

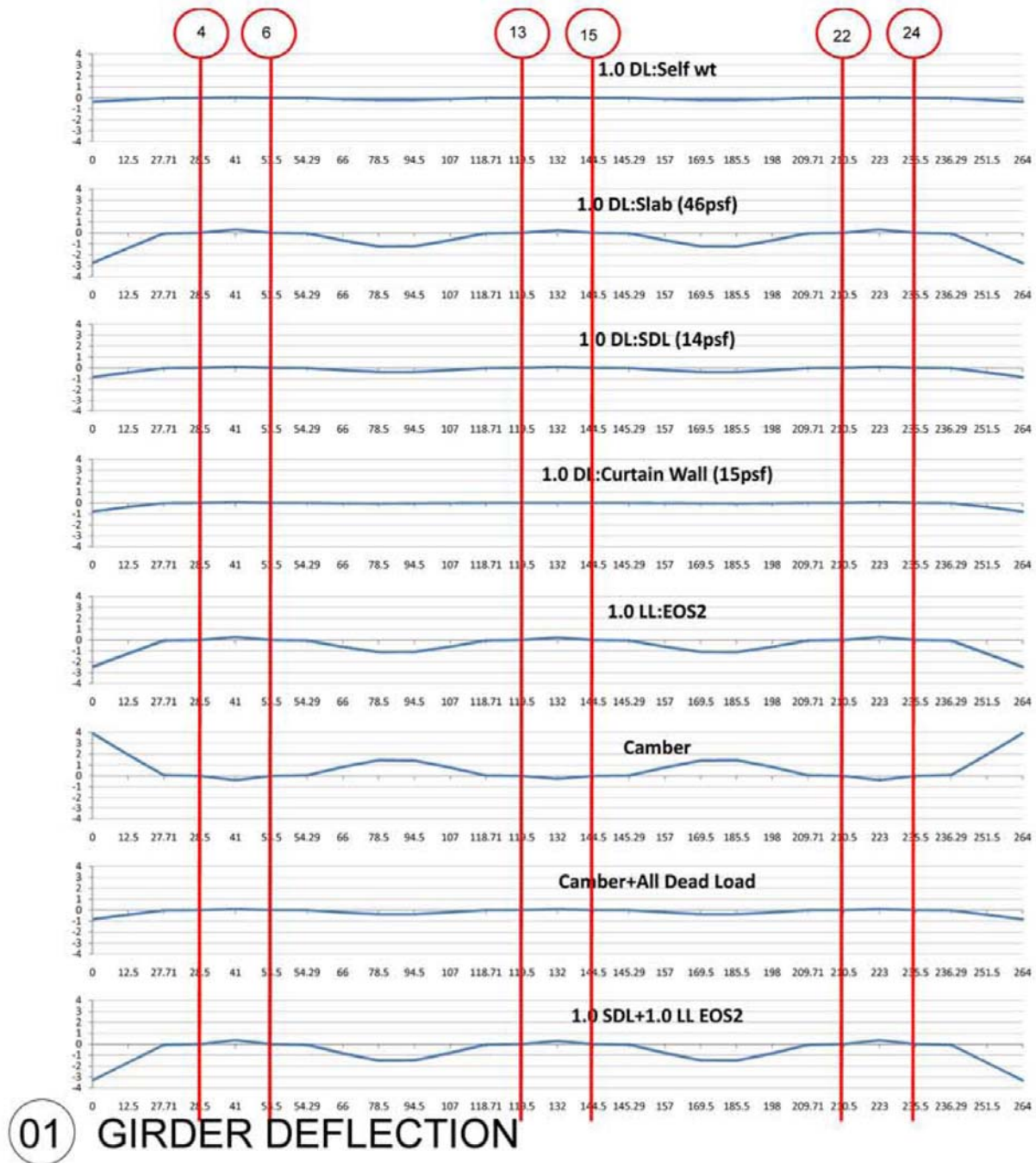
04.04.2012

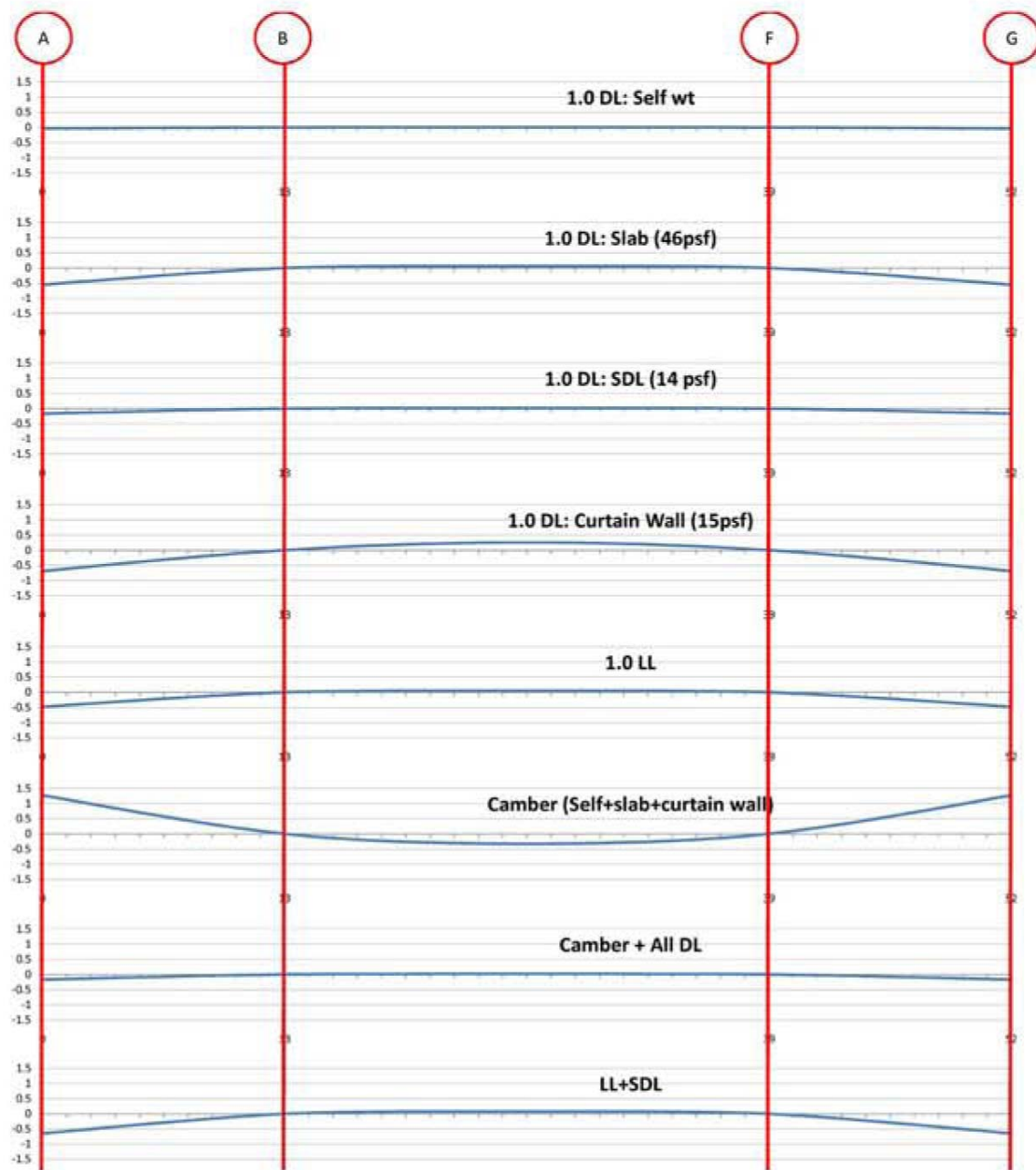
Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices | 29

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Appendices

Appendix A –

Southwest Student Housing
Tempe, Arizona
Final Summary Report**02 BEAM DEFLECTION**

TECH 1		APPENDICES - APPENDIX A	2
		SOUTH WEST STUDENT HOUSING	
BUILDING INFORMATION			
- MODEL CODE: IBC 2006 AS AMENDED BY THE CITY OF TEMPE, ARIZONA			
- DESIGN CODES: AISC "SPEC FOR STRUCTURAL STEEL BLDGS" AISC 360-05 ACI "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONC" ACI 318-05			
- STRUCTURAL STANDARDS: <u>ASCE 7-05</u> WILL USE ASCE 7-05, AISC 13TH ED, ACI 318-05, IBC 06			
• DEFLECTION CRITERIA			
↳ STRUCTURAL STEEL IS ALL CAMBERED TO DEAL W/ HIGH DEFLECTIONS.			
OUT OF CURIOSITY - HOW DOES ONE ASSEMBLE A CAMBERED STRUCTURAL STEEL FLOOR IF THE METHOD IS TO SLIDE BEAMS THROUGH PLASMA-CUT HOLES ON HYDRAULIC ROLLERS?			
CHARLIE'S NOTES: $\frac{1}{360}$ FOR LIVE $\frac{1}{240}$ FOR TOTAL $\frac{H}{400}$ FOR DRIFT			
- STRUCTURAL OVERVIEW:			
• FOUNDATIONS - SPREAD SPREAD FOOTING ACCORDING TO CHARLIE			
ACCORDING TO SOILS REPORT RECOMMENDATIONS -			
BLDG WILL EXERT SIGNIFICANT LOADS TO FOUNDATION ELEMENTS.			
↳ EMPLOY DEEP FOUNDATION SYSTEM TO LIMIT SETTLEMENTS			
ACCORDING TO TTC PACKAGE:			
(3) 350 YD ³ CORE MATS, PERIMETER GRADE BEAMS, SLAB ON GRADE ON TOP			
• DRILLED PIERS + MAT			
AXIAL CAPACITY = SKIN FRICTION OF SHAFT + END BEARING AT TIP			
SOILS:			
I SILTY SAND + POORLY GRADED SAND			
DEPTH 10-35'			
FRICTION 0.4 KSF			
END BEARING —			
II SAND GRAVEL COBBLE			
35-100'			
2.5 KSF			
20 KSF			
PIER SHAFTS SHOULD PENETRATE AT LEAST 2.5X PIER ϕ INTO II LAYER			
& NO PIER $\phi < 12"$			
MIN CLEAR SPACING = 3X BIGGEST ADJACENT PIER ϕ			
PREDICTION: FOR ISOLATED PIER, $\phi < 60"$, SETTLEMENT $\leq 1"$			
CHARLIE'S NOTES: BLDG DOESN'T HAVE SETTLING BIG SPANS ARE LONGER → NO DIFFERENTIAL SETTLING LOCAL?			
• FLOOR SYSTEM - TYP. FOR ALL FLOORS - 3.25" LIGHTWEIGHT CONCRETE ON 3" DECK			
OR HAND CALCS, CHARLIE ASSUMED 4.5" LIGHTWEIGHT CONCRETE			
UNREINFORCED CORRUGATED 50 LB LW.C			
(P 14 IN PDF) 20 GAGE			
GO W/ VULCRAFT			
SUPPORTED BY STRUCTURAL STEEL FRAME			
↳ TYP. FRAMING.			
TYP CORE BM = W14X50			
TYP BEAM = W14X40			
TYP INFILL BM = W14X22			
TYP GIRDER = W14X22			
TYP GIRDER = W14X76			
20 @ 12'-6"			
TYP CONTINUOUS EDGE BEAM = W14X22			
15'			
15'			
SEC 1:33			
SHOWS TYP. FRAMING PLAN			
• FRAMING SYSTEM - SEE ABOVE FOR FLOOR FRAMING SYSTEM SEE BELOW FOR GRAVITY FRAMING SYSTEM			
• LATERAL SYSTEM - (3) CONCRETE CORES: 8" THICK, 25' X 25' ON CENTER (KIND OF) SPACED 62'-6" APART (STARTING AT CENTER)			

Southwest Student HousingTempe, Arizona
Final Summary Report

APPENDIX	TEMPERATURE	22
TECH 1	SOUTHWEST STUDENT HOUSING	
* ROOF SYSTEM - 3" METAL DECK, 3.25" LWC, 2" RIGID INSULATION, EPDM MEMBRANE * MATERIALS: * STRUCTURAL STEEL - ALL ROLLED SHAPES - ASTM A36 OR A992 GRADE 60 - ALL PLATES & CONNECTION MATERIAL - ASTM A36 - ALL TUBULAR SECTIONS - ASTM A500 GRADE B - ALL PIPE SECTIONS - ASTM A53 GRADE B - ANCHOR BOLTS, U.B.N. - ASTM F1554 4" * CAST-IN-PLACE CONCRETE - FOUNDATIONS - 4 KSI N.W. U.O.N ON PLAN - S.O.G - 4 KSI N.W. - STRUCTURAL S.O.G - 5 KSI N.W. - FORMED SLABS - AS NOTED IN DWGS. (LIVE FLOOR 4 KSI) - WALLS (CORE) - 4-6 KSI * REINFORCEMENT - DEFORMED BARS - ASTM A615 GRADE 60 TOP, GRADE 70 FOR #9, #10, #11 - WELDED WIRE FABRIC - ASTM A195 * WELDING ELECTRODES - E7018 LOW HYDROGEN * BOLTING MATERIALS - ASTM A325 OR A490 U.O.N.		
LOADS - PRESCRIBED: DL (16 KSI) = ACTUAL LL = 40 PSF PUBLIC AREAS = 100 CURTAIN WALL = 15 PSF SLAB DL = 40 PSF SNOW = 25 PSF GROUND 20 PSF PLATEAU WIND = 105 MPH 3-SEC GUST 1.0 = I C = EXPOSURE 1.0 = INTERNAL PRESSURE COEFFICIENT EQ = 1.0 = I II = OCCUPANCY TYPE 0.360 = S_s 0.456 = S_{1s} 0.070 = S₂ 0.191 = S_{2s} 0.019 = C_s S = R F = SITE CLASS C = DESIGN CATEGORY CONCRETE SHEAR WALL = BASIC SEISMIC FORCE-RESISTING SYSTEM 3550 K = DESIGN BASE SHEAR USED EQUIVALENT LATERAL FORCE METHOD		

TECH 1

APPENDICES- APPENDIX B
SOUTHWEST STUDENT HOUSING

25

CALCULATED LOADS

*** GRAVITY**

- CONSTRUCTION DEAD LOAD

- DECK - 3.0 VLI (VULCRAST COMPOSITE DECK) 20 GAGE
3.25" LIGHTWEIGHT CONCRETE
DECK WEIGHT = 2.14 PSF
CONCRETE WEIGHT = 46 PSF
TOTAL = 48.14 PSF
- STRUCTURAL STEEL - ASSUME ≈ 8 PSF
CHECK CURRENT SIZES:

SIZE	LENGTH	#	WT (K)
W18x50	52	6	15.6 K
W18x40	52	12	25 K
W14x22	13	6	1.7 K
W24x176	262.5	2	42.4 K
W14x22	262.5	2	11.6 K
			146.3 K

TYPE FLOOR DIMENSIONS:
250' x 52' = 13,000 SF

APPROX. WEIGHT OF STRUCTURAL STL:
 $\frac{146.3 \times 10^3}{1300} = 11.25 \text{ PSF}$

STRUCTURAL STEEL - ASSUME 11 PSF ✓

→ TOTAL CONSTRUCTION DEAD LOAD = 48.14 + 11 = 59.14 → 59 PSF

- SUPERIMPOSED DEAD LOAD

→ ASSUME SDL OF 15 PSF ← ASSUMPTION BY ENGINEER. SHOULD HAVE CONFIRMED - PARTITIONS NOT INCLUDED.

- LIVE LOAD

- RESIDENTIAL = 40 PSF
- PARKING = 40 PSF
- CORRIDORS = 80 ON FLOORS ABOVE GROUND (PSF)
= 100 ON GROUND FLOOR (PSF)

(THERE IS A 6' WIDE CORRIDOR RUNNING THRU THE CENTER OF THE BUILDING IN THE LONG DIRECTION)
* ENGINEERS JUST TOOK ALL TO BE 40 PSF

LIVE LOAD REDUCTION:

81'-3" 87'-6" 81'-3" 52'

3

TECH 1

APPENDICES-APPENDIX B
SOUTHWEST STUDENT HOUSING

26

CALCULATED LOADS (CONTINUED)

REDUCTION FACTORS:

SECTION	AREA/FLOOR	# FLOORS	FACTOR
I	~9390 SF	1	0.5
		>1	0.41
II	4725 SF	1	0.5
		>1	0.4

} WILL JUST ROUND TO 0.4

$L = L_o \left(0.25 + \frac{15}{\sqrt{K_{LL} A T}} \right)$ $K_{LL} = 1$

≥ 0.5 (1 FLR)
 ≥ 0.4 (>1 FLR)

SAMPLE CALCULATIONS

Section I, 1 Floor:
 $0.25 + \frac{15}{\sqrt{1 \times 9390}} = 0.476 \rightarrow 0.5$

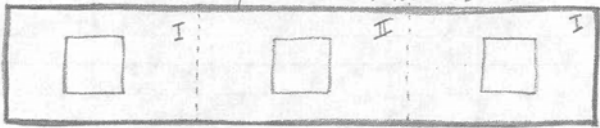
>1 Floor:
2? $0.25 + \frac{15}{\sqrt{1 \times 9390 \times 2}} = 0.41$
3? $0.25 + \frac{15}{\sqrt{1 \times 9390 \times 3}} = 0.38 \rightarrow 0.4$

$80 \text{ PSF} \times 0.5 = 40 \text{ PSF}$ (FOR CORE CALCULATIONS)

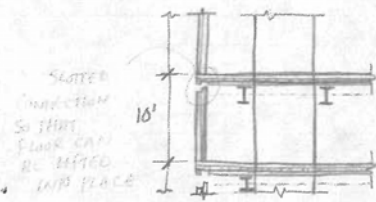
— MECHANICAL EQUIPMENT
ON GROUND FLOOR, w/ 2-PIPE SYSTEM FOR HEATING/COOLING ROOMS
CHILLER, PUMPS, ETC. ON GROUND FLOOR

— WALL LOADS

CURTAIN WALL - 15 PSF



EACH FLOOR SUPPORTS ITS RESPECTIVE "CURTAIN WALL"
 $\therefore$ FLOORS 2-19 HAVE 10' PERIMETER CURTAIN WALLS @ 15 PSF



— SNOW LOADS

$P_s = 0.7 C_e C_t I_p \geq 0$
(FLAT ROOF)

$P_s = 0$

FIGURE 7-1 (ASCE 7-05)

(5000) 10
(4000) 5
(2500) ZERO

TEMPE, AZ IS @
AN ELEVATION OF...
1140-1495 FEET

$1495 < 3500 \rightarrow P_g = 0$

SHOULD TAKE INTO ACCOUNT RAIN LOADS?

Southwest Student Housing
Tempe, Arizona
Final Summary Report

TECH 1

APPENDICES - APPENDIX C
SOUTHWEST STUDENT HOUSING

28

CALCULATED LOADS (CONTINUED)

*** LATERAL**

- WIND LOADS

ASSUME ENCLOSED BUILDING

FIGURE 6-1: 90 MPH NOMINAL S-SEC. JUST WIND SPEED
TABLE 6-1: IMPORTANCE CATEGORY II, FACTOR = 1.0
EXPOSURE CATEGORY B
(URBAN & SUBURBAN AREAS W/ NUMEROUS CLOSELY SPACED OBSTRUCTION ≥ SINGLE FAMILY DWELLINGS FOR 20 X BUILDING HEIGHT $T = 4/60 \text{ SEC}$)
→ JUSTIFIED BY SITE LOCATION IN CENTRAL TEMPE, AZ (SHOW PHOTO OF SITE?)

$G_{CPL} = 0.19$ (ENCLOSED)
 $L/B = \frac{(12.5' \times 0)}{52'} = 4.81 > 4$ (E-W) $= \frac{52}{250} = 0.209$ (N-S)

CP VALUES	E-W	N-S
WU WALL	0.8	0.7
LW WALL	-0.2	-0.5
SIDE WALL	-0.7	-0.7

ASSUME BUILDING IS RIGID (TO BE VERIFIED IN LATER REPORT)
TAKE $G = 0.85$

$q_z = 0.00256 (K_z) (K_{zt}) (K_d) (I) (PSF)$
 $15' \leq z \leq 1200'$
 $K_z = 2.01 \left(\frac{z}{1200} \right)^{2/7}$
 $K_{zt} = 1.0$
 $K_d = 0.85$
 $I = 1.0$ FOR MWFRS & COMPONENTS/CLADDING

$q_z = 0.00256 \left[2.01 \left(\frac{z}{1200} \right)^{2/7} \right] (0.85) (1.0) (1.0)$ PSF
FOR A FLOOR, HEIGHT z OFF THE GROUND

MWFRS: $P = q_z G C_p - q_i (GC_{pi})$ (PSF)

$P = \left[0.00256 \left\{ 2.01 \left(\frac{z}{1200} \right)^{2/7} \right\} 0.85 (90^2) \right] (0.85) C_p$ VARIES DEPENDING ON WALL & DIRECTION!

SO, 2ND FLOOR, WINDWARD WALL, EAST-WEST DIRECTION:
 $z = \frac{18}{2} = 9'$
 $P_w = \left[0.00256 \left\{ 2.01 \left(\frac{9}{1200} \right)^{2/7} \right\} 0.85 (90^2) \right] 0.85 (0.8) \approx 6 \text{ PSF}$

(SEE EXCEL TABLE FOR ALL CALCULATED VALUES, AS WELL AS TOTAL PRESSURE)
 TOTAL PRESSURE = $|WU| + |LW|$

TOTAL HEIGHT IS 208'

19' @ 10'

18'

Southwest Student Housing
Tempe, Arizona
Final Summary Report

TECH 1	APPENDICES APPENDIX D SOUTHWEST STUDENT HOUSING	31
AMPAD		
<u>CALCULATED LOADS (CONTINUED)</u> - SEISMIC LOADS FRAME SYSTEM: ORDINARY CONCRETE WALLS $R = 1.5$ $I = 1.0$ $C_s = \frac{S_{DS}}{(R/I)} \geq 0.01$ $C_s = \frac{S_{D1}}{T(R/I)}$ for $T \leq T_L$ (MAX) $T_a = 0.1 N \sqrt{A} = 0.1(20) = 2.0$ OR $T_a = C_t h_n^{0.75} \approx 1.1 \text{ SEC}$ $S_s = 16\% g$ $S_1 = 8\% g$ $T_L = 6 \text{ SEC}$ } AS PER FIGURES FROM CH 22 OF ASCE 7-05 SITE CLASS = C (ACCORDING TO GEOTECH REPORT) $f_a = 1.2$ $f_v = 1.7$ $S_{ms} = f_a S_s$ $S_{m1} = f_v S_1$ $S_{DS} = \frac{2}{3} S_{ms}$ $S_{D1} = \frac{2}{3} S_{m1}$ $T_0 = 0.2 \frac{S_{D1}}{S_{DS}}$ $T_s = \frac{S_{D1}}{S_{DS}}$ $V = C_s W$ $S_{ms} = 1.2(0.16) = 0.192$ $S_{m1} = 1.7(0.08) = 0.136$ $S_{DS} = \frac{2}{3}(0.192) = 0.128$ $S_{D1} = \frac{2}{3}(0.136) = 0.0907$ $T_0 = 0.2 \frac{0.0907}{0.128} = 0.142$ $T_s = \frac{0.0907}{0.128} = 0.708$ $C_s = \frac{0.128}{1.5/1.0} = 0.0853 \leq \frac{0.0907}{(1.1)1.5/1.0} = 0.055$ $\rightarrow C_s = 0.055$ $W_{TOT} = \sum_{i=1}^{20} W_i$ $W_i = (C_{DL} + S_{DL}) A_{FLOOR} + \text{CURTAIN WALL (PERIMETER)} = (59 + 15) 13,000 + 15(604) = 9771.1 \text{ K}$ $V = (0.055)(1049 \times 20) = 1154 \text{ K}$ (SEE EXCEL TABLE FOR VERTICAL DISTRIBUTION)		

Southwest Student Housing

Tempe, Arizona

Final Summary Report

APPENDICES - APPENDIX E

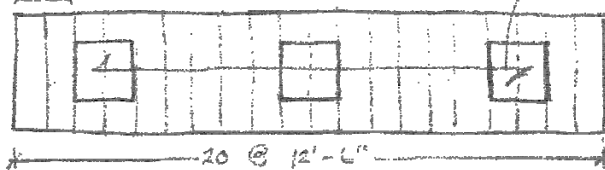
SOUTHWEST STUDENT HOUSING

38

TECH 1

SPOT CHECKS*** METAL DECKING** (SEE PSS OF VULCRIFT STEEL DECK MANUAL) $3\frac{1}{4}"$ LIGHTWEIGHT CONCRETE (110 PCF)

3" 20 GAGE DECK

MAX UNSHORED SPAN:
1 SPAN = 10'-6"
2 SPAN = 12'-10"
3 SPAN = 13'-3"MIN # SPANS? $\rightarrow$ 2 $12'-6" \leq \text{MAX UNSHORED SPAN} \leq 13'-3"$ THP SPAN = 12'-6" < 12'-10" OK

MAX SUPERIMPOSED LIVE LOAD: MAX SPAN = 12'-6"

$$\begin{aligned} &\checkmark \text{ MAX LIVE LOAD} = 75 \text{ PSF} \\ &\text{IMPROVABLE?} \rightarrow 20 \text{ PSF (6' WIDE CORRIDOR)} \\ &\quad + 15 \text{ PSF SUPERIMPOSED DEAD LOAD} \\ &\quad \hline 95 \text{ PSF} \quad 75 \text{ PSF} \quad \text{NG} \end{aligned}$$

SUPERSEDE IT:

$$\text{MAX 18 GAGE (3 VLL 18) SLL} = 169 \text{ PSF} \quad (3 \text{ VLL 18} = 84 \text{ PSF})$$

OK

USE 3" DECK (18 GAGES, MINIMUM) w/ $3\frac{1}{4}"$ LIGHTWEIGHT CONCRETE, 2 SPANS MINIMUM,
@ 12'-6" / SPAN

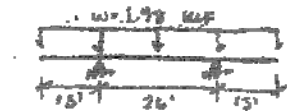
Southwest Student HousingTempe, Arizona
Final Summary Report

TECH 1

APPENDICES - APPENDIX F

3'

SOUTHWEST STUDENT HOUSING

SPOT CHECKS (CONTINUED)*TYPICAL BEAM

$$205 = \text{FACTORED LOAD} = 1.2D + 1.6L$$

$$\text{TRIANGULAR WIDTH} = 12.5' \quad (\text{AREA})_{\text{EM}} = 650 \text{ SF}$$

REDUCIBLE LIVE LOAD

$$L = (80 \text{ PSF}) \left(0.25 + \frac{15}{\sqrt{4 \times 650}} \right) = 43.5 \text{ PSF}$$

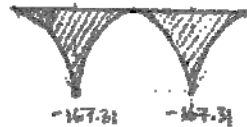
$$205 = 1.2(59 + 15) + 1.6(43.5) = 159.5 \text{ PSF}$$

$$W = 205 \times 12.5 = 1.98 \text{ klf}$$

$$M = \frac{WL^2}{2} = \frac{(1.98)(26^2)}{2} = 167.31 \text{ FT-K}$$

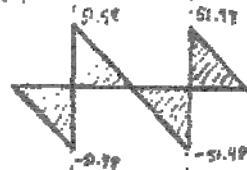
$$M @ \text{MIDSPAN} = \frac{WL^2}{8} - 167.31 = \frac{1.98(26^2)}{8} - 167.31 = 0$$

M in FT-K



$$M_k = 167.31 \text{ FT-K}$$

V in k



$$V_k = 51.98 \text{ K}$$

$$b_{\text{req}} = \begin{cases} \frac{1}{8} (\text{SPAN}) & = \frac{1}{8} (26') = 3.25' \\ \frac{1}{8} (\text{SPACING}) & = \frac{1}{8} (125') = 15.625' \\ \text{EDGE DISTANCE} & = 18' \end{cases}$$

$$\text{ASSUME } a = 1" \rightarrow \frac{1}{2} = 6.25" - \frac{1}{2} = 5.75"$$

TRY W10 X15

$$\phi M_n = 779 + \frac{192 - 174}{2} = 178 \text{ FT-K} @ \text{ TFL}$$

$$L (\text{INTERPOLATION})$$

$$a = \frac{221}{0.25(4)(3.25 \times 12)} = 1.67 > 1" \quad \underline{\text{NG}}$$

TRY W10 X22

$$\phi M_n = 869 + \frac{179 - 169}{2} = 171.5 \text{ FT-K} @ \text{ BFL}$$

$$a = \frac{117}{0.25(4)(3.25 \times 12)} = 0.882 < 1" \quad \underline{\text{OK}}$$

$$\frac{117}{12.2} = 7 \text{ SHEAR STUDS } \times 2 = 14 \text{ STUDS}$$

Southwest Student Housing

Tempe, Arizona
Final Summary Report

TECH 1

APPENDICES - APPENDIX F

SOUTHWEST STUDENT HOUSING

35

SPOT CHECKS (CONTINUED)DEFLECTIONS? $\frac{L}{360}$ (LIVE) $\frac{L}{240}$ (TOTAL)

$\Delta = \frac{w(\frac{L}{2})^2}{24EI}$
SIMPLY
SUPPORTED
w/ END MOMENTS

$\Delta = \frac{wL^4}{8EI}$
CANTILEVERED

$$\left[\left(\frac{12}{2} \right)^2 - \left(\frac{24}{2} \right)^2 \right] + \left(\frac{12}{2} \right)^2 + \left(\frac{24}{2} \right)^2 = 1296$$

$$I = 811 + \frac{329 \cdot 311}{2} = 320 \text{ in}^4$$

LIVE: 48.5 PSF $\rightarrow w = 0.584 \text{ kLF}$ TOTAL: 48.5 + 59 + 15 PSF $\rightarrow w = 1.469 \text{ kLF}$

