

$\Sigma Q_n = 204^k$

a = 0.89 < 1.5 ✓

RS MEANS page 98

35' x 35' = bay size
170 PSF = total load } $20/SF

∴ Although not indicated in RS MEANS LABOR COST SHOULD DECLINE

Alternative 2 – WAFFLE SLAB

2 WAY SLAB → CRSI DESIGN HANDBOOK 2002

32' x 32' bay

LL = 50 PSF
DL = 35 PSF
} 1.2D + 1.6L = 116 PSF

WAFFLE FLAT SYSTEM 30" x 30" VOIDS : 6" RIBS @ 36"

f'c = 4000 psi

fy = 60 000 psi

① Interior Span

33' > 32' ✓

150 PSF > 116 PSF ✓

Column Strip

Steel = 3.07 PSF

NO. RIB = 5 (Bottom)

BARS/RIB = 1 #6, 1 #7 (Bottom)

TOP BARS = 25 #6

Middle Strip

Steel = 3.07 PSF

NO. RIB = 6 (bottom)

Long bars = #5 (bottom)

Short bars = #5 (bottom)

Top bars = 12 #5

11-20

② Exterior Span

33' > 32' ✓

150 PSF > 116 PSF ✓

Column Strip

Steel = 3.42 PSF

Top edge bars = 25 #5 plus 10 #5

Bottom bars = 2 #8 per rib in 5 ribs

Top int. bars = 27 #6

Middle Strip

NO. RIB = 6 (bottom)

Long bars = #6 (bottom)

Short bars = #6 (bottom)

Top int. bars = 13 #5

Depth = 13" = 10" rib + 3" Slab

0.609 CF/SF

Wt. = 150 lb/CF (0.609 CF/SF) + 3.42 PSF = 94.77 PSF

RS MEANS page 71

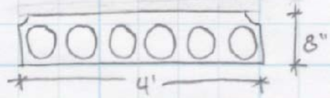
35' x 35' - bay size

174 PSF = $20.35/SF

Alternative 3 – HOLLOW CORE

Hollow-Core → PCI DESIGN HANDBOOK 5TH Edition

Span = 32'
LL = 50 PSF } Total 85 PSF
DL = 35 PSF



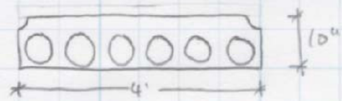
① Hollow-Core 4'x8" Light Weight Conc. untopped (page 2-27)

f'c = 5000 psi
f'ci = 3500 psi
wt. = 46 PSF

Strand Designation Code → 68-S, Span 32' } Allowable Service Load = 90 PSF
90 > 85 ✓

② Hollow-Core 4'x10" Normal Weight Conc. untopped (page 2-28)

f'c = 5000 psi
f'ci = 3500 psi
wt. = 68 PSF



Strand Designation Code → 58-S, span 32' } Allowable Service load = 87 PSF
87 > 85 ✓

→ RS MEANS page 72

30' = span
100 PSF = SUPERIMPOSED LOAD } $8.53/SF

③ Hollow-Core 4'x8" Light Weight Conc. 2" Normal Weight Topping (page 2-27)

f'c = 5000 psi
f'ci = 3500 psi
wt. = 68 psf

Strand Designation Code → 68-S, Span 32' } Allowable Service load = 103 PSF
103 > 85 ✓

→ RS MEANS page 73

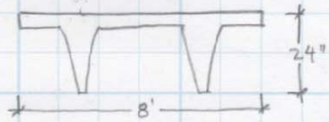
35' = span
100 PSF = Superimposed load } $11.65/SF

Alternative 4 – DOUBLE TEE

Double Tee → PCI DESIGN HANDBOOK 5TH Edition

SPAN = 32'

LL = 50 PSF
DL = 35 PSF } Total 85 PSF



① Double Tee 8' x 24" Light weight Conc. untopped (page 2-10)

f'c = 5,000 psi

f_y = 270,000 psi

wt. = 40 PSF

Strand Pattern Designation → 68-S
span 36' > 32' } Allowable service load = 118 PSF
118 > 85 ✓

→ RS MEANS page 74

30' = Span
100 PSF = superimposed Load } $9.30/SF

① Double Tee 8'x24" Light Weight Conc. 2" Normal Weight Topping (page 2-10)

f'c = 5000 psi

f_y = 270,000 psi

wt. = 65 PSF

Strand Pattern Designation → 48-S
span 32' } Allowable Service Load = 110 PSF
110 > 85 ✓

→ RS MEANS page 75

30' = span
100 PSF = Superimposed load } $11.36/SF

Alternative 5 – POST TENSION

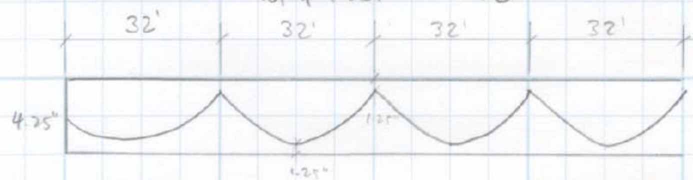
2 WAY FLAT SLAB → POST TENSIONED

Suggested span / depth ratio = 45

$t = \frac{32' \times 12}{45} = 8.5"$

Gravity Loads → 8.5" Slab = 106 PSF
Partition = 20 PSF
Live load = 50 PSF
Total load = 176 PSF

