รายการคำนวณ

การเสริมแรงด้วยแผ่นใยสังเคราะห์รับแรงดึงสูงเหนือกลุ่มเข็มที่ฐานคันดินถมสูง

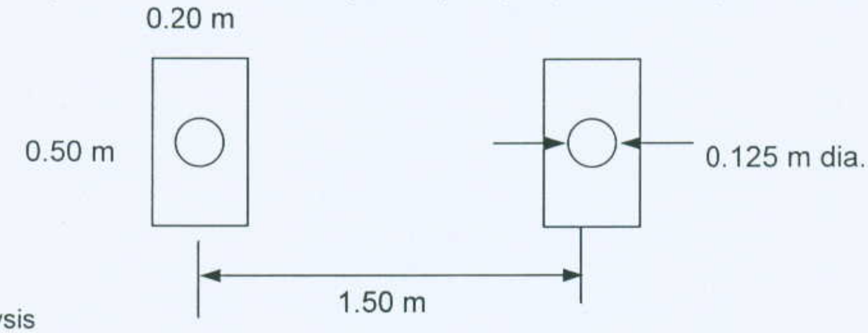
โครงการ ก่อสร้างเขื่อนกันทรายและกันคลื่นท่าเทียบเรืออเนกประสงค์ ที่ร่องน้ำท่ากระจาย ตำบลท่าชนะ อ.ท่าชนะ จ.สุราษฎร์ธานี

Basal Reinforced Piled Embankment

Design criteria and parameter given

1. พิจารณาเข็มเป็นแบบ Friction pile (normal) ตามแนวขวาง คันโครงสร้างส่วนด้านข้าง

Height of embankment = 2.3 m (maximum)
Pile spacing, s = 1.50 m
Pile diameter, a = 0.125 m (capping width 0.20m)
Unit weight of soil embankment = 20 kN/m^3
Surcharge load, q = 20 kPa (3 tons per sq.m.) in case during first lift fill material



Design analysis

Design in accordance to BS8006:1995 Section 8 – Design of embankment with reinforced soil foundation on poor ground

Cl 8.3.3.6 Vertical load shedding
Height of embankment check

$$\text{Harc} \geq 0.7\,(s-a)$$
$$\text{Harc} \geq 0.7\,(1.5-0.2)$$
$$\therefore \quad \text{Harc} \geq 0.91\text{m}$$

Height of embankment = 2.3 m > H_{arc} ∴ there is no local failure in the embankment fill

First compacted fill 0.4 m thickness < Harc, proposed the first thick as 0.91

Vertical stress on pile cap / vertical stress @ base of embankment ratio

$$P'_c/\sigma'_v = [(C_c.a) / H]^2$$

With Cc = Arching coefficient
Where Cc = 1.5H/a – 0.07 (for normal friction pile)
= 1.5(2.3)/0.2 – 0.07
= 17.18

$\therefore \ (P'_c/\sigma'_v) = [(17.18\text{x}0.2)/2.3]^2$
= 2.23

Vertical stress carried by geosynthetic reinforcement between adjacent pile caps
From table 28 Arching coefficient Cc for basal reinforced piled embankment (BS8006, page 106)

when H_o = 1.4(s-a), analyze structure will be in case as follow:

1.) H > 1.4 (s-a) or
2.) 0.7(s-a) < H < 1.4 (s-a)

H_o = 1.4x(1.5-0.2) = 1.82 < H of embankment 2.30 m
$H_o/2$ = 0.7x(1.5-0.20) = 0.91 < H of embankment 2.30 m

<u>Case 1.1: H = 2.30 > 1.4(s-a)</u>

<u>for serviceability limit state: f_{fs} = 1 and f_q = 1</u>

$$W_t = \frac{(1.4).(s).(f_{fs})}{(s^2-a^2)}.(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))$$

$$= \{(1.4).(1.5).(1).(20).(1.5-0.2).(1.5^2-0.2^2(2.23))\} / (2.21)$$

$$= 53.37\ kN/m^2$$

Tension in geotextile reinforcement

$$T_{rp} = \frac{W_t.(s-a)}{2a}.\sqrt{(1+ (1/6\varepsilon))}$$

where ε = elongation of reinforcement max)

