STRUCTURAL CALCULATIONS
FOR THE
MAPLE GROVE RESIDENCE

RETAINING WALL DESIGN

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W2 & W5

H = 7'

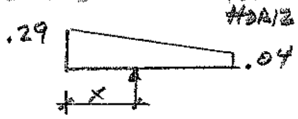
PROVIDE 1-ROW OF TIEBACKS
THIS ROW DESIGNED TO RESIST
TOTAL EARTH PRESSURES

$P_{TOT} = \frac{.29+.04}{2}(7) = 1^k/'$
H3A12

$P_R = \frac{1}{\cos 20} = 1.1^k/'$

$P_v = .4^k/'$

$x = \frac{.04(7)^2/2 + .035(7)^3/6}{1}$



= 3'

TIEBACK ROW PLACED AT 4' FROM THE TOP
3' FROM THE BOTT

TIEBACKS @ 8' O/C MAX

$P_{TB} = 1.1(8) = 8.8^k$

TOT VERT LOAD

$1^k/' + .4^k/' = 1.4^k/'$
WALL P_v TIEBACK

PILES AT 4' O/C MAX

$P = 1.4(4) = 5.6^k \le 3$ TON

W4

TIEBACKS ARE NOT PRACTICAL.
STRATEGY IS TO SPAN WALL HORIZONTALLY
BETWEEN WALLS W3 & W5

L = 11' (HORIZ)

$w = .035(6'$ AVG HT$) + .06 = .27^k/'$

$M_u = .27\frac{(11)^2}{8}(1.6) = 6.5^k/'$

$d = 6"$
$b = 12$
$f'_c = 2500$ psi
$f_y = 60$ ksi

$A_s = .25$ in²/ft
USE #5's @ 12" O/C

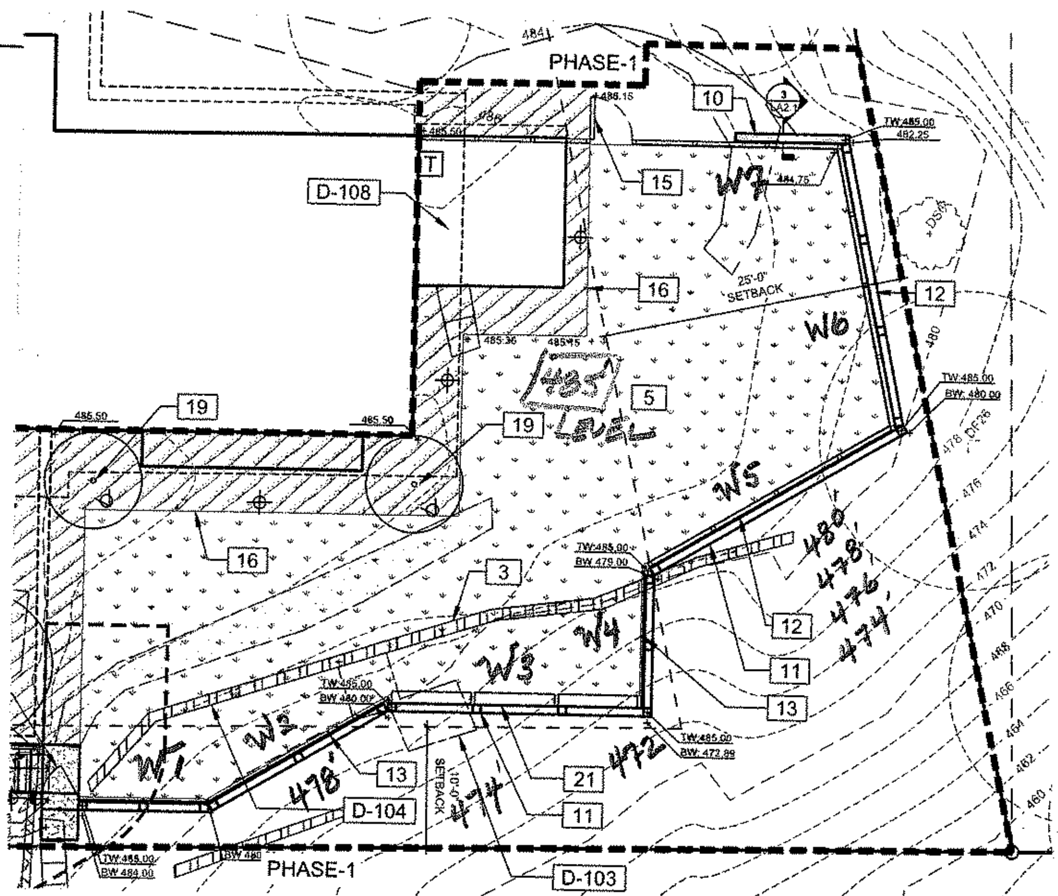
→ FOR STEEL CENTERED
$d = 4"$
$A_s = .41$ in²/ft
#5's @ 9
or #6's @ 12

BACK YARD SLOPE IS ACTIVE AND HOME OWNER IS INTERESTED IN STABILIZING SLOPE

AT THE LOWEST PT OF NEW WALL, GRADE IS AT ELEV 472'

AS WALL MOVES UP SLOPE, THE RETAINAGE IS REDUCED TO LESS THAN 2'

FOR HEIGHTS 6' AND HIGHER, TIEBACKS WILL BE PROVIDED TO RESIST ACTIVE PRESSURES.



