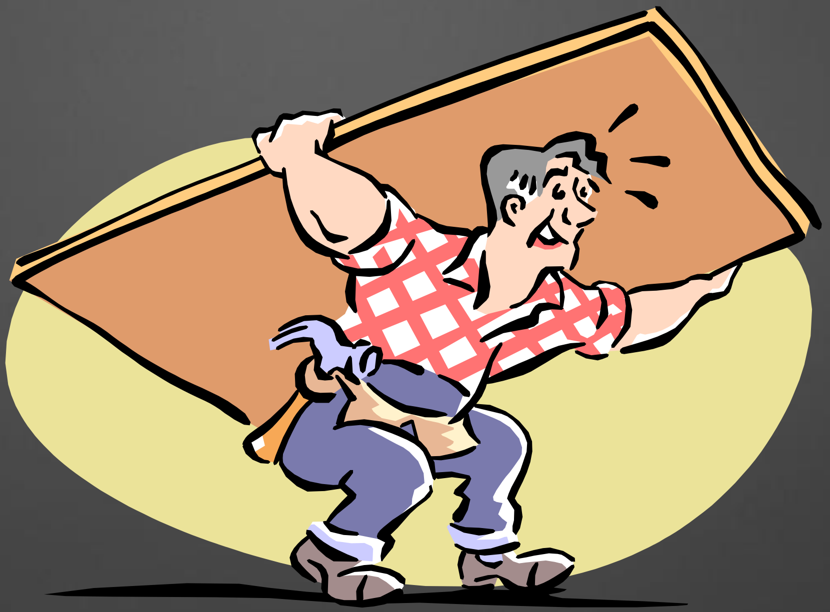
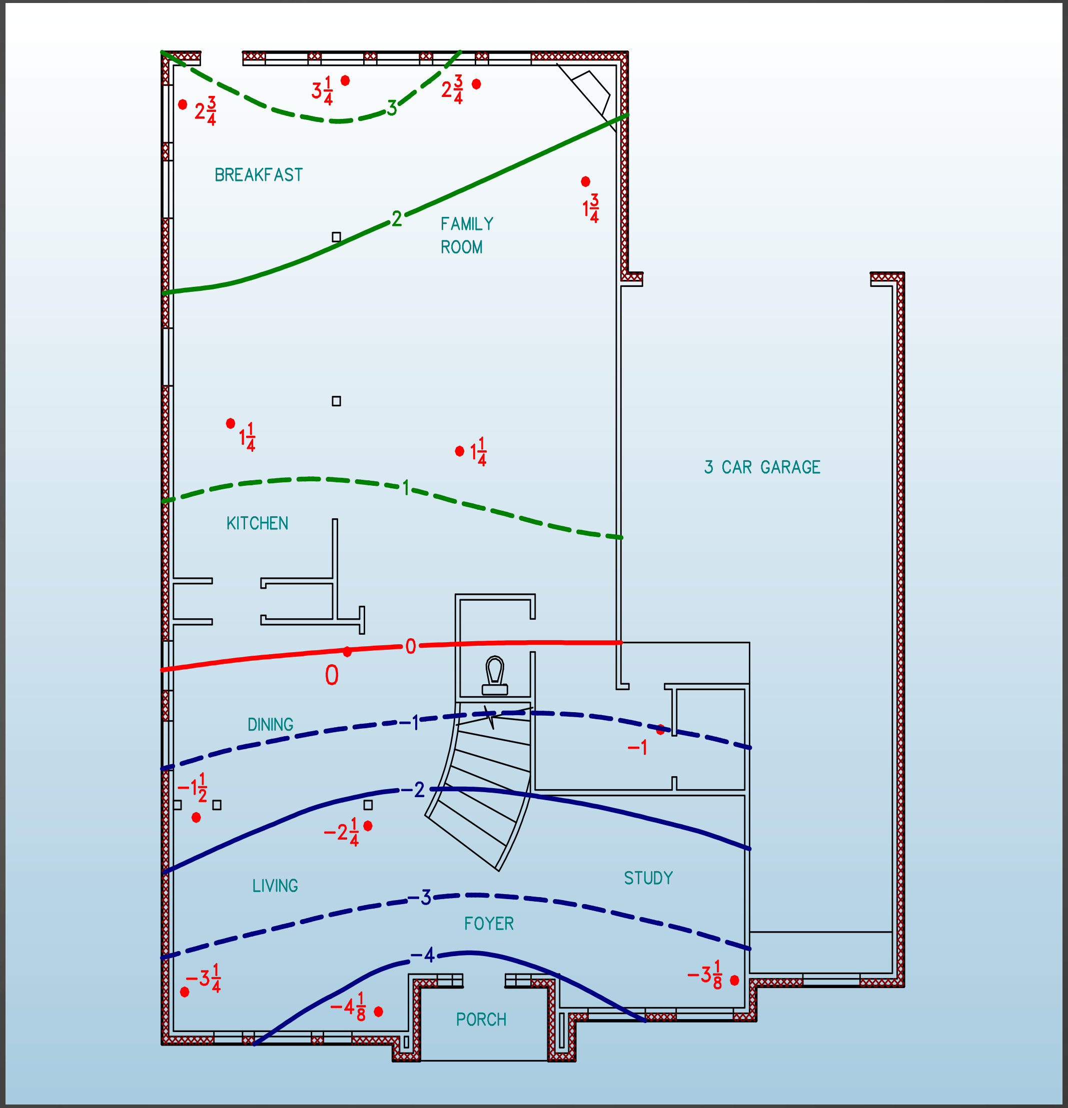
Foundation Repairs

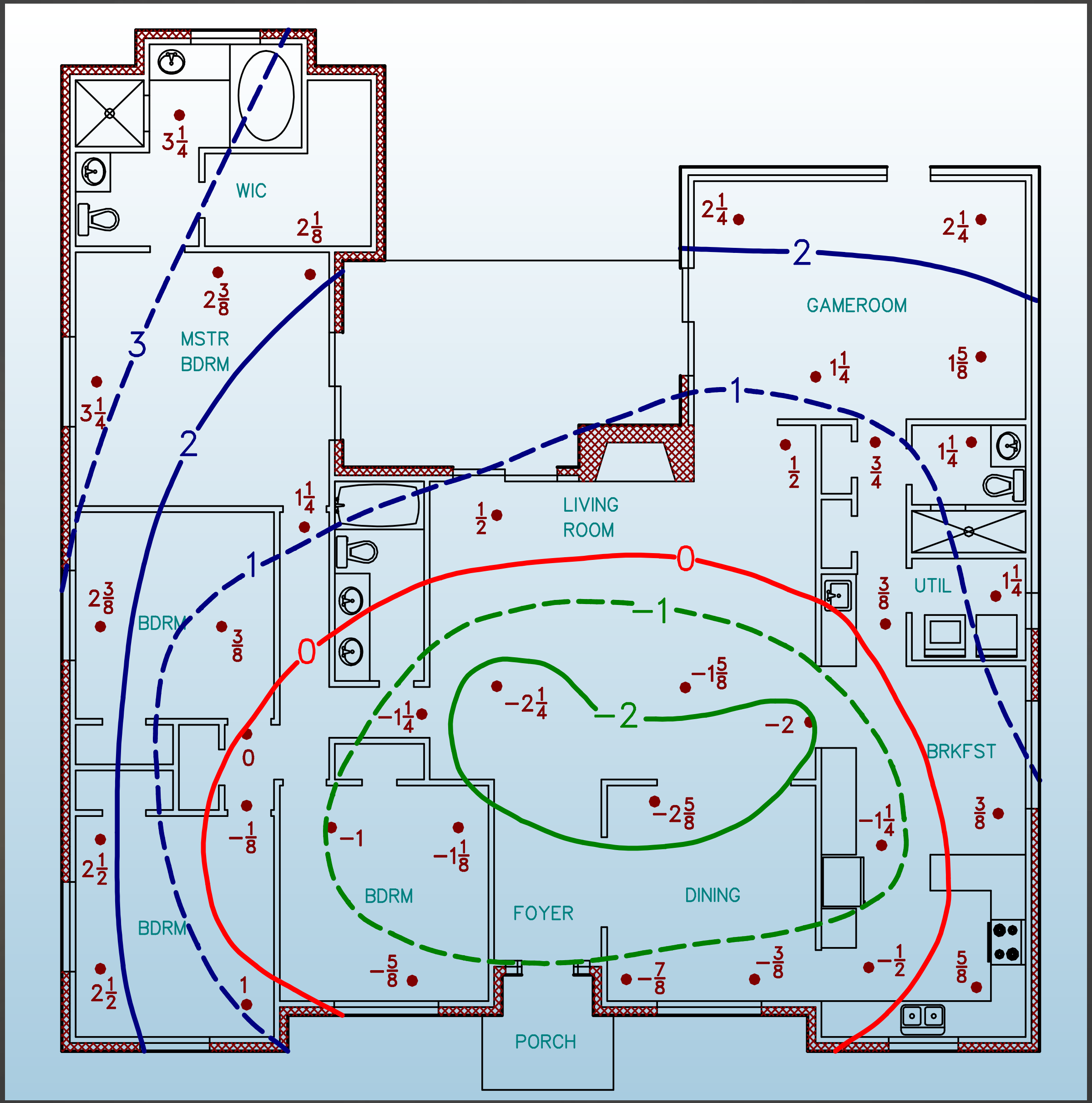
When Do You Elevate An Existing Slab On Grade?