END SPAN:

$$\frac{L}{360} = \frac{13 \times 12}{360} = 0.43"$$

$$\Delta_{\text{LIVE}} = \frac{(0.584/2) 13^4}{8 (29000) 320} \times 1296 = 0.03" \quad \text{OK}$$

$$\frac{L}{240} = \frac{13 \times 12}{240} = 0.65"$$

$$\Delta_{\text{TOTAL}} = \frac{(1.469/2) 13^4}{8 (29000) 320} \times 1296 = 0.091" \quad \text{OK}$$

MIDDLE SPAN:

$$\frac{L}{360} = 0.86"$$

$$M_{\text{LIVE}} = 48.5 \text{ PSF} \times 12' = 581.6 \text{ ft-k}$$

$$\Delta_{\text{LIVE}} = \frac{(0.584/2) (136')^4}{24 (29000) 320} \left[15^3 - \frac{312^3}{2} + 1972 \left(\frac{35' \cdot 46'}{35' + 41.2'} \right) + 312^3 - 1248 \left(\frac{55' \cdot 116'}{1.554' + 12'} \right) \right] = 0.84" \quad \text{OK}$$

$$\frac{L}{240} = 1.3"$$

$$M_{\text{TOTAL}} = 496.522 \text{ ft-k} = 5958.5 \text{ in-k}$$

$$\Delta_{\text{TOTAL}} = 4.23" \quad \text{N/A}$$

NOTE - THESE DEFLECTIONS DO NOT TAKE INTO ACCOUNT
GIRDER DEFLECTIONS

QUICK DEFLECTION CALC FOR SPECIFIED BM SIZE ON TYP. FRAMING PLAN:

W18 x 40 Assume $\alpha = 2" \rightarrow y_2 = 5.25" \quad P_{\text{RA}} = 6 \quad \phi M_n = 965 \text{ ft-k}$

$$\alpha = 1.584" < 2" \quad \text{OK} \quad I = 1190 \text{ in}^4$$

END SPANS:

$$\Delta_{\text{LIVE}} = 0.007" \quad \text{OK}$$

$$\Delta_{\text{TOTAL}} = 0.022" \quad \text{OK}$$

MIDDLE SPAN:

$$\Delta_{\text{LIVE}} = 0.226" \quad \text{OK}$$

$$\Delta_{\text{TOTAL}} = 1.157" \quad \text{OK}$$

(WILL CHECK OVERALL
DEFLECTION INCLUDING
GIRDER IN NEXT SPOT
CHECK)

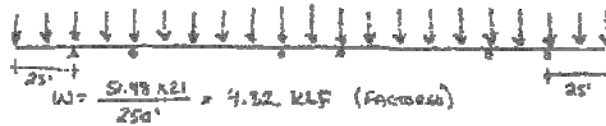
TECH 1

APPENDICES - APPENDIX G
SOUTHWEST STUDENT HOUSING

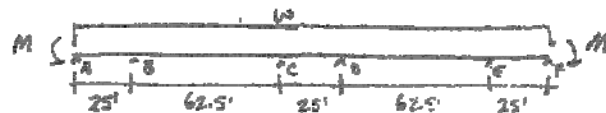
37

SEAT SHACKS (CONTINUED)TYPICAL GIRDER (INTERIOR)

TRAIL WIDTH = 19.5'



MOMENT DISTRIBUTION (SEE ATTACHED GLOBAL SHEET)



$$M = \frac{WL^2}{2} = \frac{4.32 (25)^2}{2} = 1350 \text{ K-FT}$$

 $M_{\text{UNE}} = 245.75 \text{ K-FT}$ $M_{\text{TOTAL}} = 693.75 \text{ K-FT}$ DISTRIBUTION FACTORS:

AB = 0.5

BA = 0.714

BC = 0.286

CB = 0.286

CD = 0.714

DC = 0.714

DE = 0.286

ED = 0.286

EF = 0.714

FE = 0.5

SYMMETRIC

$$DF = \frac{1/L \text{ DIRECTION OF CHOICE}}{1/L_{\text{LEFT}} + 1/L_{\text{RIGHT}}}$$

(EI IS CONSTANT THROUGHOUT)

$$FEM = \frac{WL^2}{12}$$

3 EXCEL SHEETS INCLUDED REGARDING
MOMENT DISTRIBUTION:

- FACTORED LOADS
- LIVE LOAD ONLY (UNFACTORED)
- TOTAL LOAD

* SEE TYP. BM. SPOT CHECK FOR LOADS USED IN
TYP. GIRDER SPOT CHECK

FIXED END MOMENTS: (K-FT)			
JOINT	FACTORED	LIVE	TOTAL
AB	225+1350	41+244	116+694
BC	1406.25	254	723
CD	225	41	116
DE	1406.25	254	723
EF	225+1350	41+244	116+694

DESIGN LOADS:

$$M_{\text{UE}} = 1756 \text{ K-FT}$$

LIVE LOAD REDUCTIONS: $A = 977035$

$$(80 \text{ PSF}) \left(0.25 + \frac{15}{\sqrt{4 \times 977035}} \right) = 0.36 (80 \text{ PSF}) \rightarrow L = 40 \text{ PSF}$$

Tech 1

APPENDICES-APPENDIX G
SOUTHWEST STUDENT HOUSING

35

SPOT CHECKS (CONTINUED)

$$\text{ASSUME } a = 3.25' \rightarrow 42 = 9.625'$$

$$b_{\text{ESS}} = \frac{1}{8} (\text{SPAN}) = \frac{1}{8} (162.5) = 20.3125' \leftarrow$$

$$\frac{1}{2} (\text{SPACING}) = \frac{1}{2} (25) = 12.5'$$

$$\text{EDGE DISTANCE} = 25'$$

TRY W27x102

$$\phi M_n = 1813 + (1840 - 1810) \left(\frac{9.625 - 4.5}{5 - 4.5} \right) = 1817.5 \text{ K} \cdot \text{ft} @ \text{PNA \#4}$$

$$a = \frac{879}{0.85(4)(93.75)} = 2.75 < 3.25' \text{ OK}$$

$$\frac{879}{17.2} = 51 \text{ SHEAR STUDS} \times 2 = 102 \text{ STUDS}$$

ENGINEER'S PRESCRIBED BEAM IS NOT IN COMPOSITE BM TABLE
IN AISC 13D STEEL CONSTRUCTION MANUAL (TABLE 3-19)
BUT IT'S A HEAVY W27x176, WHICH IS PROBABLY AS DEEP
OR MORE DEEP THAN MY W27x102

$$\text{DEFLECTIONS? } I = 7230 + 0.75(7430 - 7230) = 7280 \text{ in}^4$$

$$\begin{array}{ccccccc} & & & & & & (\text{SYMMETRIC}) \\ 1 & 2 & 3 & 4 & / & 3 & 2 & 1 \end{array}$$

SPAN 1:

$$\frac{L}{260} = 0.933$$

$$\Delta_{\text{LIVE}} = \frac{(0.75/12) 25^4}{7(29000) 7280} \times 1.728 = 0.526'' \text{ OK}$$

$$\frac{L}{240} = 1.25$$

$$\Delta_{\text{TOTAL}} = \frac{(8.23/12) 25^4}{7(29000) 7280} \times 1.728 = 0.674'' \text{ OK}$$

$$\Delta_x = \frac{w x}{24 E I} \left[x^3 - \left(2L + \frac{4M_1}{wL} - \frac{4M_2}{wL} \right) x^2 + \frac{12M_1}{w} x + L^3 - \frac{8M_1 L}{w} - \frac{4M_2 L}{w} \right]$$

(SINCE END MOMENTS ARE CORRELATED... TAKEN FROM CASE 32, AISC STEEL
CONSTRUCTION MANUAL, 2010, 14TH ED.)

$$\Delta_{\text{MAX}} @ x = \frac{L}{2} + \frac{M_1 - M_2}{wL}$$

SPAN 2:

$$x = 250.3''$$

$$\Delta_{\text{LIVE}} = 0.06''$$

$$\Delta_{\text{TOTAL}} = 0.17''$$

SPAN 3:

$$x = 415.1''$$

$$\Delta_{\text{LIVE}} = 0.83''$$

$$\Delta_{\text{TOTAL}} = 0.94'' \text{ OK}$$

SPAN 4:

$$x = 150''$$

$$\Delta_{\text{LIVE}} = 0.07''$$

$$\Delta_{\text{TOTAL}} = 0.19''$$

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Tech 1	APPENDICES - APPENDIX G SOUTHWEST STUDENT HOUSING	39
AMFAD	<u>SPST CHECKS (CONTINUED)</u> NEW TYPICAL BEAM DEFLECTIONS: (W18x40) END SPANS: $\Delta_{LIVE} = 0.009 + 0.33 = 0.338" \quad \underline{OK}$ $\Delta_{TOTAL} = 0.022 + 0.94 = 0.962" \quad \underline{NG} \quad (\text{CAMBERED})$ MIDDLE SPAN: $\Delta_{LIVE} = 0.226 + 0.33 = 0.556" \quad \underline{OK}$ $\Delta_{TOTAL} = 1.137 + 0.94 = 2.077" \quad \underline{NG} \quad (\text{CAMBERED})$	12.

Southwest Student Housing

Tempe, Arizona

Final Summary Report

TECH 1

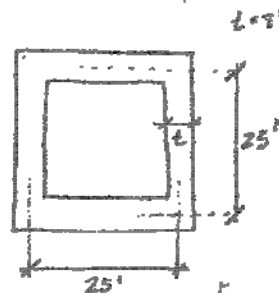
APPENDICES - APPENDIX H.

SOUTHWEST STUDENT HOUSING

9.

SPOT CHECKS (CONTINUED)

* CORES



$$\text{Area/CORE: } [(25 \times 12) \times 4] \times 9 = 9600 \text{ in}^2$$

$$\rightarrow \text{TOTAL CONCRETE AREA} = 3 \times 9600 = 28800 \text{ in}^2$$

$$P = \text{AXIAL LOAD} = L \times W \times 20$$

CURTAIN WALL WEIGHT (INCLUDED IN SEISMIC)

$$\rightarrow 15 \text{ PSF} \times 10' \times (250 \times 2 + 52 \times 2) = 90.6 \text{ k}$$

$$\text{ON 1ST FLOOR} = 90.6 \times \left(\frac{19'}{10'}\right) = 163.1 \text{ k}$$

$$P = 1.2 \left[(39 \times 15) (250 \times 2) \times 20 + 90.6 \times 19 + 163.1 \right] + 1.6 (90 \times 250 \times 2) \times 20$$

$$= 23890.3 + 16640 \approx 39730 \text{ KIPS}$$

$$f_c = \frac{39730}{28800} = 1.38 \text{ KIPS AXIAL STRESS}$$

$$f_c' = 4 \text{ KSI} \quad \text{OK}$$

WIND: MAX M W-E-W DIRECTION (WIDTH = 250')

 $\rightarrow$ TOTAL M = 68 855 k-ft (SEE WIND SPREADSHEET)

$$I_{\text{CORE}} = \frac{(12)(W)^3}{12} + 2 \left(t \cdot W \right) \left(\frac{W^2}{2} \right) = \frac{8(25 \times 12)^3}{12} + 2(8 \times 25 \times 12) \left(\frac{25 \times 12^2}{2} \right)$$

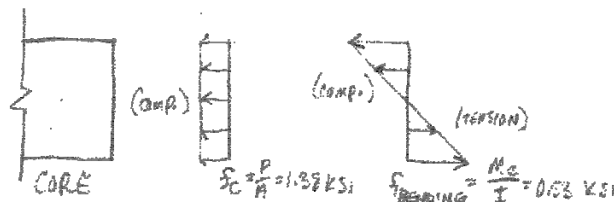
$$= 234000000 \text{ in}^4 = 11284.7 \text{ ft}^4$$

$$\text{BENDING STRESS } f = \frac{M \left(\frac{W}{2} \right)}{I} = \frac{68855 \left(\frac{25}{2} \right)}{11284.7} = 76.3 \text{ KEF} = 0.53 \text{ KSI}$$

$$\text{TOTAL MAX COMPRESSION} = f_c + f_{\text{BENDING}} = 1.91 \text{ KSI}$$

$$\text{TOTAL MIN COMPRESSION} = f_c - f_{\text{BENDING}} = 0.85 \text{ KSI}$$

OK
(CAN REINFORCE
w/ MINIMUM
REBAR REQUIRED
BY ACI 308)



SEISMIC:

$$f_{\text{BENDING}} = 76.3 \times \left(\frac{193600}{68855} \right) = 203.5 \text{ KEF} = 1.41 \text{ KSI}$$

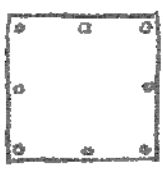
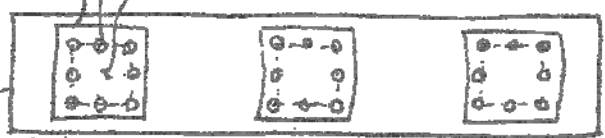
$$\text{TOTAL MAX COMPRESSION} = 2.79 \text{ KSI}$$

$$\text{TOTAL MIN COMPRESSION} = -0.3 \text{ KSI} + \text{REBAR IN CORE WILL ALLEVIATE TENSION HERE}$$

OK

Southwest Student Housing

Tempe, Arizona
Final Summary Report

Team	APPENDICES - APPENDIX SOUTHWEST STUDENT HOUSING	43
Appendix 43	<u>FOUNDATION CALCULATIONS</u> TOTAL BUILDING WEIGHT (OBTAINED FROM SEISMIC SPREADSHEET) = 21125 KIPS $21125 \text{ KIPS} = \underbrace{\left(\frac{\pi}{4} d^2\right) (30 \text{ KSF}) \pi}_{\text{SAND GRAVEL CORE}} + \underbrace{\left(\pi d\right) (2.5 \text{ KSF}) (2.5') \pi}_{\text{SHAFT FRICTION}} + \underbrace{\left(\pi d\right) (0.4 \text{ KSF}) (35') \pi}_{\text{SURF FRICTION}}$ SAND GRAVEL CORE SHAFT FRICTION SURF FRICTION 81004 SAND + 200004 GRADED SAND TRY N=12 (GOAL? $d = 48"$) $21125 = (43.2 d^2 + 44 d) 12$ $d = \frac{(-44 \times 12) \pm \sqrt{(44 \times 12)^2 - 4(43.2 \times 12)(-21125)}}{2(43.2 \times 12)}$ $d = 6'$ NG TRY N=24 $21125 = (43.2 d^2 + 44 d) 24 \rightarrow d = 4' \text{ OK}$ $N=24 \rightarrow 8 \text{ PIERS / CORE MAT}$  MIN CLEAR SPAN = $3 \times d = 12'$ NEED TO CHECK FOR PUNCHING SHEAR. MATS SIZED FOR PUNCHING SHEAR, $f'_c = 4000 \text{ PSI}$ PIER $\phi = 4'$, SPACING = 16' ON CENTER (12' CLEAR SPAN) CORE LOCATION  BUILDING FOOTPRINT	

Southwest Student Housing
Tempe, Arizona
Final Summary Report

TECH 1 (REVISION 10.11.2011) APPENDICES - APPENDIX H
SOUTHWEST STUDENT HOUSING

SPOT CHECKS (CONTINUED)
* CORES

WEAKEST SECTION:

ACTUAL CORE LAYOUT:

6' CORRIDOR

MIN. DOOR OPENINGS ACCORDING TO ADA 2

$\geq 32"$ $\geq 32"$

AREAS. — OUTER CORES: $(25 \times 12)(8'') + (25 - 6)(12)(8'')(2) + (25 \times 12 - 32 \times 2)(8'') = 7936 \text{ in}^2$
 $\uparrow$ PER CORE

MIDDLE CORE: $(25 \times 12)(8'')(2) + (25 - 6)(12)(8'')(2) = 8448 \text{ in}^2$

TOTAL CROSS-SECTIONAL AREA @ WEAKEST POINT: $(7936)(2) + 8448 = 24320 \text{ in}^2$

TOTAL AREA ELSEWHERE: $(25 \times 12)(8'')(4) \times 3 = 28800 \text{ in}^2$

GRAVITY LOAD — $P = \text{AXIAL LOAD} \times L \times W \times 25$
 CURTAIN WALL: $15 \text{ PSF} \times 10' \times (250 \times 2 + 52 \times 2) = 90.6 \text{ K}$ (FOR ALL FLOORS ABOVE 1ST FLOOR)
 $90.6 \times \left(\frac{18'}{10'}\right) = 163.1 \text{ K}$ (ON 1ST FLOOR)

CORE SELF WEIGHT @ BASE:
 ASSUME CORRIDOR & DOOR OPENINGS ARE 8' TALL
 OVER 20 FLOORS, $20 \times 8 = 160'$ OF HEIGHT W/ WEAKEST SECTION
 $\therefore \text{SW} = (150 \text{ PCF}) \left[160 \left(\frac{24320}{144} \right) + (208 - 160) \left(\frac{28800}{144} \right) \right] = 5493 \text{ KIPS}$

REINFORCED CONCRETE

$P = 1.2 \left[\frac{(59 + 15)(250 \times 52) \times 20}{1000} + 90.6 \times 19 + 163.1 + 5493 \right] + 1.6 \left[\frac{40 \times 250 \times 52 \times 20}{1000} \right]$
 $= 51941 + 16640$ FACTORED DEAD LOAD + REDUCED LIVE LOAD
 $\uparrow$ FACTORED DEAD LOAD

$P_u = 49581 \text{ KIPS}$
 $f_c = \frac{49581}{24370} = 1.998 \approx 2 \text{ KSI}$

$P_{\text{MAX}} = 0.65(0.8) \left[0.85 f'_c A \right] = 0.442(4000)(24320) = 42998 \text{ K} < P_u = 49581 \text{ K}$

NG

Southwest Student HousingTempe, Arizona
Final Summary Report

Tech 1 (REVISION 10.4.2011)

SPOT CHECKS (CONT'D)

* CORES (CONT'D)

MOMENT OF INERTIA :

UNCRACKED-

 I_x :

$$1. \quad S_{043} - \frac{bh^3}{12} = \frac{5' \left[(25'-6'') \times 12 \right]^3}{12} \times 9 = 7901568 \text{ in}^4$$

$$\text{Top} - \frac{bh^3}{12} = \frac{(25' \times 12)(9'')^3}{12} = 12900 \text{ in}^4$$

$$Ad^2 = (25' \times 12)(9'') \left(\frac{25'}{2} \times 12 \right)^2 = 54000000 \text{ in}^4$$

$$\text{Bottom} - \frac{bh^3}{12} = \frac{(25' \times 12 - 22' \times 12)(9'')^3}{12} = 10869 \text{ in}^4$$

$$Ad^2 = \left[(12' \times 12 - 22' \times 12)(9'') \right] \left(\frac{25'}{2} \times 12 \right)^2 = 42990000 \text{ in}^4$$

$$I_{x1} = 7901568 + 12900 + 54000000 + 10869 + 42990000 = 104404437 \text{ in}^4 = 5035 \text{ ft}^4$$

$$2. \quad S_{043} - \frac{bh^3}{12} = 7901568 \text{ in}^4$$

$$\text{Top/Bottom} - \frac{bh^3}{12} = 10869 \text{ in}^4 \quad Ad^2 = 54000000 \text{ in}^4$$

$$I_{x2} = 7901568 + 2 \times [10869 + 54000000] = 115921706 \text{ in}^4 = 5290 \text{ ft}^4$$

5294 ~ 5290

3. SEE CALCULATIONS FOR 1.

$$I_{x3} = 104404437 \text{ in}^4 = 5035 \text{ ft}^4$$

$$I_x = 5035 + 5040 + 5035 = 15660 \text{ ft}^4$$

$$E_{stl} = 29000 \text{ ksi} \quad E_{conc} = 57000 \sqrt{f'_{conc}} = 3605 \text{ ksi} \quad \eta = \frac{E_{stl}}{E_{conc}} = 8.0$$

$$\rho_{min} = 0.0012 \text{ FOR BARS } \leq \#5 \text{ (ACI 318-05 14.3.2 (a))}$$

$$= \frac{A_s}{b \cdot d}$$

Southwest Student Housing
Tempe, Arizona
Final Summary Report

TECH 1 (REVISION 0.11.2011)

SPOT CHECKS (CONT'D)

* CORES (CONT'D)

$$M_{CR} = \frac{f_u I_{UNCR, TR}}{y_{BOT}} \quad y_{BOT} = h - \bar{y}$$

→ NEGLECTING STEEL FOR I.

BECAUSE OF ALMOST SYMMETRICAL LAYOUT OF CORES, $\bar{y}$ CAN BE ASSUMED @ 150" (ABOUT X-AXIS)
(THE CENTERLINE) $150" = 12.5'$

$$f_u = 7.5 \sqrt{f'_c} = 7.5 \sqrt{4000} = 474.34 \text{ PSI} = 68305 \text{ PSF} = 68.3 \text{ KSF}$$

$$M_{CR} = \frac{(68.3 \text{ KSF})(15660 \text{ FT}^2)}{12.5'} = 85566.24 \text{ K-FT}$$

$$M_{MIN} = 68355 \text{ K-FT @ BASE (UNFACTORED)} \text{ OR } 110169 \text{ K-FT (FACTORED)} \quad \underline{NG}$$

$$M_{MIN} = 57469 \text{ K-FT @ BASE} \quad \underline{OK}$$

→ SECTION IS CRACKED.

[SINCE POTENTIALLY UNCRACKED - NEGLECTING STEEL IN I_x CALCULATIONS LEADS TO A SMALLER I_x (SINCE THE STEEL IS EVENLY DISTRIBUTED THROUGHOUT THE WALLS)]

$$I_{x, UNCRACKED} = \frac{(110169 \text{ K-FT})(12.5')}{68.3 \text{ KSF}} = 20162.5 \text{ FT}^4$$

QUICK RECALL OF I_{TR} : d IS ALWAYS THE X-CENTERLINE FOR A CONCRETE SEGMENT.
(WITH MORE ACCURACY)

$$I_{TR} = \frac{bh^3}{12} + bh\left(\frac{h}{2} - \bar{y}\right)^2 + (n-1)A_s(d - \bar{y})^2$$

$$1. \text{ SIDES: } \rho = 0.0012 = \frac{A_s}{(b)(150'')} \quad A_s = 1.44 \text{ in}^2 \quad d = 150''$$

$$\frac{bh^3}{12} + bh\left(\frac{h}{2} - \bar{y}\right)^2 = \frac{(8'')(12.5-3'')^3}{12} + [(12.5-3'')(12'')(8'')]\left[\left(\frac{12.5-3}{2} + 3\right)(12'')\right]^2 = 3950784 \text{ in}^4$$

$$I_{x, TR} = 3950784 \times 4 + (8-1)(1.44)(150-150)^2 = 15803136 \text{ in}^4$$

↑ PER CHUNK
OF WALL, THERE
ARE 4 CHUNKS
TOTAL.

$$\text{TOP: } A_s = 1.44 \text{ in}^2 \quad d = 4'' \quad (b = 300'')$$

$$\frac{bh^3}{12} + Ad^2 = 12960 + 54000000 = 54012960 \text{ in}^4$$

$$I_{x, TR} = 54012960 + (8-1)(1.44)(0-150)^2 = 5428960 \text{ in}^4$$

$$\text{BOTTOM: } A_s = 1.44 \text{ in}^2$$

↑ ALL AREA & I CALCS WERE DONE FROM
Q OF WALL, WHERE THE REINFORCEMENT
IS LOCATED

$$\frac{bh^3}{12} + Ad^2 = 10069 + 42980000 = 42490069 \text{ in}^4$$

$$I_{x, TR} = 42490069 + (8-1)(1.44)(300-150)^2 = 42716969 \text{ in}^4$$

$$I_{x1, TR} = 15803136 + 54012960 + 42716969 = 112759605 \text{ in}^4 = 5438 \text{ FT}^4$$

Southwest Student Housing

Tempe, Arizona
Final Summary Report

TECH 1 (REVISION 10.11.2014)

SPOT CHECKS (CONT'D)

* GRES (CONT'D)

2. SIDES - 13803126 in⁴Top/BOTTOM - 54234600 in⁴

$$I_{x2\ TR} = 13803126 + 2 \times 54234600 = 124271326 \text{ in}^4 = 5994897$$

3. SAME AS 1.

$$I_{x\ TR} = 5438 \times 2 + 5994 = 16966 \text{ ft}^4 \leftarrow \text{INSUFFICIENT TO PREVENT CONCRETE FROM CRACKING!}$$

WHAT ABOUT $\epsilon = 10^\circ$?

$$I_x: 1. \text{ SIDES} - (245774) \left(\frac{1}{12} \right) = 992469 \text{ ft}^4$$

$$\text{TOP} - (11300) \frac{10^3}{12} + 54000 \times 100 \frac{10^3}{12} + (7)(1.44)(150)^2 = 3267.35 \text{ ft}^4$$

$$\text{BOTTOM} - (10060) \frac{10^3}{12} + 4248 \times 1000 \frac{10^3}{12} + (7)(0.44)(120)^2 = 2572.63 \text{ ft}^4$$

2. SIDES - 952.64 ft⁴Top/BOTTOM - 3267.35 ft⁴

3. SAME AS 1.

$$I_{x\ TR} = 952.64 \times 8 + 3267.35 \times 4 + 2572.63 \times 2 = 21042.63 \text{ ft}^4 > I_{x\ \text{needed}} \quad \text{OK}$$

$$M_{\text{wind}} < M_{\text{cc}} @ \epsilon = 10^\circ \rightarrow \text{CAN ASSUME UNCRACKED SECTION.}$$

THEORIES FOR DENATION: THE ACTUAL DESIGN MIGHT USE MORE REINFORCEMENT. THE DESIGNERS ALSO MAY HAVE CALCULATED THE WIND LOADS DIFFERENTLY.

FROM PREVIOUS CALCULATIONS, IT WAS SHOWN THAT THE SECTION WAS ASSUMED UNCRACKED, THUS THE CALCULATIONS TO FIND AN APPROPRIATE GEOMETRY THAT JUSTIFIES THIS ASSUMPTION.

SHEAR CHECK:

$$V_u = 22 \sqrt{3} \text{ C}^1 \text{ A} \rightarrow \text{TO STEEL INT.} = 2(1.0) \sqrt{4000} \left[(12 \times 22) + 4 \times 300 + (25 \times 6) \times (2 \times 22) \right] = 916.81 \text{ kips}$$

$$\phi V_u = 0.75(1.0 V_u) = 687.6 \text{ kips / CORE} \times 3 \text{ CORES}$$

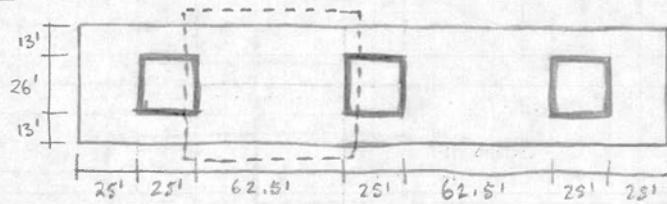
$$\phi V_u = 2062.82 \text{ kips}$$

$$V_{\text{wind}} = 565 \text{ k (UNFACTORED)} & 704 \text{ k (FACTORED)} < \phi V_u \quad \text{OK}$$

$$V_{\text{seismic}} = 255 \text{ k} < V_{\text{wind}} \quad \text{OK}$$

$$\text{IF RUN w } 0.5 V_u: \phi V_u = 0.75(0.5 V_u) = 343.9 \text{ k / CORE} \times 3 \text{ CORES} = 1031.4 \text{ k} > V_{\text{wind}} \quad \text{OK}$$

TECH 11

FLOOR SYSTEM CALCULATIONS

DESIGNING FOR THE FLOOR SPAN ENCLOSED IN THE DOTTED LINE.

- ASSUMPTIONS: THE SUPPORTS PROVIDED BY EACH CORE (USE $M = \frac{wl^2}{11}$) ARE PARTIALLY FIXED

- LOADS: CONSTRUCTION LOADS NEED TO BE RECALCULATED
FIRE RATING FOR FLOOR - 2 HOURS, MIN

↑ AS PER RECOMMENDATION
OF DR. LEPAGE

SUPERIMPOSED DEAD LOAD = 15 PSF

LIVE LOAD (NOT REDUCED) = 80 PSF ← SMALL POTENTIAL FOR REDUCTION
ON CERTAIN BEAMS;
IT IS SIMPLER TO USE 80 PSF FOR EVERYTHING.LATERAL LOADS - WIND WOULD BE UNAFFECTED BY DIFFERENT FLOOR
SYSTEMS UNLESS THE FLOOR-TO-FLOOR HEIGHT CHANGED.SEISMIC LOADS WOULD NEED TO BE RECALCULATED TO DEAL
WITH DIFFERENT FLOOR ASSEMBLY WEIGHT.FLOOR SYSTEMS TO TEST:

- NONCOMPOSITE (SAME BEAM/GIRDER LAYOUT)
- LONG SPAN DECK (REMOVE ONE OF THE BEAMS FRAMING INTO THE GIRDER)
- HOLLOW CORE (SAME BEAM/GIRDER LAYOUT)
- POST-TENSIONED SLAB (WIDE GIRDERS + BEAMS, MOST LIKELY SAME LAYOUT)

Southwest Student Housing
Tempe, Arizona
Final Summary ReportNONCOMPOSITE FLOOR SYSTEMFIRE REQUIREMENTS: 2HR EXPOSED GRID $\Rightarrow$ 2-1/2" NW w/ 0.6C, 1.0C, 1.3C, 1.5C
3" NW w/ 0.6C, 1.0C, 1.3C, 1.5C

MIN 2 SPANS (TO DEAL W/ CANTILEVER)

WILL GO W/ 2-1/2" NW $\rightarrow$ INITIAL SIZING: (BASED ON MAX UNSHORED CONDITION)

0.6C22 - 4' 7"	(2 @ 3 SPAN)	} NG
1.0C20 - 7' 3"	(2 @ 3 SPAN)	
1.3C20 - 8' 4"	(2 @ 3 SPAN)	
1.5C18 - 9' 9"	(2 SPAN) 10' 1" (3 SPAN)	
2C16 - 12' 6"	(2 SPAN) 12' 11" (3 SPAN)	OK

ASSUME FLOOR
WILL BE COVERED W/
A FINISH (AFFECTS
ALLOWABLE SLAB
LOAD)

2C16 CANNOT HOLD LOADS ON SUCH WIDE SPANS

3C16 w/ 3" NW?