GEOTECHNICAL CRITERIA

$P_{ACTIVE} = 35pcf$

$P_{PASSIVE} = 100pcf$ (AT DOWN HILL SLOPE)
250pcf (AT UPPER SLOPES < 4:1)

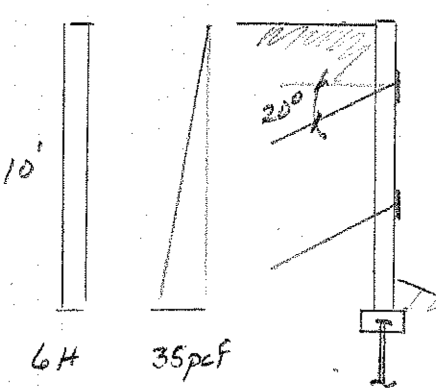
W3 CASE

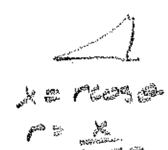
WALL FTG, SLOPES DOWN HILL

$H_{min} = 485 - 478 = 7'$
$H_{max} = 485 - 472 = 13'$ } 10' AVG

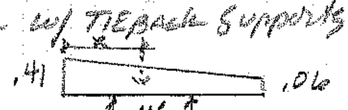
STRATEGY WILL BE TO PROVIDE (2) ROWS OF TIEBACKS

THE WALL IS TREATED LIKE A Bending member w/ TIEBACK Supports





CALCULATE x



$M = .06(10)(5) + .035(10)^3/6 = 8.83$

$x = \frac{8.83}{2.3} = 3.9'$ say 4'

FOR TOTAL LOAD DISTRIBUTED EQUALLY BOTT ROW OF TIEBACKS AT 2' ABOVE FTG

$P_{TOT} = .06(10) + .035(10)^2/2 = 2.3^k/'$ TIEBACKS @ 6' o/c max

$P_H/TIEBACK = \frac{2.3}{2}(6) = 6.9^k$ $\frac{P}{R} = \frac{6.9}{\cos 20} = 7.3^k$

$P_V = (7.3 \sin 20) - 2.5(2) = 5.0^k$

$P_{V_{TOT}} = 1.2^k/'_{WALL} + \frac{5^k}{6' o/c} = 2^k/'$

PROVIDE PILES @ 3' o/c MAX = $6^k \leq$ 3 TON

(NOTE: LOADS INCLUDE SEISMIC)

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PROJECT Maple Grove
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DESIGN
SHEET 2

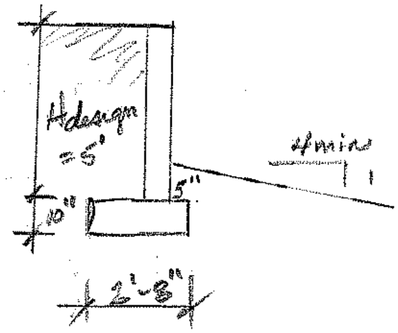
W6 CASE

$H_{AVG} \approx 4'$ (use 5' For Design)

Slope in Front of Wall is Approx 4:1

OKAY TO DESIGN WALL w/ PASSIVE RESISTANCE SUCH THAT TIEBACKS WILL NOT BE REQ'D

FOR DESIGN, FTG shall be buried 2" Below grade & FTG shall be DESIGNED FOR OVERTURNING RESISTANCE



$F_{ACTIVE} = .035(5)^2/2 = .44^k/'$

$F_{PASSIVE} = .25(2)^2/2 = .50^k/' \geq .44^k/'$ ✓

(NOTE ALSO THAT RETURN WALLS WILL PROVIDE ADD'L BUTTRESSING RESISTANCE) DESIGN OKAY w/ FTG Embedment!

$M_{OT} = .035(6)^3/6 = 1.26^{k'}/'$

$P_{soil} = 5(1.6)(.12) = 1^k/'$

$P_{WALL} = .1(5) = .5$

$P_{FTG} = .125(2.7) = .33$

$1.83^k/'$

$M_R = 1(1.87) + .5(.7) + .33(1.33) = 2.66^{k'}/'$ $FS = \frac{2.66}{1.26} = 2.1$ ✓

$P_{TOT} = 1.83^k/'$

2"φ PILES @ 3' o/c max $P = 1.8(3) = 5.4^k \leq 3$ TON

Check max Steel req'D in Wall

$M_u = .035(5)^3/6(1.6) = 1.2$ in^k/ft

$d = 4"$ (centered)

$As_{req'D} = .07$ in^2/ft

#5's @ 18" o/c $A_s = .2$

PROJECT Maple Grove

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DESIGN [illegible]