Contour Elevation Plan

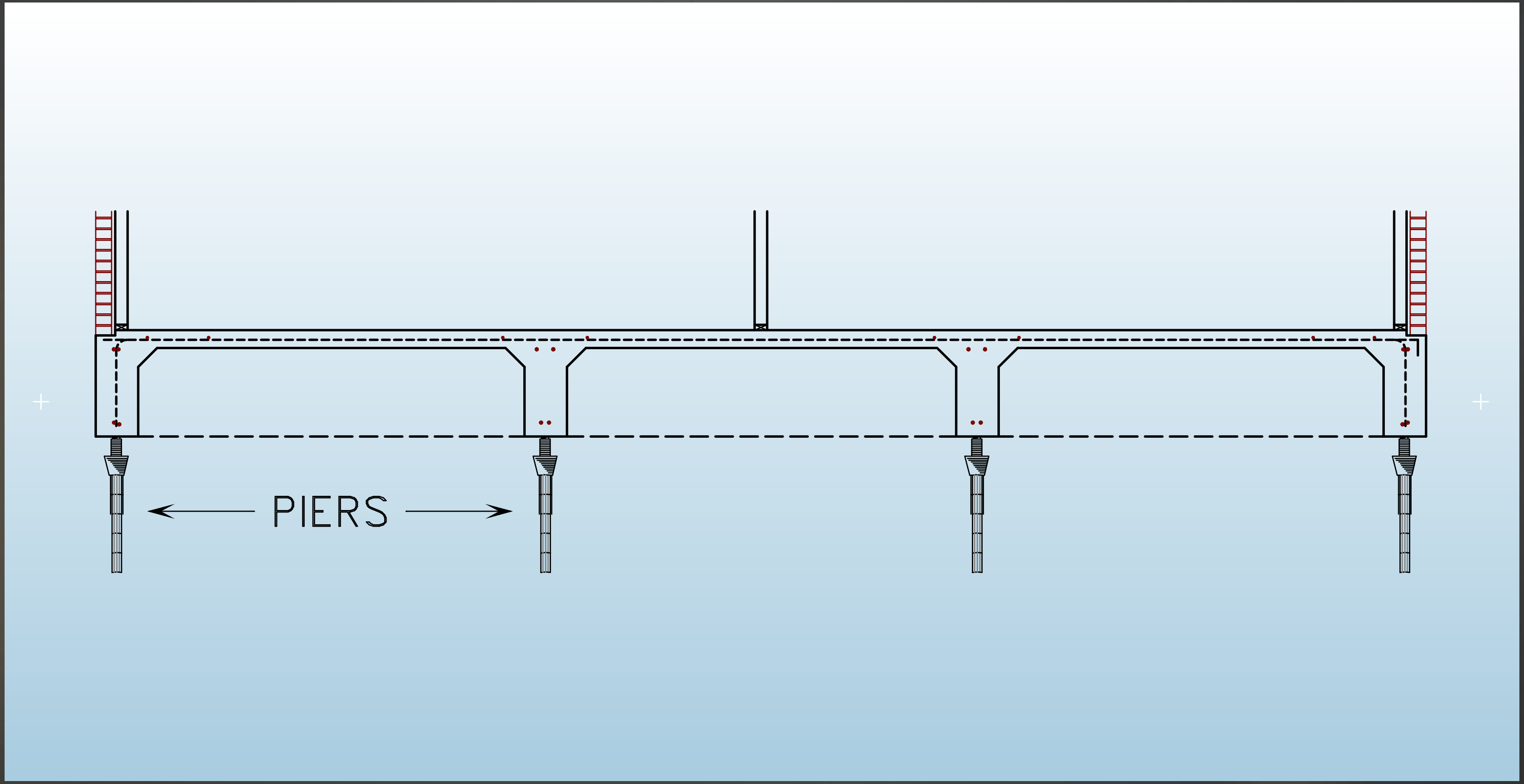


Contour Elevation Plan

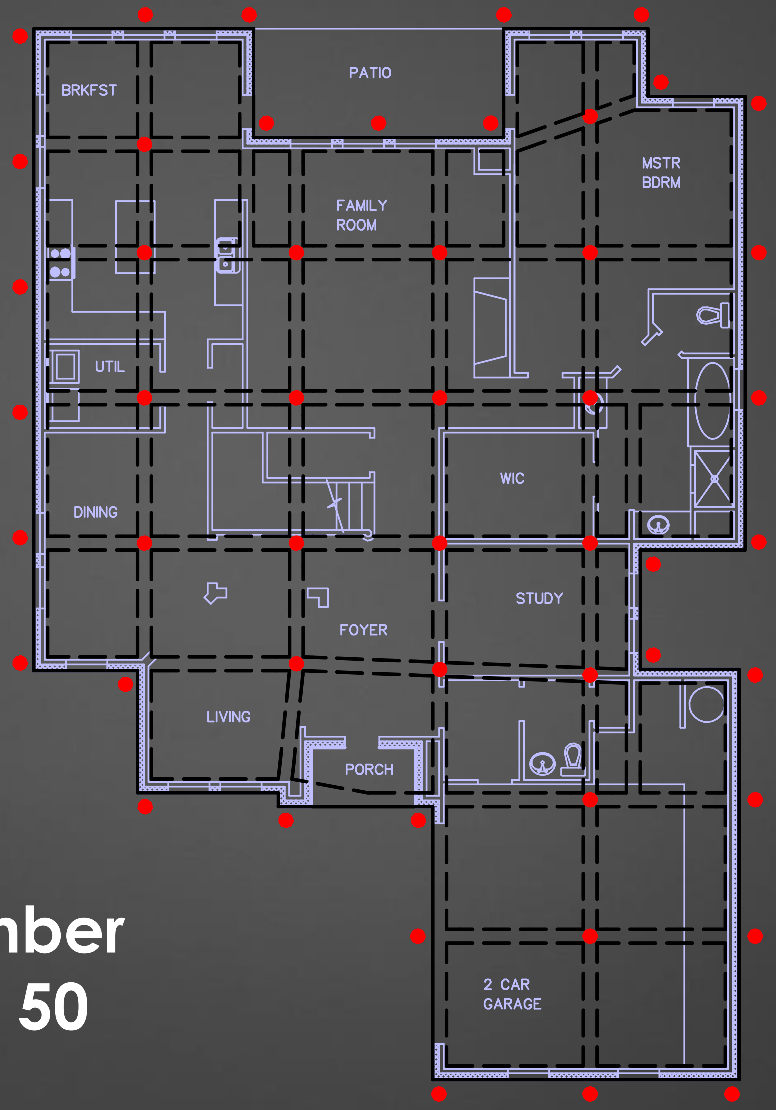



05 . 16 . 2014

Full Lift Underpin



Engineered Repair Plan



Total Number Of Piers = 50

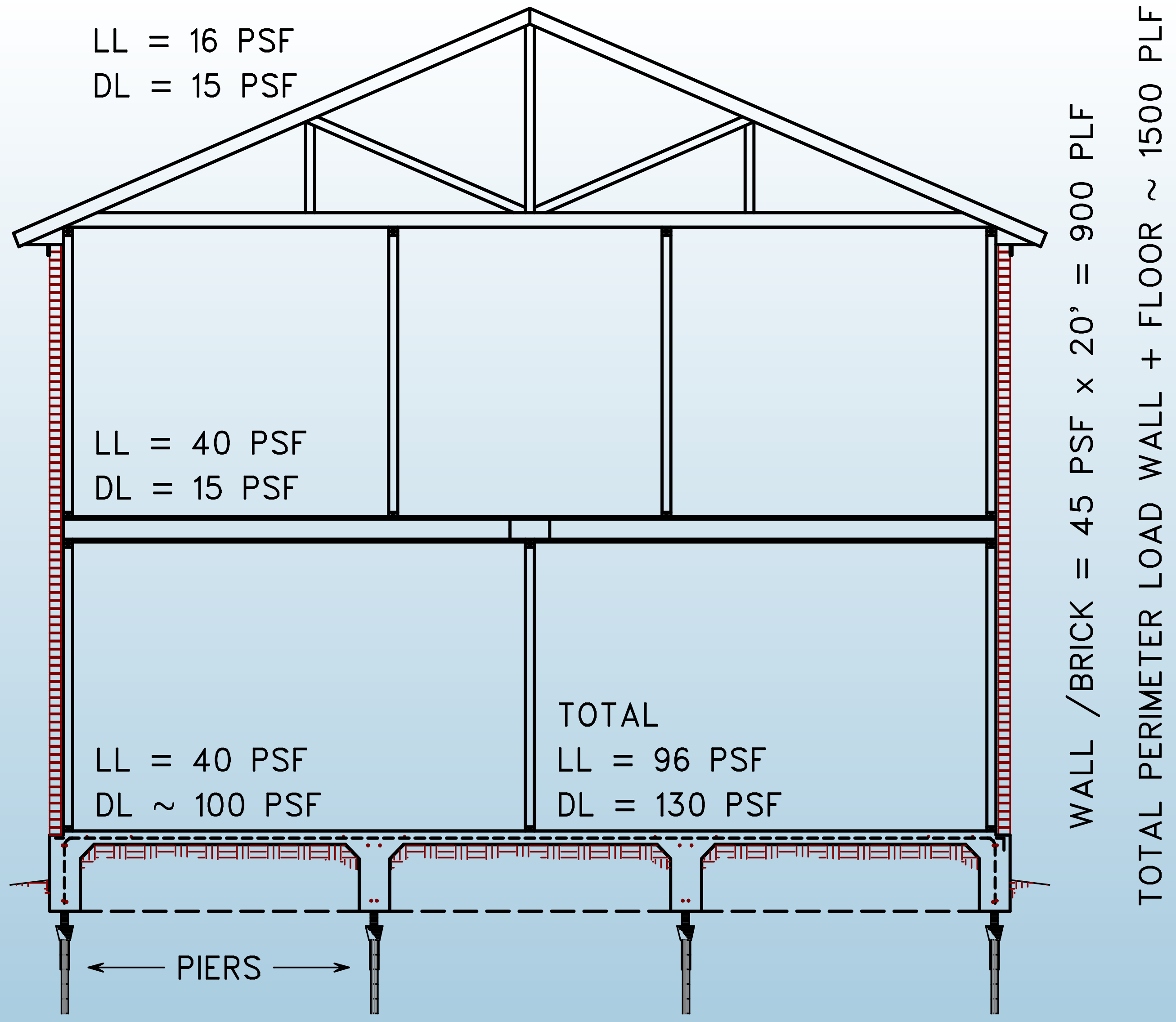
History of Full Lift Underpinning

- Started in North Texas 1998-1999
  (popular in Houston before)

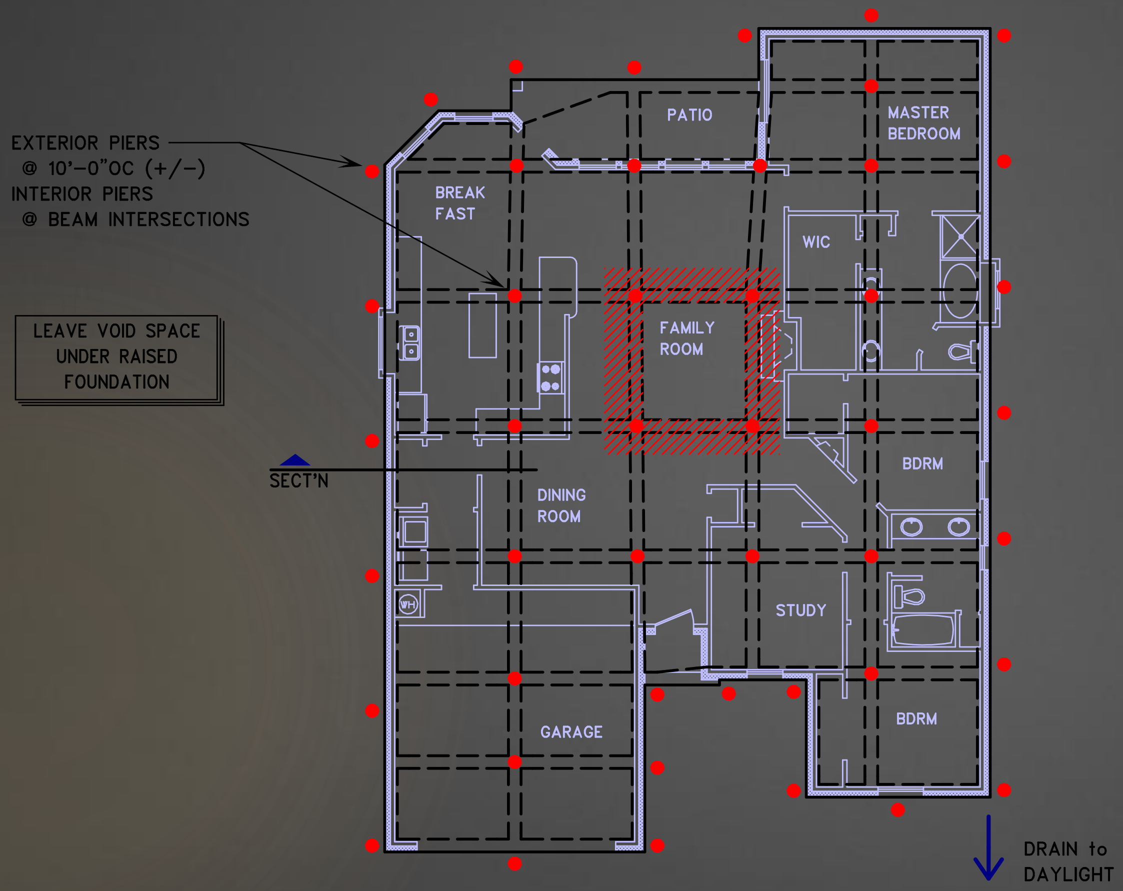
- From 1998-Present over 2,500 in North Texas
  over 10,000 in all of Texas

Analysis Of Suspended Slab

Typical Loading



Design Method



½ (D.L. & L.L.)

M- = 0.46 kip·ft
M+ = 0.23 kip·ft

Two Way Action

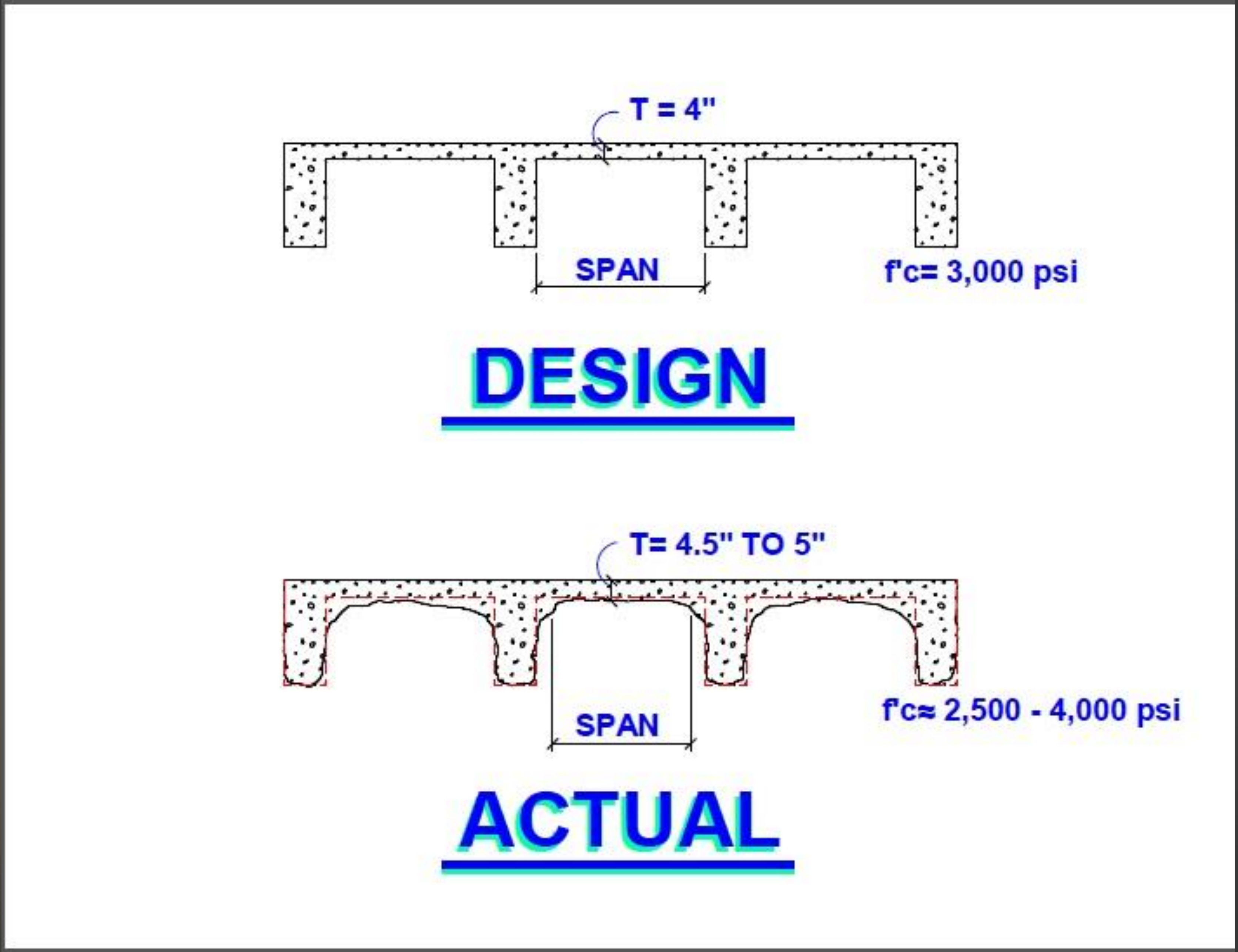
Full support on each side

M^- = -0.37 kip·ft
M^+ = 0.19 kip·ft

Supported on all four sides

METHOD 3—TABLE 4—RATIO OF LOAD w IN A and
SHEAR IN SLAB AND LOAD ON SUPP

Ratio $m = \frac{A}{B}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
1.00	W_A	0.50	0.50	0.17	0.50	0.83	0.71
	W_B	0.50	0.50	0.83	0.50	0.17	0.29
0.95	W_A	0.55	0.55	0.20	0.55	0.86	0.75
	W_B	0.45	0.45	0.80	0.45	0.14	0.25
0.90	W_A	0.60	0.60	0.23	0.60	0.88	0.79
	W_B	0.40	0.40	0.77	0.40	0.12	0.21


T = 4"
SPAN
f'c= 3,000 psi
DESIGN
T= 4.5" TO 5"
SPAN
f'c≈ 2,500 - 4,000 psi
ACTUAL

Design Method

P-T Slab Analysis

Project:	xxxx
Date:	4/15/09

SLAB / BEAM/ RECTANGLE INPUT		2 WAY SLAB MOMENT COEFFICIENTS	
f´c (psi) =	3000.00	ACI 318-63 method 3, tables 1-3 , based on "m" = 0.89	
Long Direction L_{SLAB} =	47.50	C_{Aneg} =	0.056
Width Direction W_{SLAB} =	47.00	C_{Bneg} =	0.036
Average $t_{SLAB\ (in)}$ =	4	C_{Apos_DL} =	0.022
B = Average W_{STEM} (in) =	12	C_{Bpos_DL} =	0.014
Average D_{STEM} (in) =	20	C_{Apos_LL} =	0.034
# L_{BEAMS} TOTAL =	6	C_{Bpos_LL} =	0.022
# W_{BEAMS} TOTAL =	6	TENDON INPUT	
Max Beam Span c/c (ft) =	9.17	Tendon Diameter (in) =	0.5
Transverse Span1 c/c (ft) =	8.17	* F_{AVG} (kips) =	29.00
Transverse Span2 c/c (ft) =	8.17	# L_{slab} Tndns TOTAL =	6
ADDITIONAL INPUT		Beam Tendons EACH =	1
DL_{ADDED} (psf) =	5	* Avg.Top Tndn Clear (in) =	2.00
LL (psf) =	40	Btm Tendon Clear (in) =	3.00
Friction Coeff =	0.75	* Typical Value	

LONG TENDON SPACING (FT)	7.67

EFFECTIVE SECTION PROPERTIES

	SLAB	BEAM	Totals	
A (in²)	392.00	240.00	Σ A (in²) >	632.00
y (in)	2.00	14.00		
Ay (in³)	784.00	3,360.00	Σ Ay (in³) >	4144.00
Ay² (in⁴)	1,568.00	47,040.00	Σ Ay2 (in⁴) >	48608.00
I o (in⁴)	130.67	8,000.00	Σ I o (in⁴) >	8130.67
Ay² + I o (in⁴)	1,698.67	55,040.00	Σ Ay²+I o (in⁴) >	56738.67
CGC = $Y_{t\ (in)}$ =	6.557		$I_{(in^4)}$ =	29566.616
CGS = $Y_{s\ (in)}$ =	11.307		$S_{t\ (in^3)}$ =	4509
$e_{(in)}$ =	-4.750		$S_{b\ (in^3)}$ =	1695
$Y_{b\ (in)}$ =	17.443		F/A $_{EDGE\ (psi)}$ =	93.72
Eq. t_{Slab} (in) =	8.757		F/A $_{DRAG\ (psi)}$ =	-18.55
Friction Coeff =	0.75		F/A $_{CENTER\ (psi)}$ =	75.17

BEAM PROPERTIES		SLAB UNIFORM LOADING (psf)		
H (in) =	24.00		Working	Ultimate
B_{TRIB} (ft) =	8.17	DL_{SLAB} =	50	60
B_{EFF} (ft) =	2.04	DL_{ADDED} =	5	6
Span to depth ratio =	4.08	LL =	40	64
Total Tendon Qty (B_{TRIB}) =	2.043	TL =	95	130
Total Tendon Qty (B_{EFF}) =	1.261	ACTUAL SLAB MOMENTS (kip*ft)		
SLAB PROPERTIES			Short Span	Long Span
Max Clear Span L_{SLAB} (ft) =	8.17	(-) M_{SLAB} =	-0.273	-0.228
Max Clear Span W_{SLAB} (ft) =	7.17	(+) M_{SLAB} DL =	0.062	0.051
Short / Long Span Ratio (m) =	0.89	(+) M_{SLAB} LL =	0.070	0.059
$Sx_{SLAB\ of}$ 1 ft strip (in³) =	32.00	(+) M_{SLAB} TL =	0.132	

Calculate Slab Working Shear Stress

L max (ft) =	8.17	= Longest Clear Span
TL (psf) =	95.00	= Total Uniform Load
t_{SLAB} (in) =	4.00	= Average Slab Thickness
Actual v c (psi) =	18.18	= (L max * TL) / (12 in * t_{SLAB})
Allowable V c (psi) =	108	= 1.7*sqt(f´c) + 0.2*F/A CENTER

Compare Slab Stresses (psi)

$ALLOW_{TENSILE}$ = -6*sqt(f´c) =	-328.63
$ALLOW_{COMPRESS}$ = .45*f´c =	1350
(-) = tension, (+) = compression)	
$ACTUAL_{TENSION}$= F/A CENTER + MSLAB (max) / SxSLAB	-27.30
	Slab is OK

