土壓力ノ强度及其働點ノ位置ニ就テ

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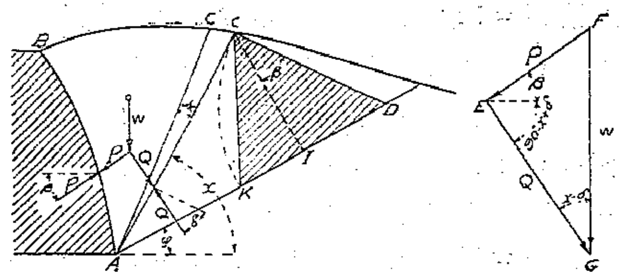
土壓力ニ關スル理論ハくーろん、らんきん、ぽんせれ、わいらうふ、うぃんくれる等ノ諸氏ニヨリテ研究セラレタルモ土壓力ノ强度及其働點ノ位置ニ就テノ研究ハ未タ完カラス依テ玆ニ土壓力ノ强度及其働點ノ位置ニ就テ聊カ論究ヲ試ミントス

らんきん氏ノ理論ハ土中ノ内部ニ於ケル應力ヲ論シタルモノナルヲ以テ擁壁ニ於ケル土壓力ニ應用スル時ハ往々不合理ノ場合ヲ生スルヲ以テ本問題ヲ研究スルニ當リテハくーろん氏ノ理論ニ原キ土壓力ヲ算出セリ抑モくーろん氏ノ理論ハ擁壁背面ト崩壊面トノ間ニ挾マレタル土ノ重量カ楔ノ作用ヲナシ擁壁背面ト崩壊面トヲ壓ス二分力トナリ擁壁ヲ壓ス力ハ乃チ土壓力ニシテ其ノ方向ハ擁壁面ヘノ垂直線ト土ト壁トノ摩擦角ニ等シキ角度ニテ傾斜シ崩壊面ヲ壓ス一分力ハ崩壊面ヘノ垂直線ト土ノ摩擦角ニ等シキ角度ニテ傾斜シテ作用スルモノトナセリ此ノ假定ニ原キ土壓力ヲ求ムルニ當リ先ツ崩壊面ノ位置ヲ求メ次ニ土壓力ヲ求ムルヲ普通ノ順序トス今崩壊面ヲ求ムルニ種々アレトモ次ノ如クシテ求ムルヲ尤モ適當ト思考ス乃チ擁壁ト崩壊面トノ間ニ挾マレタル土ノ重量ノ一分力カ崩壊面ヘ作用スル方向ヲ崩壊面ヘノ垂線ト角δヲナスモノト假定スレハ崩壊面ニ於テハ此ノδハ其ノ最大値乃チ土ノ摩擦角φナラサルヘカラス次ニ崩壊面

ノ位置ヲ求ムル方法ヲ述ヘン

第一章　土壓力

第一節　崩壊面ノ位置　今擁壁背面ニ作用スル土壓力ヲPトシ其ノ水平線トナス角ヲβトシ別ニ水平線ト角xヲナシ壁踵Aヲ通シ直線ACヲ引キ之ヲ崩壊面ト假定スル時ハAB, BC及ACニテ圍マレタル土ノ重量Wハ土壓力PトACヘノ一分力Qトノ二分力トナルヲ以テ此W P及Qノ三力ハ互ニ平衡ヲ保ツヘシ依テPニ等シク且平行ニFEヲ引キWニ等シク且平行ニFGヲ引ケハEGハQニ等シク且平行ナリ而シテQカACヘノ垂線トナス角ヲδトスレハ力ノ三角形EFGヨリ次ノ式ヲ得



第　一　圖

$$\frac{W}{sin\,(90^\circ-x+\delta+\beta)}=\frac{P}{sin(x-\delta)}$$

$$\therefore\qquad W\,sin\,(x-\delta)=P\,sin\,(90^\circ-x+\delta+\beta)\qquad\cdots\cdots\cdots\qquad(1)$$

ACカAC'ニ變シタルトキ乃チxカdx丈ケ増加シタルトキハW Q及δハ其ノ値ヲ變シWハdW丈ケ減シQハdQ丈ケ減シδハ$d\delta$丈ケ増加スヘシ故ニ(1)式ヲxニ就キテ微分スレハ

$$-\frac{dW}{dx}\,sin(x-\delta)+W\,cos\,(x-\delta)\left(1-\frac{d\delta}{dx}\right)=P\,cos\,(90^\circ-x+\delta+\beta)\left(-1+\frac{d\delta}{dx}\right)$$

故ニ

$$\frac{d\delta}{dx}=\frac{-\frac{dW}{dx}\,sin\,(x-\delta)+W\,cos\,(x-\delta)+P\,cos\,(90^\circ-x+\delta+\beta)}{W\,cos\,(x-\delta)+P\,cos\,(90^\circ-x+\delta+\beta)}\qquad\cdots\cdots\cdots\qquad(2)$$

土ノ單位重量ヲw, ACノ長サヲlトスレハ　　$dW=\frac{1}{2}wl^2\,dx$

$$\frac{dW}{dx}=\frac{wl^2}{2} \quad \cdots\cdots\cdots \quad (3)$$

(1) 式ヨリ

$$P=\frac{W\sin(x-\delta)}{\sin(90^\circ-x+\delta+\beta)} \quad \cdots\cdots\cdots \quad (4)$$

(2)(3)及(4)ヨリ

$$\frac{d\delta}{dx}=\frac{-\dfrac{wl^2}{2}\sin(x-\delta)+W\cos(x-\delta)+W\dfrac{\cos(90^\circ-x+\delta+\beta)\sin(x-\delta)}{\sin(90^\circ-x+\delta+\beta)}}{W\cos(x-\delta)+P\cos(90^\circ-x+\delta+\beta)}$$

$$=\frac{-\dfrac{wl^2}{2}\sin(x-\delta)+W\dfrac{\sin(90^\circ+\beta)}{\sin(90^\circ-x+\delta+\beta)}}{W\cos(x-\delta)+P\cos(90^\circ-x+\delta+\beta)} \quad \cdots\cdots\cdots \quad (5)$$

AC面ニ作用スル力QカAC面ヘノ垂直線トナス角δハ土相互間ノ摩擦角φヨリ大ナルコトヲ得サルニヨリδカ最大値φトナリタル時ニAC面ヨリ上ニアル土ハAC面ヲ沿フテ崩壊スヘシ故ニAC面カ崩壊面ナルトキハδハ其ノ最大値ニ達スルヲ以テ$\dfrac{d\delta}{dx}$ハ零トナリ同時ニδハφトナラサルヘカラス依テ(5)式ヨリ

$$-\frac{wl^2}{2}\sin(x-\delta)+W\frac{\sin(90^\circ+\beta)}{\sin(90^\circ-x+\varphi+\beta)}=0$$

或ハ

$$W=\frac{wl^2\sin(x-\varphi)\sin(90^\circ-x+\varphi+\beta)}{2\sin(90^\circ-\beta)} \quad \cdots\cdots\cdots \quad (6)$$

(6)式ハACカ崩壊面タルヘキ條件ナリ

今Aヨリ水平線ト角φヲナス直線ADヲ引キCヨリ之ヘ垂線CIヲ引キCIト角βヲナス直線CDヲ引ク時ハ

$$CI=l\sin(x-\varphi)$$

$$AD=\frac{l\,sin\,(90^\circ-x+\varphi+\beta)}{sin\,(90^\circ-\beta)}$$

$$\varDelta ACD\text{ノ面積}=\frac{l^2\,sin\,(x-\varphi)\,sin\,(90^\circ-x+\varphi+\beta)}{2\,sin\,(90^\circ-\beta)}$$

故ニ(6)式ヨリ

$$W=w\text{面積}\varDelta ACD\ \cdots\cdots\cdots\ (7)$$

故ニACカ崩壞面ナルトキハABCノ面積ト三角形ACDノ面積トハ相等シ換言スレハ崩壞面ACハ面積$ABCD$ヲ二等分スル直線ナリ

第二節　土壓力　ACカ崩壞面ナルトキハ$\delta=\varphi$ナルヲ以テ(4)及(6)ヨリ

$$P=\frac{wl^2\,sin^2(x-\varphi)}{2\,sin\,(90^\circ-\beta)}$$

第一圖ニ於テ

$$CI=l\,sin\,(x-\varphi)$$

$$CD=\frac{l\,sin\,(x-\varphi)}{sin\,(90^\circ-\beta)}$$

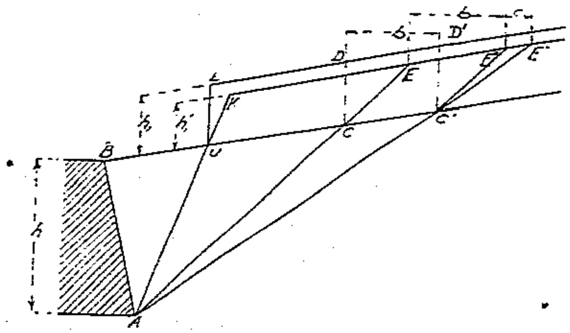
$$P=\frac{w}{2}CI.\,CD$$

故ニDKヲCDニ等シク取リ三角形CKDヲ作レハ$\varDelta CKD$ノ面積ハ$\frac{1}{2}CI.CD$ナルヲ以テ

$$P=w\text{面積}\varDelta CKD\ \cdots\cdots\cdots\ (8)$$

第三節　地表面上ニ荷重アル場合　荷重ヲ土ト同重量ノ物質ニ換算シ第二圖ニ示ス如ク高サh_1ヲ有スルULDヲ以テ之ヲ表ハストキハ土壓力ヲ惹起スヘキ楔形土ノ重量WハABCノ土ノ重量及$ULDC$ニテ表ハサレタル荷重ナリ乃チ崩壞面ハ$ACCD$トナルナリ今圖ニ示ス如クACヲ如何ニ