MAX ALLOWABLE UNIFORM LOAD FOR $S \leq \frac{b}{240} = 100 \text{ PSF}$

LOADS:

• CONSTRUCTION:

DECK WEIGHT = 59 PSF

ASSUMED STRUCTURAL SLAB = 15 PSF

TOTAL = 59 + 15 = 73 PSF

• SUPERIMPOSED: 1/8 PSF

TOTAL DEAD LOAD = 73 + 15 = 88 PSF

TOTAL LIVE LOAD = 90 PSF (COULD POTENTIALLY BE REDUCED BY ~7 PSF)

TOTAL SUPERIMPOSED UNIFORM LOAD = 15 PSF + 90 PSF = 95 PSF < 100 PSF **OK** $\rightarrow$ USE 3" CONFORM DECK, 1/8 GAGE, WITH 3" N.W. CONCRETE
2 SPANS, MIN. TYP SPAN = 12'-6"GIRDER DESIGN:TENSURE WIDTH = 26' $\rightarrow A = 26(62.5) = 1625 \text{ in}^2$

(ASSUMING THE EDGE GIRDER PROVIDES NO SUPPORT, THIS NO REDUCTION IN TENS.)

REDUCTIONS:

$$(90 \text{ PSF}) \left(1.25 + \frac{15}{\sqrt{9 \times 1625}} \right) = 0.44 (90)$$

$$\Rightarrow \text{LIVE LOAD} = 0.5(90) = 90 \text{ PSF}$$

$$W_{\text{FACTORED}} = [1.2(88) + 1.6(90)] \times 26' = 4.41 \text{ KLF}$$

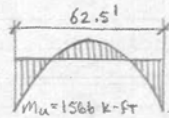
$$W_{\text{LIVE}} = (90 \text{ PSF}) \times 26' = 1.04 \text{ KLF}$$

$$W_{\text{TOTAL}} = [88 + 90] \times 26' = 3.33 \text{ KLF}$$

NONCOMPOSITE FLOOR SYSTEM (CONT'D)

GIRDER DESIGN (CONT'D)

$$\text{MAX MOMENT} \approx \frac{wl^2}{11} \rightarrow M_u = \frac{(4.41)(62.5)^2}{11} = 1566 \text{ K-FT}$$



→ MAINTAIN SAME FLOOR HEIGHTS ∴ W24 X —

FROM TABLE 3-2 OF AISC STEEL CONSTRUCTION MANUAL, 13TH ED.:

$$\phi_b M_{px} = 1570 \text{ K-FT FOR W24 X 146} > M_u = 1566 \text{ K-FT}$$

OK

DEFLECTIONS

$$I = 4590 \text{ in}^4$$

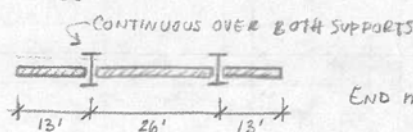
$$\delta_{\text{max}} = \frac{wl^4}{384EI} \left(\frac{12}{11} \right) = \frac{wl^4}{352EI}$$

$$\delta_{\text{LIVE}} = \frac{(1.04/12)(62.5 \times 12)^4}{352(29000)(4590)} = 0.587'' \quad \frac{l}{360} = 2.09'' \quad \text{OK}$$

$$\delta_{\text{TOTAL}} = \frac{(3.33/12)(62.5 \times 12)^4}{352(29000)(4590)} = 1.878'' \quad \frac{l}{240} = 3.125'' \quad \text{OK}$$

→ USE W24 X 146 FOR 62'-6" SPAN BETWEEN CORES (AKA GIRDER)

BEAM DESIGN:



$$\text{END MOMENT} = \frac{wl^2}{2} \quad (\text{END LOADED CANTILEVER})$$

↳ FOR UNIFORM LOAD.

TO INCLUDE CURTAIN WALL:

$$10' \times 12.5' \times 15 \text{ psf} = 1.875 \text{ K END LOAD} + PL$$

$$\text{TRIB. WIDTH} = 12.5'$$

$$\rightarrow 12.5' \times 52' = 650 \text{ SF}$$

$$(80) \left(0.25 + \frac{15}{\sqrt{4 \times 650}} \right) = 0.544(80) = 43.5 \text{ PSF}$$

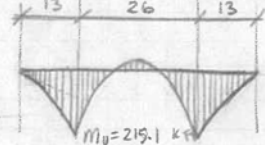
$$W_{\text{FACTORED}} = [1.2(89) + 1.6(43.5)] \times 12.5' = 2.2 \text{ KLF}$$

$$W_{\text{LIVE}} = 43.5 \times 12.5' = 0.544 \text{ KLF}$$

$$W_{\text{TOTAL}} = (89 + 43.5) \times 12.5' = 1.644 \text{ KLF}$$

$$\text{END MOMENTS} = \frac{(2.2)(13')^2}{2} + 1.875(13') = 215.1 \text{ K-FT}$$

$$\text{MIDSPAN MOMENT} = \frac{wl^2}{8} - \frac{2(M_{\text{END}})}{2} = \frac{(2.2)(26')^2}{8} - 215.1 = -29.8 \text{ K-FT}$$



$$M_u = 210.3 \text{ K-FT}$$

FOR EASE OF APPLYING DECK,

→ MAINTAIN SAME FLOOR HEIGHTS ∴ W18 X —

$$\phi_b M_{px} = 249 \text{ K-FT FOR W18 X 35} > M_u = 210.3 \text{ K-FT}$$

Southwest Student Housing

Tempe, Arizona
Final Summary Report

3/3

NONCOMPOSITE FLOOR SYSTEM (CONT'D)

BEAM DESIGN (CONT'D)

DEFLECTIONS

$$I = 510 \text{ in}^4 \quad \delta_x = \frac{w x}{24 E I} \left[x^3 - \left(2L + \frac{4M_1}{wL} - \frac{4M_2}{wL} \right) x^2 + \frac{12M_1}{w} x + L^3 - \frac{8M_1 L}{w} - \frac{4M_2 L}{w} \right]$$

$$M_1 = M_2, \quad x = \frac{L}{2}$$

$$M_{LIVE} = \frac{(0.344)(13)^2}{2} = 14.6 \text{ k-ft}$$

$$\delta_x = \frac{w L}{48 E I} \left[\frac{L^3}{8} - \frac{L^3}{2} + \frac{16 M L}{w} + L^3 - \frac{12 M L}{w} \right]$$

$$M_{TOTAL} = 16.3 \text{ k-ft}$$

$$\delta_{LIVE} = \frac{(0.344/12)(26 \times 12)}{48(29000)(510)} \left[(26 \times 12)^3 - \frac{3(26 \times 12)^3}{8} - \frac{6(46 \times 12)}{(0.344/12)(26 \times 12)} \right] = -0.076''$$

$$\delta_{TOTAL} = \frac{(1.644/12)(26 \times 12)}{48(29000)(510)} \left[(26 \times 12)^3 - \frac{3(26 \times 12)^3}{8} - \frac{6(16.3 \times 12)}{(1.644/12)(26 \times 12)} \right] = -0.469''$$

$$\frac{L}{360} = 0.867'' > |-0.076''| \quad \text{OK}$$

(DEFLECTIONS ARE NEGATIVE BECAUSE THE END MOMENTS ARE LARGE ENOUGH TO CAUSE THE BEAM TO CURVE UP @ MIDSPAN)

$$\frac{L}{240} = 1.3'' > |-0.469''| \quad \text{OK}$$

$$\delta_{CONTINUOUS} = \frac{w L^4}{8 E I} + \frac{P L^3}{24 E I}$$

COURTESY WALL, POINT-LOAD

← ENLARGED. MIGHT NEED TO CHECK CANTILEVER DEFLECTIONS

$$\delta_{LIVE, END} = \frac{(0.344/12)(13 \times 12)^4}{8(29000)(510)} + \frac{1.776(13 \times 12)^3}{24(29000)(510)} = 0.227'' < \frac{13 \times 12}{360} = 0.433'' \quad \text{OK}$$

$$\delta_{TOTAL, END} = \frac{(1.644/12)(13 \times 12)^4}{8(29000)(510)} + \frac{1.776(13 \times 12)^3}{24(29000)(510)} = 0.946'' > \frac{13 \times 12}{240} = 0.65'' \quad \text{NG}$$

$$0.18 \times 46? \quad I = 712$$

• MIDSPAN -

$$\delta_{LIVE} = (-0.076) \left(\frac{710}{712} \right) = -0.054'' < 0.867'' \quad \text{OK}$$

$$\delta_{TOTAL} = (-0.469) \left(\frac{710}{712} \right) = -0.356'' < 1.3'' \quad \text{OK}$$

• END SPAN -

$$\delta_{LIVE} = (0.227) \left(\frac{710}{712} \right) = 0.163'' < 0.433'' \quad \text{OK}$$

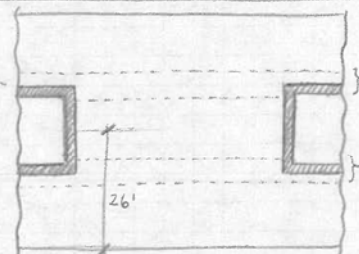
$$\delta_{TOTAL} = (0.946) \left(\frac{710}{712} \right) = 0.66'' < 0.65'' \quad \text{OK}$$

→ USE W18x46 FOR BEAMS @ 12'-6" SPACING.

Southwest Student Housing
Tempe, Arizona
Final Summary Report

1/6

POST-TENSIONED CONCRETE SLAB (2-WAY)

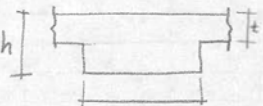


BANDED TENDONS
IN WIDE SHALLOW BEAMS
(ASPECT RATIO = $\frac{62.5'}{26'} = 2.4$)

FOR $1.5 < \text{ASPECT RATIO} < 2.5$,
RECOMMENDATION IS TO USE
WIDE SHALLOW BEAMS
(PTI TECH NOTE #3)

CAN CONSIDER
INITIAL SLAB SIZING
FROM SHORTER
DIRECTION, CAN USE
EQUIVALENT FRAME METHOD
FOR ANALYSIS

**DIMENSIONAL RESTRICTIONS
ON WIDE SHALLOW BEAMS:**



$h \leq 2t$ $h \leq \frac{b}{3}$

(SEE FIGURE 5.1-1 OF TECH NOTE)

MATERIALS:

CONCRETE - NW (150 PCF) $f'_c = 4000 \text{ PSI}$ $f'_{ci} = 3000 \text{ PSI}$
 REBAR - $F_y = 60000 \text{ PSI}$
 POST-TENSIONING - UNBONDED
 $\frac{1}{2}" \phi$ 7-WIRE $\rightarrow A = 0.153 \text{ in}^2$
 $f_{pu} = 270000 \text{ PSI}$ (ASSUME 30% PRESTRESS LOSS)
 $f_{py} = 243000 \text{ PSI}$
 $f_{pe} = 0.7 f_{pu} - \text{LOSSES} = 0.7(270) - 30 = 159000 \text{ PSI}$
 $\rightarrow P_{eff} = A f_{pe} = 24.327 \text{ K/TENDON}$

INITIAL SIZING:

FOR FULLY CONTINUOUS - $\frac{b}{t} \leq 45$ $t \geq \frac{b}{45}$ $t \geq 6.933 \text{ in} \rightarrow t = 7 \text{ in}$
 $\therefore h \leq 2t \rightarrow h \leq 2(7) = 14$, SAY $h = 14 \text{ in}$
 $h \leq \frac{b}{3} \rightarrow 14 \leq \frac{b}{3}$, SAY $b = 42 \text{ in}$

LOADS/LOADING:

DEAD - SELF WEIGHT = $\frac{BM \text{ SW}}{\text{TRIB}} + \text{SLAB SW} = \frac{150 \text{ PCF}}{12 \text{ in/ft}} \left[\frac{(14-7)(42)}{26 \times 12} + 7 \right] = 99.3 \text{ PSF}$
 SUPERIMPOSED = 15 PSF
 LIVE = 80 PSF $\rightarrow 26' \times 62.5' = 1625 \text{ SF}$ $(80) \left(0.25 + \frac{15}{\sqrt{1625 \times 1.0}} \right) = 0.622(80) \approx 50 \text{ PSF}$

$\frac{\text{LIVE}}{\text{DEAD}} = \frac{50}{114.3} = 0.44 < 0.75$ (NO PATTERN LOADING REQUIRED)

ASSUME GROSS SECTION PROPERTIES FOR CLASS II

Southwest Student Housing

Tempe, Arizona
Final Summary Report

POST-TENSIONED CONCRETE (2-WAY) (CONT'D)

DESIGN PARAMETERS:

ALLOWABLE STRESSES - (a) JACKING - $0.6 f_{ci} = 0.6(3000) = 1800 \text{ PSI}$ [COMPRESSION]
 $3 \sqrt{f_{ci}} = 164 \text{ PSI}$ [TENSION]
 (b) SERVICE - $0.45 f_{cs} = 0.45(4000) = 1800 \text{ PSI}$ [COMPRESSION]
 $6 \sqrt{f_{cs}} = 379.5 \text{ PSI}$ [TENSION]

AVERAGE PRECOMPRESSION LIMITS - $\frac{P}{A} = 123 \text{ PSI (MIN)}$
 $= 300 \text{ PSI (MAX. FOR ECONOMICAL REASONS)}$

TARGET LOAD BALANCES - $0.6 - 0.8 \rightarrow 0.8 \times (\text{SELF WEIGHT}) = 0.8(99.3) = 79.44 \text{ PSF}$

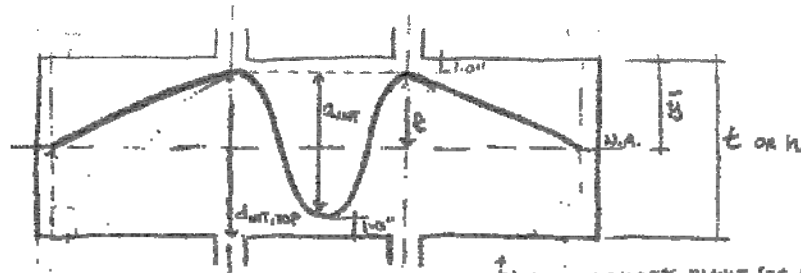
COVER - TOP = $0.75''$

BOTTOM = $0.75''$ (RESTRAINED)

$= 1.5''$ (UNRESTRAINED)

ADD $\frac{\phi}{2}$ TO C_c

TENSION PROFILE (HEIGHTS FOR REFERENCE) -



EAST-WEST DIRECTION DESIGN:

PRESTRESS FORCE TO BALANCE - 80% S.W.

$W_{BAL} = (79.44 \text{ PSF}) \times 26' = 2065.44 \text{ PLF}$

FOR E-W DIRECTION, ONLY LOOKING @ INTERIOR BAY.

$\rightarrow P = \frac{W_{BAL} L^2}{8 \Delta_{INT}}$

$A = 7' \times 31.2'' + 7' \times 24.2'' = 2478 \text{ in}^2$
 $\bar{y} = \frac{(7 \times 31.2)(3.5) + (7 \times 24.2)(10.5)}{2112 + 7 \times 92} = 4.33'' \text{ (from top)}$

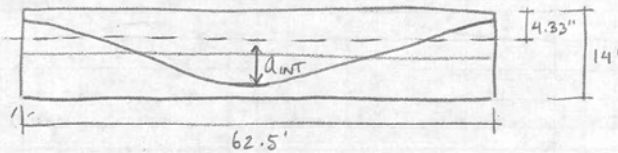
$I = \left[\frac{(7 \times 31.2)^3}{12} + (7 \times 31.2)(3.5 - 4.33)^2 \right] + \left[\frac{(7 \times 24.2)^3}{12} + (7 \times 24.2)(10.5 - 4.33)^2 \right] = 22715.3 \text{ in}^4$

$S_{TOP} = \frac{I}{\bar{y}_{TOP}} = \frac{22715.3}{14.75} = 1539.3 \text{ in}^3$ $S_{BOT} = \frac{I}{\bar{y}_{BOT}} = \frac{22715.3}{21.12} = 1075.5 \text{ in}^3$

3/

POST-TENSIONED CONCRETE (2-WAY) (CONT'D)

E-W TENDON PROFILE IN WIDE SHALLOW BEAM:



SLAB CONTIGUES OFF ON BOTH ENDS, $\therefore$ TENDONS DON'T NEED TO RETURN TO THE NEUTRAL AXIS, AS THEY ARE CONTINUOUS

$$a_{INT} = 14 - 4.33 - 1.0 = 8.67''$$

$$SO \quad P = \frac{(2065.44)(62.5)^2}{8(8.67/12)} = 1395.9 \text{ KIPS}$$

$$\frac{1395.9}{24.327} = 57.4 \rightarrow \text{MAX ACCEPTABLE TENDON AREA: } \frac{P}{A} = 300 \text{ PSI} \quad P = 300 (A)$$

$$P_{ACTUAL} = 30(24.327) = 729.8 \text{ K}$$

$$300(2478) = 743.4 \text{ K}$$

$$\hookrightarrow \frac{743.4}{24.327} = 30 \text{ TENDONS}$$

$$W_b = \frac{P_{ACTUAL}(8 \times a_{INT})}{l^2} = \frac{729.8(8 \times 8.67/12)}{62.5^2} = 1.08 \text{ KLF}$$

$$W_{S.W.} = 2.06 \text{ KLF}$$

$$\frac{W_b}{W_{S.W.}} = \frac{1.08}{2.06} = 0.523 < 1.0 \quad \underline{OK}$$

$$P_{EFF} = 729.8 \text{ K} \quad \frac{P}{A} = \frac{729.8}{2478} = 0.2945 \text{ KSI}$$

SLAB STRESSES:

$$\text{DEAD} - W_D = (99.3 + 15)(26') = 2.97 \text{ KLF}$$

IMMEDIATELY AFTER JACKING:

• MIDSPAN:

$$f_{TOP} = \frac{(-395.5 + 143.8)}{5269} - 0.2945 = -342 \text{ PSI}$$

$$f_{BOTT} = \frac{(395.5 - 143.8)}{2359} - 0.2945 = -188 \text{ PSI}$$

• SUPPORTS:

$$f_{TOP} = \frac{(1055 - 383.5)}{5269} - 0.2945 = -182 \text{ PSI}$$

$$f_{BOTT} = \frac{(1055 + 383.5)}{2359} - 0.2945 = -579 \text{ PSI}$$

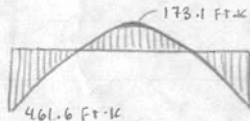
WITHIN CLASS U DESIGN
PARAMETERS, OK

$$\frac{W_D^2}{8} - \frac{W_L^2}{11} = 395.5 \text{ FT-K}$$

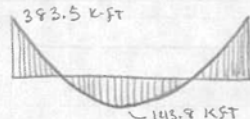


$$\frac{W_L^2}{11} = 1055 \text{ FT-K}$$

$$\text{LIVE} - W_L = (50)(26') = 1.3 \text{ KLF}$$



$$\text{BALANCING} - W_b = 1.08 \text{ KLF}$$



Southwest Student Housing
Tempe, Arizona
Final Summary ReportPOST-TENSIONED CONCRETE (E-W 44) (CONT'D)

STRESSES AT SERVICE LOAD:

• MIDSPAN:

$$f_{TOP} = \frac{(-295.5 - 173.1 + 143.2)}{5269} - 0.2945 = -375 \text{ PSI}$$

$$f_{BOT} = \frac{(295.5 + 173.1 - 143.2)}{2359} - 0.2945 = -114 \text{ PSI}$$

• SUPPORTS:

$$f_{TOP} = \frac{(1055 + 461.6 - 383.5)}{5269} - 0.2945 = -79 \text{ PSI}$$

$$f_{BOT} = \frac{(-1055 - 461.6 + 383.5)}{2359} - 0.2945 = -774 \text{ PSI}$$

WITHIN CLASS U DESIGN PARAMETERS, OK

ULTIMATE STRENGTH:

$$M_1 = P_e = (729.8 \text{ K})(4.33 - 1.0) = 202.5 \text{ K-FT}$$

$$M_{SEC} = M_{BAL} - M_1 = 383.5 - \frac{202.5}{12} = 366.6 \text{ K-FT} \leftarrow \text{EQUAL @ BOTH SUPPORTS}$$

MINIMUM BONDED REINFORCEMENT:

OVERALL, NO STRESSES IN TENSION $\Rightarrow$ TENSILE REINFORCEMENT IS UNNECESSARY

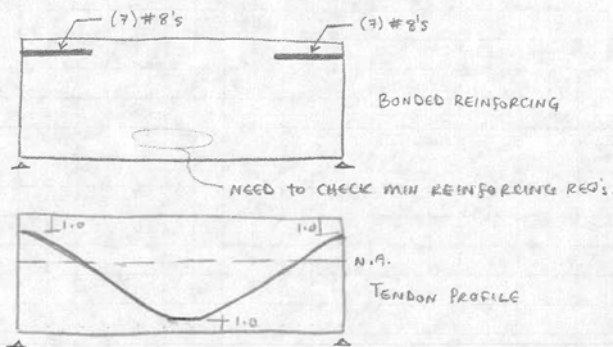
NEGATIVE MOMENT REGIONS:

$$A_{S, MIN} = 0.00075 A_{CS} \quad A_{CS} = \left\{ \frac{(25 + 62.5)}{2} = 43.75 \right\} \times 12' \times 14" = 7350 \text{ IN}^2$$

$$A_{S, MIN} = 0.00075(7350) = 5.5125 \text{ IN}^2$$

(7) #8's TOP (5.53 IN²)

AT BOTH SUPPORTS



5/1

POST-TENSIONED CONCRETE (2-WAY) (CONT'D)

$$A = 7'' \times (62.5' \times 12) = 5250 \text{ in}^2$$

$$S = \frac{bh^2}{6} = \frac{(7'')(7'')^2}{6} = 6125 \text{ in}^3$$

NORTH-SOUTH DIRECTION DESIGN:

$$W_{BAL} = (79.44)(62.5') = 4965 \text{ PLF}$$

$$P = \frac{W_{BAL} l^2}{8 a_{INT}} = \frac{3355.4 \text{ K}}{24.327} = 137.9$$

$$P_{ACTUAL} = 64(24.327) = 1556.9 \text{ K}$$

$$W_D = \frac{1556.9 (9 \times 9.67 / 12)}{(62.5')^2} = 2.3 \text{ KLF}$$

$$W_{SW} = 4.965 \text{ KLF}$$

$$\left. \begin{array}{l} W_D \\ W_{SW} \end{array} \right\} \frac{W_D}{W_{SW}} < 1.0 \text{ OK}$$

$$\frac{P}{A} = \frac{1556.9}{5250} = 0.2965 \text{ KSI}$$

MAX ACCEPTABLE TENDONS:

$$\frac{P}{A} \geq 300 \text{ PSI} \quad 300(5250) = 1575 \text{ K}$$

$$\hookrightarrow \frac{1575}{24.327} = 64 \text{ TENDONS}$$

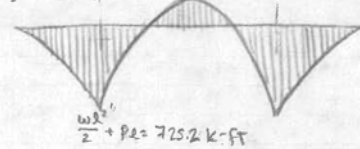
TENDON PROFILE:



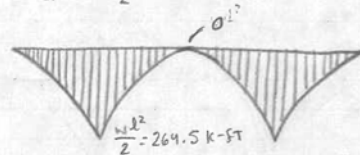
SLAB STRESSES:

$$\text{DEAD} - W_D = (99.3 + 15)(62.5') = 7.14 \text{ KLF} \quad P = (10' \times 62.5') \times 15 \text{ PSF} = 9.375 \text{ K}$$

$$\frac{wl^2}{8} - M_{\text{SUPPORT}} = 121.87 \text{ K-FT}$$



$$\text{LIVE} - W_L = (50)(62.5') = 3.13 \text{ KLF}$$



$$\text{BALANCING} - W_{BAL} = 2.3 \text{ KLF}$$



IMMEDIATELY AFTER JACKING:

• MIDSPAN

$$S_{\text{TOP}} = \frac{(-121.87 + 0)}{6125} - 0.2965 = -317 \text{ PSI}$$

$$S_{\text{BOTTOM}} = \frac{(121.87 + 0)}{6125} - 0.2965 = -277 \text{ PSI}$$

• SUPPORTS

$$S_{\text{TOP}} = \frac{(-725.2 + 194.35)}{6125} - 0.2965 = -383 \text{ PSI}$$

$$S_{\text{BUTT}} = \frac{(725.2 + 194.35)}{6125} - 0.2965 = -210 \text{ PSI}$$

WITHIN CLASS II DESIGN PARAMETERS. OK

POST-TENSIONED CONCRETE (2-WAY) (CONT'D)

STRESSES AT SERVICE LOAD:

• MIDSPAN

$$f_{TOP} = \frac{(-121.87 - 0 + 0)}{612.5} - 0.2965 = -317 \text{ PSI}$$

$$f_{BOTT} = \frac{(121.87 + 0 - 0)}{612.5} - 0.2965 = -277 \text{ PSI}$$

• SUPPORTS

$$f_{TOP} = \frac{(-725.2 - 264.5 + 194.35)}{612.5} - 0.2965 = -426 \text{ PSI}$$

$$f_{BOTT} = \frac{(725.2 + 264.5 - 194.35)}{612.5} - 0.2965 = -167 \text{ PSI}$$

WITHIN CLASS A PARAMETERS OK

ULTIMATE STRENGTH:

$$M_f = P_e = (1556.9)(2.5') = 3892.25 \text{ K-FT}$$

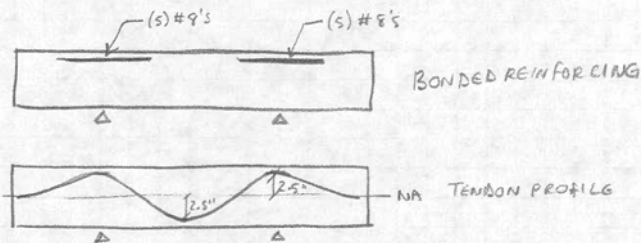
$$M_{sec} = 194.35 - \frac{3892.25}{12} = -130 \text{ K-FT} \quad \leftarrow \text{EQUAL @ BOTH SUPPORTS}$$

MINIMUM BONDED REINFORCEMENT:

OVERALL, NO STRESSES IN TENSION $\Rightarrow$ TENSILE REINFORCEMENT IS UNNECESSARY
NEGATIVE MOMENT REGIONS:

$$A_{s,min} = 0.00075 A_{cs} \quad A_{cs} = \left\{ \frac{13+26}{2} = 19.5 \right\} \times 12' \times 7' = 5250 \text{ IN}^2$$

$$A_{s,min} = 3.94 \text{ IN}^2$$

(5) #8's TOP (3.95 IN²)
AT BOTH SUPPORTS

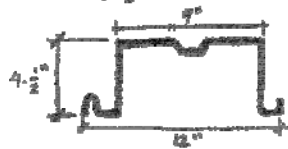
Southwest Student HousingTempe, Arizona
Final Summary ReportLONG SPAN DECKRAE REQUIREMENTS: 2 HR, EXPOSED GLEB $\rightarrow 3 \frac{1}{4}"$ L.W. CONCRETE

MIN 2 SPANS (TO DCAL W/ (ANTI)LEVEL)



GOAL: ELIMINATE A FEW BEAMS

LOOKED AT DIAMOND ENTERPRISES ROOF & FORM DECK

4 $\frac{1}{2}"$ DEEP DECK:

MAX SPAN = ?

$$S.W.: \left(\frac{3.65 \times 12}{144} + \frac{3 \times 4.5}{144} \right) / 1 \text{ FT} \times 110 \text{ PCF} = 40.1 \text{ PSF} \quad [\text{CONCRETE}]$$

X-SEA AREA

$$\text{MAX DECK S.W.} = 5.68 \text{ PSF} \Rightarrow 40.1 + 5.68 = 45.78 \approx 46 \text{ PSF}$$

LOADS:

• CONSTRUCTION -

DECK WEIGHT = 46 PSF

ALLOWANCE FOR STRUCTURAL STEEL = 15 PSF

• SUPERIMPOSED - 15 PSF

• LIVE - 80 PSF

FOR DECK, TOTAL (DL+LL) UNIFORM LOAD = 46 + 15 + 80 = 141 PSF

 $\rightarrow$ NO 4 $\frac{1}{2}"$ DECK GAUGE WORK FOR SINGLE SPAN $> 12'$ $\therefore$ 6" DECK?

$$\text{NEW S.W.:} \left(\frac{3.28 \times 12}{144} + \frac{3 \times 6}{144} \right) / 1 \text{ FT} \times 110 \text{ PCF} = 43.5 \text{ PSF} \quad [\text{CONCRETE}]$$

$$\text{MAX 6" DECK WEIGHT} = 6.61 \text{ PSF} \Rightarrow 43.5 + 6.61 = 50.2 \text{ PSF}$$

$$\text{NEW TOTAL (DL+LL) UNIFORM LOAD} = 50.2 + 15 + 80 = 145.2 \text{ PSF}$$

6" DEEP DECK, 14 GAUGE: FOR STRESS & DEFLECTION $\left(\frac{L}{240} \right)$, LOAD = 161 PSF FOR SINGLE 16' SPAN. $\rightarrow$ USE 6" DEEP DECK, 14 GAUGE, w/ 3 $\frac{1}{4}"$ L.W. CONCRETE.
TYP. SPAN $\leq 16'$ AS APPROPRIATE FOR BAY.

$$\frac{62.5}{16} \approx 4 \text{ SPANS (1 LESS BEAM PER 62.5' SOLUTION BETWEEN COLUMNS)}$$

 $\uparrow$ ABOVE DECK IS NON COMPOSITE (FORM).

