บทที่5

ผลการศึกษา

5.1 ข้อดี ข้อเสีย ทฤษฎีของ Terzaghi , ทฤษฎีของ Meyerhoft

การศึกษาทฤษฎีของ Terzaghi

ข้อดี

- ในการคำนวณจะให้ค่าที่ปลอดภัยในการออกแบบเพราะไม่คิดแรงเสียดทานของดิน

ข้อเสีย

- ไม่สามารถวิเคราะห์และออกแบบฐานรากตื้นสี่เหลี่ยมพืนผ้าได้
- ไม่สามารถวิเคราะห์และออกแบบฐานรากตื้นที่มีแรงกระทำเยื้องศูนย์ได้
- ไม่สามารถวิเคราะห์และออกแบบฐานรากตื้นที่มีแรงกระทำในแนวเอียงได้

การศึกษาทฤษฎีของ Meyerhoft

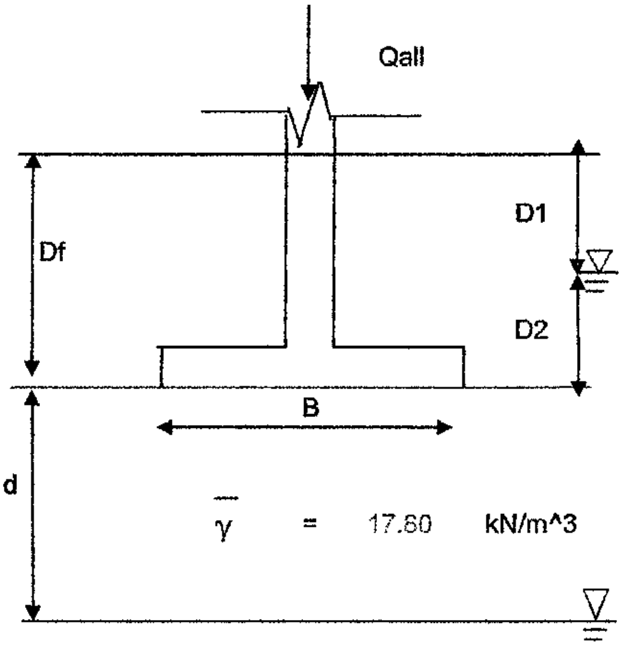
ข้อดี

- สามารถวิเคราะห์และออกแบบฐานรากตื้นได้ทุกชนิด
- สามารถวิเคราะห์และออกแบบฐานรากตื้นที่มีแรงกระทำเยื้องศูนย์ได้
- สามารถวิเคราะห์และออกแบบฐานรากตื้นที่มีแรงกระทำในแนวเอียงได้
- ประหยัดค่าก่อสร้าง

ข้อเสีย

- จะคิดแรงเสียดทานของดินที่อยู่ด้านบนฐานรากด้วยจะทำให้ได้การคำนวณการรับแรงจากโครงสร้างมากกว่าทฤษฎีของ Terzaghi จึงมีค่าความปลอดภันน้อยกว่า

5.2ตัวอย่างของผลการศึกษา



Groundwater table

γ_{dry}	=	0	kN/m^3
γ_T	=	17.8	kN/m^3
γ_{sat}	=	0	kN/m^3
γ_w	=	9.81	kN/m^3

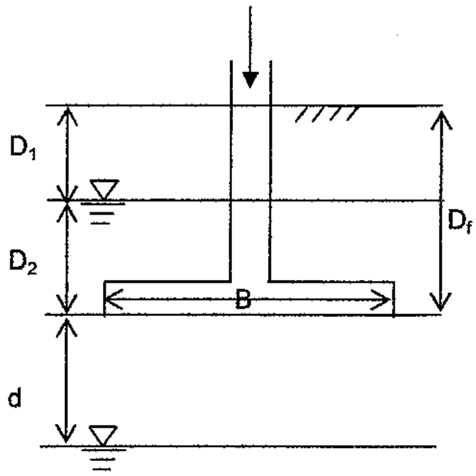
γ_{dry}	=	0	kN/m^3
γ_T	=	17.8	kN/m^3
γ_{sat}	=	0	kN/m^3

Groundwater table

ใส่หน่วย	3	1	T	ชนิดของฐานราก	2	
		2	lb	1	continuous foundation (strip)	
		3	kN	2	square foundation	
		4	N	3	circular foundation	

FS	=	4		Df	=	1	m
D1	=	1	m	q	=	17.8	kN/m^2
D2	=	0	m	Nc	=	6.00	
d	=	10	m	Nq	=	1.10	
B	=	1.5	m	Nr	=	0.01	
L	=	1.5	m	qu	=	138.2468	kN/m^2
C′	=	15.2	N/m	qall		34.56	kN/m^2
Ø	=	1	°	Qall		77.76	kN

φ'	Nc	Nq	N_r	φ'	Nc	Nq	N_r
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60
2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.25	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44000	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				



γ_{dry}	=	0	T/m^3	FS	=	4				
γ_T	=	1.7	T/m^3	C'	=	2	T/m^2	$\frac{D_f}{B} = \left(\frac{1}{2}\right)$		
γ_{sat}	=	0	T/m^3	D_1	=	1	m			
γ_w	=	1	T/m^3	D_2	=	0	m	=	0.5	
γ_{dry}	=	0	T/m^3	d	=	2	m	ใส่หน่วย 1	1	T
γ_T	=	1.7	T/m^3	B	=	2	m		2	lb
γ_{sat}	=	0	T/m^3	D_f	=	1	m		3	kN
ø	=	30							4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega})) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (\;\; 0 \; - \;\; 1 \;\;) + \left(\frac{2}{2}\right) \text{x} \;\; 0 \; - (\; 1.7 \; - \;\; 1 \;\;)) \quad \text{T/m\^{}3}$$

$$\bar{\gamma} = 1.7 \quad \text{T/m\^{}3}$$

$$q_u = c'N_c + qN_q + \frac{1}{2}\gamma B N_\gamma$$

$$= (\; 2 \;\; \text{X} \;\; 37.16) + (\; 1.7 \;\; \text{X} \;\; 22.46) + (\frac{1}{2} \;\; 1.7 \;\; \text{X} \;\; 2 \;\; \text{X} \;\; 19.13)$$

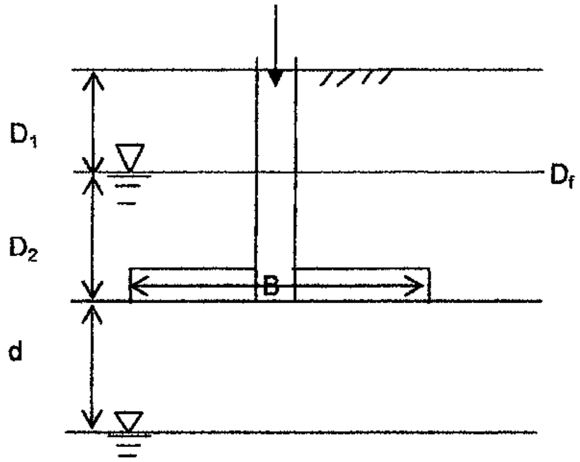
$$= 145.0 \quad \text{T/m\^{}2}$$

$$q_{all} = \frac{q_u}{FS}$$

$$= \left(\frac{145.0}{4}\right)$$

$$= 36.3 \quad \text{T/m\^{}2}$$

จงหาค่าความสามารถ ในการรับน้ำหนักบรรทุกปลอดภัยโดยสุดธิของดินรองรับฐานรากตื้น เมื่อกำหนดให้ ฐานรากมีขนาด 2 x 2 ม. ความลึกของฐานราก 1 ม. ระดับน้ำใต้ดินเท่ากับ 10 ม. unit weight = 1.8 t/m^2,angle Friction = 20 และค่า Cohesion = 2 t/m^2 F.s. =2.5