引クモ $ULDC$ ト常ニ同面積トナル $UKEC$ ヲ見出ストキハ崩壞面ハ直線 ACE ヲ以テ表ハスコトヲ得ルヲ以テ斯ノ如クスレハ第一節ニ於テ求メタルト同方法ニテ崩壞面ヲ求メ得ヘシ換言スレハ地表面カ $BUKEE'$ ナル破線ヲナスモノトシ以テ崩壞面及土壓力ヲ求メ得ヘシ今 $UKEE'$ ノ垂直高ヲ h_1' トスレハ



第二圖

$$面積\ CDD'C'=bh_1$$

$$面積\ CEE'C'=bh_1'+\frac{c}{2}h_1'$$

而シテ　面積 $CDD'C'$ ＝面積 $CEE'C'$ ナルヘキヲ以テ

$$bh_1=bh_1'+\frac{c}{2}h_1'$$

$$=h_1'\left(b+\frac{c}{2}\right)$$

而シテ　三角形 $CE'E''$ ト ACC' トハ相似形ナルヲ以テ

$$\frac{c}{h_1'}=\frac{b}{h}$$

故ニ

$$bh_1=h_1'\left(b+\frac{bh_1'}{2h}\right)$$

$$h_1=h_1'+\frac{h_1'^2}{2h}$$

$$2hh_1=2hh_1'+h_1'^2$$

$$h_1'^2+2hh_1'+h^2=2hh_1+h^2$$

$$(h+h_1')^2=h(h+2h_1)$$

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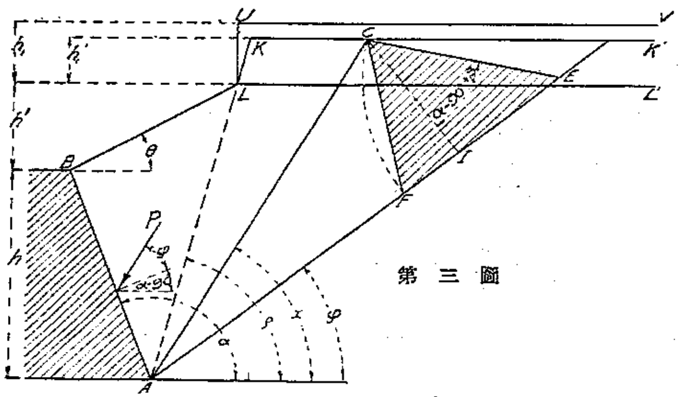
$$h_1' = \sqrt{h(h+2h_1)} - h \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (9)$$

$h+h_1'$ ハ h ト $h+2h_1$ ノ比例中項ナルヲ以テ亦圖式ニテ容易ニ h_1' ヲ求メ得ヘシ

(9)式ヨリ h_1' ヲ見出セハ第一及第二節ニ於テ述ヘタル方法ニテ崩壞面及土壓力ヲ求メ得ヘシ

第四節　擁壁背面直線ニシテ地表面ハ BLL' ナル破線ヲナシ LL' 上ニ等布荷重積載セラレタル場合ニ於ケル土壓力ヲ求ムル方法　土壓力 P ハ擁壁背面 AB ヘノ垂線ト角 φ ヲナスモノトスレハ P ハ水平線ト $\alpha+\varphi-90°$ ノ角ヲナスヘシ又荷重ヲ土ト同重ノ物質ニ換算シタル高サヲ h_1 トスレハ h_1' ハ(9)式ニヨリテ之ヲ求メ得ヘシ乃チ



第　三　圖

$$h_1' = \sqrt{(h+h')(h+h'+2h_1)} - (h+h')$$

第三圖ニ於テ

$$h' \cot\theta + h\cot\alpha = (h+h')\cot\rho$$

$$\cot\rho = \frac{h'\cot\theta + h\cot\alpha}{h+h'}$$

$$三角形 ABL ノ面積 = \frac{1}{2}(h+h')h'\cot\theta - \frac{h'(h+h')\cot\rho}{2}$$

$$= \frac{1}{2}h'(h+h')(\cot\theta - \cot\rho)$$

$$= \frac{1}{2}h'\left\{(h+h')\cot\theta - h'\cot\theta - h\cot\alpha\right\}$$

$$=\frac{1}{2}h'\left\{h\cot\theta-h\cot\alpha\right\}$$

$$=\frac{1}{2}hh'\left\{\cot\theta-\cot\alpha\right\}$$

三角形 AKC ノ面積 $=\frac{1}{2}(h+h'+h_1')^2(\cot x-\cot\rho)$

三角形 ACE ノ面積 $=\frac{1}{2}\left\{\frac{h+h'+h_1'}{\sin x}\right\}^2\frac{\sin(x-\varphi)\sin(\alpha-x+2\varphi)}{\sin(\alpha+\varphi)}$

(7) 式ヨリ

面積 $ABLKC$ = 面積 $\varDelta ABL$ + 面積 $\varDelta AKC$

= 面積 $\varDelta ACE$

ナルヲ以テ

$$hh'(\cot\theta-\cot\alpha)+(h+h'+h_1')^2(\cot x-\cot\rho)=\left\{\frac{h+h'+h_1'}{\sin x}\right\}^2\frac{\sin(x-\varphi)\sin(\alpha-x+2\varphi)}{\sin(\alpha+\varphi)}\quad\cdots\cdots\cdots(10)$$

(8) 式ヨリ

$$P=\frac{1}{2}w\,\overline{CE}^2\sin(\alpha+\varphi)$$

$$=\frac{w(h+h'+h_1')^2}{2\sin(\alpha+\varphi)}\left\{\frac{\sin(x-\varphi)}{\sin x}\right\}^2\quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(11)$$

(10) 式ニ於テ $\cot x=\cot\varphi-\frac{\sin(x-\varphi)}{\sin x\sin\varphi}$

$$\frac{\sin(\alpha-x+2\varphi)}{\sin x}=\frac{\sin(\alpha+2\varphi)\cos x-\cos(\alpha+2\varphi)\sin x}{\sin x}$$

$$=\sin(\alpha+2\varphi)\cot x-\cos(\alpha+2\varphi)$$

$$=\sin(\alpha+2\varphi)\cot\varphi-\frac{\sin(x-\varphi)\sin(\alpha+2\varphi)}{\sin x\sin\varphi}-\cos(\alpha+2\varphi)$$

$$=\frac{\sin(\alpha+2\varphi)\cos\varphi-\cos(\alpha+2\varphi)\sin\varphi}{\sin\varphi}-\frac{\sin(x-\varphi)\sin(\alpha+2\varphi)}{\sin x\sin\varphi}$$

$$=\frac{\sin(\alpha+\varphi)}{\sin\varphi}-\frac{\sin(x-\varphi)\sin(\alpha+2\varphi)}{\sin x\sin\varphi}$$

ナルヲ以テ

$$hh'(\cot\theta-\cot\alpha)+(h+h'+h_1')^2\left\{\cot\varphi-\frac{\sin(x-\varphi)}{\sin x\sin\varphi}-\frac{h'\cot\theta+h\cot\alpha}{h+h'}\right\}$$

$$-(h+h'+h_1')^2\frac{\sin(x-\varphi)}{\sin x\sin(\alpha+\varphi)}\left\{\frac{\sin(\alpha+\varphi)}{\sin\varphi}-\frac{\sin(x-\varphi)\sin(\alpha+2\varphi)}{\sin x\sin\varphi}\right\}=0$$

或ハ

$$\left\{\frac{\sin(x-\varphi)}{\sin x}\right\}^2\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)\sin\varphi}-2\frac{\sin(x-\varphi)}{\sin x\sin\varphi}+\frac{hh'(\cot\theta-\cot\alpha)}{(h+h'+h_1')^2}+\cot\varphi-\frac{h'\cot\theta+h\cot\theta-h\cot\theta+h\cot\alpha}{h+h'}=0$$

$$\left\{\frac{\sin(x-\varphi)}{\sin x}\right\}^2\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)}-2\frac{\sin(x-\varphi)}{\sin x}+\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}(\cot\theta-\cot\alpha)\sin\varphi$$

$$+(\cot\varphi-\cot\theta)\sin\varphi=0$$

故ニ

$$\frac{\sin(x-\varphi)}{\sin x}=\left\{1-\sqrt{1-\left[\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}(\cot\theta-\cot\alpha)\sin\varphi+(\cot\varphi-\cot\theta)\sin\varphi\right]\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)}}\right\}\frac{\sin(\alpha+\varphi)}{\sin(\alpha+2\varphi)}$$

$$= \left\{1-\sqrt{1-\left[\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{\sin(\alpha-\theta)\sin\varphi}{\sin\alpha\sin\theta}+\frac{\sin(\theta-\varphi)}{\sin\theta}\right]\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)}}\right\}\frac{\sin(\alpha+\varphi)}{\sin(\alpha+2\varphi)}$$

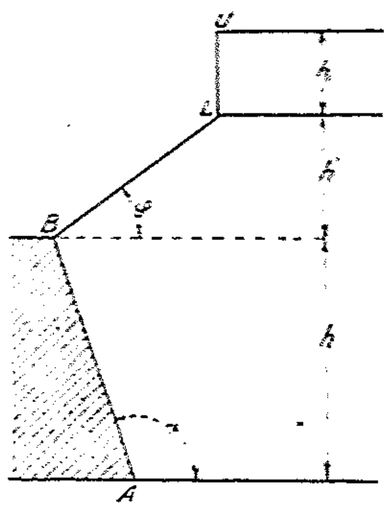
上記ノ値ヲ(11)式ニ入ルレハ

$$P=\frac{w(h+h'+h_1')^2}{2\sin(\alpha+\varphi)}\left\{1-\sqrt{1-\left[\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{\sin(\alpha-\theta)\sin\varphi}{\sin\alpha\sin\theta}+\frac{\sin(\theta-\varphi)}{\sin\theta}\right]\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)}}\right\}^2\frac{\sin^2(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}$$

$$=\frac{w(h+h'+h_1')^2\sin(\alpha+\varphi)}{2\sin^2(\alpha+2\varphi)}\left\{1-\sqrt{1-\left[\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{\sin(\alpha-\theta)\sin\varphi}{\sin\alpha\sin\theta}+\frac{\sin(\theta-\varphi)}{\sin\theta}\right]\frac{\sin(\alpha+2\varphi)}{\sin(\alpha+\varphi)}}\right\}^2 \quad (12)$$