$W_{pre} = 0.9(106) = 95$ PSF
$W_{net} = 176 - 95 = 81$ PSF



$M_{pre} = \frac{0.095(32)^2}{8} = 12.16^k$

$a = 4.25"$

$F = \frac{12.16}{4.25/12} = 34.33^k$

$F/A = 34.33/(8.5 \times 12) = 0.337$ ksi

℄ $M_n = \frac{0.081 \times 32^2}{12} = 6.9^{'k}$

$S = 2 \times 8.5^2 = 144.5$ in³

$\frac{M}{S} = \frac{6.9(12)(1000)}{144.5} = 573$

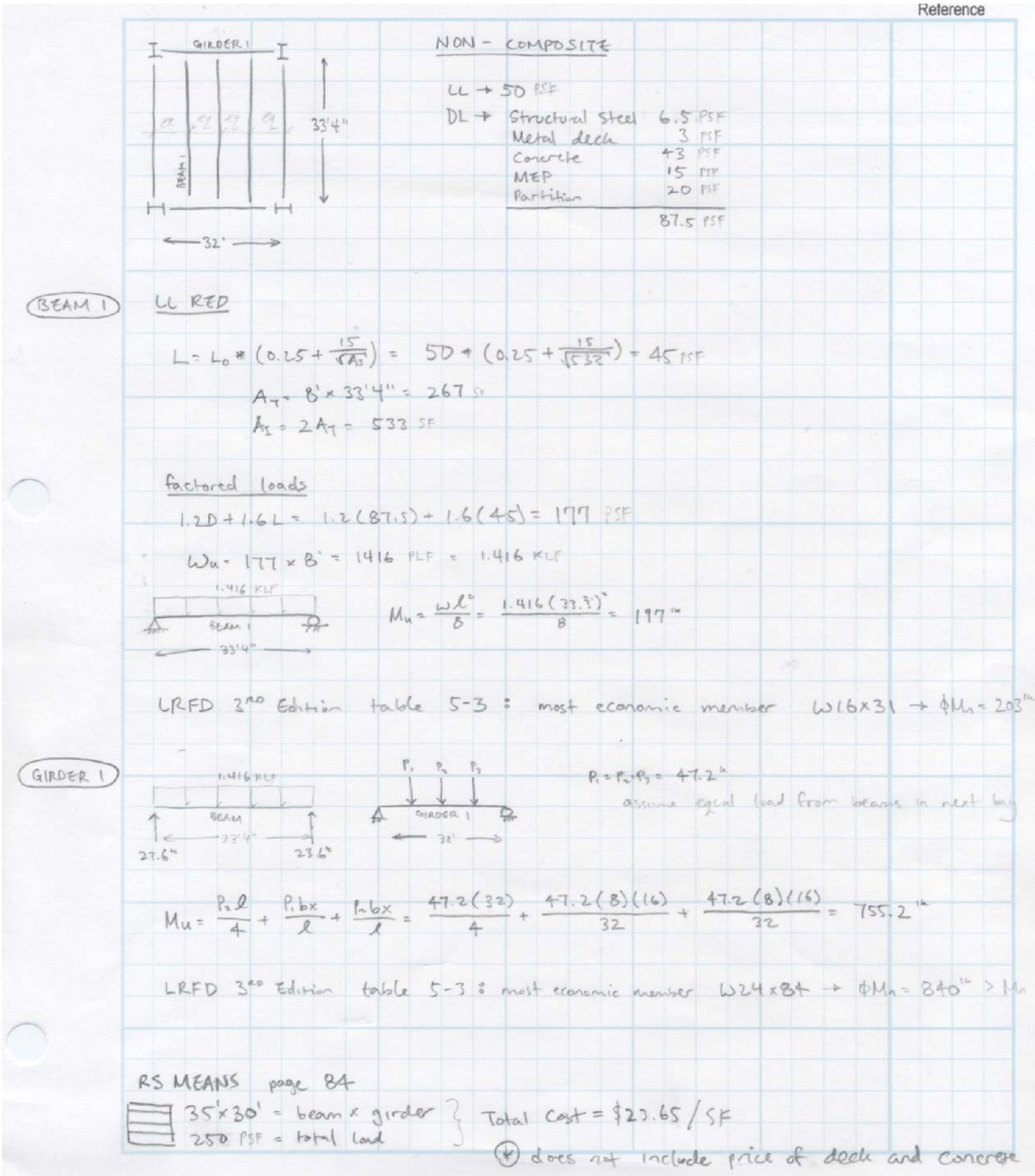
$f = (-F/A) \pm \frac{M}{S} = -337 \pm 573 =$ 236 < $7.5\sqrt{f'c}$ = 474 psi ✓
−910 < $0.6 f'c$ = 2400 psi ✓

Cost

Labor + Material + Equipment
\$305/CY + \$440/CY + \$27/CY = \$772/CY = \$28.59/CF

\$20.25/SF ← RS MEANS BUILDING CONSTRUCTION COST DATA 2006

Consideration – NON COMPOSITE



Reference

NON - COMPOSITE

LL → 50 PSF

DL → Structural Steel 6.5 PSF
Metal deck 3 PSF
Concrete 43 PSF
MEP 15 PSF
Partition 20 PSF
87.5 PSF

(BEAM 1)

LL RED

$L = L_o * (0.25 + \frac{15}{\sqrt{A_I}}) = 50 * (0.25 + \frac{15}{\sqrt{533}}) = 45$ PSF

$A_T = 8' \times 33'4" = 267$ SF

$A_I = 2A_T = 533$ SF

factored loads

$1.2D + 1.6L = 1.2(87.5) + 1.6(45) = 177$ PSF

$W_u = 177 \times 8' = 1416$ PLF $= 1.416$ KLF

$M_u = \frac{w\ell^2}{8} = \frac{1.416(33.3)^2}{8} = 197$ 'k

LRFD 3rd Edition table 5-3 : most economic member W16x31 → $\phi M_n = 203$ 'k >

(GIRDER 1)