γ_{dry}	=	0	T/m^3	FS	=	2.5		C' =	2	T/m^2		
γ_T	=	1.8	T/m^3	D_1	=	1	m	$\frac{D_f}{B}=\left(\frac{1}{2}\right)$				
γ_{sat}	=	0	T/m^3	D_2	=	0	m					
γ_w	=	1	T/m^3	d	=	10	m	=	0.5			
γ_{dry}	=	0	T/m^3	B	=	2	m	ใส่หน่วย		1	1	T
γ_T	=	1.8	T/m^3	L	=	2	m				2	lb
γ_{sat}	=	0	T/m^3	D_f	=	1	m				3	kN
ø	=	20									4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_w) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_w)) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (0 - 1) + \left(\frac{2}{2}\right) \times (1.8 - (0 - 1)) \quad \text{T/m^3}$$

$$\bar{\gamma} = 1.8 \quad \text{T/m^3}$$

$$q_u = 1.3c'N_c + qN_q + 0.4\gamma BN_\gamma$$

= (1.3 X 2 X 17.69)+ (1.8 X 7.44 + (0.4 X 1.8 X 2 X 3.64)

= 67.2 T/m^2

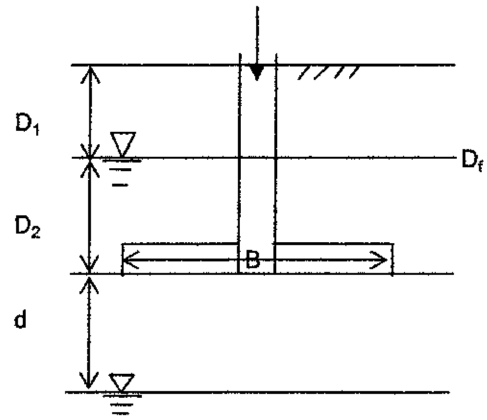
$$q_{all} = \frac{q_u}{FS} = \left(\frac{67.2}{2.5}\right) = 26.9 \quad \text{T/m^2}$$

$Q_{all} = q_{all} \times B \times L$

= 26.9 X 2 X 2

= 107.6 T

จงออกแบบฐานรากตื้นสี่เหลี่ยมจัตุรัสให้สามารถ ในการรับน้ำหนักบรรทุกปลอดภัย จากโครงสร้าง 100 ton. ความลึกของฐานราก 1 ม. ระดับน้ำใต้ดินเท่ากับ 10 ม. unit weight = 1.75 t/m^2,angle Friction = 20 และค่า Cohesion = 1.5 t/m^2 F.s. =2.5 และไม่มีการเยืองศูนย์



γ_{dry}	=	0	T/m^3	FS	=	2.5		C' =	1.5	T/m^2		
γ_T	=	1.85	T/m^3	D_1	=	1	m	$\frac{D_f}{B} = \left(\frac{1}{2}\right)$				
γ_{sat}	=	0	T/m^3	D_2	=	0	m					
γ_w	=	1	T/m^3	d	=	10	m	=	0.45455			
γ_{dry}	=	0	T/m^3	B	=	2	m		ใส่หน่วย	1	1	T
γ_T	=	1.75	T/m^3	L	=	2	m				2	lb
γ_{sat}	=	0	T/m^3	D_f	=	1	m				3	kN
ø	=	20									4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega})) \quad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (0 - 1) + \left(\frac{2.2}{2.2}\right) \times (1.75 - (0 - 1)) \text{ T/m\^3}$$

$$\bar{\gamma} = 1.75 \text{ T/m\^3}$$

$$q_u = 1.3 c' N_c + q N_q + 0.4 \gamma B N_\gamma$$

= (1.3 X 1.5 X 17.69)+ (1.85 X 7.44) + (0.4 X 1.75 X 2.2 X 3.64)

= 56.2 T/m^2

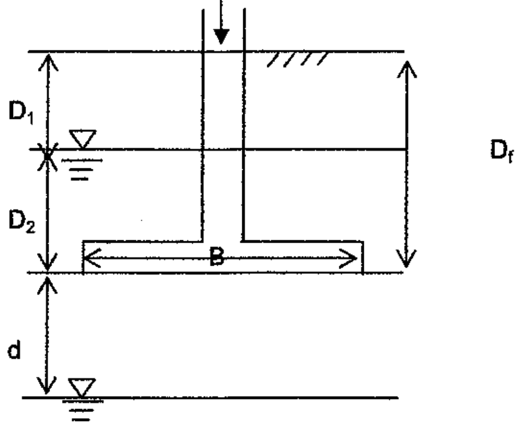
$$q_{all} = \frac{q_u}{FS} = \left(\frac{56.2}{2.5}\right) = 22.5 \text{ T/m\^2}$$

$$Q_{all} = q_{all} \times B \times L$$

= 22.5 X 2.2 X 2.2

= 108.9 T

จงออกแบบฐานรากตื้นวงกลมให้สามารถรับน้ำหนักบรรทุกปลอดภัยจากโครงสร้าง100 ton ความลึกของฐานรากของฐานราก 3 ม. ระดับน้ำใต้ดินเท่ากับ 2 ม. Unit weight = 1.7t/m^2 Angle Friction = 20 F.S. = 3 w,j,udkigpnhv'L^opN



γ_{dry} =	0	T/m^3	FS =	4		C' =	15.2	T/m^2			
γ_T =	1.7	T/m^3	D_1 =	2	m	$\frac{D_f}{B} = \left(\frac{3}{1}\right)$					
γ_{sat} =	0	T/m^3	D_2 =	1	m						
γ_w =	1	T/m^3	d =	1.5	m	=	3				
γ_{dry} =	0	T/m^3	B =	1	m	ใส่หน่วย	1		1	T	
γ_T =	1.7	T/m^3							2	lb	
γ_{sat} =	0	T/m^3	D_f =	3	m				3	kN	
ø =	25								4	N	

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega})) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (0 - 1) + \left(\frac{1}{1}\right) \times (1.7 - (0 - 1)) \text{ T/m^3}$$

$$\bar{\gamma} = 1.7 \text{ T/m^3}$$

$$q_u = 1.3c'N_c + qN_q + 0.3\gamma BN_\gamma$$

$$= (1.3 \times 15.2 \times 25.13) + (2.4 \times 12.72) + (0.3 \times 1.7 \times 1 \times 8.34)$$

$$= 538.4 \text{ T/m^2}$$

$$q_{all} = \frac{q_u}{FS}$$

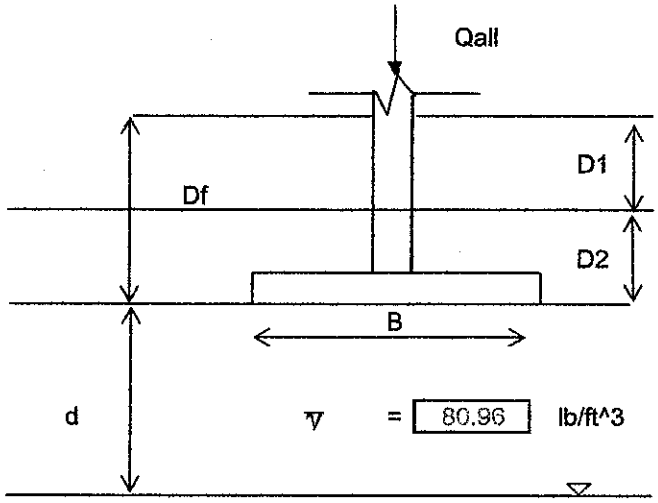
$$= \left(\frac{538.4}{4}\right)$$

$$= 134.6 \text{ T/m^2}$$

$$Q_{all} = q_u \times \frac{\pi B^2}{4}$$

$$= 105.7 \text{ T/m^2}$$

Ex1 For the column foundation shown in Figure , determine the gross allowable load Qall , Use FS=4



Groundwater table			
γ_{dry}	=	100	lb/ft^3
γ_T	=	110	lb/ft^3
γ_{sat}	=	124	lb/ft^3
w	=	62.4	lb/ft^3
γ_{dry}	=	100	lb/ft^3
γ_T	=	110	lb/ft^3
γ_{sat}	=	124	lb/ft^3
Groundwater table			