Take elongation for serviceability = 5%

$$\therefore \quad Trp = \frac{(53.37x(1.5-0.2))}{2x0.20}.\sqrt{[1+ (1/(6x0.05)))}$$

= <u>361.07 kN/m</u> ---(1)

for Ultimate limit state: f_{fs} = 1.3 and f_q = 1.3

$$W_t = \frac{(1.4).(s).(f_{fs})}{(s^2-a^2)}.(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))$$

$$= \{(1.4).(1.5).(1.3).(20).(1.5-0.2).(1.5^2-0.2^2(2.23))\} / (2.21)$$

$$= 69.39\ kN/m^2$$

take elongation at max = 12%

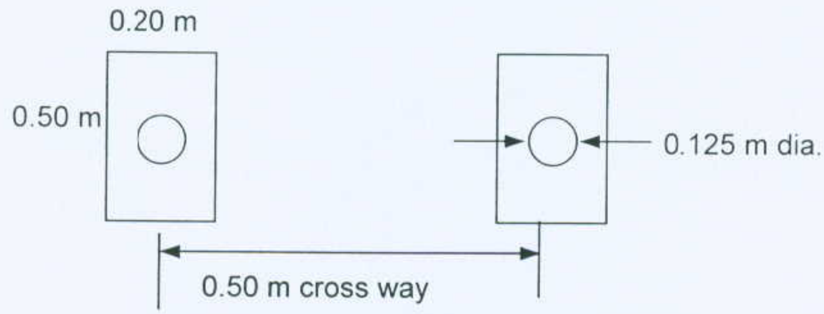
$$Trp = \frac{(69.39x(1.5-0.2).}{2x0.2}\sqrt{[1+ (1/(6x0.12)))}$$

= <u>348.56 kN/m</u> ---(2)

From (1) and (2) should be increase the capping size to reduce the tension occur during the pile, preparing the material to carried out required tensile strength.

2. พิจารณาเข็มเป็นแบบ Friction pile (normal) ตามแนวขวางของคันเขื่อน ในพื้นที่คันโครงสร้างถมส่วนกลาง ที่ระดับความสูงถม +4.00 เมตร ความสูงทั้งหมดเท่ากับ 5.618 เมตร

Height of embankment = 5.618 m (maximum)
Pile spacing, s = 0.50 m
Pile diameter, a = 0.125 m and **<u>capping size 0.20.</u>**
Unit weight of soil embankment = 20 kN/m^3
Surcharge load, q = 30 kPa (3 tons per sq.m.) in case during first lift fill material



Cl 8.3.3.6 Vertical load shedding
Height of embankment check

	Harc	$\geq$	0.7 (s-a)
	Harc	$\geq$	0.7 (0.5-0.2)
$\therefore$	Harc	$\geq$	0.21m

Height of embankment = 5.618 m > H_{arc} $\therefore$ there is no local failure in the embankment fill
First compacted fill 0.40 m. < Harc

Vertical stress on pile cap / vertical stress @ base of embankment ratio

$P'_c/\sigma'_v = [(C_c.a) / H]^2$

With Cc = Arching coefficient
Where Cc = 1.5H/a – 0.07 (for normal friction pile)
= 1.5(5.618)/0.2 – 0.07
= 42.065

$\therefore (P'_c/\sigma'_v) = [(42.065x0.2)/5.618]^2$
= 2.24

ถ้า H = 0.4 first lift fill material of construction, Cc = 2.93

$(P'_c/\sigma'_v) = [(2.93x0.2)/0.4]^2$
= 2.14

Vertical stress carried by geosynthetic reinforcement between adjacent pile caps
From table 28 Arching coefficient Cc for basal reinforced piled embankment (BS8006, page 106)

when H_o = 1.4(s-a), analyze structure will be in case as follow:
H > 1.4 (s-a) or
0.7(s-a) < H < 1.4 (s-a)