Calculate Flexural Capacity (ΦMn) Φ = (per ACI 318-02 20.2.5)

$$\phi Mn = A_{ps} \cdot f_{ps} \left(d_p - \frac{a}{2} \right)$$

$$a := \frac{A_{ps} \cdot f_{ps}}{0.85 f'c \cdot b}$$

Φ =	1.0	
A_{ps}*f_{ps} =	3.78	kips
d_p =	2	in
b =	12	in
a =	0.1236	in
Φ Mn =	0.611	kip*ft

ULTIMATE SLAB MOMENTS (kip*ft) (1'strip)

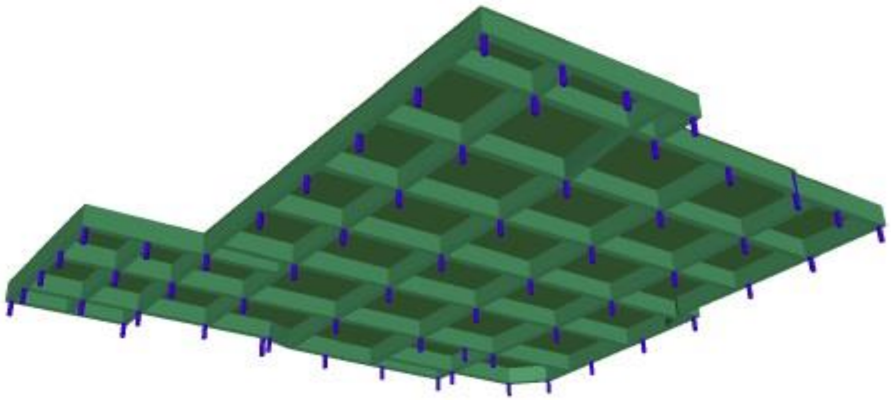
	Short Span	Long Span
(-) M_{SLAB} =	-0.374	-0.312
(+) M_{SLAB} DL =	0.075	0.062
(+) M_{SLAB} LL =	0.112	0.094
(+) M_{SLAB} TL =	0.186	

ADAPT
Structural Engineering Consultants

Hilburn Project

Capacity Analysis of Existing Post-Tensioned Slab

Prepared on February 27, 2013

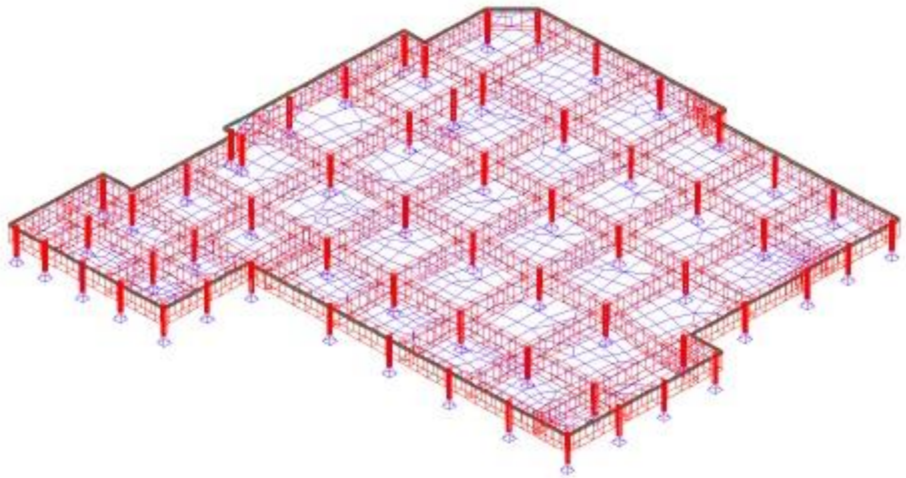


3D physical model of slab showing raised slab, beams and push piles.

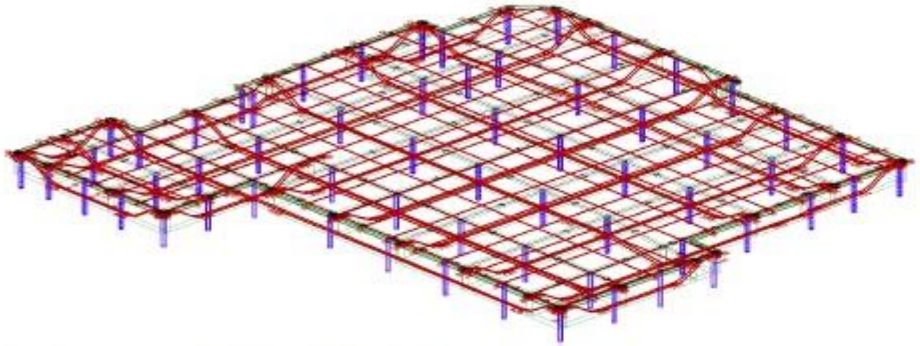
ADAPT Corporation	ADAPT International	ADAPT Latin America	ADAPT Europe
Redwood City, CA, USA	Kolkata, India	Miami, FL, USA	Perugia, Italy

sales@adaptsoft.com www.adaptsoft.com Tel: +1 (650) 306-2400 Fax: +1 (650) 306-2401

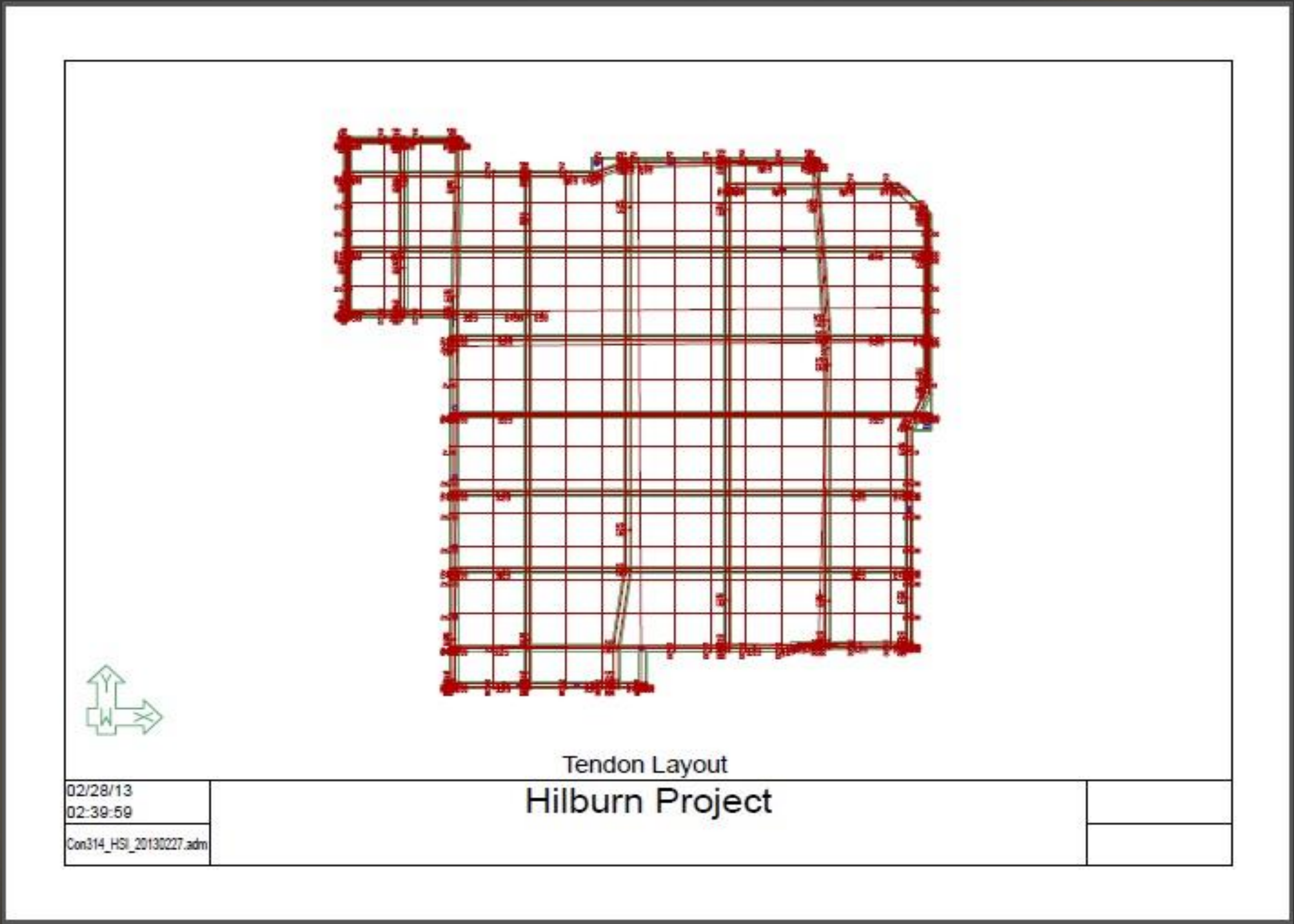
ADAPT

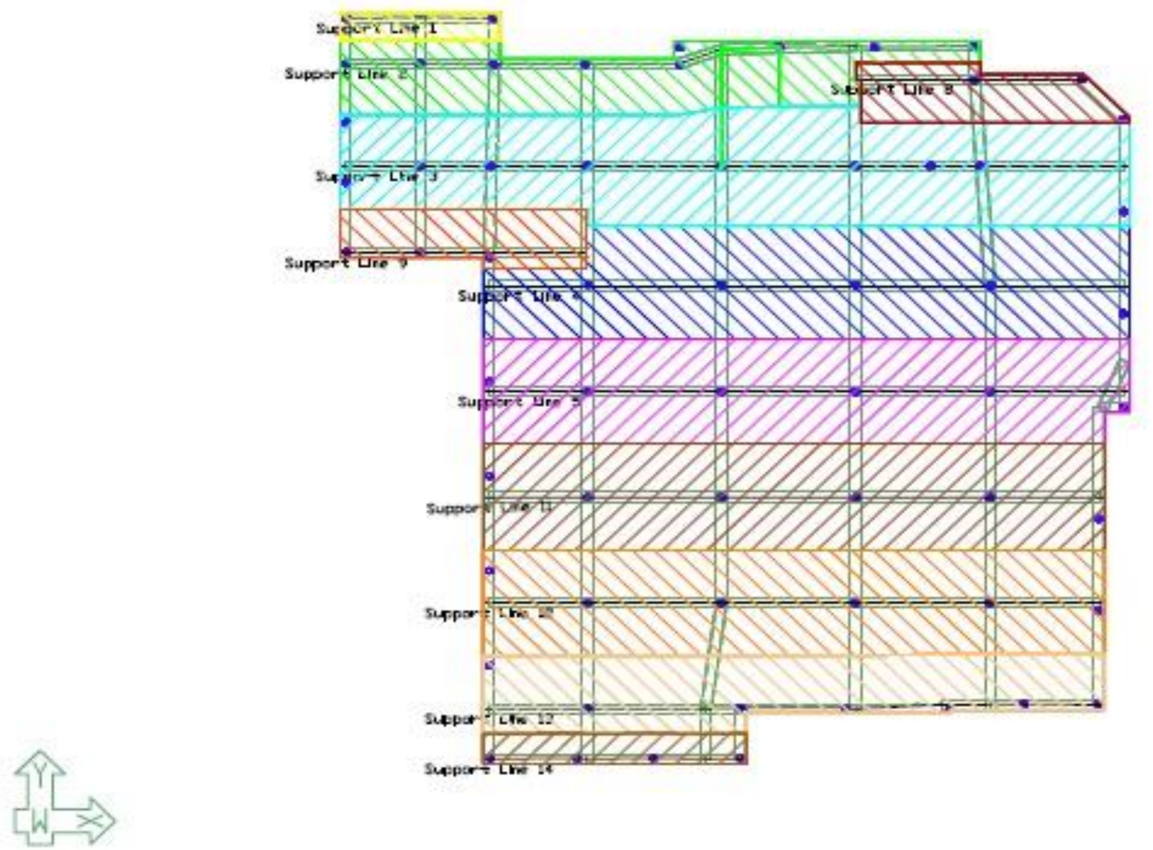


3D Finite Element Analytical Model used to accurately calculate demand on slab and inherent capacity.



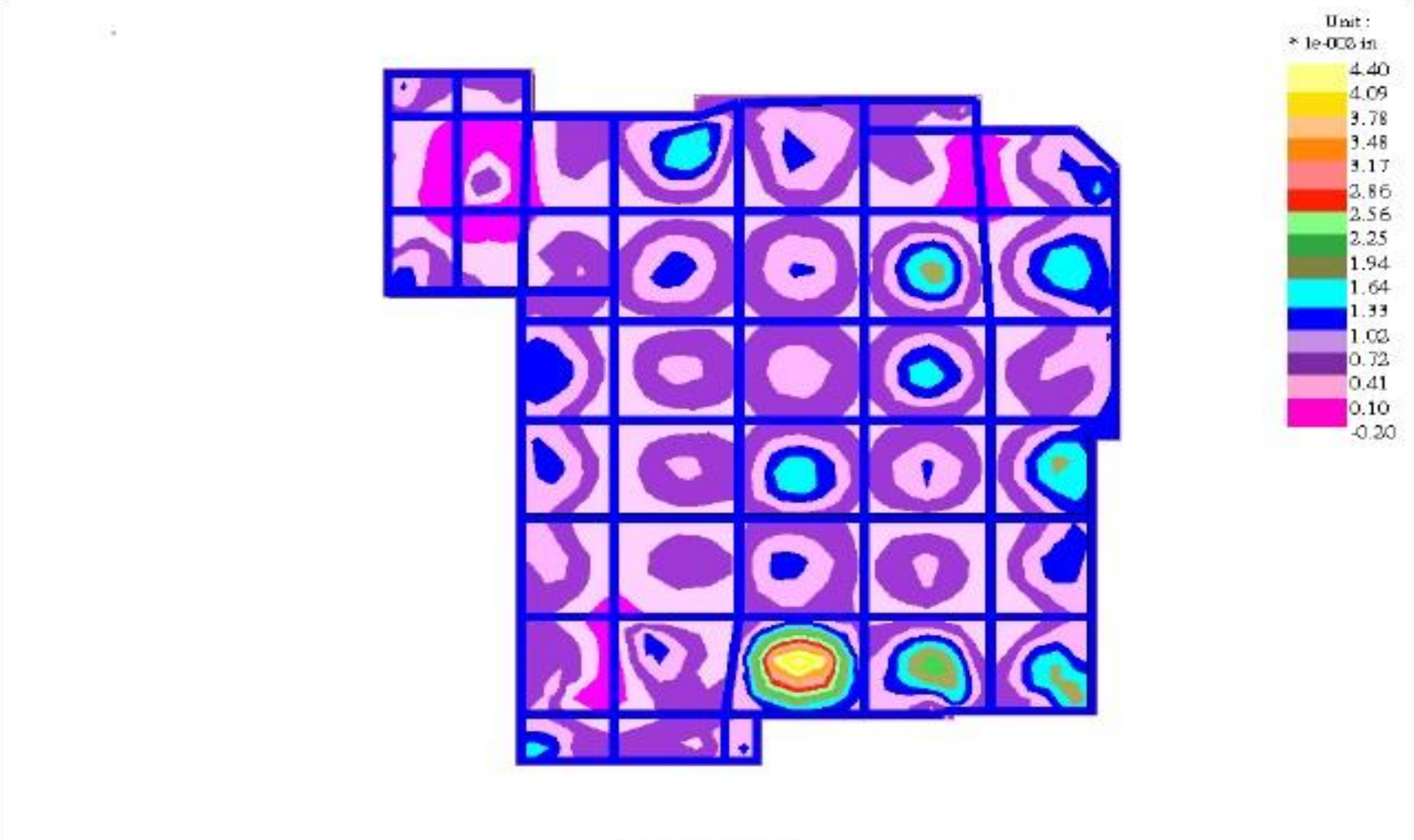
All tendons in slab are faithfully modeled: slab and beam tendons.