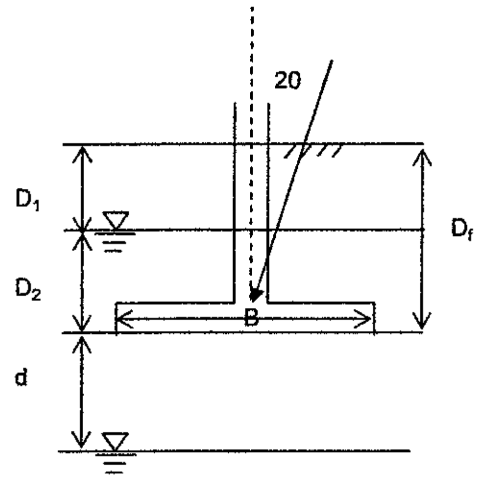
หน่วย	2	1	T
		2	lb
		3	kN
		4	N

β °	=	10	°	Nc	=	22.25	
FS	=	4	ft	Nq	=	11.85	
D1	=	3	ft	Nr	=	12.54	
D2	=	0	ft	Fcs	=	1.53	
d	=	2	ft	Fqs	=	1.49	
B	=	5	ft	Frs	=	0.6000	
L	=	5	ft	Fcd	=	1.24	
C′	=	400	lb/ft^2	Fqd	=	1.1846	
Ø	=	26	°	Frd	=	1.00	
Df	=	3	ft	Fci	=	0.79	
q	=	330	lb/ft^2	Fqi	=	0.79	
eB	=	0	ft	Fri	=	0.38	
eL	=	0	ft	qu	=	19391.2	lb/ft^2
B′	=	5	ft	qall	=	4847.8	lb/ft^2
L′	=	5	ft	Qall	=	121194.8	lb
B′	=	5	ft				
L′	=	5	ft				

Ø	Nc	Nq	N r
0	0.00	1.00	0.00
1	5.38	1.09	0.07
2	5.63	1.20	0.15
3	5.90	1.31	0.24
4	6.19	1.43	0.34
5	6.49	1.57	0.45
6	6.81	1.72	0.57
7	7.16	1.88	0.71
8	7.53	2.06	0.86
9	7.92	2.25	1.03
10	8.34	2.47	1.22
11	8.80	2.71	1.44
12	9.28	2.97	1.69
13	9.81	3.26	1.97
14	10.37	3.59	2.29
15	10.98	3.94	2.65
16	11.63	4.34	3.06
17	12.34	4.77	3.53
18	13.10	5.26	4.07
19	13.93	5.80	4.68
20	14.83	6.40	5.39
21	15.81	7.07	6.20
22	16.88	7.82	7.13
23	18.05	8.66	8.20
24	19.32	9.60	9.44
25	20.72	10.66	10.88
26	22.25	11.85	12.54

Ø	Nc	Nq	N r
27	23.94	13.20	14.47
28	25.80	14.72	16.72
29	27.86	16.44	19.34
30	30.14	18.40	22.40
31	32.67	20.63	25.99
32	35.49	23.18	30.21
33	38.64	26.09	35.19
34	42.16	29.44	41.06
35	46.12	33.30	48.03
36	50.59	37.75	56.31
37	55.63	42.92	66.19
38	61.35	48.93	78.02
39	67.87	55.96	92.25
40	75.31	64.20	109.41
41	83.86	73.90	130.21
42	93.71	85.37	155.54
43	105.11	99.01	186.53
44	118.37	115.31	224.63
45	133.87	134.87	271.75
46	152.10	158.50	330.34
47	173.64	187.21	403.65
48	199.26	222.30	496.00
49	229.92	265.50	613.14
50	266.88	319.06	762.86
51	311.75	385.98	955.77
52	366.66	470.30	1206.48
53	434.42	577.50	1535.38

ex 2 A square column foundation has to carry a gross allowable total mass of 15290 kg. 3. The depth of the foundation is 0.7 m. The load is inclined at an angle of 20 to the vertical. Determine the width of the foundation, B use factor of safety of 3.



γ_{dry}	=	18	kN/m^3	FS	=	3		eB	=	0.00	m	C' =		0		kN/m^2	
γ_T	=	18	kN/m^3	β	=	20		eL	=	0	m						
γ_{sat}	=	18	kN/m^3	D_1	=	0.7	m	B'	=	1.3	- (2 x 0)	$\frac{D_f}{B}=\left(\frac{1}{1}\right)$					
γ_w	=	9.81	kN/m^3	D_2	=	0	m	B'	=	1.3	m			= 0.53846			
γ_{dry}	=	18	kN/m^3	d	=	1.3	m	L'	=	1.3	- (2 x 0.00)						
γ_T	=	18	kN/m^3	B	=	1.3	m	L'	=	1.3	m	ใส่หน่วย	3	1	T		
γ_{sat}	=	18	kN/m^3	L	=	1.3	m	B'	=	1.3				2	lb		
ø	=	30		D_f	=	0.7	m	L'	=	1.3	m			3	kN		
														4	N		

$$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega)) \quad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (18 - 9.8) + \left(\frac{1.3}{1.3}\right) \times (18 - (18 - 9.81)) \text{ kN/m^3}$$

$\bar{\gamma}$ = 18 kN/m^3

$$N_q = \tan^2(45 + \frac{\phi'}{2})e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$= \tan^2(45 + \frac{30}{2})e^{\pi \tan 30} \qquad = (18.40 - 1) \cot 30 \qquad = 2(18.4 + 1) \tan 30$$

$$= 18.40 \qquad = 30.14 \qquad = 22.40$$

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

$$= 1 + \left(\frac{1.3}{1.3}\right)\left(\frac{18.4}{30.1}\right) \qquad = 1 + \left(\frac{1}{1}\right)\tan\ 30 \qquad = 1 - 0.4\left(\frac{1}{1}\right)$$

$$= 1.611 \qquad = 1.577 \qquad = 0.600$$

$$\frac{D_f}{B} \le 1$$

$$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2\frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$= 1 + 0.4\left(\frac{0.7}{1.3}\right) \qquad = 1 + 2\tan 30\,(1-\sin 30)^2\left(\frac{0.7}{1.3}\right)$$

$$= 1.21538 \qquad = 1.1554$$

$$\frac{D_f}{B} > 1$$

$$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F\gamma = 1$$

$$= 1 + 0.4\tan^{-1}\left(\frac{0.7}{1.3}\right) \qquad = 1 + 2\tan\ 30\,(1-\sin\ 30\ )^2\tan\left(\frac{0.7}{1.3}\right)$$

$$= 1.198 \qquad = -24.009$$

$$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2 \qquad F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$$

$$= \left(1-\left(\frac{20}{90}\right)\right)^2 = 0.6 \qquad = \left(1-\left(\frac{20}{30}\right)\right)^2 = 0.11$$

$$q_u = c'N_c F_{cs} F_{cd} F_{ci} + qN_q F_{qs} F_{qd} F_{qi} + \frac{1}{2}\gamma B' N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

$c'N_c F_{cs} F_{cd} F_{ci}$	=	0	x	30.1	x	1.61	x	1.22	x	1	=	0
$qN_q F_{qs} F_{qd} F_{qi}$	=	12.6	x	18.4	x	1.58	x	1.2	x	1	=	255.624
$\frac{1}{2}\gamma B' N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$	= $\frac{1}{2}$	18	x	1.3	x	22.4	x	0.6	x	1 x 0	=	17.47

q_u = 0 + 255.62 + 17.47

= 273.1 kN/m^2

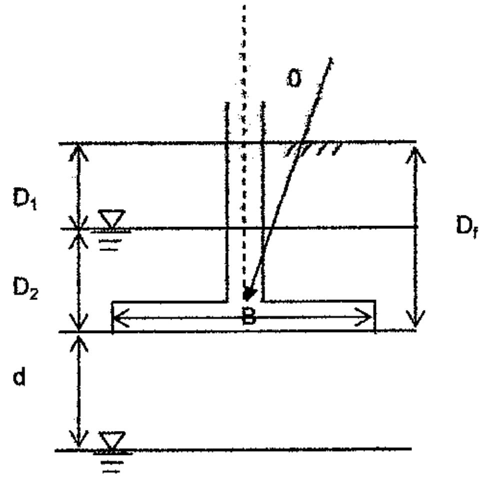
$q_{all} = \frac{q_u}{FS}$ = $\frac{273.1}{3}$ = 91.0 kN/m^2