$P_1 = P_2 = P_3 = 47.2^k$
assume equal load from beams in next bay

$M_u = \frac{P_2 \ell}{4} + \frac{P_1 bx}{\ell} + \frac{P_3 bx}{\ell} = \frac{47.2(32)}{4} + \frac{47.2(8)(16)}{32} + \frac{47.2(8)(16)}{32} = 755.2$ 'k

LRFD 3rd Edition table 5-3 : most economic member W24x84 → $\phi M_n = 840$ 'k > M_u

RS MEANS page 84

35'x30' = beam x girder
250 PSF = total load
} Total Cost = $23.65 / SF

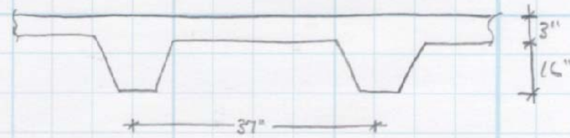
(*) does not include price of deck and concrete

Consideration – ONE WAY JOIST

ONE-WAY JOIST → CRSI DESIGN HANDBOOK 2002

SPAN = 32'
LL = 50 PSF
DL = 35 PSF } $1.2D + 1.6L = 1.2(50) + 1.6(35) = 116$ PSF

Standard One-Way Joist Multiple Spans
30" form + 6" RIB
f'c = 4000 psi
fy = 60000 psi



@ Interior Span = 32'

Δ check not neccessary if $t \geq l_n/21$

$t \geq 32(12)/21 = 18.28"$

t = 19" = 16" deep rib + 3" top slab (page 8-24) ∴ Δ ✓

TOP BARS #5 @ 11 o.c.
BOTTOM BARS #5, #5 } Allowable factored load = 145 PSF > 116 ✓

wt. = 78 PSF (table 8-1)

@ Exterior Span = 32'

Δ check not neccessary if $t \geq l_n/18.5$

$t \geq 32(12)/18.5 = 20.76"$

If Exterior Span = 28'

$t \geq 28(12)/18.5 = 18.16"$

t = 19" = 16" deep rib + 3" top slab (page 8-24) ∴ Δ ✓

TOP BARS #4 @ 10 o.c.
Bottom Bars #5, #5 } Allowable factored load = 119 PSF > 116 ✓

wt. 78 PSF (table 8-1)

RS MEANS page 69

35' x 35' = bay size
172 PSF = total load } $16.45/SF

APPENDIX B: DESIGN AIDS

Original – COMPOSITE FLOOR SYSTEM

MANUAL OF STEEL CONSTRUCTION LRFD 3RD EDITION

Alternative 1 – CHANGE IN BEAM SPACING

MANUAL OF STEEL CONSTRUCTION LRFD 3RD EDITION

Alternative 2 – WAFFLE SLAB

11-20

WAFFLE FLAT SLAB SYSTEM 30″ X 30″ Voids: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Total Depth = 13 in. Rib Depth = 10 in. Total Slab Depth = 3 in.