H_o = 1.4x(0.5-0.20) = 0.42 < H of embankment 5.618 m
$H_o/2$ = 0.7x(0.5-0.20) = 0.21 < H of embankment 5.618 m

Case 2.1: H = 5.618 > 1.4(s-a) = 0.42
for serviceability limit state: f_{fs} = 1 and f_q = 1

$$W_t = \frac{(1.4).(s).(f_{fs}).(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))}{(s^2-a^2)}$$

$= \{(1.4).(0.5).(1).(20).(0.5-0.2).(0.5^2-0.2^2(2.24))\} / (0.21)$
$= 3.208\ kN/m^2$

Tension in geotextile reinforcement

$$T_{rp} = \frac{W_t.(s-a)}{2a}.\sqrt{(1+(1/6\varepsilon))}$$

where ε = elongation of reinforcement max)
Take elongation for serviceability = 5%

$\therefore$ Trp $= \frac{(3.208x(0.5-0.2))}{2x0.2}.\sqrt{[1+(1/(6x0.05)))}$

= 5.01 kN/m --(5)

for Ultimate limit state: f_{fs} = 1.3 and f_q = 1.3

$$W_t = \frac{(1.4).(s).(f_{fs}).(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))}{(s^2-a^2)}$$

$= \{(1.4).(0.5).(1.3).(20).(0.5-0.2).(0.5^2-0.2^2(2.24))\} / (0.21)$
$= 4.17 \quad kN/m^2$

take elongation at max = 12%

Trp $= \frac{(4.17x(0.5-0.2).}{2x0.2}\sqrt{[1+(1/(6x0.12)))}$

= 4.83 kN/m --(6)

Case 2.2: H = 0.40 m First lift thickness

$H_o/2 < H < H_o$

for serviceability limit state: f_{fs} = 1 and f_q = 1

$$W_t = \frac{(s).(f_{fs}.\gamma.H + f_q.w_s).(s^2-a^2.(P'_c/\sigma'_v))}{(s^2-a^2)}$$

$= \{(0.5).((1x20x0.4)+(1x30)).(0.5^2-0.2^2(2.14))\} / (0.21)$
$= 14.87 \ kN/m^2$

Tension in geotextile reinforcement

$$T_{rp} = \frac{W_t.(s-a)}{2a}.\sqrt{(1+(1/6\varepsilon))}$$

where ε = elongation of reinforcement max)
Take elongation for serviceability = 5%

$\therefore$ Trp $= \frac{(14.87x(0.5-0.2))}{2x0.2}.\sqrt{[1+(1/(6x0.05)))}$

= 23.22 kN/m --(7)

for Ultimate limit state: f_{fs} = 1.3 and f_q = 1.3

$W_t = (s).(f_{fs}.\gamma.H + f_q.w_s).(s^2-a^2.(P'_c/\sigma'_v))$

$(s^2 - a^2)$

$= \{(0.5).((1.3x20x0.4)+(1.3x30)).(0.5^2-0.2^2(2.14))\} / (0.21)$
$= 19.33 \quad kN/m^2$

take elongation at max = 12%

$Trp = \dfrac{19.33 \times (0.5-0.2)}{2x0.2} . \sqrt{[1+ (1/(6x0.12))}$

= **22.40 kN/m** --**(8)**

2. พิจารณาเข็มเป็นแบบ Friction pile (normal) ตามแนวขวางของคันเขื่อน ในพื้นที่คันโครงสร้างถมส่วนกลาง ที่ระดับความสูงถม +4.00 เมตร ความสูงทั้งหมดเท่ากับ 5.618 เมตร