$Q_{all} = q_{all \times B' \times L'}$ = 91.03 X 1.3 X 1.3

= 153.8 kN

An eccentrically loaded foundation is shown in figure

Ditermine capacity,shape,and depthfactor



γ_{dry} = 0 lb/ft^3 FS = 3 eB = 0.50 ft C' = 400 lb/ft^2

γ_T = 105 lb/ft^3 β = 0 eL = 0 ft $\frac{D_f}{B} = \left(\frac{4}{5}\right)$

γ_{sat} = 118 lb/ft^3 D_1 = 2 ft B' = 5 - (2 x 0.5)

γ_w = 62.4 lb/ft^3 D_2 = 2 ft B' = 4 ft = 0.8

γ_{dry} = 0 lb/ft^3 d = 0 ft L' = 6 - (2 x 0.00)

γ_T = 105 lb/ft^3 B = 5 ft L' = 6 ft ใส่หน่วย 2 1 T

γ_{sat} = 118 lb/ft^3 L = 6 ft B' = 4 2 lb

ø = 25 D_f = 4 ft L' = 6 ft 3 kN

$$\bar{\gamma} = (\gamma_{sat} - \gamma_w) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_w)) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$ 4 N

$\bar{\gamma}$ = (118 - 62.4) + $\left(\frac{0}{5}\right)$ x (105 - (118 - 62.4)) lb/ft^3

$\bar{\gamma}$ = 55.6 lb/ft^3

$$N_q = \tan^2(45 + \frac{\phi'}{2})e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$= \tan^2(45 + \frac{25}{2})e^{\pi \tan 25}$ $= (10.66 - 1) \cot 25$ $= 2(10.7 + 1) \tan 25$

= 10.66 = 20.72 = 10.88

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

$= 1 + \left(\frac{4}{6}\right)\left(\frac{10.7}{20.7}\right)$ $= 1 + \left(\frac{4}{6}\right)\tan 25$ $= 1 - 0.4\left(\frac{4}{6}\right)$

= 1.343 = 1.311 = 0.733

$$\frac{D_f}{B} \leq 1$$

$$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right)$$

$$= 1 + 0.4\left(\frac{4}{5}\right)$$

$$= 1.32$$

$$F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2 \frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$= 1 + 2\tan 25\,(1-\sin 25)^2\left(\frac{4}{5}\right)$$

$$= 1.2487$$

$$\frac{D_f}{B} > 1$$

$$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right)$$

$$= 1 + 0.4\tan^{-1}\left(\frac{4}{5}\right)$$

$$= 1.270$$

$$F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F\gamma = 1$$

$$= 1 + 2\tan 25\,(1-\sin 25)^2\tan^{-1}\left(\frac{4}{5}\right)$$

$$= 0.76895$$

$$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2$$

$$= \left(1-\left(\frac{0}{90}\right)\right)^2 = 1$$

$$F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$$

$$= \left(1-\left(\frac{0}{25}\right)\right)^2 = 1.00$$

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$c'N_cF_{cs}F_{cd}F_{ci}$ = 400 x 20.7 x 1.34 x 1.32 x 1 = 14693.5

$qN_qF_{qs}F_{qd}F_{qi}$ = 321 x 10.7 x 1.31 x 1.2 x 1 = 5605.92

$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$ = $\frac{1}{2}$ 55.6 x 4 x 10.9 x 0.73 x 1 x 1 = 886.93

q_u = 14693.5 + 5605.92 + 886.93

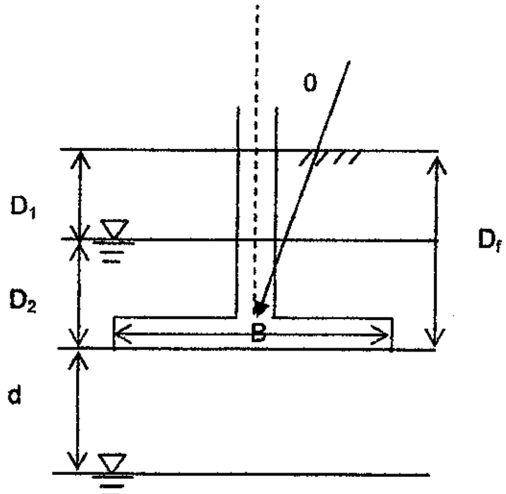
= 21186.4 lb/ft^2

$q_{all} = \frac{q_u}{FS} = \frac{21186.4}{3}$ = 7062.1 lb/ft^2

$Q_{all} = q_{all \times B' \times L'}$ = 7062.12 X 4 X 6

= 169490.9 lb

A square foundation (B x B) has to be constructed as shown in Figure Assume that .
.The gross allowable load , $\gamma = 105 lb/ft^3, \gamma_{sat} = 118 lb/ft^3, D_1 = 2 ft$
Q_{all} , With FS = 3 is 150,000 lb. The standard penetration resistance,



γ_{dry} = 105	lb/ft^3	FS = 3		eB = 0.00 ft		C' = 0	lb/ft^2
γ_T = 105	lb/ft^3	β = 0		eL = 0 ft		$\frac{D_f}{B} = \left(\frac{4}{5}\right)$	
γ_{sat} = 118	lb/ft^3	D_1 = 2	ft	B' = 4.5 - (2 x 0)			
γ_w = 62.4	lb/ft^3	D_2 = 2	ft	B' = 4.5 ft		= 0.88889	
γ_{dry} = 105	lb/ft^3	d = 4.5	ft	L' = 4.5 - (2 x 0.00)			
γ_T = 105	lb/ft^3	B = 4.5	ft	L' = 4.5 ft	ใส่หน่วย 2	1	T
γ_{sat} = 118	lb/ft^3	L = 4.5	ft	B' = 4.5		2	lb
ø = 34		D_f = 4	ft	L' = 4.5 ft		3	kN

$$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega)) \quad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T \qquad 4 \quad N$$

$$\bar{\gamma} = (118 - 62.4) + \left(\frac{4.5}{4.5}\right) \times (105 - (118 - 62.4)) \text{ lb/ft^3}$$

$\bar{\gamma}$ = 105 lb/ft^3

$$N_q = \tan^2(45 + \frac{\phi'}{2}) e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$= \tan^2(45 + \frac{34}{2}) e^{\pi \tan 34} \qquad = (29.44 - 1)\cot 34 \qquad = 2(29.4 + 1)\tan 34$$

$$= 29.44 \qquad = 42.16 \qquad = 41.06$$

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

$= 1+\left(\frac{4.5}{4.5}\right)\left(\frac{29.4}{42.2}\right)$ $\quad = 1+\left(\frac{5}{5}\right)\tan\ 34$ $\quad =1-0.4\left(\frac{5}{5}\right)$

$= 1.698$ $\quad = 1.675$ $\quad = 0.600$

$\frac{D_f}{B} \le 1$

$F_{cd} = 1+0.4\left(\frac{D_f}{B}\right)$ $\quad F_{qd} = 1+2\tan\phi'(1-\sin\phi')^2\frac{D_f}{B}$ $\quad F_{\gamma d} = 1$

$= 1+0.4\left(\frac{4}{4.5}\right)$ $\quad = 1+2\tan 34\ (1-\sin\ 34)^2\left(\frac{4}{4.5}\right)$