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column: $c_1 = c_2$ (in.)	Square Edge Column: γ_f	Square Edge Column: (2) Stirrups	Column Strip: Top Edge No.-size +	Column Strip: Bottom No. Ribs	Column Strip: Bottom Bars per Rib	Column Strip: Top Interior No.-size	Middle Strip: Bottom No. Ribs	Middle Strip: Bottom Long Bars	Middle Strip: Bottom Short Bars	Middle Strip: Top Interior No.-size	Moments: −M Edge (ft-k)	Moments: +M Bot. (ft-k)	Moments: −M Int. (ft-k)
18'- 0" D= 6.500 RIB ON COLUMN LINE 0.597 CF/SF	50	1.86	12	0.664		13-#5+ 0	3	2-#4	13-#5	3	#4	#4	5-#5	28	56	76
18'- 0"	100	1.86	12	0.687		13-#5+ 0	3	2-#4	13-#5	3	#4	#4	5-#5	37	77	98
18'- 0"	150	1.92	12	0.711		13-#5+ 0	3	1-#4 and 1-#5	13-#5	3	#4	#4	5-#5	45	106	121
18'- 0"	200	1.98	12	0.735		13-#5+ 0	3	2-#5	13-#5	3	#4	#4	5-#5	53	132	144
18'- 0"	300	2.16	12	0.782		13-#5+ 0	3	1-#5 and 1-#6	13-#5	3	#4	#5	5-#5	70	185	189
18'- 0"	400	2.61	12	0.830		13-#5+ 0	3	1-#6 and 1-#7	13-#5	3	#5	#6	5-#5	87	236	235
21'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.637 CF/SF	50	1.84	12	0.735		15-#5+ 0	4	2-#4	15-#5	3	#4	#4	6-#5	47	93	125
21'- 0"	100	1.84	12	0.763		15-#5+ 0	4	2-#4	15-#5	3	#4	#4	6-#5	60	128	162
21'- 0"	150	2.01	12	0.791		15-#5+ 0	4	2-#5	15-#5	3	#4	#5	6-#5	74	174	199
21'- 0"	200	2.19	12	0.818		15-#5+ 0	4	1-#5 and 1-#6	15-#5	3	#5	#5	6-#5	87	218	236
21'- 0"	300	2.63	12 *	0.874		15-#5+ 0	4	1-#6 and 1-#7	15-#5	3	#6	#6	6-#5	115	302	309
21'- 0"	400	3.13	12 *	0.634		15-#5+ 0	4	2-#7	18-#5	3	#7	#7	6-#5	142	385	383
24'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.613 CF/SF	50	1.92	12	0.801		18-#5+ 0	4	1-#4 and 1-#5	18-#5	4	#4	#4	7-#5	69	138	186
24'- 0"	100	1.98	12	0.831		18-#5+ 0	4	2-#5	18-#5	4	#4	#4	7-#5	90	190	242
24'- 0"	150	2.32	12	0.862		18-#5+ 0	4	2-#6	18-#5	4	#5	#5	7-#5	111	260	298
24'- 0"	200	2.57	12 *	0.892		18-#5+ 0	4	1-#6 and 1-#7	18-#5	4	#5	#6	7-#5	131	325	353
24'- 0"	300	3.32	12 *	0.634		18-#5+ 0	4	2-#8	16-#6	4	#6	#7	7-#5	172	453	464
24'- 0"	400	4.07	16 *	0.628		18-#5+ 1	4	2-#9	20-#6	4	#7	#7	9-#5	210	564	565
27'- 0" D= 9.500 RIB NOT RIB NOT ON COLUMN LINE 0.597 CF/SF	50	1.96	13	0.824		20-#5+ 0	4	2-#5	20-#5	5	#4	#4	8-#5	98	196	264
27'- 0"	100	2.22	13	0.860		20-#5+ 0	4	2-#6	20-#5	5	#4	#5	8-#5	127	263	343
27'- 0"	150	2.49	13 *	0.896		20-#5+ 0	4	2-#7	20-#5	5	#5	#5	8-#5	157	363	422
27'- 0"	200	3.03	13 *	0.632		20-#5+ 0	4	2-#8	25-#5	5	#5	#6	8-#5	186	455	502
27'- 0"	300	3.99	18 *	0.626		20-#5+ 1	4	2-#9	23-#6	5	#6	#7	8-#6	240	617	647
30'- 0" D=12.500 RIB ON COLUMN LINE 0.624 CF/SF	50	2.12	15	0.829		22-#5+ 0	5	1-#5 and 1-#6	22-#5	5	#4	#5	9-#5	136	272	367
30'- 0"	100	2.31	15 *	0.887		22-#5+ 3	5	2-#6	23-#5	5	#5	#5	9-#5	177	353	475
30'- 0"	150	2.95	15 *	0.933		22-#5+ 6	5	2-#7	28-#5	5	#6	#6	9-#5	217	483	584
30'- 0"	200	3.53	18 *	0.626		22-#5+ 3	5	2-#8	24-#6	5	#6	#7	11-#5	255	604	686
33'- 0" D=12.500 RIB ON COLUMN LINE 0.609 CF/SF	50	2.25	16 *	0.867		25-#5+ 2	5	2-#6	25-#5	6	#4	#5	10-#5	180	360	485
33'- 0"	100	2.71	16 *	0.922		25-#5+ 6	5	2-#7	31-#5	6	#5	#5	10-#5	234	467	629
33'- 0"	150	3.42	19 *	0.931		25-#5+10	5	2-#8	27-#6	6	#6	#6	13-#5	285	614	768
33'- 0"	200	4.05	25 *	0.621	3 S 4 1	25-#5+ 3	5	2-#9	32-#6	6	#6	#7	15-#5	331	711	892
36'- 0" D=12.500 RIB ON COLUMN LINE 0.597 CF/SF	50	2.52	18 *	0.875		27-#5+ 3	5	2-#7	31-#5	7	#5	#5	11-#5	231	463	623
36'- 0"	100	3.15	19 *	0.926		27-#5+ 9	5	2-#8	40-#5	7	#5	#6	13-#5	300	601	808
36'- 0"	150	3.93	27 *	0.620	3 S 4 1	27-#5+ 5	5	2-#9	35-#6	7	#6	#6	11-#6	362	725	976

SQUARE INTERIOR PANELS

Total Depth = 13 in. Rib Depth = 10 in. Total Slab Depth = 3 in.