Height of embankment = 5.618 m (maximum)
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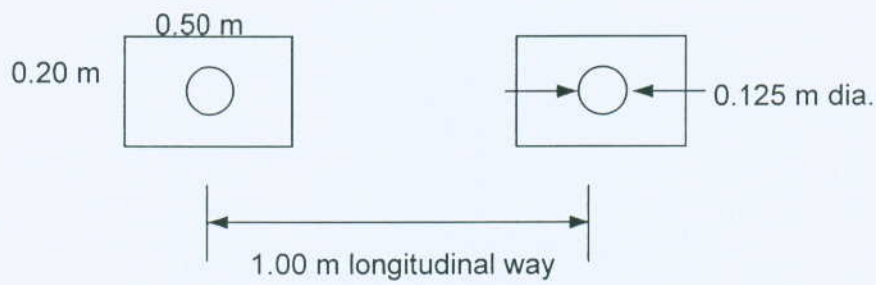
Pile diameter, a = 0.125 m and **capping size 0.20,**
Unit weight of soil embankment = 20 kN/m^3
Surcharge load, q = 30 kPa (3 tons per sq.m.) in case during first lift fill material



Cl 8.3.3.6 Vertical load shedding
Height of embankment check

Harc $\geq$ 0.7 (s-a)
Harc $\geq$ 0.7 (1.0-0.5)
$\therefore$ Harc $\geq$ 0.35m

Height of embankment = 5.618 m > H_{arc} $\therefore$ there is no local failure in the embankment fill
First compacted fill 0.40 m. < Harc (still more than Harc)

Vertical stress on pile cap / vertical stress @ base of embankment ratio

$P'_c/\sigma'_v = [(C_c.a) / H]^2$

With Cc = Arching coefficient
Where Cc = 1.5H/a – 0.07 (for normal friction pile)
= 1.5(5.618)/0.5 – 0.07
= 16.78
$\therefore (P'_c/\sigma'_v)$ = $[(16.78x0.5)/5.618]^2$

$= 2.23$

Vertical stress carried by geosynthetic reinforcement between adjacent pile caps
From table 28 Arching coefficient Cc for basal reinforced piled embankment (BS8006, page 106)

when $H_o = 1.4(s-a)$, analyze structure will be in case as follow:
$H > 1.4\ (s-a)$ or
$0.7(s-a) < H < 1.4\ (s-a)$

$H_o = 1.4x(1-0.50) = 0.7 <$ H of embankment 5.618 m
$H_o/2 = 0.7x(1-0.50) = 0.35 <$ H of embankment 5.618 m

<u>for serviceability limit state: $f_{fs} = 1$ and $f_q = 1$</u>

$$W_t = \frac{(1.4).(s).(f_{fs}).(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))}{(s^2-a^2)}$$

$$= \{(1.4).(1).(1).(20).(1-0.5).(1^2-0.5^2(2.23))\} / (0.75)$$
$$= 8.26\ kN/m^2$$

Tension in geotextile reinforcement

$$T_{rp} = \frac{W_t.(s-a).\sqrt{(1+(1/6\varepsilon))}}{2a}$$

where ε = elongation of reinforcement max)
Take elongation for serviceability = 5%

$$\therefore \quad Trp = \frac{(8.26x(1-0.5)).\sqrt{[1+(1/(6x0.05)))}}{2x0.5}$$

= **<u>8.59 kN/m</u> --(5)**

for Ultimate limit state: $f_{fs} = 1.3$ and $f_q = 1.3$

$$W_t = \frac{(1.4).(s).(f_{fs}).(\gamma).(s-a)(s^2-a^2.(P'_c/\sigma'_v))}{(s^2-a^2)}$$

$$= \{(1.4).(1).(1.3).(20).(1-0.5).(1^2-0.5^2(2.23))\} / (0.75)$$
$$= 10.74\ kN/m^2$$

take elongation at max = 12%

$$Trp = \frac{(10.74x(1-0.5)).\sqrt{[1+(1/(6x0.12)))}}{2x0.5}$$

= **<u>8.29 kN/m</u> --(6)**