(a) $\theta=\varphi$ ノ場合

第四圖



(12)式ニ於テ $\theta=\varphi$ トスレハ

$$P=\frac{w(h+h'+h_1')^2\sin(\alpha+\varphi)}{2\sin^2(\alpha+2\varphi)}$$

$$\times\left\{1-\sqrt{1-\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{\sin(\alpha-\varphi)\sin(\alpha+2\varphi)}{\sin\alpha\sin(\alpha+\varphi)}}\right\}^2$$

$$=\frac{w(h+h'+h_1')^2\sin(\alpha+\varphi)}{2\sin^2(\alpha+2\varphi)}$$

$$\times\left\{1-\sqrt{1-\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\left(1-\frac{\sin\varphi\sin2\varphi}{\sin\alpha\sin(\alpha+\varphi)}\right)}\right\}^2$$

今 $\frac{\sin\varphi\sin2\varphi}{\sin\alpha\sin(\alpha+\varphi)}=L$ トシ

$(h+h'+h_1')^2=(h+h')(h+h'+2h_1)$ ナルヲ以テ

$$P=\frac{w\sin(\alpha+\varphi)}{2\sin^2(\alpha+2\varphi)}\left\{\sqrt{(h+h')(h+h'+2h_1)}-\sqrt{h(h+2h'+2h_1)L+h'(h'+2h_1)}\right\}^2 \quad \cdots\cdots\cdots\cdots\cdots \quad (13)$$

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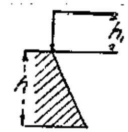
(*b*)　$h'=0$　乃チ地表面水平ニシテ荷重作用スル場合

(13) 式ニ於テ $h'=0$ トスレハ

$$P=\frac{w\,sin\,(\alpha+\varphi)}{2\,sin^2\,(\alpha+2\varphi)}\left\{\sqrt{h\,(h+2h_1)}-\sqrt{h\,(h+2h_1)\,L}\right\}^2$$

$$=\frac{w\,sin(\alpha+\varphi)\,h(h+2h_1)}{2\,sin^2\,(\alpha+2\varphi)}\left\{1-\sqrt{L}\right\}^2 \quad \cdots\cdots \quad (14)$$



第五圖

(*c*)　$h'=0$　$h_1=0$　乃チ地表面水平ニシテ荷重ナキ場合

(14) 式ニ於テ $h_1=0$ トスレハ

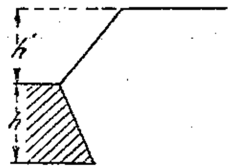
$$P=\frac{w\,sin(\alpha+\varphi)\,h^2}{2\,sin^2(\alpha+2\varphi)}\left\{1-\sqrt{L}\right\}^2 \quad \cdots\cdots \quad (15)$$

第六圖

(*d*)　$h_1=0$　乃チ過載アリテ荷重ナキ場合

(13) 式ニ於テ $h_1=0$ トスレハ

$$P=\frac{w\,sin\,(\alpha+\varphi)}{2\,sin^2\,(\alpha+2\varphi)}\left\{h+h'-\sqrt{h\,(h+2h')\,L+h'^2}\right\}^2 \quad \cdots\cdots \quad (16)$$



第七圖

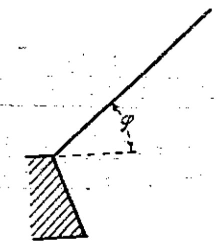
(*e*)　$h'=\infty$　乃チ地表面 φ ナル角ヲナシテ傾斜セル場合

(16) 式ヲ次ノ如ク變化シ後 $h'=\infty$ トスレハ P ヲ求メ得ヘシ

$$P=\frac{w\,sin\,(\alpha+\varphi)}{2\,sin^2\,(\alpha+2\varphi)}\left\{h+h'-h'\sqrt{1+\frac{h\,(h+2h')}{h'^2}L}\right\}^2$$

$$=\frac{w\,sin\,(\alpha+\varphi)}{2\,sin^2\,(\alpha+2\varphi)}\left\{h+h'-h'\left(1+\frac{h\,(h+2h')}{2\,h'^2}\,L+\frac{1.3}{2.4}\,\frac{h^2\,(h+2h')^2\,L^2}{h'^4}+\cdots\right)\right\}^2$$

$$=\frac{w\,sin\,(\alpha+\varphi)}{2\,sin^2\,(\alpha+2\varphi)}\left\{h+h'-h'-\frac{h^2\,L}{2\,h'}-h\,L+\frac{1.3}{2.4}\,\frac{h^2\,(h+2h')^2\,L^2}{h'^3}+\cdots\cdots\right\}^2$$



第八圖

$h'=\infty$ トスレバ

$$P=\frac{w\sin(\alpha+\varphi)h^2}{2\sin^2(\alpha+2\varphi)}\left\{1-L\right\}^2$$

$$=\frac{w\sin(\alpha+\varphi)h^2}{2\sin^2(\alpha+2\varphi)}\cdot\frac{\sin^2(\alpha-\varphi)\sin^2(\alpha+2\varphi)}{\sin^2\alpha\sin^2(\alpha+\varphi)}$$

$$=\frac{w h^2\sin(\alpha-\varphi)}{2\sin^2\alpha\sin(\alpha+\varphi)}\quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\quad(17)$$

第二章　土壓力ノ強度

(a) $\theta=\varphi$ ノ場合

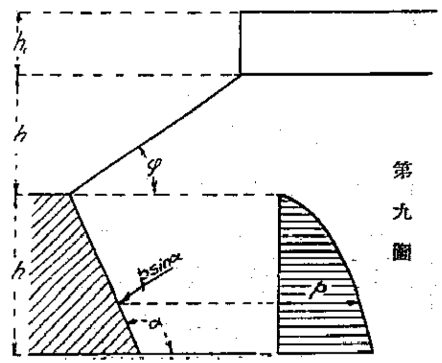
(13) 式ニヨリ

$$P=\frac{w\sin(\alpha+\varphi)}{2\sin^2(\alpha+2\varphi)}\left\{\sqrt{(h+h')(h+h'+2h_1)}-\sqrt{h(h+2h'+2h_1)L+h'(h'+2h_1)}\right\}^2$$

上式ノ P ヲ h ニ就キテ微分スレバ垂直面ニ對スル土壓力ノ強度ヲ求メ得ヘシ之ヲ p トスレバ擁壁背面ニ於ケル土壓力ノ強度ハ $p\sin\alpha$ ナリ

$$\frac{dP}{dh}=p=\frac{w\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left\{\sqrt{(h+h')(h+h'+2h_1)}-\sqrt{h(h+2h'+2h_1)L+h'(h'+2h_1)}\right\}$$

$$\times\left\{\frac{h+h'+h_1}{\sqrt{(h+h')(h+h'+2h_1)}}-\frac{L(h+h'+h_1)}{\sqrt{h(h+2h'+2h_1)L+h'(h'+2h_1)}}\right\}$$



第九圖

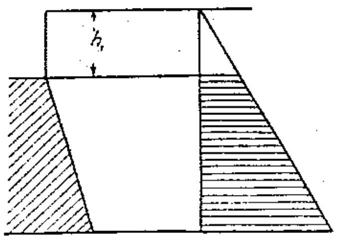
$$=\frac{w\,sin(\alpha+\varphi)(h+h'+h_1)}{sin^2(\alpha+2\varphi)}\left\{1+L-2\sqrt{L}\frac{(h+h'+h_1)^2-h_1^2-\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)}{\sqrt{\left[(h+h'+h_1)^2-h_1^2-\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)\right]^2-\left\{\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)\right\}^2}}\right\} \quad \cdots\cdots\cdots\cdots (18)$$

(b)　$h'=0$ ノ場合

(18) 式ニ於テ $h'=0$ トスレハ

$$p=\frac{w(h+h_1)\,sin(\alpha+\varphi)}{sin^2(\alpha+2\varphi)}(1-\sqrt{L})^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (19)$$

上式ヨリ p ハ $(h+h_1)$ ニ比例スルヲ知ル故ニ p ハ次ノ圖ニ示ス如クナルヘシめーるてん氏ハ p ヲ $h+h_1'$ ニ比例スルモノトシテ土壓力ノ働點ヲ見出セルモ是レ誤謬タルコト上式ニヨリテ明カナリ

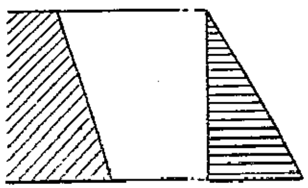


第十圖

(c)　$h'=0$ $h_1=0$ ノ場合

(19) 式ニ於テ $h_1=0$ トスレハ

$$p=\frac{w\,h\,sin(\alpha+\varphi)}{sin^2(\alpha+2\varphi)}(1-\sqrt{L})^2 \quad \cdots\cdots\cdots\cdots\cdots (20)$$