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Interior Column: $c_1 = c_2$ (in.)	Square Interior Column: (2) Stirrups	Column Strip: Bottom No. Ribs	Column Strip: Bottom Bars per Rib	Column Strip: Top Interior No.-size	Middle Strip: Bottom No. Ribs	Middle Strip: Bottom Long Bars	Middle Strip: Bottom Short Bars	Middle Strip: Top Interior No.-size
18'- 0"	50	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
18'- 0"	100	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
18'- 0"	150	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
18'- 0"	200	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
18'- 0"	300	1.95	12	3 S 4 1	3	1-#4 and 1-#5	13-#5	3	#4	#4	5-#5
18'- 0"	400	2.28	12	3 S 4 1	3	1-#5 and 1-#6	13-#5	3	#4	#5	5-#5
21'- 0"	50	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
21'- 0"	100	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
21'- 0"	150	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
21'- 0"	200	1.93	12		4	1-#4 and 1-#5	15-#5	3	#4	#4	6-#5
21'- 0"	300	2.22	12	3 S 4 1	4	2-#5	15-#5	3	#5	#5	6-#5
21'- 0"	400	2.69	12 *	3 S 4 1	4	2-#6	17-#5	3	#5	#6	6-#5
24'- 0"	50	1.86	12		4	2-#4	18-#5	4	#4	#4	7-#5
24'- 0"	100	1.86	12		4	2-#4	18-#5	4	#4	#4	7-#5
24'- 0"	150	2.05	12		4	2-#5	18-#5	4	#4	#4	7-#5
24'- 0"	200	2.25	12	3 S 4 1	4	1-#5 and 1-#6	18-#5	4	#4	#5	7-#5
24'- 0"	300	2.78	12 *	3 S 4 1	4	1-#6 and 1-#7	21-#5	4	#5	#5	7-#5
24'- 0"	400	3.49	13 *	3 S 4 1	4	2-#7	18-#6	4	#6	#6	9-#5
27'- 0"	50	1.86	13		4	2-#4	20-#5	5	#4	#4	8-#5
27'- 0"	100	2.02	13		4	2-#5	20-#5	5	#4	#4	8-#5
27'- 0"	150	2.13	13	3 S 4 1	4	1-#5 and 1-#6	20-#5	5	#4	#4	8-#5
27'- 0"	200	2.61	13 *	3 S 4 1	4	1-#6 and 1-#7	23-#5	5	#4	#5	8-#5
27'- 0"	300	3.55	14 *	3 S 4 2	4	1-#7 and 1-#8	21-#6	5	#5	#6	10-#5
30'- 0"	50	1.94	15		5	1-#4 and 1-#5	22-#5	5	#4	#4	9-#5
30'- 0"	100	2.03	15		5	2-#5	22-#5	5	#4	#4	9-#5
30'- 0"	150	2.63	15 *	3 S 4 1	5	2-#6	26-#5	5	#5	#5	9-#5
30'- 0"	200	3.12	15 *	3 S 4 1	5	1-#6 and 1-#7	22-#6	5	#5	#6	10-#5
33'- 0"	50	2.06	16		5	2-#5	25-#5	6	#4	#4	10-#5
33'- 0"	100	2.46	16 *	3 S 4 1	5	2-#6	28-#5	6	#4	#5	10-#5
33'- 0"	150	3.07	16 *	3 S 4 1	5	1-#6 and 1-#7	25-#6	6	#5	#5	12-#5
33'- 0"	200	3.63	18 *	3 S 4 2	5	2-#7	30-#6	6	#5	#6	10-#6
36'- 0"	50	2.16	18	3 S 4 1	5	1-#5 and 1-#6	28-#5	7	#4	#4	11-#5
36'- 0"	100	2.79	18 *	3 S 4 1	5	1-#6 and 1-#7	37-#5	7	#4	#5	12-#5
36'- 0"	150	3.62	18 *	3 S 4 2	5	1-#7 and 1-#8	33-#6	7	#5	#5	15-#5

See the notes on page 11-19.

CRSI Design Handbook 2002 page 11-20

Alternative 3 – HOLLOW CORE

HOLLOW-CORE

4′-0″ x 8″
Lightweight Concrete

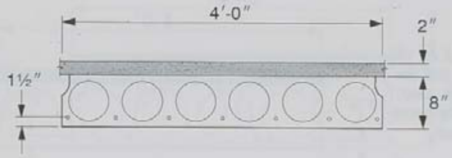
Strand Pattern Designation

76–S

- S = straight
- Diameter of strand in 16ths
- No. of strand (7)

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load. Check availability of lightweight sections.

Capacity of sections of other configurations are similar. For precise values, see local hollow-core manufacturer.



f'_c = 5,000 psi
f'_{ci} = 3,500 psi

Section Properties

		Untopped		Topped	
A	=	215	in²	—	
I	=	1,666	in⁴	3,529	in⁴
y_b	=	4.00	in.	5.70	in.
y_t	=	4.00	in.	4.30	in.
S_b	=	416	in³	619	in³
S_t	=	416	in³	821	in³
b_w	=	12.00	in.	12.00	in.
wt	=	184	plf	272	plf
		46	psf	68	psf
V/S	=	1.92	in.		

Key
346 — Safe superimposed service load, psf
0.3 — Estimated camber at erection, in.
0.4 — Estimated long-time camber, in.

4LHC8

Table of safe superimposed service load (psf) and cambers (in.) **No Topping**

Strand Designation Code	Span, ft																						
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
66-S	346	297	257	224	196	172	152	135	120	107	95	85	76	68	61	55	49	44	39	35			
	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.1	0.0			
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.0	−0.1	−0.3	−0.5	−0.8			
76-S		348	302	263	231	204	181	161	144	129	115	104	93	84	76	68	62	56	50	45	41	36	
		0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.4	0.3	0.2	0.0	
		0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.3	0.1	−0.1	−0.3	−0.6	−0.9	
58-S		350	325	304	286	265	236	211	189	170	154	139	126	114	104	95	86	79	72	66	60	55	50
		0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	0.9	0.8	0.7
		0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	0.9	0.8	0.7	0.5	0.2	0.0
68-S			334	313	292	274	258	243	229	206	187	169	154	140	128	117	107	98	90	83	76	70	64
			0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.4
			1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.3	1.1	0.9
78-S			343	319	301	283	267	249	237	225	212	197	181	165	151	139	127	117	108	100	92	85	78
			0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.1	2.1
			1.2	1.3	1.4	1.5	1.6	1.8	1.9	2.0	2.0	2.1	2.2	2.2	2.3	2.3	2.3	2.3	2.2	2.2	2.1	2.0	1.8

4LHC8+2

Table of safe superimposed service load (psf) and cambers (in.) **2″ Normal Weight Topping**

Strand Designation Code	Span, ft																						
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
66-S	320	277	242	211	186	163	144	127	113	100	88	78	69	60	53	45							
	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.2							
	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.0	−0.1	−0.3	−0.5	−0.7	−1.0							
76-S		327	286	251	222	196	174	155	138	123	109	98	87	77	69	61	52	43					
		0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.4	0.3					
		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.2	0.1	−0.1	−0.3	−0.6	−0.9	−1.2					
58-S				327	290	258	231	206	185	167	150	135	122	110	99	90	81	72	62	53	45		
				0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.8	0.7		
				0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.6	0.4	0.2	0.0	−0.2	−0.5	−0.9	−1.3		
68-S					323	304	278	250	225	204	184	167	151	138	125	114	103	93	83	73	64	56	48
					1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.3	1.2
					1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.1	0.9	0.8	0.6	0.3	0.0	−0.3	−0.7	−1.2
78-S					332	313	297	279	263	238	216	197	179	163	149	136	125	113	102	91	81	72	64
					1.3	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.2	2.1	2.1	2.0
					1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.5	1.3	1.1	0.9	0.6	0.2	−0.1

Strength based on strain compatibility; bottom tension limited to $6\sqrt{f'_c}$; see pages 2-2–2-6 for explanation.

