国　際　連　合

メコン河下流域調査調整委員会

第二次調査報告

ノンカイ・ヴィエンチャン間 架橋計画

(ラオス国及びタイ国)

附　属　書

昭和43年11月

海外技術協力事業団

東　京

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序文

ノンカイ・ヴィエンチャン間架橋計画はメコン河下流域調査調整委員会による第29回会議において、メコン河下流域総合開発10ヶ年計画の最優先計画の1つとして採り上げられたものである。

本ノンカイ・ヴィエンチャン間架橋計画に関する可能性調査は1967年4月日本政府とメコン委員会の間に取り交わされた調査運用計画書に基づき2次に分けられて行なわれた。

第一次調査は1967年8月より10月迄の約2ヶ月に亘って行なわれ次いで第二次調査が1968年2月より6月迄の約4ヶ月に亘って行なわれた。

本附属書には地形測量、工質調査、材料調査、気象・水文資料解析、経済調査等の現場調査及び研究成果が編纂されている。

従って本附属書はノンカイ・ヴィエンチャン間架橋計画に関する第二次調査報告書の補足の役割を果す重要な附属書として編集されたものである。

ハシカイ・ウイエンチャン浦架橋計画

附属書

目　次

第一章

地形測量

目次

11. 測量作業内容

第一次及び第二次調査において行なわれた測量作業内容

作業内容	測定場所
第一次調査	
1. 水準点測量（往復測定）	○ ヴィエンチャンよりパモン、ヴィエンチャン、ノンカイの各架橋候補地点迄の間
2. 深浅測量（器械の精度 1/100）	○ 上記三架橋候補地点のメコン河河床
3 メコン河の河幅を測定するための三角測量	○ 上記三候補地点
第二次調査	
1. 計画地域内の水準点を統一するための水準測量（往復測定）	○ 基準点 BM N-6 より BT を経て N.E.A. の作ったハイドロオフィス内の水準点迄。
2. 平板測量及び深浅測量（スケール 1/2,000. 1m コンター）	○ ノンカイ架橋地点周辺の計画地域全域
3. 路線測量（縦断測量は中心線より両側に 50m 中及び 100m 間隔に横断測量を行なった）	○ 両国の取付道路及び取付鉄道候補路線沿線
4 メコン河の正確な河幅を知るための三角測量	○ ノンカイ架橋地点

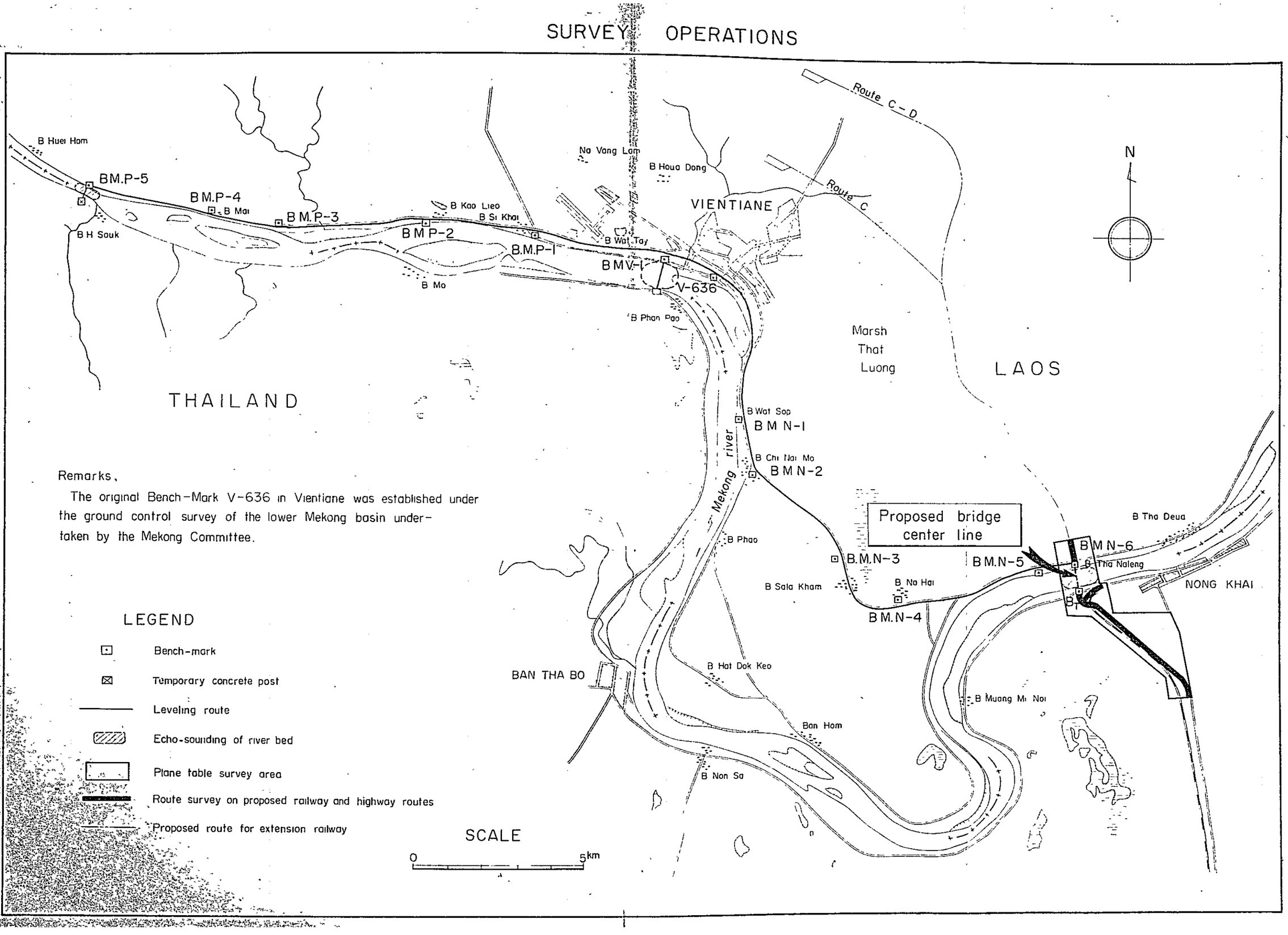
注、

1) パモン及びヴィエンチャン架橋候補地点に関して第一次調査中行なわれた測量作業成果は本附属書には編纂されていない。

2) 平板測量によるスケール 1:2,000 の実測平面図はこの附属書には添付しなかった。しかしスケールを 1:10,000 に縮小したものが第二次調査報告書の General Layout として掲載されている。

3) 路線測量の縦横断測量成果もまた本附属書には掲載されなかった。

SURVEY OPERATIONS



Remarks,

The original Bench-Mark V-636 in Vientiane was established under the ground control survey of the lower Mekong basin undertaken by the Mekong Committee.

LEGEND

- Bench-mark
- Temporary concrete post
- Leveling route
- Echo-sounding of river bed
- Plane table survey area
- Route survey on proposed railway and highway routes
- Proposed route for extension railway

SCALE

0 5km

12 水準点測量

1) 基準点 V636 はメコン委員会の認可を受けたもので サバニケオンに在る外務省の壁に打ち込まれた大くぎである。

2) 基準点 V636 より B.M. N-6 迄の水準測量は 第一次調査に於いてすでに完了しており 第二次調査に於いては B.M. N-6 より B.M. N-7 の間について行われ N.E.A によって設けられた ハイドロオフィスの水準点にも連結された。

3) B.M. N-6 及び B.M N-7 は 第一次調査に於いて選定された 斉橋中心線上に設置されたもので この B.M N-7 を第二次報告書の中では 便宜上 BT と呼んでいる。

4) ハイドロオフィス内に設けられている水準点の標高は コラットの平均海水面上 EL. 166.044 であり 一方 第二次調査において行なわれた水準測量の結果によれば EL. 165.861 であった。この違いは 18.3 cm である この問題については 第二次調査報告書の第二章を参照の事。

RESULTS OF LEVELING

ROUTE: Vientiane to Nong Khai bridge site

Unit: m

T. P. No.	DISTANCE	DIFFERENCE OF ELEVATION			ADJUST	ADJUSTED DIFFERENCE	ELEVATION	REMARKS
		1	2	MEAN				
V.636							170.105	Authorized
TPN-1		+0.084	+0.087	+0.085			170.190	
N-2		+0.751	+0.755	+0.753			170.943	
N-3		+0.558	+0.556	+0.557			171.500	
N-4		-0.855	-0.862	-0.859			170.641	Wat Sop
N-5		+0.230	+0.240	+0.235			170.876	
N-6		+0.088	+0.105	+0.096			170.972	GOV. B.M.S-S4C
N-7		+1.903	+1.902	+1.903			172.875	
N-8		+3.273	+3.272	+3.272			176.147	
N-9		-1.563	-1.565	-1.564			174,583	
N-10		-0.230	-0.235	-0.233			174.350	
N-11		-1.546	-1.549	-1.547			172.803	
N-12		-3.465	-3.464	-3.465			169.338	N.K.K B.M.43
N-13		-1.770	-1.760	-1.765			167.573	
N-14		+0.309	+0.309	+0.309			167.882	
N-15		-0.446	-0.450	-0.448			167.434	
N-16		-0.088	-0.097	-0.092			167.342	
N-17		+0.080	+0.081	+0.081			167.423	
N-18		+0.235	+0.229	+0.232			167.655	
N-19		+0.402	+0.409	+0.405			168.060	N.E.A. B.M.
BMN-6		+0.164	+0.164	+0.164			168.224	Laotian side
TPT-1		-12.172	-12.171	-12.171			156.053	
T-2		-0.653	-0.645	-0.649			155.404	
T-3		+0.277	+0.277	+0.277			155.681	
T-4		+10.180	+10.181	+10.180			165.861	N.E.A. B.M.
BMN-7		+0.713	+0.713	+0.713			166.574	Thai side

RESULTS OF LEVELING

Elevation of the bench-marks set on the leveling route

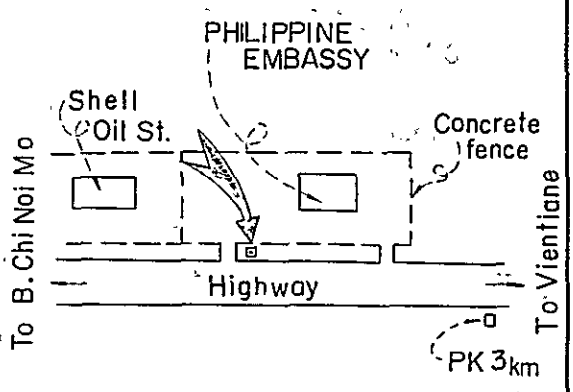
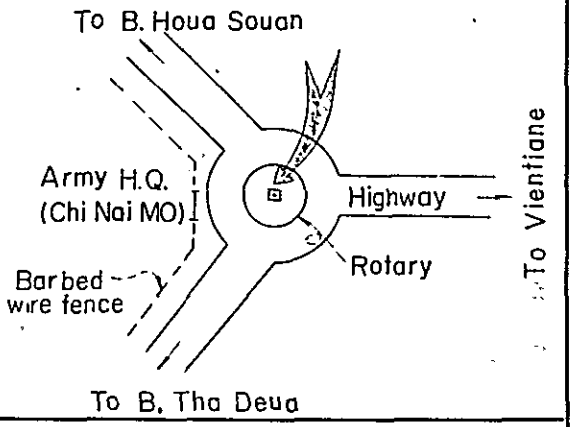
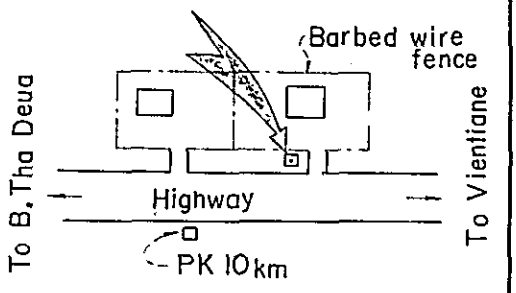
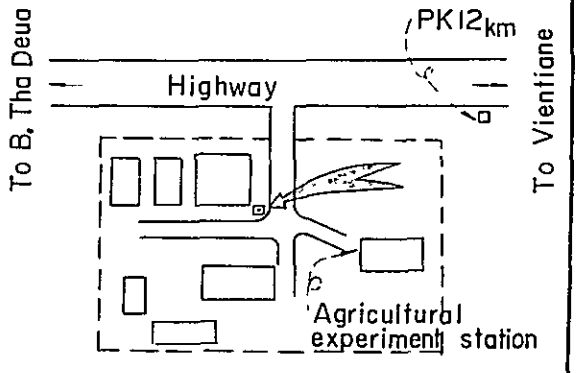
T. P. No.	DISTANCE	DIFFERENCE OF ELEVATION (m) 1	2	MEAN	ADJUST	ADJUSTED DIFFERENCE	ELEVATION (m)	REMARKS
TPN-3		-	-	-			171.500	
BMN-1		+2.878	+2.888	+2.883			174.383	
BMN-2		-	-	-			170.972	TPN-6
TPN-10		-	-	-			174.350	
BMN-3		+0.088	+0.087	+0.087			174.437	
TPN-13		-	-	-			167.573	
BMN-4		+0.218	+0.214	+0.216			167.789	
TPN-18		-	-	-			167.655	
BMN-5		-0.190	-0.191	-0.190			167.465	
Checking midway on the leveling:-								
TPN-4		-	-	-			170.641	
Zero point of staff gage in the Wat Sop G.S		-12.643	-	-12.643			157.998	

Remarks:

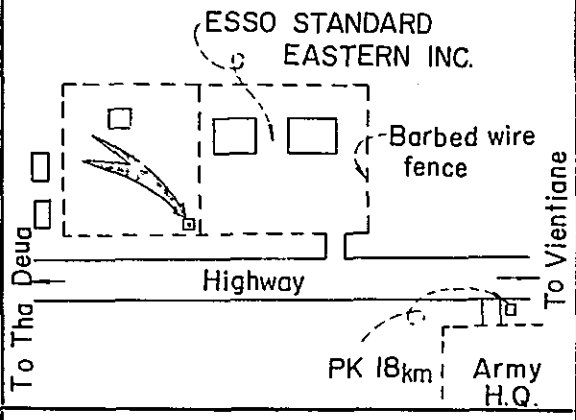
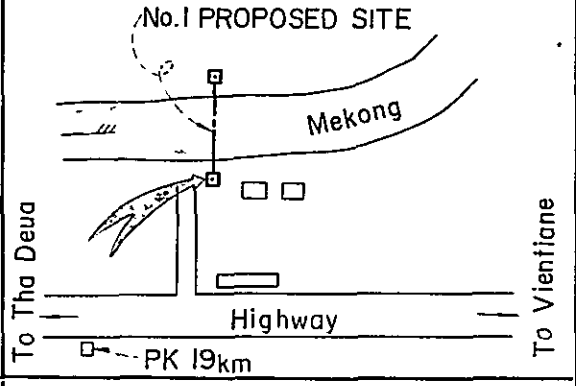
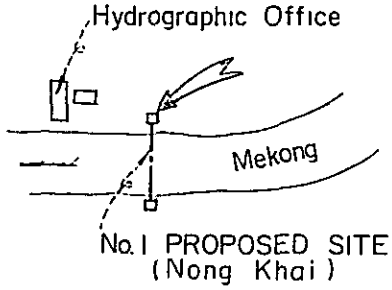
1) This leveling was of single-run.

2) Since the elevation of the zero point of staff gage in the Wat Sop gaging station is M.S.L.158.040 above the mean sea level at Ko Lak datum, the difference of the elevations is 4.2 centimeters.

Location of Bench-Marks (1)

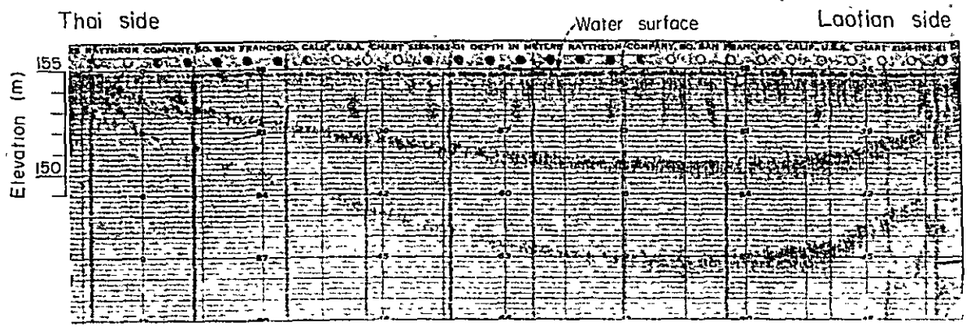
B. M. No.	DESCRIPTIONS		SKETCH
N-1	ELEVATION	174.383	
	LOCATION	Ban Wat Sop	
	ESTABLISHED ON	26 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		
N-2	ELEVATION	170.972	
	LOCATION	Ban Chi Nai Mo	
	ESTABLISHED ON	26 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		
N-3	ELEVATION	174.437	
	LOCATION	Ban 10 Km	
	ESTABLISHED ON	28 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		
N-4	ELEVATION	167.789	
	LOCATION	Ban Na Hai	
	ESTABLISHED ON	28 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		

Location of Bench-Marks (2)

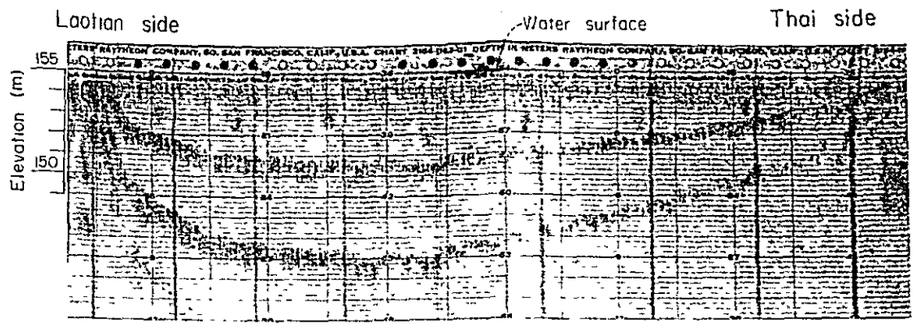
B. M. No.	DESCRIPTIONS		SKETCH
N-5	ELEVATION	167.465	
	LOCATION	Ban Tha Naleng	
	ESTABLISHED ON	28 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		
N-6	ELEVATION	168.224	
	LOCATION	Ban Tha Naleng (No.1 proposed site)	
	ESTABLISHED ON	28 Sep. 1967	
	CARVED ELEVATION		
	Concrete precast post		
N-7	ELEVATION	166.574	
	LOCATION	Nat Chommane (No.1 proposed site)	
	ESTABLISHED ON	9 Mar. 1968	
	CARVED ELEVATION		
	Concrete precast post		
	ELEVATION		
	LOCATION		
	ESTABLISHED ON		
	CARVED ELEVATION		

1.3. 深浅测量

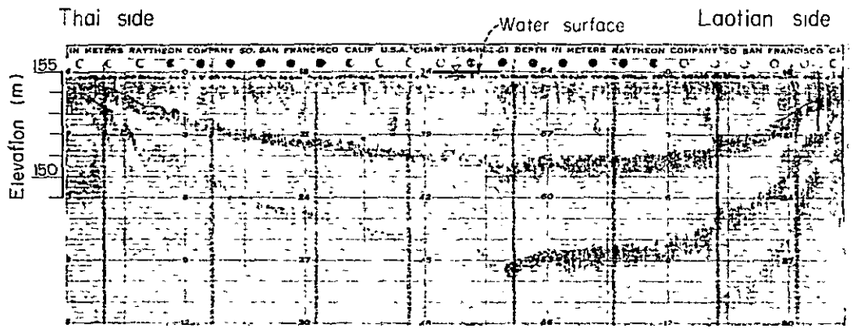
ECHO - SOUNDING RECORDS AT THE BRIDGE SITE



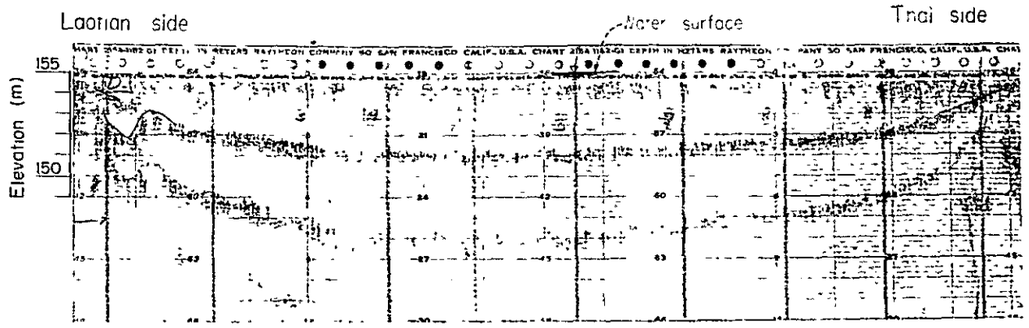
COURSE - A



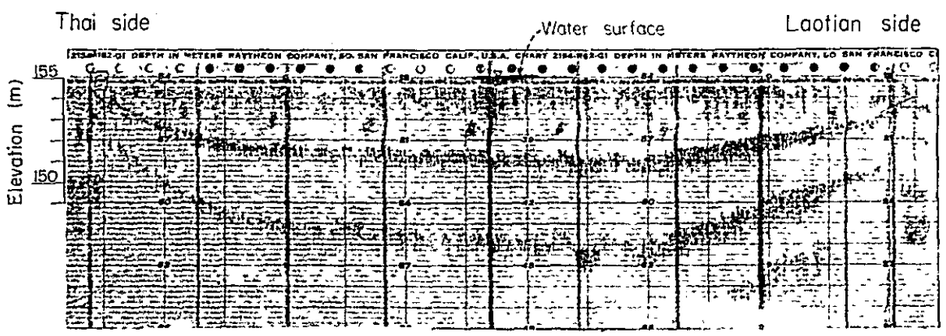
COURSE - B



COURSE - C



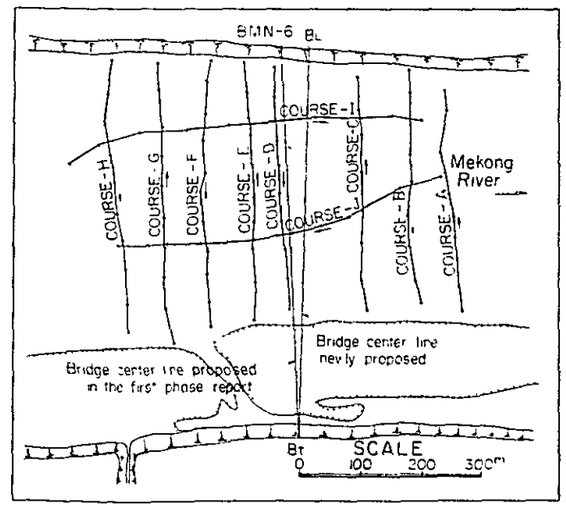
COURSE - D



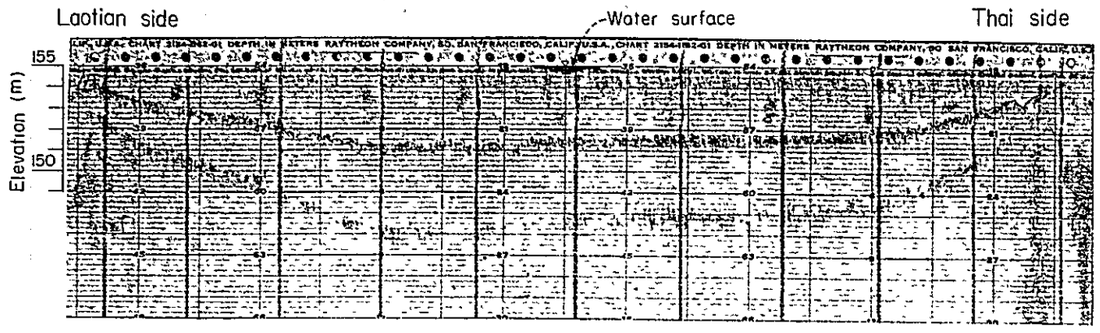
COURSE - E

Remarks

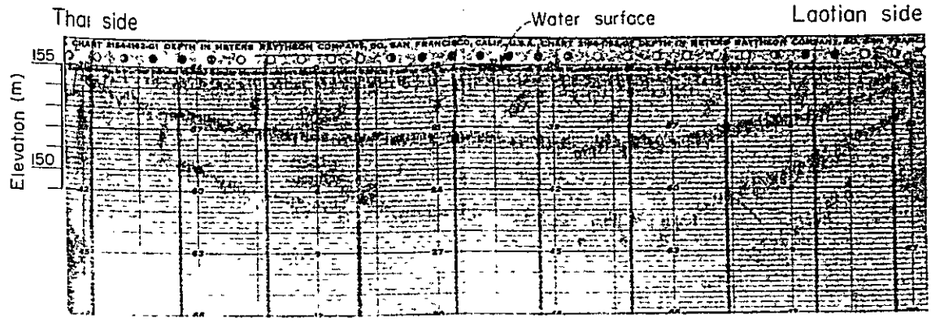
1) These records were taken on April 5 1968 in the second phase investigation
2) Water surface on April 5, 1968, EL. 155.0^{m}



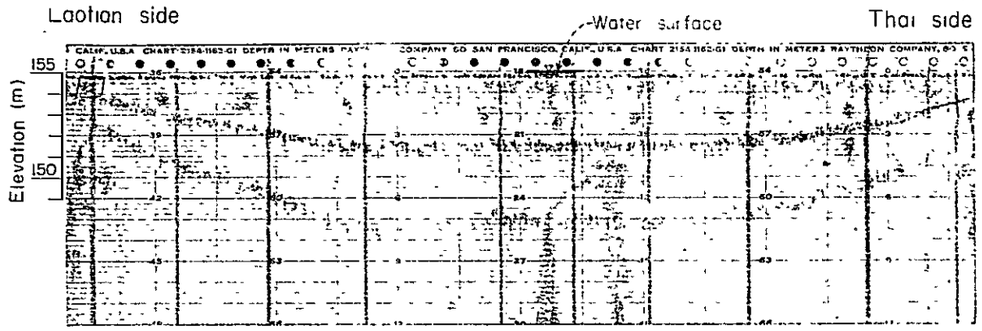
ECHO - SOUNDING RECORDS AT THE BRIDGE SITE - CONTINUED



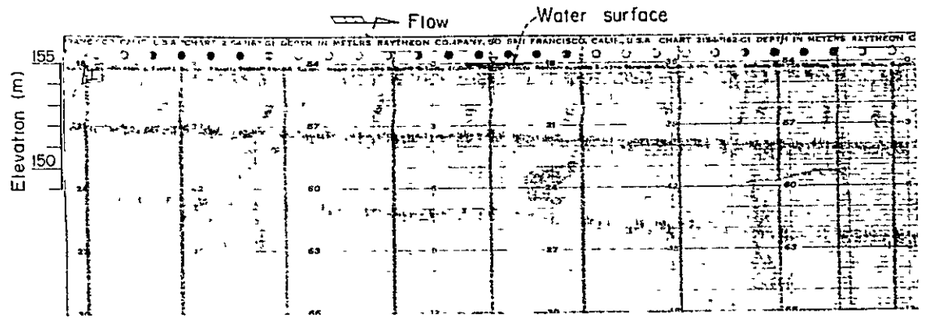
COURSE - F



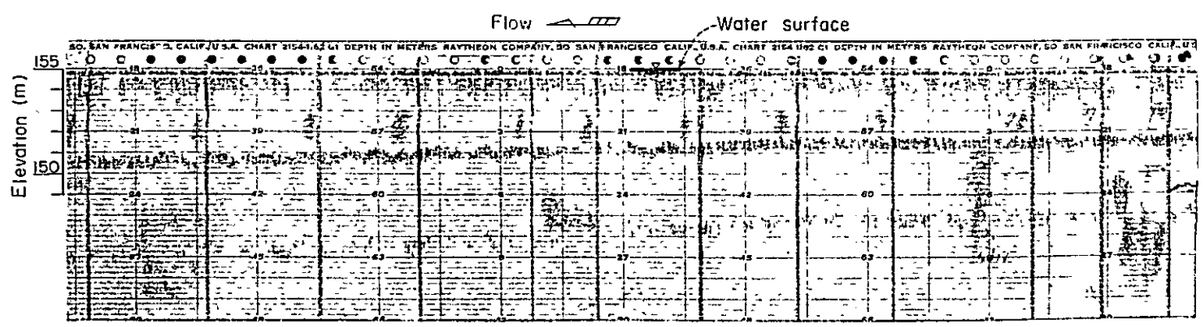
COURSE - G



COURSE - H



COURSE - I



COURSE - J

Remarks

1) These records were taken on April 5,1968 in the second phase investigation
2) Water surface on April 5.1968, EL.155.0^{m}

1.4. 三角測量

三角測量計算

1. 一般

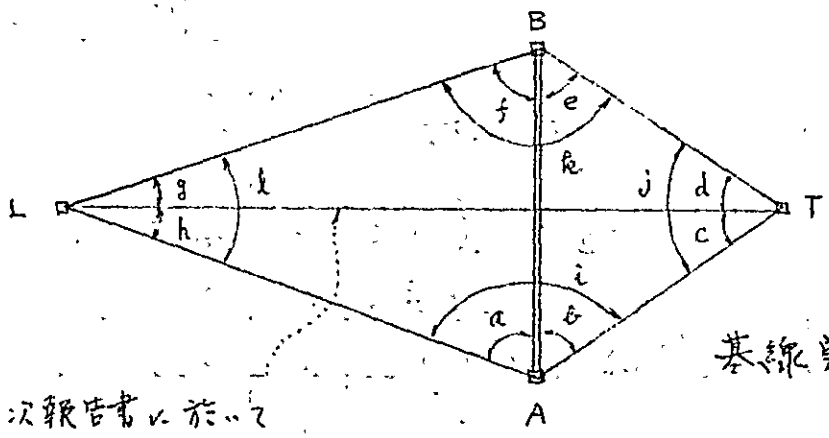
三角測量は、オ一次調査に次いでオ二次調査に於いても行なわれ、オ一次調査報告書に於いて選定された架橋中心線に沿ったメコン河の正確な河幅が測定された。

三角測量の基線はラオス側、タイ側のいずれの岸に設けても良いが、河岸はどちらも樹木が多く伐採にかなりの時間を要する処から河床敷にできた砂州上に設けられた。実測値は気温その他の影響による誤差を取り除くために各種の補正が行なわれた。

三角測量のために両岸に設けられた後の水準点間距離をも一緒に求めるべく測定資料を電子計算機にかけて計算された。尚、計算根拠は下に述べられる通りである。

2. 計算

基線 AB と四辺形 BLAT の角度は下図の如き測定を以って測定された。



基線実測長 $\overline{AB}$ = 200.00 m

オ一次報告書に於いて
選定された架橋中心線

図: 1

実測角は下記の通りである。

a.	75°43′15.0″	g	11°14′47.5″
b.	54°19′10.0″	h	10°42′00.0″
c.	39°15′55.0″	i.	130°02′00.0″
d.	37°15′05.0″	j.	76°31′10.0″
e:	49°10′00.0″	k	131°30′05.0″
f.	82°19′50.0″	l	21°56′32.5″

2.1. 基線補正

基線実測長は次の三項に示される式に当てはめて各項目についての補正が行なわれたが傾斜補正及び平均海面上への補正はその影響が小さいとみて省略した。

$$D = D_N + C_t + C_s + C_p$$

ここに
- D_N 基線実測長 200.00m
- D 補正基線長
- C_t 温度補正
- C_s たるみ補正
- C_p 張力補正

(1) 温度補正

$$C_t = D_N \cdot \alpha (T_m - T_o)$$

ここに
- T_o 標準温度 15°C
- T_m 平均気温 29°C
- α スチールテープの膨張係数 0.0000117 m/°C

$$C_t = 200 \times 0.0000117 \times (29 - 15)$$
$$= 0.03276 \text{ m}$$

(2) たるみ補正

$$C_S = -\frac{D_N}{24}\cdot\left(\frac{w\cdot d}{P}\right)^2$$

ここに　w：スチールテープ1m当りの重量　0.02158 kg/m
　　d：杭間隔　10 m
　　P：平均張力　10 kg

$$C_S = -\frac{200}{24}\times\left(\frac{0.02158\times 10}{10}\right)^2$$

$$= -0.00388\ \text{m}$$

(3) 張力補正

$$C_P = D_N\cdot\frac{(P-P_0)}{E\cdot S}$$

ここに　P：平均張力　10 kg
　　P_0：標準張力　7 kg
　　E：スチールの弾性係数　2.1×10^6 kg/cm²
　　S：スチールテープの断面積　0.02749 cm²

$$C_P = 200\times\frac{(10-7)}{2.1\times10^6\times 0.02749}$$

$$= 0.01040\ \text{m}$$

以上三つの補正により基線の修正長は次の通りなる。

$$D = 200 + 0.03276 - 0.0038 + 0.01040$$

$$= 200.03928\ (\text{m})$$

∴ 基線長 $\overline{AB}$ = 200.0393 m

2.2 角修正

2.2.1 条件

図1の四辺形BLATは次の3つの条件を満足するように修正されねばならない。

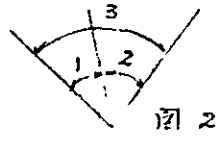


図2

i ∠1 + ∠2 = ∠3 (左図参照)

ii. 三角形の内角の総和は 180° である

iii. 三角形の辺の長さは計算の順序にかかわらず常に等しい。

この3つの条件は次の8つの式で表わされる。

測辺方程式

$$a_0 + b_0 = i_0 \quad \cdots (1)$$

$$c_0 + d_0 = j_0 \quad \cdots (2)$$

$$e_0 + f_0 = k_0 \quad \cdots (3)$$

$$g_0 + h_0 = l_0 \quad \cdots (4)$$

角方程式

$$a_0 + b_0 + c_0 + d_0 + e_0 + f_0 + g_0 + h_0 = 360^\circ \quad \cdots (5)$$

$$a_0 + h_0 = d_0 + e_0 \quad \cdots (6)$$

$$b_0 + c_0 = g_0 + f_0 \quad \cdots (7)$$

辺方程式

$$\frac{\overline{AB}}{\sin(c_0+d_0)} = \frac{\overline{TB}}{\sin b_0}, \quad \frac{\overline{TB}}{\sin g_0} = \frac{\overline{LT}}{\sin(e_0+f_0)}$$

$$\frac{\overline{AB}}{\sin(g_0+h_0)} = \frac{\overline{AL}}{\sin f_0}, \quad \frac{\overline{AL}}{\sin c_0} = \frac{\overline{LT}}{\sin(a_0+b_0)}$$

$$\therefore \frac{\sin(a_0+b_0)\cdot\sin(c_0+d_0)}{\sin(e_0+f_0)\cdot\sin(g_0+h_0)} \cdot \frac{\sin f_0 \cdot \sin g_0}{\sin b_0 \cdot \sin c_0} = 1 \quad \cdots (i)$$

更に,

$$\frac{\overline{AB}}{\sin(c_0+d_0)} = \frac{\overline{AT}}{\sin e_0}, \quad \frac{\overline{AT}}{\sin h_0} = \frac{\overline{LT}}{\sin(a_0+b_0)}$$

$$\frac{\overline{AB}}{\sin(h_0+g_0)} = \frac{\overline{BL}}{\sin a_0}, \quad \frac{\overline{BL}}{\sin d_0} = \frac{\overline{LT}}{\sin(e_0+f_0)}$$

$$\therefore \frac{\sin(a_0+b_0)\cdot\sin(g_0+h_0)}{\sin(c_0+d_0)\cdot\sin(e_0+f_0)} \cdot \frac{\sin d_0 \cdot \sin e_0}{\sin a_0 \cdot \sin h_0} = 1 \quad \cdots (ii)$$

この2つの式により次の式が導かれる。

$$\frac{\sin^2(g_0+h_0)\cdot\sin b_0\cdot\sin c_0\cdot\sin d_0\cdot\sin e_0}{\sin^2(c_0+d_0)\cdot\sin a_0\cdot\sin f_0\cdot\sin g_0\cdot\sin h_0} = 1 \quad \cdots\cdots (8)$$

2.2.2. 補正量の計算

観測式

$$a_0 = a_1 + v_a \qquad g_0 = g_1 + v_g$$
$$b_0 = b_1 + v_b \qquad h_0 = h_1 + v_h$$
$$c_0 = c_1 + v_c \qquad i_0 = i_1 + v_i$$
$$d_0 = d_1 + v_d \qquad j_0 = j_1 + v_j$$
$$e_0 = e_1 + v_e \qquad k_0 = k_1 + v_k$$
$$f_0 = f_1 + v_f \qquad l_0 = l_1 + v_l$$

ここに $a_0, b_0, \cdots\cdots, l_0$ ：最確値

$a_1, b_1, \cdots\cdots, l_1$ ：観測値

$v_a, v_b, \cdots\cdots, v_l$ ：誤差（補正量）

条件式

(1)～(8) 式は上式により次式に書き改められる。

1) $(a_1+v_a)+(b_1+v_b) = i_1+v_i$

$\therefore v_a + v_b - v_i + w_1 = 0 \equiv \varphi_1 \quad (\because w_1 = a_1+b_1-i_1) \cdots (9)$

2) $(c_1+v_c)+(d_1+v_d) = j_1+v_j$

$\therefore v_c + v_d - v_j + w_2 = 0 \equiv \varphi_2 \quad (\because w_2 = c_1+d_1-j_1) \cdots (10)$

3) $(e_1+v_e)+(f_1+v_f) = k_1+v_k$

$\therefore v_e + v_f - v_k + w_3 = 0 \equiv \varphi_3 \quad (\because w_3 = e_1+f_1-k_1) \cdots (11)$