第十一圖

(d)　$h_1=0$ ノ場合

(18) 式ニ於テ $h_1=0$ トスレハ

$$p=\frac{w(h+h')\,sin(\alpha+\varphi)}{sin^2(\alpha+2\varphi)}$$

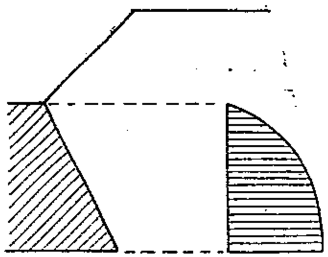
$$\times\left\{1+L-2\sqrt{L}\frac{(h+h')^2-\frac{h'^2}{2}\left(1-\frac{1}{L}\right)}{\sqrt{\left[(h+h')^2-\frac{h'^2}{2}\left(1-\frac{1}{L}\right)\right]^2-\left\{\frac{h'^2}{2}\left(1-\frac{1}{L}\right)\right\}^2}}\right\}$$

$$=\frac{w(h+h')\,sin(\alpha+\varphi)}{sin^2(\alpha+2\varphi)}$$

$$\times\left\{1+L-\sqrt{L}\left[\frac{\sqrt{(h+h')^2-h'^2\left(1-\frac{1}{L}\right)}}{h+h'}+\frac{h+h'}{\sqrt{(h+h')^2+h'^2\left(1-\frac{1}{L}\right)}}\right]\right\}$$

$$\cdots\quad\cdots\quad\cdots\quad\cdots\quad(21)$$

第十二圖

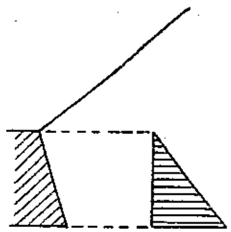


(e) $h'=\infty$ ノ場合

(21) 又ハ (17) 式ヨリ

$$p=\frac{wh\,sin(\alpha-\varphi)}{sin^2\alpha\,sin(\alpha+\varphi)}\quad\cdots\quad\cdots\quad\cdots\quad\cdots\quad\cdots\quad\cdots(22)$$

第十三圖



第三章　土壓力ノ働點ノ位置

前章ニ於テ述ヘタル所ニヨレハ(c)及(e)ノ場合ニハ p ハ h ニ比例スルヲ以テ其ノ土壓力働點ノ位置ハ壁底ヨリ高サ h ノ三分ノ一ノ點ニアルコト明カナリ又(b)ノ場合ニハ土壓力强度ノ分布ハ梯形トナルヲ以テ土壓力ノ働點ハ重心ノ高サニ等シキヲ以テ是亦容易ニ求メ得ヘシ只(a)及(d)ノ場合ニハ土壓力ノ强度ハ曲線ニテ表ハサルヽヲ以テ幾何學的ニ之ヲ求ムルコト能ハス次ニ此場合ニ於ケル土壓力働點ヲ求ムル方法ヲ述フ可シ

(a) ノ場合

(18)式ニヨリテ

$$p=\frac{w\sin(\alpha+\varphi)(h+h'+h_1)}{\sin^2(\alpha+2\varphi)}\left\{1+L-2\sqrt{L}\frac{(h+h'+h_1)^2-h_1^2-\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)}{\sqrt{\left[(h+h'+h_1)^2-h_1^2-\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)\right]^2-\left\{\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)\right\}^2}}\right\}$$

今　$h+h'+h_1=x$　　$h_1^2=a^2$　　$\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)=b^2$ トスレハ

$$p=\frac{w\sin(\alpha+\varphi)\,x}{\sin^2(\alpha+2\varphi)}\left\{1+L-2\sqrt{L}\frac{x^2-a^2-b^2}{\sqrt{(x^2-a^2-b^2)^2-b^4}}\right\}$$

力率ノ中心ヲ壁頂ヨリ $h'+h_1$ ノ高サニ取リ土壓力ノ力率ヲ求ムレハ

$$\int_{h'+h_1}^{h+h'+h_1}p\,x\,dx=\frac{w\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\int_{h'+h_1}^{h+h'+h_1}\left[(1+L)x^2-2\sqrt{L}\frac{(x^2-a^2-b^2)\,x^2}{\sqrt{(x^2-a^2-b^2)^2-b^4}}\right]dx$$

$$\int(1+L)x^2\,dx=(1+L)\frac{x^3}{3}$$

$$-\sqrt{L}\int\frac{2\,(x^2-a^2-b^2)\,x^2\,dx}{\sqrt{(x^2-a^2-b^2)^2-b^4}}=\quad-\sqrt{L}\,x\sqrt{(x^2-a^2-b^2)^2-b^4}+\sqrt{L}\int\sqrt{(x^2-a^2-b^2)^2-b^4}\;dx$$

$$-\frac{a^2\sqrt{L}}{3}\int\frac{(x^2-a^2-2b^2)^{\frac{3}{2}}}{x^2\sqrt{x^2-a^2}}dx=-\frac{a^2\sqrt{L}}{3}\int\frac{(x^2-a^2-2b^2)}{x^2}\sqrt{1-\frac{2b^2}{x^2-a^2}}dx$$

$$=-\frac{a^2\sqrt{L}}{3}\int\frac{(x^2-a^2-2b^2)}{x^2}\left(1-\frac{2b^2}{2(x^2-a^2)}-\frac{4b^4}{2.4(x^2-a^2)^2}-\frac{1.3.8\,b^6}{2.4.6\,(x^2-a^2)^3}-\cdots\right)dx$$

$$=-\frac{a^2\sqrt{L}}{3}\int\left(1-\frac{a^2+3b^2}{x^2}+\frac{1.5\,b^4}{x^2\,(x^2-a^2)}+\frac{b^6}{2x^2(x^2-a^2)^2}+\cdots\cdots\right)dx$$

$$\doteqdot-\frac{a^2\sqrt{L}}{3}\left[x+\frac{a^2+3b^2}{x}+\frac{1.5\,b^4}{a^2x}+\frac{1.5\,b^4}{2\,a^3}\log\frac{x-a}{x+a}-\frac{b^6}{10x^5}\right]$$

$$\doteqdot-\frac{a^2\sqrt{L}}{3}\left[\frac{x^2+a^2+3b^2}{x}-\frac{1.5\,b^4}{3x^3}-\frac{b^4\,(b^2+4a^2)}{10x^5}\right]$$

故ニ

$$\int_{h'+h_1}^{h+h'+h_1}p\,x\,d\,x=\Bigg[\frac{w\,sin(\alpha+\varphi)}{3\,sin^2(\alpha+2\varphi)}\Bigg\{(1+L)x^3-\frac{\sqrt{L}\,(2x^2+a^2+3b^2)\sqrt{x^2-a^2}\,\sqrt{x^2-a^2-2b^2}}{x}$$

$$-a^2\sqrt{L}\left[\frac{x^2+a^2+3b^2}{x}-\frac{1.5\,b^4}{3x^3}-\frac{b^4\,(b^2+4\,a^2)}{10x^5}\right]\Bigg\}\Bigg]_{h'+h_1}^{h+h'+h_1}$$

$$=\frac{w\,sin(\alpha+\varphi)}{3\,sin^2(\alpha+2\varphi)}\Bigg[(1+L)\{(h+h'+h_1)^3-(h'+h_1)^3\}$$

$$-\frac{\sqrt{L}\left\{2(h+h'+h_1)^2+h_1^2+h'(h'+2h_1)\left(1-\frac{1}{L}\right)\right\}\sqrt{(h+h'+h_1)^2-h_1^2}\sqrt{(h+h'+h_1)^2-h_1^2-h'(h'+2h_1)\left(1-\frac{1}{L}\right)}}{(h+h'+h_1)}$$

$$+\frac{\left\{2(h'+h_1)^2+h_1^2+h'(h'+2h_1)\left(1-\frac{1}{L}\right)\right\}h'(h'+2h_1)}{(h'+h_1)}$$

$$-\sqrt{L}h_1^2\Bigg[h+\frac{2h_1^2+3h'(h'+2h_1)\left(1-\frac{1}{L}\right)}{2}\left(\frac{1}{h+h'+h_1}-\frac{1}{h'+h_1}\right)$$

$$-\frac{1.5h'^2(h'+2h_1)^2\left(1-\frac{1}{L}\right)^2}{12}\left(\frac{1}{(h+h'+h_1)^3}-\frac{1}{(h'+h_1)^3}\right)$$

$$-\frac{h'^2(h'+2h_1)^2\left(1-\frac{1}{L}\right)^2}{4}\left\{\frac{h'(h'+2h_1)}{2}\left(1-\frac{1}{L}\right)+4h_1^2\right\}\left\{\frac{1}{(h+h'+h_1)^5}-\frac{1}{(h'+h_1)^5}\right\}\Bigg]\Bigg)\cdots(23)$$

壁底ヨリ土壓力働點マデノ高ヲkhトスレハ

$$\Bigg[(1+L)\{(h+h'+h_1)^3-(h'+h_1)^3\}$$

$$-\sqrt{L}\frac{\left\{2(h+h'+h_1)^2+h_1^2+h'(h'+2h_1)\left(1-\frac{1}{L}\right)\right\}\sqrt{(h+h'+h_1)^2-h_1^2}\sqrt{(h+h'+h_1)^2-h_1^2-h'(h'+2h_1)\left(1-\frac{1}{L}\right)}}{(h+h'+h_1)}$$

$$+\frac{\left\{2(h'+h_1)^2+h_1^2+h'(h'+2h_1)\left(1-\frac{1}{L}\right)\right\}h'(h'+2h_1)}{(h'+h_1)}\Bigg]$$

$$kh=h+h'+h_1-\frac{2}{3}\frac{\left[\begin{array}{l}-\sqrt{L}\,h_1^2\left\{h-\dfrac{2h_1^2+3h'(h'+2h_1)\left(1-\dfrac{1}{L}\right)}{2(h+h'+h_1)(h'+h_1)}h\right.\\ \qquad\left.+\dfrac{1.5h'^2(h'+2h_1)^2\left(1-\dfrac{1}{L}\right)^2\{(h+h'+h_1)^3-(h'+h_1)^3\}}{12(h+h'+h_1)^3(h'+h_1)^3}\right\}\\ -\sqrt{L}\,h_1^2\dfrac{h'^2(h'+2h_1)^2\left(1-\dfrac{1}{L}\right)^2\left\{h'(h'+2h_1)\left(1-\dfrac{1}{L}\right)+8h_1^2\right\}\{(h+h'+h_1)^5-(h'+h_1)^5\}}{80(h+h'+h_1)^5(h+h_1)^5}\end{array}\right]}{\left[\sqrt{(h+h'+h_1)^2-h_1^2}-\sqrt{L}\sqrt{(h+h'+h_1)^2-h_1^2-h'(h'+2h_1)\left(1-\dfrac{1}{L}\right)}\right]^2}$$