WILL NEED TO ACCOMMODATE +3" OF DECK IN FLOOR HEIGHT OR BEAM SIZING.

2/

LONG SPAN DECK (CONT'D)GIRDER DESIGN:

SPAN = 62.5' → LIVE LOAD REDUCTION TO 40 PSF (SEE NONCOMPOSITE CASES)

$$W_{\text{factored}} = \left[1.2(46+15+15) + 1.6(40) \right] \times 26' = 3.57 \text{ KLF}$$

$$W_{\text{LIVE}} = (40) \times 26 = 1.04 \text{ KLF}$$

$$W_{\text{TOTAL}} = (40+46+15+15) \times 26 = 3.02 \text{ KLF}$$

$$\text{MAX } M \approx \frac{Wl^2}{11} \rightarrow M_u = \frac{(3.57)(62.5)^2}{11} = 1268 \text{ K-FT}$$

→ MAINTAIN SAME FLOOR HEIGHTS ∴ W24 X
TABLE 3-2 OF AISC STEEL CONSTRUCTION MANUAL, 13TH ED.:

$$\phi_b M_{px} = 1390 \text{ FT-K FOR W24X131} > M_u = 1268 \text{ K-FT} \quad \text{OK}$$

DEFLECTIONS

$$I_x = 4020 \text{ in}^4 \quad \delta_{\text{max}} = \frac{wl^4}{384EI}$$

$$\delta_{\text{LIVE}} = \frac{(1.04/12)(62.5 \times 12)^4}{384(29000)(4020)} = 0.679'' \quad \frac{l}{360} = 2.08'' \quad \text{OK}$$

$$\delta_{\text{TOTAL}} = \frac{(3.02/12)(62.5 \times 12)^4}{384(29000)(4020)} = 1.94'' \quad \frac{l}{240} = 3.125'' \quad \text{OK}$$

BEAM DESIGN:

$$M \left(\text{---} \right) M = \frac{wl^2}{2} + Pl \quad P = 1.875$$

$$\text{TRUCK WIDTH} \approx 16' \rightarrow (16' \times 52') = 832 \text{ sq ft} \rightarrow (80) \left(0.25 + \frac{15}{\sqrt{4 \times 832}} \right) = 0.51(80) = 40.8 \text{ PSF}$$

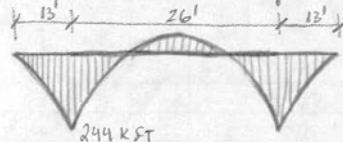
$$W_{\text{factored}} = \left[1.2(46+15+15) + 1.6(40.8) \right] \times 16' = 2.504 \text{ KLF}$$

$$W_{\text{LIVE}} = (40.8) \times 16 = 0.653 \text{ KLF}$$

$$W_{\text{TOTAL}} = (40.8+46+15+15) \times 16 = 1.969 \text{ KLF}$$

$$\text{END MOMENT } M_u = \frac{(2.504)(13')^2}{2} + (1.875 \times 1.2)(13') = 244 \text{ K-FT}$$

$$\text{MIDSPAN MOMENT} = \frac{wl^2}{8} - M_{\text{ENDS}} = \frac{(2.504)(26')^2}{8} - 244 = -32.4 \text{ K-FT}$$

→ MAINTAIN FLOOR HEIGHTS → W14 X —
 $\phi_b M_{px} = 383 \text{ K-FT FOR W14X61} > M_u = 244 \text{ K-FT}$

$$M_{\text{LIVE}} = \frac{(0.653)(13')^2}{2} = 55.2 \text{ K-FT}$$

$$M_{\text{TOTAL}} = \frac{(1.969)(13')^2}{2} + 1.875(13) = 192.3 \text{ K-FT}$$

$$I_x = 640 \text{ in}^4$$

$$\delta_x = \frac{wl}{48EI} \left[\frac{5}{8}l^3 - \frac{6Ml}{W} \right] @ \text{MIDSPAN}$$

↑ SIMPLIFIED B/C END MOMENTS ARE SYMMETRIC
& MAX MIDSPAN δ IS IN THE VERY MIDDLE ($\frac{l}{2}$)

Southwest Student HousingTempe, Arizona
Final Summary Report

3/2

LONG SPAN DECK (CONT'D)BEAM DESIGN (CONT'D)DEFLECTIONS

$$\begin{aligned} \delta_{LIVE} &= \frac{(0.453/12)(26 \times 12)}{48(29000)(640)} \left[\frac{5}{8}(26 \times 12)^3 - \frac{6(55.2 \times 12)}{0.683/12}(26 \times 12) \right] = -0.073'' < 0.867'' \quad \text{OK} \\ \delta_{TOTAL} &= \frac{(1.469/12)(26 \times 12)}{48(29000)(640)} \left[\frac{5}{8}(26 \times 12)^3 - \frac{6(132.3 \times 12)}{1.769/12}(26 \times 12) \right] = -0.399'' < 1.3'' \quad \text{OK} \end{aligned}$$

$$\delta_{LIVE} = \frac{wL^4}{384EI} + \frac{PA^3}{3EI} \quad \text{(IS APPROPRIATE)}$$

$$\delta_{LIVE} = \frac{(0.653/12)(13 \times 12)^4}{8(29000)(640)} = 0.217'' < 0.433'' \quad \text{OK}$$

$$\delta_{TOTAL} = \frac{(0.659/12)(13 \times 12)^4}{8(29000)(640)} + \frac{1.875(13 \times 12)^3}{3(29000)(640)} = 0.749'' > 0.65'' \quad \text{NG}$$

W14x74? $I = 795 \text{ in}^4$

$$\begin{aligned} \delta_{LIVE} &= (-0.073) \left(\frac{640}{795} \right) = -0.059'' < 0.867'' \quad \text{OK} \\ \delta_{TOTAL} &= (-0.399) \left(\frac{640}{795} \right) = -0.321'' < 1.3'' \quad \text{OK} \end{aligned}$$

$$\begin{aligned} \delta_{LIVE} &= (0.217) \left(\frac{640}{795} \right) = 0.173'' < 0.433'' \quad \text{OK} \\ \delta_{TOTAL} &= (0.749) \left(\frac{640}{795} \right) = 0.603'' < 0.65'' \quad \text{OK} \end{aligned}$$

→ USE W14x74 FOR BEAMS @ $\frac{62.5}{4} \approx 15'-6"$ SPACING (4 BEAMS / 62.5' SPAN)

Southwest Student Housing
Tempe, Arizona
Final Summary Report

TECH 1 (REVISION 10.11.2011)	APPENDICES - APPENDIX D SOUTHWEST STUDENT HOUSING
<u>CALCULATED LOADS (CONTINUED)</u> - SEISMIC LOADS FRAME SYSTEM: REINFORCED CONCRETE SHEAR WALLS $R=4.0$ $I=1.0$ $C_s = \frac{S_{DS}}{(R/I)} \geq 0.01$ $C_s \leq \frac{S_{D1}}{C_u T_a (R/I)}$ FOR $T \leq T_L$ $T_a = (C_a) h_n^{0.75} \approx 1.1 \text{ SEC}$ $C_a = 16\%, g$ $0.02 \rightarrow 208$ $S_1 = 9\%, g$ $T_L = 6.24 \text{ SEC}$ } FIGURES FROM ASCE 7-05, CH 22 $F_x = C_{vx} V$ $C_{vx} = \frac{w_x h_x}{\sum_{i=1}^n w_i h_i}$ SITE CLASS C (FROM GEOTECH REPORT) $f_a = 1.2$ $f_v = 1.7$ $S_{ms} = f_a S_s = 1.2(0.16) = 0.192$ $S_{DS} = \frac{2}{3} S_{ms} = 0.128$ $S_{m1} = f_v S_1 = 1.7(0.09) = 0.153$ $S_{D1} = \frac{2}{3} S_{m1} = 0.0907 < 0.1$ $T_0 = 0.2 \frac{S_{D1}}{S_{DS}} = 0.2 \frac{0.0907}{0.128} = 0.142$ $C_u = 1.7$ $T_s = \frac{S_{D1}}{S_{DS}} = \frac{0.0907}{0.128} = 0.708$ $C_s = \frac{0.128}{4/1.0} = 0.032 \leq \frac{0.0907}{1.7(9.1)(4/1.0)} = 0.0121 \Rightarrow C_s = 0.0121$ $W_{TOT} = \sum_{i=1}^{40} w_i$ $w_i = (C_{DL} + S_{DL}) A_{FLOOR} + \text{CURTAIN WALL (PERIMETER)} = (9+15)13000 + 15(604) = 971.1 \text{ K}$ PER FLOOR $V = 0.0121 (971.1 \times 20) = 235.5 \text{ KIPS}$ (SEE EXCEL TABLE FOR VERTICAL DISTRIBUTION)	

04.04.2012

Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices | 64

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Appendix B –

See following pages for scans

Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH $\frac{1}{31}$	DESIGN LOADS $\frac{1}{3}$	$\frac{1}{9}$
	<u>DESIGN LOADS</u> - ASSUME SIMILAR GRAVITY LOADS TO EXISTING CONDITIONS → <u>SNOW LOADS</u>: $P_g = 20 \text{ PSF}$ (ASCE 7-05, FIG. 7-1) FLAT ROOF, $P_s = 0.7 C_e C_t I P_g \geq I P_g$ (ASCE 7-05, EQU. 7-1) SURFACE ROUGHNESS B (URBAN/SUBURBAN) EXPOSURE CATEGORY B - ASSUME ROOF IS PARTIALLY EXPOSED $\left. \begin{array}{l} \text{ } \end{array} \right\} C_e = 1.0$ (ASCE 7-05, § 6.5.6, TABLE 7-2) $C_t = 0.85$ (CONTINUOUSLY HEATED BUILDING) (TABLE 7-3) $I = 1.0$ (OCCUPANCY II) (TABLE 7-4) $\Rightarrow P_s = 0.7 (1.0)(0.85)(1.0)(20) \geq (1.0)(20)$ $= 11.9 \geq 20 \text{ PSF} \quad \therefore P_s = 20 \text{ PSF}$ <u>EXISTING GRAVITY LOADS</u>: DEAD LOADS: CONSTRUCTION = 59 PSF SUPERIMPOSED = 15 PERIMETER WALL = 15 PSF LIVE LOADS = 80 PSF <u>LATERAL LOADS</u>: <u>WIND</u> SAME WIND SPEED, SAME EXPOSURE CATEGORY, ETC AS EXISTING $\therefore$ CAN USE PREVIOUSLY CALCULATED WIND LOADS (SEE TABLE 2 FROM ALL TECHNICAL REPORTS) BUILDING HEIGHT: 208', 19' FIRST STORY, 10' SUBSEQUENT STORIES <u>BASE SHEARS</u> PLAN <u>SEISMIC</u> - ASSUME STIFF SOIL $\therefore$ SITE CLASS D (ASCE 7-05, TABLE 20.3-1) $S_s = 60\%g \rightarrow F_a = 1.32$ (ASCE 7-05, TABLE 11.4.1) $S_1 = 15\%g \rightarrow F_v = 2.2$ (TABLE 11.4.2) $T_L = 12 \text{ SEC}$ (ASCE 7-05, FIGS 22-1, 22-2, 22-15) FRAME - ORDINARY REINFORCED CONCRETE SHEAR WALLS, $R = 4.0$ (ASCE 7-05, TABLE 12.2-1) $\uparrow$ NOT PERMITTED IN SDC D NEED TO USE SPECIAL REINFORCED CONCRETE SHEAR WALLS IN ACCORDANCE w/ ASCE 7-05 12.2.5.4: 1. NO EXTREME TORSIONAL IRREGULARITY (TYPE 1b) 2. SHEAR WALLS IN ANY ONE PLANE SHALL RESIST NO MORE THAN 60% OF TOTAL SEISMIC FORCES IN EACH DIRECTION, NEGLECTING ACCIDENTAL TORSION	COLUMN TO NOTE WHERE ASSUMPTIONS ARE MADE.

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH	DESIGN LOADS	
ASSUME: MEETS ASCE 7-05, § 12.2.5.9 REQUIREMENTS (NEED TO CHECK!) ∴ SPECIAL REINFORCED CONCRETE SHEAR WALLS, $R=5.0$ (MAX HEIGHT = 240') (→ ASCE 7-05, TABLE 12.2-1) CHAPTER 9 FACTORS - $S_{M1} = 1.32 (0.6) = 0.792$ $S_{D1} = \frac{2}{3} (0.792) = 0.528$ $S_{M2} = 2.2 (0.15) = 0.33$ $S_{D2} = \frac{2}{3} (0.33) = 0.22$ $S_{D1} > 0.3$? SDC D FOR OCCUPANCY CATEGORY II $S_{D1} > 0.2$ (ASCE 7-05, TABLE 11.6-1) $T_0 = 0.2 \frac{0.22}{0.528} = 0.333 \text{ sec}$ (ASCE 7-05 § 11.4.2) $T_1 = \frac{0.22}{0.528} = 0.4167 \text{ sec}$ CHAPTER 12 FACTORS - $C_u = 1.48$ (ASCE 7-05, TABLE 12.8-1) $C_t = 0.2$ FOR OTHER STRUCTURES (ASCE 7-05, TABLE 12.8-2) $\chi = 0.75$ → $T_a = (0.2) (208')^{0.95} \approx 1.1 \text{ sec}$ $T \leq C_u T_a = 1.48 (1.1) = 1.628 \text{ sec}$ $3.5 T_1 = 3.5 (0.4167) = 1.458 \text{ sec}$ → ASSUME $T < 3.5 T_1$ TO USE EQUIVALENT LATERAL FORCE METHOD (NEED TO CHECK!) IF USING ELF (ASCE 7-05, § 12.4) $C_s = \frac{S_{D1}}{R/I} = \frac{0.528}{5/1.0} = 0.1056 > 0.01 \checkmark$ $C_s \leq \frac{S_{D2}}{3.5 T_1 (5/1.0)} = \frac{0.22}{1.458 (5/1.0)} = 0.0302 \times$ USED IN PLACE OF C_{s1} BECAUSE $3.5 T_1 < C_u T_a$ ∴ $C_s = 0.0302$ $V = C_s W_{TOT}$ $C_0 \leq \frac{0.22}{1.628 (5/1.0)} = 0.027$ DON'T USE THIS REQ. $C_s \geq 2.4\%$		

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH $\frac{2}{3}$	DESIGN LOADS $\frac{2}{3}$	$\frac{2}{3}$
So $V = C_s W_{TOT}$ $W_{TOT} = W_{ROOF} + 19 W_{FLOOR TYP} + W_{FIRST FLOOR}$ $W_{ROOF} = (59 \text{ psf} + 15 \text{ psf})(250' \times 52') + \frac{16}{12} (2') (25' + 19') (2) (144 \text{ psf}) = 1046.5 \text{ K}$ $W_{FLOOR TYP} = (20 \text{ psf} + 59 \text{ psf} + 15 \text{ psf})(250' \times 52') + (15 \text{ psf})(10') (250' + 52') + 2 + \frac{16}{12} (10') (25' + 19') (2) (144 \text{ psf}) = 1481.6 \text{ K}$ $W_{FIRST FLOOR} = W_{FLOOR TYP} + \frac{16}{12} (9') (25' + 19') (2) (144 \text{ psf}) = 1623.6 \text{ K}$ $W_{TOT} = 1046.5 + 1481.6 \times 19 + 1623.6 = 29349 \text{ K}$ $V = (0.0302)(29349) = 896.34 \text{ K}$ (SEE TABLE @ END FOR DESIGNATION + ACCIDENTAL TORSION) ASSUME NO OPENINGS IN CORG EXCEPT CORRIDOR $\phi V_n = 0.75 (1.0 V_u)$ $V_u = 2.2 \sqrt{f_c} A_{SHALL, CRITICAL DIRECTION}$ $A_{SHALL} = (25' - 6' CORRIDOR) (2' / 12) \times 6 \text{ WALLS} \times t_{WALL} = 1368 t_{WALL}$ $\phi V_n = (0.75)(1.0)(2 \times 1.0 \times \sqrt{4000} 1368 t) \geq 896.34 \text{ K}$ @ 4000 PSI: $t_{WALL} \geq 6.25"$ $\geq 796.34 \text{ K}$ @ 5000 PSI: $t_{WALL} \geq 4.82"$ MODEL TRIAL WALLS IN ETABS. USE NON-ITERATIVE, MASS-BASED P-Delta. MODEL MUST HAVE... Mode 1 $\leq 1.958 \text{ sec}$ $\delta_{max} \leq 4.16"$ (2%) $\delta_{max} = 0.029"$ WITH CRITICAL LOAD COMBINATION $1.2D + 1.0E + L + 0.2S$		

04.04.2012

Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices | 68

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Appendix C –

See following pages for scans

Southwest Student Housing
Tempe, Arizona
Final Summary Report

	STRUCTURAL DEPTH ^{4/31}	CORE DESIGN ^{4/10}	^{4/4}
	MASSSES TO MODEL FOR 16" WALLS @ CRITICAL LOAD COMBO: $1.2D + 1.0E + 1.0L + 0.2S$ $M_{ROOF} = \left[\frac{1046.5 \text{ K}}{250 \times 52 \times 144} \times 1.2 + \frac{0.020}{144} \times 1 \right] \frac{1}{32.2} = 2.1696 \times 10^{-5}$ $M_{FLR TYP} = \left[\frac{1491.6 \text{ K}}{250 \times 52 \times 144} \times 1.2 + \frac{0.070}{144} \times 1.0 \right] \frac{1}{32.2} = 4.6748 \times 10^{-5}$ $M_{FLR ONE} = \left[\frac{1653.6 \text{ K}}{250 \times 52 \times 144} \times 1.2 + \frac{0.070}{144} \times 1.0 \right] \frac{1}{32.2} = 4.977 \times 10^{-5}$ 16" @ 8000 PSI: MODE 1 = 1.2293 SEC 2 = 1.2224 SEC 3 = 1.0430 SEC 16" @ 4000 PSI: MODE 1 = 1.4648 SEC 2 = 1.4565 SEC 3 = 1.2422 SEC MASSSES TO MODEL FOR 8" WALLS @ CRITICAL LOAD COMBO: $W_{ROOF} = (59 + 15)(250 \times 12) + \frac{8}{12}(6')(250 + 19)(2)(144 \text{ PCF}) = 1004.24 \text{ K}$ $M_{ROOF} = \left[\frac{W_{ROOF}}{250 \times 52 \times 144} \times 1.2 + \frac{0.020}{144} \times 0.2 \right] \frac{1}{32.2} = 2.0853 \times 10^{-5}$ $W_{FLR TYP} = (20 + 59 + 15)(250 \times 52) + (15)(10)(250 + 52)(2) + \frac{8}{12}(10)(250 + 19)(2)(144) = 1397.1 \text{ K}$ $M_{FLR TYP} = \left[\frac{W_{FLR TYP}}{250 \times 52 \times 144} \times 1.2 + \frac{0.070}{144} \times 1.0 \right] \frac{1}{32.2} = 4.507 \times 10^{-5}$ $W_{FLR ONE} = W_{FLR TYP} + \frac{8}{12}(9')(250 + 19)(2)(144 \text{ PCF}) = 1473.1 \text{ K}$ $M_{FLR ONE} = \left[\frac{W_{FLR ONE}}{250 \times 52 \times 144} \times 1.2 + \frac{0.070}{144} \times 1.0 \right] \frac{1}{32.2} = 4.658 \times 10^{-5}$ 8" @ 8000 PSI: MODE 1 = 1.7490 SEC 2 = 1.7371 SEC 3 = 1.4808 SEC 8" @ 4000 PSI: MODE 1 = 2.0360 SEC 2 = 2.0741 SEC 3 = 1.7651 SEC		

$$V_{BASE} = (0.080 + (0.0625/4)) \times 854.3 \text{ K}$$

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH

5/31

CORE DESIGN

2/10

5/4

NEW MODEL ANALYSIS PARAMETERS:

- 18" WALLS
- 3' COUPLING BMS
- 6000 KSI CONCRETE
- $E_c = \frac{1}{2} 57000 \text{ PSI}$
- $M_{ROOF} = 2.206 \text{ E-5}$
- $M_{1ST} = 5.427 \text{ E-5}$
- $M_{2ND} = 4.752 \text{ E-5}$
- RIGID DIAPHRAGM

(NOT TAKING INTO ACCOUNT EV)

WEIGHTS:

$$W_{ROOF} = (59+15)(250 \times 52) + \left[\frac{18}{12}(5')(25+19)(2)(3) + \frac{18}{12}(3')(6')(6) \right] 150 = 1283.3 \text{ K}$$

SHEAR WALLS COUPLING BM

→ 2142

$$W_{TYP FLR} = (59+15+20)(250 \times 52) + (15)(10)(250 \times 52)(2) + \left[2142 + \frac{18}{12}(5)(25+19)(2)(3) \right] 150 = 1930.9 \text{ K}$$

→ 4122

$$W_{1ST FLR} = W_{TYP FLR} + \frac{18}{12}(8')(25+19)(2)(3)(150) = 2406.1 \text{ K}$$

MASSES (BASED ON 1.2D + 1.0E + 1.0L + 0.25 LOAD COMBINATION):

$$M_{ROOF} = \left[\frac{W_{ROOF}}{250 \times 52 \times 144} \times 1.2 + \frac{0.020 \text{ KSF}}{144} \times 0.2 \right] \frac{1}{32.2} = \frac{2.641 \times 10^{-5}}{12} = 2.2008 \text{ E-6}$$

$$M_{TYP FLR} = \left[\frac{W_{TYP FLR}}{250 \times 52 \times 144} \times 1.2 + \frac{0.080 \text{ KSF}}{144} \times 1.0 \right] \frac{1}{32.2} = \frac{5.5693 \times 10^{-5}}{12} = 4.6411 \text{ E-6}$$

$$M_{1ST FLR} = \left[\frac{W_{1ST FLR}}{250 \times 52 \times 144} \times 1.2 + \frac{0.080 \text{ KSF}}{144} \times 1.0 \right] \frac{1}{32.2} = \frac{6.5153 \times 10^{-5}}{12} = 5.4279 \text{ E-6}$$

DESIGN LOADS:

$$X = C_{NS} W_{TOT} = 0.0294 (12 \times 3.3 + 18 \times 1930.9 + 2406.1) = 750 \text{ K}$$

SEE 03-07-2012 SPREADSHEET FOR FORCE DISTRIBUTION + ACCIDENTAL MOMENT +
FLOOR DIAPHRAGM FORCE CALC

	STRUCTURAL DEPTH 6/31	CORE DESIGN 3/10	6/1
	NEW MODEL: - 16" WALLS - 2' CORNER WALLS - 4000 PSI CONCRETE - RIGID DIAPHRAGM ASSUME CRACKED PROPERTIES (USE 0.5 I_g FOR WALLS, 0.25 I_g FOR BEAMS, AS ADVISED BY PREVIOUS ADVISEE) WEIGHTS: $ROOF = (59+15)(250 \times 52) + \left[\frac{16}{12}(5)(25+19) \times 2 \times 3 + \frac{16}{12}(3)(6) \times 6 \right] 150 = 1247.6 \text{ K}$ 1904 $\text{TYPICAL FLOOR} = (59+15+20)(250 \times 52) + (15)(10)(250+52)(2) + \left[1904 + \frac{16}{12}(5)(25+19) \times 2 \times 3 \right] 150 = 1862.2 \text{ K}$ 3064 $\text{FIRST FLOOR} = \text{TYPICAL FLOOR} + \frac{16}{12}(8)(25+19)(2)(3)(150) = 2284.6 \text{ K}$ MASSSES: $\text{ROOF} = \frac{1247.6}{250 \times 52} \left(\frac{1}{32.2} \times \frac{1}{12^3} \right) = 1.725 \text{ E-6}$ $\text{TYPICAL FLOOR} = \frac{1862.2}{250 \times 52} \left(\frac{1}{32.2} \times \frac{1}{12^3} \right) = 2.574 \text{ E-6}$ $\text{FIRST FLOOR} = \frac{2284.6}{250 \times 52} \left(\frac{1}{32.2} \times \frac{1}{12^3} \right) = 3.158 \text{ E-6}$ DESIGN LOADS: $V = C_e W_{TOT} = (0.027) \underbrace{(1247.6 + 1862.2 \times 18 + 2284.6)}_{37051.8 \text{ K}} = 1006.41$ MODE 1 =		

Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH	CORE DESIGN	
	$V_{BASE} = \frac{116}{1001.1} K \rightarrow$ INITIAL CORE SIZING CHECK: $\phi V_n = 0.75 (1.0 V_c) \quad V_c = 2 \lambda \sqrt{f'_c} A$ $A = [25-6] \times 12 \times 2 t_{WALL} \times 3 CORES = 1368 t$ $V_c = 2 (1.0) \sqrt{4000} (1368 t) = 173.0^K t$ $\phi V_n = 0.75 (173.0^K t) = 129.78^K t \geq 1001.1^K \times 1.2$ $t \geq 9.26"$ $t = 16" \quad \underline{OK}$ $V_c = 17.3^K (16) = 276.8^K \leftarrow$ OVERALL PER CORE (IN WEAK DIRECTION), $V_c = 922.7^K$ $V_{BASE} \text{ PER CORE} = \frac{1.2 \times 1001.1}{3} = 400.56^K \ll V_c \text{ PER CORE}$ SHEAR RDNF: $V_u - \underbrace{2 \sqrt{f'_c} A_g}_{V_c} = V_s = 0 \therefore$ USE MIN. REINFORCEMENT FOR SHEAR MOMENT REINFORCEMENT: TOTAL CALCULATED MOMENT = $151215 \text{ FT-K} \times 1.2 \text{ (TORSIONAL EFFECTS)} = 181458 \text{ FT-K}$ $\frac{181458}{6 \text{ WEBS}} = 30243 \text{ FT-K / WEB}$ $\frac{30243}{25' \text{ LEVER ARM}} = 1209.72^K$ IN TENSION PRODUCED BY EQ. MOMENT APPROXIMATION IGNORING EFFECT OF "FLANGES" AXIAL LOAD COUNTERACTS T. $AXIAL \text{ LOAD} = \frac{W_{ELDG}}{A_{CROSSSECTIONAL \text{ TOTAL}}} \times A_{CROSS-SECTIONAL, 1 \text{ WEB}}$ $= \frac{38445.6}{264 \times \frac{16}{12}} \times (25 \times \frac{16}{12}) = 3640.7^K \text{ PER WEB} > 1209.72^K$ WHOLE CORE IS IN COMPRESSION, NO NEED FOR T REINFORCEMENT $\therefore$ USE MIN. REINFORCEMENT FOR MOMENT WHAT FRACTION IS AXIAL LOAD? $3641 = x (4 \text{ WEBS}) (25 \times 12 \times 16) \quad x = 0.193$ AXIAL IS <u>$0.193 f'_c A_g$</u>	

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH 8/31	CORE DESIGN 8/10	8/11
AMPAD	CORE REINFORCEMENT: 11.10.8 $V_u \leq 0.5 \phi V_c$? <u>NO</u> $\rho_t \geq 0.0025$ $s \leq \begin{cases} \frac{L_w}{5} = \frac{9.512}{5} = 23 \\ 3h = 3 \times 16 = 48 \\ 19" \end{cases}$ $\rho_1 \geq 0.0025$ $s \leq 19"$ 14.3.2 $\rho_2 \geq \begin{cases} 0.0012 \text{ FOR } \#5 \text{ OR LESS} \\ 0.0015 \text{ OT} \end{cases}$ $\rho_t \geq \begin{cases} 0.002 \text{ FOR } \#5 \text{ OR LESS} \\ 0.0025 \text{ OT} \end{cases}$ OR $\rho_2 \>\rho_t$ AS CALCULATED IN 11.10.8 & 11.10.9 $\Rightarrow \rho_t = \rho_2 \geq 0.0025$ IN 2 LAYERS (14.3.4) 14.3.6 - NO TIE IF $A_s \leq 0.01 A_g$ OR IS NOT NEEDED FOR COMPRESSION APPLICABLE? NOT FOR DESIGN 4. 21.7.4.1 $V_n = A_{cv} (\alpha_c \sqrt{f_c} + \rho_t f_c)$ $\alpha_c = \begin{cases} 3.0 \text{ } h_w/h_n \leq 1.5 \\ 2.0 \text{ } h_w/h_n > 2.0 \end{cases}$ $\downarrow$ ALREADY TOOK V_n AS $A_{cv} (\alpha_c \sqrt{f_c})$, $\alpha_c = 2.0$ 21.7.4.4 $V_n \leq 8 A_{cv} \sqrt{f_c}$ (OVERALL) $V_n \leq 10 A_{cv} \sqrt{f_c}$ (PER A.C.I.) 21.7.6 - BOUNDARY ELEMENTS $\leftarrow$ EXTEND FROM CRITICAL SECTION A TO B $\begin{cases} L_w \\ h_n/4 \end{cases}$ $c \geq \frac{L_w}{600 (S_u/h_n)}$ LARGEST MOMENT AXIS DEPTH FOR FACED WALL + MOMENT @ S_u (DSR) $S_u/h_n \geq 0.004$	8/11