4) $(g_1+v_g)+(h_1+v_h) = l_1+v_l$

$\therefore v_g + v_h - v_l + w_4 = 0 \equiv \varphi_4 \quad (\because w_4 = g_1+h_1-l_1) \cdots (12)$

5) $(a_1+v_a)+(b_1+v_b)+(c_1+v_c)+(d_1+v_d)+(e_1+v_e)+$
$(f_1+v_f)+(g_1+v_g)+(h_1+v_h)-360^\circ=0$

$\therefore v_a+v_b+v_c+v_d+v_e+v_f+v_g+v_h+w_5=0\equiv\varphi_5$ ……(13)

$(\because w_5=a_1+b_1+c_1+d_1+e_1+f_1+g_1+h_1-360^\circ)$

6) $(a_1+v_a)+(h_1+v_h)=(d_1+v_d)+(e_1+v_e)$

$\therefore v_a+v_h-v_d-v_e+w_6=0\equiv\varphi_6$

$(\because w_6=a_1+h_1-d_1-e_1)$ ……(14)

7) $(b_1+v_b)+(c_1+v_c)=(g_1+v_g)+(f_1+v_f)$

$\therefore v_b+v_c-v_g-v_f+w_7=0\equiv\varphi_7$ $(\because w_7=b_1+c_1-g_1-f_1)$ ……(15)

8) $2\log\sin(g_0+h_0)-2\log\sin(c_0+d_0)+\log\sin b_0+$
$\log\sin c_0+\log\sin d_0+\log\sin e_0-\log\sin a_0-$
$\log\sin f_0-\log\sin g_0-\log\sin h_0=0$

この三角関数の対数をテイラーの級数に展開すると次の形になる

$$\log\sin(M+v)=\log\sin M+\mu\cot M\frac{v}{\rho}+\cdots$$
$$\fallingdotseq\log\sin M+d\cdot v \qquad \text{ただし } v:\text{秒}$$

ここに $d=\frac{\mu}{\rho}\cot M=21.055\times10^{-7}\cot M$ を $\log\sin M$ に対する1"の変差と称している。従って

$\{2\log\sin(g_1+h_1)+d_{gh}(v_g+v_h)\}-\{2\log\sin(c_1+d_1)+d_{cd}(v_c+v_d)\}+$
$(\log\sin b_1+d_b v_b)+(\log\sin c_1+d_c v_c)+(\log\sin d_1+d_d v_d)+$
$(\log\sin e_1+d_e v_e)-(\log\sin a_1+d_a v_a)-(\log\sin f_1+d_f v_f)-$
$(\log\sin g_1+d_g v_g)-(\log\sin h_1+d_h v_h)=0$

$\therefore d_{gh}(v_g+v_h)-d_{cd}(v_c+v_d)+d_b v_b+d_c v_c+d_d v_d+d_e v_e-$
$d_a v_a-d_f v_f-d_g v_g-d_h v_h+w_8=0\equiv\varphi_8$ ……(16)

$\therefore$ $w_8=2\log\sin(g_1+h_1)-2\log\sin(c_1+d_1)+\log\sin b_1+$
$\log\sin c_1+\log\sin d_1+\log\sin e_1-\log\sin a_1-$
$\log\sin f_1-\log\sin g_1-\log\sin h_1$

未定係数式

補正角の最確値は次式の Ω の値が最小二乗法によって最小ならしめるように決められるであろう。

$$\Omega = [vv] - 2\lambda_1\varphi_1 - 2\lambda_2\varphi_2 - \cdots\cdots - 2\lambda_8\varphi_8$$

ここに $[vv]$: 確率誤差の二乗の和

λ ; 未定係数

上式を満足するような条件は,

$$\frac{\partial\Omega}{\partial v_x} = 0 \quad (x = a, b, c, \cdots\cdots, l) \quad \cdots\cdots\cdots\cdots (17)$$

上式(17)を微分することによって次の諸式が導かれる。

$$v_a - \lambda_1 - \lambda_5 - \lambda_6 + \lambda_8 d_8 = 0 \quad \cdots\cdots\cdots\cdots (18)$$

$$v_b - \lambda_1 - \lambda_5 - \lambda_7 - \lambda_8 d_b = 0 \quad \cdots\cdots\cdots\cdots (19)$$

$$v_c - \lambda_2 - \lambda_5 - \lambda_7 + \lambda_8 d_{cd} - \lambda_8 d_c = 0 \quad \cdots\cdots\cdots\cdots (20)$$

$$v_d - \lambda_2 - \lambda_5 + \lambda_6 + \lambda_8 d_{cd} - \lambda_8 d_d = 0 \quad \cdots\cdots\cdots\cdots (21)$$

$$v_e - \lambda_3 - \lambda_5 + \lambda_6 - \lambda_8 d_e = 0 \quad \cdots\cdots\cdots\cdots (22)$$

$$v_f - \lambda_3 - \lambda_5 + \lambda_7 + \lambda_8 d_f = 0 \quad \cdots\cdots\cdots\cdots (23)$$

$$v_g - \lambda_4 - \lambda_5 + \lambda_7 - \lambda_8 d_{gh} + \lambda_8 d_g = 0 \quad \cdots\cdots\cdots\cdots (24)$$

$$v_h - \lambda_4 - \lambda_5 - \lambda_6 - \lambda_8 d_{gh} + \lambda_8 d_h = 0 \quad \cdots\cdots\cdots\cdots (25)$$

$$v_i + \lambda_1 = 0 \quad \cdots\cdots\cdots\cdots (26)$$

$$v_j + \lambda_2 = 0 \quad \cdots\cdots\cdots\cdots (27)$$

$$v_k + \lambda_3 = 0 \quad \cdots\cdots\cdots\cdots (28)$$

$$v_l + \lambda_4 = 0 \quad \cdots\cdots\cdots\cdots (29)$$

(7)～(16)式および(18)～(29)式により次のような未定係数式を得る。

1) $(\lambda_1+\lambda_5+\lambda_6-\lambda_8 d_a)+(\lambda_1+\lambda_5+\lambda_7+\lambda_8 d_b)+\lambda_1+\omega_1$
$= 3\cdot\lambda_1+2\cdot\lambda_5+\lambda_6+\lambda_7+(d_b-d_a)\lambda_8+\omega_1=0$ ——— (30)

2) $(\lambda_2+\lambda_5+\lambda_7-\lambda_8 d_{cd}+d_c\lambda_8)+(\lambda_2+\lambda_5-\lambda_6-\lambda_8 d_{cd}+\lambda_8 d_d)+\lambda_2+\omega_2 = 3\lambda_2+2\cdot\lambda_5-\lambda_6+\lambda_7+(d_c+d_d-2d_{cd})\lambda_8+\omega_2=0$, ——— (31)

3) $(\lambda_3+\lambda_5-\lambda_6+\lambda_8 d_e)+(\lambda_3+\lambda_5-\lambda_7-\lambda_8 d_f)+\lambda_3+\omega_3$
$= 3\lambda_3+2\lambda_5-\lambda_6-\lambda_7+(d_e-d_f)\lambda_8+\omega_8=0$ ——— (32)

4) $(\lambda_4+\lambda_5-\lambda_7-\lambda_8 d_g+\lambda_8 d_{gh})+(\lambda_4+\lambda_5+\lambda_6+\lambda_8 d_{gh}-\lambda_8 d_h)+\lambda_4+\omega_4 = 3\cdot\lambda_4+2\cdot\lambda_5+\lambda_6-\lambda_7+(2\cdot d_{gh}-d_g-d_h)\lambda_8+\omega_4=0$ ——— (33)

5) $(\lambda_1+\lambda_5+\lambda_6-\lambda_8 d_a)+(\lambda_1+\lambda_5+\lambda_7+\lambda_8 d_b)+(\lambda_2+\lambda_5+\lambda_7-\lambda_8 d_{cd}+\lambda_8 d_c)+(\lambda_2+\lambda_5-\lambda_6-\lambda_8 d_{cd}+\lambda_8 d_d)+(\lambda_3+\lambda_5-\lambda_6+\lambda_8 d_e)+(\lambda_3+\lambda_5-\lambda_7-\lambda_8 d_f)+(\lambda_4+\lambda_5-\lambda_7-\lambda_8 d_g+\lambda_8 d_{gh})+(\lambda_4+\lambda_5+\lambda_6+\lambda_8 d_{gh}-\lambda_8 d_h)+\omega_5$
$= 2\lambda_1+2\cdot\lambda_2+2\cdot\lambda_3+2\lambda_4+8\cdot\lambda_5+(-d_a+d_b+d_c+d_d+d_e-d_f-d_g-d_h-2\cdot d_{cd}+2\cdot d_{gh})\lambda_8+\omega_5=0$ ——— (34)

6) $(\lambda_1+\lambda_5+\lambda_6-\lambda_8 d_a)+(\lambda_4+\lambda_5+\lambda_6+\lambda_8 d_{gh}-\lambda_8 d_h)-(\lambda_2+\lambda_5-\lambda_6-\lambda_8 d_{cd}+\lambda_8 d_d)-(\lambda_3+\lambda_5-\lambda_6+\lambda_8 d_e)+\omega_6$
$= \lambda_1-\lambda_2-\lambda_3+\lambda_4+4\cdot\lambda_6-(d_a+d_d+d_e-d_{gh}-d_{cd})\lambda_8+\omega_6=0$ ——— (35)

7) $(\lambda_1+\lambda_5+\lambda_7+\lambda_8 d_b)+(\lambda_2+\lambda_5+\lambda_7-\lambda_8 d_{cd}+\lambda_8 d_c)+(-\lambda_4-\lambda_5+\lambda_7+\lambda_8 d_g-\lambda_8 d_{gh})+(-\lambda_3-\lambda_5-\lambda_7+\lambda_8 d_f)+\omega_7$
$= \lambda_1+\lambda_5-\lambda_3-\lambda_4+4\cdot\lambda_7+(d_b+d_c+d_f+d_g-d_{cd}-d_{gh})\lambda_8+\omega_7=0$ ——— (36)

8) $d_{gh}(\lambda_4+\lambda_5-\lambda_7-\lambda_8 d_g+\lambda_8 d_{gh}+\lambda_4+\lambda_5+\lambda_6+\lambda_8 d_{gh}-\lambda_8 d_h)-d_{cd}(\lambda_2+\lambda_5+\lambda_7-\lambda_8 d_{cd}+\lambda_8 d_c+\lambda_2+\lambda_5-\lambda_6-\lambda_8 d_{cd}+\lambda_8 d_d)+d_a(\lambda_1+\lambda_5+\lambda_7+\lambda_8 d_b)+$

$$d_c(\lambda_2+\lambda_5+\lambda_7-\lambda_8 d_{cd}+\lambda_8 d_c)+d_d(\lambda_2+\lambda_5-\lambda_6+\lambda_8 d_{cd}+\lambda_8 d_d)+d_e(\lambda_3+\lambda_5-\lambda_6+\lambda_8 d_e)-d_a(\lambda_1+\lambda_5+\lambda_6-\lambda_8 d_a)-d_f(\lambda_3+\lambda_5-\lambda_7-\lambda_8 d_f)-d_g(\lambda_4+\lambda_5-\lambda_7+\lambda_8 d_g+\lambda_8 d_{gh})-d_h(\lambda_4+\lambda_5+\lambda_6+\lambda_8 d_{gh}-\lambda_8 d_h)+w_8=(d_b-d_a)\lambda_1+(d_d+d_e-2\cdot d_{cd})\lambda_2+(d_e-d_f)\lambda_3+(2\cdot d_{gh}-d_g-d_h)\lambda_4+(-d_a+d_b+d_c+d_d+d_e-d_f-d_g-d_h-2d_{cd}+2\cdot d_{gh})\lambda_5-(d_a+d_d+d_e-d_{gh}-d_{cd})\lambda_6+(d_a+d_c+d_f+d_g-d_{cd}-d_{gh})\lambda_7+(d_a^2+d_b^2+d_c^2+d_d^2+d_e^2+d_f^2+d_g^2+d_h^2+2\cdot d_{cd}^2+2d_{gh}^2-2\cdot d_g\cdot d_{gh}-2\cdot d_h\cdot d_{gh}-2\cdot d_c\cdot d_{cd}-2\cdot d_d\cdot d_{cd})\lambda_8+w_8=0 \quad \cdots\cdots (37)$$

未定係数 $\lambda_1, \lambda_2 \cdots\cdots \lambda_8$ は上記の未定係数式 (30) ～ (37) を同時に満足するように決められる。

従って前度の最確補正値は (18) ～ (29) 式より観測式の両方から簡単に計算することができる。

2.3 $\overline{LT}$ の長さを求める計算

前述の辺方程式は次式によって書き改められる。

$$\overline{LT} = \frac{\sin(a_0 + b_0) \cdot \sin f_0}{\sin(g_0 + h_0) \cdot \sin c_0} \cdot \overline{AB}$$

従って メコン河側岸に設置された 2つの水準点間の距離は基線 $\overline{AB}$ と前項に於いて求められた最確補正一角を用いて上式より計算される。

これらの三角計算は電子計算機によってなされその結果 $\overline{LT}$ の長さは 641.722 m となった。

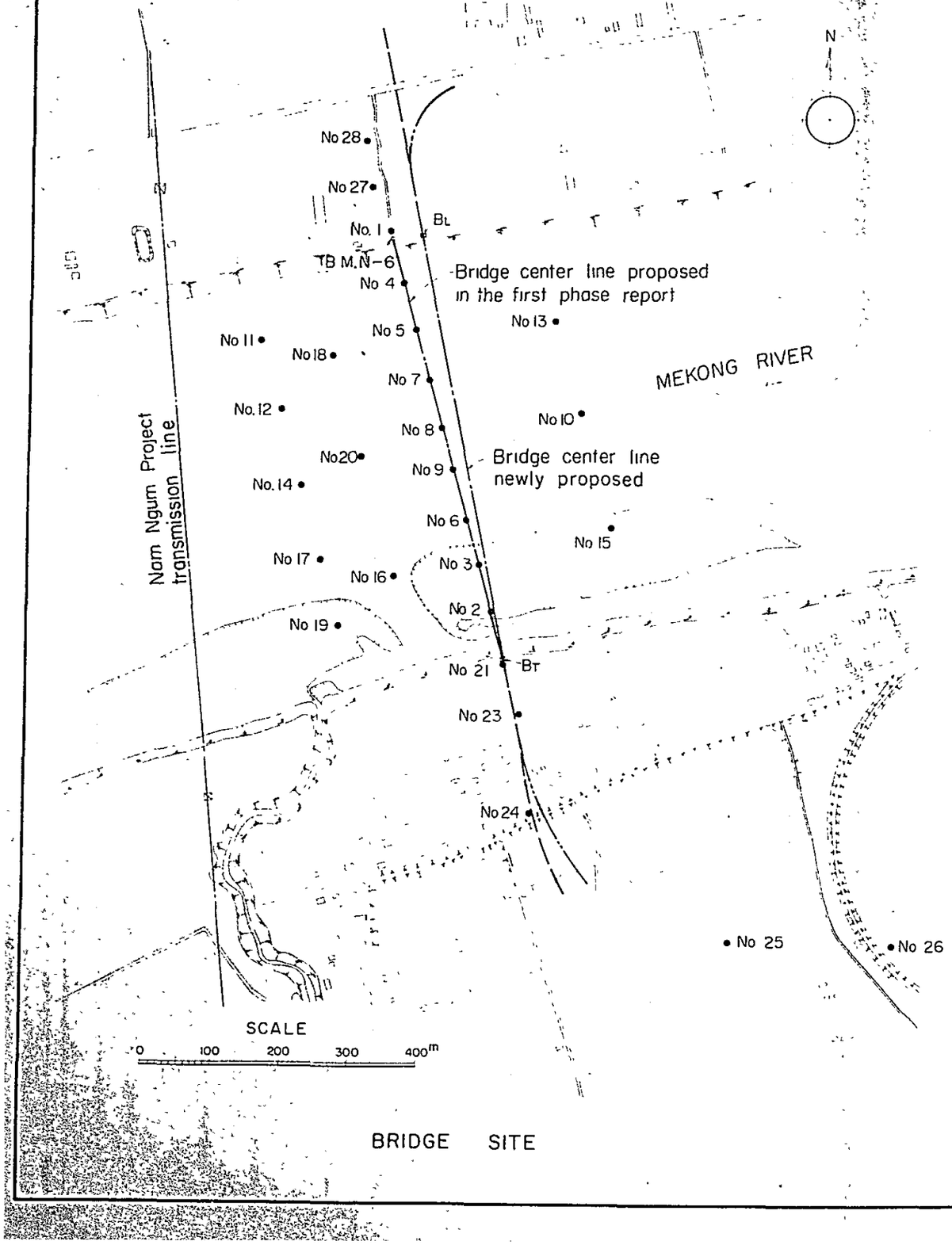
第二章

土質調査

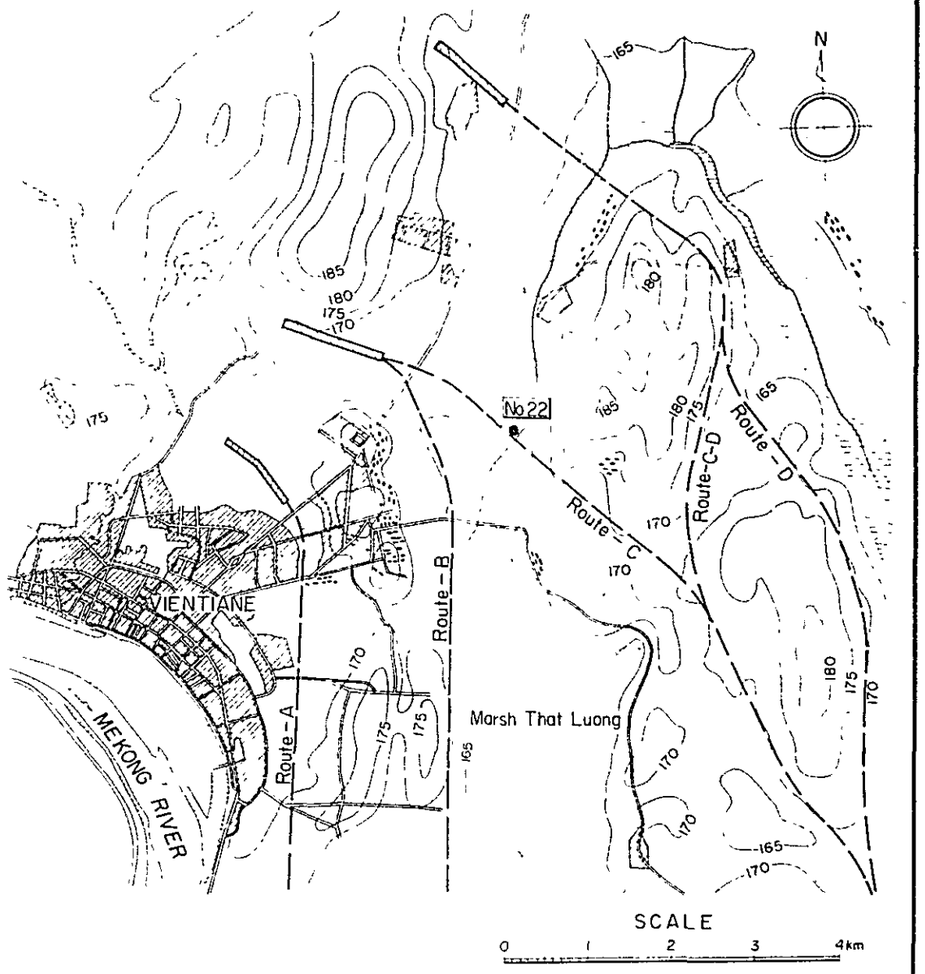
目次

2.1 試　錐

LOCATION OF THE TEST DRILLING HOLES



BRIDGE SITE



MARSH THAT LUONG

LEGEND

- Test drilling hole
- Proposed railway and station
- Proposed access highway

Summary of Test Drilling Holes

	Hole No.	Depth (m)	Elevation of ground surface(m)	Diameter of hole (mm)	Nos. of penetration test	Operation period (year: 1968)
Drilling of the riverside terrains	1	24.00	168.33	65 - 56	18	Feb.23-Mar. 1
	21	22.00	166.59	65 - 56	13	Apr.29-May 5
	22	44.30	Unobserved	65 - 56	43	Apr.27-May 28
	23	23.40	163.81	65 - 56	14	May 6-May 11
	24	26.00	165.80	65 - 56	13	May 12-May 16
	25	25.00	164.71	85 - 65	11	May 18-May 26
	26	35.00	165.41	85 - 65	23	May 27-Jun. 7
	27	23.00	168.17	65 - 56	15	May 30-Jun. 4
	28	21.30	167.90	65 - 56	14	Jun. 5-Jun. 8
	Total	244.00			164	
Drilling of the Mekong river-bed	2	16.60	155.73	65 - 56	11	Feb.26-Mar. 2
	3	17.15	155.73	65 - 56	7	Mar. 3-Mar. 7
	4	13.00	151.92	65 - 56	3	Mar. 2-Mar. 8
	5	13.00	150.96	65 - 56	4	Mar. 9-Mar.13
	6	13.60	153.58	65 - 56	6	Mar.11-Mar.16
	7	16.21	149.84	65 - 56	3	Mar.14-Mar.18
	8	13.00	150.73	65 - 56	3	Mar.19-Mar.25
	9	12.80	151.61	65 - 56	4	Mar.21-Mar.23
	10	17.10	151.13	65 - 56	3	Mar.26-Mar.30
	11	12.50	152.16	65 - 56	1	Mar.26-Mar.29
	12	13.00	150.95	65 - 56	1	Mar.30-Apr. 1
	13	7.20	149.82	65 - 56	1	Apr. 2-Apr. 3
	14	13.50	151.35	65 - 56	4	Apr. 2-Apr.10
	15	16.30	156.11	65 - 56	5	Apr. 5-Apr. 9
	16	23.80	153.28	65 - 56	3	Apr.11-Apr.18
	17	15.00	152.36	65 - 56	6	Apr.11-Apr.16
	18	16.00	151.20	65 - 56	1	Apr.16-Apr.23
	19	28.00	155.57	65 - 56	7	Apr.19-Apr.26
	20	13.00	150.93	65 - 56	4	Apr.21-Apr.25
	Total	289.76			75	

Drilling machine: DD - 5

Inclination of hole: Vertical

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 1

LOCATION Left Bank (Laos)

ELEVATION OF SURFACE 168 M 33

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY %	DESCRIPTION	N-VALUE 20 40 60
	m	m			m	m			
	1	167 13	Surface soil		1.20	1.20		Light yellow, fine silt and clay	
	2		Silt and clay					Silty clay, light brown N=39/30 cm	
	3							N=35/30 cm	
	4							N=34/30 cm	
	5							Silty clay, N=30/30 cm	
	6							Light grey	
	7							N=32/30 cm Clayey silt	
	8							N=25/30 cm	
	9							N=15/30 cm Light brown silt	
	10	158 33			8 80	10 00		N=17/30 cm Containing gravel ø 4cm	
	11		Sand and gravel					N=20/30 cm Light brown,	
	12							N=21/30 cm Earthy sand with pebble	
	13							N=31/30 cm Sand with	
	14							N=24/30 cm pebble	
	15							N=23/30 cm	
	16	151 93			6.40	16.40		N=19/30 cm N=16/30 cm	
	17		Weathered siltstone					N=16/30 cm Reddish brown	
	18							fragments of N=33/30 cm siltstone	
	19	148 93			3 00	19.40		Reddish siltstone N=50/23 cm	
	20		Fresh siltstone					Fresh reddish brown	
	21								
	22								
	23								
	24	144 33			4 60	24.00			
	25								
	26								
	27								
	28								
	29								
	30								

HOLE NO 2

LOCATION Riverbed

ELEVATION OF SURFACE 155 M 73

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY %	DESCRIPTION	N-VALUE 20 40 60
	m	m			m	m			
	1							Light brownish grey, Fine sand N=2/30 cm	
	2							N=2/30 cm Ditto	
	3		Fine sand and silty sand					N=4/30 cm	
	4							N=8/30 cm Grey silty Sand	
	5							N=4/30 cm Ditto	
	6							N=6/30 cm Ditto	
	7	148.03			7.70	7 70		N=5/30 cm	
	8		Sand with pebble					N=17/30 cm Grey sand	
	9							N=19/30 cm with pebble	
	10							N=20/30 cm	
	11	144 03			4 00	11 70		N=67/30 cm	
	12	143.53	Siltstone		4,50	12,20		Reddish brown siltstone	
	13								
	14		Shale					Reddish brown shale cracked	
	15								
	16	139 13			4 40	16 60			
	17								
	18								
	19								
	20								

HOLE NO 3

LOCATION Riverbed

ELEVATION OF SURFACE 155 M 73

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY %	DESCRIPTION	N-VALUE 20 40 60
	m	m			m	m			
	1							Grey, fine sand N=2/30 cm	
	2							N=5/30 cm Medium grained sand	
	3		Sand					Silty sand N=8/30 cm	
	4							Fine sand	
	5	149 73			6 00	6.00			
	6							N=5/30 cm	
	7		Silt					Silt	
	8	147 73			7 00	8 00			
	9							N=16/30 cm	
	10		Fine sand					Fine sand	
	11							N=16/28 cm Ditto	
	12	144 33			3.40	11.40		N=50/15 cm	
	13	143 68	Shale		0 65	12.05		Reddish brown shale	
	14		Siltstone					Massive siltstone	
	15	141 48			2 20	14.25			
	16		Shale					Silty shale cracked	
	17	138 58			2 90	17 15			
	18								
	19								
	20								

N=100

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 4

LOCATION : Riverbed

ELEVATION OF SURFACE. 151 M 92

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
1	150.42	Sand and Pebble		1.50	1.50		Light yellow sand and pebble N = 9/30cm
2	149.92	Gravel		0.50	2.00		Gravel
3		Weathered and fragmental siltstone with gravel		2.30	4.30		N=25/30cm Weathered siltstone with N=32/30cm gravel
4	147.62						
5		Fresh siltstone					Fresh shaly siltstone
6							
7							
8					8.00		
9					9.00		Fine-grained siltstone
10							Fresh siltstone
11							
12							
13	138.92			9.70	13.00		
14							
15							
16							
17							
18							
19							
20							

N – VALUE: 20 40 60

HOLE NO 5

LOCATION . Riverbed

ELEVATION OF SURFACE. 150 M 96

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
1		Sand and gravel		1.50	1.50		Yellow brown sand and pebble N=16/30cm
2	148.96			0.50	2.00		Gravel and sand
3		Weathered siltstone with gravel		1.90	3.90		N=23/30cm Weathered siltstone and N=30/30cm gravel
4	147.06						
5	146.46	Siltstone		0.60	4.50		N=50/11cm Siltstone
6	145.96	Shale		0.50	5.00		Shale, crushed
7		Siltstone					Siltstone, sound
8							
9							Vertical joint at 7.5m
10							
11							
12							
13	137.96			8.00	13.00		
14							
15							
16							
17							
18							
19							
20							

N – VALUE: 20 40 60 — N=136

HOLE NO 6

LOCATION . Riverbed,

ELEVATION OF SURFACE. 153 M 58

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
1		Grey fine sand					Grey, fine sand
2							N=2/30cm
3							
4							N=2/30cm
5							N=7/30cm
6	147.58			6.00	6.00		Ditto
7	146.58	Sand with pebble		1.00	7.00		N=24/30cm Fine sand with pebble
8		Gravel with weathered siltstone					N=32/30cm Gravel N=50/25cm with fragmental siltstone
9	144.98			1.60	8.60		Siltstone with joints
10		Siltstone					
11							Massive siltstone
12							
13	139.98			5.00	13.60		
14							
15							
16							
17							
18							
19							
20							

N – VALUE: 20 40 60

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 7

LOCATION : Riverbed
ELEVATION OF SURFACE, 149 M 84

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION
	m	m			m	m	%	
		148.94	Gravel with rock fragments		0.90	0.90		Chert gravel and fragments of siltstone
	1		Gravel, sand and silt					N = 18/30 cm
	2	146.84			2.10	3.00		Gravel, sand and silt N = 22/30 cm
	3							N = 50/11 cm
	4							Redd'sh brown siltstone
	5							Partly shaly
	6							
	7							
	8		Siltstone					Vertical joint at 8.5 m
	9				6.00	9.00		
	10							Shaly siltstone
	11							
	12							Sound
	13							
	14							
	15							
	16	133.63			7.21	16.21		
	17							
	18							
	19							
	20							

N-VALUE: 20 40 60 — N=136

HOLE NO 8

LOCATION . Riverbed
ELEVATION OF SURFACE, 150 M 73

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION
	m	m			m	m	%	
	1		Mud and sand		1.50	1.50		Mud and grey sand N = 27/30 cm
	2	149.23	Sand and gravel					Mud, sand and gravel N = 25/30 cm
	3							Sand and gravel N = 37/30 cm
	4	146.73			2.50	4.00		
	5	145.73	Gravel and rock fragments		1.00	5.00		Gravel and siltstone fragments
	6				0.80	5.80		Shaly siltstone
	7							
	8							
	9		Siltstone					Siltstone vertical joint between 7 m and 8 m
	10							
	11							
	12							
	13	137.73			7.20	13.00		
	14							
	15							
	16							
	17							
	18							
	19							
	20							

N-VALUE: 20 40 60

HOLE NO 9

LOCATION . Riverbed
ELEVATION OF SURFACE, 151 M 61

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION
	m	m			m	m	%	
	1		Sand with pebble					N = 4/30 cm Fine sand with pebbles
	2							
	3							N = 18/30 cm
	4	147.31			4.30	4.30		N = 19/30 cm
		146.96	Gravel		0.35	4.65		N = 70/30 cm Gravel 5cm
		146.66	Siltstone		0.30	4.95		Siltstone
		146.06	Shale		0.60	5.55		Silty shale cracked
	6							
	7							
	8							
	9		Siltstone					Siltstone
	10							
	11							
	12							
	13	138.81			7.25	12.80		
	14							
	15							
	16							
	17							
	18							
	19							
	20							

N-VALUE: 20 40 60 — N=150

HOLE NO 10

LOCATION : Riverbed
ELEVATION OF SURFACE. 151 M 13

DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1	150 13	Muddy sand		1 00	1 00		Muddy sand	
2		Sand and pebble					N = 3/30 cm Fine sand N = 18/30 cm with pebble	
3	148 13			2 00	3 00		N = 19/30 cm	
4		Gravel and sand					Gravel and N = 26/30 cm sand	
5	146 03			2 10	5 10			
6	145.03	Weathered siltstone		1 00	6.10		Fragmental siltstone	
7		Siltstone					Reddish brown siltstone	
8				2.00	8 10			
9				1 00	9 10		Ditto, brittle	
10	141 03			1.00	10 10		Siltstone	
11	140 03	Sandstone		1.00	11 10		Fine grained sandstone	
12		Siltstone					Shaly siltstone	
13				1 70	12 80			
				0. 30	13.10		Ditto, cracked	
14							Massive siltstone	
15								
16								
17	134 03			4 00	17 10			
18								
19								
20								

HOLE NO 11

LOCATION . Riverbed
ELEVATION OF SURFACE. 152 M 16

DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1		Sand and gravel					Brown gravel Contents 40~70%	
2	150 26			1 90	1 90			
3		Clay					Hard clay N = 50/17 cm	
	148 66			1.60	3 50			N=88
4				0 60	4.10		Reddish brown siltstone	
5								
6							Reddih brown, clayey siltstone	
7		Siltstone						
8								
9								
10								
11								
12	139 66			8 40	12 50			
13								

HOLE NO 12

LOCATION Riverbed
ELEVATION OF SURFACE. 150 M 95

DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
	150 55	Sand		0 40	0.40		Grey med sand	
1	149.15	Sand and gravel		1.40	1.80		Sand, pebble and gravel with N = 30/30 cm siltstone fragment	
2								
3								
4								
5								
6		Siltstone and shale (alternated)					Fine-grained siltstone and shale (alternated)	
7								
8								
9								
10								
11								
12	138 95			10 20	12 00			
13								

HOLE NO 13

LOCATION . Riverbed
ELEVATION OF SURFACE. 149 M 82

DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1	148 57	Weathered shale		1 25	1.25		Weathered shale N = 50/25 cm	
	148 02	Shale		0 65	1 80		Shale, cracked	
2								
3								
4		Siltstone					Siltstone	
5								
6								
7	142 62			5 40	7 20			
8								
9								

HOLE NO 14

LOCATION . Riverbed
ELEVATION OF SURFACE 151 M 35

DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1		Sand and gravel					Grey sand and N = 24/30 cm gravel N = 28/30 cm Containing N = 21/30 cm siltstone fragments	
2								
3	147 35			4.00	4.00			
	146 85	Weathered Siltstone		0.50	4.50		N = 23/30 cm Weathered Siltstone	
5								
6							Shaly	
7								
8								
9		Siltstone					Shaly	
10								
11								
12								
13	137 85			9 00	13 50			
14								
15								

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 15

LOCATION : Riverbed

ELEVATION OF SURFACE, 156 M 11

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
						N= 2/32cm	
1–8		Fine sand				Grey, N=5/30cm fine sand; N=6/30cm; N=12/30cm	
	147.61		8.50	8.50			
9–11	144.81	Sand and pebble	2.80	11.30		Sand and pebble N=58/30cm	
12–16	139.81	Siltstone	5.00	16.30		Siltstone	
17–20							

HOLE NO 16

LOCATION . Riverbed

ELEVATION OF SURFACE, 155 M 28

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1–3		Sand					Grey, fine sand	
	151.98			3.30	3.30		N-4/30cm	
4–5		Sand with pebble					Sand with subangular pebble	
	149.28			2.70	6.00			
6–8		Sand					N-7/30cm Fine sand N=18/30cm	
	146.28			3.00	9.00			
	145.48	Weathered siltstone		0.80	9.80		Weathered siltstone	
10–11		Siltstone					Clayey siltstone	
	143.48			2.00	11.80			
12	143.18	Shale		0.30	12.10		Shale	
	142.78	Siltstone		0.40	12.50		Clayey siltstone	
13	142.08	Shale		0.70	13.20		Shale	
	141.48	Siltstone		0.60	13.80		Siltstone	
14–15	139.48	Shale		2.00	15.80		Shale	
16–17	137.38	Siltstone		2.10	17.90		Sound siltstone	
18–23	131.48	Shale		5.90	23.80		Shale	
24–30								

HOLE NO 17

LOCATION . Riverbed

ELEVATION OF SURFACE, 152 M 36

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1–5		Sand					N=13/30cm Grey sand; N=15/30cm; N=18/30cm; N=22/30cm; N=15/30cm Accompanied pebbles	
	146.16			6.20	6.20		N=25/30cm	
6–7	145.36	Weathered siltstone		0.80	7.00		Weathered Siltstone partly shale	
8–15	137.36	Siltstone		8.00	15.00		Siltstone	
16–20								

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 18

LOCATION . Riverbed
ELEVATION OF SURFACE. 151 M 20

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE (20 40 60)
	1	149 50	Gravel		1 70	1 70		Subangular or round (N=50/13cm)	N=115
	2 3	147 60	Shale		1 90	3 60		Reddish brown shale, cracky after drying	
	4 5 6 7 8 9 10 11 12 13 14 15		Siltstone					Siltstone; Shaly, fine-spotted; Siltstone	
	16	135 20			12 40	16 00			
	17 18 19 20								

HOLE NO 19

LOCATION . Riverbed
ELEVATION OF SURFACE. 155 M 57

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE (20 40 60)
	1 2 3 4 5 6		Sand					Fine sand (N=4/30cm; N=5/30cm)	
		149 07			6 50	6 50			
	7	148 57	Silt		0 50	7 00		Loamy silt (N=21/30cm)	
	8 9 10	145 57	Sand and pebble		3 00	10 00		Fine sand with pebble (N 14/30cm)	
	11 12	143 47	Gravel		2 10	12 10		Gravel ϕ = 5 ~ 6cm (N=40/10cm)	N=135
	13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30		Siltstone					→(Core lost); →(Core lost); Reddish-brown siltstone; Sound siltstone; →(Core lost); Reddish brown siltstone party Conchoidal	
		127 57			15 90	28 00			

HOLE NO 20

LOCATION . Riverbed
ELEVATION OF SURFACE. 150 M 93

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE (20 40 60)
	1	148 93	Sand		2 00	2 00		Grey med sand (N=15/30cm)	
	2 3 4 5	145 93	Sand and gravel		1 00	5 00		(N=21/30cm) Sand & gravel (N=27/30cm); (N=50/25cm) with weathered siltstone	
	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		Siltstone					Fine-grained siltstone	
		137 93			8 00	13 00			

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 21

LOCATION . Right Bank (Thai)

ELEVATION OF SURFACE, 166 M 59

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
1		Loam				Light brown loam N=5/30cm	
2						N=7/30cm	
3						N=7/30cm	
4	162 59		4 00	4 00		N=8/30cm	
5		Silt				Light brown N=12/30cm	
6						570 TWS 630 Clayey	
7						N=11/30cm 740 TWS 790	
8						Dark brown	
9						N=10/30cm	
10						Gray brown 1030 TWS	
11	155 59		7 00	11 00		1085 TWS 1125	
12		Sand				Fine-grained	
13						N=17/30cm	
14						Medium-grained	
15						N=23/30cm	
16							
17						N=36/30cm	
18						Coarse-grained	
19	147 59		8 00	19.00		N=37/30cm	
20		Sand and pebbles				Sand and pebbles N=29/30cm	
21	145 04		1 50	21 55		N=45/15cm	
22	144 59	Siltstone	0 45	22.00		Siltstone	
23							
24							
25							
26							
27							
28							
29							
30							