Tendon Layout
02/28/13
02:39:59
Con314_HSI_20130227.adm
Hilburn Project



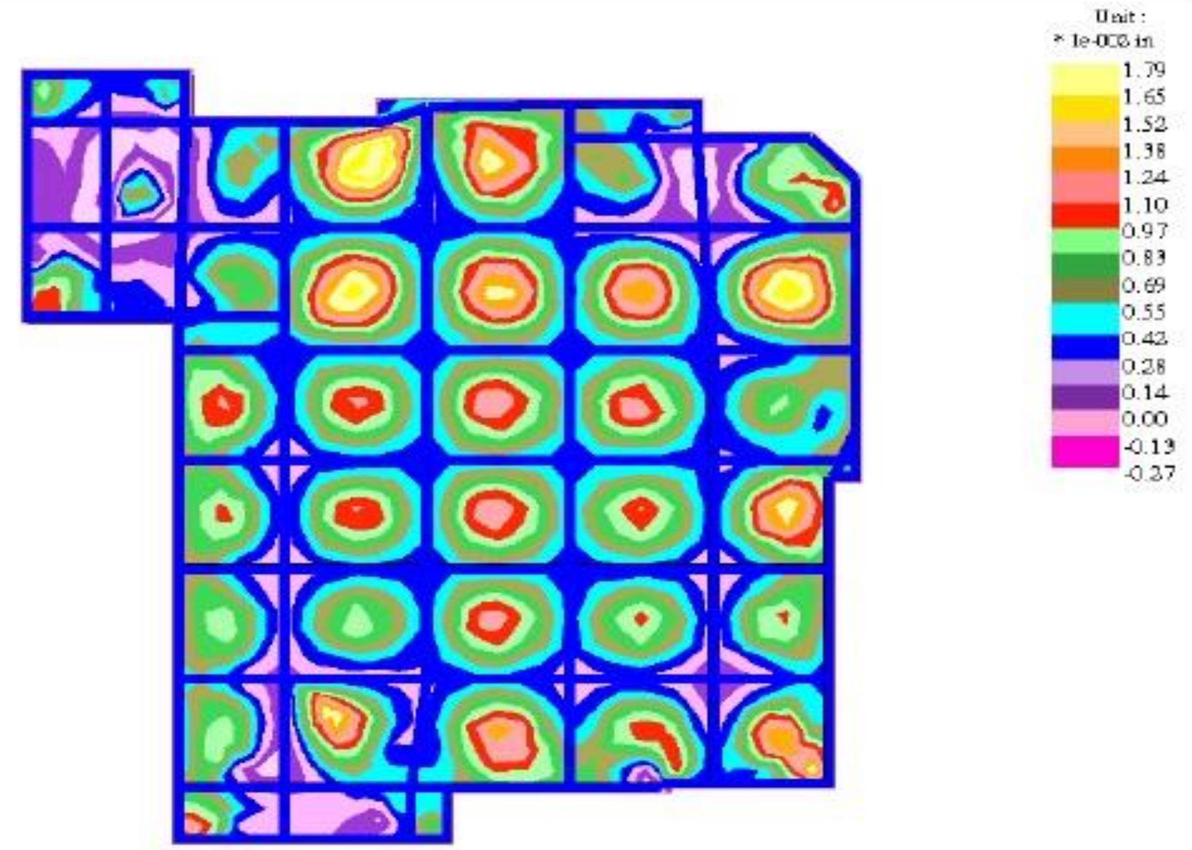
Idealized Tributary Plan for Support Lines in X-Direction

02/28/13 02:41:56	Hilburn Project	
Con314_HSI_20130227.adm		



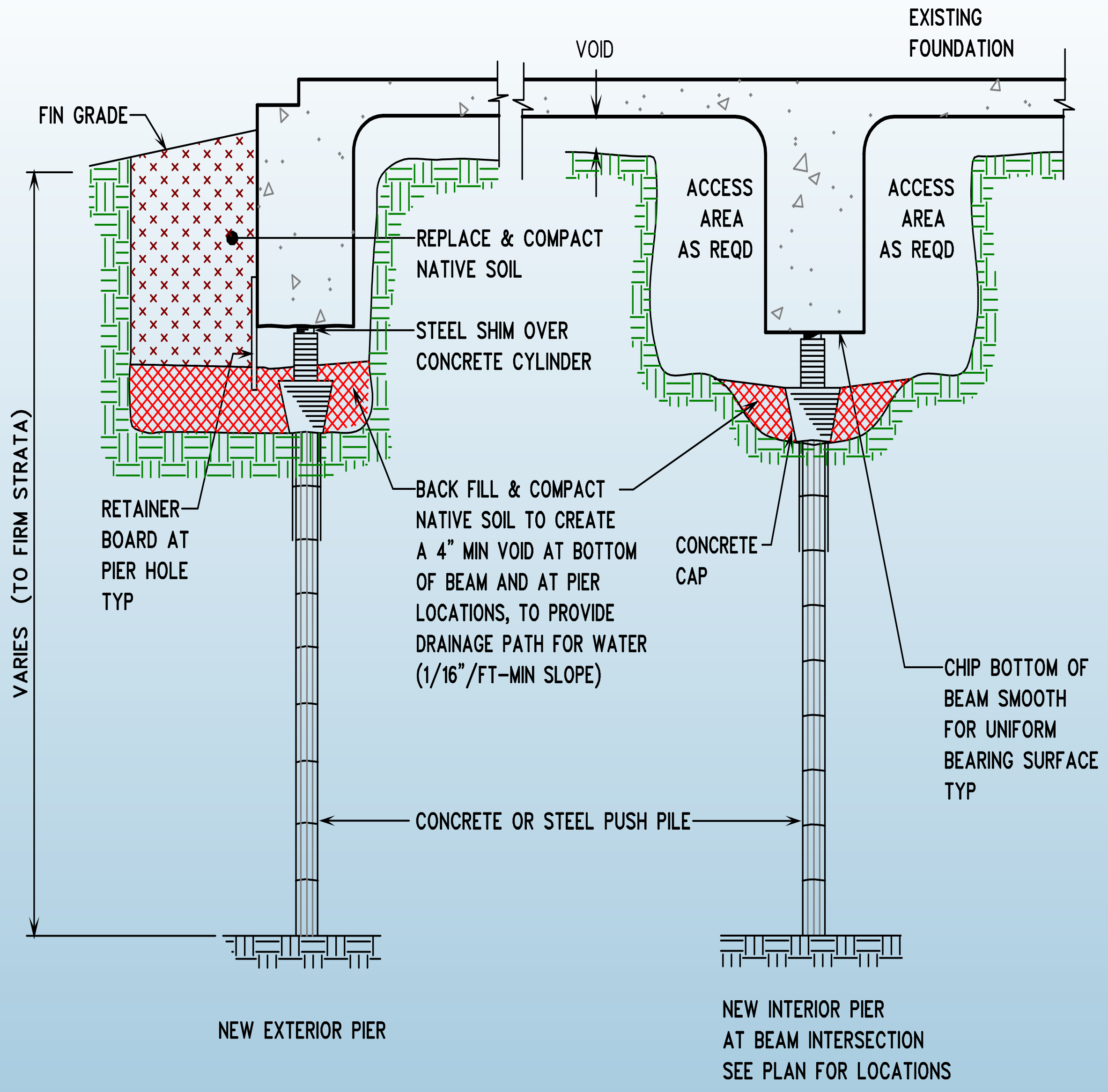
Z-Translation

02/28/13 02:28:36	Hilburn Project	Units: in
Con314_HSI_20130227.adv	Service Sustained Load - Line Load	Deformation

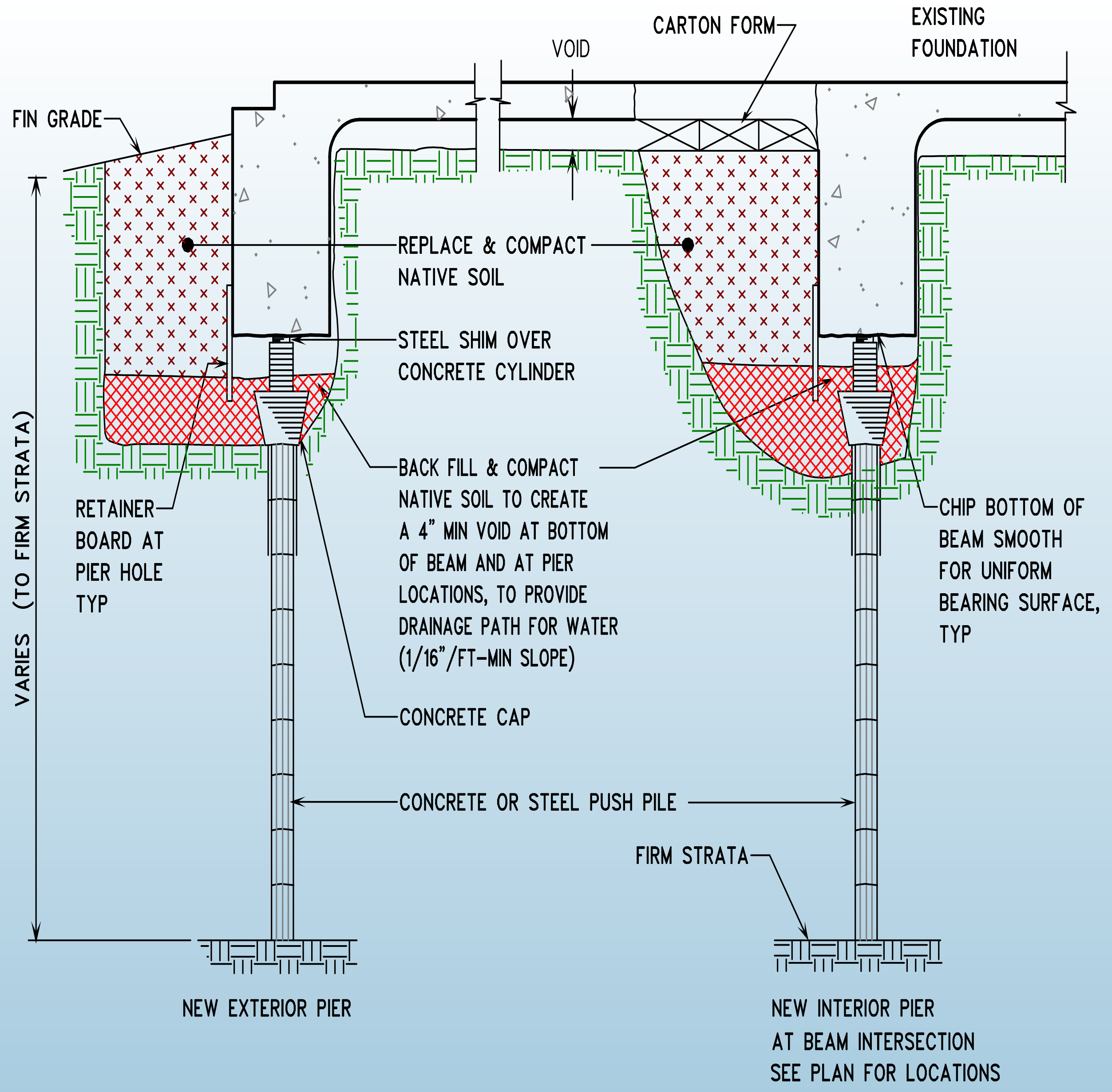


Z-Translation

02/28/13 02:27:19	Hilburn Project	Units: in
Con314_HSI_20130227.adv	Service Sustained Load - Uniform Load	Deformation



EXISTING
FOUNDATION
VOID
FIN GRADE
ACCESS
AREA
AS REQD
ACCESS
AREA
AS REQD
REPLACE & COMPACT
NATIVE SOIL
STEEL SHIM OVER
CONCRETE CYLINDER
VARIES (TO FIRM STRATA)
RETAINER
BOARD AT
PIER HOLE
TYP
BACK FILL & COMPACT
NATIVE SOIL TO CREATE
A 4" MIN VOID AT BOTTOM
OF BEAM AND AT PIER
LOCATIONS, TO PROVIDE
DRAINAGE PATH FOR WATER
(1/16"/FT-MIN SLOPE)
CONCRETE
CAP
CHIP BOTTOM OF
BEAM SMOOTH
FOR UNIFORM
BEARING SURFACE
TYP
CONCRETE OR STEEL PUSH PILE
NEW EXTERIOR PIER
NEW INTERIOR PIER
AT BEAM INTERSECTION
SEE PLAN FOR LOCATIONS


CARTON FORM
EXISTING FOUNDATION
VOID
FIN GRADE
REPLACE & COMPACT NATIVE SOIL
STEEL SHIM OVER CONCRETE CYLINDER
VARIES (TO FIRM STRATA)
BACK FILL & COMPACT NATIVE SOIL TO CREATE A 4" MIN VOID AT BOTTOM OF BEAM AND AT PIER LOCATIONS, TO PROVIDE DRAINAGE PATH FOR WATER (1/16"/FT-MIN SLOPE)
RETAINER BOARD AT PIER HOLE TYP
CHIP BOTTOM OF BEAM SMOOTH FOR UNIFORM BEARING SURFACE, TYP
CONCRETE CAP
CONCRETE OR STEEL PUSH PILE
FIRM STRATA
NEW EXTERIOR PIER
NEW INTERIOR PIER AT BEAM INTERSECTION SEE PLAN FOR LOCATIONS

TYPICAL EXTERIOR PILING

TYPICAL INTERIOR PILING

FLAT SLAB REPAIR

TYPICAL TUNNEL

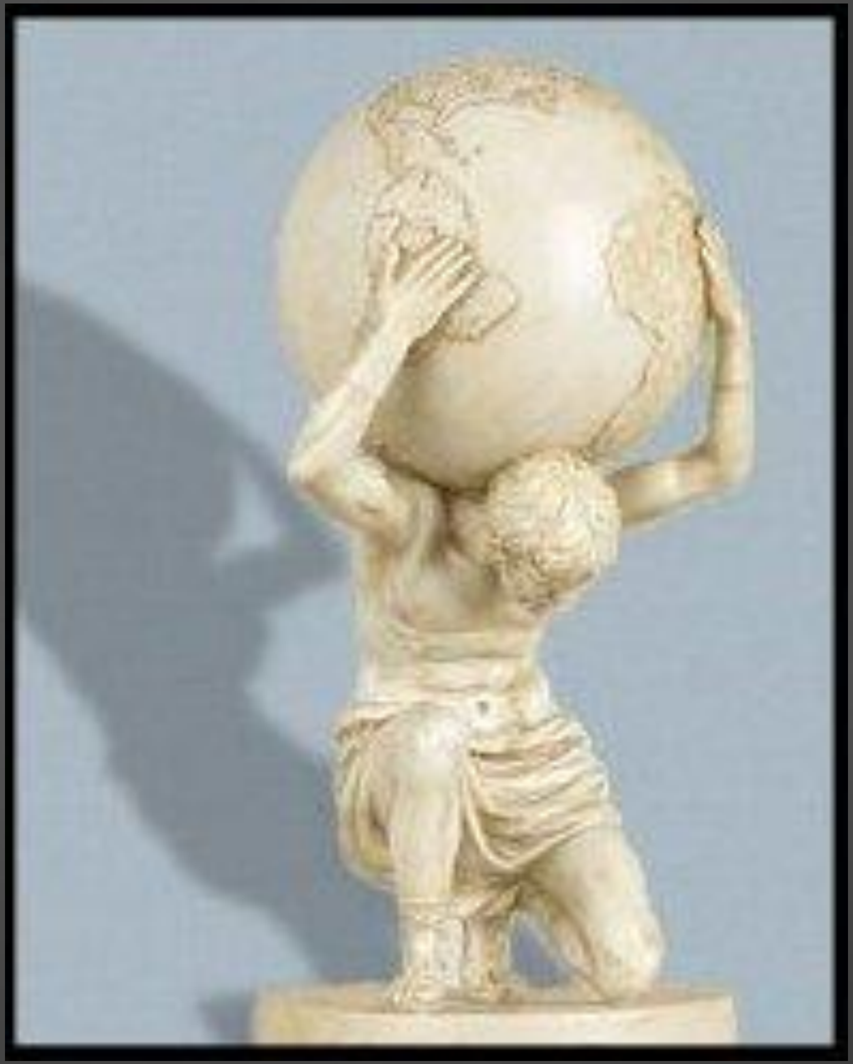
ACI 437

- States the engineering analysis should be for strength and not design code compliance. ACI 437 states: **“Engineering judgement is critical in the strength evaluation of reinforced concrete buildings. Judgement of qualified structural engineers may take precedence over compliance with code provisions or formulas for analyses that may not be applicable to the case studies.”**