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH

9/31

CORE DESIGN

6/10

9/6

b) IN FLANGED, BOUNDARY ELEMENT EXTENDS 12" INTO FLANGE

CHOOSE TO INCLUDE BOUNDARY ELEMENTS FOR STRUCTURAL INTEGRITY WHEN HOLDING GRAVITY LOADS. THE BOUNDARY ELEMENTS ESSENTIALLY FUNCTION AS A COLUMN.

$$\rho_{min, COLUMN} = 1\% \text{ (BOUNDARY ELEMENT)}$$

$$\rho_{min, EVERYTHING ELSE} = 0.25\% \text{ (WALLS)}$$

REINFORCEMENT IS IN 2 LAYERS

-NORMAL LONGITUDINAL REINFORCEMENT:

$$\rho = 0.0025 \rightarrow A_s = 0.48 \text{ in}^2/\text{ft} \rightarrow (12) \#4S @ 6" \quad A_s = 0.795 \text{ in}^2$$

-BOUNDARY LONGITUDINAL REINFORCEMENT:

$$\rho = 1\% \rightarrow A_s = 6.4 \text{ in}^2 / 640 \text{ in}^2$$

$$6.4 + \left(\frac{16 + 12 \times 12}{12} \right) \times 0.48 = 8 \text{ in}^2$$

USE #8'S TO LIMIT CIRCLES

$$8 \text{ in}^2 = (4) \#8'S \text{ MINIMUM}$$

$$(16) \#8'S \rightarrow A_s = 12.57 \text{ in}^2$$

$$\rho = 1.96\%$$

-TRANSVERSE REINFORCEMENT

$$A_{tr} = \frac{0.09 S_b f_c}{f_y}$$

$$S_b = \frac{16}{3} = 5.33 \text{ in}$$

$$\therefore S = 5"$$

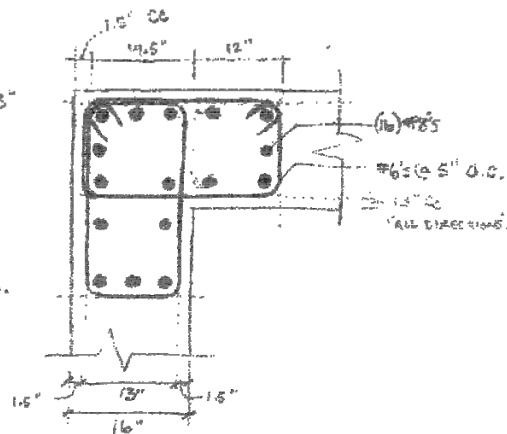
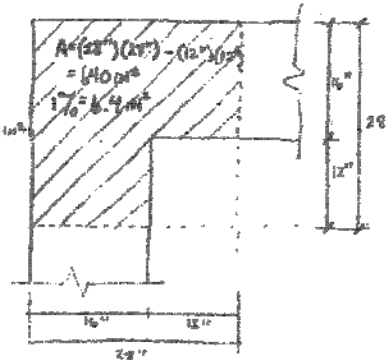
$$b_c = 16 - 1.5 \times 2 = 13"$$

$$f_c = 4 \text{ ksi}$$

$$f_y = 60 \text{ ksi}$$

$$A_{tr} = \frac{0.09(5)(13)(4)}{(60)} = 0.39 \text{ in}^2$$

$$\rightarrow \text{USE } \#6'S (A_s = 0.44) @ 5" \text{ O.C.}$$



BOUNDARY ELEMENT CAN BE DISCONTINUED WHEN
COMPRESSIVE STRESS $< 0.15 f_c$ (ACI 318.05
21-7.6.3)

[SEE PG OF CORE DESIGN FOR CIRCLES]

① BASE, COMPRESSIVE STRESS $\approx 0.188 f_c$ (UNDER GRAVITY ONLY)

W/ GR MOMENT: 1209.72 K IN C

+ 5641 K OF GRAVITY

$$\frac{9850.72}{100} \text{ IN C TOTAL} \rightarrow 0.253 f_c$$

$$M_{END} = 151157.1 \times 1.2 = 181387.52 \rightarrow \text{AXIAL DUE TO MOMENT} = 1209.26 \text{ K}$$

$$M_{3RD} = 151010.1 \times 1.2 = 181212.12 \rightarrow = 1209.07 \text{ K}$$

$$M_{4TH} = 150688.6 \times 1.2 = 180826.32 \rightarrow = 1205.51 \text{ K}$$

$$M_{5TH} = 150103.2 \times 1.2 = 180123.84 \rightarrow = 1200.83 \text{ K}$$

$$M_{6TH} = 149152.2 \times 1.2 = 178982.64 \rightarrow = 1193.12 \text{ K}$$

$$M_{7TH} = 147722.4 \times 1.2 = 177266.98 \rightarrow = 1181.73 \text{ K}$$

$$\text{AXIAL DUE TO GRAVITY} = 3412.93 \text{ K}$$

$$= 3229.98 \text{ K}$$

$$= 3097.13 \text{ K}$$

$$= 2864.27 \text{ K}$$

$$= 2681.42 \text{ K}$$

$$= 2498.56 \text{ K}$$

Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH	CORE DESIGN	
AXIAL LOAD ON n^{th} FLOOR: 2ND = 4622.1 K $\rightarrow$ 0.241% 3RD = 4439.1 K $\rightarrow$ 0.231% 4TH = 4252.6 K $\rightarrow$ 0.222% 5TH = 4065.1 K $\rightarrow$ 0.212% 6TH = 3874.7 K $\rightarrow$ 0.202% 7TH = 3680.4 K $\rightarrow$ 0.192% AXIAL STRESS: 2ND = 4622.1 K $\rightarrow$ 0.241% 3RD = 4439.1 K $\rightarrow$ 0.231% 4TH = 4252.6 K $\rightarrow$ 0.222% 5TH = 4065.1 K $\rightarrow$ 0.212% 6TH = 3874.7 K $\rightarrow$ 0.202% 7TH = 3680.4 K $\rightarrow$ 0.192% M_{11TH} = 134578.8 X 1.2 = 161506.56 $\rightarrow$ 1076.7 K M_{12TH} = 128713.4 X 1.2 = 154456.1 $\rightarrow$ 1029.71 K M_{13TH} = 121435.4 X 1.2 = 145720.5 $\rightarrow$ 991.8 K AXIAL DUE TO GRAVITY = 1767.2 K AXIAL DUE TO GRAVITY = 1584.33 K AXIAL DUE TO GRAVITY = 1491.5 K AXIAL LOAD @ n^{th} FLOOR: 12TH = 2614.04 K $\rightarrow$ 0.136% 13TH = 2372.3 K $\rightarrow$ 0.124% 11TH = 2949.28 K $\rightarrow$ 0.149% AXIAL STRESS: 12TH = 2614.04 K $\rightarrow$ 0.136% 13TH = 2372.3 K $\rightarrow$ 0.124% 11TH = 2949.28 K $\rightarrow$ 0.149% BOO! FIRST FLOOR W/ MAX AXIAL COMPRESSIVE STRESS UNDER GRAVITY + EQ UNDER 0.15% $\rightarrow$ EXTEND BOUNDARY REINFORCEMENT THRU 11TH FLOOR (118 FT)	10/31 4/10	10/6
10" CONCRETE WALLS, f'_c = 4000 PSI REINFORCED W/ (2) #4 @ 6" O.C. & BOUNDARY ELEMENTS @ CORNERS, AS PRESCRIBED BY PG OF CORE DESIGN, DISCONTINUED @ A HEIGHT OF 118 FT.	10/31	10/6
DEFLECTION CHECK: (SEE NEXT PAGE FOR INITIAL CALC + ATTEMPTS TO REDUCE DEFLECTION)		

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH

CORE DESIGN

• PAUL - USE RUBBER AS SLEEVE?

• MCMASTER - CORRELATION OF TORQUE & AXIAL FORCE IN BOLTS
 ↳ CHECK BOLT STR TOO (LEPAGE THINKS THEN ARE ASTM A490, $f_y = 130 \text{ ksi}$)
 BOLTS ARE 7/8" ?
 [NEED TO VERIFY] OR A325

- TAKE A LOOK @ NISSEN

a) TURN ON AUTO EQUIV. LFT. FORCE METHOD → LOAD CASES EQ > AUTO

$$b) T = \frac{2\pi}{15\pi} \sqrt{\frac{11 \text{ in}^4}{E I}}$$

$$T = 1.9 \text{ sec} \pm 10\%$$

$$11. \text{ MAX / MIN HEIGHT} = \frac{0.150 \text{ in} (250' \times 12)}{32 \text{ in} \left(\frac{208 \times 12}{20.5 \text{ in}^4} \right)} = 0.04 \frac{\text{in} \cdot \text{sec}^2}{\text{in}^2}$$

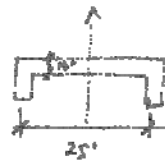
(VIB = 5764)

$$I = 5764 \text{ in}^4 \rightarrow 10 \text{ in}$$

$$\omega = 8400$$

$$h = 208' \rightarrow 10 \text{ in}$$

$$\frac{0.150 \text{ in} (250' \times 12)}{576 \text{ in}^4 / \text{sec}^2 \left(\frac{208 \times 12}{20.5 \text{ in}^4} \right)} = 0.0405$$



$$I = \frac{bh^3}{12} + Ad^2$$

$$= \frac{16(95 \times 12)^3}{12} + (16 \times 95 \times 12)(12.5 \times 12)^2 = 2089 \text{ in}^4$$

$$I_{2 \text{ SIDES}} = 9148.9 \text{ in}^4$$

$$I_{2 \text{ SIDES}} = \frac{(208 \times 12)(12)^3}{12} = 9.99 \text{ in}^4$$

$$I_c = 9158.9 \text{ in}^4$$

GET I

VERIFY #S IN OTHER SHEET

GET Δ IN MODEL & VERIFY STIFFNESS

$$\Delta = \frac{PL^3}{3EI}$$

(CANTILEVER - 56)

$$\Delta = \frac{1000 \text{ K} (208 \times 12)^3}{3(3600)(9158.9 \times 12^4 \times 6)} = 2.79 \text{ IN}$$

APPROX DEFLECTION w/ 1000 K LOAD IN Y-DIR
@ ROOFTOP.

$$T = \frac{2\pi}{3.52} \sqrt{\frac{0.0405 \times (208 \times 12)^4}{(3600)(9158.9 \times 12^4 \times 6)}} = 1.64 \text{ SEC} \pm 10\%$$

CON'S DERIVED FROM
C.M. HARRIS, "SHOCK AND VIBRATION HANDBOOK"

LOOK @ "DYNAMIC ANALYSIS OF STRUCTURES"
HARRIS
HARRIS - "INTRODUCTION TO SEISMIC ENGINEERING"

Southwest Student Housing
Tempe, Arizona
Final Summary Report

12/31 | 9/10 | 12/1

STRUCTURAL DEPTH | CORE DESIGN

COUPLING BEAMS:

FLOOR	SHEAR FORCE (K)	0.8 V _{MAX, GROUP} (K)
1	103.56	104.6
2	123.11	
3	130.7	
4	130.57	
5	135.87	
6	116.92	
7	106.51	
8	95.05	
9	83.23	
10	71.58	
11	60.50	
12	50.32	40.256
13	41.29	
14	33.64	
15	27.51	
16	22.99	19.392
17	20.10	
18	18.7	
19	18.5	
20	9.73	

INITIAL SIZING:
LOWER BEAMS —
 $V = 104.6 \text{ K} \rightarrow M = 104.6 \times \frac{6 \times 12}{2} = 373.6 \text{ K-ft}$
@ MIDDLE OF BEAM

$A_s = \frac{M_u}{4d}$ FOR $f'_c = 4000 \text{ PSI}$
 $f_y = 60 \text{ KSI}$
 $\phi = 1.0$
 $\phi = 0.9$
 $A_s = \frac{0.9 M_u}{4d} = \frac{M_u}{4.44d}$

$M_u = M_{PR}$
 $M_{PR} = M \times 1.25$
 $A_s = \frac{M \times 1.25}{4.44d} = \frac{373.6(1.25)}{4.44(33)} = 2.68 \text{ in}^2$
SAY (3) #9's?
 $A_s = 2.98 \text{ in}^2$

SHEAR REINFORCEMENT: $\frac{V}{4.44(33)} = 3.16$ $M = \frac{477 \text{ K-ft} \times 12 \text{ ft}}{6 \times 12 \text{ ft} / 2} = 159 \text{ K}$

DESIGNED w/ $V_c = 0$

$V_s = V_u / \phi \leq 8 \sqrt{f'_c} b_w d$
 $= \frac{159}{0.75} \leq 8 \sqrt{4000} 16(34) \Rightarrow 212 \text{ K} \leq 275.2 \text{ K}$

IF $V_s \leq 4 \sqrt{f'_c} b_w d$, $S_{MAX} = \frac{d}{2} = 12''$ (2 LEGS) $\therefore S_{MAX} = 12''$ (4 LEGS)
 $\downarrow$
137.6 NG

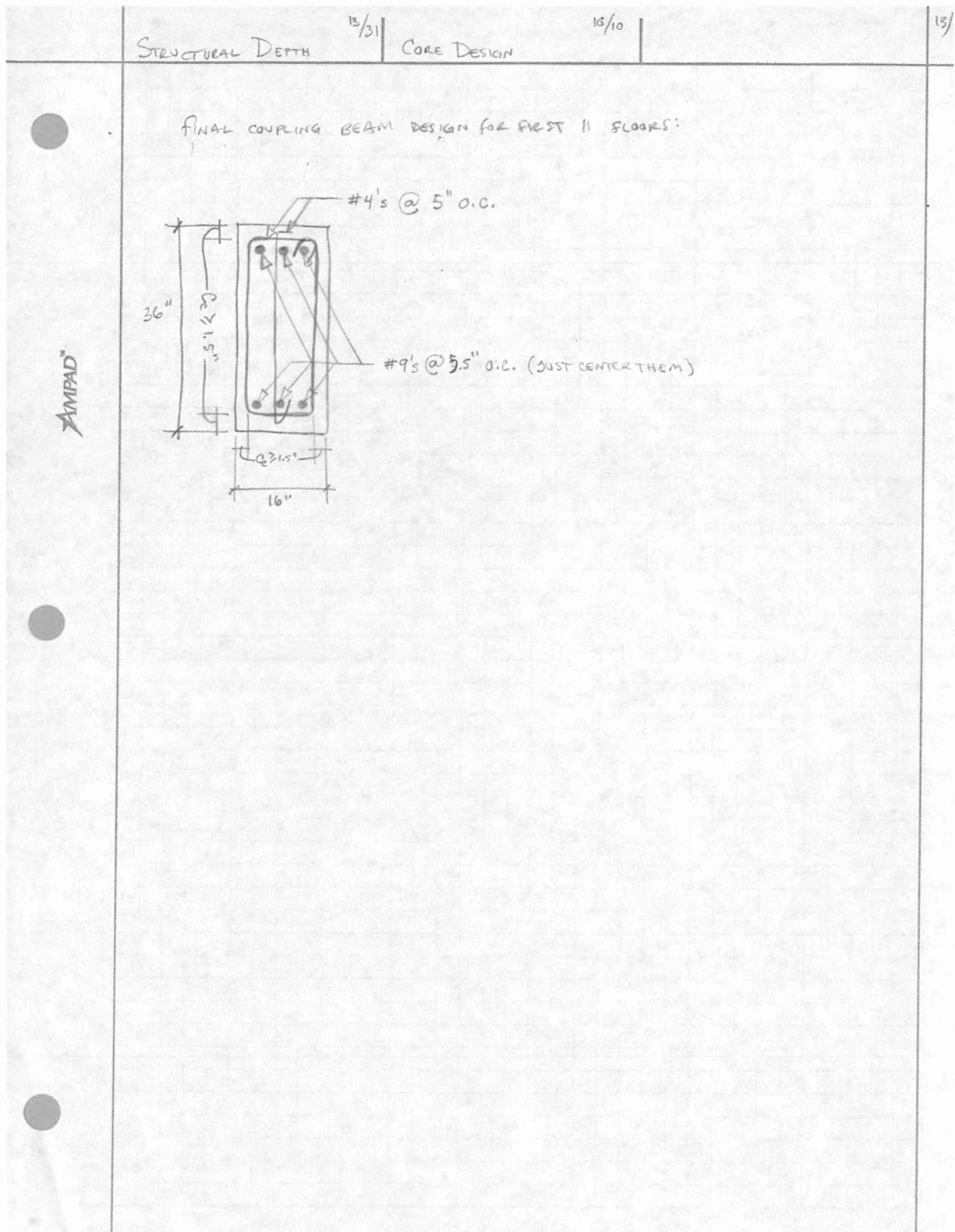
LET $S = 6''$

$A_{V_{MIN}} = \frac{0.75 \sqrt{f'_c} b_w S}{f_{yt}} = 0.036 \text{ in}^2$
 $\frac{50 b_w S}{f_{yt}} = 0.08 \text{ in}^2$ MAX

$V_s = \frac{A_v f_y d}{S}$
 $212 \leq \frac{A_v (60)(33)}{6''}$ $A_v \geq 0.642 \text{ in}^2$

$S = 5''$
 $212 \leq \frac{A_v (60)(33)}{5''}$ $A_v \geq 0.535 \text{ in}^2 \Rightarrow \text{use (3) \#9's}$

$A_s = 3(0.2) = 0.6 \text{ in}^2 @ 5''$

Southwest Student Housing
Tempe, Arizona
Final Summary Report

04.04.2012

Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices | 79

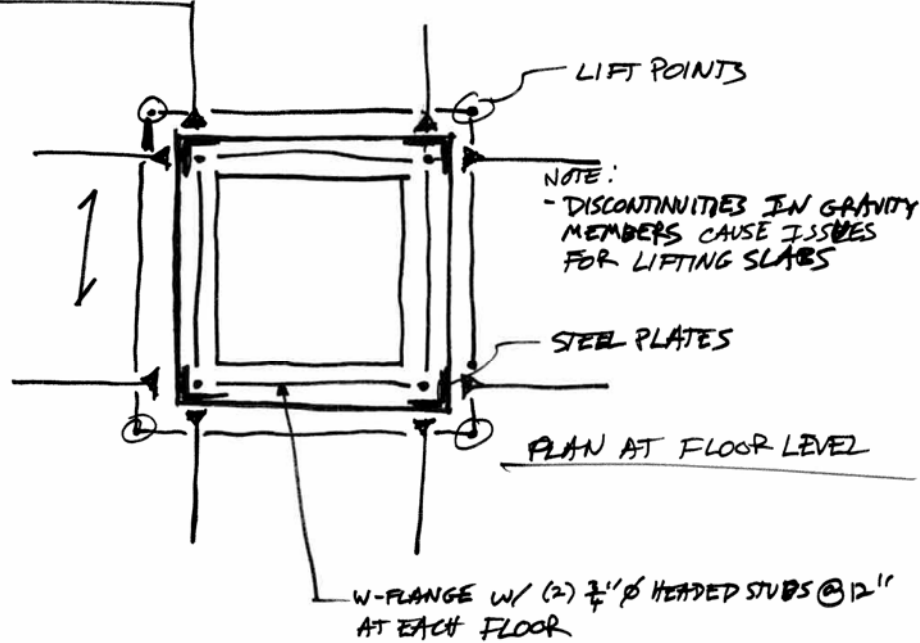
Southwest Student Housing
Tempe, Arizona
Final Summary Report

Appendix D –

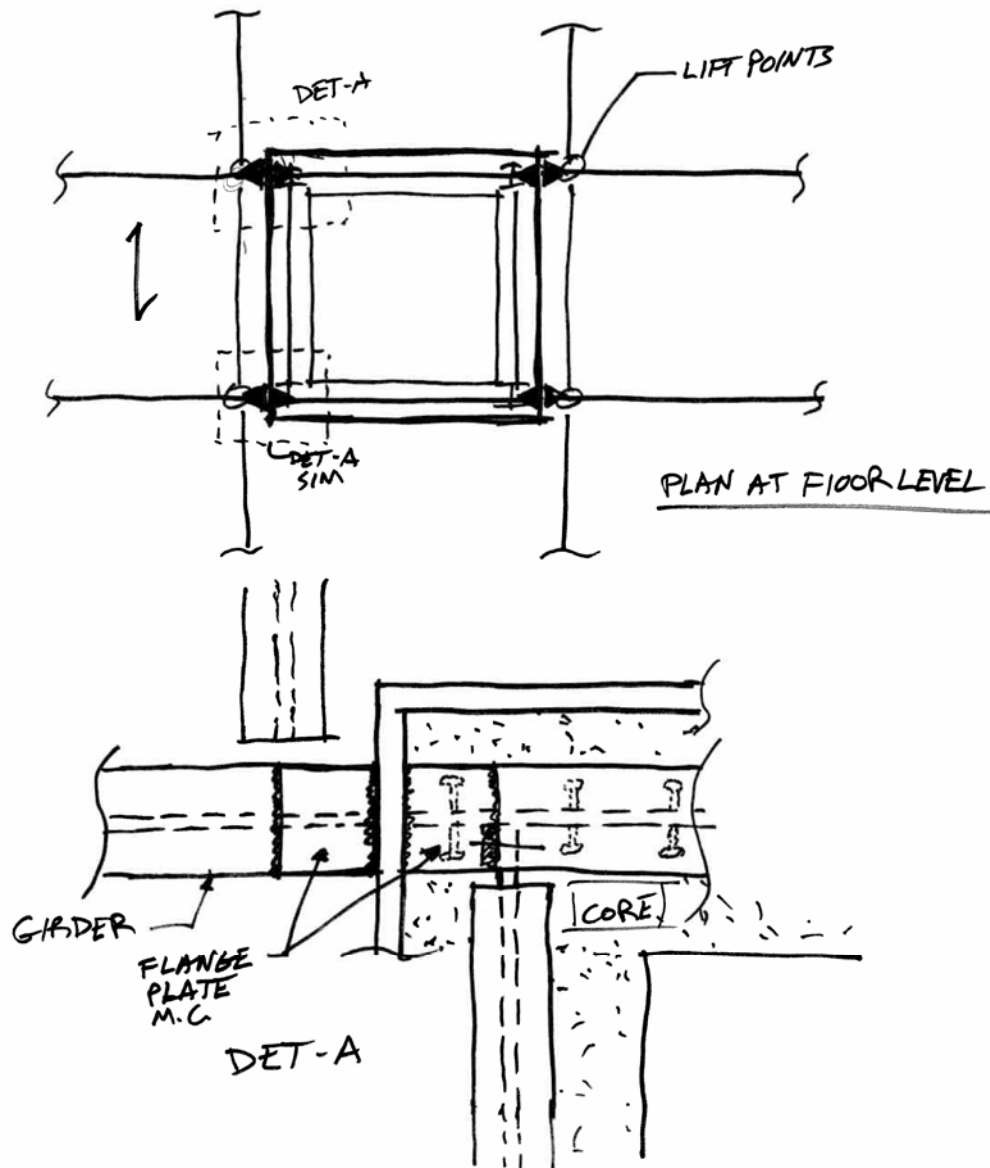
See following pages for scans

Southwest Student Housing
Tempe, Arizona
Final Summary Report

REV.	LERA LESLIE E. ROBERTSON ASSOCIATES, RLLP CONSULTING STRUCTURAL ENGINEERS	P	DRAWING NO.
		DRAFT	
		DESIGN	
		CHECK	

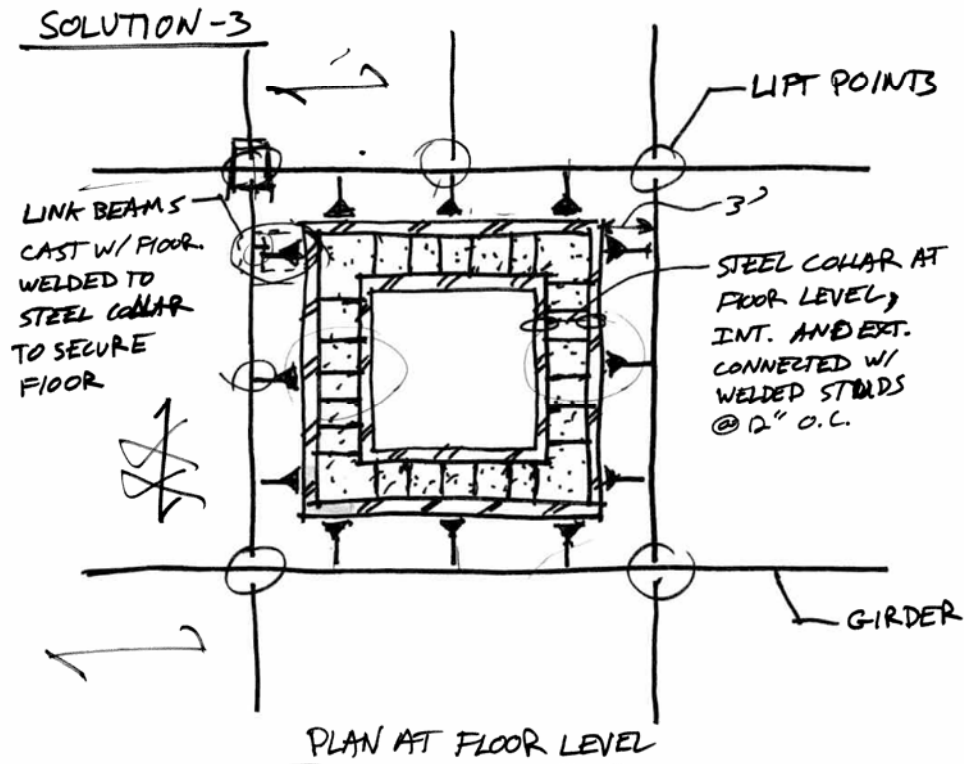
SOLUTION-1

REV.	LERA LESLIE E. ROBERTSON ASSOCIATES, RLLP CONSULTING STRUCTURAL ENGINEERS	P	DRAWING NO.
		DRAFT	
		DESIGN	
		CHECK	

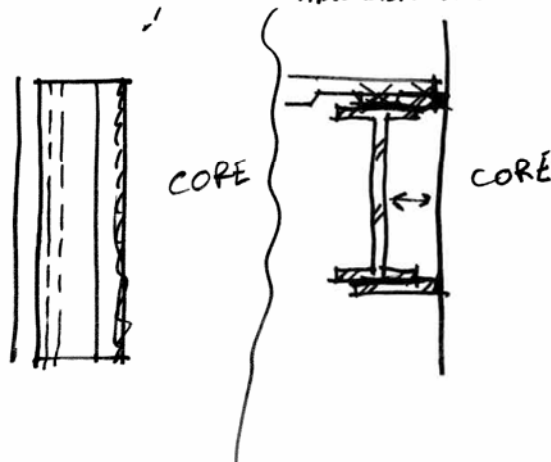
SOLUTION-2

Southwest Student Housing
Tempe, Arizona
Final Summary Report

REV.	LERA LESLIE E. ROBERTSON ASSOCIATES, RLLP CONSULTING STRUCTURAL ENGINEERS	P	DRAWING NO.
		DRAFT	
		DESIGN	
		CHECK	



NOTE: CONNECTION OF STEEL COLLAR TO CONCRETE
CORE TO RESIST GRAVITY AND LATERAL LOADS
AND DISTRIBUTE



04.04.2012

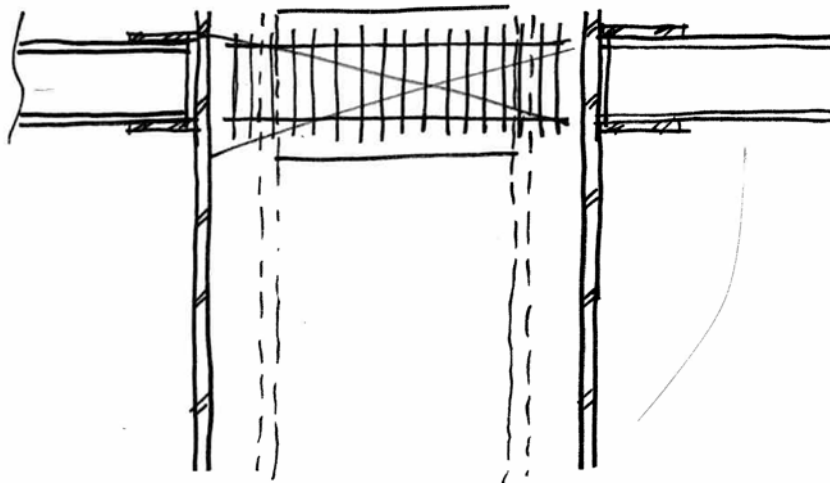
Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices | 83

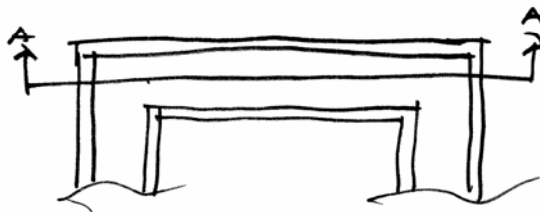
Southwest Student Housing
Tempe, Arizona
Final Summary Report

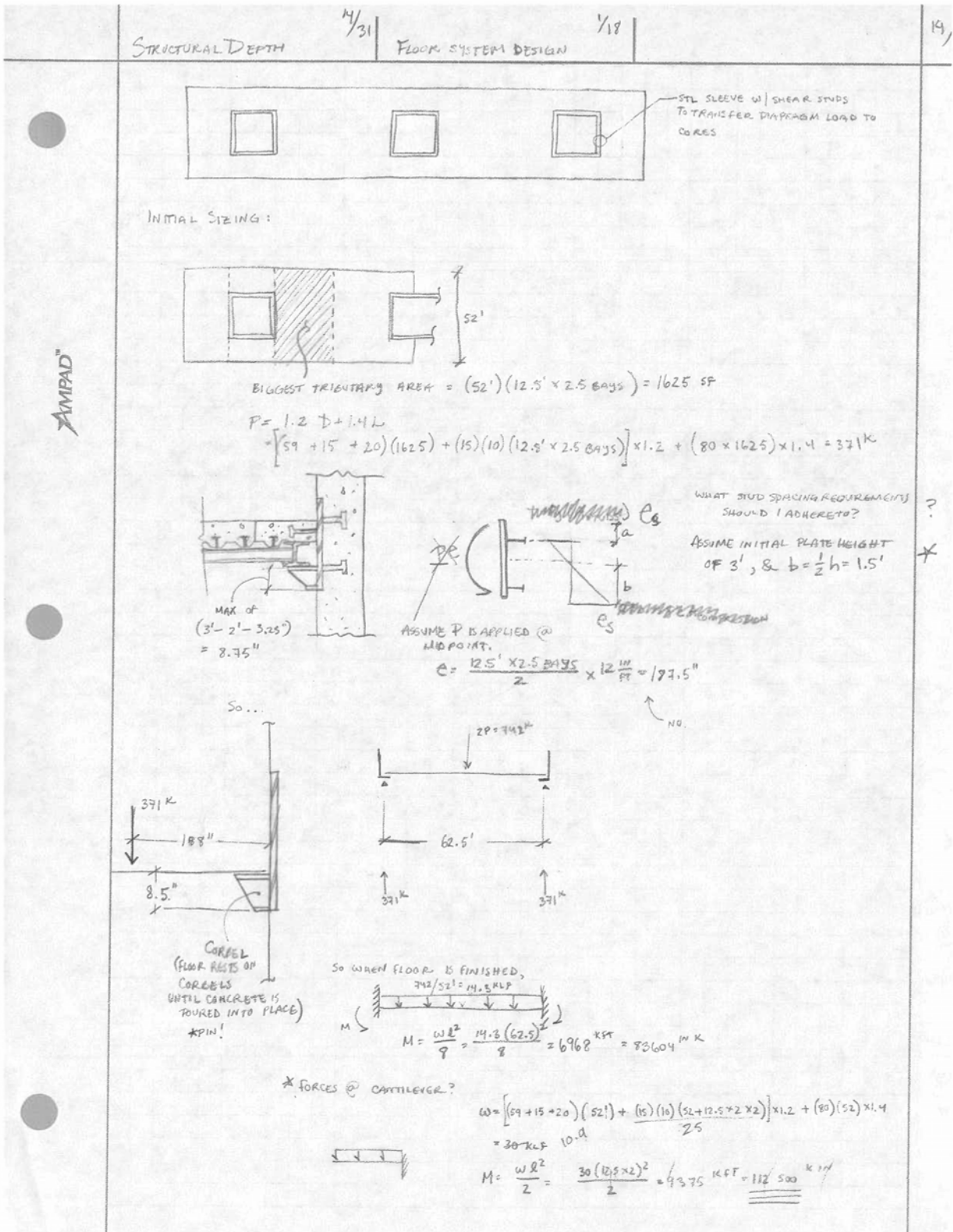
REV.	LERA LESLIE E. ROBERTSON ASSOCIATES, RLLP CONSULTING STRUCTURAL ENGINEERS	P	DRAWING NO.
		DRAFT	
		DESIGN	
		CHECK	

SOLUTION-3 CONT'D



SECTION-A



Southwest Student Housing
Tempe, Arizona
Final Summary Report

15/31 | 3/18 | 15/

STRUCTURAL DEPTH | FLOOR SYSTEM DESIGN

∴ USE CANTILEVERED ENDS TO DESIGN 3FL SLEEVE CONNECTION

$M_u = 112,500 \text{ K IN}$

ASSUME:

STUDS @ 6" O.C.