$= 1.35556$ $\quad = 1.2330$

$\frac{D_f}{B} > 1$

$F_{cd} = 1+0.4\tan^{-1}\left(\frac{D_f}{B}\right)$ $\quad F_{qd} = 1+2\tan\ \phi'(1-\sin\ \phi')^2\ \tan^{-1}\left(\frac{D_f}{B}\right)$ $\quad F\gamma = 1$

$= 1+0.4\tan^{-1}\left(\frac{4}{4.5}\right)$ $\quad = 1+2\tan\ 34\ (1-\sin\ 34)^2\tan^{-1}\left(\frac{4}{4.5}\right)$

$= 1.291$ $\quad = 0.79906$

$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2$ $\quad F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$

$= \left(1-\left(\frac{0}{90}\right)\right)^2 = 1$ $\quad = \left(1-\left(\frac{0}{34}\right)\right)^2 = 1.00$

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$c'N_cF_{cs}F_{cd}F_{ci}$	=	0	x	42.2	x	1.70	x	1.36	x	1		=	0
$qN_qF_{qs}F_{qd}F_{qi}$	=	321	x	29.4	x	1.67	x	1.2	x	1		=	19523.7
$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$	=	$\frac{1}{2}$ 105	x	4.5	x	41.1	x	0.6	x	1 x	1	=	5820.79

$= 1+\left(\frac{4.5}{4.5}\right)\left(\frac{29.4}{42.2}\right)$ $= 1+\left(\frac{5}{5}\right)\tan 34$ $=1-0.4\left(\frac{5}{5}\right)$

$= 1.698$ $= 1.675$ $= 0.600$

$\frac{D_f}{B} \le 1$

$F_{cd} = 1+0.4\left(\frac{D_f}{B}\right)$ $F_{qd} = 1+2\tan\phi'(1-\sin\phi')^2\frac{D_f}{B}$ $F_{\gamma d} = 1$

$= 1+0.4\left(\frac{4}{4.5}\right)$ $= 1+2\tan 34\,(1-\sin 34)^2\left(\frac{4}{4.5}\right)$

$= 1.35556$ $= 1.2330$

$\frac{D_f}{B} > 1$

$F_{cd} = 1+0.4\tan^{-1}\left(\frac{D_f}{B}\right)$ $F_{qd} = 1+2\tan\phi'(1-\sin\phi')^2\tan^{-1}\left(\frac{D_f}{B}\right)$ $F\gamma = 1$

$= 1+0.4\tan^{-1}\left(\frac{4}{4.5}\right)$ $=1+2\tan 34\,(1-\sin 34)^2\tan^{-1}\left(\frac{4}{4.5}\right)$

$= 1.291$ $= 0.79906$

$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2$ $F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$

$= \left(1-\left(\frac{0}{90}\right)\right)^2 = 1$ $=\left(1-\left(\frac{0}{34}\right)\right)^2 = 1.00$

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$c'N_cF_{cs}F_{cd}F_{ci}$	=		0	x	42.2	x	1.70	x	1.36	x	1		=	0
$qN_qF_{qs}F_{qd}F_{qi}$	=		321	x	29.4	x	1.67	x	1.2	x	1		=	19523.7
$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$	=	$\frac{1}{2}$	105	x	4.5	x	41.1	x	0.6	x	1 x	1	=	5820.79

q_u = 13367.2 + 5447.32 + 576.65

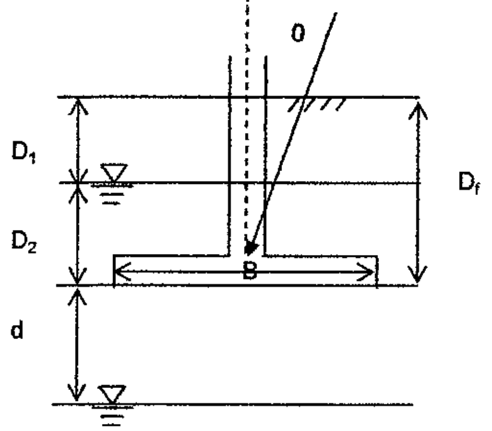
= 19391.2 lb/ft^2

$q_{all} = \frac{q_u}{FS}$ = $\frac{19391.2}{4}$ = 4847.8 lb/ft^2

$Q_{all} = q_{all \times B' \times L'}$ = 4847.79 X 5 X 5

= 121194.8 lb

For a square foundation, $D_f = 2m, \gamma = 16.5 kN/m^3, \phi' = 30°, c' = 0$
,gross allowable load Q_{all} =3,330 kN,and FS = 4.
Determine the size of the foundation and the bearing capacity, shape,and depth factors



γ_{dry} = 0 kN/m^3	FS = 4	eB = 0.00 m	C' = 0 kN/m^2	
γ_T = 16.5 kN/m^3	β = 0	eL = 0 m	$\frac{D_f}{B} = \left(\frac{2}{3}\right)$	
γ_{sat} = 0 kN/m^3	D_1 = 2 m	B' = 3.02 - (2 x 0)		
γ_w = 9.81 kN/m^3	D_2 = 0 m	B' = 3.02 m	= 0.66225	
γ_{dry} = 0 kN/m^3	d = 10 m	L' = 3.02 - (2 x 0.00)		
γ_T = 16.5 kN/m^3	B = 3.02 m	L' = 3.02 m	ใส่หน่วย 3	1 T
γ_{sat} = 0 kN/m^3	L = 3.02 m	B' = 3.02		2 lb
ø = 30	D_f = 2 m	L' = 3.02 m		3 kN

$$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega)) \quad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$ 4 N

$$\bar{\gamma} = (0 - 9.81) + \left(\frac{10}{3.02}\right) \times (16.5 - (0 - 9.81)) \text{kN/m}^3$$

$$\bar{\gamma} = 16.5 \text{ kN/m}^3$$

$$N_q = \tan^2(45 + \frac{\phi'}{2}) e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$= \tan^2(45 + \frac{30}{2}) e^{\pi \tan 30} \qquad = (18.40 - 1) \cot 30 \qquad = 2(18.4 + 1)\tan 30$$

$$= 18.40 \qquad = 30.14 \qquad = 22.40$$

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

$$= 1 + \left(\frac{3.02}{3.02}\right)\left(\frac{18.4}{30.1}\right) \qquad = 1 + \left(\frac{3}{3}\right)\tan 30 \qquad = 1 - 0.4\left(\frac{3}{3}\right)$$

$$= 1.611 \qquad = 1.577 \qquad = 0.600$$

$$\frac{D_f}{B} \leq 1$$

(D_f) . . D_f

$\frac{D_f}{B} \leq 1$

$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right)$ $\quad$ $F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2 \frac{D_f}{B}$ $\quad$ $F_{\gamma d}$ = 1

$= 1 + 0.4 \left(\frac{2}{3.02}\right)$ $\quad$ $= 1 + 2\tan 30\,(1-\sin\,30)^2\left(\frac{2}{3.02}\right)$

= 1.2649 $\quad$ = 1.1912

$\frac{D_f}{B} > 1$

$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right)$ $\quad$ $F_{qd} = 1 + 2\tan\,\phi'(1-\sin\,\phi')^2\,\tan^{-1}\left(\frac{D_f}{B}\right)$ $\quad$ Fγ = 1

$= 1 + 0.4\tan^{-1}\left(\frac{2}{3.02}\right)$ $\quad$ $=1 + 2\tan\;30\;(1-\sin\;30\,)^2\tan^{-1}\left(\frac{2}{3.02}\right)$

= 1.234 $\quad$ = -28.6162

$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2$ $\quad$ $F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$

$= \left(1-\left(\frac{0}{90}\right)\right)^2$ = 1 $\quad$ $=\left(1-\left(\frac{0}{30}\right)\right)^2$ = 1.00