N-VALUE: 20, 40, 60; N=90

HOLE NO 22

LOCATION . That Luong

ELEVATION OF SURFACE, Unobserved

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
		Soil	0 40	0 40		Surface soil	
1		Clay	1 20	1 60		Dark grey 070 TWS N 6/30cm 135	
2		Sand	1 30	2 90		Grey, brown, N=7/30cm coarse	
3		Clay				Grey, silty 300 TWS N=6/30cm 340	
4						Grey, sandy	
5						N=9/30cm	
6						Gray brown, N=14/30cm sandy	
7						Light yellow N=15/30cm	
8						Yellow brown N=12/30cm	
9			6 80	9 70		Reddish brown N=9/30cm	
10		Sand				N=10/30cm	
11						Clayey N=12/30cm	
12			3 10	12 80		Grey brown N=15/30cm	
13		Clay				N=17/30cm	
14						Sandy, N=23/30cm	
15			3 10	15 90		containing N=26/30cm pebbles	
16		Sand	0 80	16 70		N=17/30cm Clayey	
17		Clay	1 10	17 80		Sandy N=13/30cm	
18		Sand				N=17/30cm	
19						Containing N=19/30cm gravel	
20						N=19/30cm	
21						Light grey, N=18/30cm clayey	
22						N=28/30cm	
23						Sometimes N=31/30cm with gravels	
24						N=34/30cm	
25			8 00	25 80		N=25/30cm	
26		Clay				Yellow N=32/30cm brown	
27						Sandy, sometimes N=39/30cm with gravel	
28			2 30	28 10			
29		Sand with gravel				N=31/30cm Fine grained N=34/30cm	
30							

N-VALUE: 20, 40, 60

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
31		Sand with gravel				N=35/30cm Containing gravel ø10-50m/m	
32						N=40/30cm	
33						N=50/25cm	
34						N=50/22cm	
35						N=50/13cm Grey,	
36						N=50/21cm Containing N=50/27cm gravel ø10-50m/m	
37						N=50/26cm	
38						N=50/21cm	
39						N=50/25cm With	
40						N=50/23cm gravel	
41						N=50/21cm Cave-in	
42						N=50/21cm	
43						N=50/18cm	
44			16 20	44 30		N=50/17cm Finish	

N-VALUE: 20, 40, 60; N=115, N=71, N=71, N=71, N=83, N=88

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 23

LOCATION . Thai side
ELEVATION OF SURFACE. 163.81 M

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
1		Clay			Yellow brown silty clay N=4/30cm	
2	161.51		2.30	2.30	N=4/30cm	
3	160.51	Sand	1.00	3.30	Brown, med. grain N=5/30cm	
4	159.31	Clay	1.20	4.50	Brown, silty clay N=6/30cm	
5					N=11/30cm	
6					N=13/30cm	
7					N=15/30cm	
8					Yellow brown sand	
9		Sand				
10					N=12/30cm	
11					N=13/30cm	
12					N=12/30cm	
13					N=15/30cm Casing pipe	
14						
15	148.21		11.10	15.60		
16					N=32/30cm	
17		Gravel			Gravel ϕ = 10cm	
18	145.51		2.70	18.30	N=32/30cm	
19	144.91	Weathered siltstone	0.60	18.90	N=45/10cm Weathered	
20					Fresh reddish brown	
21		Fresh siltstone				
22						
23	140.41		4.50	23.40		
24						
25						
26						
27						
28						
29						

N-VALUE: 20 40 60; N=135

HOLE NO 24

LOCATION : Thai side
ELEVATION OF SURFACE. 165.80 M

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
1	164.80	Sandy clay w. pebble	1.00	1.00	Yellow brown sandy clay with pebble N=9/30cm	
2					Silty clay N=12/30cm	
3		Silty clay			Brown silty clay N=13/30cm	
4					Ditto N=14/30cm	
5					Ditto N=13/30cm	
6	159.60		5.20	6.20	Ditto N=13/30cm 6.20	
7	158.80	Clay	0.80	7.00	Brownsh gray clay TWS 6.93 N=11/30cm	
8					Brown clayey sand	
9		Clayey sand			N=12/30cm 9.60 TWS	
10					Clayey sand 10.35	
11						
12					Grey brown	
13	152.80		6.00	13.00	N=9/30cm	
14		Silty sand			Silty sand	
15					N=16/30cm Ditto	
16	123.50		3.30	16.30		
17					Gravel Casing pipe N=24/30cm	
18						
19		Gravel			Gravel N=30/30cm	
20						
21	144.30		5.20	21.50		
22	143.80	Weathered siltstone	0.50	22.00	N=50/15cm	
23					Slightly weathered siltstone	
24		Fresh siltstone			Reddish-brown fresh siltstone	
25						
26	139.80		4.00	26.00		
27						
28						
29						

N-VALUE: 20 40 60

HOLE NO 25

LOCATION . Thai side
ELEVATION OF SURFACE 164.71 M

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
1					N=13/30cm Yellow	
2					N=14/30cm Clayey silt	
3		Clayey silt			N=12/30cm	
4					N=15/30cm	
5					N=17/30cm	
6					6.50 TWS 7.25	
7					7.30 TWS	
8	156.21		8.50	8.50	8.2	
9					N=13/30cm	
10					Yellow grey	
11					N=12/30cm sand	
12		Sand			N=14/30cm	
13						
14						
15						
16	148.31		7.90	16.40		
17					Casing pipe N=32/30cm	
18		Gravel			Gravel ϕ = 10cm	
19	145.11		3.20	19.60	N=42/30cm	
20					Reddish brown fresh siltstone	
21						
22		Fresh siltstone				
23						
24						
25	139.7		5.40	25.00		
26						
27						
28						
29						

N-VALUE: 20 40 60

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 26

LOCATION : Thai side
ELEVATION OF SURFACE 165.41 M

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION	N - VALUE
	m	m			m	m	%		20 40 60
28	1							Yellow - brown	N=19/30cm
	2								N=16/30cm
	3		Sandy silt					Sandy silt	N=15/30cm
	4								N=15/30cm
	5								N=12/30cm
	6	158.91			6.50	6.50			
29	7								N=11/30cm
	8		Silty sand					Silty sand 80 TW.S 875 90 TW.S 975	
	9								
	10								N=14/30cm
	11	154.41			4.50	11.00		Sand	
	12								N=18/30cm
	13							Sand and gravel	N=38/30cm
	14								N=39/30cm
	15								ø=5-10cm
	16								N=39/30cm
	17								
	18								N=39/30cm
	19								N=40/30cm
	20								N=41/30cm
	21							Yellow-brown	N=40/30cm
	22								N=41/30cm Sand and gravel
31	23								N=42/30cm
	24	141.41	Sand and gravel		13.00	24.00			N=41/30cm
	25							Pebble	N=30/30cm
	26							Pebble and gravel	N=43/30cm
	27		Gravel					Gravel	
	28								N=42/30cm
	29								ø=10cm
	30								

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION	N - VALUE
	m	m			m	m	%		20 40 60
3	31							Gravel	
	32							N=41/30cm ø=5-15cm	
	33		Gravel					Ditto N=43/30cm ø=1-10cm	
5	34								
	35	130.41			11.00	35.00			
	36								
	37								
	38								
	39								
	40								
	41								
	42								
	43								
	44								

HOLE NO 27

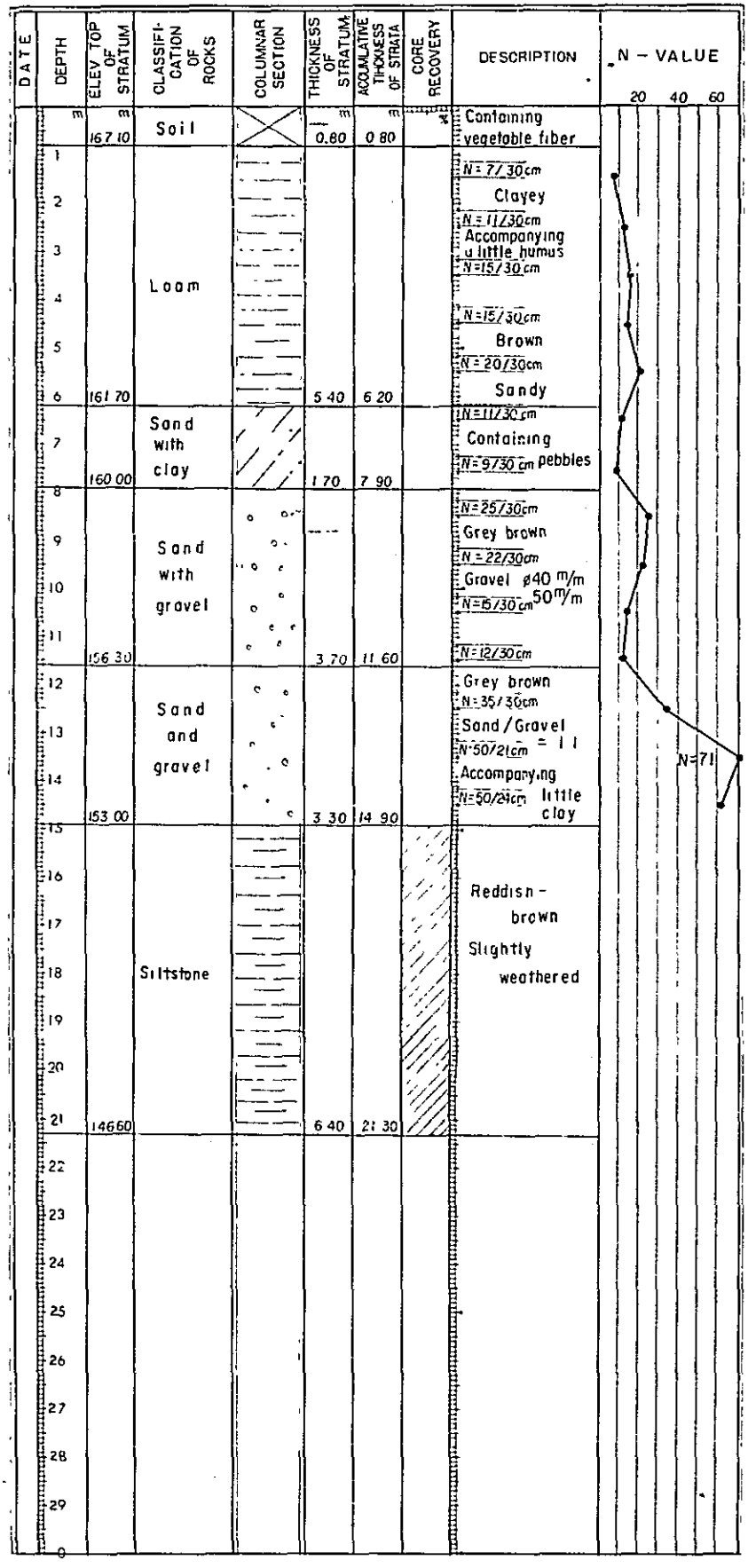
LOCATION Laotion side
ELEVATION OF SURFACE 168.17 M

DATE	DEPTH	ELEV. TOP OF STRATUM	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM	ACCUMULATIVE THICKNESS OF STRATA	CORE RECOVERY	DESCRIPTION	N - VALUE
	m	167.77 m	Soil		0.40 m	0.40 m	%	Soil	20 40 60
	1							Dark grey Clayey loam TWS 10 17	N=1/20cm
	2		Clayey loam					Containing humus	N=12/34cm
	3							Containing light grey clay	N=17/30cm
	4	163.37			4.40	4.80			
	5		Clayey sand						N=13/30cm
	6	161.57			1.80	6.60		Containing mica	N=12/30cm
	7								N=10/30cm
	8		Sand						N=10/30cm
	9	159.07			2.50	9.10			
	10								N=22/30cm
	11								N=23/30cm
	12		Sand with gravel					Accompanying brown clay	N=31/30cm
	13								N=25/30cm
	14								N=38/30cm
	15							Gravel. ø 10-30m/m	N=32/30cm
	16	152.27			6.80	15.90		Sometimes ø=50m/m	N=30/30cm
	17	151.37	Weathered siltstone		0.90	16.80		N=50/22cm Reddish brown decomposed	
	18								
	19								
	20		Siltstone					Fresh, reddish brown siltstone	
	21								
	22								
	23	145.17			6.20	23.00			
	24								
	25								
	26								
	27								
	28								
	29								
	0								

GEOLOGICAL RELORD OF TEST DRILLING HOLE

HOLE NO 28

LOCATION . Laos - side
ELEVATION OF SURFACE. 167 M 90



2.2. 土質試験

Summary of soil test

Location: Nong Khai

Items	Unit	Characteristics											
Sample No.		1	2	3	4	5	6	7	8	9	10	11	12
Bore Hole No.		21	21	21	22	22	24	24	25	25	26	26	27
Sampling Depth	m	5.70-6.30	7.40-7.80	10.30-11.25	0.70-1.35	3.00-3.40	6.20-6.93	9.60-10.35	6.50-7.25	7.30-8.20	8.00-8.75	9.00-9.75	1.00-1.70
I. Observation		Reddish brown	Reddish brown	Reddish brown	Grey brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Yellow brown
II. Properties													
(1) Natural water content, w	%	20.11	21.23	24.04	26.25	36.70	22.04	28.42	25.41	25.75	25.72	25.40	16.45
(2) Specific gravity of soil, G		2.68	2.65	2.70	2.68	2.70	2.75	2.67	2.73	2.69	2.70	2.65	2.76
(3) Wet density, r_t	g/cm^3	1.875	1.940	1.893	2.044	1.789	2.009	1.792	1.899	1.891	1.948	1.992	2.067
(4) Dry density, r_d	g/cm^3	1.561	1.600	1.526	1.619	1.308	1.646	1.395	1.514	1.503	1.549	1.588	1.775
(5) Void ratio, e		0.717	0.656	0.769	0.655	1.064	0.671	0.914	0.803	0.790	0.743	0.669	0.555
(6) Degree of saturation, S	%	75.17	85.76	84.41	100	93.13	90.33	83.02	86.39	87.68	93.46	100	81.81
III. Grain Size													
(1) Constitution													
i) Gravel part	%	-	-	-	1.0	-	-	-	-	-	-	-	-
ii) Sand part	%	3.5	3.0	5.0	16.5	13.5	2.0	1.5	19.5	51.0	33.0	31.0	25.5
iii) Silt part	%	75.0	74.0	78.5	34.5	45.0	62.0	68.5	63.5	38.0	54.0	54.0	51.0
iv) Clay part	%	21.5	23.0	16.5	48.0	41.5	36.0	30.0	17.0	11.0	13.0	15.0	23.5
(2) Max. diameter	mm	0.105	0.105	0.105	4.8	2.0	0.105	0.105	0.42	0.84	0.42	0.42	2.0
(3) 60 % diameter, D_{60}	mm	0.035	0.033	0.0403	0.016	0.013	0.017	0.018	0.06	0.13	0.07	0.063	0.06
(4) 10 % diameter, D_{10}	mm	-	-	0.0018	-	0.0017	-	-	0.0018	0.004	0.0028	0.002	-
(5) Uniformity coefficient		-	-	22.4	-	7.65	-	-	33.3	32.5	25.0	31.5	-
(6) Grain size classification		Silty clay loam	Silty clay loam	Silty loam	Clay	Clay	Silty clay	Silty clay	Silty loam	Silty loam	Silty loam	Silty loam	Silty clay loam
(7) Unified classification		CL	CL	CL	CL or CH	CL or CH	CL	CL or CH	ML or CL	SC	ML or OL	CL	CL
IV. Consistency													
(1) Liquid limit, L.L.	%	33.25	39.80	35.20	49.80	52.00	37.10	53.10	28.20	24.10	26.40	26.85	36.50
(2) Plastic Limit, P.L.	%	20.45	21.70	22.05	17.37	20.47	20.64	24.33	22.15	18.66	22.49	18.43	11.68
(3) Plasticity index, P.I.		12.80	18.10	13.15	32.43	31.53	16.46	28.77	6.05	5.46	3.91	8.42	24.82
(4) Flow index, F.I.		6.30	8.48	8.25	10.10	10.10	10.00	12.80	5.10	5.95	5.10	5.05	15.70
V. Shearing Strength													
(1) Unconfined compression													
i) Compression strength	kg/cm^2	1.195	0.883	1.051	0.505	0.471	0.861	3.925	0.426	0.290	0.498	0.556	0.664
ii) Sensitivity ratio		2.36	1.56	4.08	1.18	1.64	1.38	5.16	N.G./1	4.08	N.G./1	N.G./1	1.06
(2) Direct compression													
i) Cohesion, c	kg/cm^2	-	-	-	-	-	0.60	-	0.30	-	0.70	0.28	0.60
ii) Internal friction angle, ϕ		-	-	-	-	-	$40^\circ02'$	-	$37^\circ36'$	-	$15^\circ39'$	$22^\circ47'$	$30^\circ58'$
(3) Triaxial compression													
i) Cohesion, c	kg/cm^2	0.50	0.80	0.45	0.925	0.20	0.82	1.15	0.21	0.10	0.35	0.24	0.50
ii) Internal friction angle, ϕ		$12^\circ25'$	$19^\circ18'$	$10^\circ46'$	$5^\circ43'$	$8^\circ32'$	$11^\circ52'$	$13^\circ30'$	$15^\circ39'$	$16^\circ42'$	$6^\circ17'$	$8^\circ32'$	$15^\circ07'$
VI. Consolidation													
(1) Initial void ratio, e_o		0.610	0.672	0.670	0.642	1.360	0.689	0.876	0.769	0.657	0.616	0.680	0.682
(2) Preconsolidation load, p_o	kg/cm^2	3.50	4.50	3.20	1.22	1.17	3.00	4.90	3.00	2.63	3.90	2.48	0.56
(3) Compression index, C_c		0.198	0.186	0.147	0.161	0.361	0.235	0.308	0.251	0.201	0.137	0.146	0.158
(4) Coef. of consolidation, C_v	cm^2/sec	2.8×10^{-2}	1.66×10^{-2}	2.1×10^{-3}	8.2×10^{-3}	8.1×10^{-3}	1.22×10^{-2}	2.0×10^{-2}	2.22×10^{-2}	3.1×10^{-2}	1.29×10^{-2}	1.15×10^{-2}	1.7×10^{-2}
(5) Coef. of volume compressibility, M_v	cm^2/g	1.3×10^{-5}	7.0×10^{-6}	8.1×10^{-6}	1.95×10^{-5}	4.7×10^{-5}	1.21×10^{-5}	8.6×10^{-6}	1.38×10^{-5}	1.28×10^{-5}	6.3×10^{-6}	1.03×10^{-5}	5.4×10^{-5}
(6) Coef. of permeability, K	cm^2/sec	3.6×10^{-7}	1.18×10^{-7}	1.74×10^{-8}	1.6×10^{-7}	3.8×10^{-7}	1.5×10^{-7}	1.75×10^{-7}	3.04×10^{-7}	4.0×10^{-7}	8.1×10^{-8}	1.2×10^{-7}	9.2×10^{-7}

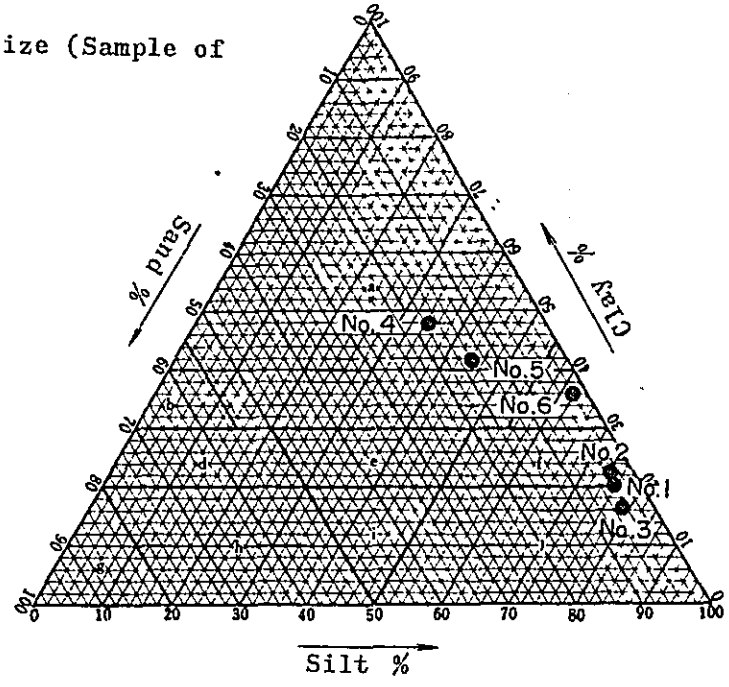
Remarks: /1 The remoulding was impossible for testing.

MECHANICAL ANALYSIS

Location Nong Khai

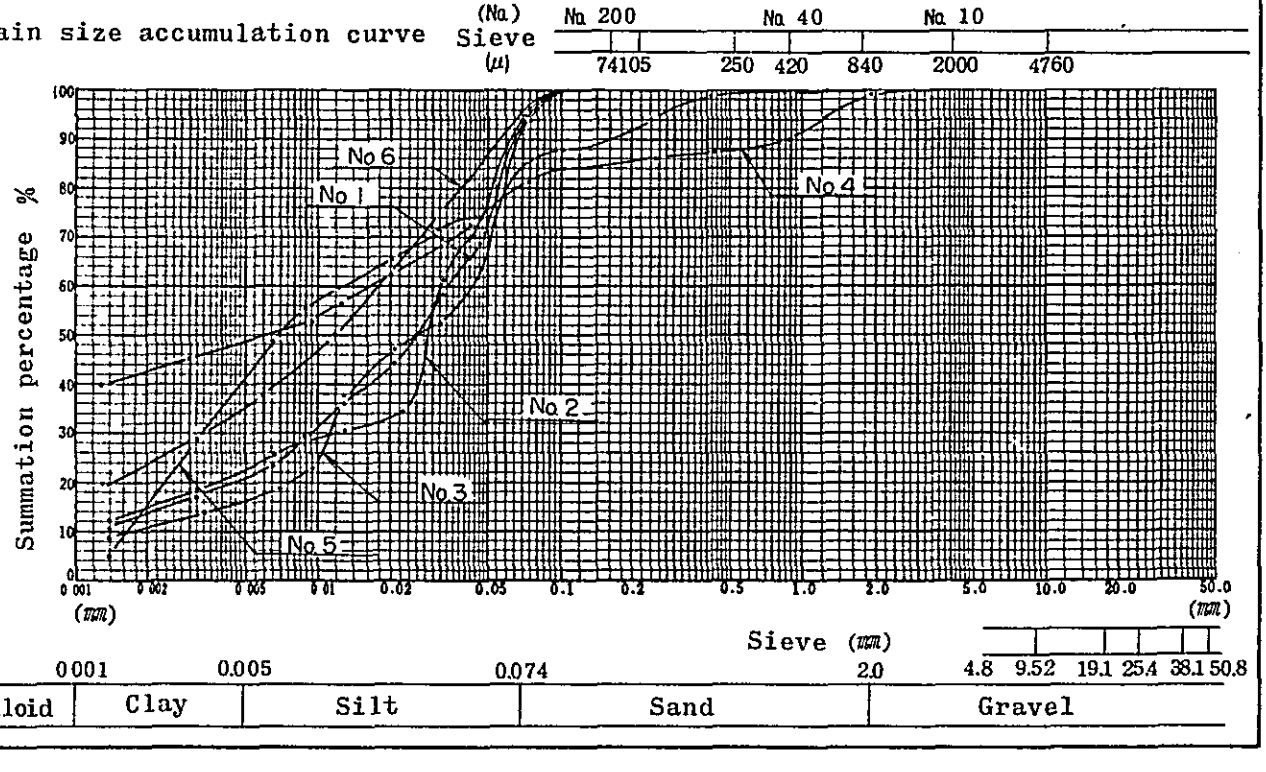
Soil classification of grain size (Sample of passed 2000 μ sieve)

a CLAY
b SANDY CLAY
c SILTY CLAY
d SANDY CLAY LOAM
e CLAYEY LOAM
f SILTY CLAY LOAM
g SAND
h SANDY LOAM
i LOAM
j SILTY LOAM



Sample No.	Gravel %	Sand %	Silt %	Clay %	Max. size mm	D60 mm	D10 mm	Uniformity Coett.	2000μ sieve Passed Percentage	420μ sieve Passed Percentage	74μ sieve Passed Percentage	Sign of Plotted part on triangular diagram	Classification	Remarks
No 1	—	3 5	75.0	21.5	0 105	0035	—	—	100	100	96 0	f	SILTY CLAY LOAM	
No 2	—	3.0	74.0	23 0	0. 105	0 033	—	—	100	100	97.0	f	SILTY CLAY LOAM	
No. 3	—	5.0	78.5	16 5	0 105	00403	0.0018	224	100	100	95.5	j	SILTY LOAM	
No. 4	1 0	16.5	34 5	48.0	4.8	0.016	—	—	990	870	82.0	a	CLAY	
No. 5	—	13 5	45 0	41 5	2.0	0 013	00017	7.65	100	985	86.5	a	CLAY	
No 6	—	2.0	62 0	36.0	0. 105	0.0107	—	—	100	100	98.5	c	SILTY CLAY	

Grain size accumulation curve

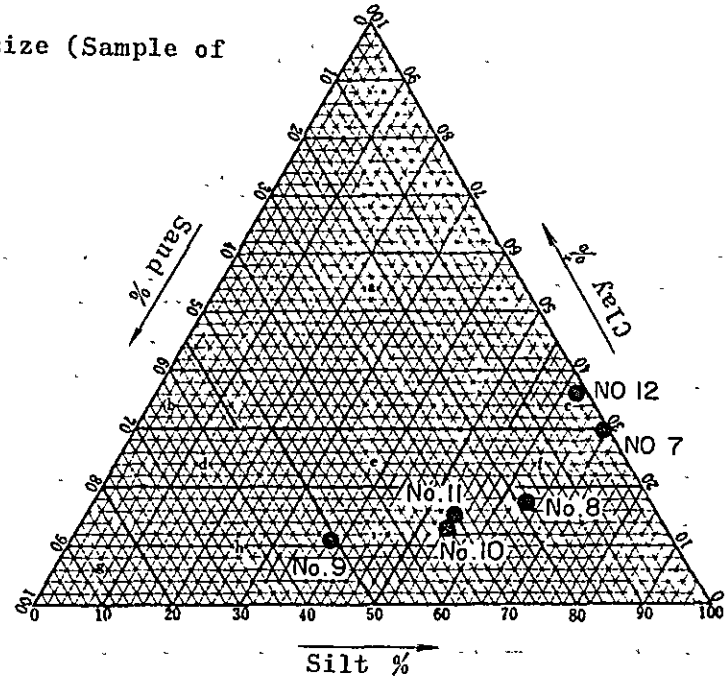


MECHANICAL ANALYSIS

Location Nong Khai

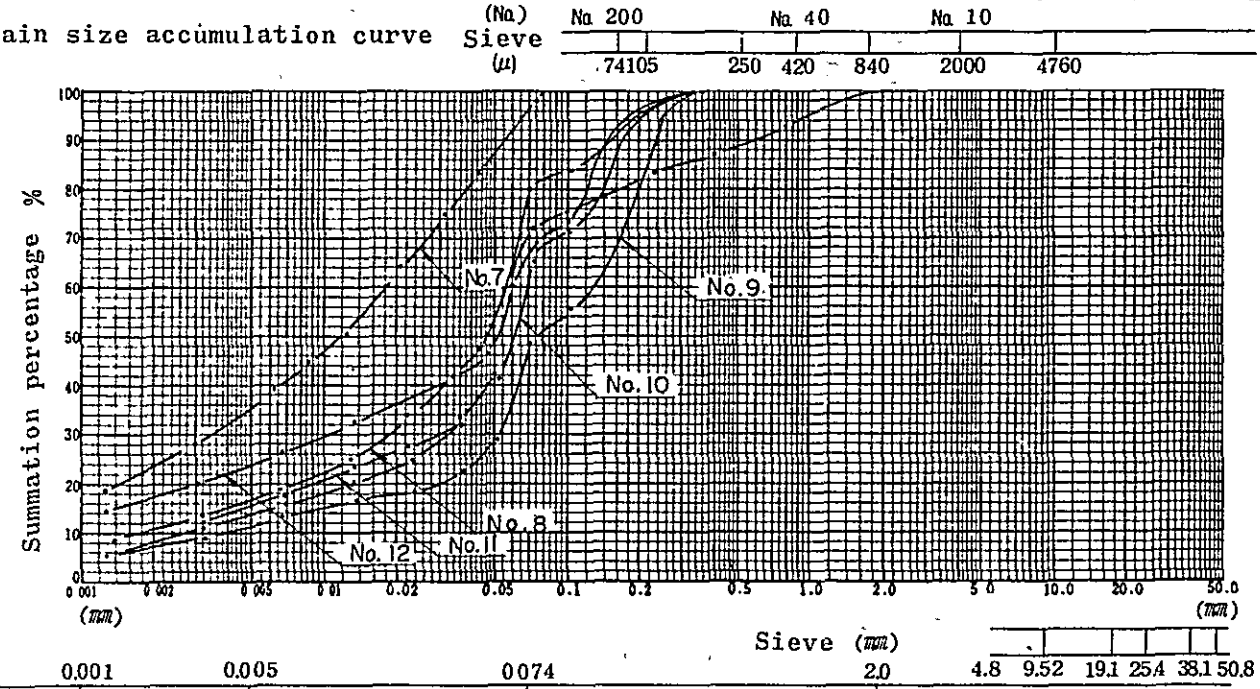
Soil classification of grain size (Sample of passed 2000 μ sieve)

a CLAY
b SANDY CLAY
c SILTY CLAY
d SANDY CLAY LOAM
e CLAYEY LOAM
f SILTY CLAY LOAM
g SAND
h SANDY LOAM
i LOAM
j SILTY LOAM



Sample No	Gravel %	Sand %	Silt %	Clay %	Max. size mm	D60 mm	D10 mm	Uniformity Coett	2000μ sieve	420μ sieve	74μ sieve	Size of Plotted part on triangular diagram	Classification	Remarks
									Passed Percentage					
No 7		1 5	68 5	30.0	0.105	0018	—	—	100	100	98 5	c	SILTY CLAY	
No.8		19 5	63.5	17.0	0 420	0006	00018	33 3	100	100	80 5	j	SILTY LOAM	
No 9		51.0	38.0	11.0	0.84	0 13	0004	32.5	100	995	49 0	h	SANDY LOAM	
No10		33.0	540	13 0	0.42	0 007	0.0028	25.0	100	100	67 0	j	SILTY LOAM	
No.11		31.0	54.0	15.0	0.42	0.063	0.002	31 5	100	100	69.0	j	SILTY LOAM	
No12		25.5	51 0	23 5	20	0 06	—	—	100	905	74.5	c	SILTY CLAY LOAM	

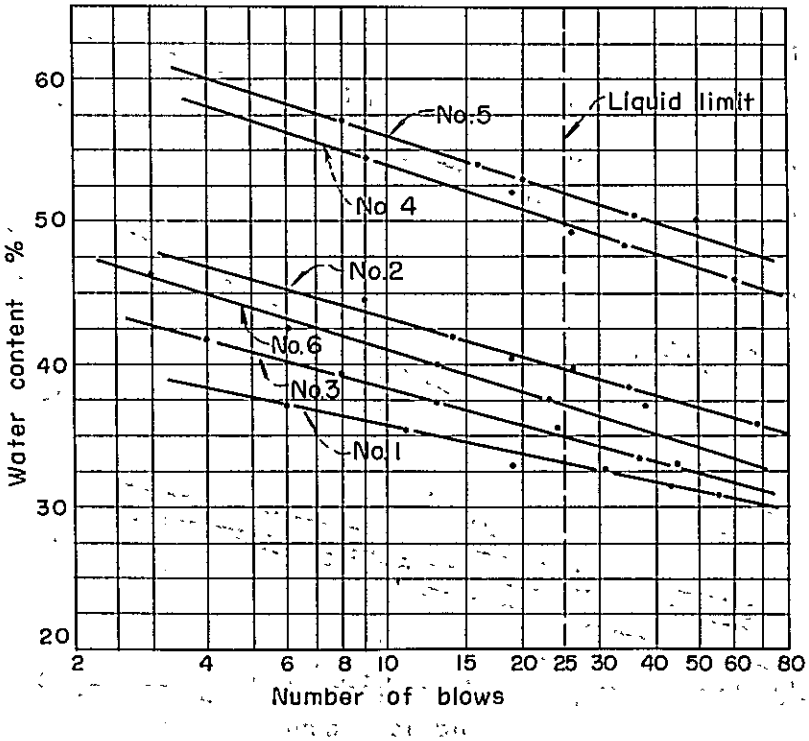
Grain size accumulation curve



Liquid Limit and Plastic Limit Tests - 1

Result of Test

Sample No.	Liquid limit	Plastic limit (1)	Plastic limit (2)	Plastic limit Mean	Plasticity index	Flow index
1	33.25	20.76	20.14	20.45	12.80	6.30
2	39.80	21.67	21.72	21.70	18.10	8.48
3	35.20	22.17	21.92	22.05	13.15	8.25
4	49.80	17.49	17.24	17.37	32.43	10.10
5	52.00	20.62	20.32	20.47	31.53	10.10
6	37.10	20.66	20.62	20.64	16.46	10.00

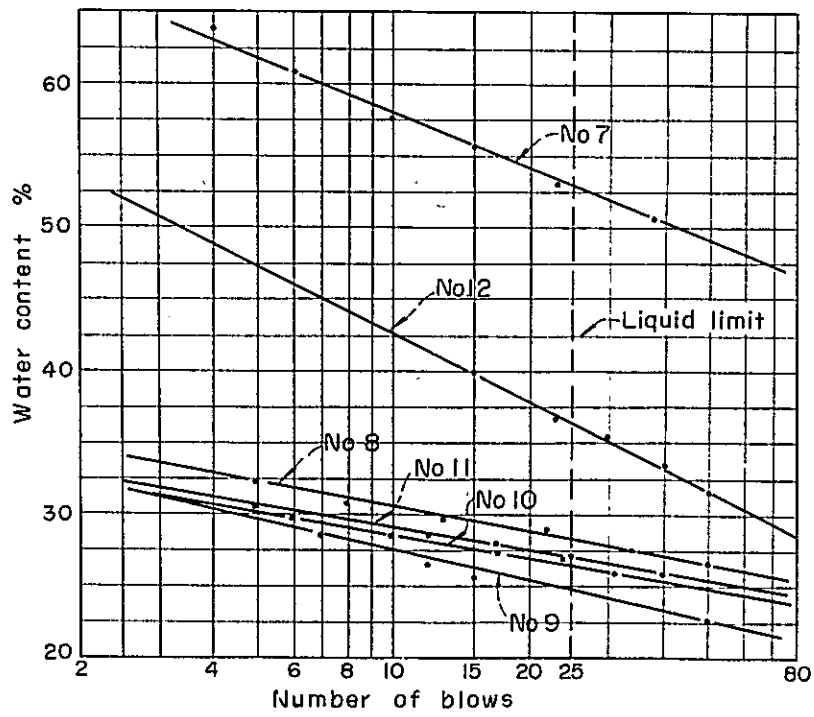


Remarks : The soil passing 0.4 mm sieve was used for the test to decide the liquid and plastic limits.

Liquid Limit and Plastic Limit Tests - 2

Result of Test

Sample No.	Liquid limit	Plastic limit			Plasticity index	Flow index
		(1)	(2)	Mean		
7	53.10	24.75	23.91	24.33	28.77	12.80
8	28.20	22.27	22.02	22.15	6.05	5.10
9	24.10	18.46	18.85	18.66	5.46	5.95
10	26.40	22.54	22.43	22.49	3.91	5.10
11	26.85	18.50	18.36	18.43	8.42	5.05
12	36.50	11.85	11.50	11.68	24.82	15.70



Remarks: The soil passing 0.4 mm sieve was used for the test to decide the liquid and plastic limits.