… … … (24)

土壓力ノ力率ヲ求ムルニ當リ省略セル項カ幾何ノ影響ヲ有スルヤヲ考究スル爲メニ(23)式ヲ x ニ就キテ微分シ之ヲ x ニテ除シ以テ得タル土壓力ノ強度ヲ p' トスレハ

$$p'=\frac{w\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left[(1+L)x-2\sqrt{L}\frac{(x^2-a^2-b^2)x}{\sqrt{(x^2-a^2-b^2)^2-b^4}}+\frac{\sqrt{L}a^2}{3x^3}\left\{\frac{(x^2-a^2-2b^2)^{\frac{3}{2}}}{\sqrt{x^2-a^2}}-\left(x^2-a^2-3b^2+1.5\frac{b^4}{x^2}+\frac{b^4(b^2+4a^2)}{2x^4}\right)\right\}\right]$$

然ルニ

$$p=\frac{w\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left[(1+L)x-2\sqrt{L}\frac{(x^2-a^2-b^2)x}{\sqrt{(x^2-a^2-b^2)^2-b^4}}\right]$$

ナルヲ以テ p' ト p トノ差ハ

$$\frac{w\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\ \frac{\sqrt{L}a^2}{3x^3}\left\{\frac{(x^3-a^2-2b^2)^{\frac{3}{2}}}{\sqrt{x^2-a^2}}-\left(x^2-a^2-3b^3+\frac{1.5\,b^4}{x^2}+\frac{b^4(b^2+4a^2)}{2\,x^2}\right)\right\}$$

ニシテ此差ハ$b=0$ノトキ乃チ$h'=0$ $L=1$ノ場合及$a=0$ノ場合ニハ零トナルヲ以テp'トpトノ差ハLカ最大及最小ノトキ最大ナリ故ニ$L=3$及$L=0.36$ノ場合ニ$h_1=6'$ $h'=3'$ $6'$ $12'$及$24'$トシ又

$$(1+L)x-\frac{2\sqrt{L}(x^2-a^2-b^2)x}{\sqrt{(x^2-a^2-b^2)^2-b^4}}=A$$

$$\frac{\sqrt{L}a^2}{3x^3}\left\{\frac{(x^2-a^2-2b^2)^{\frac{3}{2}}}{\sqrt{x^2-a^2}}-\left(x^2-a^2-3b^2+\frac{1.5b^4}{x^2}+\frac{b^4(b^2+4a^2)}{2x^4}\right)\right\}=B$$

トシA及Bノ値ヲ算出スレハ次表ノ如ク其差極メテ小ナルヲ以テ(24)式ハ土壓力働點ノ高ヲ求ムル公式トシテ實用上差間ナキモノト云フヲ得ヘシ

$L=3$　$h_1=6'$

h' / 壁頂ヨリノ垂直距離	3′		6′		12′		24′	
	A	B	A	B	A	B	A	B
0′	0.	+0.0504	0.	+0.0200	0.0	+0.0079	0.	+0.0046
1′	3.6130	+0.0130	3.5048	+0.0069	3.5050	+0.0039	3.6022	+0.0031
2′	4.9896	+0.0036	5.3214	+0.0023	5.7960	+0.0020	6.3744	+0.0022
3′	5.8800	+0.0010	6.5385	+0.0007	7.4697	+0.0006	8.6031	+0.0016
4′	6.6001	−0.0021	7.4832	+0.0001	8.7890	+0.0005	10.4550	+0.0011
6′	7.8465	−0.0001	9.0018	−0.0004	10.8504	+0.0000	13.4244	+0.0006
8′	8.9947	−0.0001	10.2940	−0.0002	12.5008	−0.0001	15.7814	+0.0003
10′	10.1061	−0.0001	11.4994	−0.0001	13.9384	−0.0001	17.7600	+0.0002
12′	11.2014	−0.0000	12.6504	−0.0001	15.2580	−0.0001	19.5048	+0.0001
14′	12.2889	−0.0000	13.7774	−0.0000	16.5050	−0.0000	21.0848	+0.0000
16′	13.3700	−0.0000	14.8848	−0.0000	17.5882	−0.0000	22.5492	+0.0000

$L=0.36 \quad h_1=6'$

壁頂ヨリノ垂直距離 \ h'	3′		6′		12′		24′	
	A	B	A	B	A	B	A	B
0′	0.	+0.0101	0.	−0.0111	0.	+0.0110	0.	+0.0203
1′	0.6000	−0.0023	0.4979	−0.0082	0.4408	+0.0064	0.4185	+0.0154
2′	1.0274	−0.0034	0.9170	−0.0057	0.8480	+0.0037	0.8192	+0.0118
3′	1.0788	−0.0027	1.2825	−0.0040	1.2264	+0.0022	1.2045	+0.0091
4′	1.6458	−0.0018	1.6080	−0.0027	1.5796	+0.0013	1.5776	+0.0070
6′	2.1195	−0.0008	2.1708	−0.0014	2.2248	+0.0004	2.2824	+0.0043
8′	2.5279	−0.0004	2.6600	−0.0007	2.8028	+0.0001	2.9450	+0.0027
10′	2.9013	−0.0002	3.0998	−0.0004	3.3320	−0.0000	3.5640	+0.0017
12′	3.2571	−0.0001	3.5064	−0.0002	3.8220	−0.0001	4.1496	+0.0011
14′	3.6018	−0.0001	3.8922	−0.0001	4.2816	−0.0001	4.6332	+0.0007
16′	3.9400	−0.0000	4.2616	−0.0001	4.7158	−0.0000	5.2348	+0.0005

(*b*) $h'=0$ ノ場合

$$kh=\frac{h}{3}\,\frac{h+3h_1}{h+2h_1} \text{ 或ハ } k=\frac{h+3h_1}{3(h+2h_1)} \qquad \cdots\cdots(25)$$

(*c*) $h'=0 \quad h_1=0$

$$kh=\frac{h}{3} \text{ 或ハ } k=\frac{1}{3} \qquad \cdots\cdots(26)$$

(*d*) $h_1=0$ ノ場合、(24) 式ヨリ

$$kh=h+h'-\frac{2}{3}\,\frac{(1+L)\{(h+h')^3-h'^3\}+\frac{h'^3}{L}(3L-1)-\frac{1}{L}\Big\{2Lh(h+2h')+h'^2(3L-1)\Big\}\sqrt{h(h+2h')L+h'^2}}{\{h+h'-\sqrt{h(h+2h')L+h'^2}\}^2}\quad\cdots\cdots(27)$$

(e) $h_1=0$　$h'=\infty$ ノ場合

$$kh=\frac{h}{3}\ \text{或ハ}\ k=\frac{1}{3}\quad\cdots\cdots(28)$$

次ニ(a)及(d)ノ場合ニ於ケルkノ圖表並ニL及$\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}$ノ値ヲ擧クヘシ

$$L=\frac{\sin\varphi\sin2\varphi}{\sin(\alpha+2\varphi)\sin\alpha}=\frac{2\cot\varphi(1+\cot^2\alpha)}{(\cot\varphi+\cot\alpha)(1+\cot^2\varphi)}$$

$$\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}=\frac{(\cot\varphi+\cot\alpha)\sqrt{1+\cot^2\alpha}\ \sqrt{(1+\cot^2\varphi)^3}}{(\cot^2\varphi-1+\cot\varphi\cot\alpha)^2}$$

$\cot\alpha$	$L=\frac{\sin\varphi\sin2\varphi}{\sin\alpha\sin(\alpha+2\varphi)}$			$\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}$		
	$\cot\varphi=1$	$\cot\varphi=1.5$	$\cot\varphi=2$	$\cot\varphi=1$	$\cot\varphi=1{\cdot}5$	$\cot\varphi=2$
−0.6	3.4000	1.3949	0.7771	3.6650	50.1996	5.6339
−0.5	2.5000	1.1538	0.6667	6.3245	26.2022	4.6875
−0.4	1.9333	0.9734	0.5800	11.4236	16.4293	3.9807
−0.3	1.5571	0.8385	0.5129	22.9675	11.4881	3.4450
−0.2	1.3000	0.7385	0.4622	57.6887	8.4201	3.0360
−0.1	1.1222	0.6659	0.4253	255.8289	6.8129	2.7230
0	1.0000	0.6154	0.4000	∞	5.6247	2.4845

+0.1	0.9182	0.5827	0.3848	312.6798	4.8067	2.3043
+0.2	0.8667	0.5647	0.3782	86.5330	4.2279	2.1699
+0.3	0.8385	0.5590	0.3791	42.6540	3.8099	2.0715
+0.4	0.8286	0.5636	0.3867	26.6552	3.5032	2.0014
+0.5	0.8333	0.5769	0.4000	18.9736	3.2753	1.9531
+0.6	0.8500	0.5978	0.4185	14.6600	3.1041	1.9218

$sin(\alpha+2\varphi)=0$ ノ場合ニハ上記ノ公式ニヨリテ土壓力ノ强度及其働點ノ位置ヲ求ムルコト能ハサルニヨリ次ニ $sin(\alpha+2\varphi)=0$ ノ場合ヲ述フヘシ