3'

TOP STUDS ARE YIELDING

$E_{ST} \geq 0.002$

FINDING N.A.

$\frac{0.002}{(3-C-0.5)} = \frac{0.003}{C}$

$0.002 C = 0.003 (3-C-0.5)$

$0.005 C = 0.0075 \quad C = 1.5'$

If $E_{ST} = 0.002$,
 $E_{S2} = 0.001$

$T = \sum A_{si} f_{si} (1.5' - d_i) \quad A_{ST} > A_{S2}$

$= \frac{A_S}{2} (60) (1.5 \times 12'' - 6'') + \frac{A_S}{2} (60) (1.5 \times 12'' - 12'') = 540 A_S \text{ K}$

$112,500 \leq (0.9) \left[540 A_S \left(1.5' \times 12'' - \frac{6'' + 12''}{2} \right) + 19278 \left(1.5' \times 12'' - \frac{12.6''}{2} \right) \right]$

$112,500 \leq 203,000 + 4374 A_S \quad (\text{COMPRESSION TAKES CARE OF ALL MOMENT IN THIS CASE})$

$\rightarrow T < C \quad 19278 \text{ K} < 540 A_S \quad A_S = 35.7 \text{ IN}^2 = 17.85 \text{ IN}^2 \quad = 41 \text{ SHEAR STUDS OVER 28'}$

$(1) \frac{3}{4}" \text{ SHEAR STUD } A_S = 0.44 \text{ IN}^2 \quad (\times 2 \text{ ROWS})$

$\therefore \text{STUDS @ 6" O.C. BOTH WAYS}$

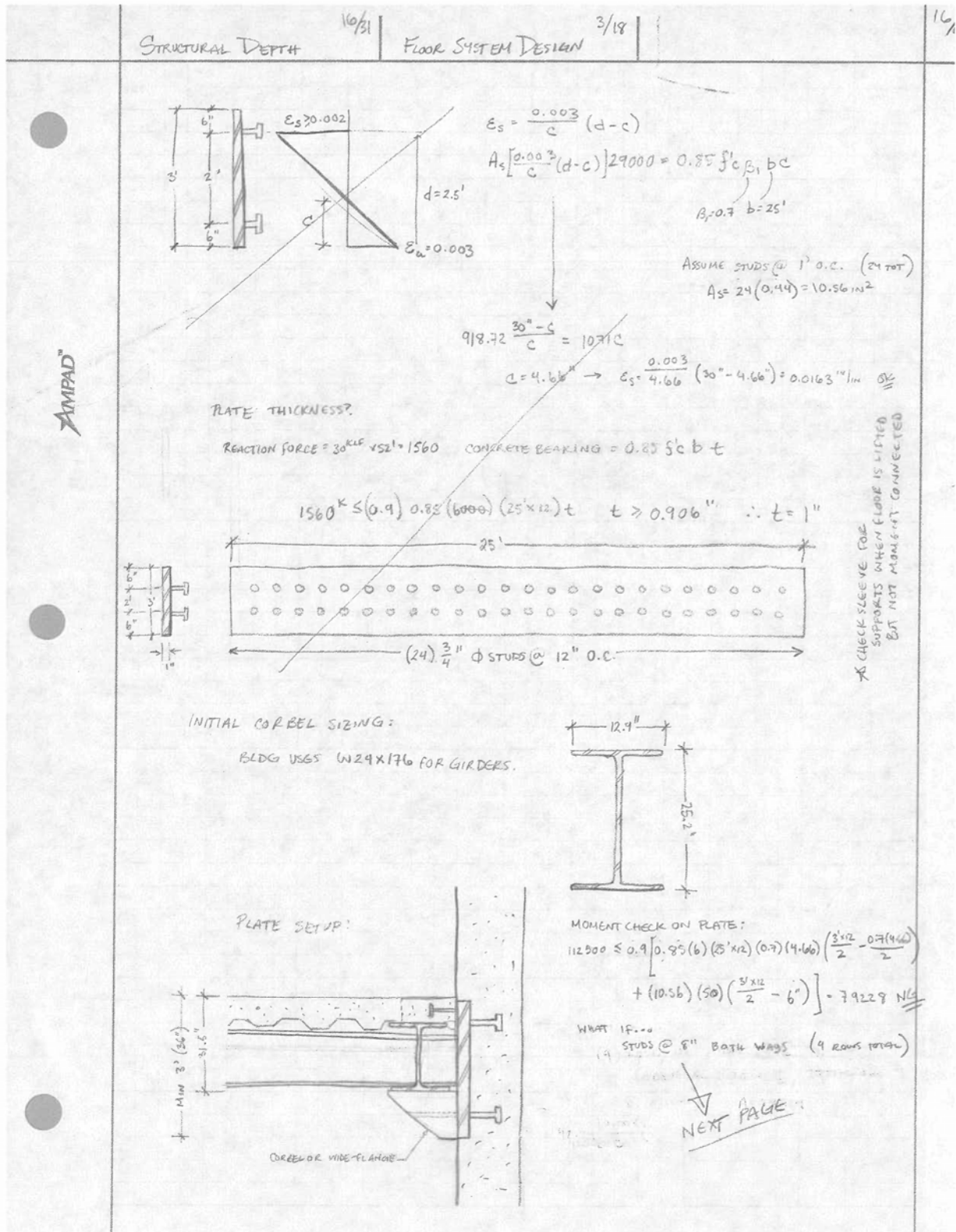
GROSSLY OVERDESIGNED!

BUT, THE SLEEVE HAS TO BE 3' TALL TO ACCOMMODATE FLOOR THICKNESS.

WHAT IF ONE ROW OF SHEAR STUDS?

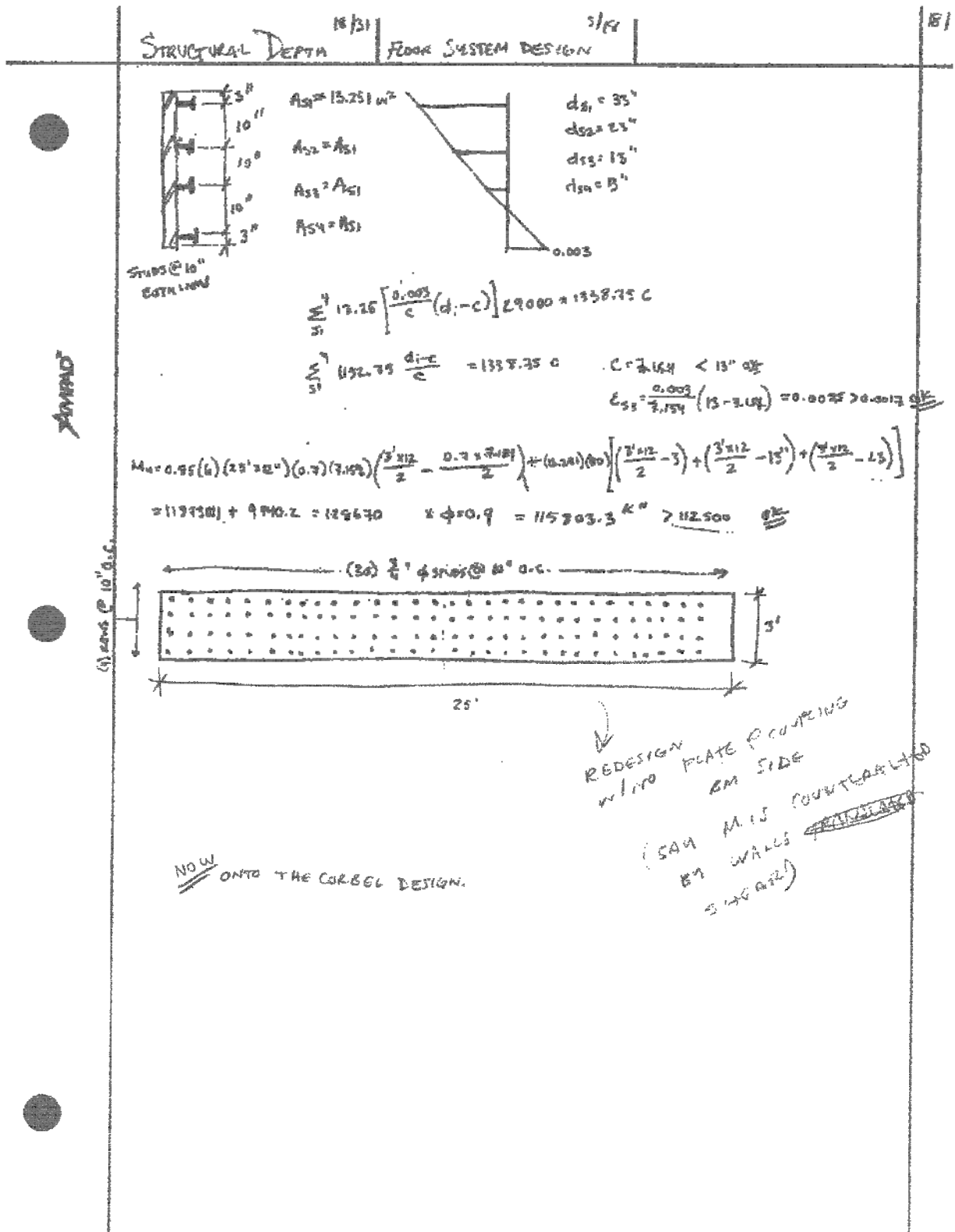
$T = A_S (60) (1.5' \times 12'' - 6'') = 720 A_S = 19278 \text{ K} \quad A_S = 26.78 \text{ IN}^2 = 61 \text{ STUDS}$

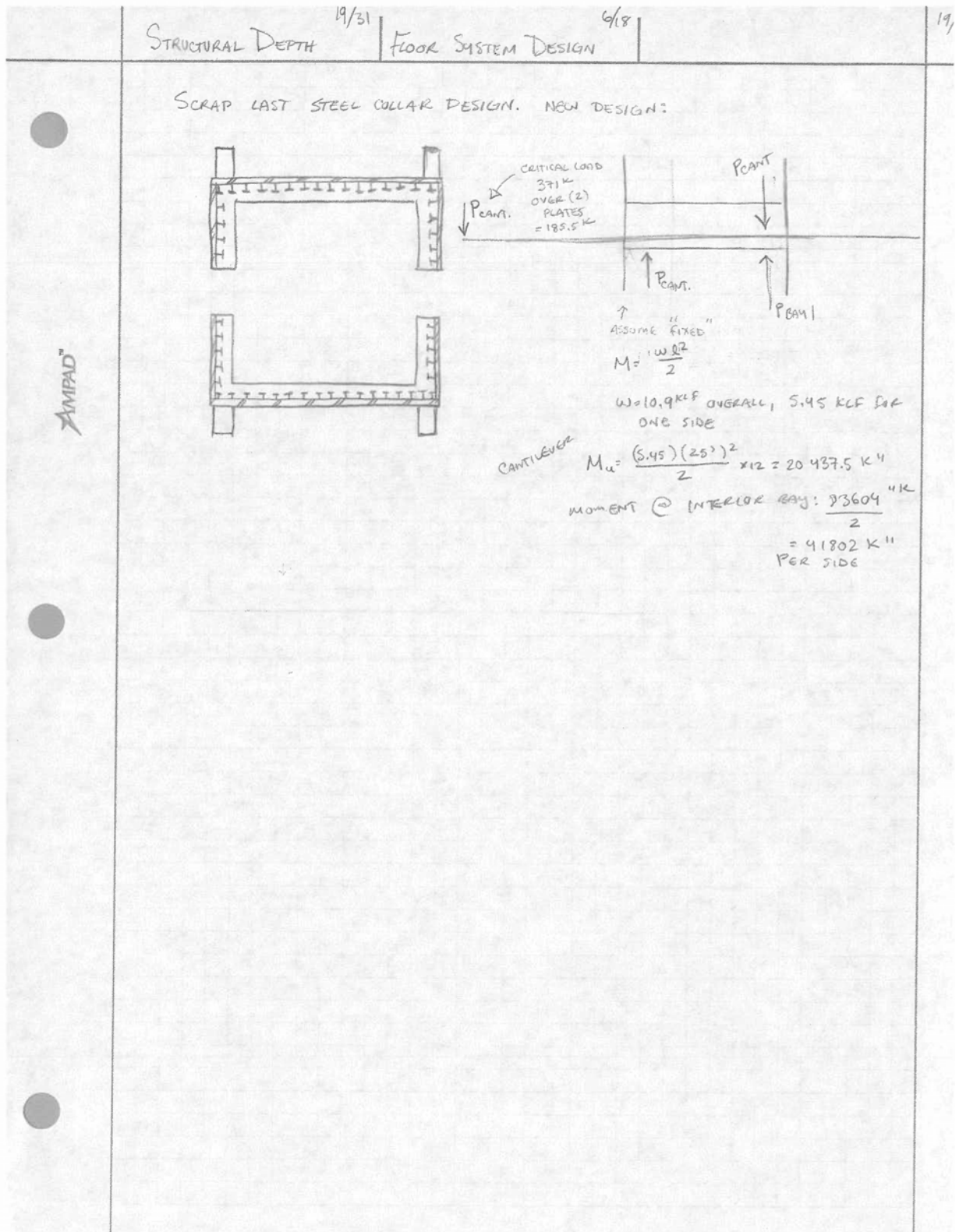
SO ONE SHEAR STUDS
STUDS @ 4" O.C.

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Southwest Student Housing
Tempe, Arizona
Final Summary Report

17/21	4/19	17/1
STRUCTURAL DEPTH	FLOOR SYSTEM DESIGN	
 $A_{s1} = 16.35 \text{ m}^2$ $A_{s2} = A_{s1}$ $A_{s3} = A_{s1}$ $A_{s4} = A_{s1}$	 $E_u = 0.003$	Assume $E_{s1, s2, s3} > 0.007$ $d_{s1} = 34" \quad d_{s2} = 26" \quad d_{s3} = 18" \quad d_{s4} = 10"$
$\sum_{s1} 16.35 \left[\frac{0.003}{c} (d_f c) \right] 29000 = 0.85 f'_c \beta_1 b c$ $\downarrow$ $\downarrow$ $\downarrow$ 16.35 $\frac{d_f - c}{c}$ b 0.85 25×12		
$1422.45 \left[\frac{34-c}{c} + \frac{26-c}{c} + \frac{18-c}{c} + \frac{10-c}{c} \right]$		
$1422.45 \left(\frac{88-4c}{c} \right) = 1339.75 c \quad c = 7.775" < 10" \quad \underline{OK}$		
$E_{s1} = \frac{0.003}{7.775} (10 - 7.775) = 0.0008 \quad \underline{OK}$		
$E_{s2} = \frac{0.003}{7.775} (18 - 7.775) = 0.004 \quad \underline{OK}$		
Assume s_4 is in comp. $\therefore E_{s4} = 0.007 > 0.007$		
$1422.45 \left[\frac{34-c}{c} + \frac{26-c}{c} + \frac{18-c}{c} \right] = 0.85 (b) (0.7) (25 \times 12) c$		
$c = 7.65" < 10" \quad \underline{OK}$		
s_4 is in T BUT NOT YIELDING.		
$c = 7.775"$		
$M_n = 0.85 (b) (25' \times 12") (0.7) (7.775) \left(\frac{3' \times 12}{2} - \frac{0.7 \times 7.775}{2} \right) +$ $(16.35) (50) \left[\left(\frac{3' \times 12}{2} - 2' \right) + \left(\frac{3' \times 12}{2} - 10 \right) + \left(\frac{3' \times 12}{2} - 18 \right) + \left(\frac{3' \times 12}{2} - 26 \right) \right]$		
$= 127276.5 + \dots$		
$\downarrow$ <u>OVERDESIGNED</u>		

Southwest Student HousingTempe, Arizona
Final Summary Report



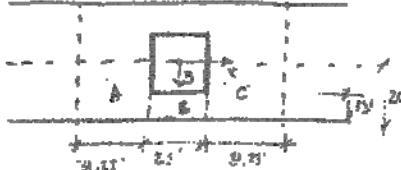
Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH	20/31	FLOOR SYSTEM DESIGN	7/19	20
PARTIAL STEEL COLLAR CENTER COLLAR HAS MOST LOAD STUDS FOR GRAVITY: CHECK SHEAR FRICTION (ACI 318-05 §11.7) $V_u = A_{ve} f_y \mu$ ASSUME $\mu = 1.0$ $f_y = 50 \text{ ksi}$ $\leq \begin{cases} 0.2 S_c' A_c \\ 800 A_c \\ \text{MIN} \end{cases}$ * $\phi = 0.75?$ TRIBUTARY AREA FOR INITIAL SIZING: CENTER COLLAR HAS MOST LOAD. $A_{\text{ONE COLLAR}} = \frac{4550}{2} = 2275 \text{ SF}$ FLOOR LOAD: $\left[(59 + 20 + 15)(2275) + (15)(10')(87.5') \right] \times 1.2 + \left[(80)(2275) \right] \times 1.4 = 527.17 \text{ K}$ $V_u = 528 \text{ K}$ $528 \leq (0.75) A_{\text{SHEAR STUDS}} (50)(1.0) \quad A_{\text{SHEAR STUDS}} \geq 14.08 \text{ IN}^2$ START OUT W/ 6" O.C. IN BOTH DIRECTIONS, $\frac{3}{4}" \phi$ 50 KSI SHEAR STUDS DOUBLE ROW TOP + BOTTOM $A_{\text{ONE}} = 0.442$ $A_{\text{STL}} = 86.57 \text{ IN}^2 > A_{\text{MIN}} \quad \text{OK}$				

Southwest Student Housing

Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH 2/31	KENNA SYSTEM DESIGN 8/8	21,
--------------------------	----------------------------	-----

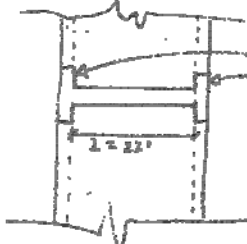


CENTROID $X = 0$ BY OBSERVATION

$$y = \frac{(26 \times 31.25) \times 2 \times 13 + (25 \times 15) \times \frac{15}{2}}{26 \times 31.25 \times 2 + 25 \times 15} = 11.92'$$

$V_{u1} = 329^k$

$M_{u1} = 329^k \times 11.92' \times 12 = 755.04^k$



ADDITIONAL TIES FOR STUDS IF NECESSARY

$\frac{M_u}{L} = 3432^k$ OF FORCE TO RESIST

+ V_{u1}

$V_u = 3960^k$

$3960 \leq (0.45) A_{STUDS} (50) (1.0) \quad A_{STUDS} \geq 105.6 \text{ in}^2$

$\frac{3}{4}" \phi$ STUDS @ 6" O.C, 106 ROW = NG

$\rightarrow \frac{3}{4}" \phi$ STUDS @ 4" O.C, 106 ROW? (TOP + BOT)

$A_{STL} = 130.7 \text{ in}^2$ OK

(TOP) $\frac{3}{4}" \phi$ STUDS @ 4" O.C.

FOR ROWS: 4 ROWS @ 6" O.C, 2 ROWS @ 4" O.C.

$\rightarrow$ 2 ROWS TOP, 2 ROWS BOTTOM.



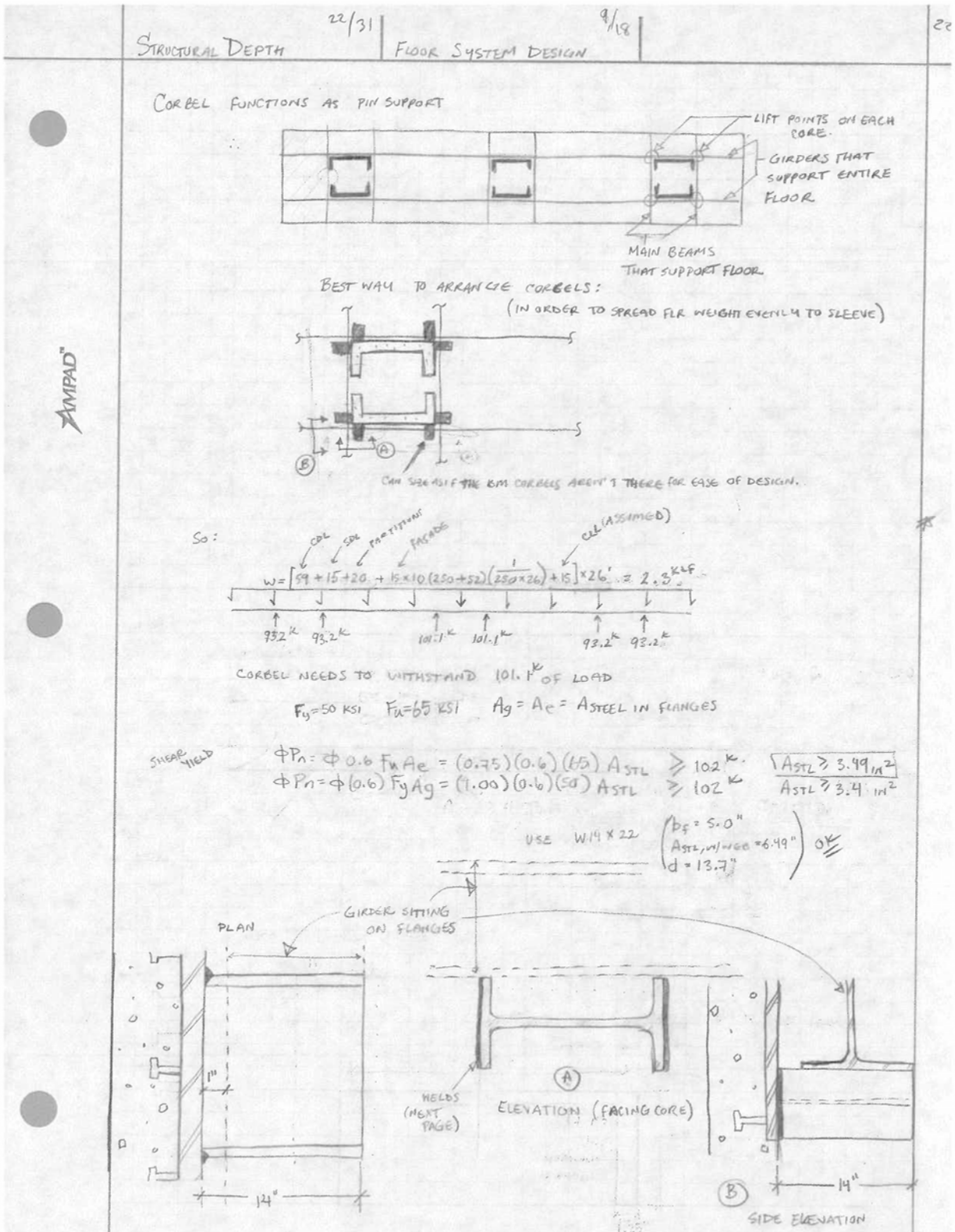
$M_{u1} = 755.04^k$

$\phi M_n = (0.9) A_s f_y = (0.9) (t) (w) (60 \text{ ksi})$

$755.04 \leq (0.9) (25 \times 12) (60) t \quad t \geq 4.661" \rightarrow \boxed{t = 5"} \leftarrow$

CHECK BUCKLING:

$329 \leq 0.95 f_c A_g = 0.95 (6) (25 \times 12 \times 5) = 7650^k \quad \text{OK}$



23/31 | FLOOR SYSTEM DESIGN | 10/19 | 23,

STRUCTURAL DEPTH

WELD DESIGN:

THE WELDS ON THIS CORBEL ARE ECCENTRICALLY LOADED.
USE TABLE 8-4 IN AISC STEEL CONSTRUCTION MANUAL

PLAN VIEW AGAIN:

W24x176 GIRDER
CORBEL

18" 4 KSI CONCRETE CORE
5" STL PLATE

1" 6.45" 6.45" 0.1" 14" 7.45"

$e_x = a$
 $K=0$
 $L=5"$ (FULL HEIGHT OF CORBEL)
 $e_x = 7.45"$

a	C
1.40	0.927
1.60	0.815

$7.45 = a(5")$ $a = 1.49$
 $\therefore C = 0.8766$

$\phi R_n = \phi C C_1 D L$
 $C_1 = \text{ELECTRODE STRENGTH}$
(ASSUME E70XX, $C_1 = 1.0$)
 $\phi = 0.75$