PCI Design Handbook 5th Edition page2-27

Alternative 4 – DOUBLE TEE

Strand Pattern Designation

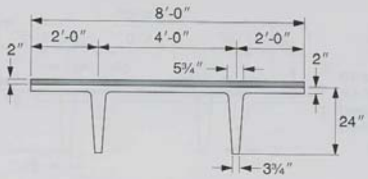
108-D1
- No. of strand (10)
- S = straight D = depressed
- No. of depression points
- Diameter of strand in 16ths

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

Key
118 — Safe superimposed service load, psf
1.1 — Estimated camber at erection, in.
1.4 — Estimated long-time camber, in.

DOUBLE TEE

8′-0″ x 24″
Lightweight Concrete



f'_c = 5,000 psi
f_{pu} = 270,000 psi

Section Properties

		Untopped		Topped	
A	=	401	in^2	—	
I	=	20,985	in^4	29,857	in^4
y_b	=	17.15	in.	19.94	in.
y_t	=	6.85	in.	6.06	in.
S_b	=	1,224	in^3	1,497	in^3
S_t	=	3,063	in^3	4,926	in^3
wt	=	320	plf	520	plf
		40	psf	65	psf
V/S	=	1.41	in.		

8LDT24

Table of safe superimposed service load (psf) and cambers (in.) — No Topping

Strand Pattern	e_e, in. e_c, in.	Span, ft																						
		36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
68-S	11.15 11.15	118 1.1 1.4	103 1.2 1.4	89 1.2 1.5	78 1.3 1.5	69 1.3 1.5	60 1.4 1.5	53 1.4 1.4	46 1.4 1.4	40 1.3 1.2	35 1.3 1.0	30 1.2 0.8												
88-S	9.15 9.15	144 1.2 1.6	126 1.3 1.6	110 1.4 1.7	97 1.5 1.8	86 1.6 1.8	76 1.6 1.8	67 1.6 1.8	59 1.6 1.7	53 1.6 1.6	47 1.6 1.5	41 1.6 1.3	36 1.5 1.0	32 1.4 0.7										
88-D1	9.15 14.40		176 1.9 2.4	156 2.1 2.6	139 2.2 2.8	124 2.4 2.9	111 2.5 3.0	99 2.7 3.1	89 2.8 3.2	80 2.9 3.2	72 3.0 3.2	64 3.0 3.1	58 3.1 2.9	52 3.1 2.8	47 3.0 2.6	42 3.0 2.4	38 2.9 2.1	34 2.8 1.8						
108-D1	7.15 14.15								113 3.3 3.9	102 3.4 4.0	93 3.6 4.1	84 3.7 4.1	76 3.8 4.1	69 3.9 4.0	63 4.0 3.9	57 4.1 3.8	52 4.1 3.5	47 4.0 3.2	43 3.9 2.8	38 3.8 2.4	35 3.6 1.9	31 3.4 1.3		
128-D1	5.48 13.9																65 4.8 4.7	59 4.9 4.5	54 4.9 4.2	50 4.9 3.8	45 4.8 3.4	41 4.7 2.8	38 4.5 2.2	34 4.3 1.5
148-D1	4.29 13.65																						46 5.6 3.8	42 5.5 3.2

8LDT24+2

Table of safe superimposed service load (psf) and cambers (in.) — 2″ Normal Weight Topping

Strand Pattern	e_e, in. e_c, in.	Span, ft																					
		26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68
48-S	14.15 14.15	193 0.6 0.6	159 0.6 0.6	132 0.7 0.7	110 0.8 0.7	92 0.8 0.7	76 0.9 0.6	63 0.9 0.6	52 1.0 0.5	43 1.0 0.4	34 1.0 0.2												
68-S	11.15 11.15			185 0.9 0.9	157 0.9 0.9	133 1.0 0.9	113 1.1 0.9	96 1.2 0.9	82 1.2 0.9	70 1.3 0.8	59 1.3 0.7	50 1.4 0.5	41 1.4 0.3	34 1.4 0.0									
68-D1	11.15 14.65					166 1.2 1.2	143 1.4 1.3	123 1.5 1.3	106 1.6 1.3	91 1.7 1.3	79 1.8 1.2	68 1.9 1.1	58 1.9 0.9	49 2.0 0.7	42 2.0 0.5	35 2.0 0.2							
88-D1	9.15 14.40						200 1.8 1.8	175 1.9 1.9	153 2.1 1.9	134 2.1 1.8	117 2.4 2.0	103 2.5 1.9	90 2.7 1.9	79 2.8 1.7	70 2.9 1.6	61 3.0 1.3	53 3.0 1.0	46 3.1 0.6	40 3.1 0.2				
108-D1	7.15 14.15													106 3.3 2.4	94 3.4 2.3	84 3.6 2.1	74 3.7 1.9	66 3.8 1.6	58 3.9 1.3	51 4.0 0.8	45 4.1 0.3		
128-D1	5.48 13.90																					53 4.8 0.7	46 4.9 0.1

Strength based on strain compatibility; bottom tension limited to $12\sqrt{f'_c}$; see pages 2-2–2-6 for explanation.
Shaded values require release strengths higher than 3500 psi.