$sin(\alpha+2\varphi)=0$ ノ場合. (13)式ヨリ

$$P=\frac{w(h+h'+h_1')^2 sin(\alpha+\varphi)}{2\,sin^2(\alpha+2\varphi)}\left\{1-\sqrt{1-\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{sin(\alpha-\varphi)\,sin(\alpha+2\varphi)}{sin\,\alpha\,sin(\alpha+\varphi)}}\right\}^2$$

$$=\frac{w(h+h'+h_1')^2 sin(\alpha+\varphi)}{2\,sin^2(\alpha+2\varphi)}\left\{1-1+\frac{1}{2}\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{h+h'}\right\}\frac{sin(\alpha-\varphi)\,sin(\alpha+2\varphi)}{sin\,\alpha\,sin(\alpha+\varphi)}+\cdots\cdots\cdots\right\}^2$$

$sin(\alpha+2\varphi)=0$ トスレハ上式ヨリ

$$P=\frac{w(h+h'+h_1')^2}{8}\left\{\frac{hh'}{(h+h'+h_1')^2}+\frac{h}{(h+h')}\right\}^2\frac{sin^2(\alpha-\varphi)}{sin^2\alpha\,sin(\alpha+\varphi)}$$

$(h+h'+h_1')^2=(h+h')(h+h'+2h_1)$ ナルヲ以テ

$$P=\frac{w\,sin^2(\alpha-\varphi)}{8\,sin^2\alpha\,sin(\alpha+\varphi)}\,\frac{\{(h+h'+h_1)^2-(h'+h_1)^2\}^2}{(h+h'+h_1)^2-h_1^2}\quad\cdots\cdots\cdots\cdots\cdots\cdots(29)$$

(b) $h'=0$ ノ場合 (29)ヨリ

$$P=\frac{w\sin^2(\alpha-\varphi)\,h(h+2h_1)}{8\sin^2\alpha\sin(\alpha+\varphi)}\quad\cdots\cdots\cdots(30)$$

又

$$\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left\{1-\sqrt{L}\right\}^2=\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left\{1-\sqrt{1-\frac{\sin(\alpha-\varphi)\sin(\alpha+2\varphi)}{\sin\alpha\sin(\alpha+\varphi)}}\right\}^2$$

$$=\sin(\alpha+\varphi)\left\{\frac{1}{2}\,\frac{\sin(\alpha-\varphi)}{\sin\alpha\sin(\alpha+\varphi)}+\frac{1}{2.4}\,\frac{\sin^2(\alpha-\varphi)\sin(\alpha+2\varphi)}{\sin^2\alpha\sin^2(\alpha+\varphi)}+\cdots\cdots\right\}^2$$

故ニ $\sin(\alpha+2\varphi)=0$ ナル場合ニハ

$$\frac{\sin(\alpha+\varphi)}{\sin^2(\alpha+2\varphi)}\left\{1-\sqrt{L}\right\}^2=\frac{\sin^2(\alpha-\varphi)}{4\sin^2\alpha\sin(\alpha+\varphi)}$$

ナルヲ以テ(14)ヨリモ亦(30)ト同一ノ結果ヲ得ヘシ

(c)　$h'=0$　$h_1=0$

$$P=\frac{w\sin^2(\alpha-\varphi)h^2}{8\sin^2\alpha\sin(\alpha+\varphi)}\quad\cdots\cdots\cdots(31)$$

(d)　$h_1=0$　(29)ヨリ

$$P=\frac{w\sin^2(\alpha-\varphi)}{8\sin^2\alpha\sin(\alpha+\varphi)}\,\frac{\{(h+h')^2-h'^2\}^2}{(h+h')^2}\quad\cdots\cdots\cdots(32)$$

(e)　$h'=\infty$　(32)ヨリ

$$P=\frac{w\sin^2(\alpha-\varphi)}{8\sin^2\alpha\sin(\alpha+\varphi)}\,\frac{h^2(h+2h')^2}{(h+h')^2}$$

$$=\frac{w\sin^2(\alpha-\varphi)h^2\left(2+\frac{h}{h'}\right)^2}{8\sin^2\alpha\sin(\alpha+\varphi)\left(1+\frac{h}{h'}\right)^2}$$

$h'=\infty$ トスレバ

$$P=\frac{w\sin^2(\alpha-\varphi)h^2}{2\sin^2\alpha\sin(\alpha+\varphi)}\quad\cdots\cdots\cdots(33)$$

土壓力ノ强度ヲ求ムレバ

$$\frac{dP}{dh}=p=\frac{w\sin^2(\alpha-\varphi)}{8\sin^2\alpha\sin(\alpha+\varphi)}\left[\frac{2\times2\{(h+h'+h_1)^2-(h'+h_1)^2\}(h+h'+h_1)}{(h+h'+h_1)^2-h_1^2}-\frac{2\{(h+h'+h_1)^2-(h'+h_1)^2\}^2(h+h'+h_1)}{\{(h+h'+h_1)^2-h_1^2\}^2}\right]$$

$$=\frac{w\sin^2(\alpha-\varphi)(h+h'+h_1)}{4\sin^2\alpha\sin(\alpha+\varphi)}\left[\frac{2\{(h+h'+h_1)^2-h_1^2\}\{(h+h'+h_1)^2-(h'+h_1)^2\}-\{(h+h'+h_1)^2-(h'+h_1)^2\}^2}{\{(h+h'+h_1)^2-h_1^2\}^2}\right]$$

$$=\frac{w\sin^2(\alpha-\varphi)(h+h'+h_1)}{4\sin^2\alpha\sin(\alpha+\varphi)}\left[1-\frac{h'^2(h'+2h_1)^2}{\{(h+h'+h_1)^2-h_1^2\}^2}\right]\quad\cdots\cdots\cdots(34)$$

$h_1=0$ ノ場合ニハ

$$p=\frac{w\sin^2(\alpha-\varphi)(h+h')}{4\sin^2\alpha\sin(\alpha+\varphi)}\left[1-\frac{h'^4}{(h+h')^4}\right]\quad\cdots\cdots\cdots(35)$$

土壓力ノ働點ノ高サヲ求ムル爲メニ壁頂ヨリ $h'+h_1$ ノ點ニ於テ土壓力ノ力率ヲ求ムレバ

$$\int_{h'+h_1}^{h+h'+h_1}px\,dx=\frac{w\sin^2(\alpha-\varphi)}{4\sin^2\alpha\sin(\alpha+\varphi)}\left[\int x^2dx-h'^2(h'+2h_1)^2\int\frac{x^2dx}{(x^2-h_1^2)^2}\right]$$

33

$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{x^3}{3}+h'^2(h'+2h_1)^2\left\{\frac{x}{2(x^2-h_1^2)}-\frac{1}{2}\int\frac{dx}{x^2-h_1^2}\right\}\right]$$

$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{x^3}{3}+h'^2(h'+2h_1)^2\frac{x}{2(x^2-h_1^2)}-\frac{h'^2(h'+2h_1)^2}{4h_1}log\,\frac{x-h_1}{x+h_1}\right]$$

$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{(h+h'+h_1)^3-(h'+h_1)^3}{3}+h'^2(h'+2h_1)^2\frac{(h+h'+h_1)}{2(h+h')(h+h'+2h_1)}-\frac{h'(h'+2h_1)(h'+h_1)}{2}\right.$$
$$\left.-\frac{h'^2(h'+2h_1)^2}{4h_1}\left\{log\,\frac{h+h'}{h+h'+2h_1}-log\,\frac{h'}{h'+2h_1}\right\}\right]$$

$$kh=h+h'+h_1$$
$$-2\frac{\dfrac{(h+h'+h_1)^3-(h'+h_1)^3}{3}+\dfrac{h'^2(h'+2h_1)^2(h+h'+h_1)}{2(h+h')(h+h'+2h_1)}-\dfrac{h'(h'+2h_1)(h'+h_1)}{2}-\dfrac{h'^2(h'+2h_1)^2}{4h_1}\left\{log\dfrac{h+h'}{h+h'+2h_1}-log\dfrac{h'}{h'+2h_1}\right\}}{\dfrac{\{(h+h'+h_1)^2-(h'+h_1)^2\}^2}{(h+h'+h_1)^2-h_1^2}}\quad\cdots\cdots\quad(36)$$

$h_1=0$ ノ場合ニハ
$$p=\frac{w\,sin^2(\alpha-\varphi)(h+h')}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[1-\frac{h'^4}{(h+h')^4}\right]$$

$$\int_{h'}^{h+h'}px\,dx=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\int x^2dx-h'^4\int\frac{dx}{x^2}\right]$$

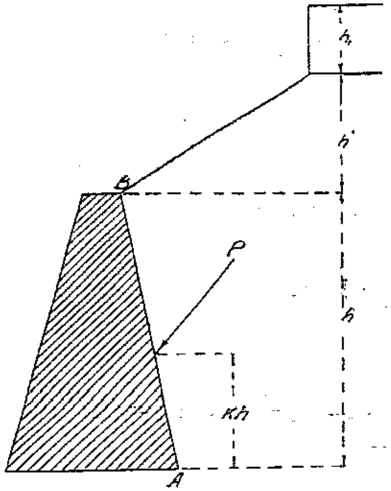
$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{x^3}{3}+\frac{h'^4}{x}\right]$$

$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{(h+h')^3-h'^3}{3}+h'^4\left(\frac{1}{h+h'}-\frac{1}{h'}\right)\right]$$

$$=\frac{w\,sin^2(\alpha-\varphi)}{4\,sin^2\alpha\,sin\,(\alpha+\varphi)}\left[\frac{(h+h')^3-h'^3}{3}-\frac{hh'^4}{(h+h')h'}\right]$$

$$kh=h+h'-2\cdot\frac{\left\{\frac{(h+h')^3-h'^3}{3}-\frac{hh'^4}{h'(h+h')}\right\}}{\{(h+h')^2-h'^2\}^2}\times(h+h')^2\cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots(37)$$