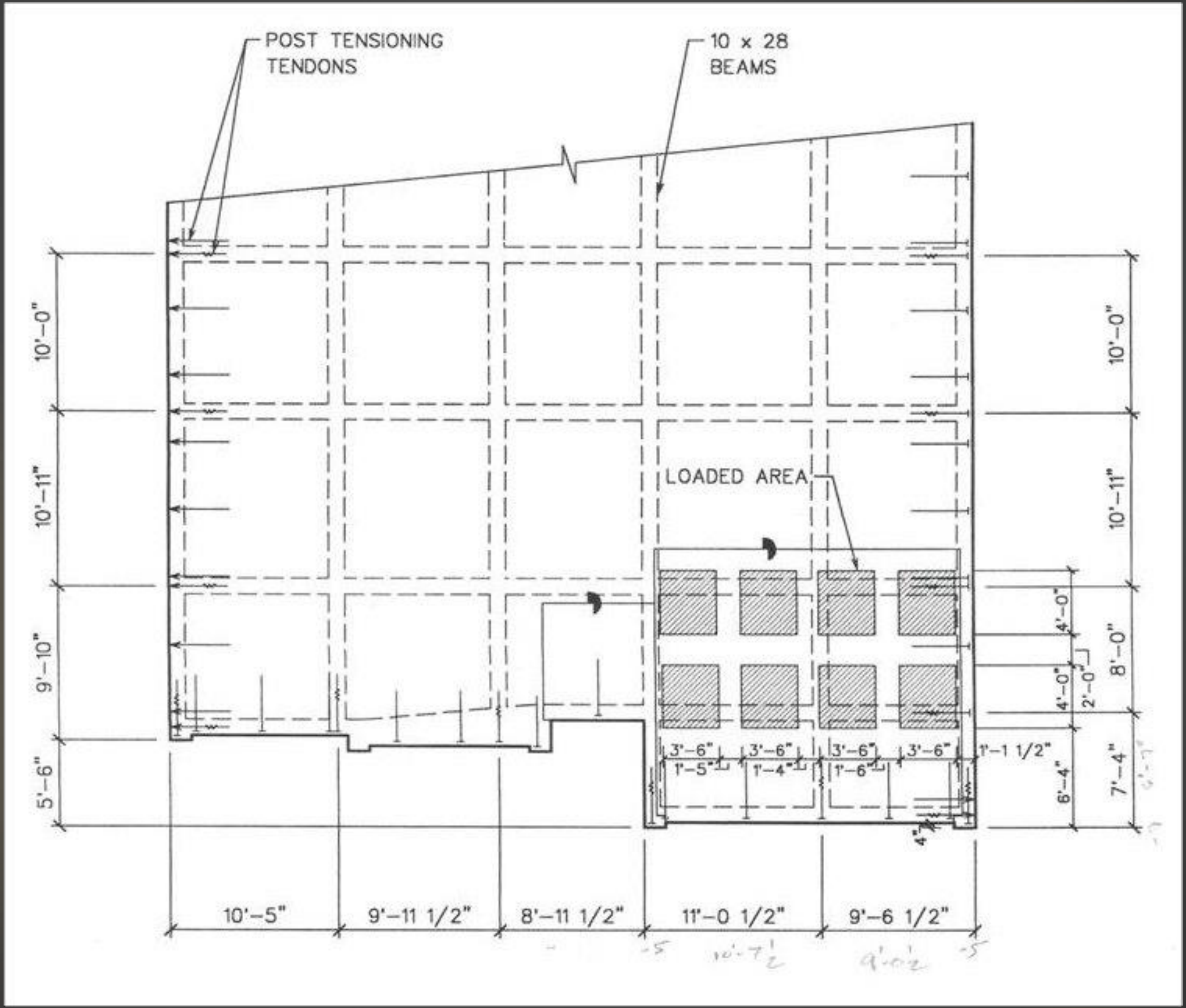
UBC Code Compliance

- **1713.1**
  - Whenever there is a reasonable doubt as the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standards….

Actual Load Test



Partial Floor Plan



Load Test Photos

Load Test Photos

Load Test Photos

Floor Load Test

FLOOR LOAD TEST AT
2124 GATE POINT WAY
ARLINGTON, TEXAS
RONE JOB NO. 00-3874

Date	West half load (inches of water)	East half load (inches of water)	Gauge 1 disp (inches)	Gauge 2 disp (inches)	Gauge 3 disp (inches)	Gauge 4 disp (inches)	Gauge 5 disp (inches)	Gauge 7 disp (inches)	Gauge 8 disp (inches)	Gauge 9 disp (inches)
07/19/2000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
07/19/2000	5.5	0	0.001	-0.001	-0.001	-0.002	-0.002	-0.001	0.000	-0.001
07/19/2000	11	0	0.002	-0.003	-0.001	-0.001	-0.001	-0.001	0.000	-0.001
07/19/2000	16.5	0	0.003	-0.005	-0.002	0.000	-0.001	-0.001	0.000	-0.001
07/19/2000	22	0	0.003	-0.006	-0.002	0.001	-0.001	0.000	0.001	0.000
07/20/2000 (24 hr. reading)	22	0	-0.001	-0.048	-0.020	0.000	-0.027	-0.004	-0.001	-0.001
07/20/2000	22	5.5	0.001	-0.048	-0.020	0.001	-0.028	-0.005	-0.001	-0.002
07/20/2000	22	11	0.000	-0.050	-0.021	0.001	-0.028	-0.006	-0.002	-0.004
07/20/2000	22	16.5	0.000	-0.049	-0.021	0.002	-0.028	-0.006	-0.002	-0.006
07/20/2000	22	22	0.001	-0.050	-0.021	0.003	-0.027	-0.007	-0.004	-0.007
07/21/2000 (24 hr. reading)	22	22	0.002	-0.052	-0.030	0.004	-0.038	-0.010	-0.008	-0.012
07/21/2000	26	26	0.003	-0.054	-0.040	0.005	-0.040	-0.010	-0.008	-0.012
	30	30	0.003	-0.056	-0.042	0.006	-0.041	-0.012	-0.010	-0.012

Upward disp (+)

Downward disp (-)

Gauge 6 was not functioning properly

RONE/JOBS/2000/3800'S/00-3874/BOOK5.XLS

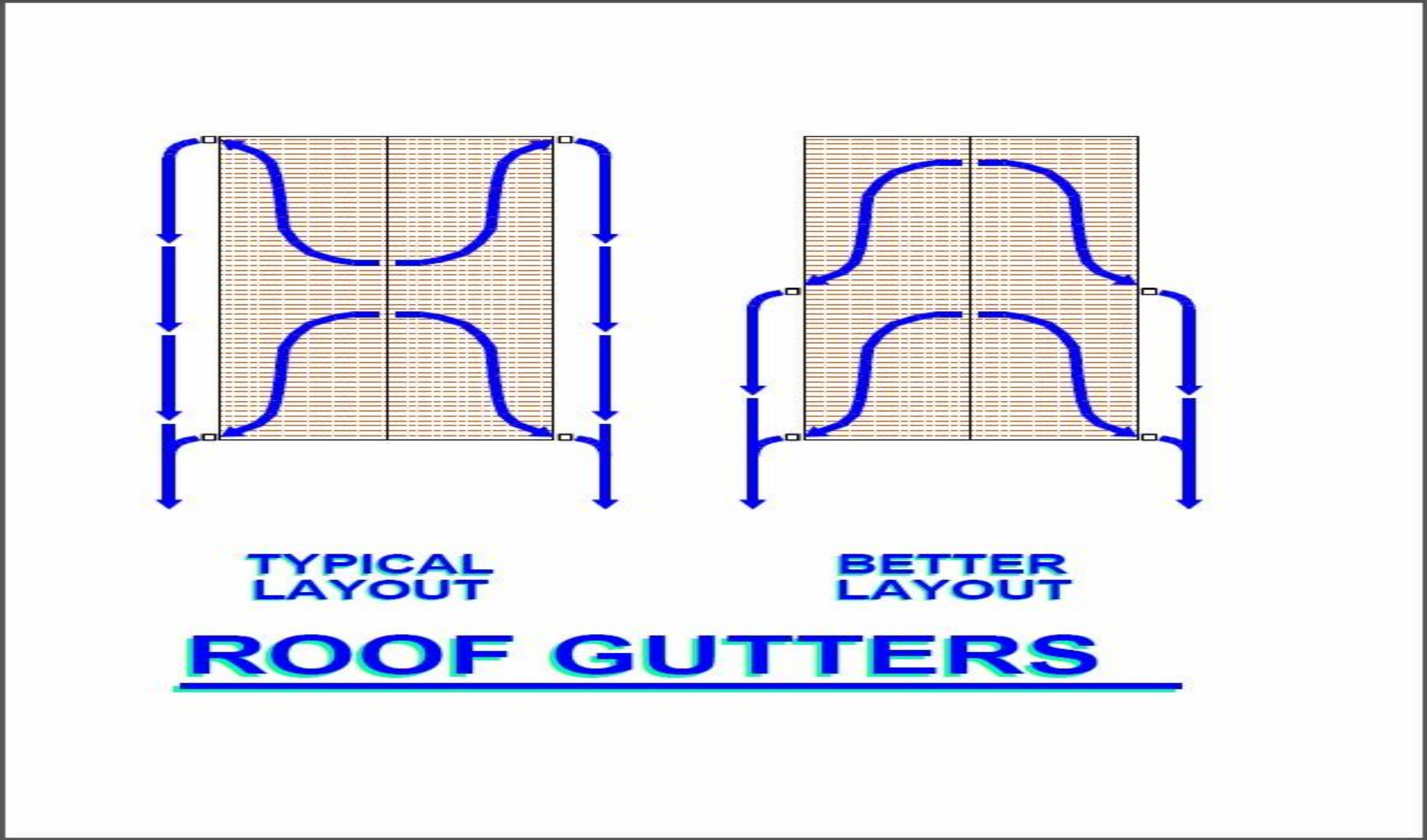

06.18.2010


GROSS NET MOTION ZERO lb kg
1 2 3 4 5 F1 CLEAR
6 7 8 9 0 F2 ENTER
ZERO TARE NET GROSS UNITS PRINT
Model AD-5000
06.18.2010

Questions?