PCI Design Handbook 5th Edition page2-10

Alternative 5 – POST TENSION

POST-TENSIONED CONCRETE DESIGN WORKBOOK

APPENDIX C: COST DATA

Original – COMPOSITE FLOOR SYSTEM

310 Superstructure

1010 Floor Construction

1010 256 — Composite Beams, Deck & Slab

	BAY SIZE (FT.)	SUPERIMPOSED LOAD (P.S.F.)	SLAB THICKNESS (IN.)	TOTAL DEPTH (FT.-IN.)	TOTAL LOAD (P.S.F.)	COST PER S.F.		
						MAT.	INST.	TOTAL
000	35 x 35	125	5-1/2	2 - 8-1/2	170	13.90	6.10	20
200		200	5-1/2	2 - 11-1/2	254	15.90	6.75	22.65
400	35x40	40	5-1/2	2 - 5-1/2	85	11.50	5.35	16.85
500		75	5-1/2	2 - 5-1/2	121	12.45	5.50	17.95
000		125	5-1/2	2 - 5-1/2	171	14.25	6.20	20.45
000		200	5-1/2	2 - 11-1/2	255	17.25	7.05	24.30

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Alternative 1 – CHANGE IN BEAM SPACING

RS Means page 98

Alternative 2 – WAFFLE SLAB

B1010 Floor Construction

B1010 227 — Cast in Place Waffle Slab

	BAY SIZE (FT.)	SUPERIMPOSED LOAD (P.S.F.)	MINIMUM COL. SIZE (IN.)	RIB DEPTH (IN.)	TOTAL LOAD (P.S.F.)	COST PER S.F.		
						MAT.	INST.	TOTAL
6900	30 x 35	40	16	12	169	10.20	9.50	19.70
7000		75	18	12	204	10.20	9.50	19.70
7100		125	22	12	254	10.60	9.80	20.40
7200		200	26	14	334	11.55	10.35	21.90
7400	35 x 35	40	16	14	174	10.65	9.70	20.35
7500		75	20	14	209	10.85	9.85	20.70
7600		125	24	14	259	11.05	10	21.05
7700		200	26	16	346	11.75	10.50	22.25
8000	35 x 40	40	18	14	176	10.90	9.85	20.75
8300		75	22	14	211	11.20	10.10	21.30
8500		125	26	16	271	11.65	10.30	21.95
8750		200	30	20	372	12.60	10.85	23.45
9200	40 x 40	40	18	14	176	11.20	10.10	21.30
9400		75	24	14	211	11.55	10.35	21.90
9500		125	26	16	271	11.80	10.45	22.25
9700	40 x 45	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Alternative 3 – HOLLOW CORE

B1010 238	Precast Beam & Plank with 2″ Topping							
	BAY SIZE (FT.)	SUPERIMPOSED LOAD (P.S.F.)	PLANK THICKNESS (IN.)	TOTAL DEPTH (IN.)	TOTAL LOAD (P.S.F.)	COST PER S.F.		
						MAT.	INST.	TOTAL
4300	20x20	40	6	22	135	14.35	5.55	19.90
4400	RB1010 -010	75	6	24	173	15.15	5.55	20.70
4500		100	6	28	200	15.60	5.55	21.15
4600	20x25	40	6	26	134	13.45	5.55	19
5000	RB1010 -100	75	8	30	177	14.25	5.25	19.50
5200		100	8	30	202	14.25	5.25	19.50
5400	25x25	40	6	38	143	14.85	5.50	20.35
5600		75	8	38	183	14.85	5.50	20.35
6000		100	8	46	216	16.30	5.20	21.50
6200	25x30	40	8	38	144	13.85	5.20	19.05
6400		75	10	46	200	15.15	4.97	20.12
6600		100	10	46	225	15.15	4.97	20.12
7000	30x30	40	8	46	150	15.05	5.20	20.25
7200		75	10	54	181	16.10	5.20	21.30
7600		100	10	54	231	16.10	5.20	21.30
7800	30x35	40	10	54	166	14.95	4.94	19.89
8000		75	12	54	200	15.60	4.76	20.36
8200	35x35	40	10	62	170	15.45	4.94	20.39
9300		75	12	62	206	16.65	5.60	22.25
9500	35x40	40	12	62	167	15.95	5.55	21.50
9600	40x40	40	12	62	173	16.75	5.55	22.30

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Alternative 4 – DOUBLE TEE

B1010 239	Precast Double "T" & 2″ Topping on Precast Beams							
	BAY SIZE (FT.)	SUPERIMPOSED LOAD (P.S.F.)	DEPTH (IN.)		TOTAL LOAD (P.S.F.)	COST PER S.F.		
						MAT.	INST.	TOTAL
3000	25x30	40	38		130	14	4.51	18.51
3100	RB1010 -100	75	38		168	14	4.51	18.51
3300		100	46		196	14.65	4.51	19.16
3600	30x30	40	46		150	15.20	4.48	19.68
3750		75	46		174	15.20	4.48	19.68
4000		100	54		203	15.90	4.48	20.38
4100	30x40	40	46		136	12.40	4.25	16.65
4300		75	54		173	12.95	4.25	17.20
4400		100	62		204	13.60	4.25	17.85
4600	30x50	40	54		138	11.85	4.11	15.96
4800		75	54		181	12.35	4.11	16.46
5000		100	54		219	13.60	3.87	17.47
5200	30x60	40	62		151	12.50	3.88	16.38
5400		75	62		192	13.10	3.88	16.98
5600		100	62		215	13.05	3.88	16.93
5800	35x40	40	54		139	13.20	4.24	17.44
6000		75	62		179	14.35	4.12	18.47
6250		100	62		212	14.65	4.12	18.77
6500	35x50	40	62		142	12.60	4.11	16.71
6750		75	62		186	13.15	4.11	17.26
7300		100	62		231	15.20	3.87	19.07