此等ノ公式ヨリ土壓力働點ノ位置ヲ求メ得ヘシ而シテ過載アル場合ニ荷重 h_1 アルトキ及過載ノミアル場合ニ於ケル公式ハ複雜ナルヲ以テ次ニ特種ノ場合ニ於ケル k ノ價ヲ求メ表及圖表ヲ示スコトトセリ



第十四圖

35

土壓力働點ノ高サ

$$L=\frac{2\cot\varphi(1+\cot^2\alpha)}{(\cot\varphi+\cot\alpha)(1+\cot^2\varphi)}$$

過載アル場合ニ荷重 (h_1) アル時

$L=3.0,\ 2.0,\ 1.5,\ 0.75,\ 0.5,\ 0.36$

$$k=1+m+n-\frac{2}{3}\times\frac{\left[\begin{array}{l}(1+L)\{(1+m+n)^3-(1+n)^3\}+\dfrac{\left\{2(1+n)^2+1+n(2+n)\left(1-\frac{1}{L}\right)\right\}(2+n)n}{1+n}\\ -\sqrt{L}\times\dfrac{\left\{2(1+m+n)^2+1+n(2+n)\left(1-\frac{1}{L}\right)\right\}}{1+m+n}\sqrt{\{(1+m+n)^2-1\}\left\{(1+m+n)^2-1-n(2+n)\left(1-\frac{1}{L}\right)\right\}}\\ -\sqrt{L}\times\left[m-\dfrac{\left\{2+3n(2+n)\left(1-\frac{1}{L}\right)\right\}m}{2(1+m+n)(1+n)}+\dfrac{1.5n^2(2+n)^2\left(1-\frac{1}{L}\right)^2\{(1+m+n)^3-(1+n)^3\}}{12(1+m+n)^3(1+n)^3}\right]\\ -\sqrt{L}\times\dfrac{n^2(2+n)^2\left(1-\frac{1}{L}\right)^2\left\{n(2+n)\left(1-\frac{1}{L}\right)+8\right\}\{(1+m+n)^5(1+n)^5\}}{80(1+m+n)^5(1+n)^5}\end{array}\right]}{\left\{\sqrt{(1+m+n)^2-1}-\sqrt{L}\times\sqrt{(1+m+n)^2-1-n(2+n)\left(1-\frac{1}{L}\right)}\right\}^2}$$

$L=1.0$

$$k=1+m+n-2\times\frac{\left[\frac{(1+m+n)^3-(1+n)^3}{3}+\frac{n^2(2+n)^2(1+m+n)}{2(m+n)(2+m+n)}-\frac{n(2+n)(1+n)}{2}-\frac{n^2(2+n)^2}{4}\times\left\{\log\frac{m+n}{2+m+n}-\log\frac{n}{2+n}\right\}\right]}{\frac{\{(1+m+n)^2-(1+n)^2\}^2}{(1+m+n)^2-1}}$$

$$h=mh_1 \qquad \therefore m=\frac{h}{h_1} \qquad m=1,\ 2,\ 3,\ 4,\ 5$$

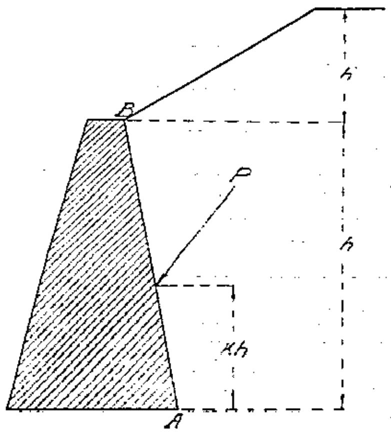
$$h_1=6'-0''$$

$$h'=nh_1 \qquad \therefore n=\frac{h'}{h_1} \qquad n=0.5,\ 1,\ 2,\ 4$$

k ノ 値

n \ L	0.36	0.50	0.75	1.00	1.50	2.00	3.00
$m=1.0$							
0.5	0.3721	0.3745	0.3793	0.3868	0.3919	0.3976	0.4055
1.0	.3639	.3667	.3686	.3705	.3782	.3838	.3923
2.0	.3362	.3532	.3577	.3574	.3651	.3701	.3785

0.5	0.3776	0.3819	0.3873	0.3918	0.3968	0.4006	0.4054
1.0	.3655	.3703	.3763	.3808	3.880	.3929	.3997
2.0	.3515	.3585	.3646	.3690	.3771	.3829	.3913
4.0	.3369	.3470	.3536	.3579	.3653	.3710	.3800
$m=3.0$							
0.5	0.3780	0.3816	0.3860	0.3892	0.3931	0.3957	0.3990
1.0	.3685	.3732	.3789	.3831	.3890	.3929	.3980
2.0	.3573	.3630	.3698	.3747	.3822	.3875	.3947
4.0	.3463	.3528	.3595	.3645	.3724	.3784	.3874
$m=4.0$							
0.5	0.3763	0.3797	0.3828	0.3852	0.3881	0.3901	0.3925
1.0	.3697	.3739	.3790	.3825	.3872	.3903	.3944
2.0	.3611	.3661	.3727	.3772	.3840	.3886	.3947
4.0	.3510	.3568	.3637	.3689	.3768	.3826	.3907
$m=5.0$							
0.5	0.3741	0.3767	0.3793	0.3812	0.3835	0.3849	0.3867
1.0	.3697	.3734	.3778	.3808	.3846	.3871	.3903
2.0	.3629	.3679	.3740	.3782	.3841	.3880	.3933
4.0	.3543	.3598	.3667	.3719	.3795	.3849	.3923



第十五圖

過載ノミアル場合

$L=3.0,\ 2.0,\ 1.5,\ 0.75,\ 0.5,\ 0.36$

$$k=(1+n)-\frac{2}{3}\times\frac{(1+L)\left\{(1+n)^3-n^3\right\}+n^3\left(3-\frac{1}{L}\right)-\left\{2(1+2n)+n^2\left(3-\frac{1}{L}\right)\right\}\sqrt{(1+2n)L+n^2}}{\left\{(1+n)-\sqrt{(1+2n)L+n^2}\right\}^2}$$

$L=1.0$

$$k=(1+n)-2\times\frac{\frac{(1+n)^3}{3}+\frac{n^4}{1+n}-\frac{4n^3}{3}}{\frac{(1+2n)^2}{(1+n)^2}}$$

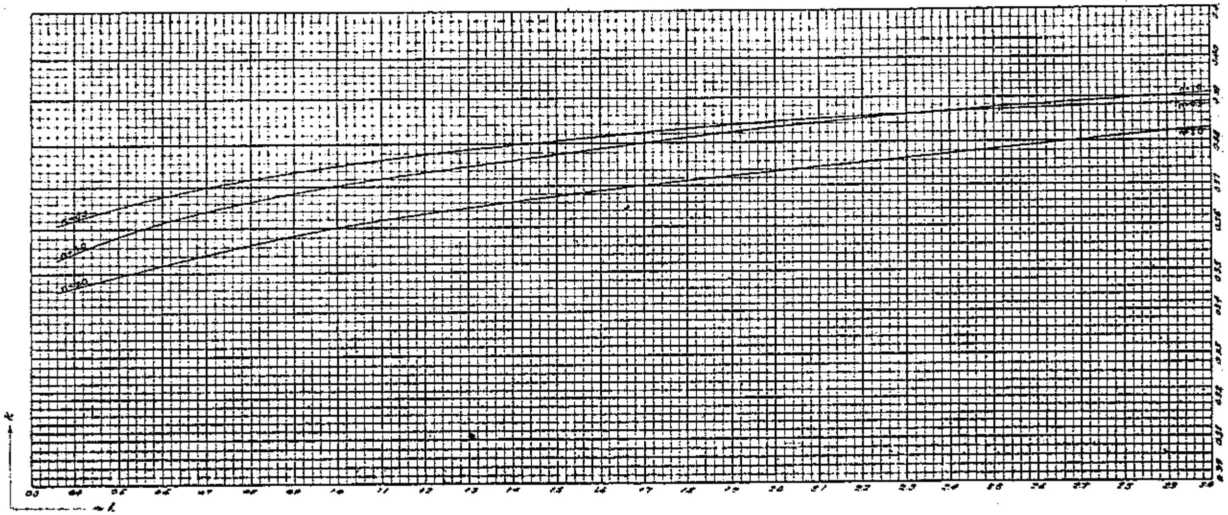
$h'=nh$

$n=0.5,\ 1,\ 2$

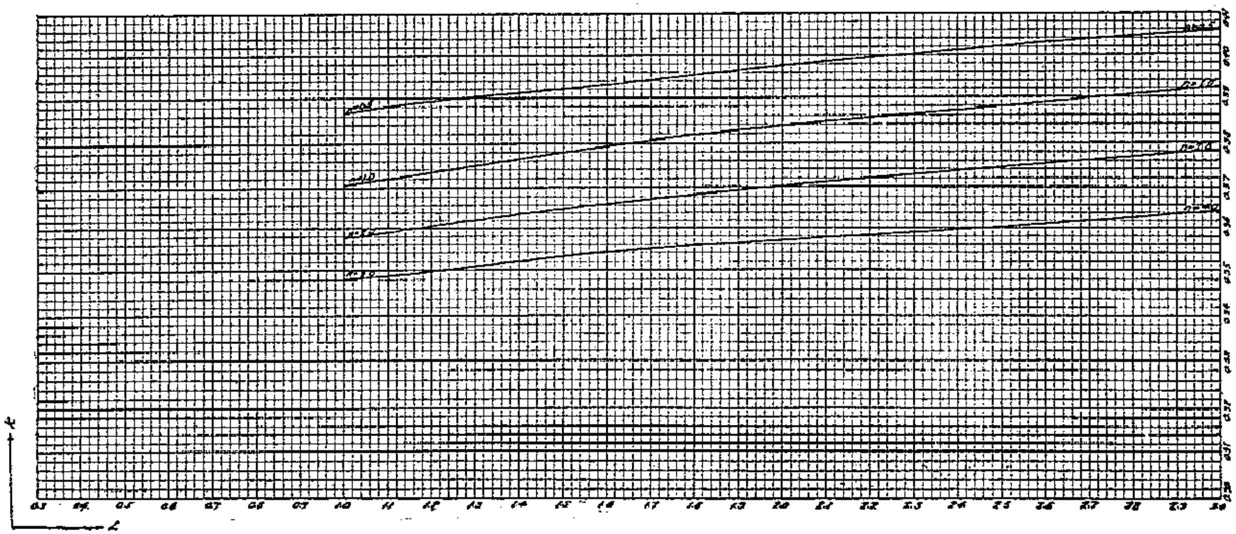
k ノ値

n \ L	0.36	0.50	0.75	1.00	1.50	2.00	3.00
0.5	0.3605	0.3652	0.3709	0.3750	0.3805	0.3841	0.38
1.0	.3534	.3583	.3651	.3704	.3780	.3835	.3911
2.0	.3457	.3494	.3552	.3600	.3677	.3738	.3828