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$c'N_cF_{cs}F_{cd}F_{ci}$	=	0	x	30.1	x	1.61	x	1.26	x	1				=	0
$qN_qF_{qs}F_{qd}F_{qi}$	=	33	x	18.4	x	1.58	x	1.2	x	1				=	1140.94
$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$	=	$\frac{1}{2}$ 16.5	x	3.02	x	22.4	x	0.6	x	1	x	1	=		334.89

q_u = 0 + 1140.94 + 334.89

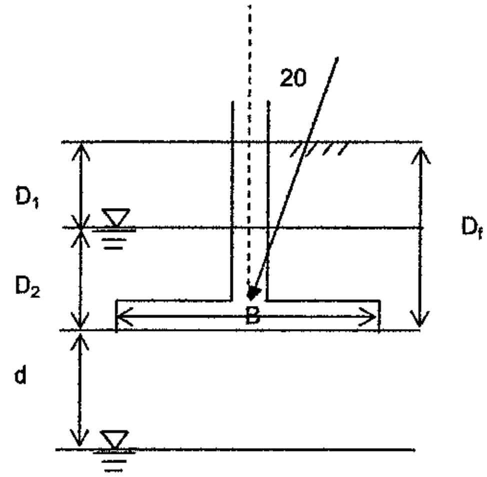
= 1475.8 kN/m^2

$q_{all} = \frac{q_u}{FS}$ = $\frac{1475.8}{4}$ = 369.0 kN/m^2

$Q_{all} = q_{all \times B' \times L'}$ = 368.96 X 3.02 X 3.02

= 3365.0 kN

ex 2 A square column foundation has to carry a gross allowable total mass of 15290 kg. 3.
The depth of the foundation is 0.7 m. The load is inclined at an angle of 20 to the vertical.
Determine the width of the foundation, B use factor of safety of 3.



γ_{dry} = 18 kN/m^3	FS = 3	eB = 0.00 m	C' = 0 kN/m^2
γ_T = 18 kN/m^3	β = 20	eL = 0 m	$\frac{D_f}{B} = \left(\frac{1}{1}\right)$
γ_{sat} = 18 kN/m^3	D_1 = 0.7 m	B' = 1.3 - (2 x 0)	
γ_w = 9.81 kN/m^3	D_2 = 0 m	B' = 1.3 m	= 0.53846
γ_{dry} = 18 kN/m^3	d = 1.3 m	L' = 1.3 - (2 x 0.00)	
γ_T = 18 kN/m^3	B = 1.3 m	L' = 1.3 m	ใส่หน่วย 3 1 T
γ_{sat} = 18 kN/m^3	L = 1.3 m	B' = 1.3	2 lb
ø = 30	D_f = 0.7 m	L' = 1.3 m	3 kN
			4 N

$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega))$; $d \geq B \Rightarrow \bar{\gamma} = \gamma_T$

$\bar{\gamma}$ = (18 - 9.81) + $\left(\frac{1.3}{1.3}\right)$ x (18 - (18 - 9.81))kN/m^3

$\bar{\gamma}$ = 18 kN/m^3

$N_q = \tan^2(45 + \frac{\phi'}{2}) e^{\pi \tan\phi}$

$= \tan^2(45 + \frac{30}{2}) e^{\pi \tan 30}$

= 18.40

$N_c = (N_q - 1)\cot\phi'$

= (18.40 - 1) cot 30

= 30.14

$N_\gamma = 2(N_q + 1)\tan\phi'$

= 2(18.4 + 1) tan 30

= 22.40

$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$

$= 1 + \left(\frac{1.3}{1.3}\right)\left(\frac{18.4}{30.1}\right)$

= 1.611

$F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi'$

$= 1 + \left(\frac{1}{1}\right)\tan 30$

= 1.577

$F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$

$= 1 - 0.4\left(\frac{1}{1}\right)$

= 0.600

$$\frac{D_f}{B} \le 1$$

$$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2 \frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$= 1 + 0.4\left(\frac{0.7}{1.3}\right) \qquad = 1 + 2\tan 30\,(1-\sin 30)^2\left(\frac{0.7}{1.3}\right)$$

$$= 1.21538 \qquad = 1.1554$$

$$\frac{D_f}{B} > 1$$

$$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2 \tan^{-1}\left(\frac{D_f}{B}\right) \qquad F\gamma = 1$$

$$= 1 + 0.4\tan^{-1}\left(\frac{0.7}{1.3}\right) \qquad = 1 + 2\tan 30\,(1-\sin 30)^2\tan^{-1}\left(\frac{0.7}{1.3}\right)$$

$$= 1.198 \qquad = -24.0088$$

$$F_{ci} = F_{qi} = \left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2 \qquad F_{\gamma i} = \left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$$

$$= \left(1-\left(\frac{20}{90}\right)\right)^2 = 0.6 \qquad = \left(1-\left(\frac{20}{30}\right)\right)^2 = 0.11$$

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$$c'N_cF_{cs}F_{cd}F_{ci} = 0 \times 30.1 \times 1.61 \times 1.22 \times 1 = 0$$

$$qN_qF_{qs}F_{qd}F_{qi} = 12.6 \times 18.4 \times 1.58 \times 1.2 \times 1 = 255.624$$

$$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} = \frac{1}{2}\; 18 \times 1.3 \times 22.4 \times 0.6 \times 1 \times 0 = 17.47$$

q_u = 0 + 255.624 + 17.47

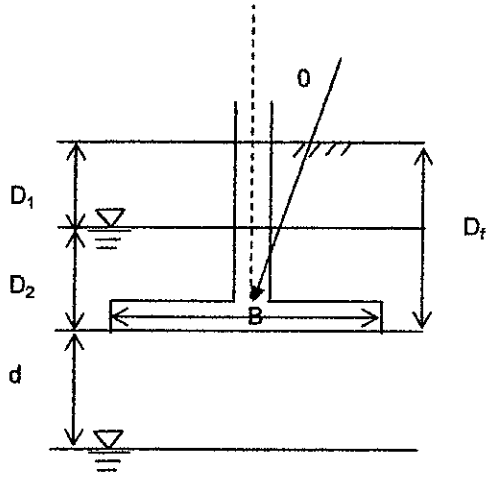
= 273.1 kN/m^2

$$q_{all} = \frac{q_u}{FS} = \frac{273.1}{3} = 91.0 \text{ kN/m^2}$$

$$Q_{all} = q_{all \times B' \times L'} = 91.03 \times 1.3 \times 1.3$$

= 153.8 kN

A square footing is shown in figure. Use FS = 6, and determine the size of the footing capacity, shape, and depth factors given in Section 3.7 in Braja M.Das.



γ_{dry} =	0	lb/ft^3	FS =	6		eB	=	0.50 ft		C' =	0	lb/ft^2
γ_T =	100	lb/ft^3	β =	0		eL	=	0 ft		$\frac{D_f}{B} = \left(\frac{4}{7}\right)$		
γ_{sat} =	120	lb/ft^3	D_1 =	4	ft	B'	=	6.78 - (2 x 0.5)				
γ_w =	62.4	lb/ft^3	D_2 =	0	ft	B'	=	5.78 ft		= 0.58997		
γ_{dry} =	0	lb/ft^3	d =	0	ft	L'	=	6.78 - (2 x 0.00)				
γ_T =	100	lb/ft^3	B =	6.78	ft	L'	=	6.78 ft		ใส่หน่วย 2	1	T
γ_{sat} =	120	lb/ft^3	L =	6.78	ft	B'	=	5.78			2	lb
ø =	30		D_f =	4	ft	L'	=	6.78 ft			3	kN

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega})) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T \qquad 4 \quad N$$

$$\bar{\gamma} = (120 - 62.4) + \left(\frac{0}{6.78}\right) \times (100 - (120 - 62.4)) \text{ lb/ft^3}$$