Direct Shear Test

Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
6	1.650	0.6	1.118	0.60	$40^{\circ}02'$
	1.618	1.1	1.511		
	1.649	1.6	1.739		
	1.630	2.1	2.400		
8	1.491	0.6	0.758	0.30	$37^{\circ}36'$
	1.496	1.1	1.190		
	1.498	1.6	1.373		
	1.501	2.1	1.914		
10	1.480	0.6	0.874	0.70	$15^{\circ}39'$
	1.507	1.1	0.963		
	1.499	1.6	1.137		
	1.501	2.1	1.309		
11	1.542	0.6	0.531	0.28	$22^{\circ}47'$
	1.520	1.1	0.766		
	1.536	1.6	0.937		
	1.510	2.1	1.163		
12	1.754	0.6	0.973	0.60	$30^{\circ}58'$
	1.770	1.1	1.237		
	1.781	1.6	1.560		
	1.783	2.1	1.654		

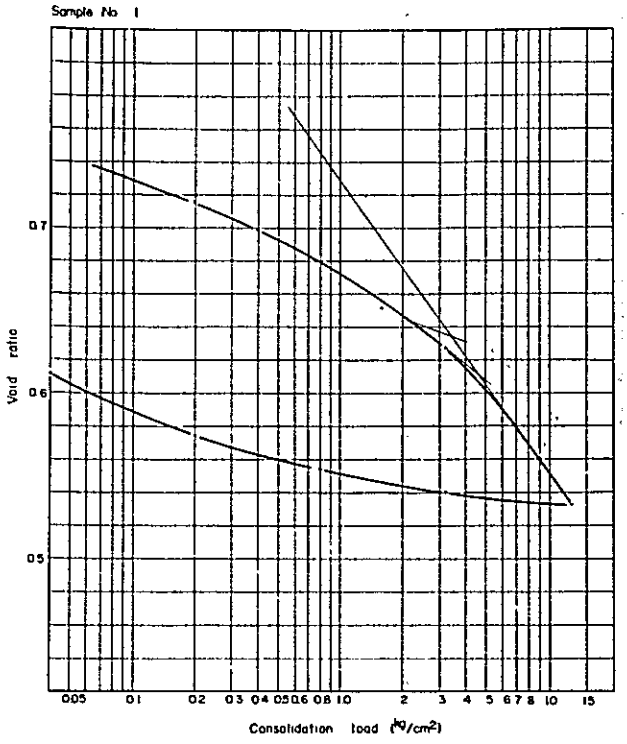
Triaxial Compression Test

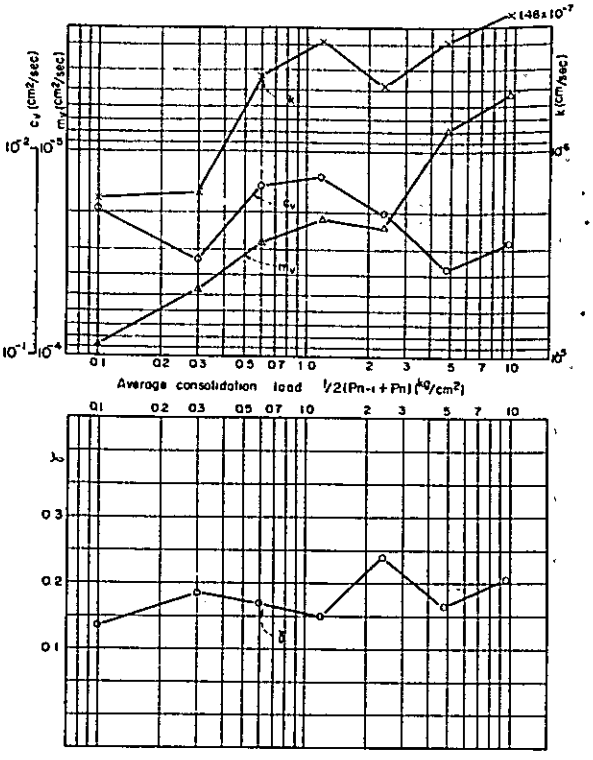
Sample No.	Dry density γ_d (g/cm^3)	Lateral pressure σ_3 (kg/cm^2)	Max. compression stress σ_1 (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
1	1.600 1.561 1.562	1 2 3	1.803 2.431 2.776	0.50	12°25'
2	1.600 1.615	1 2	3.238 4.250	0.80	19°18'
3	1.543 1.526 1.509	1 2 3	1.569 2.038 2.747	0.45	10°46'
4	1.619 1.605 1.619	1 2 3	0.725 0.921 1.198	0.925	5°43'
5	1.273 1.308 1.329	1 2 3	0.828 1.161 1.804	0.20	8°32'
6	1.622 1.619 1.646	1 2 3	2.547 3.100 3.651	0.82	11°52'
7	1.406 1.400 1.395	1 2 3	3.602 4.182 4.691	1.15	13°30'
8	1.461 1.514 1.551	1 2 3	1.160 1.985 2.583	0.21	15°39'
9	1.503 1.481	1 2	1.031 1.896	0.10	16°42'
10	1.611 1.549 1.549	1 2 3	1.046 1.358 2.100	0.35	6°17'
11	1.595 1.588 1.580	1 2 3	0.961 1.231 1.709	0.24	8°32'
12	1.668 1.742 1.775	1 2 3	2.10 2.78 3.31	0.50	15°07'

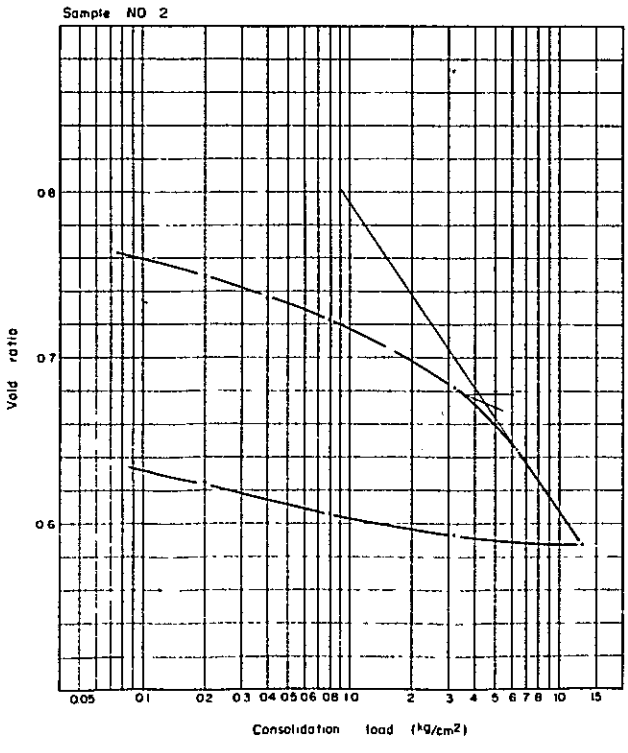
Unconfined Compression Test

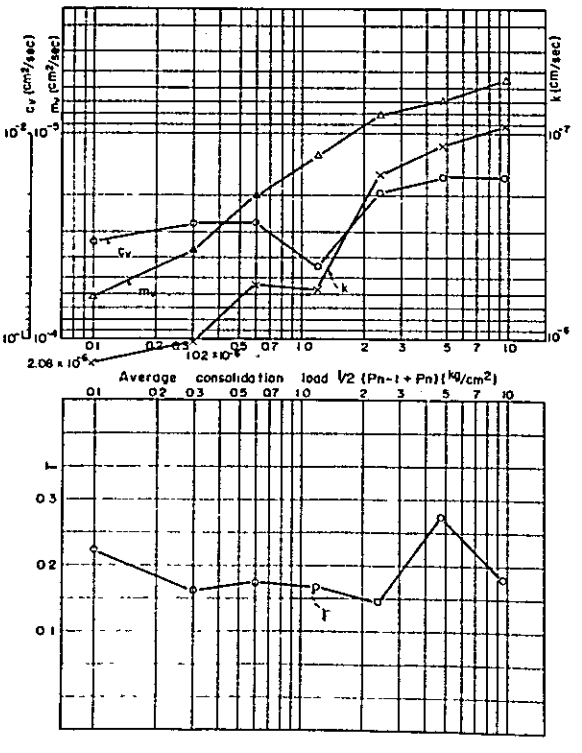
Sample No.	Mean water content (%)	Unit weight (g/cm^3)	Unconfined compression strength (kg/cm^2)		Sensitivity ratio
			undisturbed sample	disturbed sample	
1	19.06	1.878	1.195	0.508	2.36
2	27.41	1.878	0.883	0.564	1.56
3	22.89	1.858	1.051	0.258	4.08
4	26.77	2.030	0.505	0.427	1.18
5	38.27	1.803	0.471	0.287	1.64
6	24.86	1.965	0.861	0.626	1.38
7	28.70	1.797	3.920	0.760	5.16
8	27.18	1.848	0.426	-	-
9	21.17	1.838	0.290	0.071	4.08
10	25.76	1.934	0.498	-	-
11	25.85	1.950	0.556	-	-
12	16.51	1.992	0.664	0.627	1.06

CONSOLIDATION TEST — I



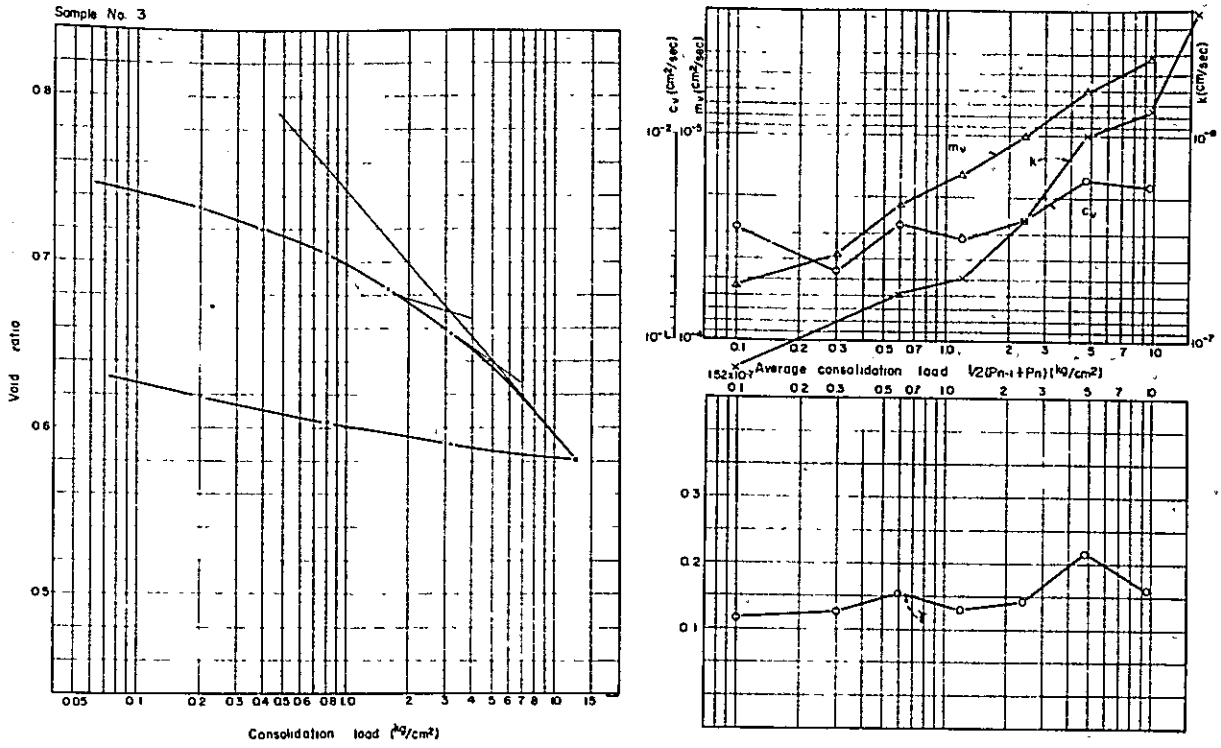


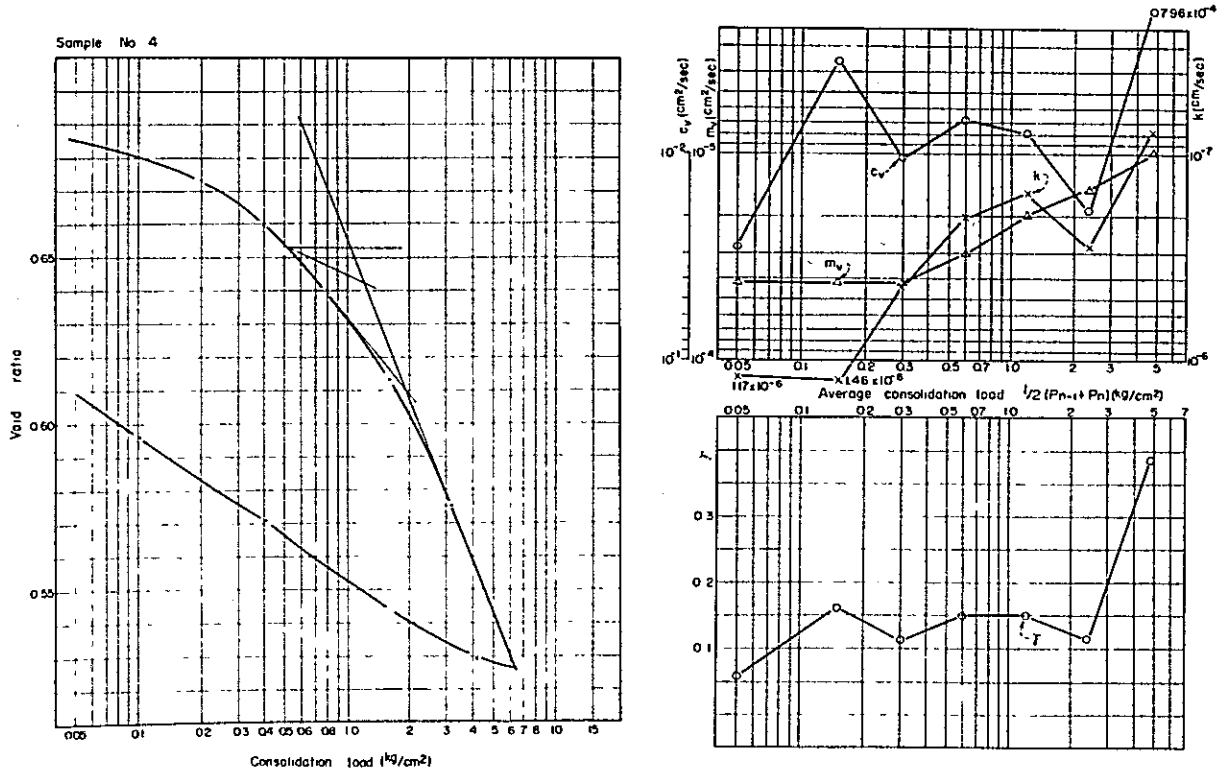




Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

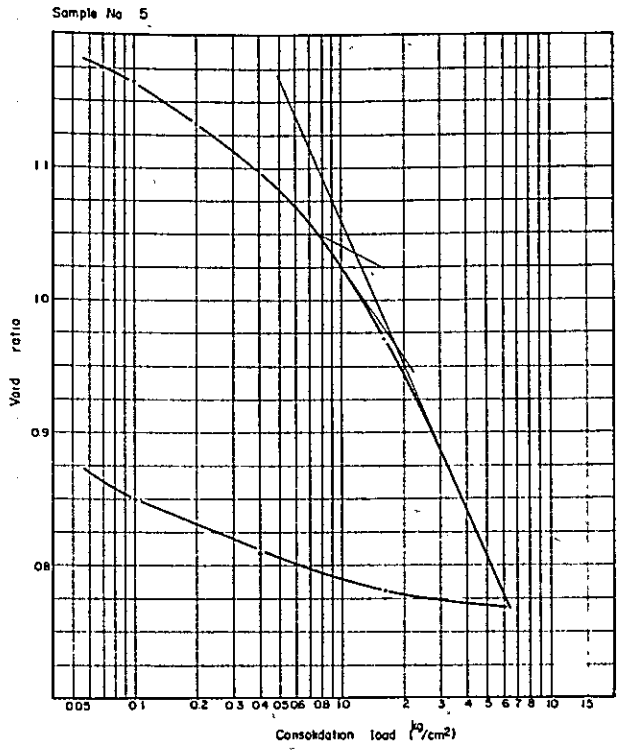
CONSOLIDATION TEST — 2

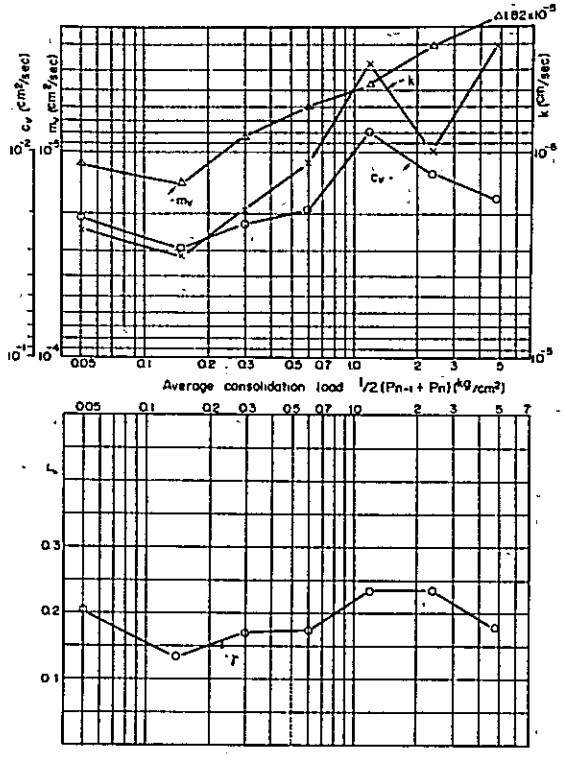


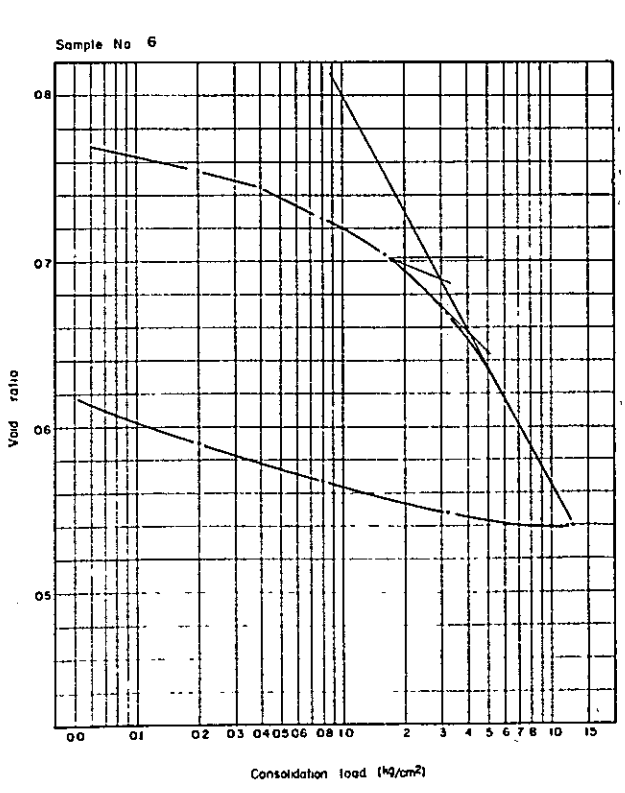


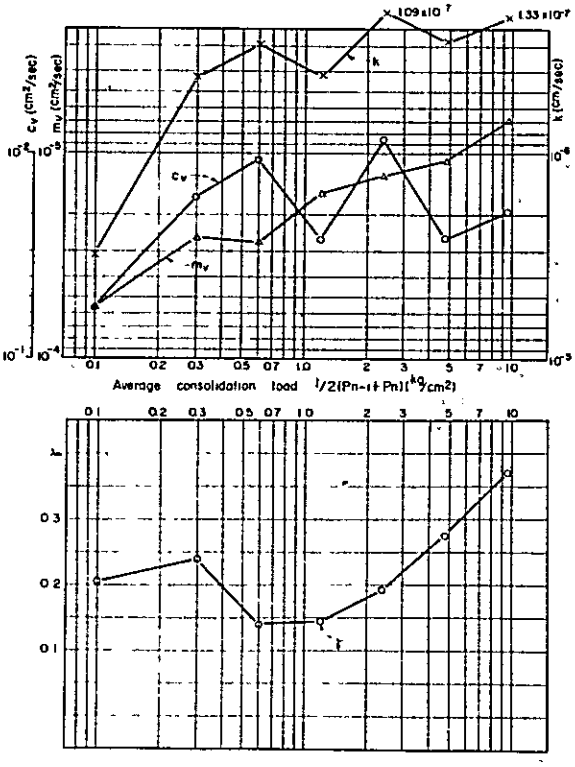
Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

CONSOLIDATION TEST — 3



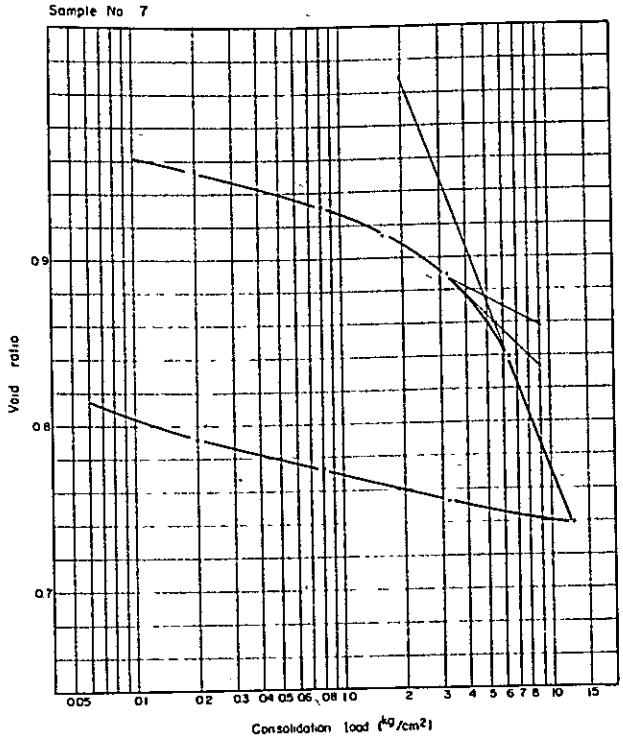


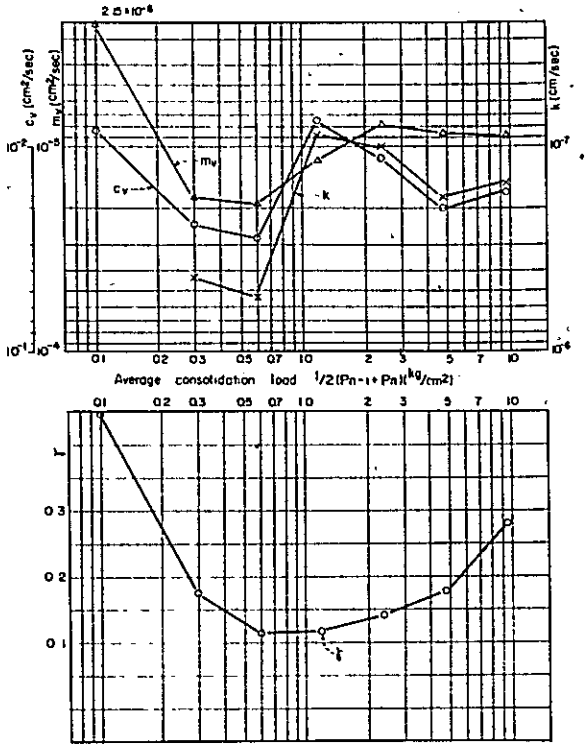


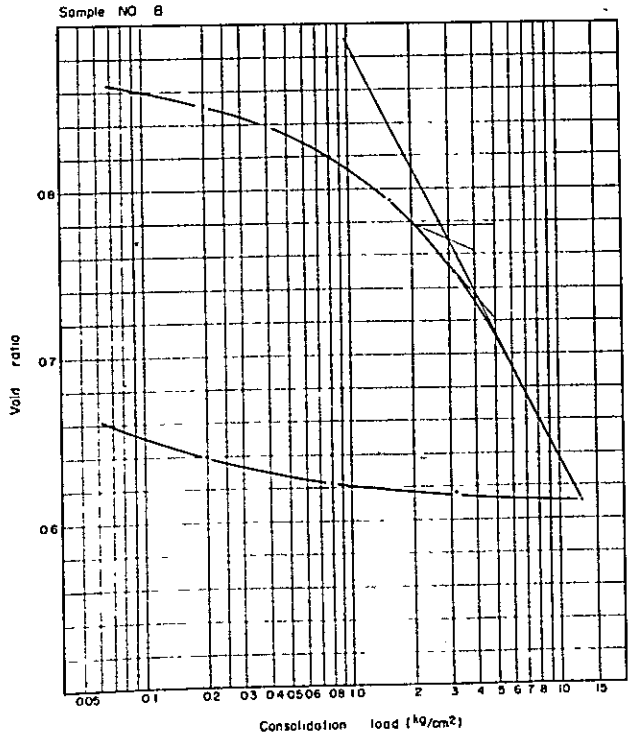


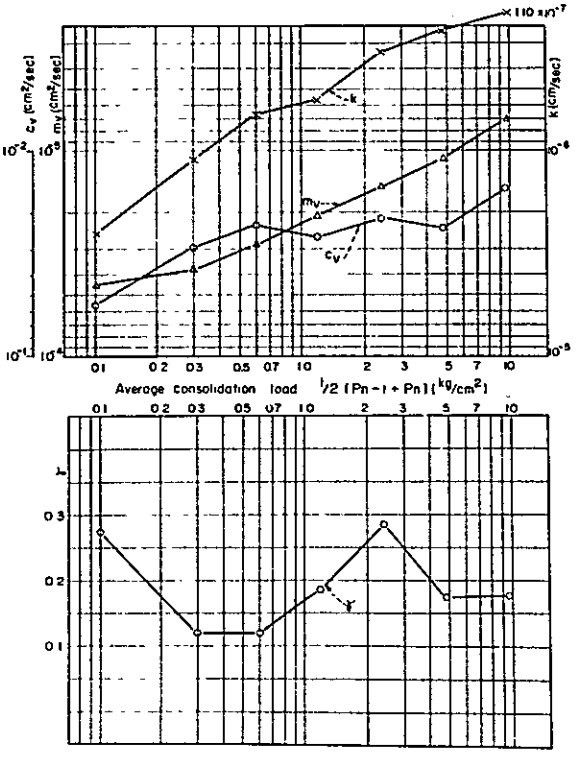
Remarks c_v Coefficient of consolidation
m_v: Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

CONSOLIDATION TEST — 4



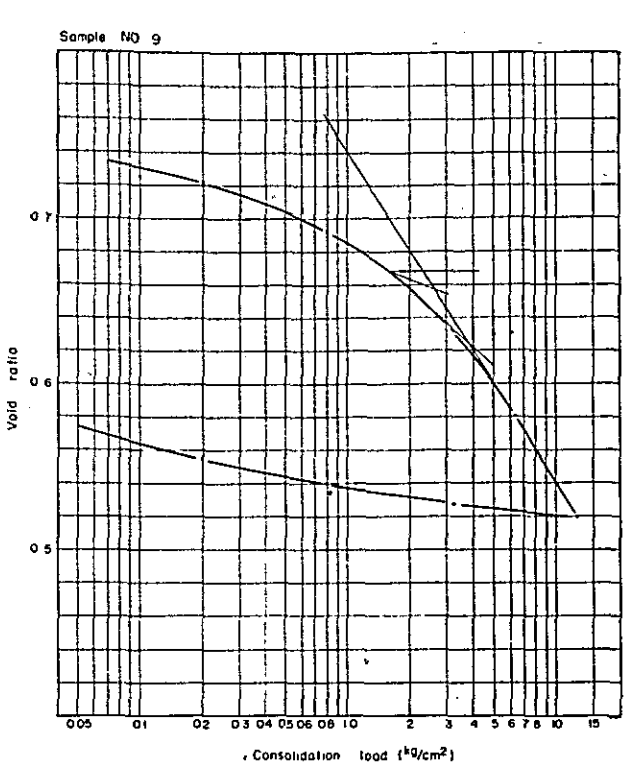


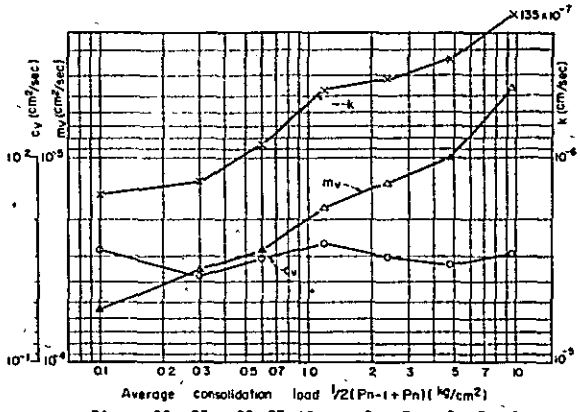


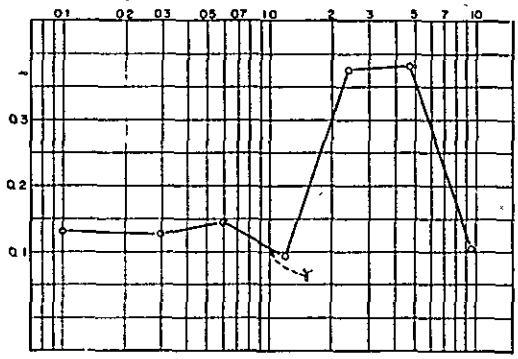


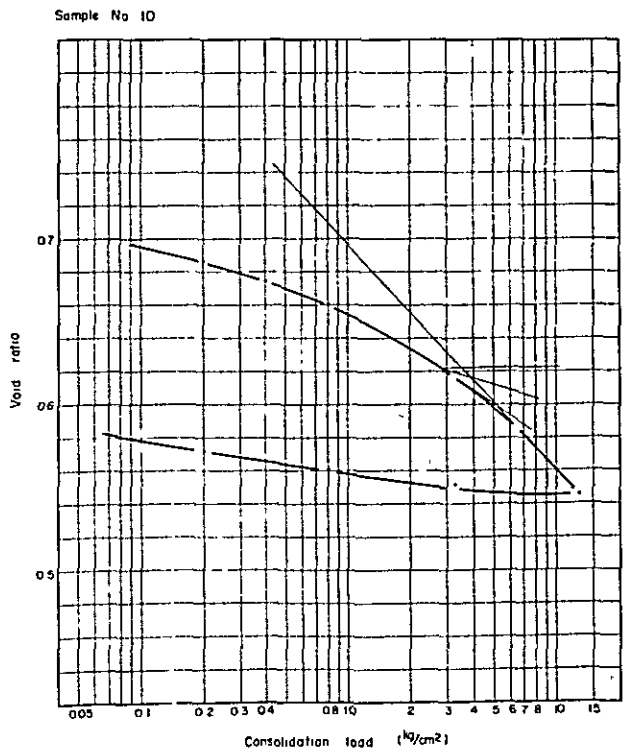
Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

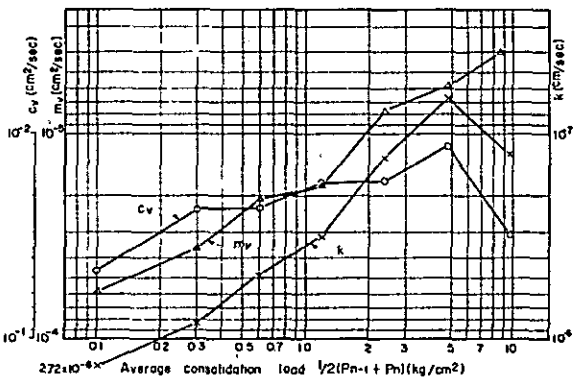
CONSOLIDATION TEST — 5

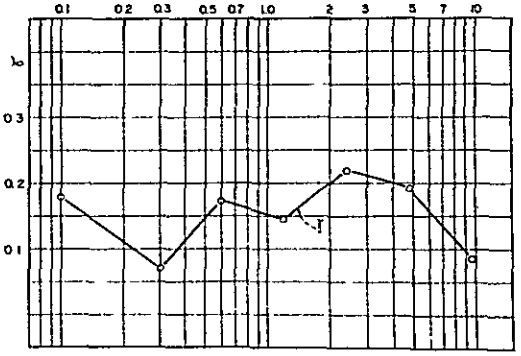






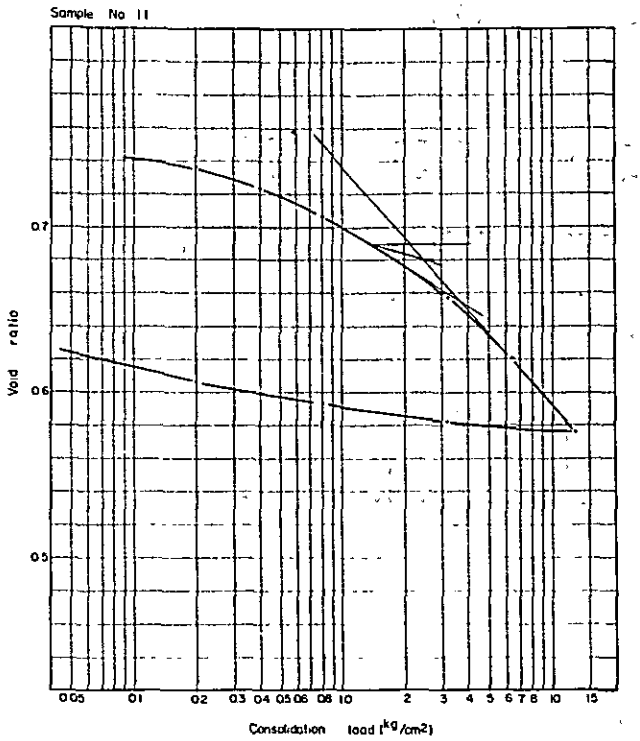


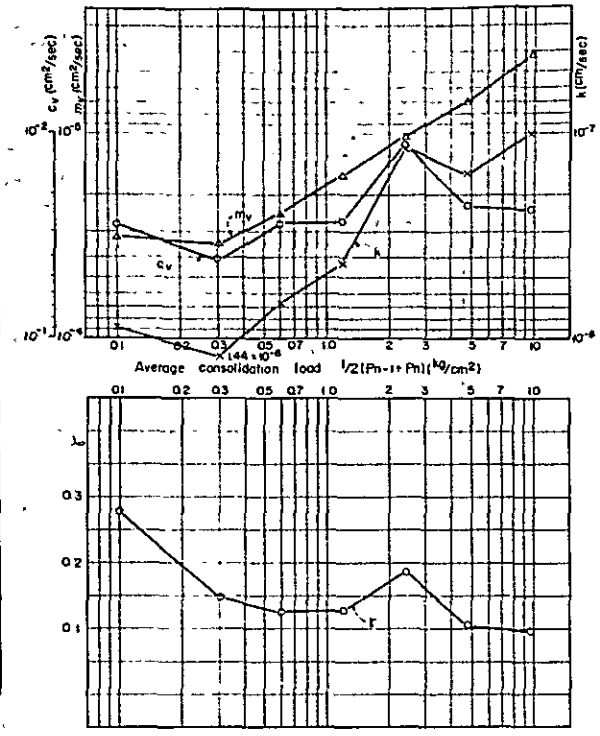


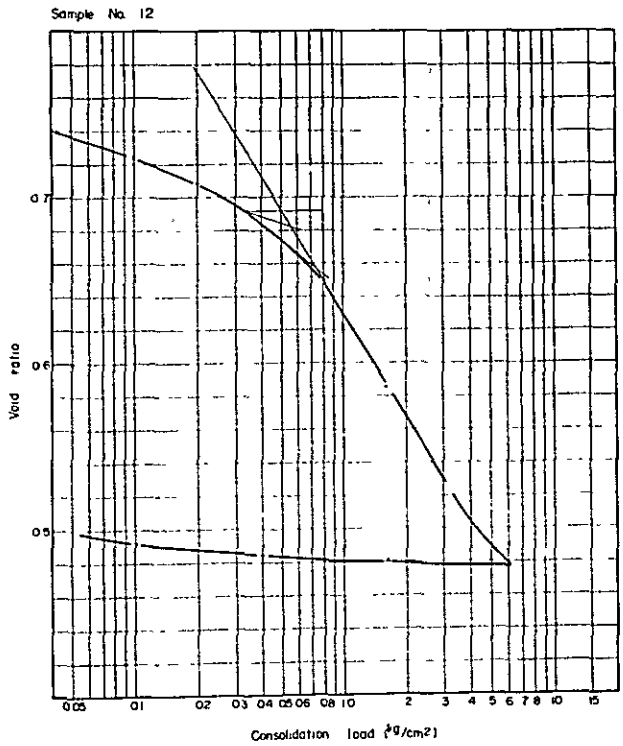


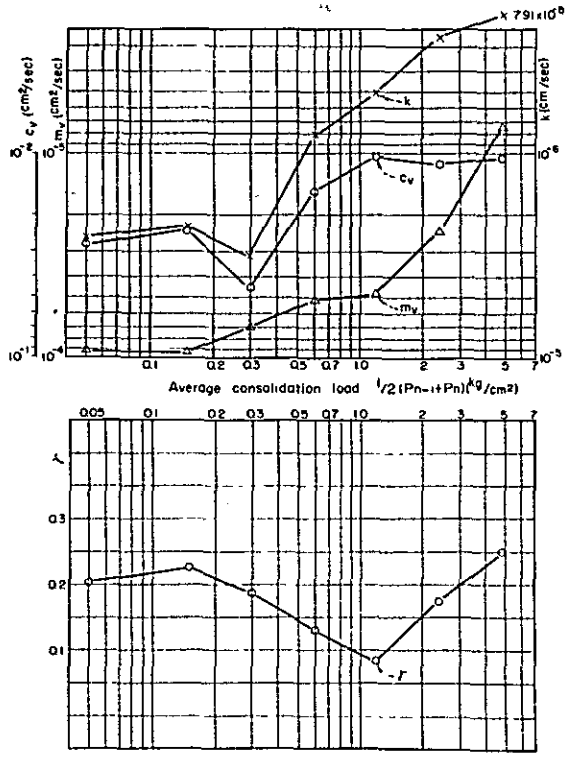
Remarks
c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

CONSOLIDATION TEST — 6









Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

Compressive Strength Test of Core Samples (Siltstone)

Sample No.	Bore hole No.	Sampling depth (m)	Compressive strength (kg/cm^2)
1	5	7.5 - 7.7	173
2	6	10.45 - 10.60	170
3	9	7.3 - 7.4	165
Mean			169

Remarks.

(1) The test was made with the dry condition at the laboratory of Chuo Univ. in Tokyo on Aug. 17, 1968.