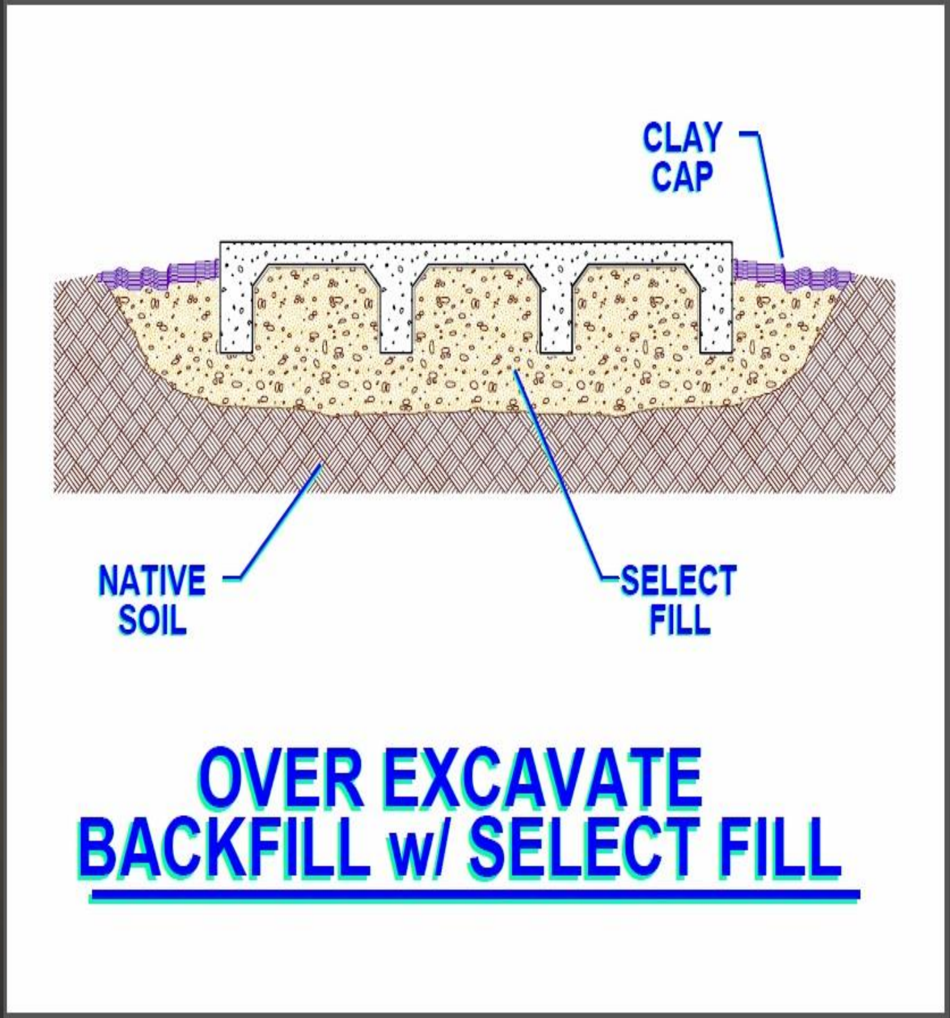
LESSONS LEARNED

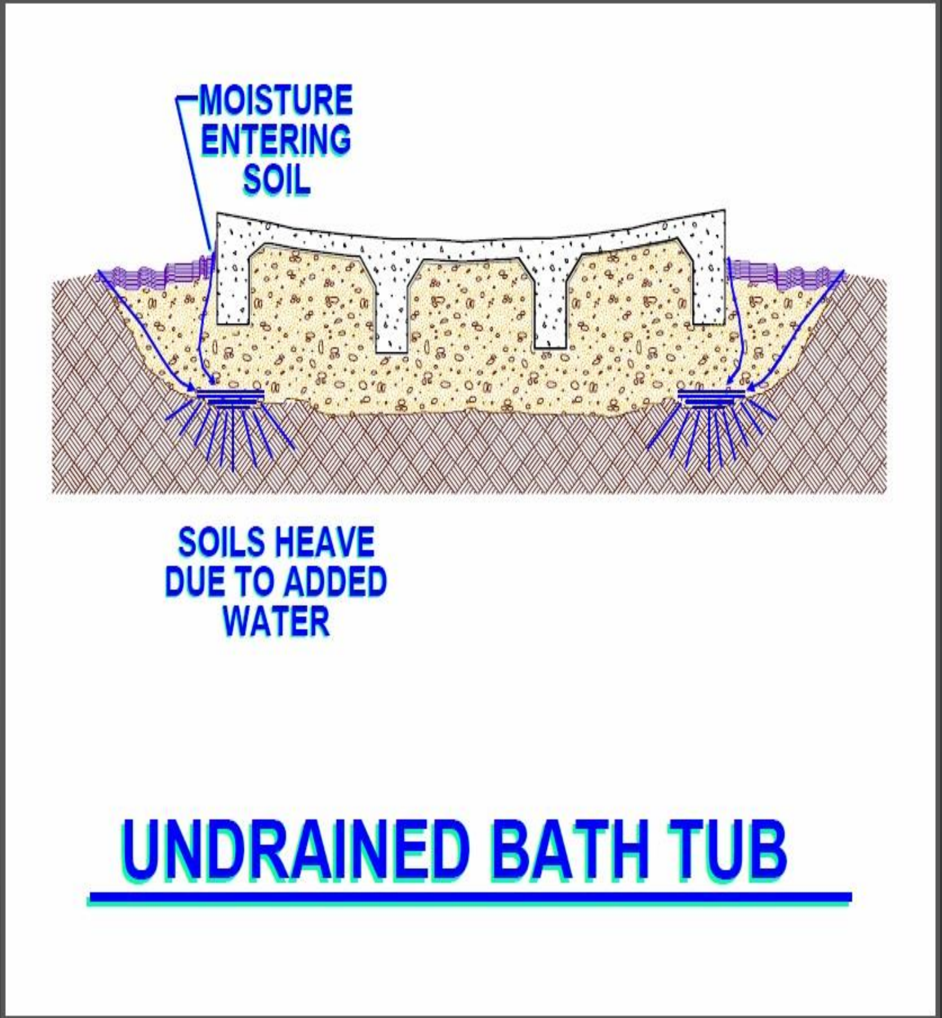
Roof Gutters and Downspout Placement



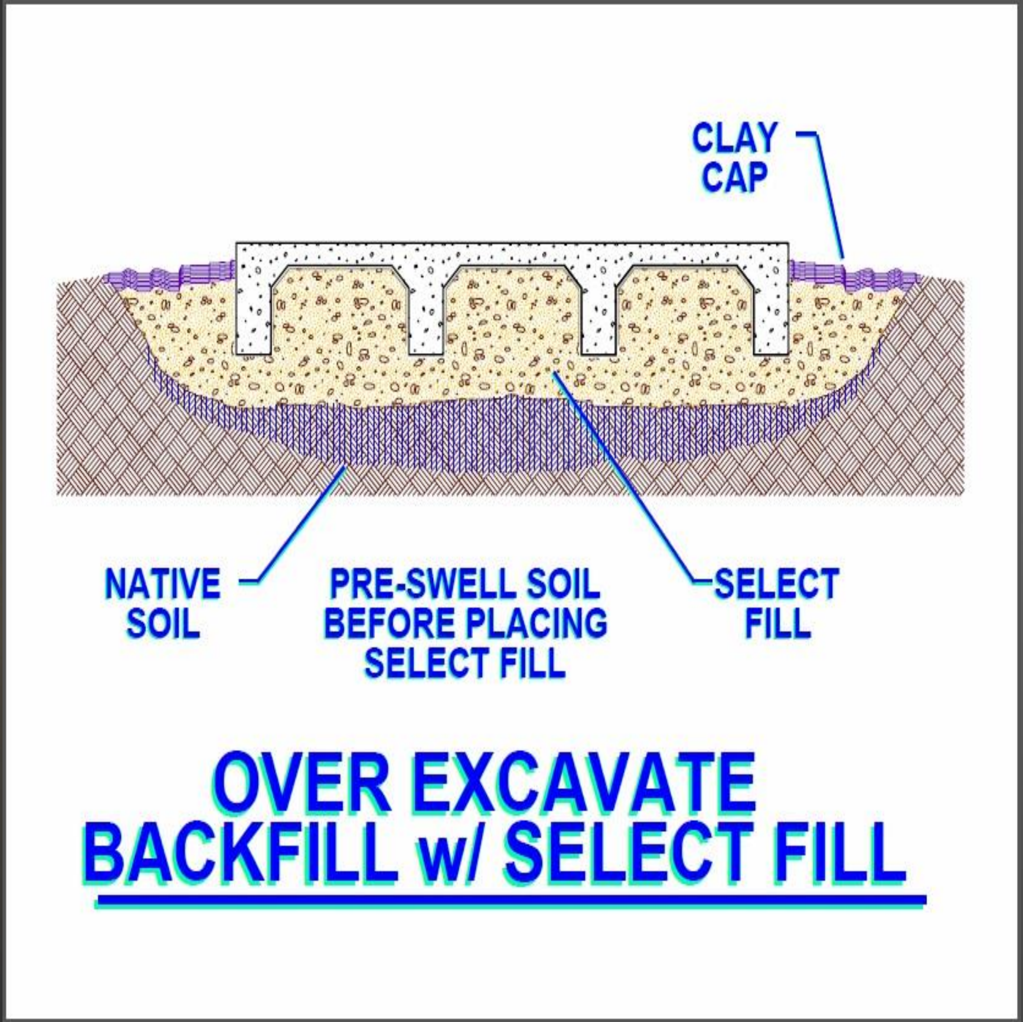
Undrained Bathtub

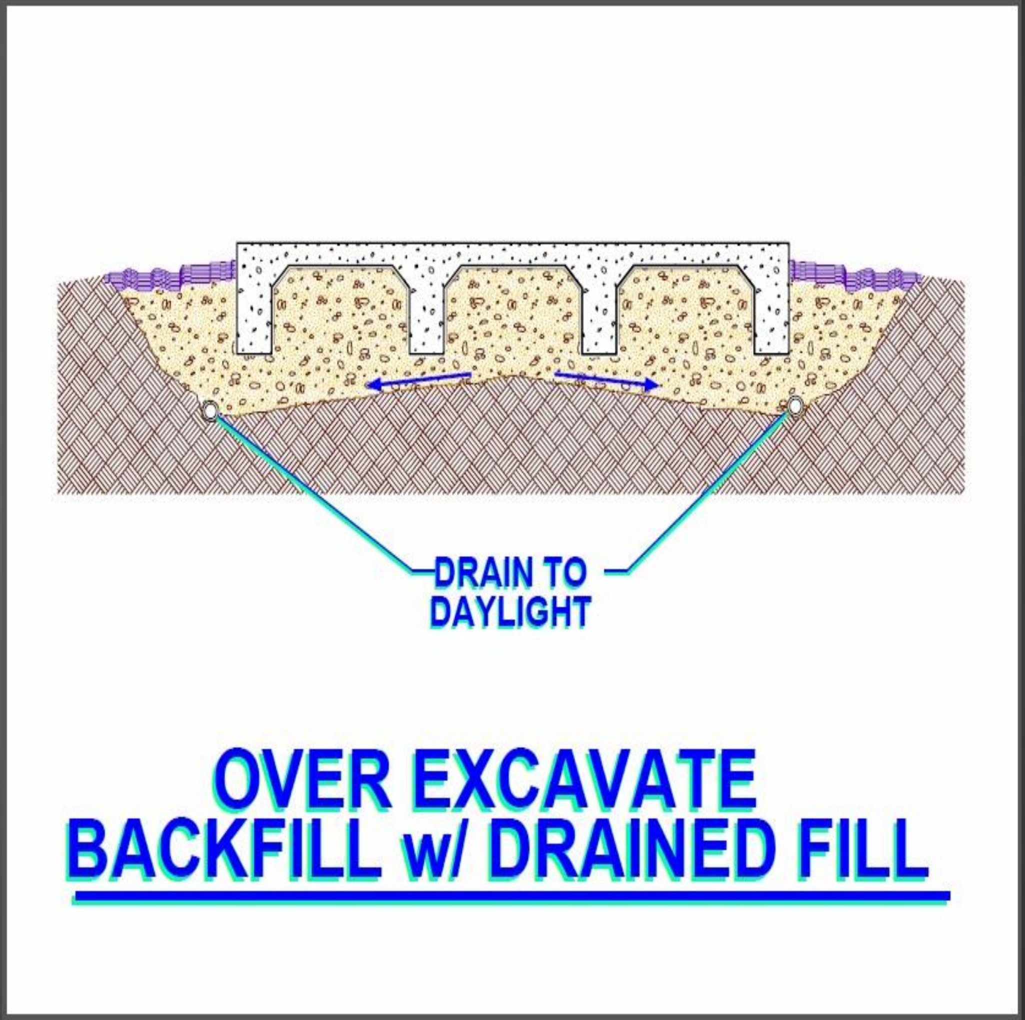
Over Excavation and Backfill with Select fill "BATH TUB"



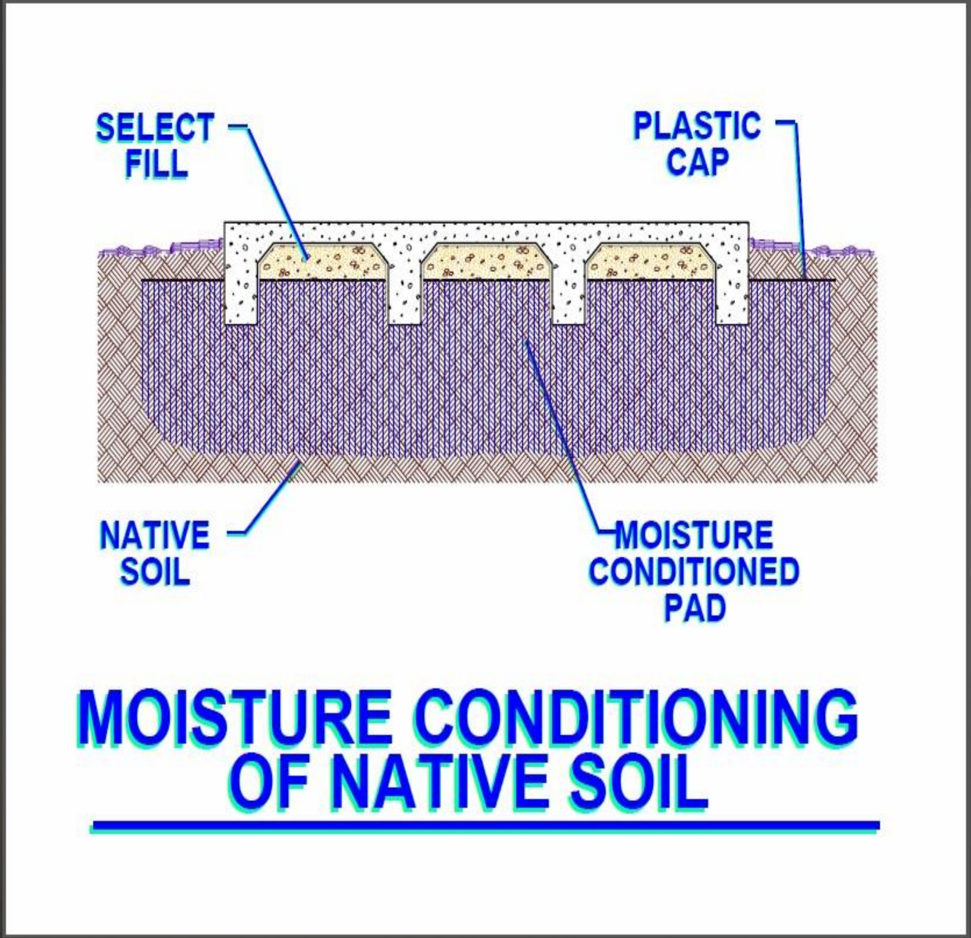


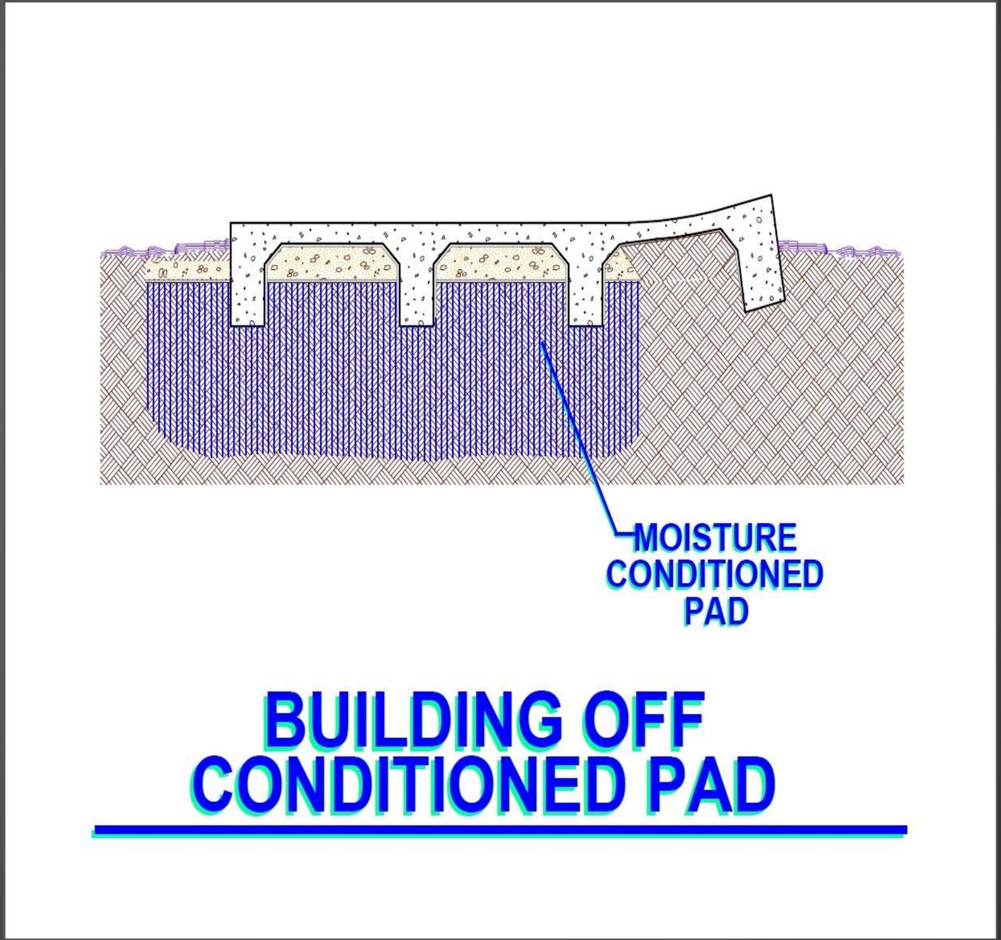
Over Excavation and Backfill with Select fill "BATH TUB"