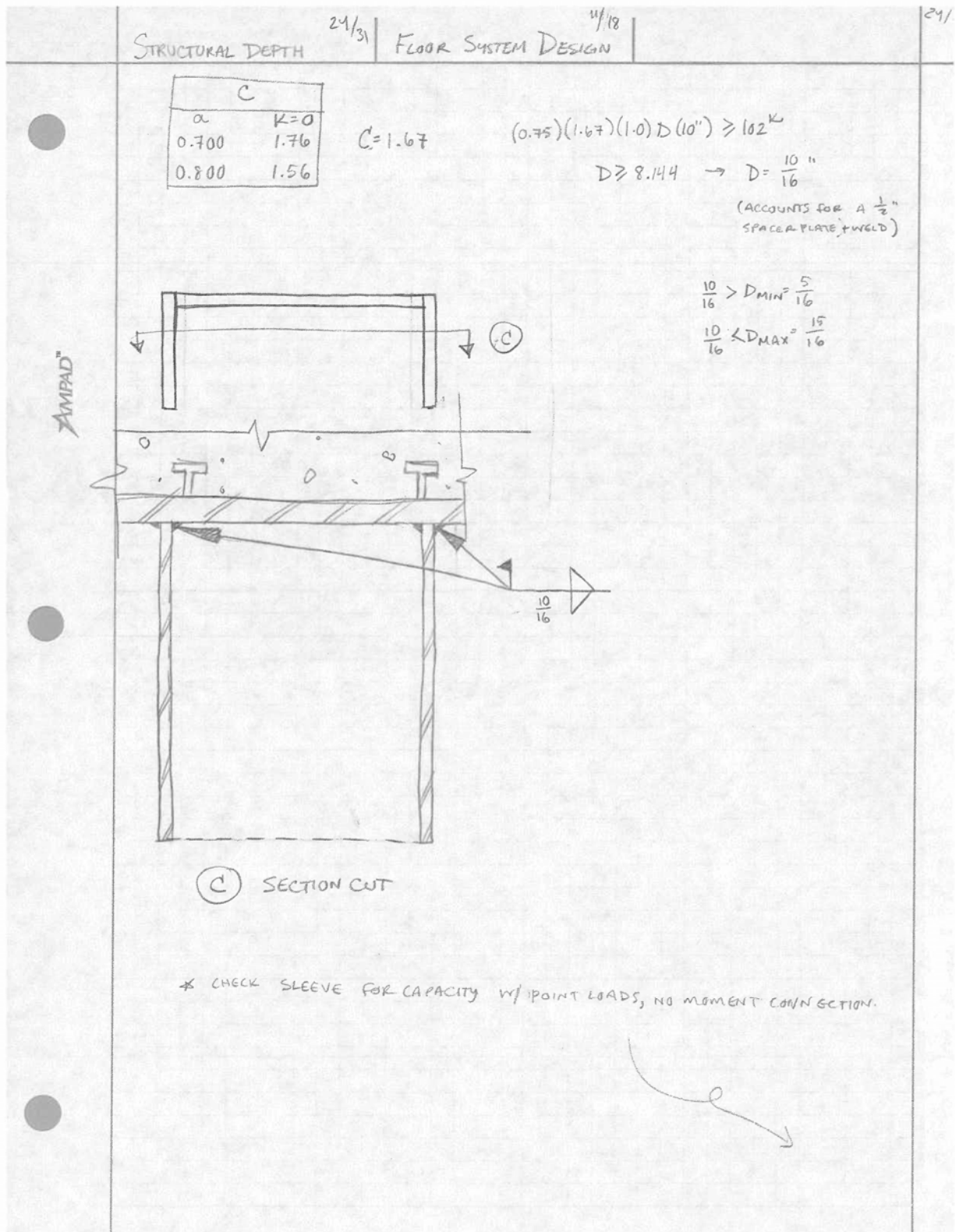
$(0.75)(0.8766)(1.0) D(5") \geq 102 K$
 $D \geq 31.03 \rightarrow \frac{32}{16} \text{ " NG}$

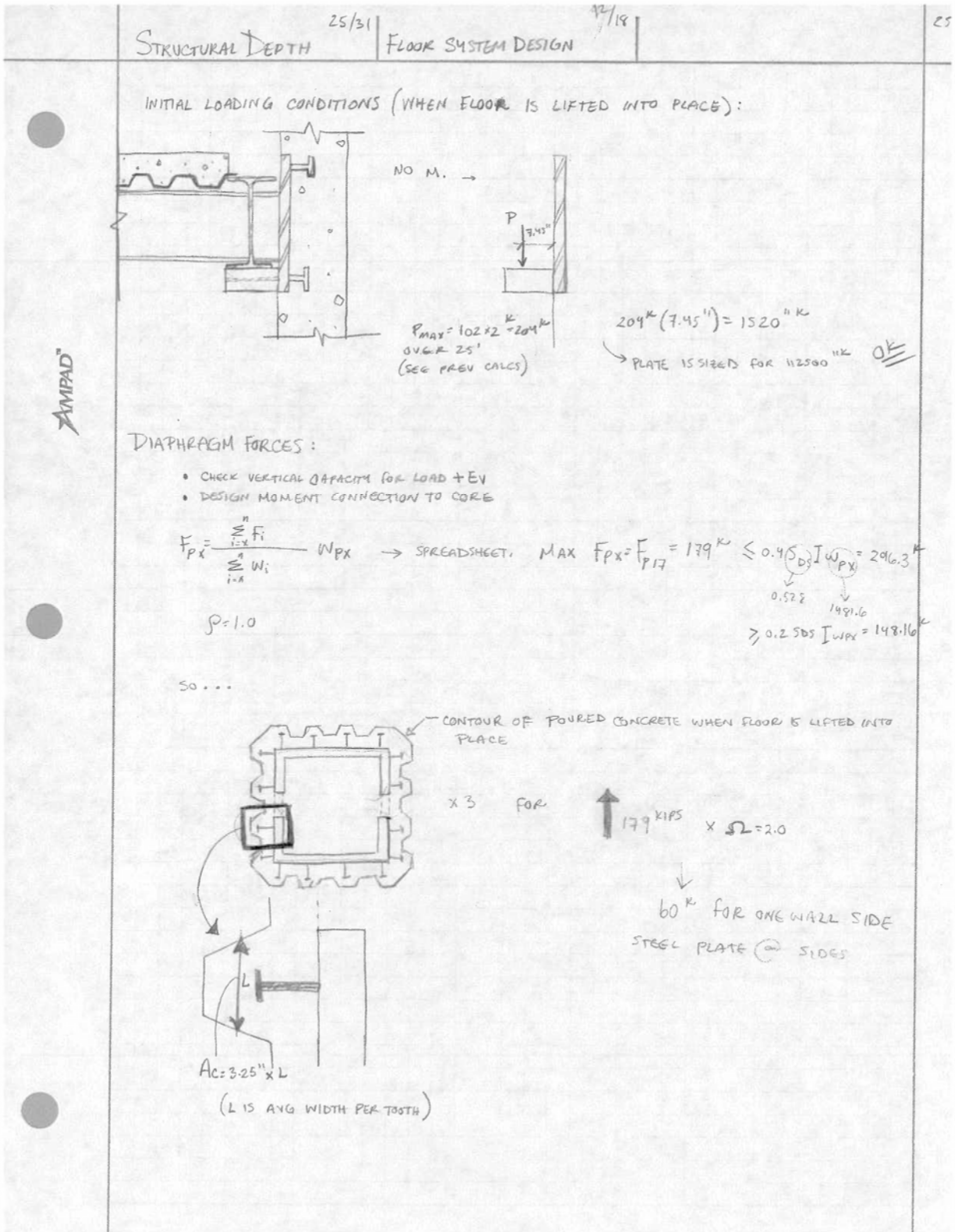
$\text{MIN } D = \frac{5}{16}$
 $\text{MAX } D = (1" - \frac{1}{16}) = \frac{15}{16}$

→ USE BUILT UP MEMBER & WELD ON BOTH SIDES OF EACH PLATE TO DOUBLE L.

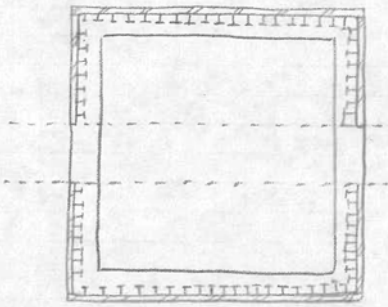
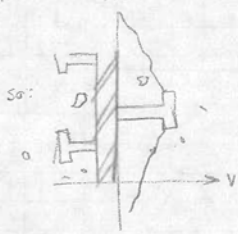
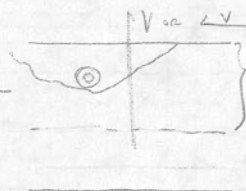
$A_{STL} \geq 3.49 \text{ in}^2 \rightarrow t_{\text{PLATE}} = 0.5" (A_{STL} = 5" \times 0.5" \times 2 = 5 \text{ in}^2)$
W/ SPACER PLATE @ TOP PREATTACHED

CAN WELD BOTH SIDES OF PLATES
 $\therefore L = 5" \times 2 = 10"$
 $e_x = 7.45 = a(10")$ $a = 0.745$

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH	26/31	FLOOR SYSTEM DESIGN	13/18	26,
$\phi V_n = 0.75 (1.0 V_c)$ $V_c = 2 \lambda \sqrt{f'_c} A_g \quad \lambda = 0.75 \text{ FOR LIGHTWEIGHT}$ $V_c = 2 (0.7) \sqrt{4000} (3.25') L_{\text{CHC}} = 287.77 L_c$ $\phi V_n = (0.75) 287.77 L_c = 215.93 L_c \geq 179,000 \text{ lb} \quad \frac{L_c \geq 829.37 \text{ IN}}{6 \text{ SIDES}} \quad L_{\text{ONE SIDE}} \geq 138.23 \text{ IN}$ $\downarrow$ USE HALF OF WALL LENGTH: 150 IN (USE AVG LENGTH OF SHEAR TAB) SHEAR STUD STRENGTH Q_n FOR $f'_c = 3 \text{ KSI}$, LW CONCRETE $\phi = \frac{1}{2}''$ $\rightarrow = 7.6 \text{ K}$ SO $\sum Q_n \geq V_u \quad (7.6)n \geq 179 \quad \frac{n \geq 23.6}{6 \text{ SIDES}} \quad n_{\text{ONE SIDE}} \geq 3.93 \text{ STUDS}$ SO MIN 4 STUDS / SIDE (@ $\frac{1}{2}''$) $\rightarrow$ move to $\frac{3}{4}''$ (EASIER TO FIND) MIN $S = 6\phi$ MAX $S = 36''$ OR 8" SLAB t (FOR STUDS IN DECK) } FROM L. GESCHWINDER WHAT ABOUT STUDS NOT IN DECK? "UNIFIED STEEL CONSTRUCTION" MAY AS WELL ADHERE TO MAXIMUM $\star$ STL COLLAR WILL ENCASE CORE LIKE SO:  SAY $\frac{3}{4}''$ STUDS @ 12" O.C. ALONG STL PLATE 6'-WIDE CORRIDOR TOPPED W/ 8" DEEP COUPLING BEAM IN ADDITION TO SHEAR, NEED TO DESIGN STUDS FOR: - D.4.1. c) CONCRETE BREAKOUT STR IN TENSION (D.5.2) d) CONCRETE BREAKOUT STR IN SHEAR (D.6.2) (AMONG OTHERS) SO:  &  3.25" TOPPING				

29/31 STRUCTURAL DEPTH	4/18 FLOOR SYSTEM DESIGN	29
----------------------------------	------------------------------------	----

CONCRETE BEAM-HOOK STRENGTH IN TENSION - SINGLE ANCHOR

$$N_b \leq \frac{A_{sc}}{A_{sc0}} \psi_{e,h} \psi_{t,h} \psi_{d,h} N_b$$

$$N_b = \phi_s f_c' h_{ef}^{1.5} = 17 \sqrt{\text{in}} (7.5)^{1.5} = 22.64 \text{ k}$$

17 for POST-INSTALLED ANCHORS

AND PROJECTED CONCRETE FAILURE AREA

AND PROJECTED CONCRETE FAILURE AREA $\rightarrow$ AREA $\geq 1.3 h_{ef}^2$

$$A_{sc0} = 9 h_{ef}^2 = 523 \text{ in}^2$$

$$\frac{3}{4} \text{ STUDS, ADDITIONALLY, TOLER. A } L_{d,req} = 8 \frac{f_y}{f_c'} \left(\text{REQD. } L = \frac{3}{8} \right)$$

$$h_{ef} = 7.5 - \frac{3}{8} - \frac{3}{8} = 7 \frac{5}{8}$$

$$\psi_{e,h} = 0.7 + 0.5 \frac{C_{min}}{15 \text{ in}} \text{ for } C_{min} < h_{ef}/5$$

$$= 0.778$$

1625 7625

$$\psi_{t,h} = 1.0 \text{ (UNREINFORCED) (NO CRACKING IS EXPECTED IN SLAB @ BEAM JOINTS BUT NOT ASSUMED)}$$

$$\psi_{d,h} = \frac{1.5 h_{ef}}{C_{min}} \text{ for } C_{min} < C_{ac}$$

$$\text{in } 12" \rightarrow \text{USE } 1.0$$

$$12" \text{ O.C. SPACING} < 3 h_{ef} \therefore$$

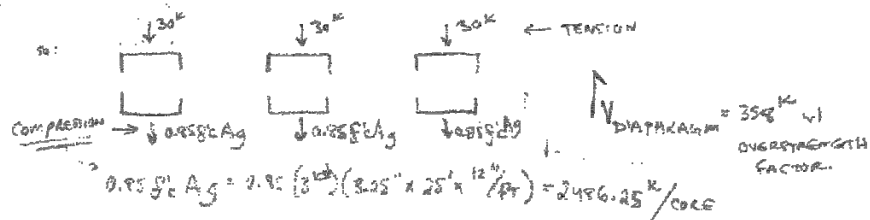


$$A_{sc} = (3.25") (12") = 39 \text{ in}^2$$

* SPACING MIGHT WORK AGAINST ME $\therefore$ ADJUSTED A_{sc} TO ACCOUNT FOR PROJECTED LENGTH OVERLAP

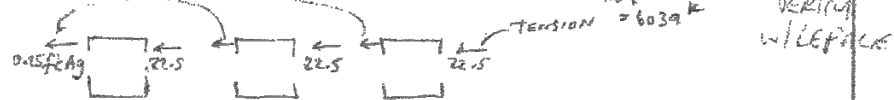
$$N_b = 22.64 \leq \frac{39}{523} (0.778)(1.0)(1.0)(22.64) = 1.25 \text{ k}$$

$$\text{FOR (24) STUDS @ } 12" \text{ O.C.}, N_b = 24(1.25) = 30 \text{ k}$$



$$\text{TOTAL RESISTING FORCE} = 30 \text{ k} \times 3 + 2486.25 \text{ k} \times 3 = 7549.75 \text{ k} >> 358 \text{ k}$$

(COMPRESSION) X.O.P.



$$V_{DAMAGE} = 358 \text{ k}$$

$$9 \text{ STUDS PER WEB} \times \text{lower } 55 = 1.25 (9) (6) = 67.5 \text{ k}$$

$$0.85 f_c' A_g = 0.85 (3 \text{ k}) (h' \times \frac{12}{16} \times 3.25" \times 2 \text{ SIDES}) = 663 \text{ k/core}$$

$$\text{TOTAL RESISTING FORCE} = 67.5 \text{ k} + 663 \text{ k} \times 3 = 2056.3 \text{ k} >> 358 \text{ k}$$

X.O.P. = 1645

Southwest Student Housing
Tempe, Arizona
Final Summary Report

28/31 | STRUCTURAL DEPTH | FLOOR SYSTEM DESIGN | 15/19 | 29/

CONCRETE BREAKOUT STRENGTH IN SHEAR

D6.2.1 (2) SINGLE ANCHOR, PERPENDICULAR TO EDGE

$$V_{cb} = \frac{A_{vc}}{A_{vc0}} \psi_{ed,v} \psi_{c,v} V_b$$

(3) PARALLEL TO EDGE

$$V_{cb, PARALLEL} = 2 V_{cb} ; \psi_{ed,v} = 1.0$$

$A_{vc0} = 4.5 (C_{a1})^2 = 162 \text{ in}^2$
 C from prism edge to anchor axis = 6"

$V_b = 8 \left(\frac{l_e}{d_o} \right)^{0.2} \sqrt{f_c} \sqrt{f_c'} (C_{a1})^{1.5}$ [FOR HEADED BOLTS CONTINUOUSLY WELDED IN STL ATTACHMENTS $\geq \frac{3}{4} l_e$]

$l_e = \text{LOAD BEARING LENGTH OF ANCHOR}$
 $= l_{ef} = 7.625"$
 $8 d_o = 8 \left(\frac{3}{4} \right) \cdot 6" \leftarrow = l_e$
 MIN

$= 8 \left(\frac{6}{1.75} \right)^{0.2} \sqrt{3/4} \sqrt{3000} (1.125)^{1.5} = 1.19 \text{ K} \times 2 \text{ (D6.2.1.1.C)}$

$\psi_{ed,v} = 1.0$ (NO EDGE PERPENDICULAR TO C_{a1})

$\psi_{c,v} = 1.0$ (CONSERVATIVELY SPEAKING, THERE WON'T BE CRACKING MOST LIKELY)

$A_{vc} = 1.5 C_{a1} (C_{a2} \times 2) = 29.25 \text{ in}^2$

$V_b = 1.19 \text{ K} \leq \frac{29.25}{162} (1.0)(1.0)(1.19) = 0.215 \text{ K} / \text{ANCHOR} \times 2 \text{ (D6.2.1.1.C)}$

for...

$V_{DIAPHRAGM} = 358 \text{ K}$

9 STUDS/WEB X 12 WEBS = 108 STUDS RESISTING
 $= 25.22 \text{ K CAPACITY}$
 (ADD TO NOM. CAPACITY OF STUDS IN T & FLOOR DIAPHRAGM IN C)
 $\rightarrow 6036.4 \text{ K} = \text{TOTAL SHEAR CAPACITY IN } \phi 5 > 358 \text{ K}$

24 STUDS/WALL X 6 WALLS = 144
 $= 30.96$
 TOTAL CAPACITY = 1666 K / 77358 K

USE $\frac{3}{4} \phi$ SHEAR STUD CONNECTORS @ 12" O.C., CENTERED IN FNC TOPPING ON ALL SIDES IN STL PLATE AREA (SET STUDS 6" FROM CIRCUMFERENCES)

COLUMN? DEAG STUD

Southwest Student Housing
Tempe, Arizona
Final Summary Report

STRUCTURAL DEPTH 29/3 | FLOOR SYSTEM DESIGN 16/18 | 29

2 IDEAS TO TRANSFER FLOOR DIAPHRAGM FORCES TO CORE:

- A - USE SHEAR STUDS IN CONCRETE TOPPING THAT ARE ATTACHED TO STEEL COLLAR ON CORE
- B - USE STEEL BEAMS RUNNING BESIDE THE CORE AS COLLECTOR ELEMENTS ("DRAG STRUTS") TO TRANSFER SHEAR INTO CORE → PUT STUDS INTO BEAM TO PROMOTE SHEAR TRANSFER/COMPOSITE ACTION

A

RECHECK OF APPENDIX D CALCS: (ACI 318-05)

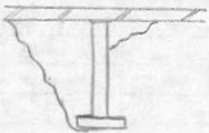
SO $V_u = 179 \text{ K}$ @ 17TH FLOOR $\Omega_b = 2.5$ $C_d = 5$

$V_{\text{PER WALL}} = \frac{179 \times 2.5}{6} = 74.58 \text{ K} \rightarrow V_{\text{PER WEB}} = \frac{74.58}{2} = 37.3 \text{ K}$ (PER 9.5' PORTION OF WALL)

LOOKS LIKE I SHOULD CHECK CONCRETE PRISM IN SHEAR. (FOR ANCHORS FAR FROM A FREE EDGE)

I THINK INITIAL ADVICE WAS NOT ENTIRE. (CONCRETE BREAKOUT NEEDS MORE FREE EDGES OR ACCURATE CALC)

g) PRISM D.6.3



$V_{cp} \leq K_{cp} N_{cp}$ $K_{cp} = 2.0$ for $h_{ef} \geq 2.5"$

$V_{cp} \leq 2(1.25) = 2.5 \text{ K}$ $\rightarrow 1.25 \text{ K}$ (SEE P 14 CALCS)

@ 9 STUDS / WEB, $V = 22.5 \text{ K} < 37.3 \text{ K}$ NG

STUDS @ 6" SPACING? USE MULTIPLE ANCHORS THIS TIME

LET'S START W/ CONCRETE BREAKOUT IN TENSION:

c) BREAKOUT, TENSION D.5.2



BREAKOUT CONE FOR ONE WEB OF ANCHORS

$N_{cbg} = \frac{A_{nc}}{A_{nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$

$A_{nc} \leq n A_{nco}$ $n = 18$

$A_{nc} = (1.5 \times 7.625 \times 2 + 17 \times 6) \times 3.25 = 405.844 \text{ in}^2$

$A_{nco} = 9 h_{ef}^2 = 9(7.625)^2 = 523.3 \text{ in}^2$

$406 \text{ in}^2 \leq (18)(523) = 9414 \text{ in}^2$ OK

FOR $\frac{3}{4}" \phi$, $8 \frac{3}{16}"$ STUDS.

USE $3 \frac{3}{16}"$ STUDS. $h_{ef} = 2.625 \text{ in}$

$A_{nc} = [1.5 \times 2.625 \times 2 + 17 \times 6] \times 3.25 = 109.9 \text{ in}^2$

$A_{nco} = 9(2.625)^2 = 62.0 \text{ in}^2$ $\times n = 18 = 1116.3 \text{ in}^2$ $\left\{ \frac{A_{nc}}{A_{nco}} = 1.773 \right.$

$N_b = K_c \sqrt{f'_c} h_{ef}^{1.5} = 24(\sqrt{3000})(2.625)^{1.5} = 5.6 \text{ K / STUD}$

$\psi_{ec,N} = 1.0$ (NO ECCENTRIC LOADING)

$\psi_{cp,N} = 1.0$

$\psi_{ed,N} = 0.7 + 0.3 \frac{1.625}{1.5(2.625)} = 0.924$

$\psi_{c,N} = 1.25$ (NO CRACKING, CAST-IN-PLACE)

30/31 | STRUCTURAL DEPTH | FLOOR SYSTEM DESIGN | 17/18 | 30/

c) CONTINUED

$$N_b = 5.6 \text{ K/STUD} \leq (1.77)(1.0)(0.824)(1.25)(5.6) = 10.224 \text{ K/NSG} \underline{\underline{NG}} \quad (NEED \geq 38 \text{ K})$$

↓
WHAT WOULD IT TAKE TO WORK?

→ INCREASE TOPPING THICKNESS TO ALLOW FOR FULL CONE OF FAILURE TO FORM.

→ NEW $t = (2.625)_{hef} (1.5) \times 2 = 7.875 \rightarrow 8''$ OF TOPPING @ CORE (A CURE)

$$A_{NC} = [1.5 \times 2.625 \times 2 + 17 \times 6] \times (7.875) = 865.3 \text{ IN}^2$$

$$\frac{A_{NC}}{A_{NCO}} = \frac{865.3}{62.0} = 13.96 \quad N_b = 5.6 \text{ K/STUD}$$

$\phi_{FEN} = 1.0 \quad \phi_{FEN} = 1.0 \quad (C_{a, min} = 4'' > 1.5 \times 2.625 = 3.94'')$ $\phi_{CIN} = 1.25$

$N_b = 18 \times 5.6 \text{ K} \leq (13.96)(1.0)(1.0)(1.25)(5.6) = 97.7 \text{ K} > 74.6 \text{ K} \underline{\underline{OK}}$
100.8 K

→ CAN REDUCE CURE SIZE IF NECESSARY

d) BREAKOUT, SHEAR D.6.2



$$V_u = \left[\frac{A_{NC}}{A_{NCO}} \phi_{FEN} \phi_{FEN} \phi_{CIN} V_b \right] \times 2 \quad (D.6.2.1c)$$

$C_{a1} = 6''$ (DISTANCE FROM ANCHOR TO EDGE OF FAILURE PRISM IN DIR. OF V)

$$V_b = \left(\frac{2.625}{2.14} \right)^{0.2} \sqrt{3/4} \sqrt{3000} (6'')^{1.5} = 7.165 \text{ K/STUD} \times 2 = 14.3 \text{ K/STUD}$$

$$A_{NCO} = 4.5 (6'')^2 = 162 \text{ IN}^2$$

$$A_{NC} = 8' (1.5 \times 6'') = 72 \text{ IN}^2 \quad \frac{A_{NC}}{A_{NCO}} = 0.4444$$

$\phi_{FEN} = 1.0$ (NO EDGE EFFECT)

$\phi_{CIN} = 1.4$ (NO CRACKING)

IN CASE C_{a1} WAS ESTIMATED INCORRECTLY, MAX CALC FOR $C_{a1} = 2.625''$
 $\rightarrow V_b = 4.15 \text{ K} \leq 2.58 \text{ K/STUD} \times 18 \text{ STUDS} = 46.44 \text{ K} > 37.3 \text{ K} \underline{\underline{OK}}$

$$V_b = 14.3 \text{ K/STUD} \leq (0.4444)(1.0)(1.4)(14.3) = 8.9 \text{ K/STUD} \times 18 \text{ STUDS} = 160.16 \text{ K/NSG}$$

$> 37.3 \text{ K} \underline{\underline{OK}}$

e) PRYOUT, SHEAR D.6.3

$$V_{cpq} = K_{cp} N_{cbg} \quad K_{cp} = 2.0 \text{ FOR } h_{ef} \geq 2.5'' \quad h_{ef} = 2.625''$$

$$N_{cbg} = 97.7 \text{ K}$$

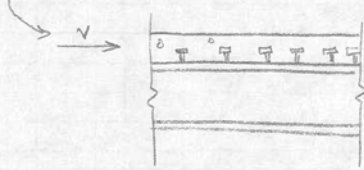
$$V_{cpq} = (2)(97.7) = 195.4 \text{ K/NSG} \gg 37.3 \text{ K} \underline{\underline{OK}}$$

SOLUTION 1: PARTIAL STEEL COLLAR, w/ LWC TOPPING CAST OVER SHEAR STUDS THAT CONNECT INTO THE COLLAR. LWC TOPPING WILL BE INCREASED FROM 3.25" TO 8" IN THE CORE PERIMETER TO ACCOMMODATE NEW SHEAR TRANSFER STRESSES.

31/31 | FLOOR SYSTEM DESIGN | 18/19 | 31/

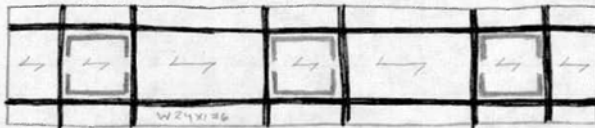
STRUCTURAL DEPTH

SOLUTION 2: DRAG STRUT AS SHEAR COLLECTOR?



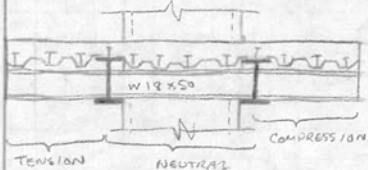
SHEAR TRANSFER TO BEAMS & GIRDERS, THEN FROM GIRDERS TO CORES.

BEAMS & GIRDERS WOULD NEED TO BE DESIGNED AS BEAM-COLUMNS.



FIRST: CONNECTION BETWEEN SLAB & STRUCTURAL STEEL FRAMING -
 Q_u FOR $F'_c = 3000$ PSI, LW CONCRETE, STUD $\phi = 1/2"$ IS 7.6 K

$V_u = 179 \times 2.5 = 447.5$ K
 $\frac{447.5}{6 \text{ BEAMS IN THIS DIR}} = 74.6$ K PER BEAM COLLECTOR ELEMENT



TENSION NEUTRAL COMPRESSION

DIAPHRAGM

$\frac{75 \text{ K}}{52 \text{ FT}} = 1.5 \text{ K/FT}$

1 STUD/FT WOULD BE FINE IN BOTH DIRECTIONS

$\Sigma Q_u = 7.6 (51 \text{ STUDS}) = 387.6 \text{ K/BY BEAM}$
 $\Sigma Q_u = 7.6 (244 \text{ STUDS}) = 1892.4 \text{ K/GIRDER}$

BEAM DESIGN?