(2) Furthermore, two more samples were tested in the laboratory of N.E.A. in Bangkok on Apr. 1, 1968. The results were as follows:

Bore hole No.	Sampling depth (m)	Compressive strength (kg/cm^2)
1	20	115.3
3	12	126.9

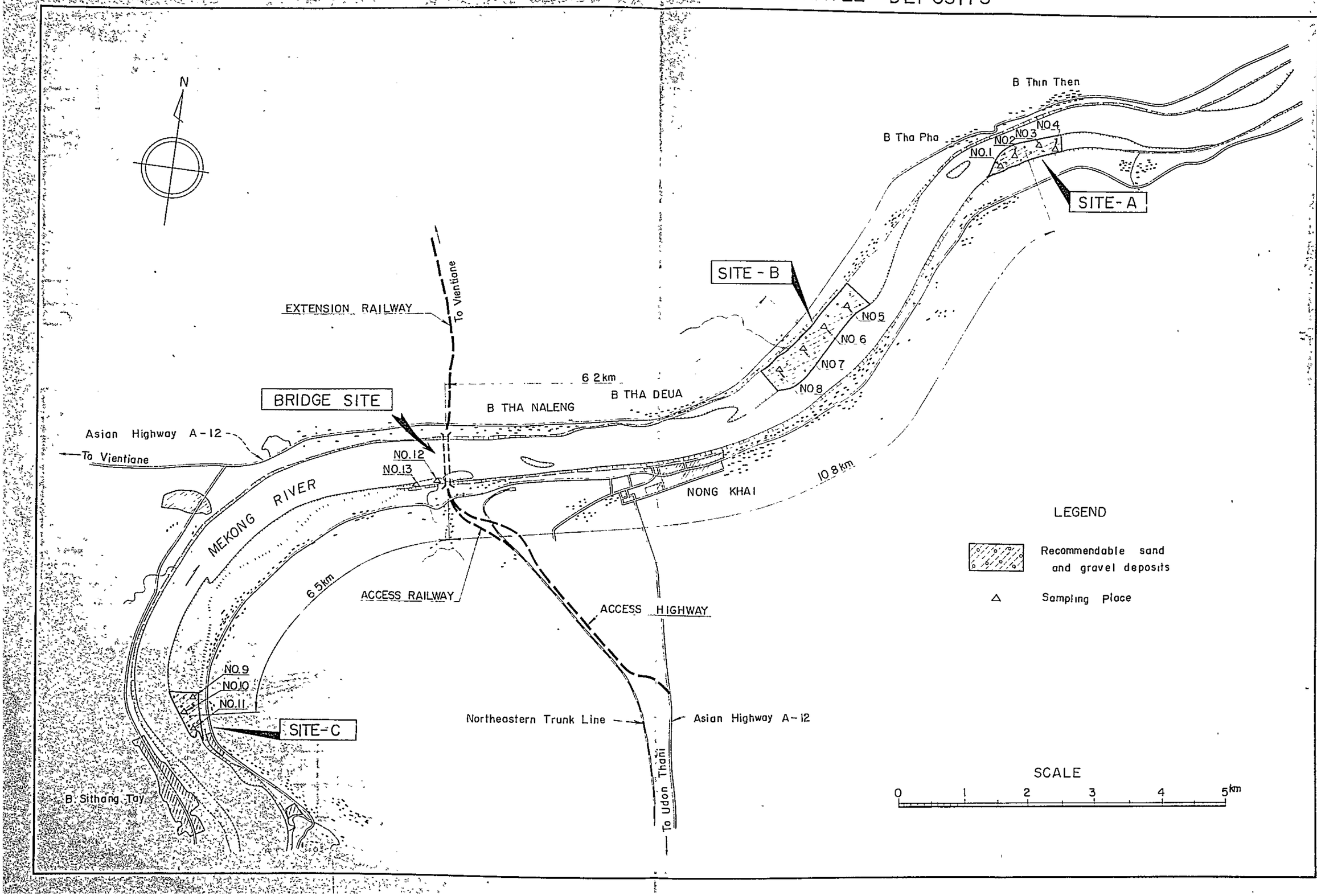
第三章

材料調査

目次

3.1. コンクリート骨材

RECOMMENDABLE SAND AND GRAVEL DEPOSITS



SAND TEST

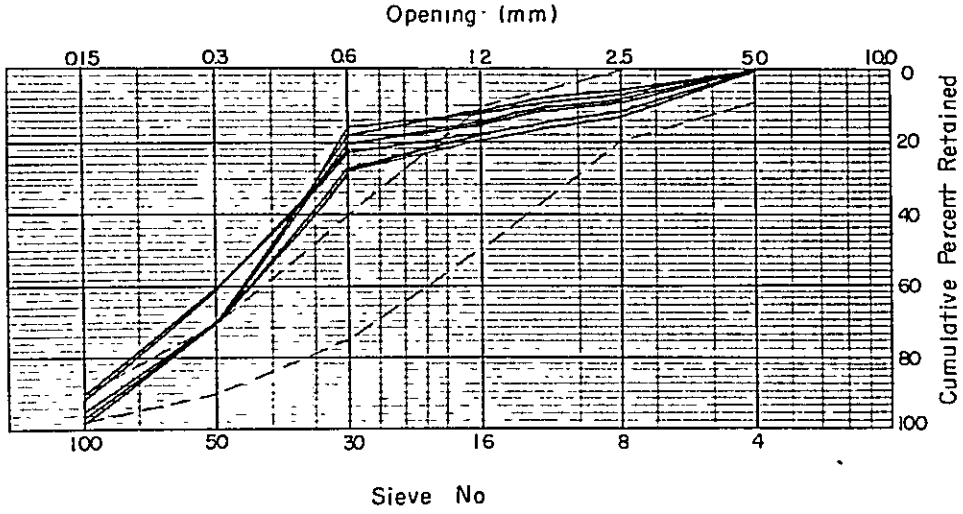
1) SIEVE ANALYSIS

SITE: A

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	1				2			
Weight of sample	516 grms		541.7 grms		516 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	71	13.4	63.2	11.7	37	7.2	27	5.4
12	84	15.9	76.4	14.1	43	8.3	34	6.8
16		(19.0)		(18.0)		(11.0)		(10.0)
30	146	27.6	165.2	26.8	79	15.3	86	17.2
50	371	70.1	384.2	71.0	360	69.8	402	80.4
100	499	94.4	513.2	94.9	487	94.5	490	98.0
Passing	529	100.0	541.7	100.0	516	100.0	500	100.0
Max. size	2.7 mm		3.0 mm		1.3 mm		1.3 mm	
F.M.	2.25		2.22		1.98		2.11	

Sample No.	3				4			
Weight of sample	504 grms		505 grms		503 grms		495 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	1	0.2	0	0	0	0	0	0
8	42	8.3	44	8.7	66	13.1	67	13.5
12	50	9.9	53	10.5	76	15.1	76	15.4
16		(13.0)		(13.0)		(18.5)		(18.5)
30	98	19.4	96	19.0	110	21.9	113	22.8
50	355	70.5	355	70.4	302	60.0	300	60.6
100	487	96.6	489	96.8	450	89.3	447	90.4
Passing	504	100.0	505	100.0	503	100.0	495	100.0
Max. size	1.8 mm		1.8 mm		2.9 mm		2.9 mm	
F.M.	2.08		2.08		2.03		2.06	



SAND TEST

SITE: A

2) UNIT WEIGHT

Sample No.		2		3	
Weight of sample	(grm)	3,212	3,226.5	3,319	3,331
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,610	1,610	1,660	1,670

3) SPECIFIC GRAVITY

Sample No.			2			
Weight of sample	(grm)	A =	500	500		
Capacity of flask	(cm^3)	B =	500	500		
Water added to flask	(cm^3)	C =	311	309		
Specific gravity	A/(B - C)		2.64	2.62		

4) ABSORPTION

Sample No.			2			
Weight, surface dry condition	(grm)	A =	500.0	500.0		
Weight, oven dry condition	(grm)	B =	494.2	493.8		
Absorption	(A - B)/B x 100 (%)		1.17	1.25		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		1		4	
Weight of sample before washing	(grm)	500.0	500.0	500.0	500.0
weight of sample after washing	(grm)	495.2	496.1	494.3	496.1
Decreased amount	(grm)	4.8	3.9	5.7	3.9
Percentage		0.96	0.78	1.14	0.78

SAND TEST

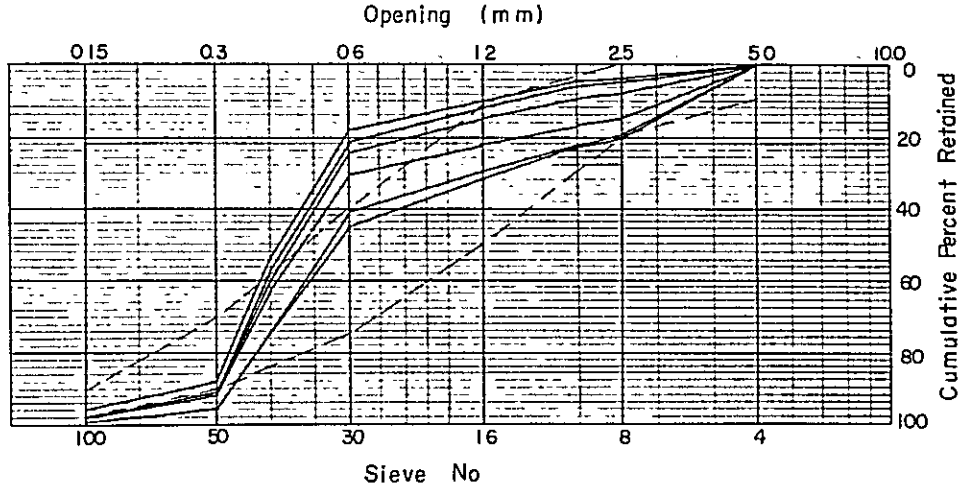
1) SIEVE ANALYSIS

SITE: B

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	5				6			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	3	0.6	4	0.8	4	0.8	0.5	0.1
8	98	19.6	101	20.2	76	15.2	39.5	7.9
10	112	22.4	113	22.6	84	16.8	46.5	9.3
16		(32.5)		(30.0)		(23.0)		(15.0)
30	226	45.2	203	40.6	152	30.4	117.5	23.5
40	371	74.2	375	75.0	307	61.5	293.5	58.7
50	483	96.6	477	95.5	461	92.2	457.5	91.5
100	499	99.8	495	99.0	491	98.2	487.5	97.5
Passing	500	100.0	500	100.0	500	100.0	500.0	100.0
Max. size	3.5 mm		3.5 mm		1.9 mm		3.2 mm	
F.M.	2.94		2.86		2.60		2.36	

Sample No.	7				8			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	1	0.2	0.8	0.2	0	0
8	19	3.8	25	5.0	14.3	2.9	18	3.6
10	22	4.4	30	6.0	109.6	21.9	22	4.4
16		(11.0)		(12.5)		(23.5)		(13.5)
30	91	18.2	105	21.0	127.8	25.6	138	27.6
40	267	53.4	283	56.6	420.8	84.2	437	87.5
50	441	88.2	455	91.0	484.8	97.0	491	98.2
100	479	95.8	492	98.4	488.8	97.8	495	99.0
Passing	500	100.0	500	100.0	500.0	100.0	500	100.0
Max. size	1.2 mm		1.5 mm		2.2 mm		1.5 mm	
F.M.	2.17		2.28		2.47		2.42	



SAND TEST

SITE: B

2) UNIT WEIGHT

Sample No.		6		7	
Weight of sample	(grm)	3,317.2	3,322.2	3,327.2	3,322.2
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,560	1,560	1,660	1,660

3) SPECIFIC GRAVITY

Sample No.			6			
Weight of sample	(grm)	A =	500	500		
Capacity of flask	(cm^3)	B =	500	500		
water added to flask	(cm^3)	C =	306	307		
Specific gravity	A/(B - C)		2.58	2.59		

4) ABSORPTION

Sample No.		6			
Weight, surface dry condition (grm)	A =	500.0	500.0		
Weight, oven dry condition (grm)	B =	495.2	494.7		
Absorption	(A - B)/B x 100 (%)	0.97	1.07		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.	5		8	
Weight of sample before washing (grm)	641.8	570.0	522.6	500.0
Weight of sample after washing (grm)	634.9	563.0	517.2	497.7
Decreased amount (grm)	6.9	7.0	5.4	2.3
Percentage	1.1	1.2	1.0	0.5

6) ORGANIC IMPURITIES

Sample No. 5

Result Trace

SAND TEST

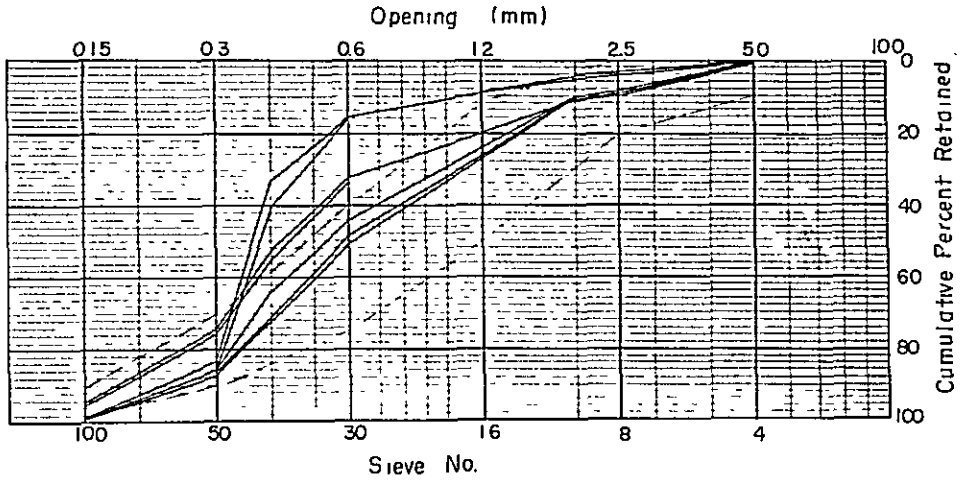
1) SIEVE ANALYSIS

SITE : C

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	9				10			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	19	3.8	15	3.0	47	9.4	49	9.8
10	23	4.6	20	4.0	55	11.0	58	11.6
16		(9.0)		(9.0)		(20.0)		(20.0)
30	79	15.8	79	15.8	165	33.0	163	32.6
40	164	32.8	200	40.0	272	54.4	263	52.5
50	418.9	83.8	434	86.8	380	76.0	371	74.2
100	498.0	99.6	498	99.6	475	95.0	472	94.4
Passing	500	100.0	500	100.0	500	100.0	500	100.0
Max. size	1.1 mm		1.1 mm		2.3 mm		2.3 mm	
F.M.	2.12		2.14		2.33		2.31	

Sample No.	11 - 1				11 - 2			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	43	8.6	42.4	8.5	43	8.6	47	9.4
10	51	10.2	50.0	10.0	50	10.0	53	10.6
16		(24.0)		(24.0)		(26.0)		(27.0)
30	217	43.5	217.0	43.4	242	48.4	251	50.2
40	323	64.6	319.0	63.8	354	70.8	356	71.2
50	430	86.0	431.0	86.2	433	86.6	437	87.4
100	490	98.0	489.0	97.8	492	98.4	492	98.4
Passing	500	100.0	500	100.0	500	100.0	500	100.0
Max. size	2.0 mm		2.0 mm		2.0 mm		2.2 mm	
F.M.	2.60		2.60		2.68		2.72	



SAND TEST

SITE: C

2) UNIT WEIGHT

Sample No.	10		11-1		11-2	
Weight of sample (grm)	3,408.2	3,427.3	3,438.2	3,446.2	3,404.2	3,410.2
Volume of sample (cm^3)	2,000	2,000	2,000	2,000	2,000	2,000
Unit weight (kg/m^3)	1,700	1,710	1,720	1,720	1,700	1,710

3) SPECIFIC GRAVITY

Sample No.			11-1		11-2	
Weight of sample	(grm)	A =	500.0	500.0	500.0	500.0
Capacity of flask	(cm^3)	B =	500.0	500.0	500.0	500.0
Water added to flask	(cm^3)	C =	307.5	307.5	308.3	308.3
Specific gravity	A/(B - C)		2.60	2.60	2.60	2.60

4) ABSORPTION

Sample No.		11-1		11-2	
Weight, surfece dry condition (grm)	A =	500.0	500.0	500.0	500.0
Weight, oven dry condition (grm)	B =	496.3	495.7	494.9	494.5
Absorption (A - B)/B x 100 (%)		0.75	0.87	1.03	1.11

5) MATERIAL PASSING NO.200 SIEVE

Sample No.	9 and 10			
Weight of sample before washing (grm)	502.0	500.7		
Weight of sample after washing (grm)	499.1	497.8		
Decreased amount (grm)	2.9	2.9		
Percentage	0.58	0.58		

6) ORGANIC IMPURITIES

Sample No. 9

Result Trace

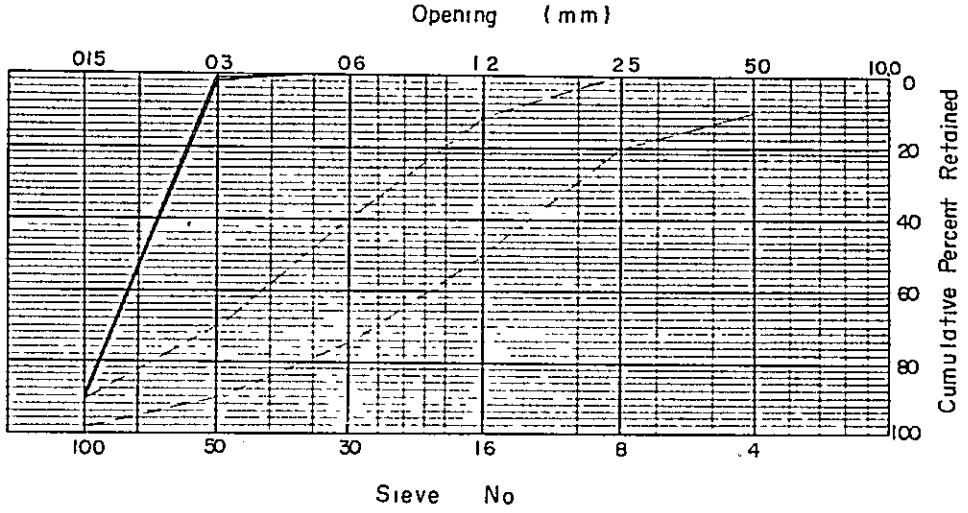
SAND TEST

1) SIEVE ANALYSIS

SITE: Bridge Site

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	12				13			
Weight of sample	494.2 grms		490.5 grms		500.4 grms		500.9 grms	
Sieve No.	W	%	W	%	W	%	W	%
4								
8								
12								
16		(0)		(0)		(0)		
30	0	0	1.7	0.3	0.2	0	0	0
50	2.0	0.4	5.2	1.1	5.7	1.1	5.7	1.1
100	444.4	88.9	439.2	89.6	447.7	89.5	453.7	90.6
Passing	494.2	100.0	490.5	100.0	500.4	100.0	500.9	100.0
Max. size	0.3 mm		0.3 mm		0.3 mm		0.3 mm	
F.M.	0.89		0.91		0.91		0.92	



SAND TEST

SITE: Bridge site

2) UNIT WEIGHT

Sample No.		12		13	
Weight of sample	(grm)	2,903	2,903	2,925	2,927
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,450	1,450	1,460	1,460

3) SPECIFIC GRAVITY

Sample No.			13			
Weight of sample	(grm)	A =	500.0	500.0		
Capacity of flask	(cm^3)	B =	500.0	500.0		
Water added to flask	(cm^3)	C =	303.2	302.5		
Specific gravity	A/(B - C)		2.54	2.53		

4) ABSORPTION

Sample No.			13			
Weight, surface dry condition	(grm)	A =	500.0	500.0		
Weight, oven dry condition	(grm)	B =	491.9	492.1		
Absorption	(A - B)/B	( )	1.65	1.61		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		13			
Weight of sample before washing	(grm)	500.0	500.0		
Weight of sample after washing	(grm)	491.3	487.7		
Decreased amount	(grm)	8.7	12.3		
Percentage		1.74	2.46		

GRAVEL TEST

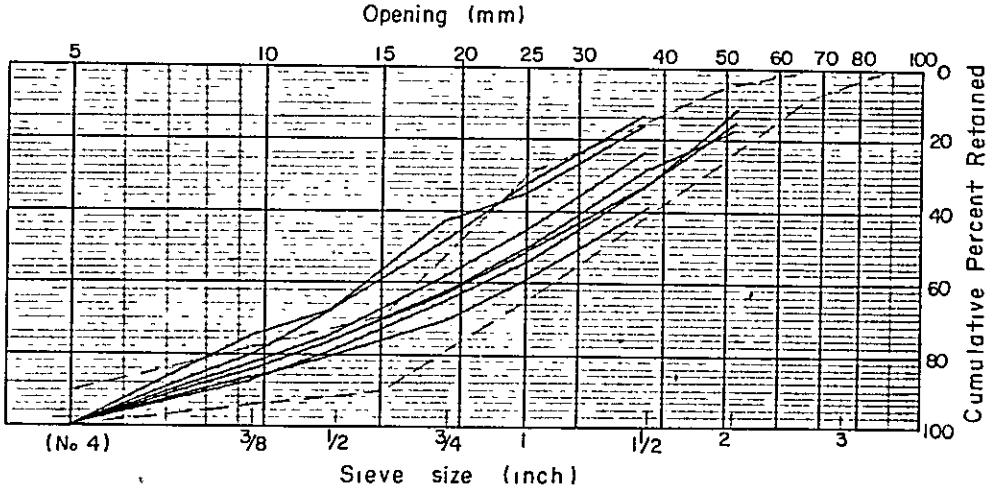
1) SIEVE ANALYSIS

SITE: A

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	1				2			
Weight of sample	21,515 grms		21,464 grms		4,855 grms		6,302 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2	3,680	17.1	3,675	17.1				
1½	6,008	27.9	5,999	27.9	1,114	23.0	2,433	38.6
1	11,150	51.8	11,090	51.6	2,238	46.1	3,762	59.7
3/4	13,437	62.5	13,337	62.1	2,808	57.9	4,449	70.6
1/2			16,067	74.8	3,553	73.2	5,076	80.5
3/8	17,887	83.0	17,874	83.3	3,981	82.1	5,457	86.6
No.4	21,515	100.0	21,464	100.0	4,855	100.0	6,302	100.0
Max. size	(60 mm)		(60 mm)		(55 mm)		(70 mm)	
F.M.	7.73		7.73		7.63		7.96	

Sample No.	3				4			
Weight of sample	4,125 grms		5,131 grms		11,831 grms		13,884 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2					1,747	14.8	1,566	11.3
1½	542	13.1	820	16.0	3,835	32.4	4,521	32.5
1	1,298	31.5	1,800	35.1	5,940	50.2	7,630	55.0
3/4	1,994	48.4	2,194	42.8	7,370	62.3	9,027	65.0
1/2	2,804	68.0	3,498	68.2	9,080	76.8	11,015	79.3
3/8	3,082	74.8	4,088	79.7	10,052	85.0	12,053	86.7
No.4	4,125	100.0	5,131	100.0	11,831	100.0	13,884	100.0
Max. size	(45 mm)		(50 mm)		(55 mm)		(50 mm)	
F.M.	7.36		7.38		7,80		7.84	



GRAVEL TEST

SITE: A

2) UNIT WEIGHT

Sample No.		2		3	
Weight of sample	(grm)	18,596	18,585	19,944	19,956
Volume of sample	(cm^3)	10,776	10,776	10,776	10,776
Unit weight	(kg/m^3)	1,730	1,720	1,850	1,850

3) SPECIFIC GRAVITY and ABSORPTION

Sample No.		2		3	
(Surface dry condition) Weight in air (grm) A =		2,000.0	2,000.0	2,000.0	2,000.0
(Surface dry condition) Weight in water(grm) B =		1,237.5	1,235.0	1,233.0	1,242.5
Weight, oven dry condition (grm) C =		1,991.0	1,990.0	1,984.0	1,983.2
Specific gravity	A/(A - B)	2.62	2.61	2.61	2.64
Absorption	(A - C)/C x 100 (%)	0.45	0.50	0.86	0.85

GRAVEL TEST

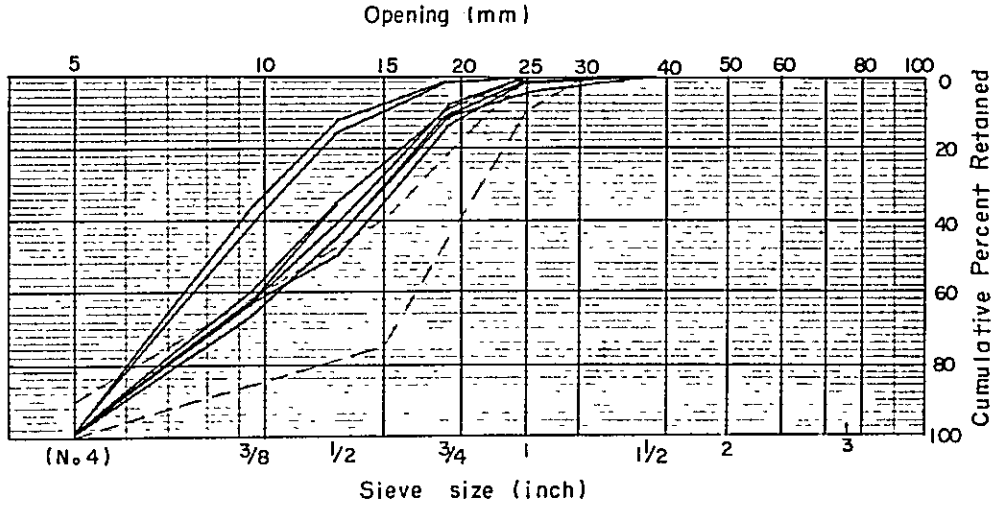
1) SIEVE ANALYSIS

SITE: B

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	5				6			
Weight of sample	5,000 grms		5,000 grms		5,000 grms		5,000 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2								
1½	0	0	0	0	0	0	0	0
1	43	0.9	107	2.1	90	1.8	55	1.1
3/4	372	7.4	676	13.5	439	8.8	567	11.4
1/2	2,043	40.8	1,989	39.8	2,259	45.2	2,222	44.5
3/8	3,145	62.9	3,151	63.0	3,152	63.0	3,348	67.0
No.4	5,000	100.0	5,000	100.0	5,000	100.0	5,000	100.0
Max. size	20 mm		22 mm		20 mm		20 mm	
F.M.	6.70		6.77		6.72		6.78	

Sample No.	7				8			
Weight of sample	4,957 grms		4,912 grms		1,420 grms		1,370 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2								
1½	0	0	0	0	0	0	0	0
1	222	4.5	180	3.7	13	0.9	12	0.9
3/4	472	9.5	459	9.3	20	1.4	20	1.5
1/2	1,732	35.0	1,690	34.4	178	12.5	204	14.8
3/8	2,940	59.3	3,041	62.0	527	37.1	559	40.6
No.4	4,957	100.0	4,912	100.0	1,420	100.0	1,370	100.0
Max. size	20 mm		20 mm		15 mm		15 mm	
F.M.	6.69		6.71		6.38		6.42	



GRAVEL TEST

SITE: B

2) UNIT WEIGHT

Sample No.		6 and 7			
Weight of sample	(grm)	18,726	18,626		
Volume of sample	(cm^3)	10,776	10,776		
Unit weight	(kg/m^3)	1,740	1,730		

3) SPECIFIC GRAVITY and ABSORPTION

Sample No.		6			
Surface dry condition	Weight in air (grm) A =	2,106.3	2,052.1		
	Weight in water(grm) B =	1,288.0	1,256.9		
Weight, oven dry condition	(grm) C =	2,080.6	2,025.9		
Specific gravity	A/(A - B)	2.58	2.58		
Absorption	(A - C)/C x 100 (%)	1.23	1.28		

GRAVEL TEST

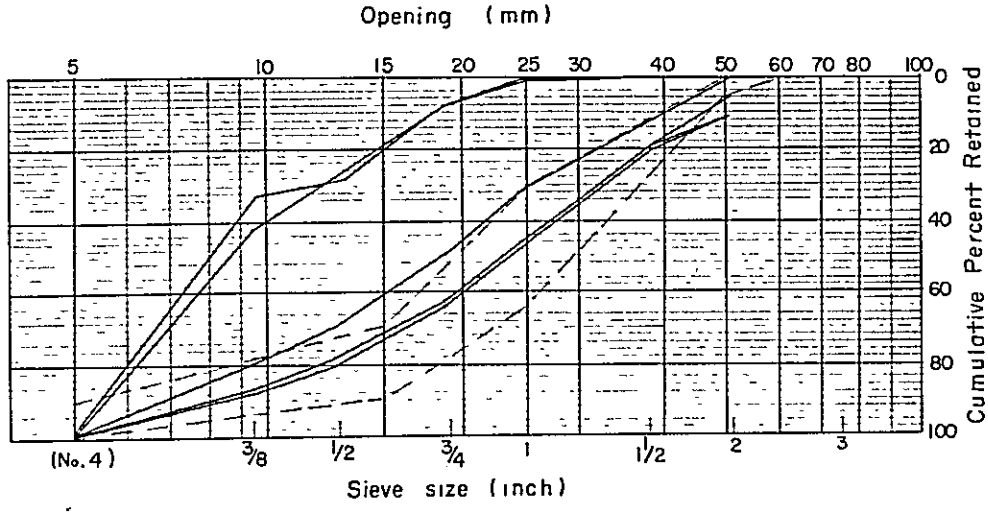
1) SIEVE ANALYSIS

SITE: C

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	9				10			
Weight of sample	2,120 grms		2,120 grms		15,000 grms		15,000 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2						(0)		(0)
1½	0	0	0	0	1,645	11.0	1,645	11.0
1	32	1.5	18	0.8	4,570	30.4	4,652	31.0
3/4	166	7.8	173	8.2	7,275	48.5	7,278	48.5
1/2	601	28.3	582	27.5	10,344	69.0	10,338	69.0
3/8	720	34.0	914	43.1	12,088	80.0	12,016	80.1
No.4	2,120	100.0	2,120	100.0	15,000	100.0	15,000	100.0
Msx. size	18 mm		18 mm		40 mm		40 mm	
F.M.	6.42		6.51		7.39		7.40	

Sample No.	11 - 1				11 - 2			
Weight of sample	20,833 grms		20,544 grms		18,841 grms		18,728 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2	1,192	5.7	1,192	5.8	2,077	11.0	2,077	11.1
1½	4,250	20.4	4,199	20.4	3,802	20.2	3,632	19.4
1	9,910	47.6	9,647	47.0	8,456	44.9	8,399	44.8
3/4	13,218	63.5	12,996	63.2	11,861	62.9	11,690	62.4
1/2	16,680	80.1	16,458	80.0	14,925	78.2	14,755	78.8
3/8	18,291	87.8	18,160	88.4	16,400	87.0	16,230	86.6
No.4	20,833	100.0	20,544	100.0	18,841	100.0	18,728	100.0
Max. size	45 mm		45 mm		50 mm		50 mm	
F.M.	7.72		7.72		7.70		7.68	



GRAVEL TEST

SITE: C

2) UNIT WEIGHT

Sample No.		10		11-1 and 11-2	
Weight of sample	(grm)	19,656	19,656	20,226	20,026
Volume of sample	(grm)	10,776	10,776	10,776	10,776
Unit weight	(kg/m^3)	1,820	1,820	1,880	1,860

3) SPECIFIC GRAVITY AND ABSORPTION

Sample No.		11 - 1		11 - 2	
Surface dry condition	Weight in air (grm) A =	5,053.5	5,135.0	5,023.3	5,083.9
	Weight in water(grm) B =	3,120.4	3,192.5	3,099.1	3,134.5
Weight, oven dry condition (grm) C =		5,022.6	5,102.7	4,989.6	5,050.6
Specific gravity	A/(A - B)	2.62	2.64	2.61	2.61
Absorption	(A - C)/C x 100 (%)	0.62	0.63	0.68	0.66

COMPRESSIVE STRENGTH TEST OF CONCRETE

1) DESIGN MIX

Cement:	250 kg/m^3	Gravel:	1,380 kg/m^3
Water:	150 kg/m^3	Sand:	640 kg/m^3
W/C:	60 %		

2) RESULTS OF TESTS

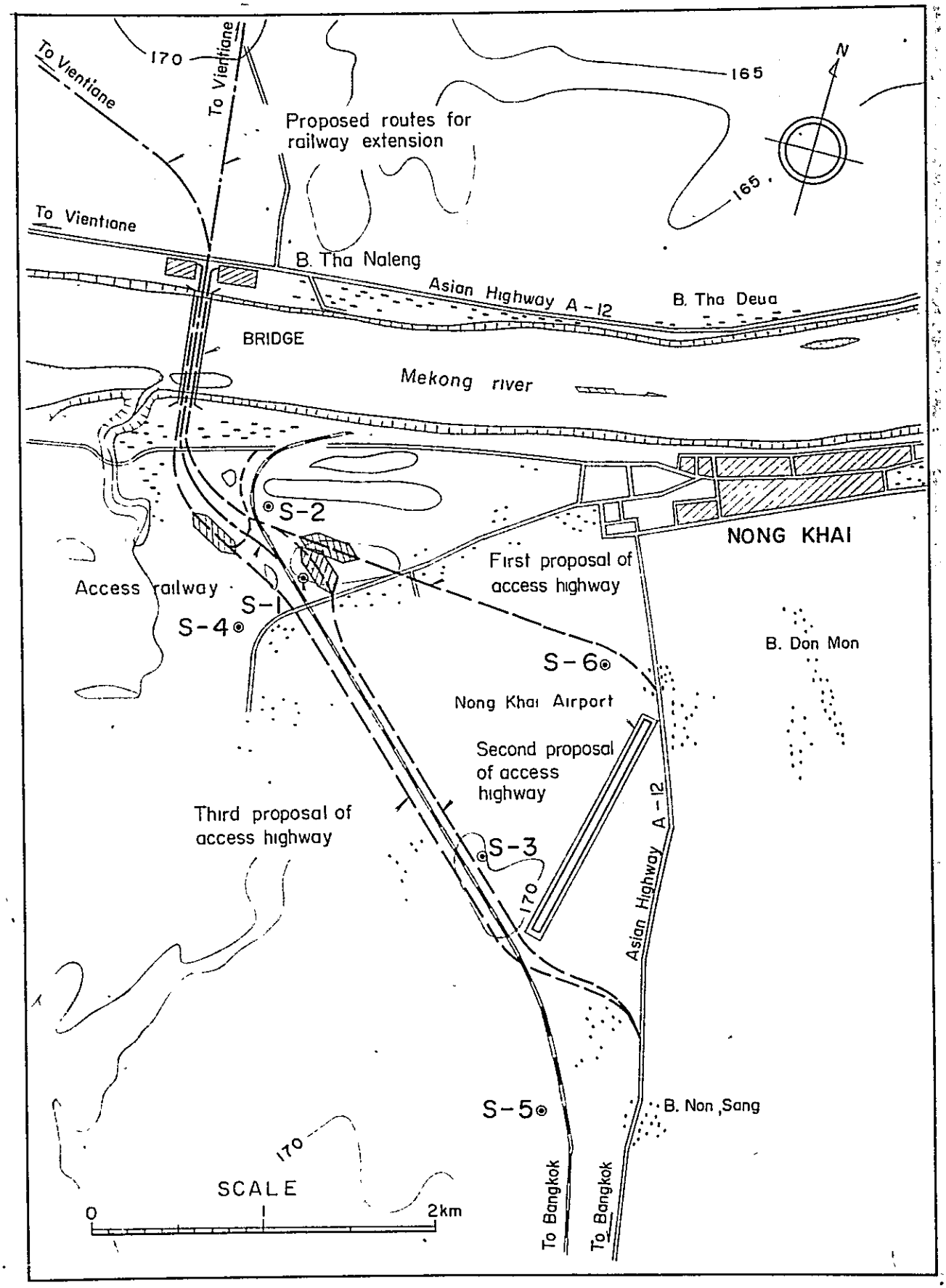
Sampling site		Weight (kg)	Apparent density (kg/m^3)	Slump (cm)	Compressive strength (kg/cm^2)	
Sand	Gravel					
A	A	13.48	2,550	6.5, 6.5	σ_7	109
		13.43	2,540			104
		13.52	2,550			95
	Mean	13.48	2,550	6.5		103
	A,B,C	13.08	2,470	7.2, 7.7	σ_{28}	108
		12.90	2,440			114
		13.05	2,460			133
		12.91	2,440			107
		12.95	2,440			113
	Mean	12.98	2,450	7.5		113
B	B,C	13.10	2,470	7.0, 7.5	σ_{28}	172
		13.14	2,480			169
		12.92	2,440			172
		12.97	2,450			175
		13.04	2,460			164
	Mean	13.03	2,460	7.3		170
C	C	13.06	2,460	10.1, 10.9	σ_7	105
		13.45	2,540			105
		13.16	2,480			115
					Mean	108
		13.37	2,530		σ_{28}	178
		13.34	2,520			177
		13.40	2,530			176
		13.46	2,540			172
	Mean	13.32	2,510	10.5	Mean	176

Remarks:

1) Specimen size: 15 cm dia. x 30 cm high (V = 5,300 cm^3)
2) Cement used: Ordinary Portland cement made in Thailand (Tiger brand)
3) σ_7 : Compressive strength at 7-day age
4) σ_{28} : Compressive strength at 28-day age