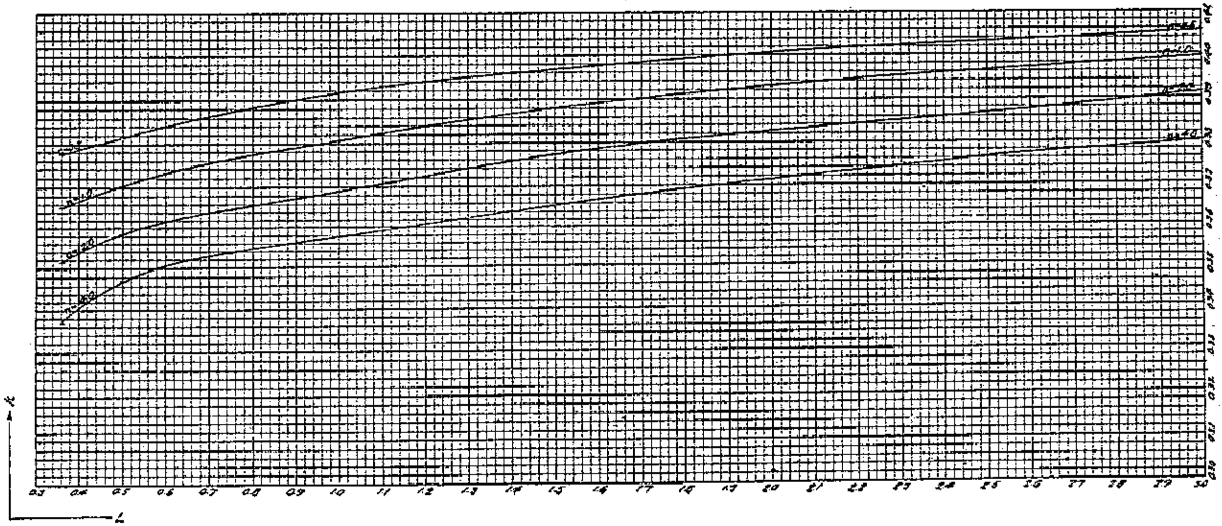
k ノ値　　　　(過載ノミアル場合)



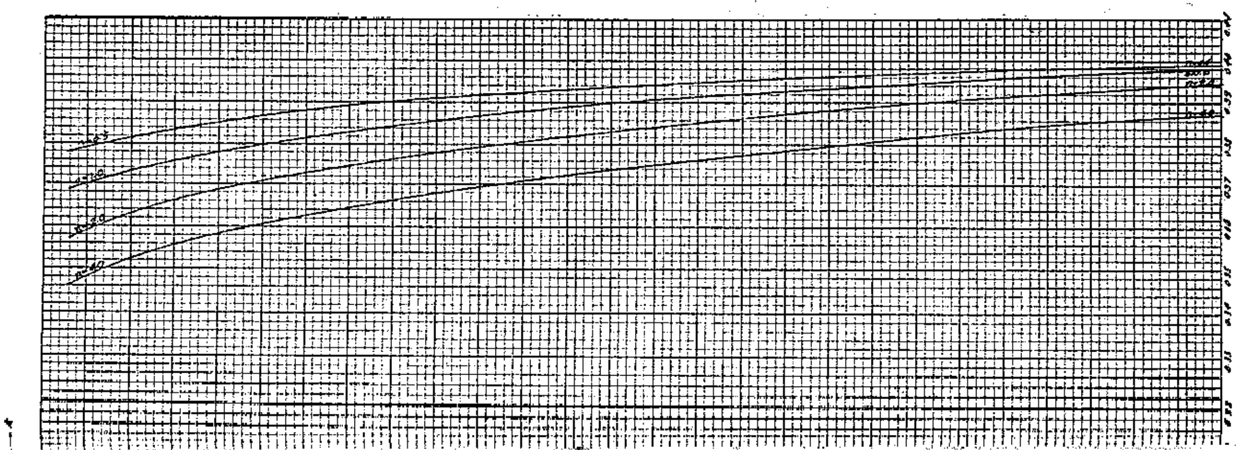
k ノ値　　　　(過載アル場合ニ荷重アルトキ $m=1.0$)

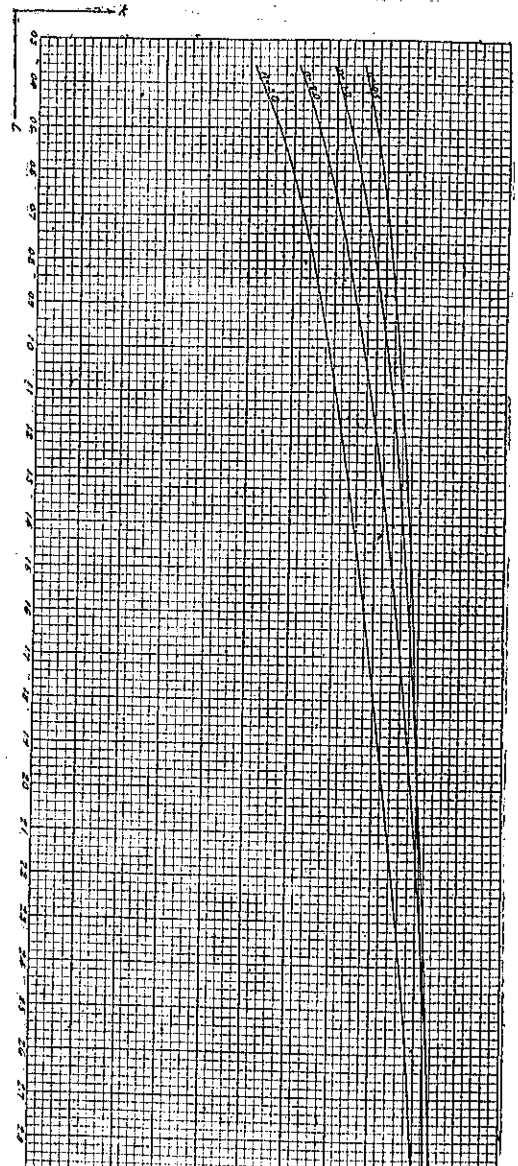


k ノ値 (過載アル場合ニ荷重アルトキ $m=2.0$)

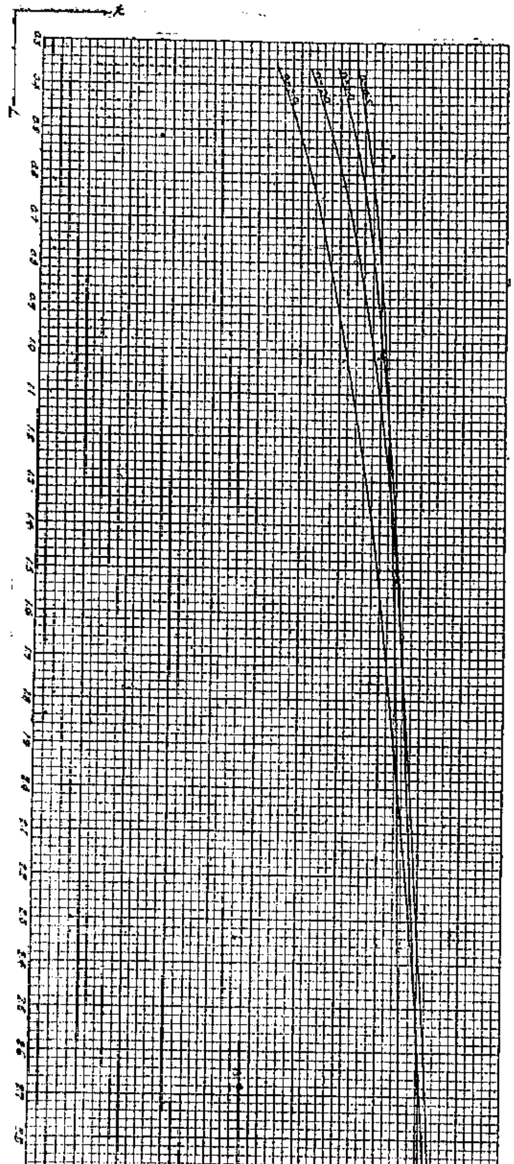


k ノ値 (過載アル場合ニ荷重アルトキ $m=3.0$)





k ノ値　(過載アル場合ニ荷重アルトキ m=4.0)



k ノ値　(過載アル場合ニ荷重アルトキ m=5.0)