04.04.2012

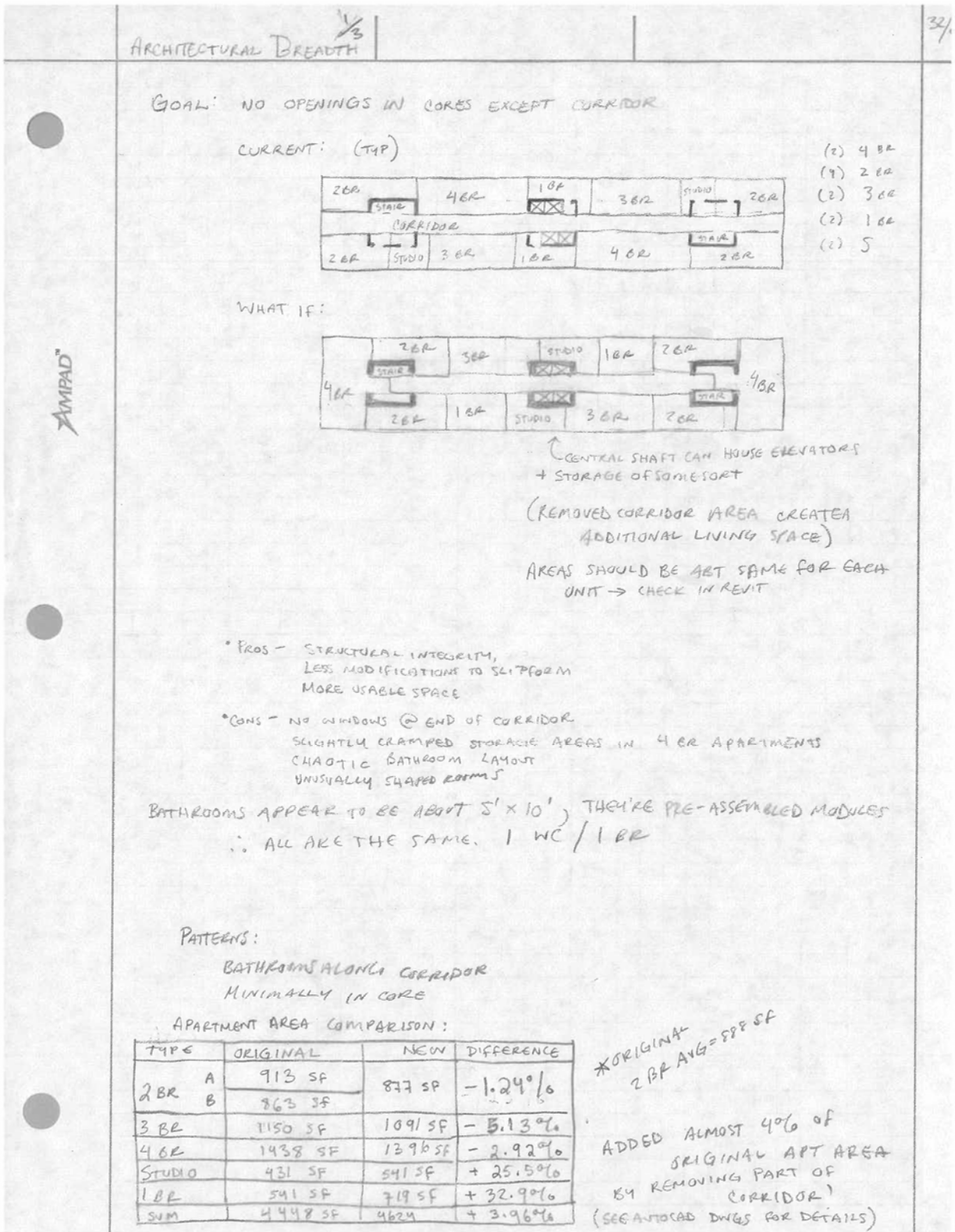
Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices |102

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Appendix E –

See following pages for scans



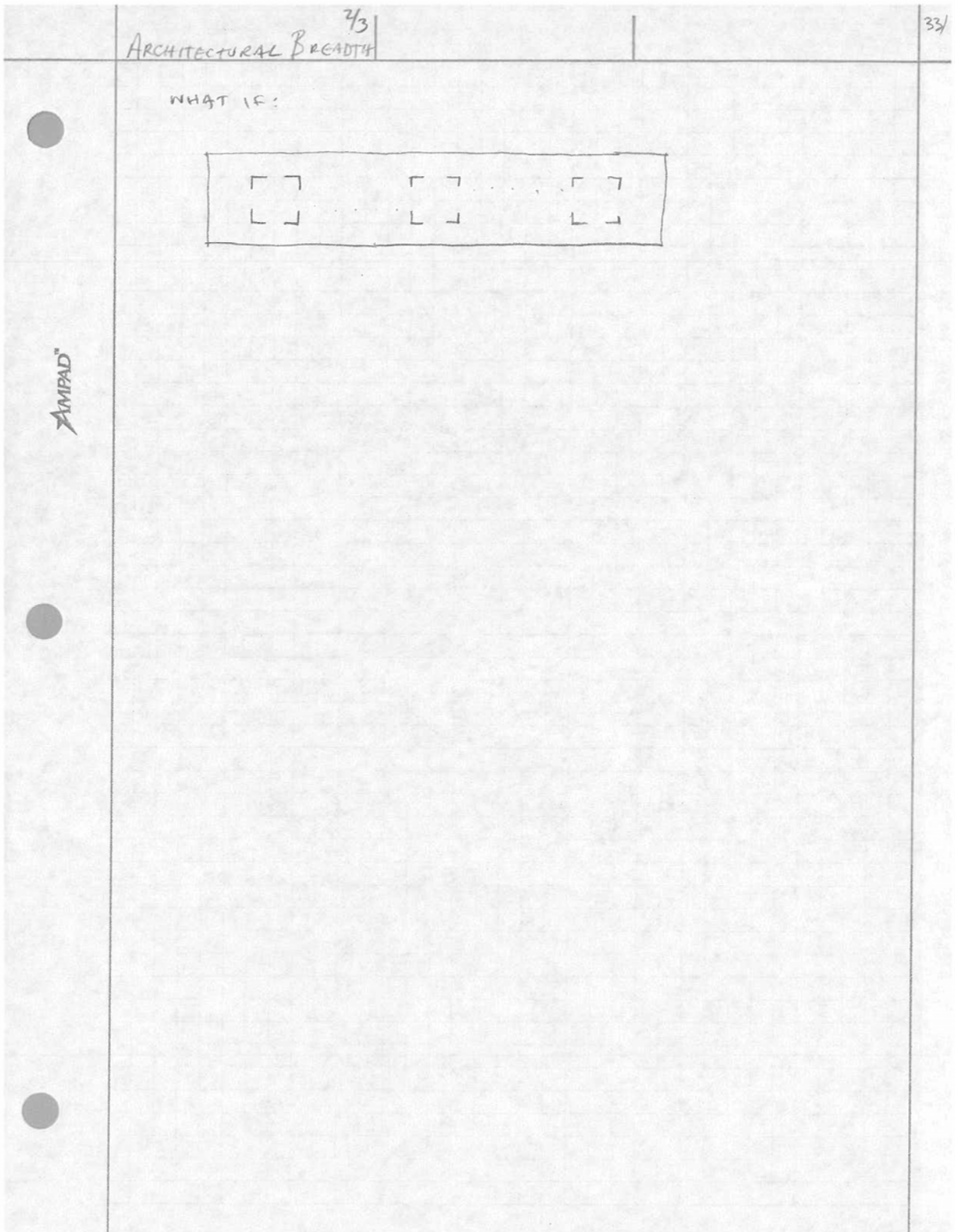
04.04.2012

Ksenia Tretiakova, Structural Option
AE Consultant: Dr. Andres Lepage

Appendices |104

Southwest Student Housing

Tempe, Arizona
Final Summary Report



Southwest Student Housing
Tempe, Arizona
Final Summary Report

	ARCHITECTURAL BREADTH 3/	34
	ORIGINAL: - BATHROOMS ARE ALL LOCATED ALONG CENTRAL CORRIDOR (FLOOR PLANS CAN VARY, & THE PLUMBING WILL JUST RUN THRU CORE & CORRIDOR WALLS) - CAN MODULARIZE FLOOR PLAN, SO THAT THE INTERIOR PARTITIONS CAN COME PREASSEMBLED.	

Southwest Student Housing
Tempe, Arizona
Final Summary Report

	SUSTAINABILITY BREADTH ^{1/3}	351
	CREDITS TO WORK IN: SUSTAINABLE SITES CREDIT 4.2 - COVERED STORAGE FACILITIES FOR SECURING (1) BICYCLES FOR 15% OR MORE OF BLDG OCCUPANTS → 528 RESIDENTS, 15% = 79 → DOABLE. * CAN HAVE CANTILEVERED ROOF AS COVER FOR BIKE RACKS @ FRONT & BACK OF BUILDING SUSTAINABLE SITES CREDIT 4.4 - PROVIDE NO NEW PARKING (2) SUSTAINABLE SITES CREDIT 5.1 - FOR PREVIOUSLY DEVELOPED AREAS (CHECK), RESTORE OR PROTECT A MIN. OF 50% OF SITE (EXCLUDING BLDG FOOTPRINT) OR 20% OF TOTAL SITE AREA (WHICHEVER IS BIGGER) (1) CAN GO HARD ON LAND SUSTAINABLE SITES CREDIT 7.1 - SHADE 50% OF HARDSCAPE W/ NATIVE VEGETATION (1) SUSTAINABLE SITES CREDIT 7.2 - ROOFING SRI ≥ 79 → USE WHITE - ON - BLACK (1) EPDM ROOF, INSTEAD OF CONVENTIONAL BLACK. WATER EFFICIENCY PREREQUISITE - USE WATER - EFFICIENT FIXTURES IN PREPARED BATHROOMS MATERIALS+RESOURCES CREDIT 2 - PLAN TO RECYCLE OR SALVAGE 50% OF CONSTRUCTION WASTE (1) MATERIALS+RESOURCES CREDIT 3 - 10% OF MATERIALS, BY COST, ARE RECYCLED (2) → CAN USE RECYCLED CONCRETE AS AGGREGATE, + RECYCLED STEEL MATERIALS+RESOURCES CREDIT 4 - 20% OF MATERIALS, BY COST, ARE RECYCLED (2) → SAME. + CAN USE RECYCLED FLOORING MATERIALS REUSE CREDIT 6 - 2.5% OF VALUE OF BLDG MATS IS RECYCLED MATS (1) → FLOOR FINISHES, PARTITION WALLS, DOORS, FURNITURE, (THE MAJORITY OF THE INTERIOR FINISHES) (Axiom) INDOOR ENVIRONMENT QUALITY CREDIT 4.1 - LOW E ADHESIVES + SEALANTS (1) JUST NEED PLANNING ↓ DITTO 4.2 - PAINTS & COATINGS (1) ↓ DITTO 4.4 - COMPOSITE WOOD & AGG FIBER PRODUCTS (1) HAVE NO ADDED UREA-FORMALDEHYDE RESINS (NO LAMINATES) ↓ DITTO - FOCUS ON CASE WORK, DOORS & FINISHES 4.3 - LOW E FLOORING ↓ DITTO. USE TILE IN KITCHENS, NOT LINOLEUM, & MEET CARPET REQ'S. (DON'T USE OTHER HARD SURFACE FLOORING) INDOOR ENVIRONMENT QUALITY CREDIT 7.2 - SEND OUT FLUERS TO RESIDENCES TO SURVEY (1) INNOVATION IN DESIGN CREDIT 2 - LEED ACCREDITED PROFESSIONAL (1)	

★ ASSUME BLDG MEETS LEED PREREQUISITE

Southwest Student Housing
Tempe, Arizona
Final Summary Report

SUSTAINABILITY BREADTH		2/3	36/
CLOSER EVALUATION OF ATTAINABLE CREDITS.			
<u>SUSTAINABLE SITES</u>			
4.2 (1 CREDIT) - \$			
RESIDENTIAL: PROVIDE COVERED BIKE STORAGE FOR $\geq 15\%$ OF OCCUPANTS.			
15% OF 528 IS 79 RESIDENTS			
USE ... 13342370010 (ALUMINUM FRAME, ACRYLIC GLAZING, 9' X 12' X 8' SHELTER)			
DAILY OUTPUT = 0.73			
BARE MATERIAL = 4950			
BARE LABOR = 946			
05521650002 (INDUSTRIAL RAILINGS, SHOP FABBED, UNITS = 2 L.F.)			
DAILY OUTPUT = 255			
BARE MATERIAL = 27.03			
BARE LABOR = 5.17			
03305340360 (ON-GRADE, DIRECT CHUTE, 500 PSF NO FORMS, REINF, FINISH, C.I.)			
DAILY OUTPUT = 150			
BARE MATERIAL = 86.90			
BARE LABOR = 9.20			
IF 1 BIKE IS $\sim 45' \times 1'$ $\rightarrow 79 \times 4.5 \text{ SF} = 356 \text{ SF} \rightarrow$ WOULD NEED ~ 4 SHELTERS			
$\downarrow$ ESTIMATE @ $\sim \$70.00/\text{SF}$ X 400 SF = \$28,000.00			
HALF OF RAILING + 400 SF OF CONCRETE \$26,000 $\rightarrow$ 65 / SF TOO LOW?			
4.4 (2 CREDITS) - FREE			
PROVIDE NO NEW PARKING			
5.1 (1 CREDIT) } - \$\$			
7.1 (1 CREDIT) }			
LANDSCAPE + PROTECT MIN 50% OF HARDSCAPE, SHADE W/ NATIVE VEGETATION			
SO, A TREE COSTS ABOUT \$250 (LABOR, MATERIAL, EQUIPMENT) ON AVERAGE			
SAY A TREE PER 5' X 5' SQUARE WOULD WORK.			
LOTS ABOUT 150' X 250', BUILDING + VARIOUS STUFF WILL PROBABLY TAKE UP			
$85' \times 250' \rightarrow \frac{(150-85) \times 250}{(5 \times 5)} = 650 \text{ "TREES"} \rightarrow \sim \$170,000.00$			
IN BASE LANDSCAPING COSTS			
7.2 (1 CREDIT) - FREE			
USE WHITE-ON-BLACK EPDM ON ROOF			
<u>WATER EFFICIENCY</u>			
PREREQUISITE - FREE?			
CHOOSE MORE EFFICIENT FIXTURES FOR PREFABBED BATHROOMS			
(INITIAL INVESTMENT IS ALREADY MADE, JUST PLAN FOR IT)			

SUSTAINABILITY BREADTH ^{3/3}		37/
2 (1 CREDIT) - FREE HAVE BINS AVAILABLE & PLAN AHEAD. ASU ADVOCATES FOR THIS CREDIT & WILL PROVIDE HELP. 3 (2 CREDITS) } FREE 4 (2 CREDITS) } 20% OF MATERIALS, BY COST, ARE RECYCLED 6 (1 CREDIT) } USE OF RECYCLED STEEL & CONCRETE AGGREGATE WILL EASILY MEET THIS CREDIT (CONCRETE + STEEL ARE ... ~30-35% OF THE COST, IF NOT MORE? CAN ALSO USE RECYCLED FLOORING, CASEWORK, POTENTIALLY GLAZING, DOORS, PARTITION BARRIERS, MAYBE FURNITURE. <u>INDOOR ENVIRONMENT QUALITY</u> 4.1 (1 CREDIT) } FREE 4.2 (1 CREDIT) } WILL EXPEND THE \$ ANYWAY, SO CAN PLAN AHEAD & LOOK INTO ADHERING TO THESE CREDITS. 4.3 (1 CREDIT) } 4.4 (1 CREDIT) } SHOULDN'T HAVE TO PAY EXTRA. 7.2 (1 CREDIT) - FREE-ISH SEND OUT EMAILS OR FLYERS TO RESIDENCES TO EVALUATE THEIR CONTENTEDNESS WITH THE THERMAL COMFORT LEVEL <u>INNOVATION IN DESIGN</u> 2 (1 CREDIT) - FREE HIRE A LEED AP OR USE ONE YOU HAVE ON STAFF.		

04.04.2012

Ksenia Tretiakova, Structural Option
 AE Consultant: Dr. Andres Lepage

Appendices |109
Southwest Student Housing
 Tempe, Arizona
Final Summary Report

Appendix F –

Bare Material					Labor Costs		Total Costs		Daily Output	
Properties	Existing Tempe, AZ Material Cost	St Louis, MO Material Cost	Units		AZ	MO	AZ	MO	AZ	MO
Welding structural steel in field										
01902200 Continuous fillet weld, 3/4" thick, type 6011	2.7	2.96	ft		26.83	40.49	39.42	54.23	12	12
Shear Stud Connectors										
050523851100 3/4" dia x 8-3/16" L	1.04	1.13	ea.		0.72	1.08	2.18	2.67	890	890
Steel Plates (Used: Structural Steel Projects - 051223.77; Apartments over 15 stories)										
051223770500 Apartments over 15 stories	2605.5	2818.8	ton		346.95	536.85	3078.1	4193.21	13.9	13.9
051223650400 1/2" thick plate	24.61	26.62	SF		-	-	24.61	26.62	-	-
Reinforcing Steel										
032110600700 Walls, #3 to #7	964.41	863.97	ton		448.88	581.18	1413.29	1445.15	3	3
032110600750 Walls, #8 to #18	964.41	863.97	ton		337.73	437.27	1302.14	1301.24	4	4
032110601050 10-50 ton job, #3 to #7, add	10%	10%	-		-	-	-	-	-	-
032110601150 Over 100 ton job, #3 to #7, deduct	10%	10%	-		-	-	-	-	-	-
032110601160 Over 100 ton job, #8 to #18, deduct	15%	15%	-		-	-	-	-	-	-
032110602000 Unloading and sorting, add	-	-	ton		23.09	29.89	29.86	37.27	100	100
032110602210 Crane cost for handling, avg, add	-	-	ton		25.22	32.66	32.62	40.73	92	59.79
032110501020 Shop extra, bending of limited % of bars	33.18	29.73	ton		-	-	33.18	29.73	-	-
032110502200 Shop extra for quantity, 20-49 tons	24.89	22.3	ton		-	-	24.89	22.3	-	-
032110502300 Shop extra for quantity, 100-300 tons	9.96	8.92	ton		-	-	9.96	8.92	-	-
032110502550 Shop extra for size #4	76.74	68.75	ton		-	-	76.74	68.75	-	-
032110502650 Shop extra for size #6	34.74	31.12	ton		-	-	34.74	31.12	-	-
032110502700 Shop extra for size #7-11	46.15	41.34	ton		-	-	46.15	41.34	-	-
Concrete										
Normal Weight										
033105350300 4000 psi	87.76	92.8	yd ³		-	-	87.76	92.8	-	-
033105350412 8000 psi	172.1	182	yd ³		-	-	172.1	182	-	-

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Building Height = 208 ft			
	Existing Design	New Design	
		1	2
Concrete			
Concrete Shear Walls			
f'c (psi)	4000	4000	4000
thickness (in)	8	16	16
LF of wall (ft)	240	264	216
volume (yd3)	1233	2712	2219
bare material cost (\$)	108172	237979	194710
Concrete Coupling Beams			
f'c (psi)	4000	4000	4000
depth (in)	24	36	36
LF of beam (ft)	60	36	84
volume (yd3)	59	107	249
bare material cost (\$)	5201	9361	21842
Steel Reinforcing Bars			
Ordinary Wall Reinforcement (Vertical)			
pmin	0.0012	0.0025	0.0025
Ag (in2)	23040	50688	41472
As min (in2)	27.648	126.72	103.68
bar size (#)	4	4	4
bar size (in)	0.5	0.5	0.5
min # bars	141	645	528
# layers	1	2	2
spacing (in)	20.5	9.8	9.8
real # bars	160.0	792	648
weight (tons)	11.12	55.02	45.02
bare material cost (\$)	10720	53064	43416
Ordinary Wall Reinforcement (Horizontal)			
pmin	0.002	0.0025	0.0025
Ag (in2)	96	192	192
As min (in2/ft height)	0.192	0.48	0.48
bar size (#)	4	4	4
bar size (in)	0.5	0.5	0.5
min # bars	0.98	2.44	2.44
# layers	1.00	2.00	2.00
spacing (in)	12.27	9.82	9.82
new spacing (in)	12	6	6
weight (tons)	16.67	36.68	30.01
bare material cost (\$)	16080	35376	28944
Special Wall Reinforcement (Vertical)			
bar size (#)	-	8	8
bar size (in)	0	1	1
real # bars/element	0	16	16
# elements	0	12	12
height of element (ft)	-	118	118
weight (tons)	0	30.25	30.25
bare material cost (\$)	0	29169	29169

Southwest Student Housing
Tempe, Arizona
Final Summary Report

Special Wall Reinforcement (Horizontal)			
bar size (#)	-	6	6
bar size (in)	0	0.75	0.75
extension into wall flange (in)	-	12	12
spacing (in)	-	5	5
weight (tons)	0	35.54	35.54
bare material cost (\$)	0	34274	34274
Coupling Beam Reinforcement (Longitudinal)			
bar size (#)	4	9	9
bar size (in)	0.5	1.13	1.13
real # bars	4	6	6
weight (tons)	0.96192	6	13
bare material cost (\$)	927.68527	6249	12499
Coupling Beam Reinforcement (Transverse)			
bar size (#)	3	4	4
bar size (in)	0.375	0.5	0.5
bars/ft	1	3.6	3.6
weight (tons)	15.6	80	159
bare material cost (\$)	15044.796	76812	153625
Additional Costs			
weight of #4 bars (tons)	27.8	91.7	75.0
weight of #6 bars (tons)	0.0	35.5	35.5
weight of #8 bars (tons)	0.0	30.2	30.2
total job weight (tons)	27.8	157.5	140.8
% bars bent	-	22.6	25.2
shop extras (\$)	31612	146083	130331
labor costs (\$)	13816	74939	66650
Other Steel			
Shear Stud Connectors			
quantity	0	67840	6120
bare material cost (\$)	0	70553.6	6364.8
Welds			
LF of continuous fillet welds (ft)	0	400	400
bare material cost (\$)	0	1080	1080
labor costs (\$)	0	10732	10732
Steel Plates			
1/2" thick plate area (ft2)	0	794.4	794.4
weight of other steel (tons)	0	1615.7	1615.7
bare material cost (\$)	0	2069809	2069809
labor costs (\$)	0	560567	560567
OVERALL COST (\$)		185601	3262433.3 3191524.7

Southwest Student Housing
Tempe, Arizona
Final Summary Report

CONSTRUCTION BREADTH	MATERIAL COST	36/
ST. LOUIS PRICES VS TEMPE PRICES (+ REDDIGN COSTS)		
CONCRETE VOLUME:		
ORIGINAL • 8" WALLS, 2' DEEP COUPLING BMS		
VOLUME = $\frac{8"}{12} (208') (25' + 19') (6 \text{ C-SHAPED WALLS}) = 36608 \text{ FT}^3 \text{ (WALLS)}$		
= $\frac{8"}{12} (2') (6') (6 \text{ COUPLING BMS PER FLOOR}) (20 \text{ STORIES}) = 960 \text{ FT}^3 \text{ (BEAMS)}$		
TOTAL = 37568 FT ³		
NEW • 16" WALLS, 3' DEEP COUPLING BMS		
VOLUME = $\frac{16"}{12} (208') (25' + 19') (6 \text{ C-SHAPED WALLS}) = 73216 \text{ FT}^3 \text{ (WALLS)}$		
= $\frac{16"}{12} (3') (6') (6 \text{ COUPLING BMS PER FLOOR}) (20 \text{ STORIES}) = 2880 \text{ FT}^3$		
TOTAL = 76096 FT ³		
REINFORCEMENT BARS:		
ORIGINAL • $\rho_{\text{MIN, CORES VERTICAL}} = 0.0012$ FOR BAR $\phi \leq \#5$ [ACI 318-05 14.3.2 a]		
$0.0012 = \frac{A_s}{A_g}$		
$A_g = [(25'-6') \times 6 + (25'-3' \times 2) \times 2 + (25'-3') \times 2 + (25'-1') \times 2] \times 12 \frac{\text{IN}}{\text{FT}} \times 8 \text{ IN}$		
= 23616 IN ²		
$A_s = 28.24 \text{ IN}^2$ @ #5'S OR LESS		
CHECK: $\frac{28.24}{144 \text{ BARS}} = 0.196 \text{ IN}^2/\text{FT} > 0.19 \text{ IN}^2/\text{FT} \rightarrow \text{USE } 163 \text{ BARS}$		
(MAINTAIN CONSISTENCY - USE #4'S 144 BARS OVER ENTIRE CROSS-SECTION (208' UP))		
$\rightarrow \text{TONNAGE} = \frac{(163 \text{ BARS}) (0.668 \text{ LB/FT BAR}) (208 \text{ FT})}{2000 \text{ LB/TON}} = 11.32 \text{ TONS}$		
$\rho_{\text{MIN, CORES HORIZONTAL}} = 0.0020$ FOR BAR $\phi \leq \#4$ [ACI 318-05 14.3.3 a]		
$0.002 = \frac{A_s}{8' \times 12'}$		
$A_s = 0.192 \text{ IN}^2/\text{FT OF HEIGHT} \rightarrow \#4'S @ 12"$		
LF PER FT HEIGHT = $[25' + (25'-3' \times 2) + (25'-6') \times 2] \times 2$		
+ $[25'-3' \times 2 + (25'-6') \times 2] \times 2 = 246 \text{ LF/FT H}$		
$\rightarrow \text{TONNAGE} = \frac{(246 \text{ LF OF BAR}) (208 \text{ FT H}) (0.668 \text{ LB/FT BAR})}{2000} = 17.1 \text{ TONS}$		
TOTAL TONNAGE = $(11.32 + 17.1) \times 1.1 = 31.3 \text{ TONS}$ ASSUME 10% WASTE		

* NOMINAL MT OF #4'S: 0.668 LB/FT (ASTM A615 / A706 CHART)

CONSTRUCTION BREADTH	MATERIAL COST	39,
NEW • BOUNDARY ELEMENTS: 4 CORNERS/CORE X 3 CORE = 12 BOUNDARY ELEMENTS GOING UP 118 FT VERTICAL REINFORCEMENT - (16) #8'S PER ELEMENT $\text{TONNAGE} = \frac{(16 \text{ BARS/ELEMENT})(12 \text{ ELEMENTS})(118 \text{ LF})(2.670 \text{ LB/BAR-LF})}{2000} = 30.25 \text{ TONS}$ HORIZONTAL REINFORCEMENT - #6'S @ 5" O.C. → LF OF HOOP: $\frac{13" \times 2 + (14.5" + 12") \times 2}{12} \times 2 \text{ HOOPS} / 5" \text{ OF HEIGHT}$ $= 13.2 \text{ LF OF BAR} / 5" \text{ OF HEIGHT}$ $\text{TONNAGE} = \frac{(13.2 \text{ LF BAR/ELEMENT})(5" \text{ HEIGHT})(118 \text{ FT HEIGHT})(12 \text{ ELEMENTS})(1.502 \text{ LB/BAR-LF})}{2000} = 33.69 \text{ TONS}$ ORDINARY WALL REINFORCEMENT: VERTICAL - (2) #4'S @ 6" O.C. FOR WALL SECTIONS NOT IN BOUNDARY ELEMENT AREA → LF WALL NOT IN ELEMENT AREA = $\left[(25' - \frac{25"}{12} \times 2) \times 2 + (25' - 6' - \frac{25"}{12} \times 2) \times 2 \right] \times 3 \text{ CORES}$ $= 208 \text{ LF OF WALL}$ $\text{TONNAGE} = \frac{(2 \text{ BARS})(\frac{12"}{6" \text{ LENGTH}})(208 \text{ FT L})(208 \text{ FT HEIGHT})(0.668 \text{ LB/BAR-LF})}{2000} = 115.6 \text{ TONS}$ HORIZONTAL - $\rho_{\min} = 0.0025 \rightarrow (2) \#4'S @ 6" \text{ O.C. (SAME AS VERTICAL)}$ HORIZONTAL REINF GOES ALL THE WAY THRU THE WALLS ∴ LF OF BAR / FT HEIGHT = $\left[(25' - 6') \times 2 + (25') \right] \times 3 \text{ CORES} \times \frac{12"}{6" \times 2} = 528 \text{ LF OF BAR} / \text{FT HEIGHT}$ $\text{TONNAGE} = \frac{(528 \text{ BAR-LF})(208 \text{ FT H})(0.668 \text{ LB/BAR-LF}) \times \frac{2 \text{ BARS}}{\text{AREA}}}{2000} = 73.36 \text{ TONS}$ COUPLING BEAMS: $\frac{l_n}{h} = \frac{6'}{3'} = 2$ ∴ MIGHT BE REDUCED TO 2 ∴ RATIO = 3 → USE § 21.3.1 PROVISIONS (ACI 717-05) DIAGONAL REINF. NOT REQ. ASSUME IT IS UNNEEDED.		

Southwest Student Housing
Tempe, Arizona
Final Summary Report

	CONSTRUCTION BREADTH ^{3/}	MATERIAL COST ^{3/}	40/
	<u>STEEL COLLARS:</u>		
	ORIGINAL • NONE		
	NEW • STEEL PLATE: UNIT WEIGHT = 490 PCF		
	FOR 5" PLATE: $(490 \frac{lb}{ft^3}) (\frac{5 in}{12 in/ft}) = 204 PSF$		
	TOTAL AREA OF PLATE PER CORE PER FLOOR -		
	LF LENGTH = $(25') \times 2 + (25' - 6') \times 2 = 88 ft \times 3 CORES = 264 ft$		
	HEIGHT = 3 ft		
	AREA/FLOOR = $264 (3) = 792 SF$		
	TOTAL PLATE WEIGHT = $(204 PSF) (792 \frac{SF}{FLR}) (20 FLRS) = \underline{1615.7 TONS OF STEEL PLATE}$		
	SHEAR STUD CONNECTORS:		
	(4) ROWS OF (94) STUDS @ 4" O.C. W/ 3" CLR FROM EDGE ON 25' PLATES.		
	(4) ROWS OF (28) STUDS @ 4" O.C. W/ 4" CLR FROM EDGE ON 10' PLATES		
	+ (1) ROW OF STUDS @ 12" O.C. ON OTHER SIDE OF BOTH PLATES		
	↳ 24 STUDS FOR 25' PLATE		
	9 STUDS FOR 9' PLATE		
	882 STUDS/COLLAR/CORE/FLOOR		
	↳ 2646 STUDS/FLOOR		
	↳ 52920 STUDS IN BLDG (ALL $\frac{3}{4}" \Phi$, $8 \frac{3}{16}" L$)		
	CORBELS:		
	14" LONG 0.5" THICK 5" HIGH + 12" LONG SPACER PLATE (14" WIDE, 0.5" THICK)		
	NEED SF		
	SF PLATE/CORBEL: $\frac{14 \times 5}{144} \times 2 + \frac{12 \times 14}{144} \times 2 = 3.31 ft^2$		
	(1) CORBELS		
	↳ 4 CORBELS/FLOOR-CORE		
	WELDS - 5" x 2 SIDES/PLATE x 2 PLATES/CORBEL x 12 CORBELS/FLR x 20 FLRS/12" x 200'		

Southwest Student Housing
Tempe, Arizona
Final Summary Report

	CONSTRUCTION BREADTH ^{4/9}	SCHEDULING ^{1/1}	^{4/1/41}
AMPAD	ORIGINAL CORES ARE $9 \text{ yd}^3 / \text{FT OF HEIGHT}$ $\rightarrow 1 \text{ TRUCK/HR} \quad (1 \text{ FT/HR})$ NEW DESIGN - ROUGHLY $15 \text{ yd}^3 / \text{FT OF HEIGHT}$ ↓ CORES WILL TAKE TWICE THE TIME @ SAME CONCRETE RATE FOR CONCRETE RACING STEEL CAN TAKE PLACE IN THE MEANTIME COLLARS WOULD BE PLACED AS WELL ↓ WOULD BE UNNIELDY	COES RISE @ ABOUT 24' A DAY WILL BE TIME CONSUMING? ASSUME ASSEMBLY IS DONE AS CORES ARE SLIPFORMED. NEED TO TAKE INTO ACCOUNT THE USE OF A CRANE FOR THE COLLAR IN ADDITION TO THE REBAR.	*
	ASSUME ASSUME THE COMPANY SCHEDULE IS CORRECT & MAKE ALTERATIONS ↓ • 16 DAYS FOR CORE w/ MIN CONVENTIONAL REINFORCEMENT • 43 WORK DAYS TO LIFT FLOORS INTO PLACE • 12 DAYS / FLOOR TO FINISH		