$\bar{\gamma}$ = 57.6 lb/ft^3

$$N_q = \tan^2(45 + \frac{\phi'}{2}) e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$= \tan^2(45 + \frac{30}{2}) e^{\pi \tan 30} \qquad = (18.40 - 1)\cot 30 \qquad = 2(18.4 + 1)\tan 30$$

$$= 18.40 \qquad = 30.14 \qquad = 22.40$$

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

$$= 1 + \left(\frac{5.78}{6.78}\right)\left(\frac{18.4}{30.1}\right) \qquad = 1 + \left(\frac{6}{7}\right)\tan 30 \qquad = 1 - 0.4\left(\frac{6}{7}\right)$$

$$= 1.520 \qquad = 1.492 \qquad = 0.659$$

$$\frac{D_f}{B} \leq 1$$

$$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2 \frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$= 1 + 0.4\left(\frac{4}{6.78}\right) \qquad = 1 + 2\tan 30\,(1-\sin 30)^2\left(\frac{4}{6.78}\right)$$

$$= 1.23599 \qquad = 1.1703$$

$$\frac{D_f}{B} > 1$$

$$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi'(1-\sin\phi')^2\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F\gamma = 1$$

$$= 1 + 0.4\tan^{-1}\left(\frac{4}{6.78}\right) \qquad = 1 + 2\tan 30\,(1-\sin 30)^2\tan^{-1}\left(\frac{4}{6.78}\right)$$

$$= 1.213 \qquad = -25.987$$

$$F_{ci} = F_{qi} = \left(1 - \left(\frac{\beta^\circ}{90^\circ}\right)\right)^2 \qquad F_{\gamma i} = \left(1 - \left(\frac{\beta^\circ}{\phi'}\right)\right)^2$$

$$= \left(1 - \left(\frac{0}{90}\right)\right)^2 = 1 \qquad = \left(1 - \left(\frac{0}{30}\right)\right)^2 = 1.00$$

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$$c'N_cF_{cs}F_{cd}F_{ci} = 0 \times 30.1 \times 1.52 \times 1.24 \times 1 = 0$$

$$qN_qF_{qs}F_{qd}F_{qi} = 400 \times 18.4 \times 1.49 \times 1.2 \times 1 = 12853.8$$

$$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} = \frac{1}{2}\ 57.6 \times 5.78 \times 22.4 \times 0.66 \times 1 \times 1 = 2457.54$$

q_u = 0 + 12853.8 + 2457.54

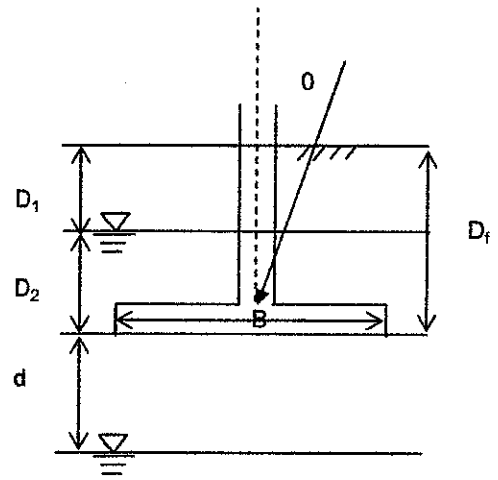
= 15311.3 lb/ft^2

$$q_{all} = \frac{q_u}{FS} = \frac{15311.3}{6} = 2551.9 \text{ lb/ft\^{}2}$$

$Q_{all} = q_{all \times B' \times L'}$ = 2551.89 X 5.78 X 6.78

= 100004.3 lb

The shallow foundation measures shown in Figure are 4 ft x 6 ft and is subjected to a centric load and a moment.If e_B = 0.4 ft ,e_L =1.2 ft, and the depth of the foundation is 3 ft, determine the allowable load the foundation can carry.Use a factor of safety of 4.For the soil,we are told that unit weight $\gamma = 115 lb/ft^3, \phi' = 35^0, c' = 0$



γ_{dry}	=	0	lb/ft^3	FS	=	4		eB	=	0.40	ft		C' =	0		lb/ft^2
γ_T	=	115	lb/ft^3	β	=	0		eL	=	1.2	ft		$\frac{D_f}{B} = \left(\frac{4}{4}\right)$			
γ_{sat}	=	120	lb/ft^3	D_1	=	4	ft	B'	=	4	- (2 x	0.4)				
γ_w	=	62.4	lb/ft^3	D_2	=	0	ft	B'	=	3.2	ft		=	1		
γ_{dry}	=	0	lb/ft^3	d	=	0	ft	L'	=	6	- (2 x	1.20)				
γ_T	=	115	lb/ft^3	B	=	4	ft	L'	=	3.6	ft		ใส่หน่วย	2	1	T
γ_{sat}	=	120	lb/ft^3	L	=	6	ft	B'	=	3.2					2	lb
ø	=	35		D_f	=	4	ft	L'	=	3.6	ft				3	kN
															4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega)) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (120 - 62.4) + \left(\frac{0}{4}\right) \times (115 - (120 - 62.4)) \text{ lb/ft\^3}$$

$\bar{\gamma}$ = 57.6 lb/ft^3

$$N_q = \tan^2(45 + \frac{\phi'}{2})e^{\pi \tan\phi} \qquad N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$= \tan^2(45 + \frac{35}{2})e^{\pi \tan 35} \qquad = (33.30 - 1)\cot 35 \qquad = 2(33.3 + 1)\tan 35$$

$$= 33.30 \qquad = 46.12 \qquad = 48.03$$

$$F_{cs}=1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) \qquad F_{qs}=1+\left(\frac{B}{L}\right)\tan\phi' \qquad F_{\gamma s}=1-0.4\left(\frac{B}{L}\right)$$

$$=1+\left(\frac{3.2}{3.6}\right)\left(\frac{33.3}{46.1}\right) \qquad = 1+\left(\frac{3}{4}\right)\tan\ 35 \qquad =1-0.4\left(\frac{3}{4}\right)$$

$$= 1.642 \qquad = 1.622 \qquad = 0.644$$

$$\frac{D_f}{B}\leq 1$$

$$F_{cd}=1+0.4\left(\frac{D_f}{B}\right) \qquad F_{qd}=1+2\tan\phi'(1-\sin\phi')^2\frac{D_f}{B} \qquad F_{\gamma d}= 1$$

$$= 1+0.4\left(\frac{4}{4}\right) \qquad = 1+2\tan 35\,(1-\sin\ 35)^2\left(\frac{4}{4}\right)$$

$$= 1.4 \qquad = 1.2546$$

$$\frac{D_f}{B}>1$$

$$F_{cd}=1+0.4\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd}=1+2\tan\phi'(1-\sin\phi')^2\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F\gamma = 1$$

$$=1+0.4\tan^{-1}\left(\frac{4}{4}\right) \qquad =1+2\tan\ 35\ (1-\sin 35)^2\tan^{-1}\left(\frac{4}{4}\right)$$

$$= 1.314 \qquad = 2.51808$$

$$F_{ci}=F_{qi}=\left(1-\left(\frac{\beta^\circ}{90^\circ}\right)\right)^2 \qquad F_{\gamma i}=\left(1-\left(\frac{\beta^\circ}{\phi'}\right)\right)^2$$

$$=\left(1-\left(\frac{0}{90}\right)\right)^2 = 1 \qquad =\left(1-\left(\frac{0}{35}\right)\right)^2 = 1.00$$

$$q_u=c'N_cF_{cs}F_{cd}F_{ci}+qN_qF_{qs}F_{qd}F_{qi}+\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

$$c'N_cF_{cs}F_{cd}F_{ci} = 0 \times 46.1 \times 1.64 \times 1.4 \times 1 = 0$$

$$qN_qF_{qs}F_{qd}F_{qi} = 460 \times 33.3 \times 1.62 \times 1.3 \times 1 = 31176.9$$

$$\frac{1}{2}\gamma B'N_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} = \frac{1}{2}\ 57.6 \times 3.2 \times 48.0 \times 0.64 \times 1 \times 1 = 2852.52$$