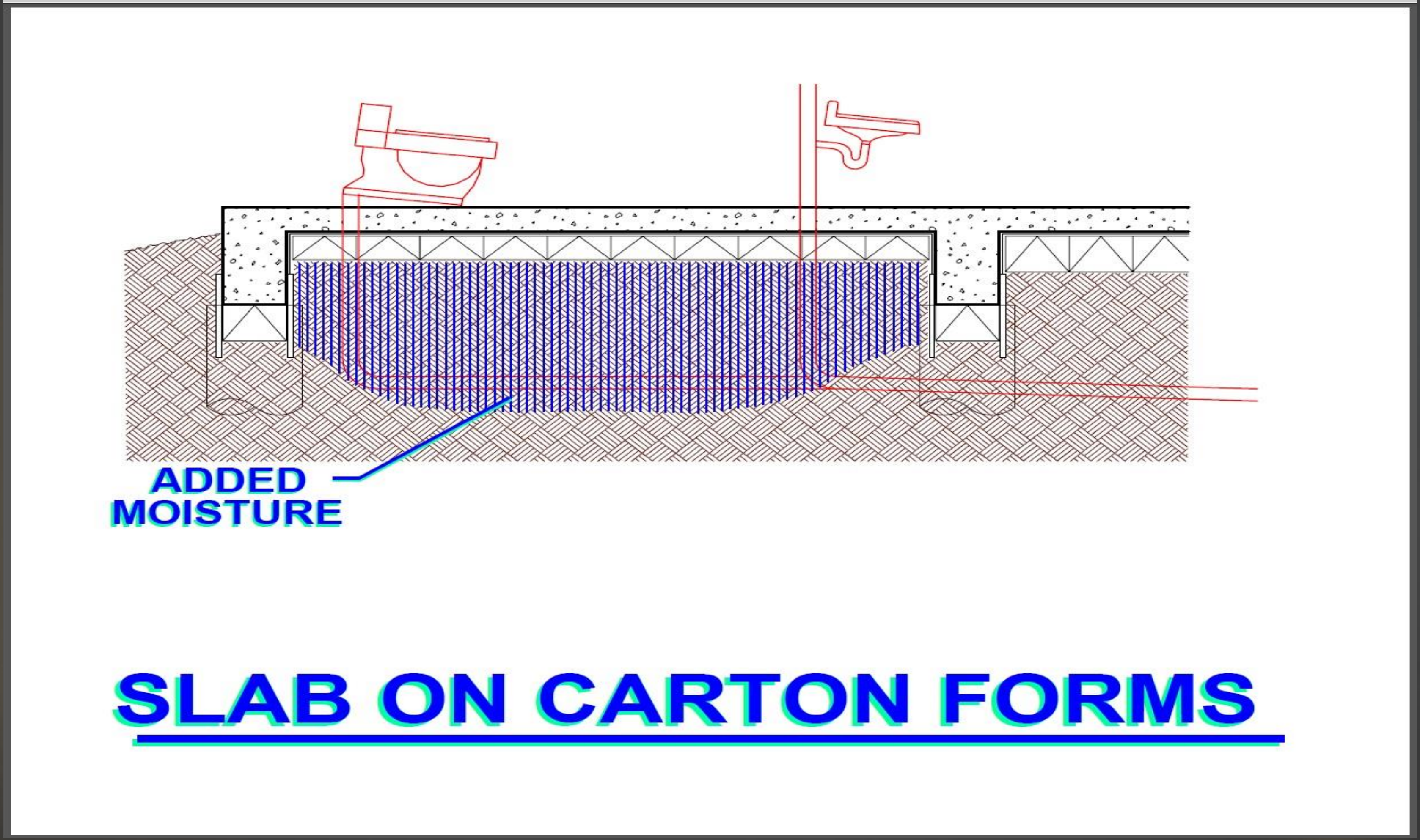


Building Off of Moisture Conditioned Pad





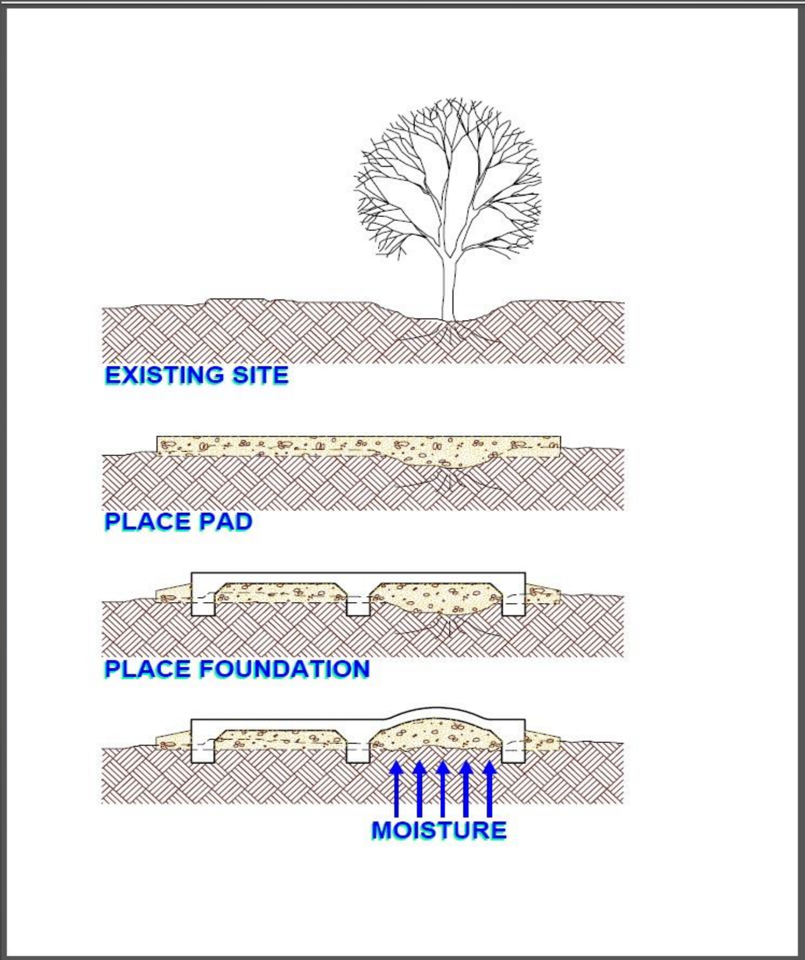
Plumbing Problems and Moisture Problems with Foundation on Void Boxes

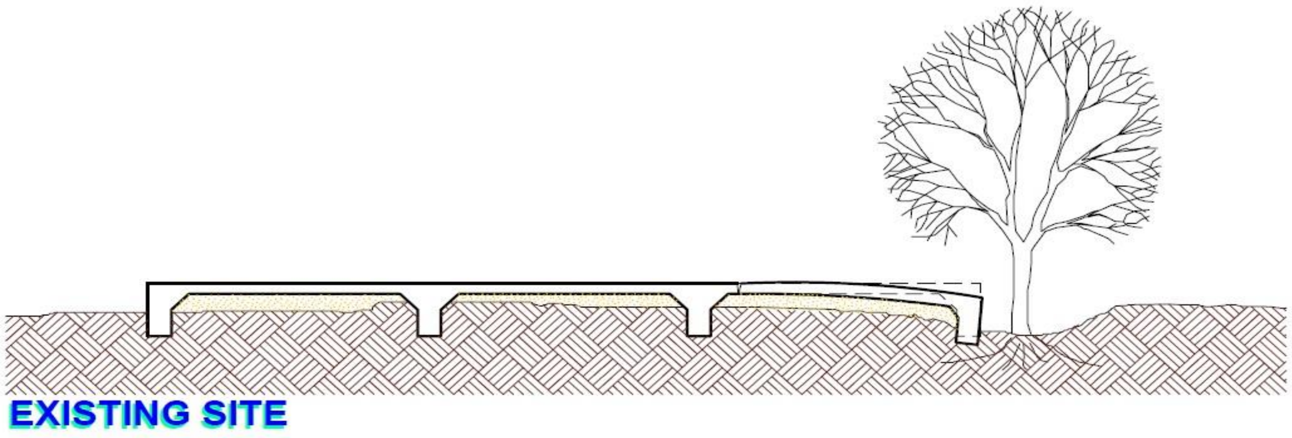



08/22/2008

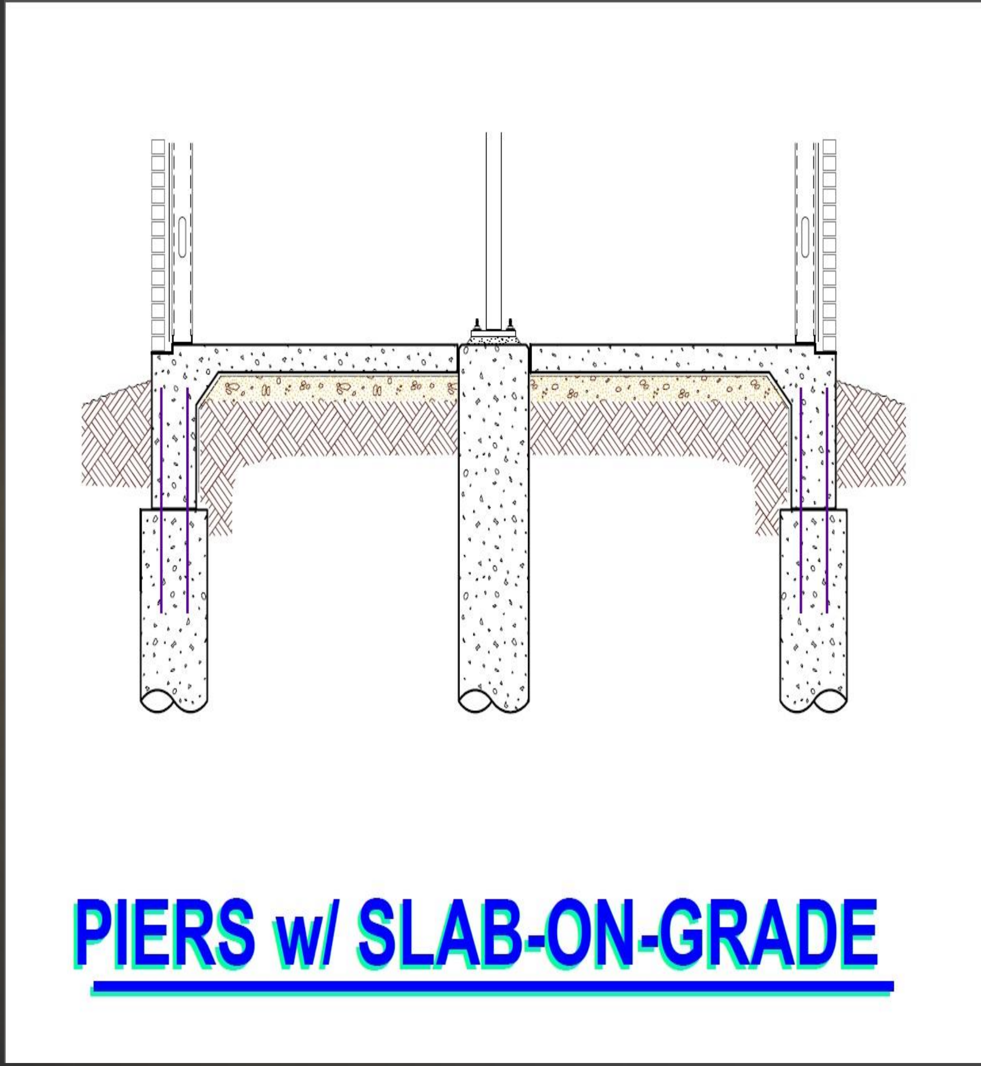

08/22/2008

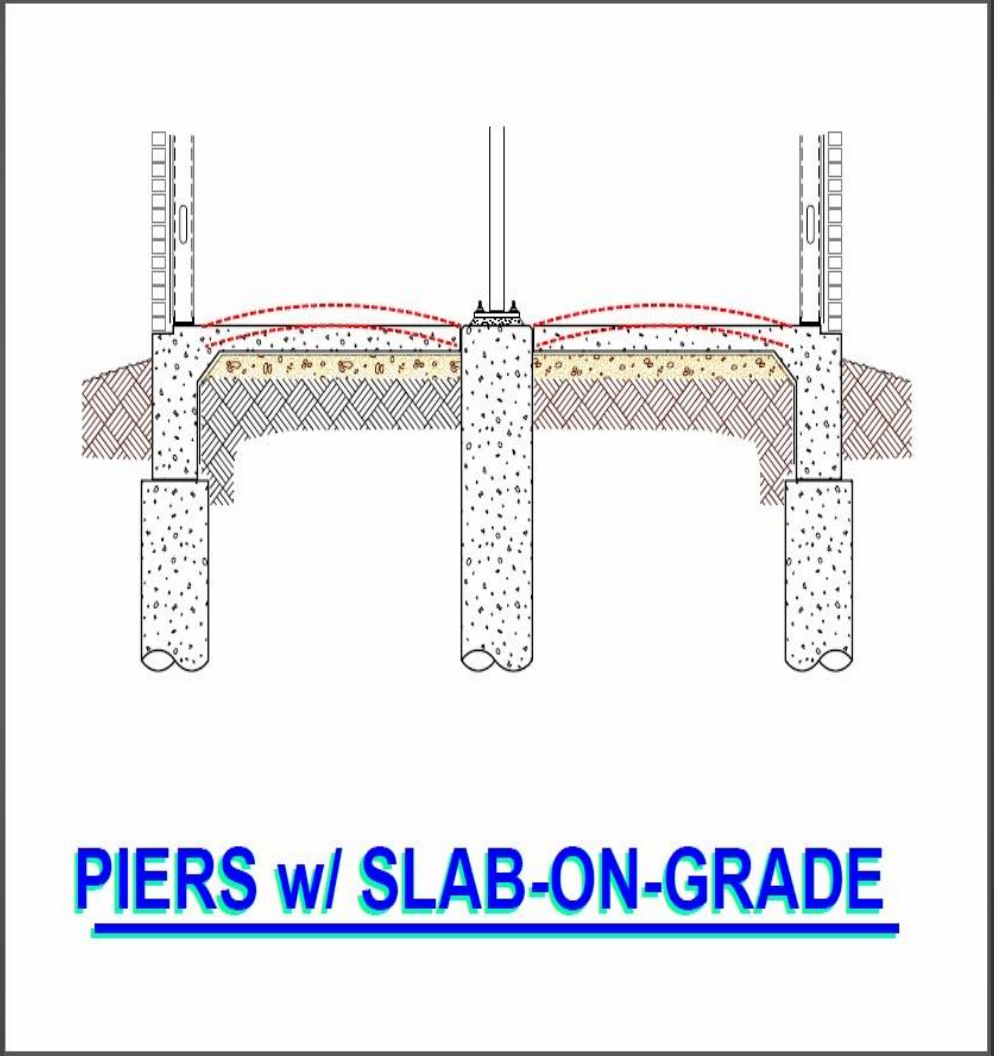
Previous Tree Rows and Uneven Soil Moisture Conditions