3.2 路盤材料

LOCATION OF SAMPLING PLACES FOR HIGHWAY EMBANKMENT MATERIAL



Summary of soil test

Location: Nong Khai

Items	Unit	Characteristics					
Sample No.		1	2	3	4	5	6
I. Observation		Grey brown	Grey brown	Yellow brown	Yellow brown	Yellow brown	Red brown
II. Properties							
(1) Natural water contents, w	%	32.20	30.71	9.56	12.41	14.27	14.21
(2) Specific gravity of soil, G		2.73	2.75	2.71	2.70	2.71	2.72
III. Grain size							
(1) Proportion							
i) Gravel part	%	0	0	6.0	0	8.0	0
ii) Sand part	%	0.1	1.0	24.0	5.0	12.0	8.0
iii) Silt part	%	26.9	38.0	38.0	68.0	41.0	58.0
iv) Clay part	%	73.0	61.0	32.0	27.0	39.0	34.0
(2) Maximum diameter	mm	0.105	0.105	4.8	0.42	4.8	0.25
(3) 60 % diameter, D_{60}	mm	0.032	0.0049	0.037	0.047	0.04	0.04
(4) Grain size classificatic.		Clay	Clay	Clay	Silty clay loam	Clay	Silty clay
(5) Unified classification		CH	CH	CL	ML or CL	CH	MH or CH
(6) AASHO's classification		A-7	A-7	A-7	A-6	A-7	A-7
IV. Consistency							
(1) Liquid limit, L.L.	%	63.52	56.55	45.20	34.50	50.80	54.70
(2) Plastic limit, P.L.	%	28.32	25.07	16.81	16.04	16.61	16.00
(3) Plasticity index, P.I.		35.20	31.48	28.39	18.46	34.19	38.70
(4) Flow index, F.I.		9.73	13.60	13.12	9.76	13.60	6.80
V. Compaction							
(1) Optimum water contents		17.8	17.7	12.5	13.2	12.0	14.0
(2) Max. density, d_{max}	g/cm^3	1.638	1.750	1.970	1.918	1.896	1.881
VI. Shearing strength							
(1) Triaxial compression							
i) Cohesion, c	kg/cm^2	2.05	1.75	1.10	1.10	1.55 2.10	1.75 1.75
ii) Internal friction angle, ϕ		33°00'	16°42'	33°01'	19°18'	21°48' 33°01'	30°58' 16°46'
VII. Consolidation							
(1) Initial void ratio e_o		0.539	0.573	0.383	0.381	0.407 0.586	0.335 0.398
(2) Preconsolidation load, P_o	kg/cm^2	0.58	0.61	0.35	0.47	0.91 0.78	0.69 0.60
(3) Compression index, C_c		0.539	0.573	0.383	0.381	0.407 0.386	0.335 0.398
(4) Coef. of consolidation, C_v	cm^2/sec	0.58	0.61	0.35	0.47	0.91 0.78	0.69 0.60
(5) Coef. of volume compressibility, M_v	cm^2/g	0.195	0.196	0.150	0.148	0.086 0.083	0.259 0.266
(6) Coef. of permeability k	cm/sec	4.4×10^{-3}	1.1×10^{-2}	7.0×10^{-3}	9.8×10^{-3}	1.9×10^{-2} 1.6×10^{-2}	1.7×10^{-3} 4.7×10^{-3}
VIII. Modified C.B.R.		1.31		1.14		6.20	0.68
IX. Swelling test							
(1) Case 1							
Curing period							
0 day,							
Swelling ratio	%	22.84		21.34		9.24	58.28
Direct compression, C	kg/cm^2	0.112		0.062		0.17	0.028
ϕ	°	0°55'		2°07'		23°16'	0°24'
τ	kg/cm^2	0.128		0.099		0.60	0.035
1 day,							
Swelling ratio	%	-		12.98		4.31	-
Direct compression, C	kg/cm^2	-		0.26		0.14	-
ϕ	°	-		0°04'		28°49'	-
τ	kg/cm^2	-		0.27		0.69	-
7 days,							
Swelling ratio	%	-		11.10		5.52	-
Direct compression, C	kg/cm^2	-		0.24		0.25	-
ϕ	°	-		3°27'		25°39'	-
τ	kg/cm^2	-		0.30		0.73	-
14 days,							
Swelling ratio	%	-		19.15		11.56	-
Direct compression, C	kg/cm^2	-		0.10		0.24	-
ϕ	°	-		6°17'		20°19'	-
τ	kg/cm^2	-		0.21		0.61	-
(2) Case 2							
Surcharge load							
0.15 kg/cm^2,							
Swelling ratio	%	1.50		0.90		- 0.79	-
Direct compression, C	kg/cm^2	0.62		0.48		0.20	-
ϕ	°	2°52'		15°39'		31°48'	-
τ	kg/cm^2	0.67		0.76		0.82	-
0.30 kg/cm^2,							
Swelling ratio	%	- 0.75		- 0.05		- 1.39	-
Direct compression, C	kg/cm^2	0.48		0.70		0.57	-
ϕ	°	5°43'		2°52'		18°16'	-
τ	kg/cm^2	0.58		0.75		0.90	-
0.45 kg/cm^2,							
Swelling ratio	%	0.76		- 0.10		- 2.31	-
Direct compression, C	kg/cm^2	0.78		0.52		0.33	-
ϕ	°	7°59'		11°19'		25°11'	-
τ	kg/cm^2	0.92		0.72		0.80	-

V. Compaction									
(1) Optimum water contents		17.8	17.7	12.5	13.2	12.0		14.0	
(2) Max. density, d_{max}	g/cm^3	1.638	1.750	1.970	1.918	1.896		1.881	
VI. Shearing strength									
(1) Triaxial compression									
i) Cohesion, c	kg/cm^2	2.05	1.75	1.10	1.10	1.55	2.10	1.75	1.75
ii) Internal friction angle, ϕ		33°00'	16°42'	33°01'	19°18'	21°48'	33°01'	30°58'	16°46'
VII. Consolidation									
(1) Initial void ratio, e_o		0.539	0.573	0.383	0.381	0.407	0.586	0.335	0.398
(2) Preconsolidation load, P_o	kg/cm^2	0.58	0.61	0.35	0.47	0.91	0.78	0.69	0.60
(3) Compression index, C_c		0.539	0.573	0.383	0.381	0.407	0.386	0.335	0.398
(4) Coef. of consolidation, Cv	cm^2/sec	0.58	0.61	0.35	0.47	0.91	0.78	0.69	0.60
(5) Coef. of volume compressibility, M_v	cm^2/g	0.195	0.196	0.150	0.148	0.086	0.083	0.259	0.266
(6) Coef. of permenbility K	cm/sec	4.4×10^{-3}	1.1×10^{-2}	7.0×10^{-3}	9.8×10^{-3}	1.9×10^{-2}	1.6×10^{-2}	1.7×10^{-3}	4.7×10^{-3}
VIII. Modified C.B.R.		1.31		1.14		6.20		0.68	
IX. Swelling test									
(1) Case 1									
Curing period									
0 day,									
Swelling ratio	%	22.84		21.34		9.24		58.28	
Direct compression, C	kg/cm^2	0.112		0.062		0.17		0.028	
ϕ	°	0°55'		2°07'		23°16'		0°24'	
τ	kg/cm^2	0.128		0.099		0.60		0.035	
1 day,									
Swelling ratio	%	-		12.98		4.31		-	
Direct compression, C	kg/cm^2	-		0.26		0.14		-	
ϕ	°	-		0°04'		28°49'		-	
τ	kg/cm^2	-		0.27		0.69		-	
7 days,									
Swelling ratio	%	-		11.10		5.52		-	
Direct compression, C	kg/cm^2	-		0.24		0.25		-	
ϕ	°	-		3°27'		25°39'		-	
τ	kg/cm^2	-		0.30		0.73		-	
14 days,									
Swelling ratio	%	-		19.15		11.56		-	
Direct compression, C	kg/cm^2	-		0.10		0.24		-	
ϕ	°	-		6°17'		20°19'		-	
τ	kg/cm^2	-		0.21		0.61		-	
(2) Case 2									
Surcharge load									
0.15 kg/cm^2,									
Swelling ratio	%	1.50		0.90		- 0.79		-	
Direct compression, C	kg/cm^2	0.62		0.48		0.20		-	
ϕ	°	2°52'		15°39'		31°48'		-	
τ	kg/cm^2	0.67		0.76		0.82		-	
0.30 kg/cm^2,									
Swelling ratio	%	- 0.75		- 0.05		- 1.39		-	
Direct compression, C	kg/cm^2	0.48		0.70		0.57		-	
ϕ	°	5°43'		2°52'		18°16'		-	
τ	kg/cm^2	0.58		0.75		0.90		-	
0.45 kg/cm^2,									
Swelling ratio	%	0.76		- 0.10		- 2.31		-	
Direct compression, C	kg/cm^2	0.78		0.52		0.33		-	
ϕ	°	7°59'		11°19'		25°11'		-	
τ	kg/cm^2	0.92		0.72		0.80		-	
(3) Case 3									
Mixing ratio									
30 %,									
Swelling ratio	%	-		30.55		16.13		-	
Direct compression, C	kg/cm^2	-		0.28		0.12		-	
ϕ	°	-		21°49'		32°38'		-	
τ	kg/cm^2	-		0.68		0.76		-	
60 %,									
Swelling ratio	%	-		27.52		12.34		-	
Direct compression, C	kg/cm^2	-		0.17		0.15		-	
ϕ	°	-		23°17'		31°48'		-	
τ	kg/cm^2	-		0.60		0.77		-	
(4) Case 4									
Curing period									
1 day,									
Swelling ratio	%	-		5.21		0.18		-	
Direct compression, C'	kg/cm^2	-		1.12		3.20		-	
ϕ	°	-		33°02'		1°44'		-	
τ	kg/cm^2	-		1.77		3.23		-	
7 days,									
Swelling ratio	%	-		3.55		1.09		-	
Direct compression, C	kg/cm^2	-		1.60		0.77		-	
ϕ	°	-		11°52'		51°49'		-	
τ	kg/cm^2	-		1.81		2.04		-	

Remarks:-

(1) The details of the cases in the swelling test are described in this paragraph of the report.

(2) In making CBR and swelling tests, the sample No.1 was mixed with the sample No.2, and the sample No.3 with the sample No.4, because of the similar characteristic each other.

(3) The CBR test was made after the samples were saturated with water for four days.

(4) The specimen that was used for the swelling test was 6 cm in diameter and 2 cm in height.

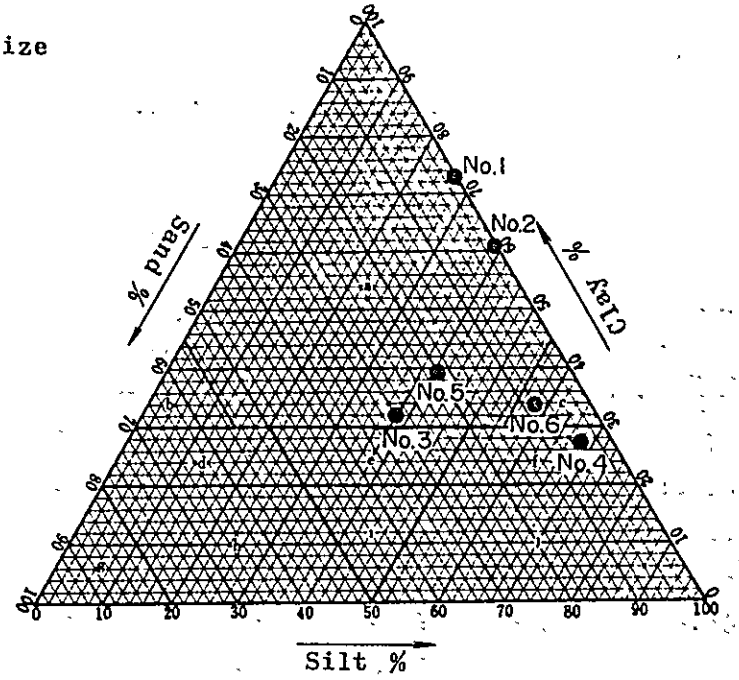
(5) The negative swelling ratio means the compression ratio.

GRAIN SIZE ANALYSIS

Location Nong Khai

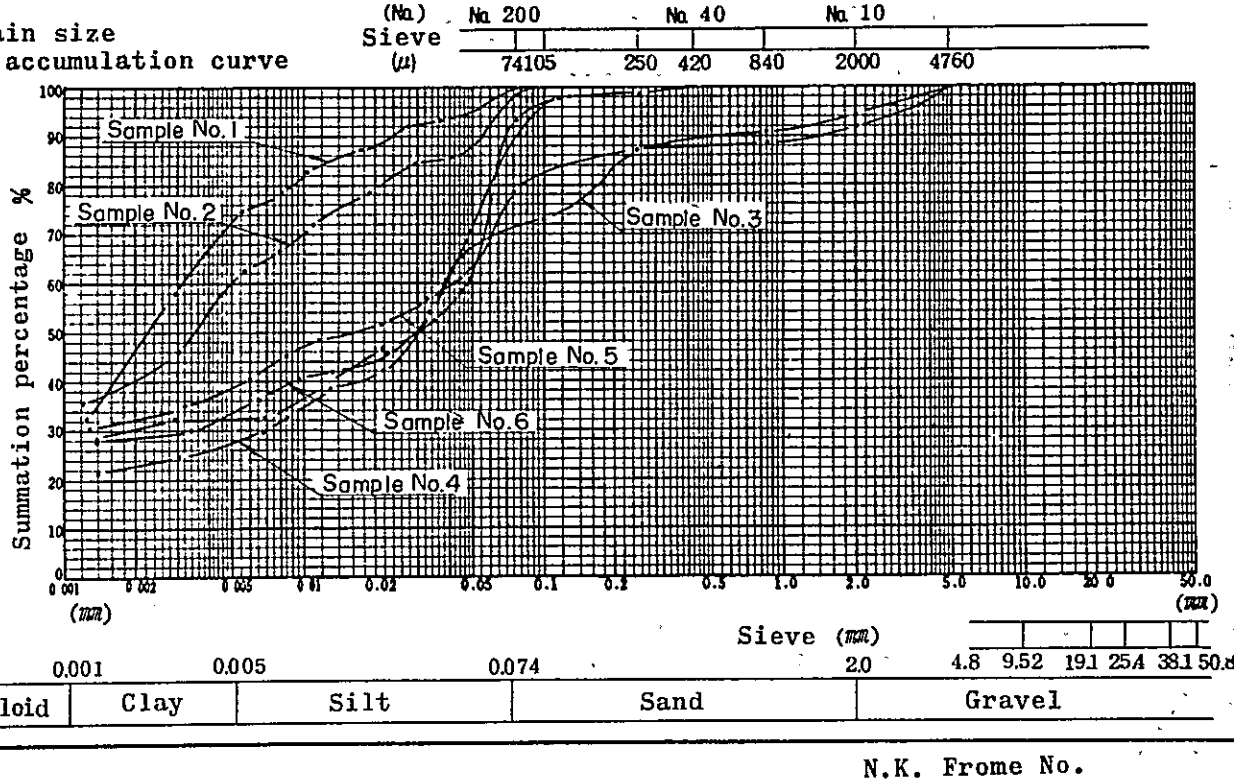
Soil classification of grain size

a CLAY
b SANDY CLAY
c SILTY CLAY
d SANDY CLAY LOAM
e CLAYEY LOAM
f SILTY CLAY LOAM
g SAND
h SANDY LOAM
i LOAM
j SILTY LOAM



Sample No.	Gravel %	Sand %	Silt %	Clay %	Max. size mm	D60 mm	D10 mm	Uniformity Coeff	2000μ sieve Passed Percentage	420μ sieve Passed Percentage	74μ sieve Passed Percentage	Sign of Plotted part on triangular diagram	Classification	Remarks
1	0	0 1	26 9	73	0.105	0.0032	—	—	100	100	999	a	CLAY	
2	0	1	38	61	0.105	0.0049	—	—	100	100	98.9	a	CLAY	
3	6	24	38	32	4.8	0.037	—	—	94 1	900	70 2	a	CLAY	
4	0	5	68	27	0.42	0 047	—	—	100	100	94.8	f	SILTY CLAY LOAM	
5	8	12	4 1	39	4.8	0.04	—	—	92.2	87.5	79.7	a	CLAY	
6	0	8	58	34	0 25	0.04	—	—	100	100	92.1	c	SILTY CLAY	

Grain size accumulation curve

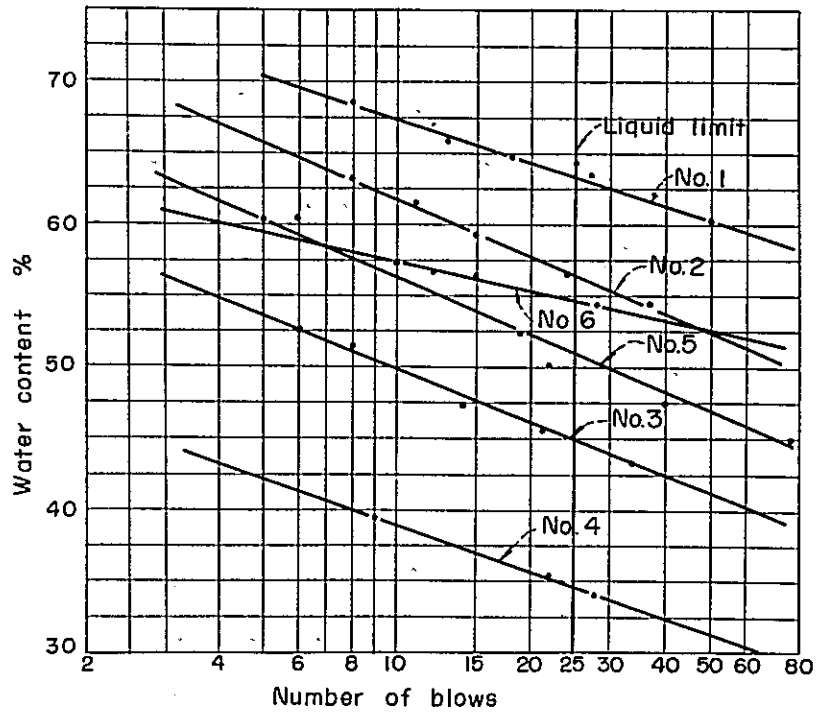


N.K. Frome No.

Liquid Limit and Plastic Limit Tests

Result of Test

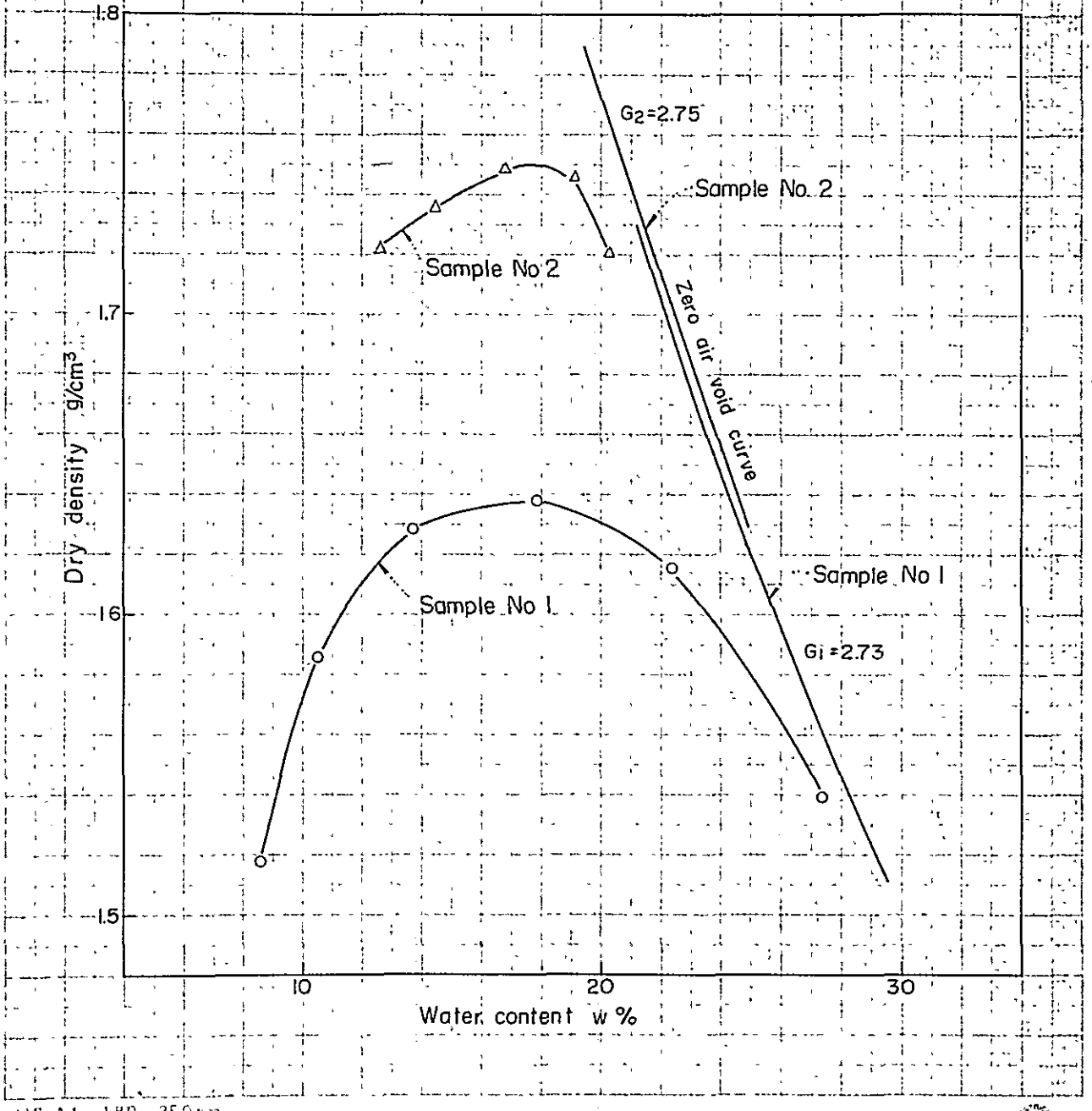
Sample No.	Liquid limit	Plastic limit			Plasticity index	Flow index
		(1)	(2)	Mean		
1	63.52	28.82	27.82	28.32	35.20	9.73
2	56.55	25.08	25.05	25.07	31.48	13.60
3	45.20	16.72	16.90	16.81	28.39	13.12
4	34.50	16.01	16.06	16.04	18.46	9.76
5	50.80	16.71	16.50	16.61	34.19	13.60
6	54.70	16.07	15.93	16.00	38.70	6.80



Remarks . The soil passing 0·4 mm sieve was used for the test to decide the liquid and plastic limits.

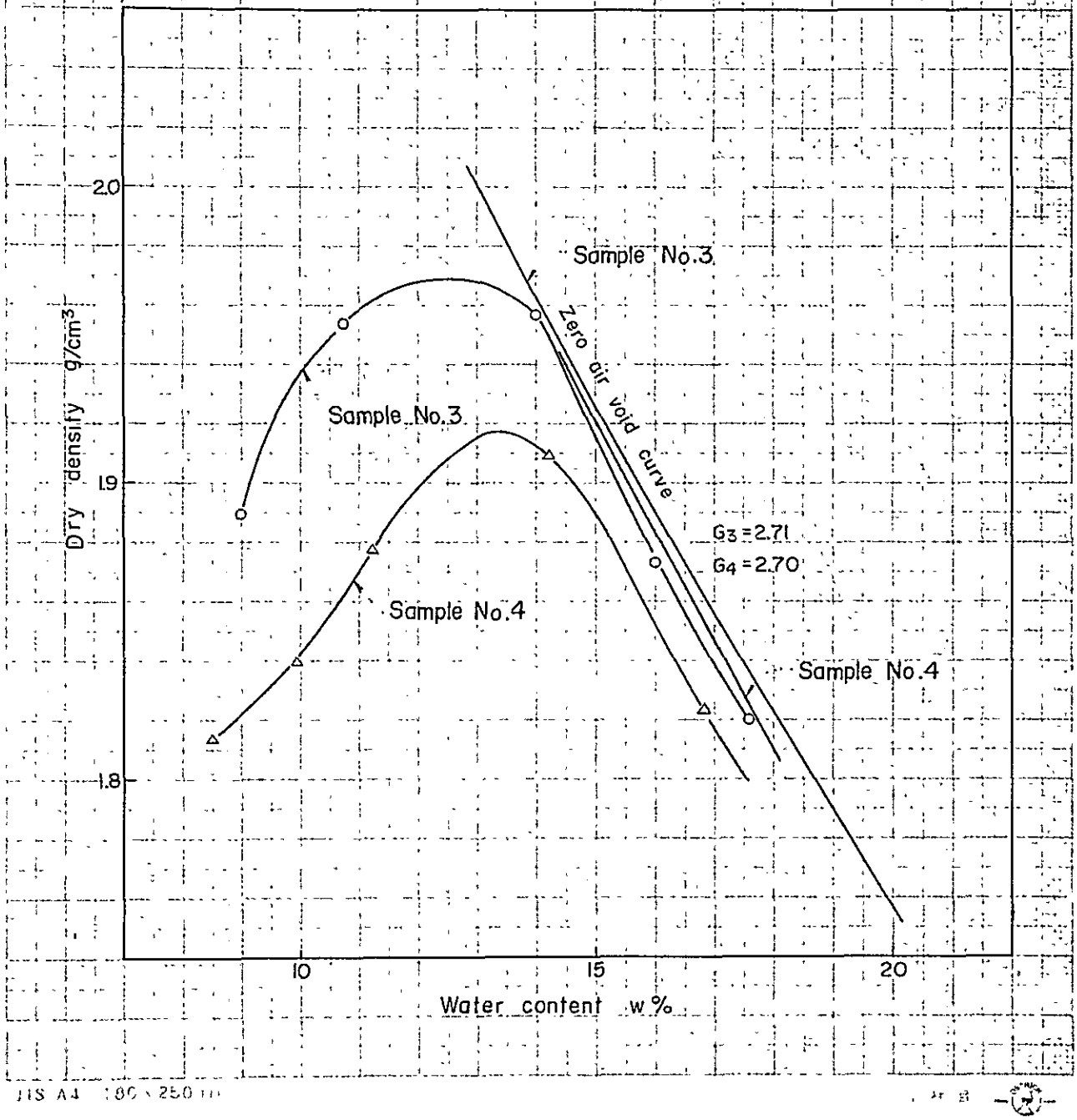
COMPACTION TEST - I

Sample No.	Optimum water content	Max. dry density
1	17.8 %	1.638 g/cm³
2	17.7	1.750



COMPACTION TEST - 2

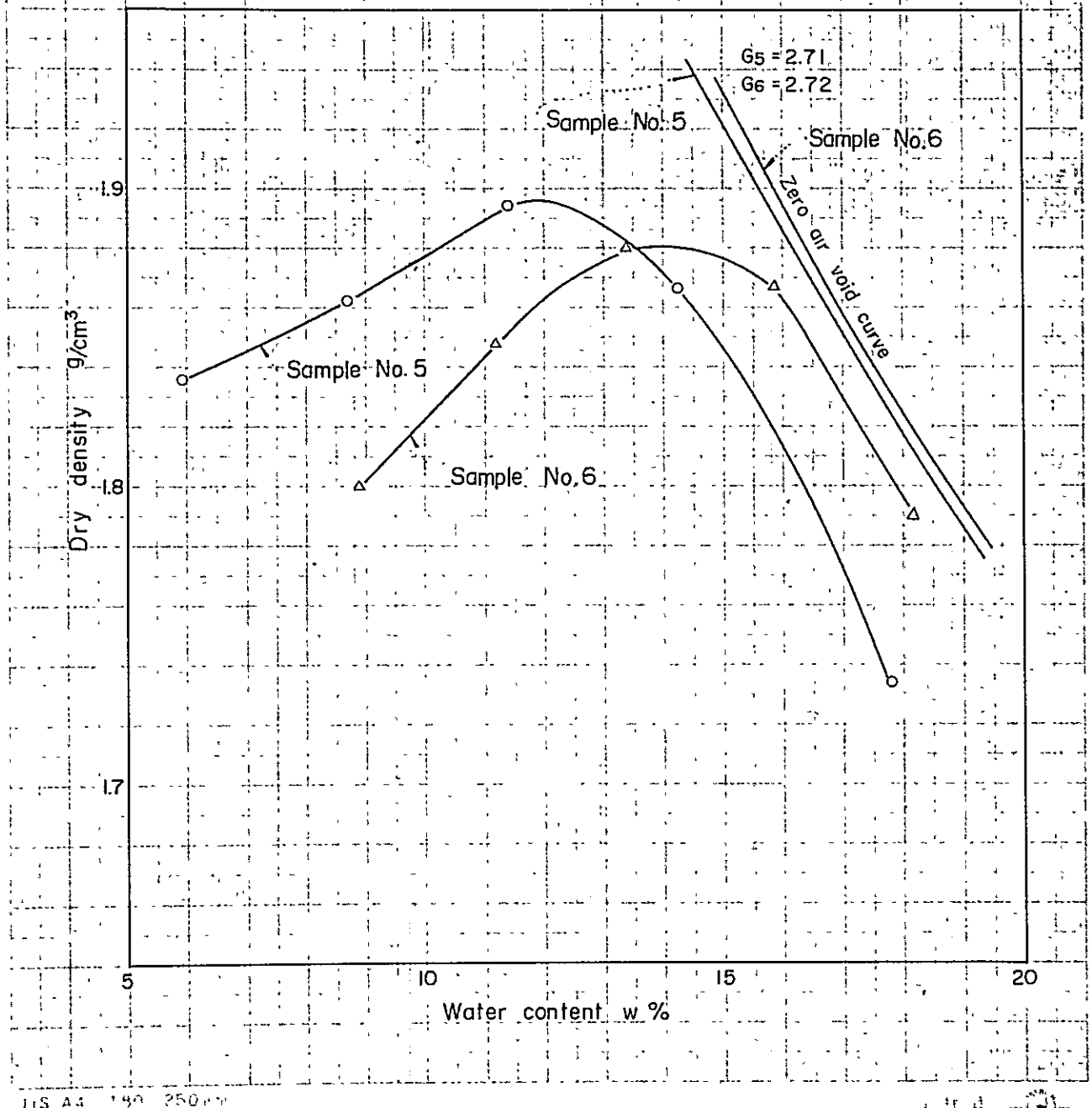
Sample No.	Optimum water content	Max. dry density
3	12.5 %	1.970 g/cm³
4	13.2	1.918



JIS A4 180 × 250 mm

COMPACTION TEST - 3

Sample No.	Optimum water content	Max. dry density
5	12.0	1.896
6	14.0	1.881



Direct Shear Test - 1

Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength r (kg/cm^2)
(1)	Curing period, 0 day	1 & 2	1.445	0.6	0.121	0.112	$0^\circ 55'$	0.128
			1.453	1.1	0.208			
			1.428	1.1	0.129			
		3 & 4	1.559	0.6	0.0831	0.062	$2^\circ 07'$	0.099
			1.542	1.6	0.112			
			1.620	2.1	0.140			
		5	1.830	0.6	0.396	0.17	$23^\circ 16'$	0.60
			1.725	1.1	0.741			
			1.876	1.6	0.869			
			1.764	2.1	1.329			
		6	1.222	0.1	0.0265	0.028	$0^\circ 24'$	0.035
			1.309	0.6	0.0542			
			1.197	1.1	0.0358			
	Curing period, 1 day	3 & 4	1.734	0.6	0.269	0.26	$0^\circ 04'$	0.27
			1.690	1.1	0.240			
			1.693	1.6	0.270			
		5	1.753	0.6	0.491	0.14	$28^\circ 49'$	0.69
			1.738	1.1	0.770			
			1.817	1.6	1.039			
	Curing period, 7 days	3 & 4	1.766	0.6	0.271	0.24	$3^\circ 27'$	0.30
			1.766	1.1	0.369			
			1.648	1.6	0.332			
		5	1.758	0.6	0.548	0.25	$25^\circ 39'$	0.73
			1.776	1.1	0.782			
			1.784	1.6	1.025			
	Curing period, 14 days	3 & 4	1.616	0.6	0.153	0.1	$6^\circ 17'$	0.21
			1.587	1.1	0.308			
			1.544	1.6	-			
			1.598	2.1	0.278			
		5	1.658	0.6	0.494	0.24	$20^\circ 19'$	0.61
			1.709	1.1	0.675			
			1.691	1.6	1.036			
			1.699	2.1	1.217			

Direct Shear Test - 2

Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength r (kg/cm^2)
(2)	Surcharge load, 0.15 kg/cm^2	1 & 2	1.688	0.6	0.655	0.62	2°52'	0.67
			1.703	1.1	0.677			
			1.722	1.6	0.960			
		3 & 4	1.958	0.6	0.634	0.48	15°39'	0.76
			1.986	1.1	0.793			
			1.978	1.6	1.036			
		5	1.903	0.6	0.573	0.20	31°48'	0.82
			1.827	1.1	0.909			
			1.922	1.6	1.216			
	Surcharge load, 0.30 kg/cm^2	1 & 2	1.734	0.6	0.521	0.48	5°43'	0.58
			1.729	1.1	0.663			
			1.713	1.6	0.633			
		3 & 4	1.992	0.6	0.729	0.70	2°52'	0.75
			1.985	1.1	0.885			
			1.946	1.6	0.774			
		5	1.934	0.6	0.770	0.57	18°16'	0.90
			1.932	1.1	0.940			
			1.928	1.6	1.104			
	Surcharge load, 0.45 kg/cm^2	1 & 2	1.706	0.6	0.879	0.78	7°59'	0.92
			1.707	1.1	0.990			
			1.741	1.6	1.020			
		3 & 4	1.965	0.6	0.659	0.52	11°19'	0.72
			1.965	1.1	0.713			
			1.981	1.6	0.856			
		5	1.938	0.6	0.602	0.33	25°11'	0.80
			1.945	1.1	0.845			
			1.971	1.6	1.121			

Direct Shear Test - 3

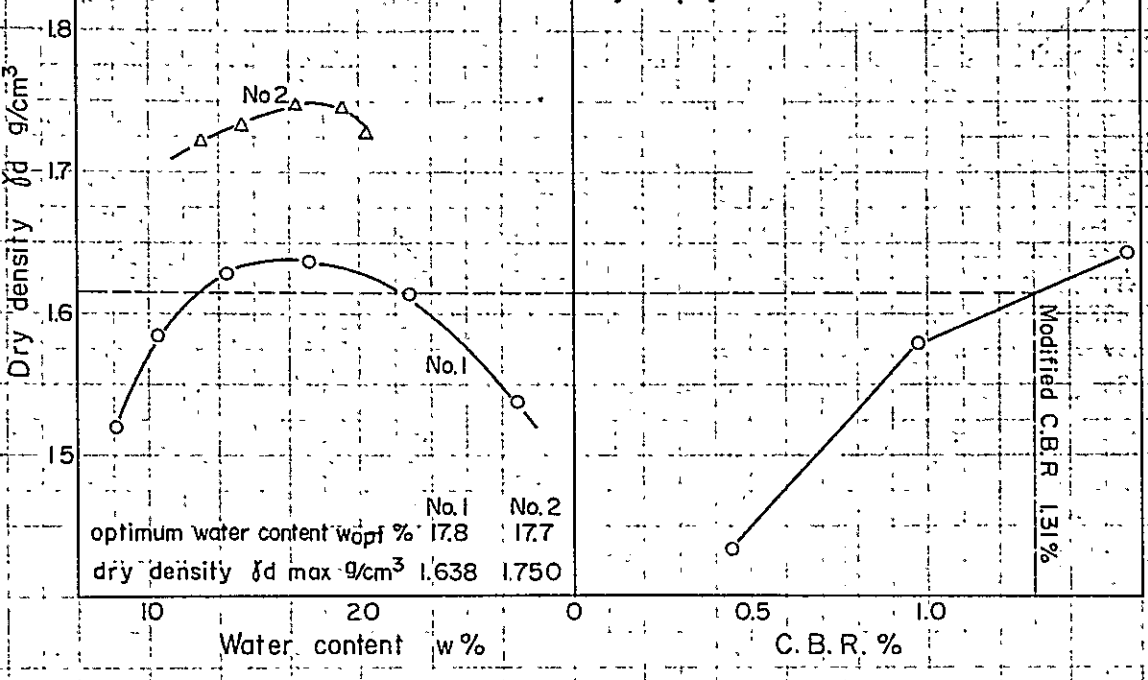
Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength r (kg/cm^2)
(3)	Mixing ratio, 30 %	3 & 4	1.394 1.616 1.600 1.622	0.6 1.1 1.6 2.1	0.480 0.600 1.023 1.140	0.28	21°49'	0.68
		5	1.759 1.800 1.784 1.668	0.6 1.1 1.6 2.1	0.516 0.856 1.157 1.486	0.12	32°38'	0.76
	Mixing ratio, 60 %	3 & 4	1.569 1.581 1.599 1.557	0.6 1.1 1.6 2.1	0.403 0.629 0.891 1.311	0.17	23°17'	0.60
		5	1.687 1.771 1.738 1.710	0.6 1.1 1.6 2.1	0.515 0.847 1.152 1.489	0.15	31°48'	0.77
(4)	Curing period, 1 day	3 & 4	1.900 1.790 1.838	0.6 1.1 2.1	1.526 2.359 2.444	1.12	33°02'	1.77
		5	1.905 1.903 1.900	0.6 1.6 2.1	3.243 3.880 3.268	3.20	1°44'	3.23
	Curing period, 7 days	3 & 4	1.831 1.838 1.977	0.6 1.1 1.6	1.786 1.829 2.753	1.60	11°52'	1.81
		5	1.858 1.838 1.880	0.6 1.1 2.1	1.556 2.210 2.352	0.77	51°49'	2.04