SHEET 3

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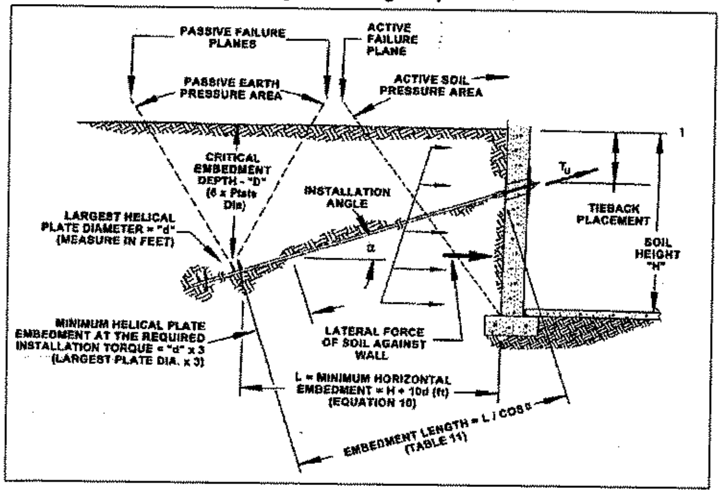
Helical Torque Anchor Tieback Design In Cohesive Soils

Helical anchors installed in cohesive soils with internal friction angles near zero, generally fine grained clay soils, develop capacity related to undrained shear strength according to equation 1a:



Equation 1a
Ultimate Capacity - Cohesive Soil
P_u or $T_u = \Sigma A_H$ (9c) or $\Sigma A_H = P_u$ or T_u / (9c)

Table 5. Properties of Cohesive Soil			
Soil Density Description	SPT Blow Count - "N"	Undrained Shear Strength "c" - lb/ft²	Unconfined Compressive Strength lb/ft²
Very Soft	0 – 2	< 250	< 500
Soft	2 – 4	250–500	500—1,000
Firm	4 – 8	500–1,000	1,000—2,000
Stiff	8 – 15	1,000–2,000	2,000—4,000
Very Stiff	15 – 32	2,000–4,000	4,000—8,000
Hard	32 – 48	4,000–6,000	8,000—12,000
Very Hard	> 48	> 6,000	> 12,000

Determine Undrained Shear Strength, c, from soils investigation and using table 5:

SOIL PROPERTIES

Undrained Shear Strength	c=	1500	lb/ft²
STP Blow Count	N=	6	

TIEBACK INSTALLATION:

Wall Type		Cantilevered Retaining Wall	
Backfill Condition		Level	
Approximate Backfill Incline Angle		0	°
Soil Height	H=	7	ft
Use Placement Depth	H_{PILE}=	4	ft
Use Installation Angle (From 5° to 30°)	α=	20	°
Use Embedment Length		19	ft
Horizontal Embedment	L=	17.9	ft
Minimum Horizontal Embedment	L_{min}=	17.0	ft
Check Critical Embedment Depth, "D"		OK	
Check Minimum Horizontal Embedment		OK	

TORQUE ANCHOR REQUIRED CAPACITY

Use Tieback Loading	10000	lbs
Desired Factor of Safety	2	
Required Ultimate Capacity = S.F. x Capacity= $Pu_{,RQD}$=	20000	lbs
Minimum Tieback Spacing (5 x d)	5.0	ft
Use Tieback Spacing	5	ft
Loading Condition (Compression, Tension, Bot	Tension	
Try Helical Lead Section:	*TAF-150.84 (8-10-12)	

CHECK ESTIMATED INSTALLATION TORQUE:

Empirical Torque Factor, k	k=	10.0	
Estimated Installation Torque, T = ($Pu_{,RQD}$)/k	T=	2000	ft-lb
Section Usable Torsional Strength=	Ta=	5500	ft-lb
Section Installation Torque Check	TA>1.1T	OK	

CHECK SECTION LOAD LIMITS:

Section Ultimate Tension Strength	$Tu_{,Max}$=	60000	lbs
Tension Strength Check	$Tu_{,Max}>Tu_{,RQD}$	OK	

CHECK LEAD SECTION ULTIMATE SOIL CAPACITY:

Plate Projected Area	Ah=	1.63	ft²
Ultimate Capacity of Anchor	Tu=	22046	lbs
Soils Capacity Check	$Tu>Tu_{,RQD}$	OK	

CHECK HELICAL PLATE CAPACITY:

Ultimate Plate Capacity /Plate		30,000	lbs
Lead Section Number of Plates		3	Plates
Total Helical Plate Ultimate Strength	$Tu_{,Plates}$	90000	lbs
Plate Strength Check	$Tu_{,Plates}>Tu_{,RQD}$	OK	

TIEBACK DESIGN SUMMARY:	
Soils Capacity Check	OK
Section Installation Torque Check	OK
Tension Check	OK
Plate Strength Check	OK
Critical Embedment Depth	OK
Minimum Horizontal Embedment	OK
Minimum Tieback Spacing	OK

Maple Grove

10/4/19

4