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Alternative 4 – DOUBLE TEE

03400 | Precast Concrete

03410		Plant-Precast Structural Concrete		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	2006 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
100	1300	24" x 44"	R034105-30	C-11	22	3.273	Ea.	1,100	128	70	1,298	1,525
	1400	30' span, 12" x 36"			24	3		1,200	117	64	1,381	1,575
	1450	18" x 44"			20	3.600		1,500	141	77	1,718	1,975
	1500	24" x 52"			16	4.500		1,925	176	96	2,197	2,525
	1600	40' span, 12" x 52"			20	3.600		2,200	141	77	2,418	2,750
	1650	18" x 52"			16	4.500		2,625	176	96	2,897	3,300
	1700	24" x 52"			12	6		2,875	235	128	3,238	3,725
	2000	"T" shaped, 20' span, 12" x 20"			32	2.250		1,325	88	48	1,461	1,650
	2050	18" x 36"			24	3		1,500	117	64	1,681	1,925
	2100	24" x 44"			22	3.273		1,875	128	70	2,073	2,375
	2200	30' span, 12" x 36"			24	3		2,025	117	64	2,206	2,500
	2250	18" x 44"			20	3.600		2,550	141	77	2,768	3,125
	2300	24" x 52"			16	4.500		3,275	176	96	3,547	4,000
	2500	40' span, 12" x 52"			20	3.600		3,750	141	77	3,968	4,425
	2550	18" x 52"			16	4.500		4,475	176	96	4,747	5,325
	2600	24" x 52"			12	6		4,900	235	128	5,263	5,950
210	0010	**PRECAST COLUMNS**	R034105-30									
	0020	Rectangular to 12' high, small columns		C-11	120	.600	L.F.	42.50	23.50	12.85	78.85	102
	0050	Large columns			96	.750		74.50	29.50	16.05	120.05	151
	0300	24' high, small columns			192	.375		42.50	14.65	8	65.15	81.50
	0350	Large columns			144	.500		74.50	19.55	10.70	104.75	128
400	0010	**PRECAST JOISTS**	R034105-30									
	0015	40 psf L.L., 6" deep for 12' spans		C-12	600	.080	L.F.	7.10	2.80	1.06	10.96	13.30
	0050	8" deep for 16' spans			575	.083		11.85	2.92	1.11	15.88	18.75
	0100	10" deep for 20' spans			550	.087		20.50	3.05	1.16	24.71	29
	0150	12" deep for 24' spans			525	.091		28.50	3.20	1.21	32.91	37.50
620	0010	**PRECAST SLAB PLANKS**	R034105-30									
	0020	Prestressed roof/floor members, grouted, solid, 4" thick		C-11	2400	.030	S.F.	4.44	1.17	.64	6.25	7.65
	0050	6" thick			2800	.026		5.50	1.01	.55	7.06	8.40
	0100	Hollow, 8" thick	CN		3200	.023		5.75	.88	.48	7.11	8.40
	0150	10" thick			3600	.020		6.10	.78	.43	7.31	8.55
	0200	12" thick			4000	.018		6.90	.70	.38	7.98	9.25
650	0010	**PRESTRESSED CONCRETE** post-tensioned in place	R034105-30									
	0020	See also Division 03230-600										
	0100	Post-tensioned in place, small job	R034136-90	C-17B	8.50	9.647	C.Y.	585	355	32	972	1,225
	0200	Large job		"	10	8.200	"	440	305	27	772	985
660	0010	**PRESTRESSED** Roof and floor members, see Division 03400	R034105-30									

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APPENDIX D: DECK CAPACITY

			L, Uniform Live Loads, psf *												
	Slab Depth	φMn in.k	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00
22 gage	4.50	40.27	400	370	315	270	235	205	180	160	140	125	110	100	90
	5.00	46.44	400	400	365	315	270	240	210	185	165	145	130	115	105
	5.25	49.53	400	400	390	335	290	255	225	195	175	155	140	125	110
	5.50	52.61	400	400	400	355	310	270	235	210	185	165	150	130	120
	6.00	58.78	400	400	400	400	345	300	265	235	210	185	165	150	135
	6.25	61.87	400	400	400	400	365	320	280	245	220	195	175	155	140
	6.50	64.95	400	400	400	400	380	335	295	260	230	205	185	165	145
	7.00	71.12	400	400	400	400	400	365	320	285	250	225	200	180	160
20 gage	4.50	48.60	400	400	385	335	290	255	225	200	175	155	140	125	115
	5.00	56.18	400	400	400	385	335	295	260	230	205	180	165	145	130
	5.25	59.96	400	400	400	400	360	315	275	245	220	195	175	155	140
	5.50	63.75	400	400	400	400	380	335	295	260	230	205	185	165	150
	6.00	71.32	400	400	400	400	400	375	330	290	260	230	210	185	170
	6.25	75.11	400	400	400	400	400	395	345	310	275	245	220	200	180
	6.50	78.90	400	400	400	400	400	400	365	325	290	255	230	210	185
	7.00	86.47	400	400	400	400	400	400	400	355	315	280	255	230	205

United Steel Deck Design Manuel and Catalog of Products page 39

The 20 gage 5.25" slab depth composite construction is more than adequate to carry the office live load of 50 PSF and the corridor live load of 100 PSF through the 11' span.