Triaxial Compression Test

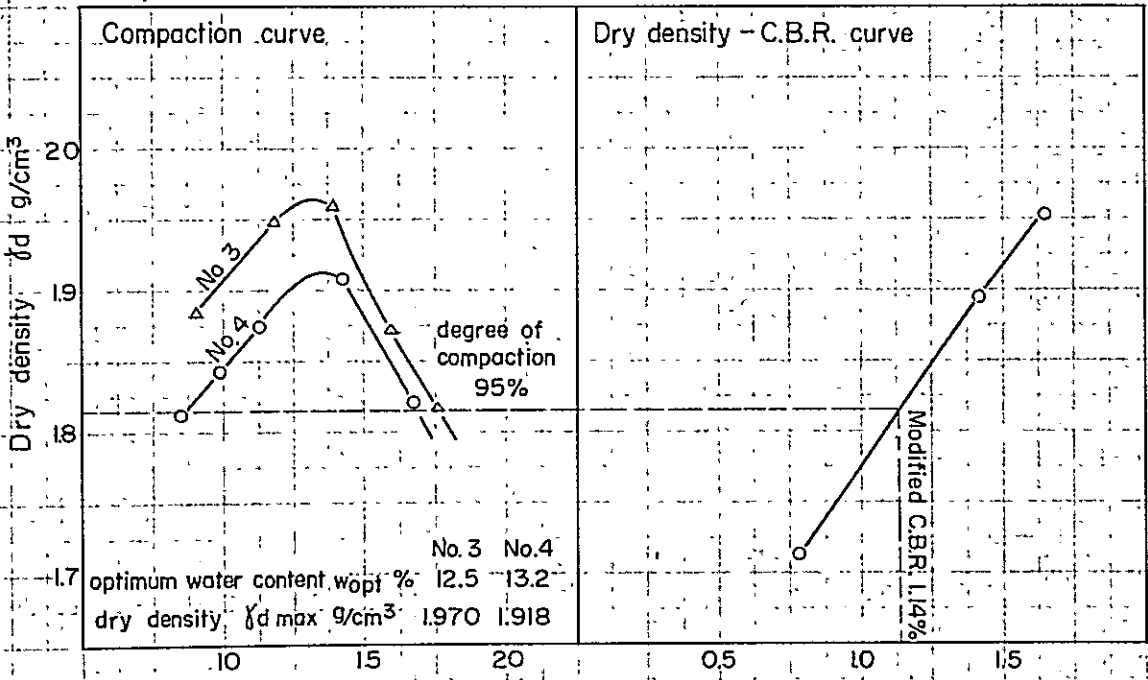
Sample No.	Dry density γ_d (g/cm^3)	Lateral pressure σ_3 (kg/cm^2)	Max. compression stress σ_1 (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
1 & 2	1.720	0.5	10.48	2.05	35°00'
	1.720	1.0	12.72		
	1.725	1.5	10.88		
	1.715	2.0	14.92		
	1.402	1.0	3.961	1.75	16°42'
	1.398	2.0	6.490		
	1.396	3.0	7.502		
	1.382	4.0	7.734		
3 & 4	1.920	0.5	5.41	1.10	33°01'
	1.927	1.0	10.18		
	1.922	1.5	10.19		
	1.926	2.0	9.17		
	1.600	1.0	4.029	1.10	19°18'
	1.605	2.0	5.226		
	1.603	3.0	6.153		
5	1.903	0.5	9.90	2.10	33°01'
	1.900	1.0	12.19		
	1.901	1.5	11.64		
	1.904	2.0	12.37		
	1.618	1.0	4.703	1.55	21°48'
	1.615	2.0	7.118		
	1.611	3.0	8.263		
6	1.889	0.5	7.64	1.75	30°58'
	1.884	1.0	8.44		
	1.889	1.5	9.83		
	1.881	2.0	14.26		
	1.599	1.0	4.286	1.75	16°42'
	1.606	2.0	6.520		
	1.596	3.0	7.575		
	1.589	4.0	8.444		

C. B. R. TEST

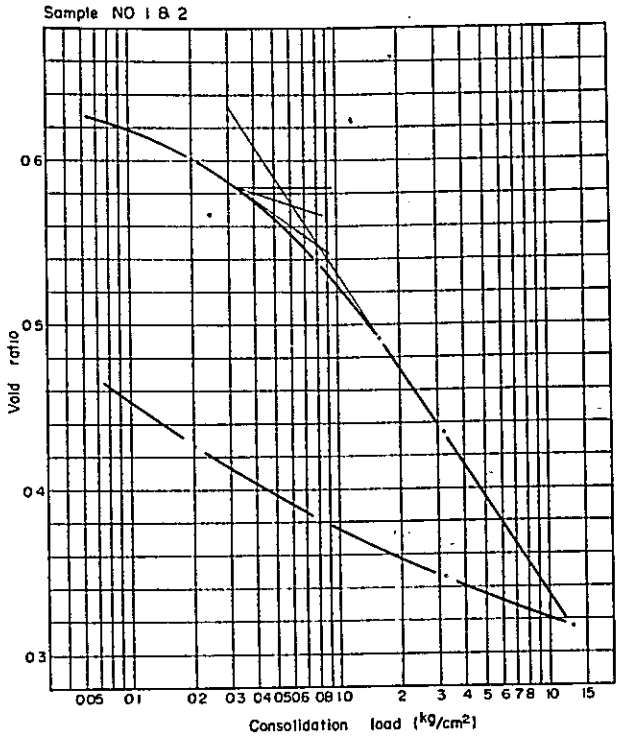
Sample No. 1 & 2

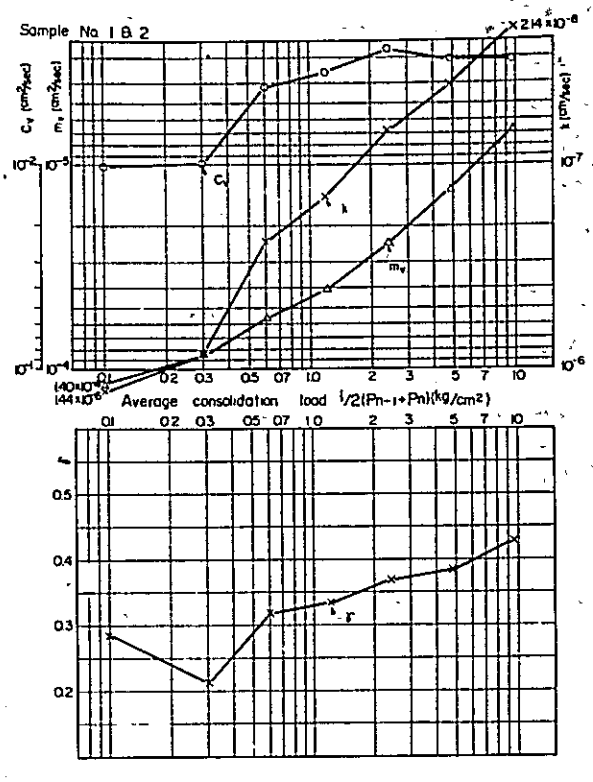


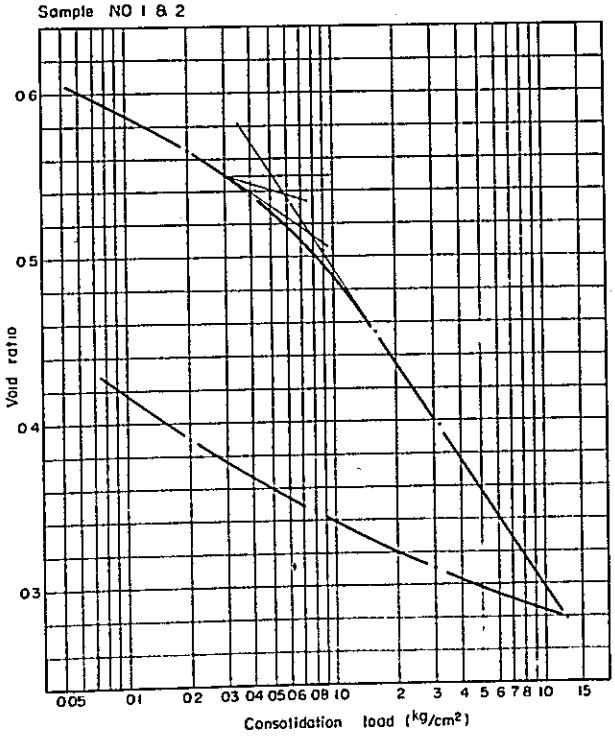
Sample No. 3 & 4

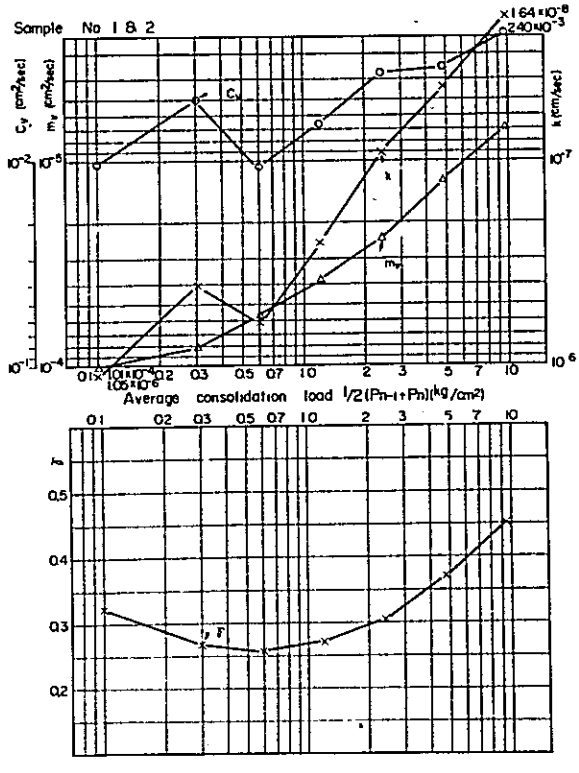


CONSOLIDATION TEST — 1



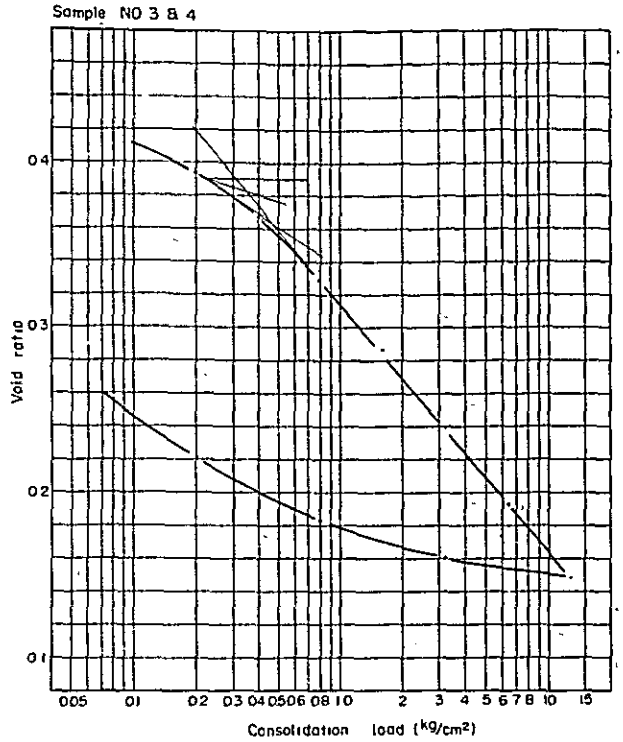


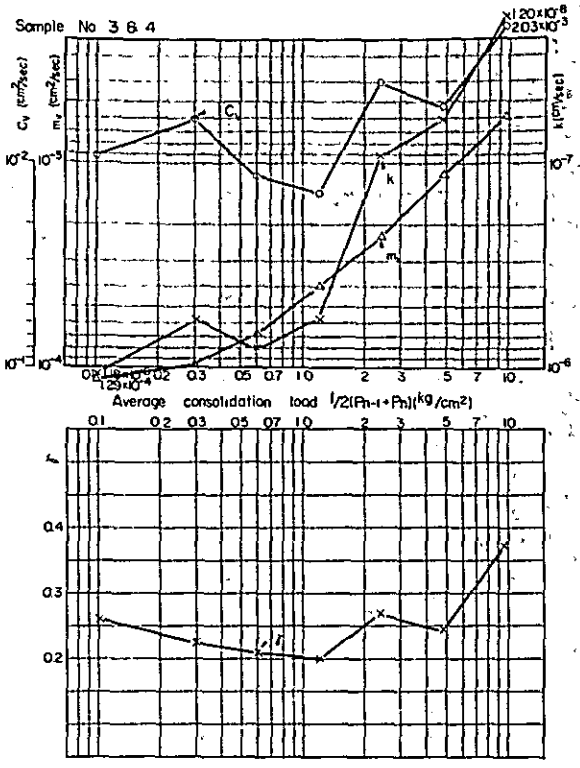


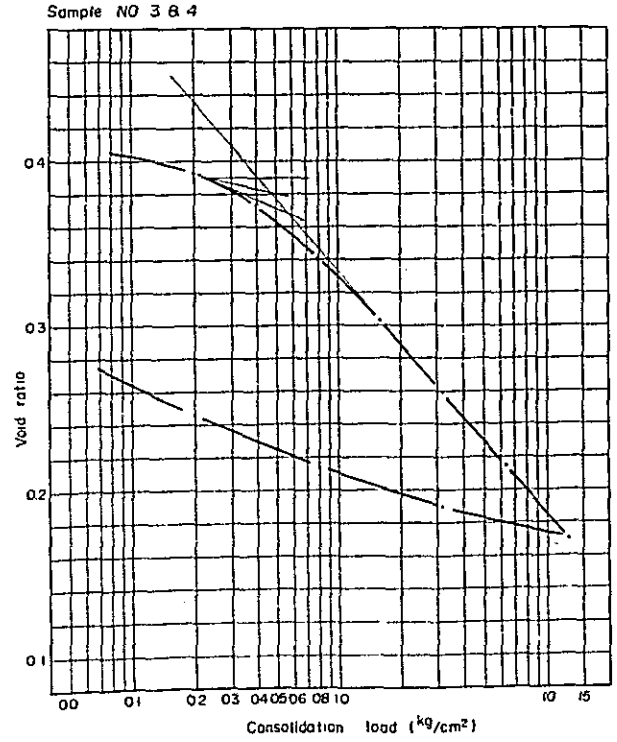


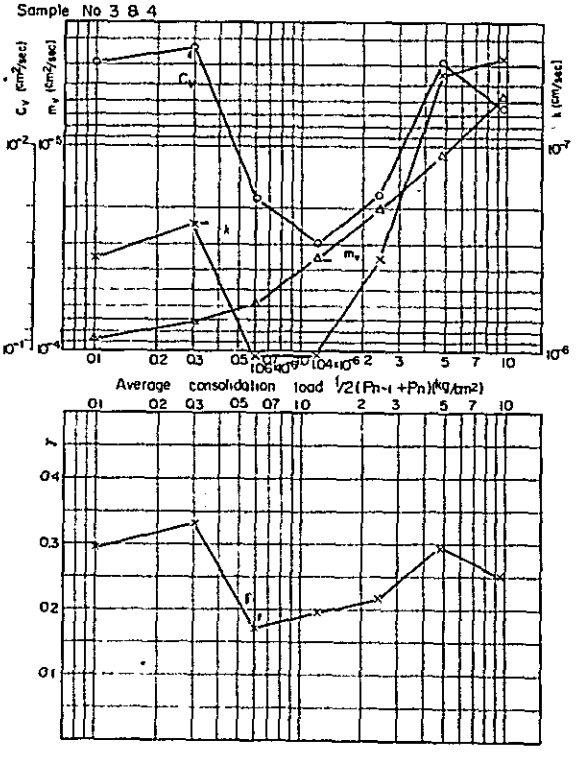
Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
f Primary compression ratio

CONSOLIDATION TEST — 2



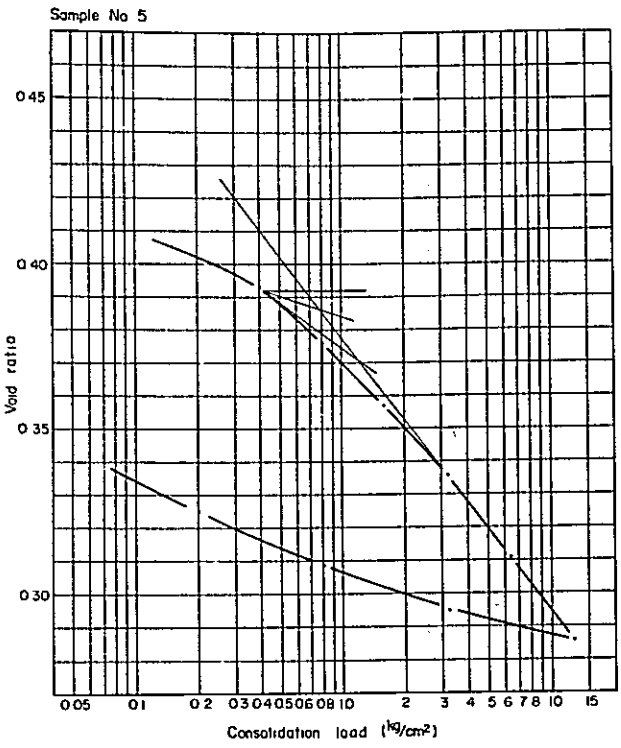


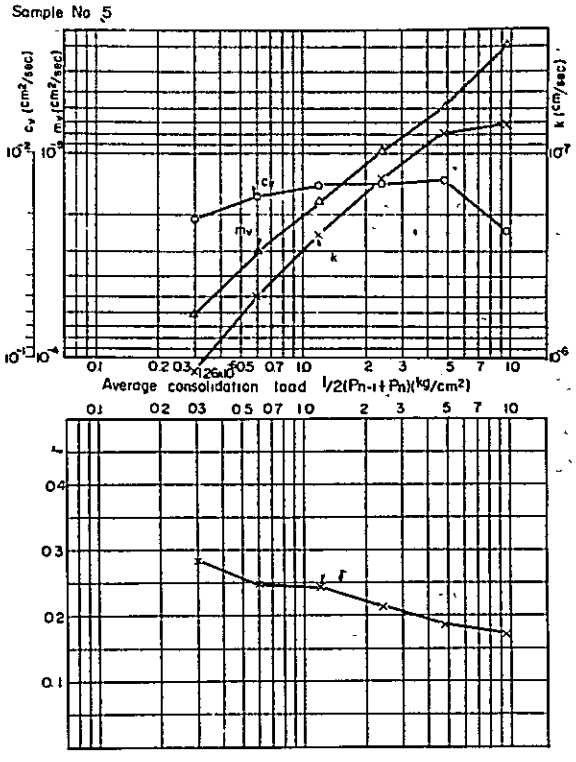


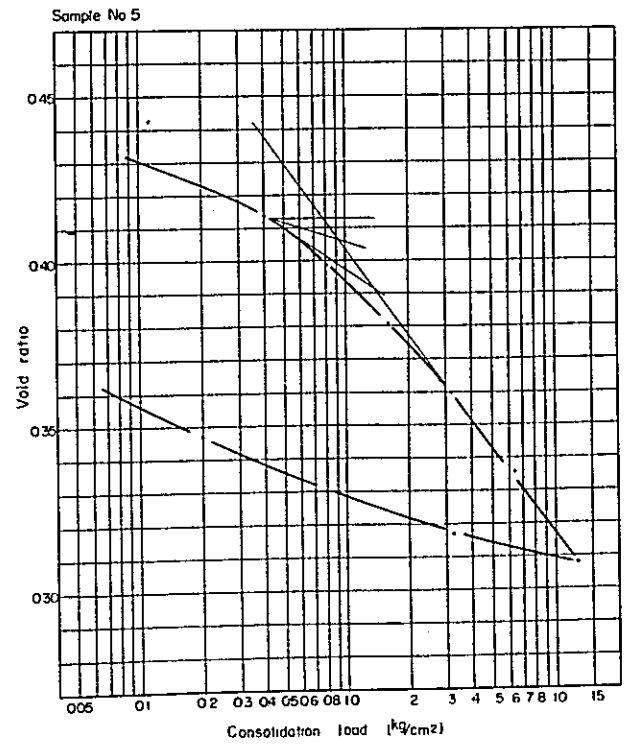


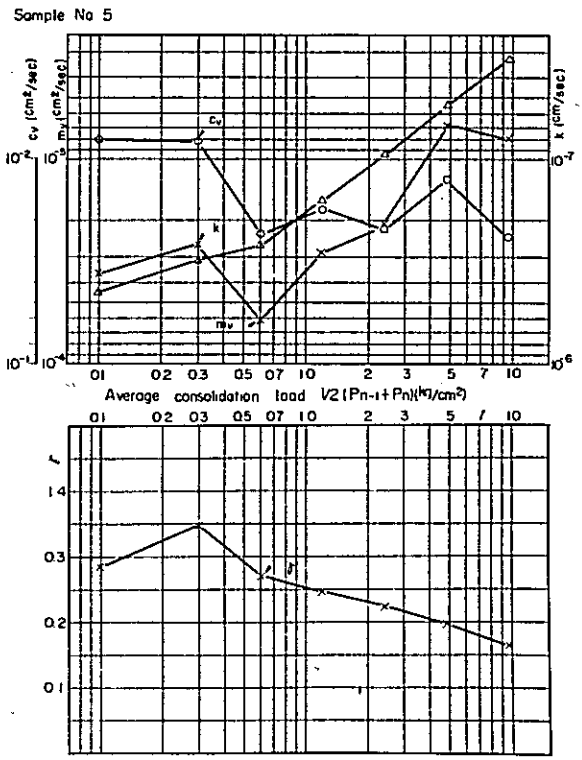
Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
r Primary compression ratio

CONSOLIDATION TEST — 3



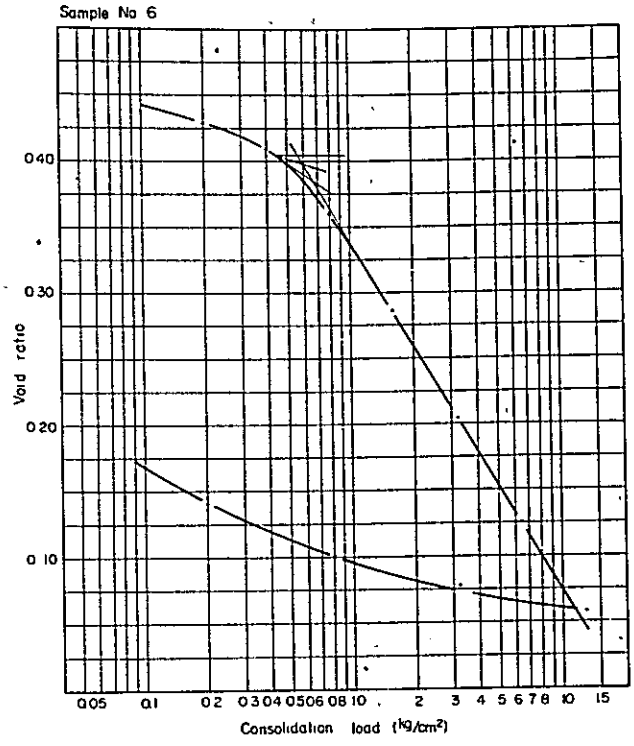


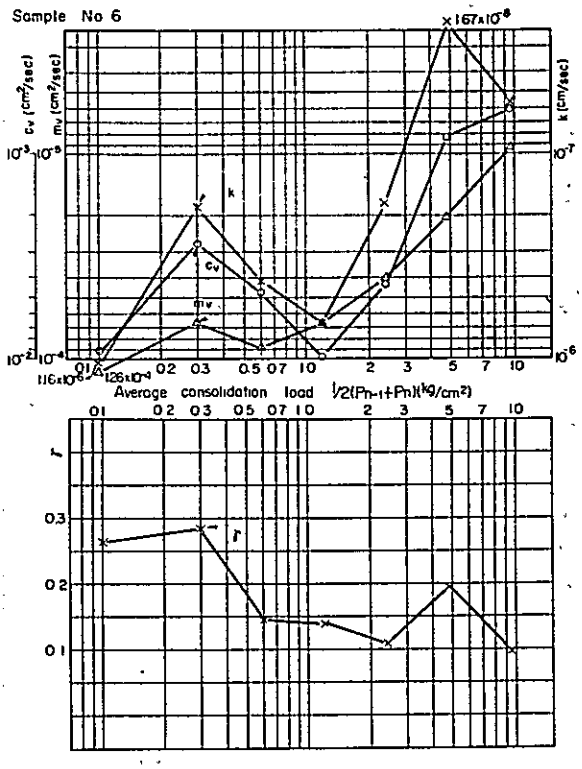


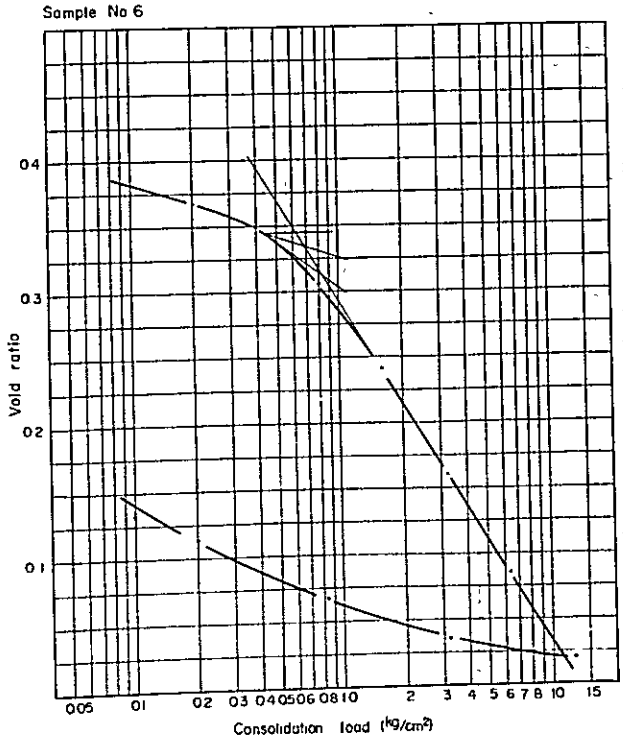


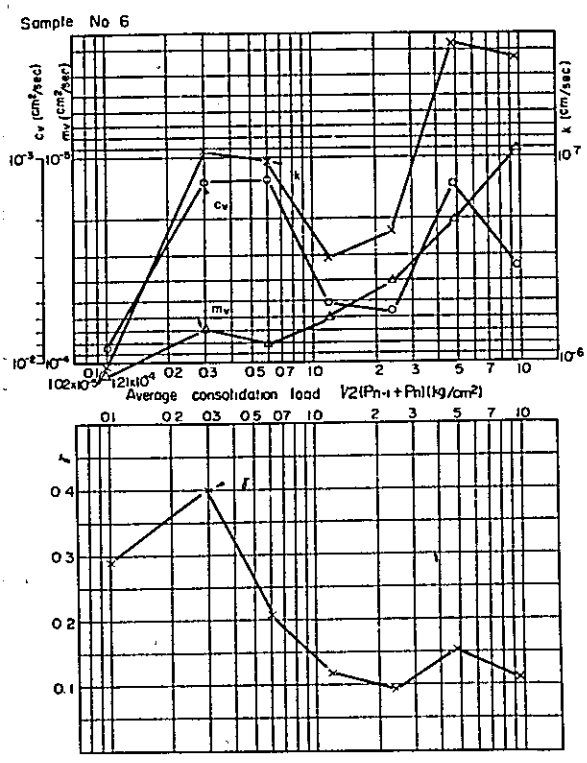
Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

CONSOLIDATION TEST — 4









Remarks c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

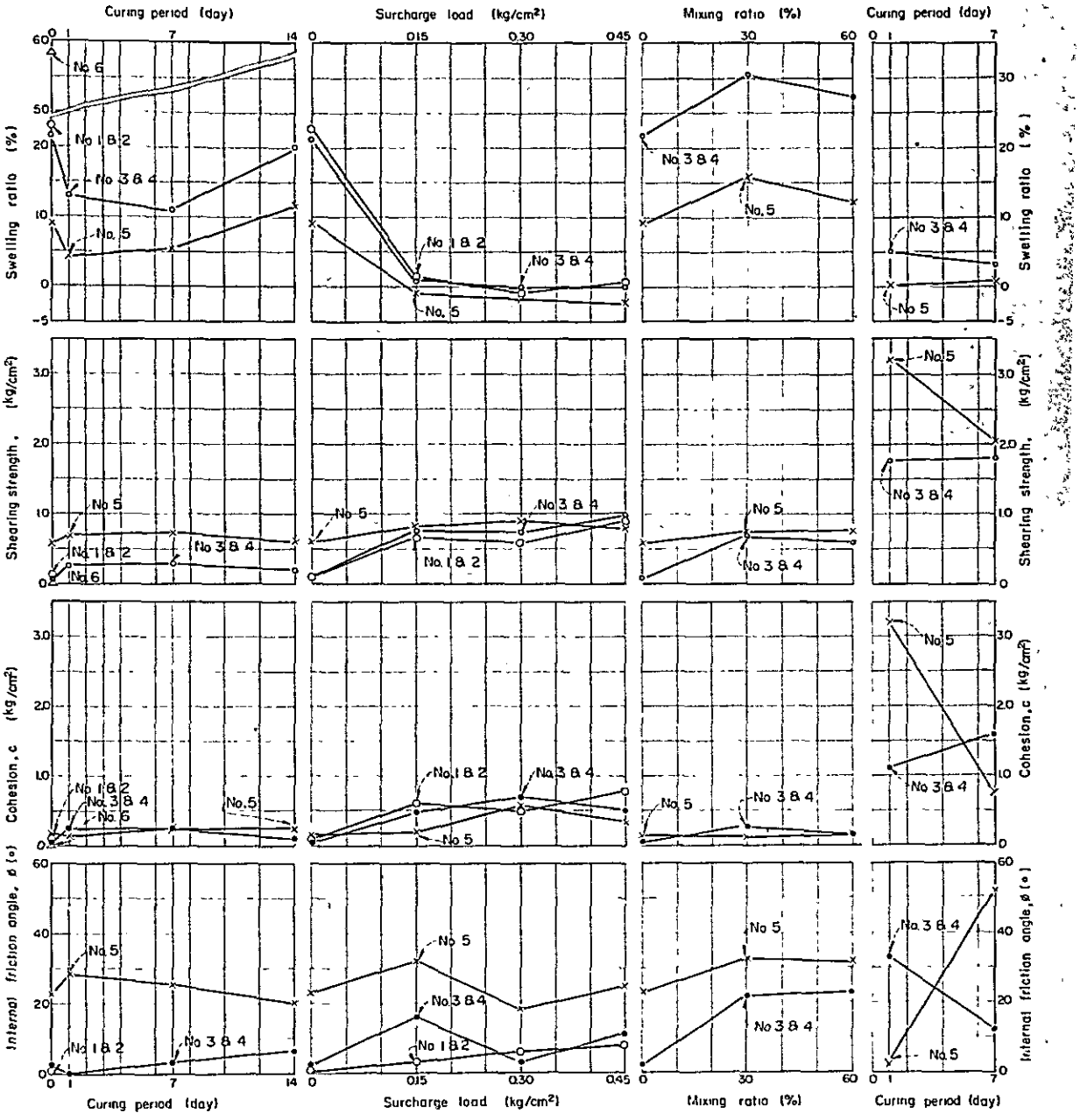
Swelling Test

Unit: Percent

		1 & 2				3 & 4					5					6				
		(1)	(2)	(3)	Mean	(1)	(2)	(3)	(4)	Mean	(1)	(2)	(3)	(4)	Mean	(1)	(2)	(3)	(4)	Mean
1. Case (1)																				
Curing period,	0 day	24.26	21.21	23.04	22.84	26.37	24.99	21.43	12.55	21.34	5.05	12.15	6.29	13.45	9.24	47.41	60.27	65.85	59.60	58.28
	1 day	-	-	-	-	11.59	13.29	14.05	-	12.98	4.84	6.33	1.76	-	4.31	-	-	-	-	-
	7 days	-	-	-	-	8.39	9.95	14.97	-	11.10	6.05	5.74	4.77	-	5.52	-	-	-	-	-
	14 days	-	-	-	-	15.56	22.66	21.63	-	19.95	13.09	10.11	11.47	-	11.56	-	-	-	-	-
2. Case (2)																				
Surcharge load,	0.15 kg/cm^2	3.10	1.18	0.16	1.50	2.61	0.13	-0.04	-	0.90	-0.79	-0.77	-0.81	-	-0.79	-	-	-	-	-
	0.30 kg/cm^2	-0.98	-0.91	-0.36	-0.75	-0.03	-0.04	-0.08	-	-0.05	-1.85	-1.38	-0.95	-	-1.39	-	-	-	-	-
	0.45 kg/cm^2	1.31	0.98	-0.02	0.76	-0.07	-0.05	-0.18	-	-0.10	-2.04	-2.36	-2.52	-	-2.31	-	-	-	-	-
3. Case (3)																				
Mixing ratio,	30 %	-	-	-	-	33.45	32.90	28.12	27.74	30.55	14.90	16.23	15.89	17.49	16.13	-	-	-	-	-
	60 %	-	-	-	-	27.31	27.05	29.61	26.11	27.52	11.12	9.76	13.26	15.22	12.34	-	-	-	-	-
4. Case (4)																				
Curing period,	1 day	-	-	-	-	4.19	10.45	0.14	6.05	5.21	0.11	0.21	0.21	-	0.18	-	-	-	-	-
	7 days	-	-	-	-	4.05	4.19	2.40	-	3.55	0.64	1.19	0.33	1.1	1.09	-	-	-	-	-

SWELLING TEST

Case (1) Case (2) Case (3) Case (4)



Remarks Case (1) The samples were molded in the state of optimum water content and saturated with water after curing for several days at the unloaded condition

Case (2) The samples were molded in the state of optimum water content and saturated with water at the loaded condition *after the compressive deformation due to loading was almost completed (generally after 24 hours)*

Case (3) The samples were mixed with the sand of 0.3millimeter in maximum size by 30 percent of the soil sample in weight in the state of optimum water content or by 60 percent of it, and saturated with water at the unloaded condition immediately after molding

Case (4) The samples were mixed with cement by five percent in weight in the state of optimum water content and saturated with water after curing for several days at the unloaded condition

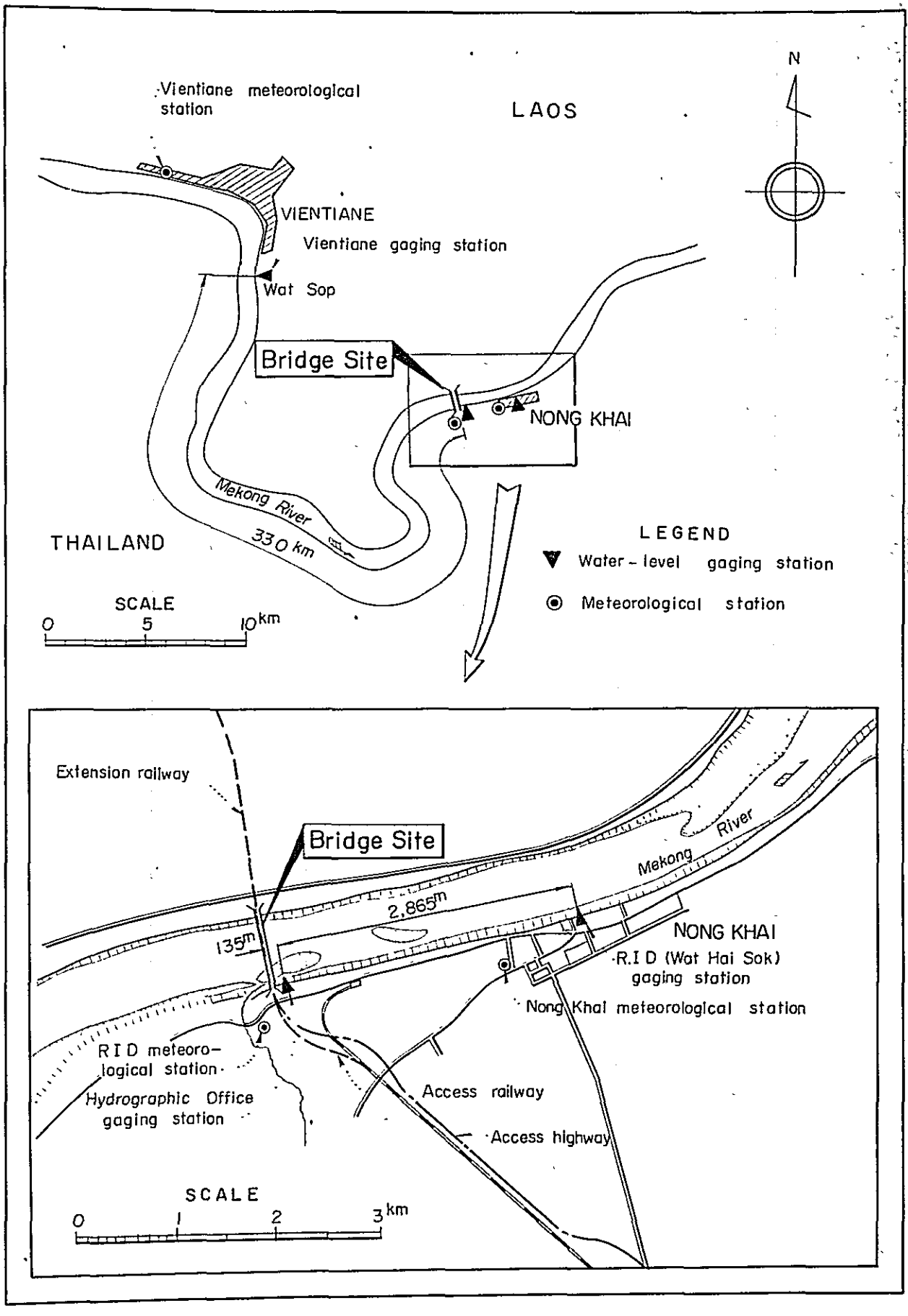
第四章

水文

目次

4.1 水文資料

LOCATION OF THE WATER-LEVEL GAGING STATIONS AND THE METEOROLOGICAL STATIONS



Hydrologic data collected in the first and second phase investigations

Data	Available Period					
	Vientiane	Hydro. Office	R.I.D.			
			W.H.S. /1	B.D.K. /2	W.S.K. /3	A.T.B. /4
Water-level	Jan.'66-Apr.'68	Jun.'64-Apr.'68	Jun.'55-Mar.'68	Jan.'63-Dec.'67*	Jan.'63-Dec.'67*	Jan.'63-Dec.'67*
Water-level and discharge	Jan.'66-Mar.'67	-	-	-	-	-
Water temperature	Jan.'60-Dec.'61	-	-	-	-	-
Flow velocity	-	1966-1968	-	-	-	-
Flow velocity at the flood time	-	Sept.'66	-	-	-	-
Stage hydrograph	-	-	Jun.'37-Mar.'66	-	-	-
Flood hydrograph	1923-1967*	-	-	-	-	-

Remarks

/1 ..... W.H.S.: Wat Hai Sok gaging station

/2 ..... B.D.K.: Ban Dok Kham gaging station

/3 ..... W.S.K.: Wat Sri Mong Kol gaging station

/4 ..... A.T.B.: Ampho Tha Bo gaging station

* ..... The data asterisked are not compiled in Appendices because they were not available for the hydrologic analysis on the Second Phase Report.