$q_u =$ 0 + 31176.9 + 2852.52

= 34029.4 lb/ft^2

$q_{all} = \frac{q_u}{FS}$ = $\frac{34029.4}{4}$ = 8507.3 lb/ft^2

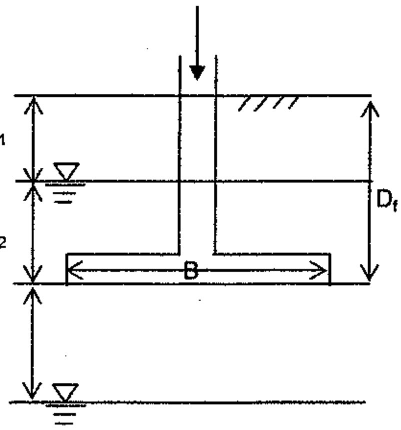
$Q_{all} = q_{all \times B' \times L'}$ = 8507.35 X 3.2 X 3.6

= 98004.7 lb

For a continuous foundation , follwing are given

$$B = 4ft, D_f = 3ft, \gamma = 110 lb/ft^3, \phi' = 25^\circ, c' = 600 lb/ft^2$$

Use Terzaghi's equartion and a factor of savfety of 4 to determine thegross allowable vertical load-bering capacity Assumethat gerneral shear failuar occurs in soild



γ_{dry}	=	0	lb/ft^3	FS	=	4						
γ_T	=	110	lb/ft^3	C'	=	600	lb/ft^2	$\frac{D_f}{B} = \left(\frac{3}{4}\right)$				
γ_{sat}	=	0	lb/ft^3	D_1	=	3	ft					
γ_w	=	62.4	lb/ft^3	D_2	=	0	ft		=	0.75		
γ_{dry}	=	0	lb/ft^3	d	=	4	ft	ใส่หน่วย	2	1	T	
γ_T	=	110	lb/ft^3	B	=	4	ft			2	lb	
γ_{sat}	=	0	lb/ft^3	D_f	=	3	ft			3	kN	
ø	=	25								4	N	

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega})) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (\; 0 \; - \; 62.4 \;) + \left(\frac{4}{4}\right) \text{x} \; 0 \; - (110 \; - \; 62.4)) \quad \text{lb/ft^3}$$

$$\bar{\gamma} = 110 \quad \text{lb/ft^3}$$

$$q_u = c'N_c + qN_q + \frac{1}{2}\gamma BN_\gamma$$

$$= (600 \; \text{X} \; 25.13) + (330 \; \text{X} \; 12.72) + (\frac{1}{2} \; 110 \; \text{X} \; 4 \; \text{X} \; 8.34)$$

$$= 21110.4 \quad \text{lb/ft^2}$$

$$q_{all} = \frac{q_u}{FS}$$

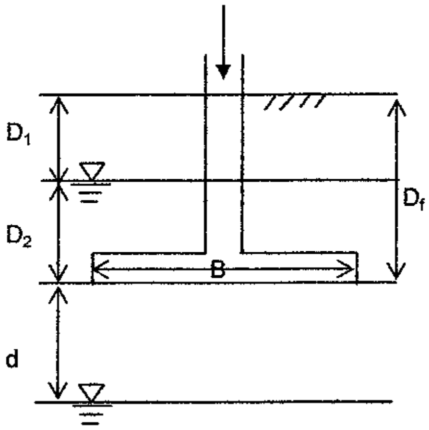
$$= \left(\frac{21110.4}{4}\right)$$

$$= 5277.6 \quad \text{lb/ft^2}$$

For a continuous foundation , follwing are given

$B = 2\ \ , D_f = 1m, \gamma = 17kN/m^3, \phi' = 30^\circ, c' = 0lb/ft^2$

Use Terzaghi's equartion and a factor of savfety of 4 to determine thegross allowable vertical load-bering capacity Assumethat gerneral shear failuar occurs in soild



γ_{dry}	=	0	T/m^3	FS	=	4				
γ_T	=	17	T/m^3	C'	=	0	T/m^2	$\frac{D_f}{B} = \left(\frac{1}{2}\right)$		
γ_{sat}	=	0	T/m^3	D_1	=	1	m			
γ_w	=	1	T/m^3	D_2	=	0	m	= 0.5		
γ_{dry}	=	0	T/m^3	d	=	2	m	ใส่หน่วย 1	1	T
γ_T	=	17	T/m^3	B	=	2	m		2	lb
γ_{sat}	=	0	T/m^3	D_f	=	1	m		3	kN
ø	=	30							4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_\omega) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_\omega)) \qquad ; d \geq B \Rightarrow \bar{\gamma} = \gamma_T$$

$$\bar{\gamma} = (\ 0\ -\ 1\ ) + \left(\frac{2}{2}\right) x\ 0\ -(\ 17\ -\ 1\ ))\ \text{T/m^3}$$

$\bar{\gamma}$ = 17 T/m^3

$$q_u = c'N_c + qN_q + \frac{1}{2}\gamma B N_\gamma$$

$$= (\ 0\ \text{X}\ 37.16) + (\ 17\ \text{X}\ 22.46) + (\frac{1}{2}\ 17\ \text{X}\ 2\ \text{X}\ 19.13)$$

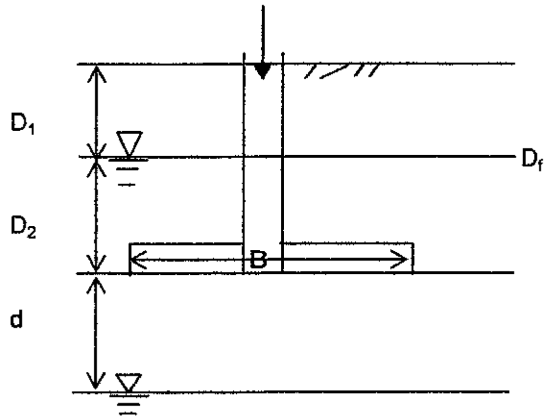
= 707.0 T/m^2

$$q_{all} = \frac{q_u}{FS}$$

$$= \left(\frac{707.0}{4}\right)$$

= 176.8 T/m^2

A square column foundation is 2x2 m in plan . Ket D_f=1.5m .
unit weight = 16.5 kN/m^2,angle Friction = 36 และค่า Cohesion = 0 t/m^2 F.s. =3
Determine the soss allowable vertical load the column could carry



γ_{dry}	=	0	kN/m^3	FS	=	3		C'	=	0	kN/m^2			
γ_T	=	16.5	kN/m^3	D_1	=	1.5	m	$\frac{D_f}{B}=\left(\frac{2}{2}\right)$						
γ_{sat}	=	0	kN/m^3	D_2	=	0	m							
γ_w	=	9.81	kN/m^3	d	=	10	m		=	0.75				
γ_{dry}	=	0	kN/m^3	B	=	2	m			ใส่หน่วย		3	1	T
γ_T	=	16.8	kN/m^3	L	=	2	m						2	lb
γ_{sat}	=	0	kN/m^3	D_f	=	1.5	m						3	kN
ø	=	36											4	N

$$\bar{\gamma} = (\gamma_{sat} - \gamma_{\omega}) + \left(\frac{d}{B}\right) \times (\gamma_T - (\gamma_{sat} - \gamma_{\omega}))$$; $d \geq B \Rightarrow \bar{\gamma} = \gamma_T$

$$\bar{\gamma} = (0 - 9.81) + \left(\frac{2}{2}\right) \times (16.8 - (0 - 9.81)) \quad kN/m^3$$

$$\bar{\gamma} = 16.8 \quad kN/m^3$$

$$q_u = 1.3c'N_c + qN_q + 0.4\gamma BN_\gamma$$

= (1.3 X 0 X 63.53)+ (24.75 X 47.16) + (0.4 X 16.8 X 2 X 54.36)

= 1240.8 kN/m^2

$$q_{all} = \frac{q_u}{FS} = \left(\frac{1240.8}{3}\right) = 413.6 \quad kN/m^2$$

$$Q_{all} = q_{all} \times B \times L$$

= 413.6 X 2 X 2

= 1654.4 kN