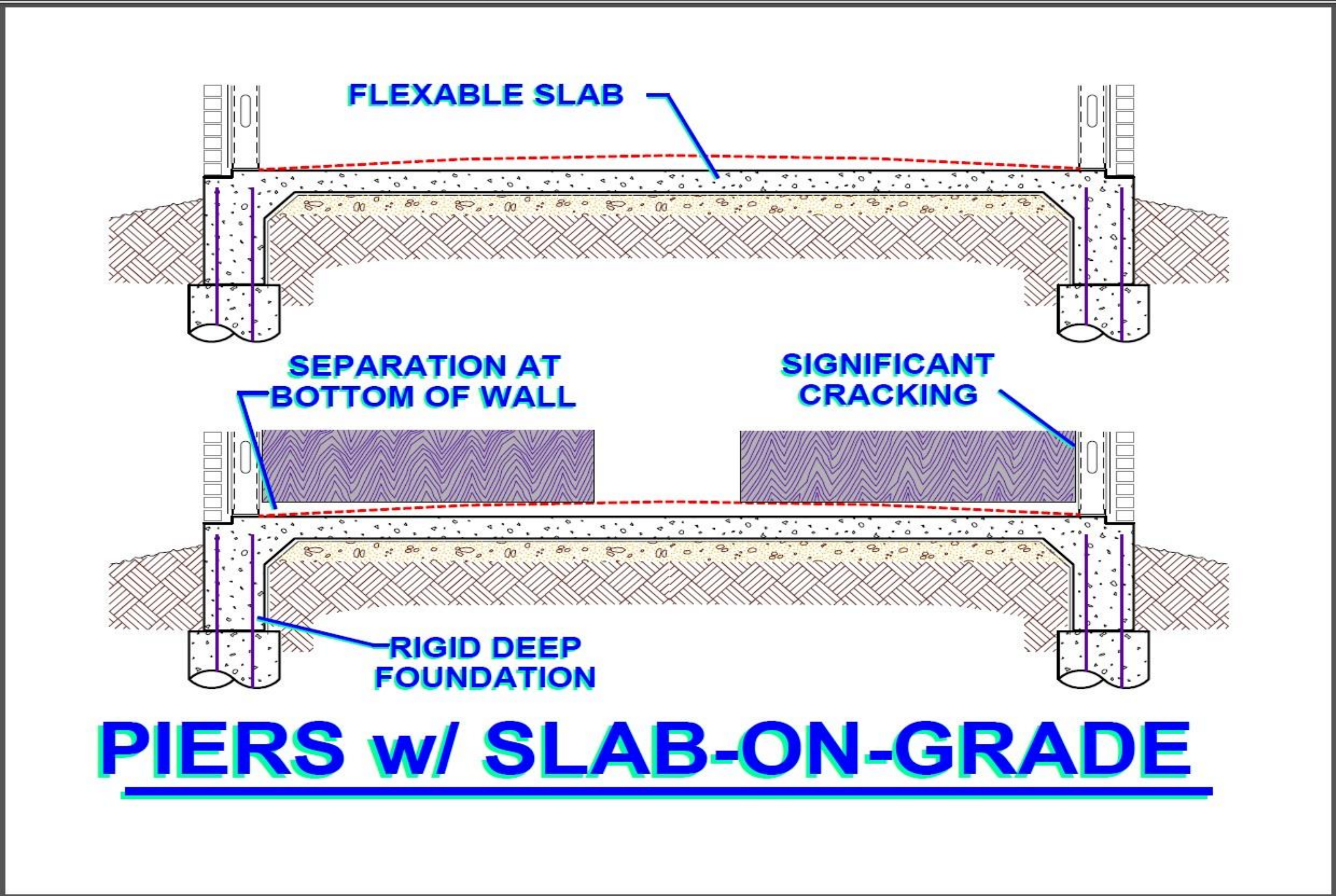

EXISTING SITE

Incompatible Foundation Systems

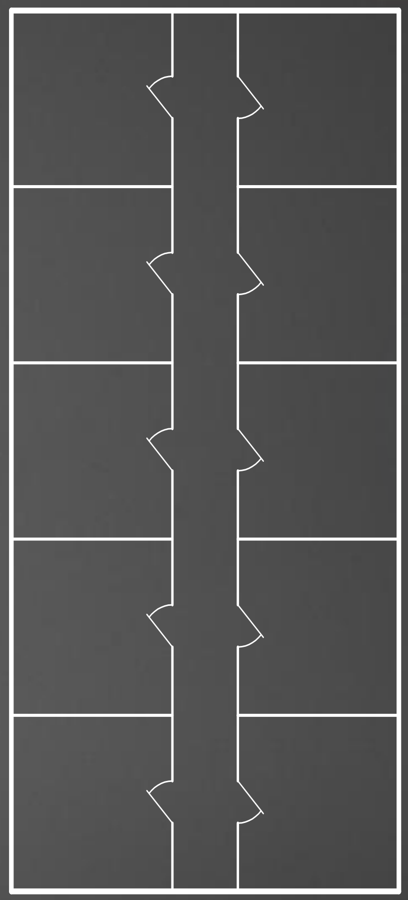




Incompatible Foundation Systems



SANCTUARY



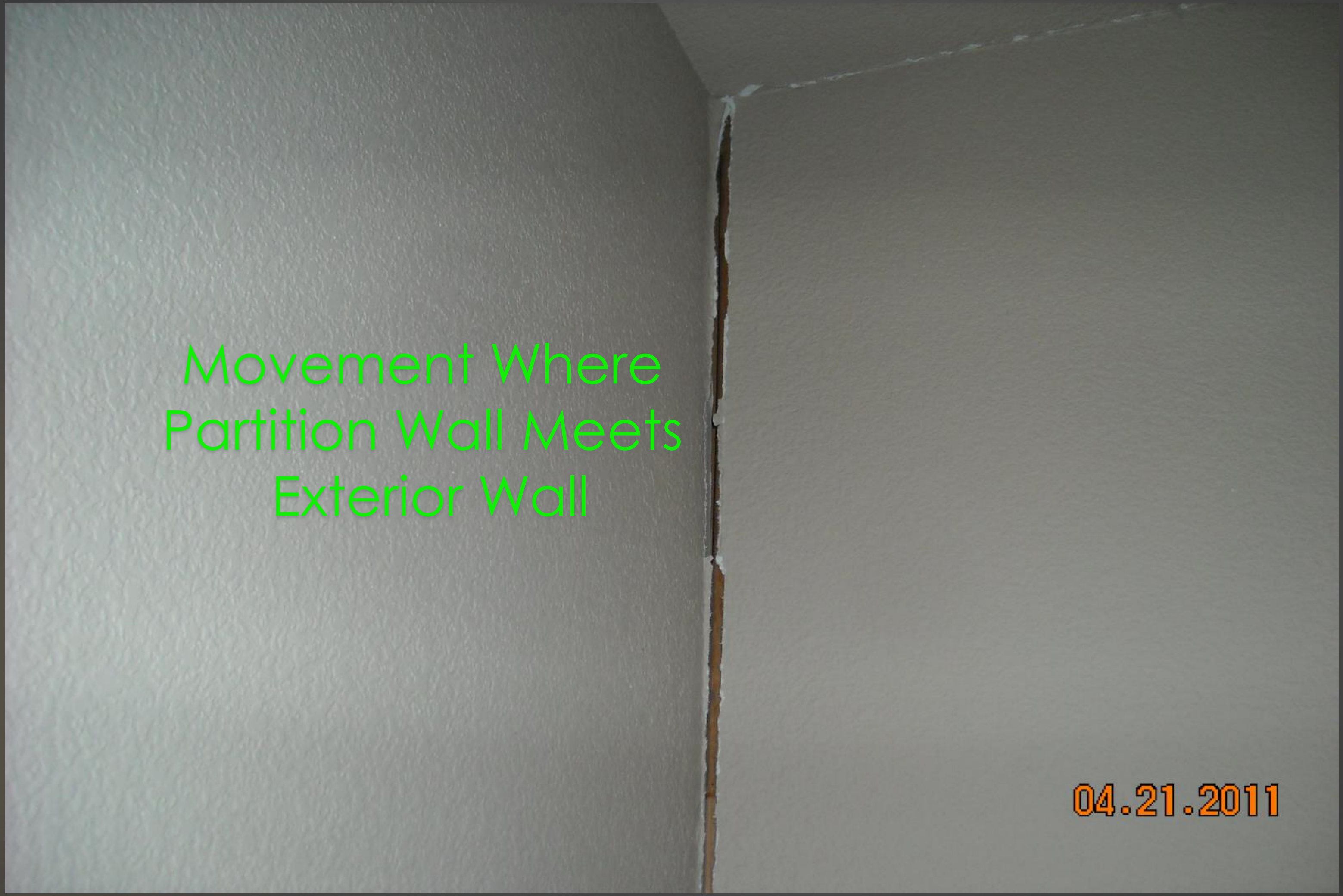
CLASSROOM BUILDING

Heads Up "THINK"

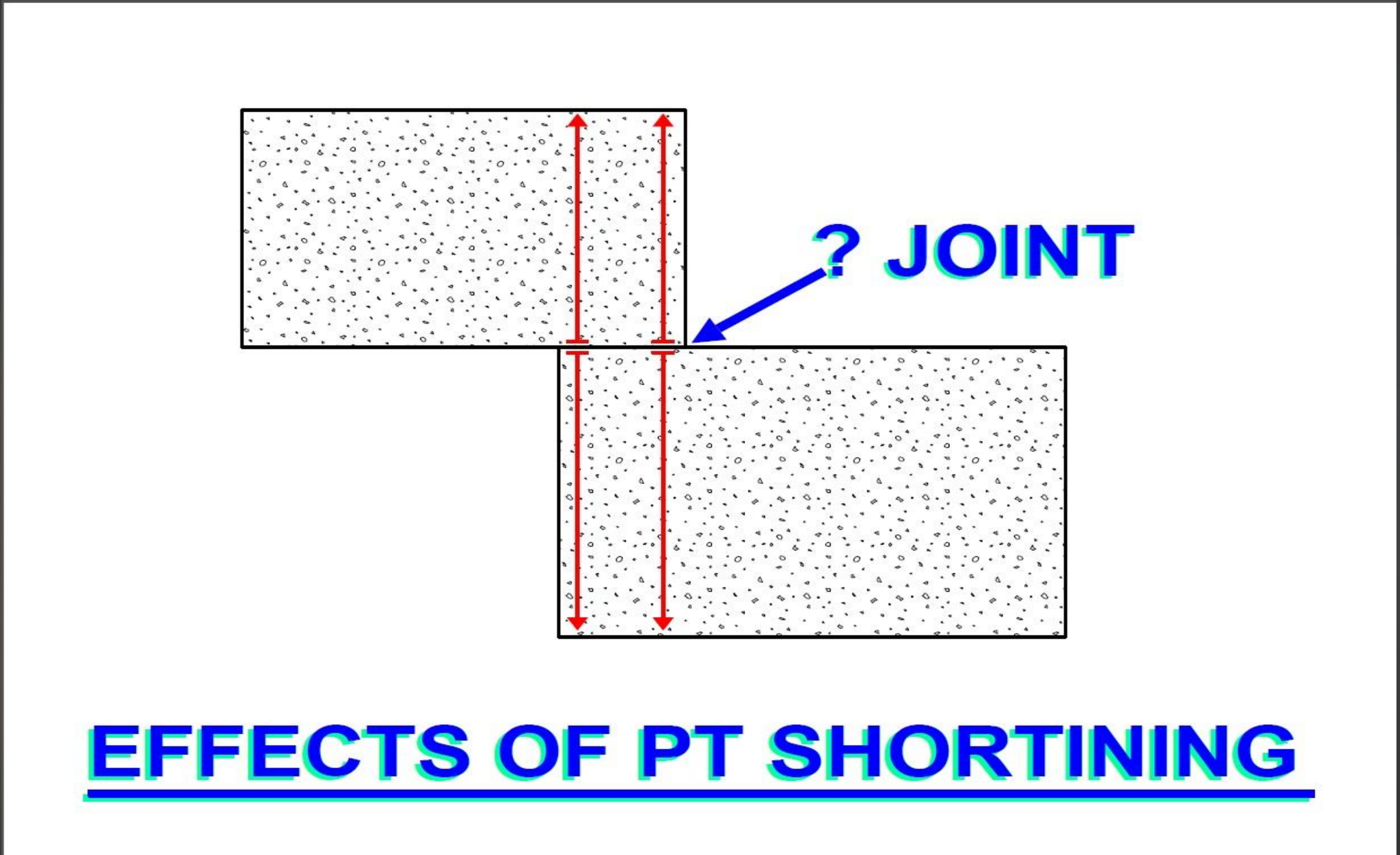
- Metal Building Type: Slab-On-Grade
- P.I. = 20 – 30 4" S.O.G. Turned Down
- P.V.R. < 1" Exterior Grade Beam


FIRE
05.09.2013

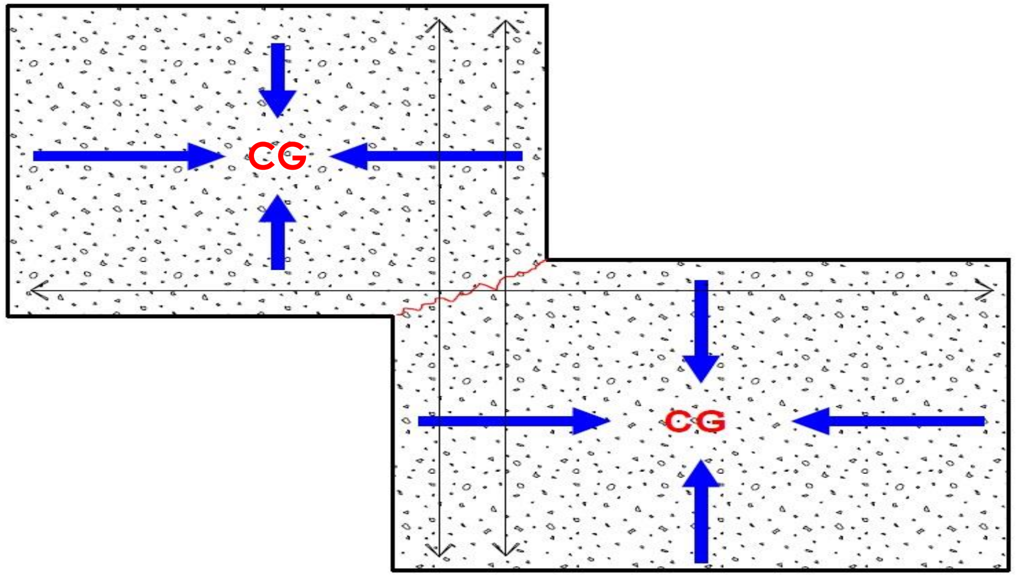

04.21.2011


Movement Where
Partition Wall Meets
Exterior Wall
04.21.2011

Effect of Post-Tensioning

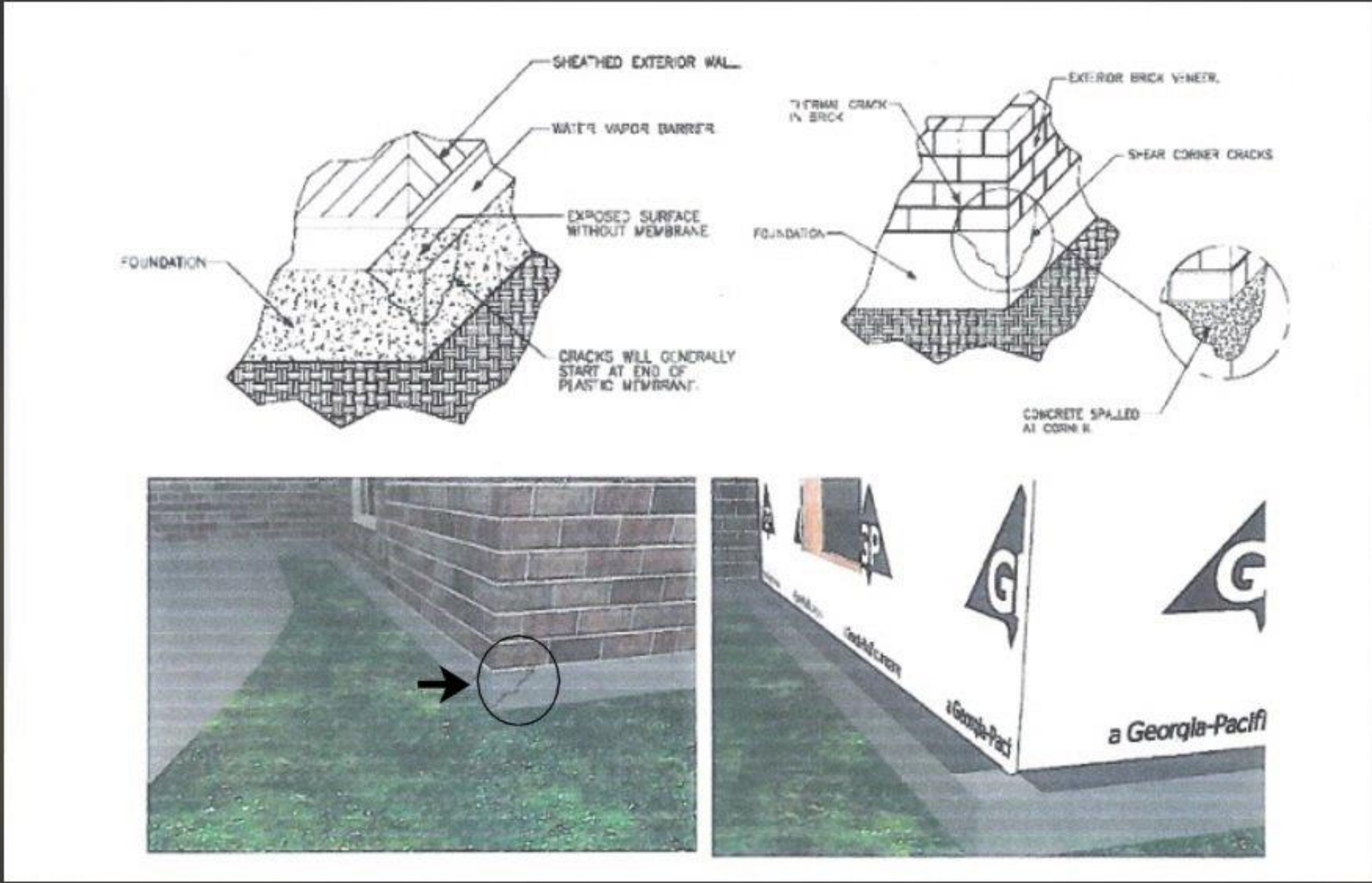


Effect of Post-Tensioning cont.



EFFECTS OF PT SHORTINING

Corner Cracks



Corner Cracks

FOUNDATION MAINTENANCE

Proper foundation maintenance will minimize differential soil movement. Because of heavy rains at certain times of the year, it is impossible to keep moisture away from the foundation. However, good drainage will control excessive moisture, and this is very important. Excessive drying of the soil can be prevented by controlled watering around the foundation during dry seasons. Trees and other large vegetation accelerate the drying process, and careful consideration should be given when planting. Proper landscaping and ground cover will help prevent drying. Some recommended steps for foundation maintenance and care are listed below:

- Maintain positive drainage away from the foundation with a suggested slope of four inches in the first six feet away from the foundation.
- Fill any depressions adjacent to or near the foundation with native soil. Do not use sand or other granular materials.
- Check gutters and downspouts to be sure that water is discharged away from the foundation area.
- Water liberally around the foundation during dry spells. This should be done in a uniform manner around the entire house to prevent uneven soil movement. This will include the areas of the yard where there is not grass or plants. Automatic lawn sprinkling or automatic foundation soaker hose systems may be installed and are very beneficial.
- Plant trees a distance away from the foundation equal to their anticipated height. If existing trees are near the foundation, they will draw added water from the foundation thus requiring more water within this area. Sometimes tree roots that go under the foundation will need to be cut and a barrier trench installed to prevent new roots from growing under the foundation.
- Cracks in the soil from drying should not be allowed to form. If they do, gradual watering should be applied adjacent to the cracks so that they will close. Water should not be placed directly into the open cracks.

The object of a proper maintenance program is to attain as constant a moisture content as is possible for the soil under the foundation and the perimeter of the house. Special emphasis must be made in watering programs during dry seasons and the effect that trees have in the removal of soil moisture during these dry seasons.

Questions?

THANK YOU