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system: Mekong Name of stream: _____ Drainage area (Km²): _____ Year 1964

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1											–		1
2											–		2
3											–		3
4											–		4
5											–		5
6											–		6
7											–		7
8											–		8
9											–		9
10											–		10
11											157.52		11
12											157.54		12
13											157.71		13
14											157.84		14
15											157.78		15
16											157.65		16
17											157.50		17
18											157.37		18
19											157.21		19
20											157.11		20
21											157.18		21
22											157.33		22
23											157.55		23
24											157.73		24
25											157.93		25
26											158.41		26
27											158.61		27
28											158.71		28
29											158.86		29
30											159.21		30
31													31
MAX													MAX
MIN													MIN
TOTAL													TOTAL
DAYS													DAYS
MEAN													MEAN

H : W. S. EL. in m, Q : Discharge in m³/sec. N.K.Form №1201

Zero point of water gauge : El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system: Mekong Name of stream: Drainage area (Km²): Year 1964

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	159.45		161.37		164.01		161.91		159.51		158.32		1
2	159.32		161.91		163.69		161.71		159.42		158.02		2
3	159.08		162.37		163.34		161.60		159.36		157.83		3
4	158.83		162.47		163.18		161.85		159.30		157.72		4
5	158.72		162.29		163.04		162.15		159.21		157.76		5
6	158.93		161.93		163.09		162.20		159.14		157.80		6
7	161.45		161.58		163.36		161.85		159.10		157.73		7
8	164.38		161.55		164.09		161.52		158.95		157.59		8
9	164.56		161.77		164.85		161.33		158.85		157.47		9
10	165.32		162.13		165.07		161.33		158.72		157.40		10
11	165.41		162.31		164.91		162.22		158.60		157.38		11
12	165.12		162.36		164.73		162.73		158.56		157.37		12
13	165.84		162.31		164.57		162.74		158.43		157.31		13
14	164.29		162.19		164.38		162.57		158.35		157.23		14
15	165.00		162.10		164.02		162.33		158.20		157.15		15
16	163.62		162.20		163.99		162.05		158.16		157.08		16
17	163.16		162.72		163.89		161.82		158.08		157.01		17
18	162.72		163.20		163.82		161.62		158.01		156.96		18
19	162.38		163.37		163.54		161.37		157.85		156.90		19
20	162.11		163.31		164.08		161.17		157.68		156.87		20
21	161.75		163.16		163.93		161.01		157.82		156.82		21
22	161.63		163.13		163.64		160.84		157.74		156.79		22
23	161.75		163.68		163.41		160.66		157.72		156.74		23
24	161.95		164.26		163.39		160.53		157.71		156.71		24
25	161.80		164.79		163.28		160.48		157.65		156.69		25
26	161.67		165.18		163.21		160.44		157.63		156.72		26
27	161.65		165.81		163.06		160.34		157.74		156.72		27
28	161.61		165.63		163.88		160.10		158.38		156.70		28
29	161.44		165.18		162.60		159.91		158.64		156.65		29
30	161.43		164.84		162.28		159.76		158.55		156.63		30
31	161.16		164.38				159.61				156.60		31
MAX	165.84		165.81		165.07		162.74		163.64		158.32		MAX
MIN	158.72		161.37		162.28		159.61		157.63		156.60		MIN
TOTAL	5027.53		5055.48		4912.33		5001.75		4753.36		4872.67		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	162.18		163.08		163.74		161.35		158.44		157.18		MEAN

H : W.S. EL. in m, Q : Discharge in m³/sec

N.K. Form No 1202

Zero point of water gauge : El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system: Mekong Name of stream: _____ Drainage area (Km²): _____ Year 1965

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.57		155.86		155.34		154.87		154.94		156.10		1
2	156.55		155.84		155.32		154.86		154.90		156.30		2
3	156.53		155.82		155.30		154.84		154.88		156.52		3
4	156.50		155.78		155.30		154.81		154.86		156.61		4
5	156.48		155.79		155.29		154.85		154.87		156.66		5
6	156.46		155.79		155.29		154.87		154.89		156.72		6
7	156.43		155.79		155.25		154.84		154.91		156.82		7
8	156.39		155.80		155.22		154.84		155.01		156.90		8
9	156.36		155.83		155.10		154.84		155.09		156.90		9
10	156.34		155.82		155.16		154.84		155.07		156.92		10
11	156.31		155.81		155.14		154.86		155.07		156.96		11
12	156.27		155.81		155.12		154.86		155.16		157.13		12
13	156.23		155.80		155.09		154.90		155.24		157.39		13
14	156.20		155.79		155.07		154.91		155.34		157.63		14
15	156.17		155.78		155.06		154.91		155.40		157.89		15
16	156.16		155.76		155.04		154.89		155.42		158.62		16
17	156.14		155.75		155.04		154.90		155.39		158.33		17
18	156.13		155.77		155.06		154.89		155.34		158.70		18
19	156.13		155.79		155.06		154.92		155.20		159.13		19
20	156.13		155.78		155.05		154.91		155.16		159.32		20
21	156.12		155.71		155.04		154.98		155.61		159.53		21
22	156.09		155.65		155.02		155.03		155.05		159.47		22
23	156.10		155.59		155.01		155.07		155.07		159.47		23
24	156.13		155.54		155.01		155.10		155.19		159.60		24
25	156.16		155.50		155.01		155.12		155.45		159.89		25
26	156.13		155.45		155.02		155.12		155.52		160.21		26
27	156.08		155.40		155.00		155.08		155.54		160.52		27
28	156.07		155.37		154.98		155.04		155.59		160.66		28
29	155.96				154.95		155.01		155.62		160.56		29
30	155.93				154.92		154.97		155.70		160.71		30
31	155.90				154.89				155.84				31
MAX	156.57		155.86		155.34		155.12		155.84		160.71		MAX
MIN	155.90		155.37		154.89		154.84		154.86		156.10		MIN
TOTAL	4843.15		4360.17		4808.15		4647.96		4812.32		4748.17		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	156.23		155.72		155.10		154.93		155.24		158.27		MEAN

H : W.S. EL. in m, Q : Discharge in m³/sec, N.K.Form No.1201

Zero point of water gauge : El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong Name of stream: _____ Drainage area (Km²,): _____ Year 1965

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	160.90		162.26		162.90		161.51		163.64		158.40		1
2	160.89		162.29		162.67		161.28		163.29		158.31		2
3	160.77		162.56		162.41		161.01		162.72		158.21		3
4	160.67		162.61		162.35		160.78		162.29		158.15		4
5	160.54		162.72		162.46		160.63		162.15		158.06		5
6	160.49		162.49		162.25		160.53		162.83		158.00		6
7	160.74		162.12		162.01		160.45		163.56		157.95		7
8	160.86		161.75		161.91		160.43		163.65		157.89		8
9	160.78		161.50		162.18		160.44		163.15		157.83		9
10	160.72		161.10		162.56		160.39		162.56		157.79		10
11	161.02		161.07		162.87		160.39		162.00		157.73		11
12	161.74		161.41		162.98		160.32		161.56		157.66		12
13	161.99		161.98		162.91		160.21		161.20		157.62		13
14	161.83		162.61		162.85		160.13		160.88		157.66		14
15	161.60		162.91		162.93		160.01		160.58		157.53		15
16	161.33		162.82		162.94		159.98		160.24		157.54		16
17	161.02		162.82		162.91		159.96		160.02		157.58		17
18	160.84		163.11		162.79		159.95		159.83		157.59		18
19	160.98		163.33		162.76		159.88		159.65		157.53		19
20	161.70		163.53		162.69		159.68		159.50		157.56		20
21	161.65		163.41		162.69		159.58		159.37		157.42		21
22	161.40		163.34		162.63		159.54		159.24		157.72		22
23	161.63		163.07		162.45		159.37		159.13		158.66		23
24	161.78		162.78		162.09		159.20		159.03		157.35		24
25	161.73		162.64		161.89		159.02		158.96		159.41		25
26	161.61		162.73		161.86		158.85		158.86		159.06		26
27	161.63		162.79		161.92		158.70		158.77		158.64		27
28	162.56		162.70		161.88		158.68		158.70		158.29		28
29	162.60		162.78		161.82		159.76		158.60		158.02		29
30	162.40		162.95		161.75		162.53		158.49		157.78		30
31	162.33		163.04				163.93				157.63		31
MAX	162.60		163.53		162.98		163.93		163.65		159.41		MAX
MIN	160.49		161.07		161.75		160.01		158.49		157.42		MIN
TOTAL	5002.73		5039.23		4873.21		4967.15		4822.39		4898.59		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	161.38		162.56		162.44		160.23		160.81		158.02		MEAN

H : W. S. EL. in m, Q : Discharge in m³/sec N.K.Form No.1202

Zero point of water gauge : El. 154.211m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system: Mekong Name of stream: Drainage area (Km²): Year 1966

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	15748		15635		15573		15520		15533		15677		1
2	15738		15637		15571		15520		15530		15689		2
3	15729		15643		15569		15519		15537		15705		3
4	15721		15646		15567		15518		15523		15713		4
5	15706		15645		15565		15515		15520		15713		5
6	15711		15638		15563		15512		15518		15703		6
7	15706		15633		15561		15511		15522		15713		7
8	15702		15626		15558		15511		15519		15708		8
9	15698		15621		15554		15517		15519		15714		9
10	15694		15617		15551		15526		15521		15724		10
11	15691		15613		15548		15530		15523		15742		11
12	15686		15600		15548		15533		15526		15767		12
13	15684		15606		15546		15534		15535		15781		13
14	15682		15604		15547		15535		15543		15791		14
15	15679		15601		15546		15534		15536		15802		15
16	15675		15599		15544		15524		15567		15815		16
17	15672		15596		15545		15529		15576		15831		17
18	15667		15593		15543		15527		15577		15848		18
19	15663		15589		15542		15528		15579		15874		19
20	15660		15586		15541		15537		15581		15902		20
21	15660		15584		15543		15541		15586		15955		21
22	15657		15582		15543		15546		15603		15993		22
23	15649		15581		15541		15535		15647		16012		23
24	15646		15579		15534		15532		15703		16018		24
25	15644		15577		15530		15530		15710		16036		25
26	15642		15576		15527		15538		15698		16077		26
27	15638		15575		15520		15533		15700		16102		27
28	15635		15575		15519		15539		15704		16131		28
29	15631				15520		15539		15713		16164		29
30	15635				15519		15536		15706		16163		30
31	15635				15517				15687				31
MAX	15748		15646		15573		15546		15713		16164		MAX
MIN	15634		15575		15517		15511		15518		15677		MIN
TOTAL	485962		436957		481897		465859		483264		473063		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	15677		15606		15545		15528		15589		15802		MEAN

H : W.S.EL. in m, Q : Discharge in m³/sec. N.K.Form No.1201

Zero point of water gauge : El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system Mekong Name of stream: _____ Drainage area (Km²) _____ Year 1966

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	161.40		162.75		167.43		162.29		160.42		157.85		1
2	160.99		163.37		167.52		162.03		160.25		157.79		2
3	160.60		164.01		167.72		161.79		160.45		157.71		3
4	160.27		164.28		167.97		161.68		160.49		157.65		4
5	160.00		164.42		168.14		161.76		160.33		157.60		5
6	160.26		165.03		168.23		161.82		160.06		157.54		6
7	161.80		165.50		168.29		162.08		159.80		157.48		7
8	162.52		165.46		168.36		162.62		159.61		157.41		8
9	162.60		165.30		168.38		163.20		159.43		157.41		9
10	162.58		165.15		168.39		163.27		159.20		157.42		10
11	162.29		165.08		168.35		162.96		159.15		157.43		11
12	161.97		164.97		168.23		162.54		159.03		157.43		12
13	161.76		164.93		168.07		162.12		158.91		157.37		13
14	161.49		164.97		167.82		161.76		158.81		157.29		14
15	161.20		164.99		167.51		161.46		158.73		157.22		15
16	161.16		165.05		167.13		161.20		158.64		157.13		16
17	161.37		165.26		166.75		161.01		158.57		157.07		17
18	161.86		165.41		166.51		160.91		158.51		157.02		18
19	162.58		165.48		166.26		160.97		158.41		156.97		19
20	163.07		165.34		165.92		161.22		158.38		156.93		20
21	163.13		165.12		165.57		161.51		158.32		156.92		21
22	163.20		165.02		165.19		161.71		158.23		156.91		22
23	163.16		165.24		164.74		161.61		158.16		156.92		23
24	163.01		165.86		164.27		161.34		158.09		156.93		24
25	162.78		166.04		163.90		161.07		158.05		156.89		25
26	162.60		166.16		163.67		160.89		158.01		156.83		26
27	162.31		166.40		163.51		160.65		157.98		156.76		27
28	162.07		166.65		163.23		160.47		157.94		156.69		28
29	162.74		166.89		162.90		160.67		157.94		156.64		29
30	161.85		167.13		162.55		160.53		157.91		156.59		30
31	161.83		167.33				160.55				156.55		31
MAX	163.16		167.33		168.39		163.27		160.49		157.85		MAX
MIN	161.40		162.75		162.55		160.47		157.91		156.55		MIN
TOTAL	5022.65		5124.62		4992.51		5009.69		4767.84		4872.38		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	161.94		165.31		166.42		161.60		158.92		157.17		MEAN

H : W. S. EL. in m, Q : Discharge in m³/sec

N.K.Form No.1202

Zero point of water gauge : El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong Name of stream: _____ Drainage area (Km²): _____ Year 1967

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.51		155.87		155.31		155.10		155.76		156.01		1
2	156.48		155.83		155.28		155.06		155.76		155.98		2
3	156.41		155.80		155.25		155.02		155.82		155.90		3
4	156.41		155.76		155.23		154.98		155.82		155.84		4
5	156.36		155.74		155.21		154.95		155.78		155.84		5
6	156.32		155.72		155.29		154.94		155.71		155.91		6
7	156.29		155.69		155.33		154.93		155.61		156.00		7
8	156.26		155.66		155.32		154.95		155.51		156.07		8
9	156.24		155.66		155.29		155.00		155.49		156.30		9
10	156.20		155.66		155.24		155.03		155.49		156.67		10
11	156.18		155.65		155.20		154.98		155.61		157.08		11
12	156.18		155.67		155.18		154.95		155.68		157.75		12
13	156.18		155.71		155.17		154.92		155.71		158.38		13
14	156.20		155.70		155.16		154.93		155.77		158.35		14
15	156.23		155.66		155.19		154.96		155.81		158.16		15
16	156.21		155.64		155.25		155.01		155.85		157.94		16
17	156.17		155.60		155.30		155.08		155.87		157.72		17
18	156.18		155.56		155.34		155.12		155.93		157.52		18
19	156.21		155.53		155.38		155.20		155.92		157.35		19
20	156.27		155.50		155.40		155.30		155.86		157.27		20
21	156.29		155.48		155.39		155.39		155.83		157.24		21
22	156.27		155.46		155.32		155.46		155.80		157.26		22
23	156.26		155.43		155.26		155.51		155.70		157.31		23
24	156.23		155.41		155.19		155.57		155.56		157.45		24
25	156.16		155.40		155.16		155.64		155.48		157.28		25
26	156.09		155.38		155.13		155.67		155.45		157.14		26
27	156.05		155.36		155.08		155.70		155.46		157.00		27
28	156.00		155.34		155.06		155.74		155.52		156.97		28
29	155.96				155.07		155.77		155.65		156.99		29
30	155.94				155.08		155.79		155.81		157.06		30
31	155.91				155.10				155.94				31
MAX	156.51		155.87		155.40		155.79		155.94		158.38		MAX
MIN	155.91		155.34		155.06		154.92		155.45		155.84		MIN
TOTAL	4841.68		4356.79		4812.19		4656.65		4826.99		4709.74		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	156.22		155.60		155.23		155.21		155.71		156.99		MEAN

H : W. S. EL in m, Q : Discharge in m³/sec. N.K.Form No.1201

Zero point of water gauge : El. 154.211m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system: Mekong Name of stream: Drainage area (Km²): Year 1967

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	157.23		162.74		161.08		163.03		158.64		158.32		1
2	157.41		162.53		160.93		162.91		158.68		158.12		2
3	157.52		162.25		160.77		163.03		158.65		157.92		3
4	157.70		161.86		160.62		163.01		158.57		157.76		4
5	157.85		161.45		160.51		162.84		158.45		157.65		5
6	157.78		161.02		160.41		162.57		158.35		157.58		6
7	157.67		160.62		160.40		162.31		158.23		157.52		7
8	157.69		160.25		160.43		162.08		158.18		157.46		8
9	157.69		159.90		160.49		161.84		158.13		157.38		9
10	157.71		159.71		160.72		161.61		158.14		157.39		10
11	157.74		159.74		161.03		161.37		158.16		157.22		11
12	157.79		160.14		161.04		161.12		158.06		157.15		12
13	157.70		160.83		161.33		160.84		157.96		157.08		13
14	157.66		161.50		161.63		160.84		157.84		157.09		14
15	157.66		162.00		161.98		160.30		157.78		156.96		15
16	157.73		161.85		162.72		160.07		157.74		156.92		16
17	158.19		161.60		163.48		159.90		157.69		156.90		17
18	158.13		161.53		163.90		159.78		157.65		156.88		18
19	158.96		161.87		163.88		159.73		157.76		156.88		19
20	158.96		162.33		163.45		159.78		158.34		156.93		20
21	159.35		162.85		163.00		160.01		158.94		157.00		21
22	160.37		163.73		162.75		160.28		159.01		157.00		22
23	160.79		164.05		162.65		160.21		159.09		156.92		23
24	160.63		164.09		162.63		159.85		158.77		156.84		24
25	160.31		165.00		162.99		159.51		158.79		156.77		25
26	159.97		164.65		163.48		159.22		158.73		156.71		26
27	159.74		163.10		163.74		159.60		158.56		156.65		27
28	159.70		162.57		163.68		158.81		158.34		156.61		28
29	161.66		162.13		163.69		158.69		158.23		156.57		29
30	162.86		161.70		163.38		158.63		158.13		156.52		30
31	162.98		161.31				158.62				156.48		31
MAX	162.98		165.00		163.90		163.03		159.01		158.32		MAX
MIN	157.23		159.71		160.40		158.62		157.65		156.48		MIN
TOTAL	4905.76		5020.90		4862.79		4982.39		4750.63		4871.11		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	158.90		161.96		162.09		160.72		158.35		157.13		MEAN

H : W.S.EL. in m, Q : Discharge in m³/sec N.K.Form №1202

Zero point of water gauge : El. 154.211m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

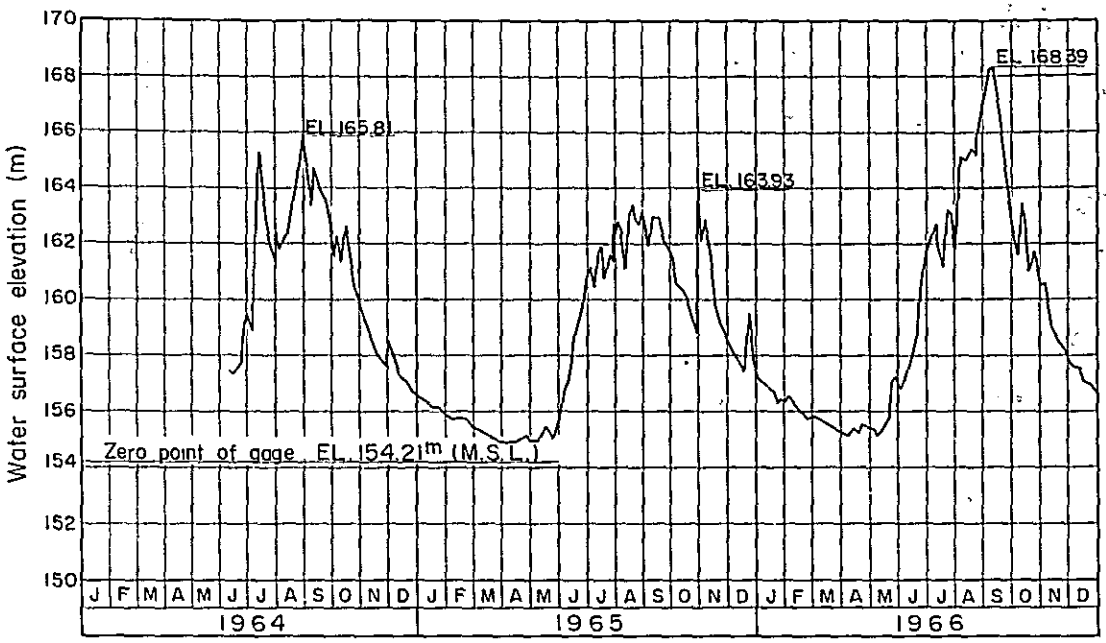
River system. Mekong Name of stream: _____ Drainage area (Km²): _____ Year 1968

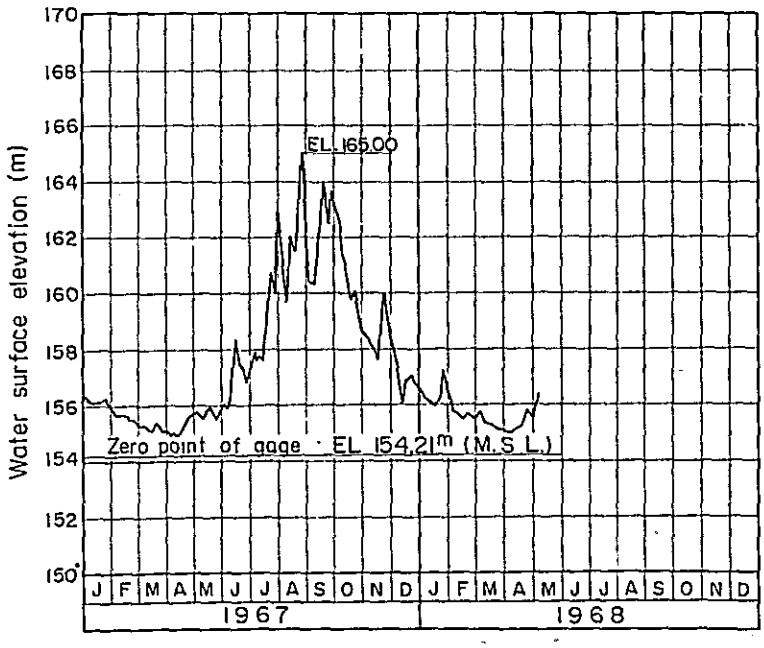
	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.41		156.09		155.49		155.02		155.65				1
2	156.41		155.99		155.55		155.02		155.81				2
3	156.38		155.91		155.65		155.01		156.00				3
4	156.34		155.88		155.72		155.01		156.14				4
5	156.31		155.86		155.75		155.03		156.26				5
6	156.28		155.82		155.70		155.03						6
7	156.25		155.79		155.60		155.01						7
8	156.23		155.75		155.31		155.00						8
9	156.21		155.72		155.42		155.02						9
10	156.20		155.69		155.40		155.06						10
11	156.17		155.65		155.37		155.07						11
12	156.16		155.62		155.38		155.06						12
13	156.13		155.59		155.39		155.07						13
14	156.11		155.56		155.38		155.08						14
15	156.08		155.55		155.33		155.16						15
16	156.07		155.53		155.29		155.22						16
17	156.03		155.52		155.27		155.22						17
18	156.01		155.51		155.28		155.20						18
19	156.00		155.51		155.22		155.23						19
20	156.00		155.66		155.20		155.30						20
21	156.02		155.65		155.17		155.42						21
22	156.08		155.67		155.14		155.56						22
23	156.05		155.70		155.11		155.65						23
24	156.31		155.65		155.05		155.80						24
25	156.58		155.60		155.03		155.81						25
26	157.04		155.53		155.07		155.72						26
27	157.06		155.48		155.04		155.61						27
28	156.79		155.45		155.03		155.55						28
29	156.51		155.45		155.02		155.50						29
30	156.34				155.05		155.57						30
31	156.20				155.04								31
MAX	157.06		156.09		155.75		155.81						MAX
MIN	156.00		155.45		155.02		155.00						MIN
TOTAL	4841.82		4513.41		4814.45		4658.01						TOTAL
DAYS	31		29		31		30						DAYS
MEAN	156.28		155.64		155.31		155.27						MEAN

H · W.S.EL. in m, Q: Discharge in m³/sec, N.K.Form No.1201

Zero point of water gauge: El. 154.211m

WATER-LEVEL OF THE MEKONG AT HYDROGRAPHIC OFFICE G. S.

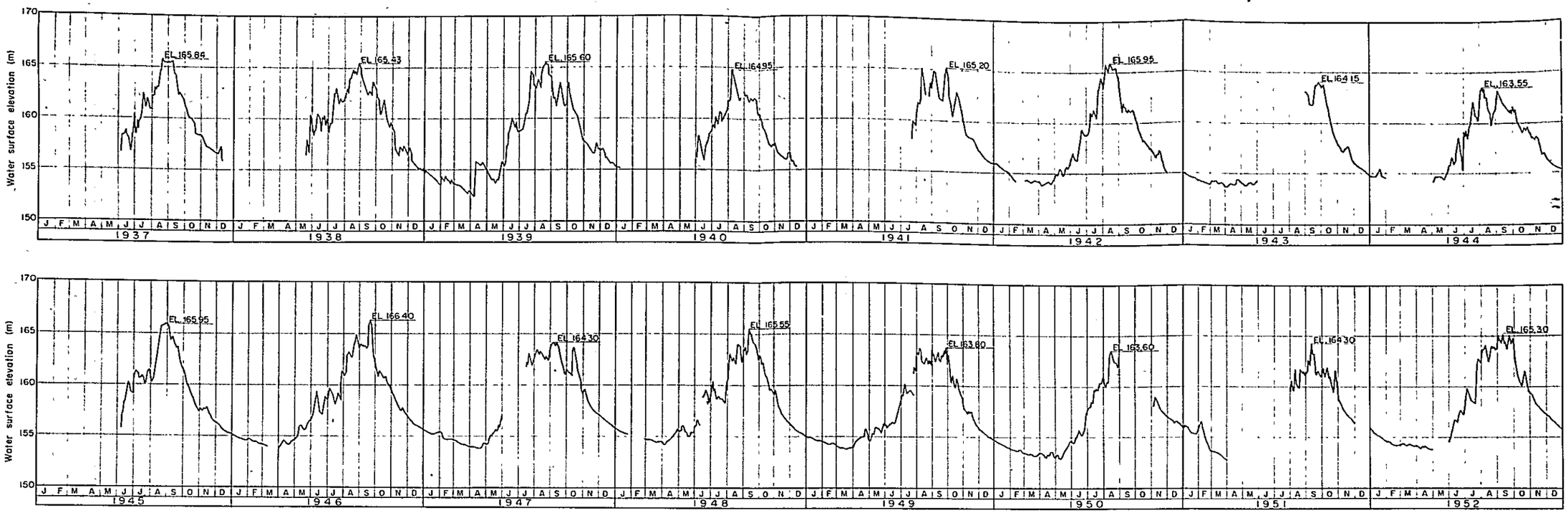


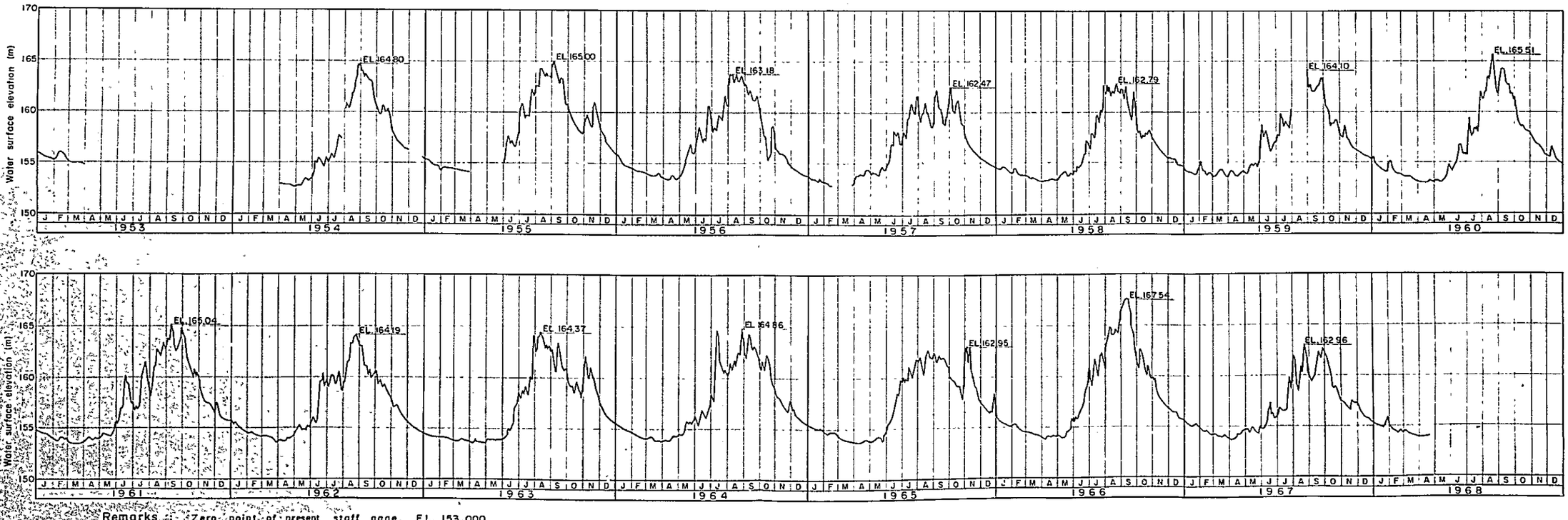


Remarks :

1) Gage was installed on June 11, '64 and data were taken ever since
2) Figures given here show daily mean value of three readings a day taken at 6.00, 12:00 and 18:00.

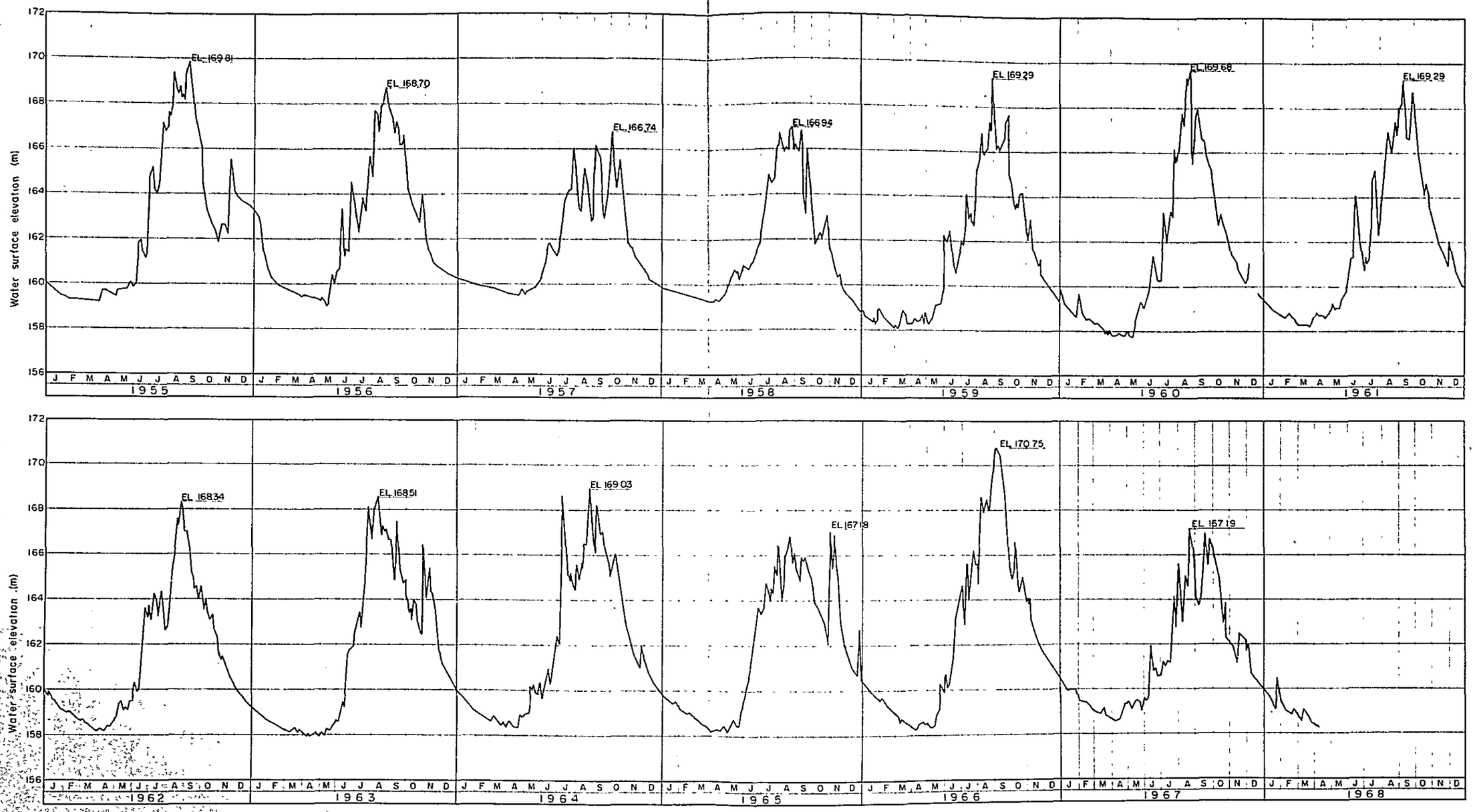
WATER LEVEL OF THE MEKONG AT R.I.D. (WAT HAI SOK) GAGING STATION





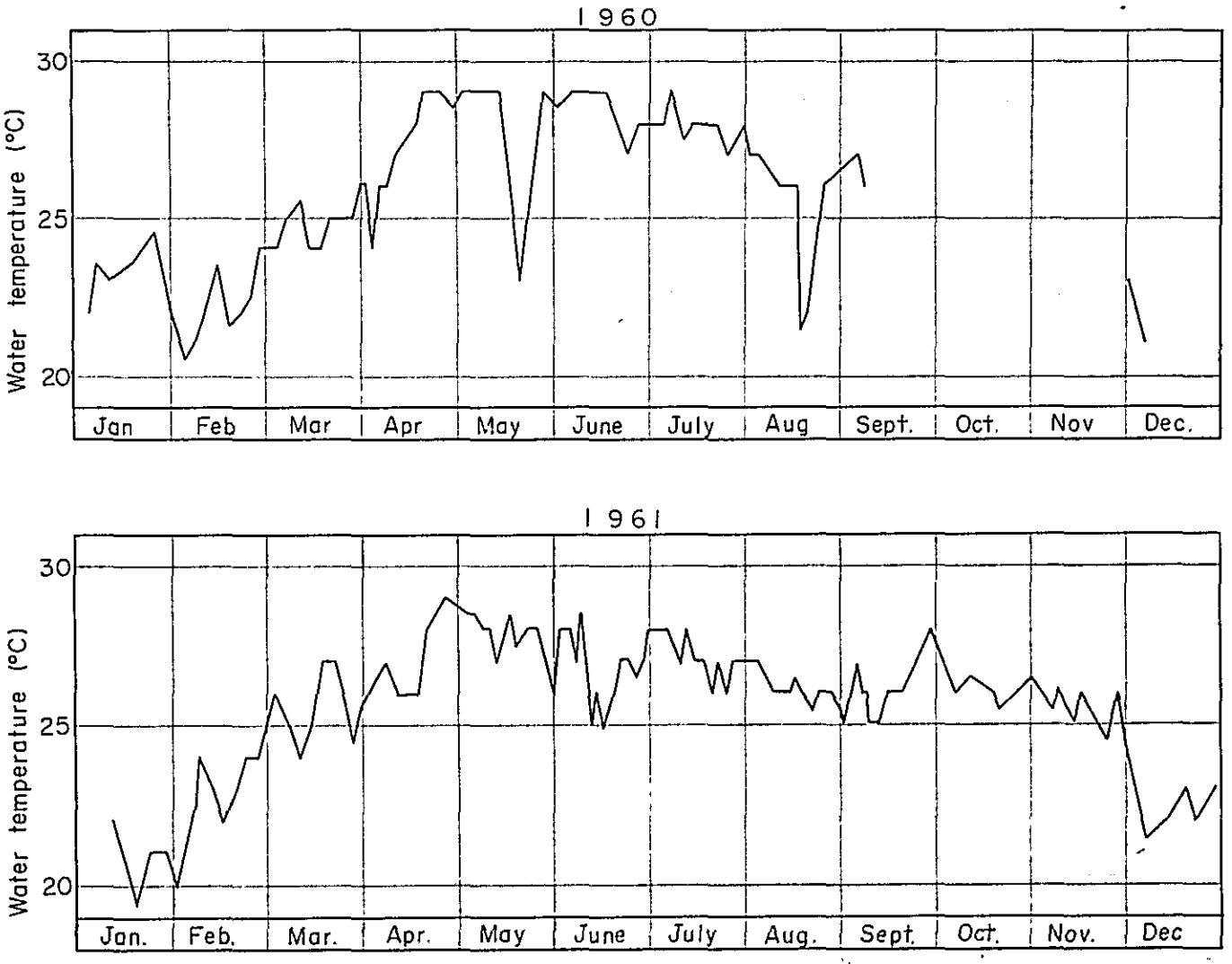
Remarks : Zero point of present staff gage, EL. 153.000

WATER-LEVEL OF THE MEKONG AT VIENTIANE (WAT SOP) GAGING STATION

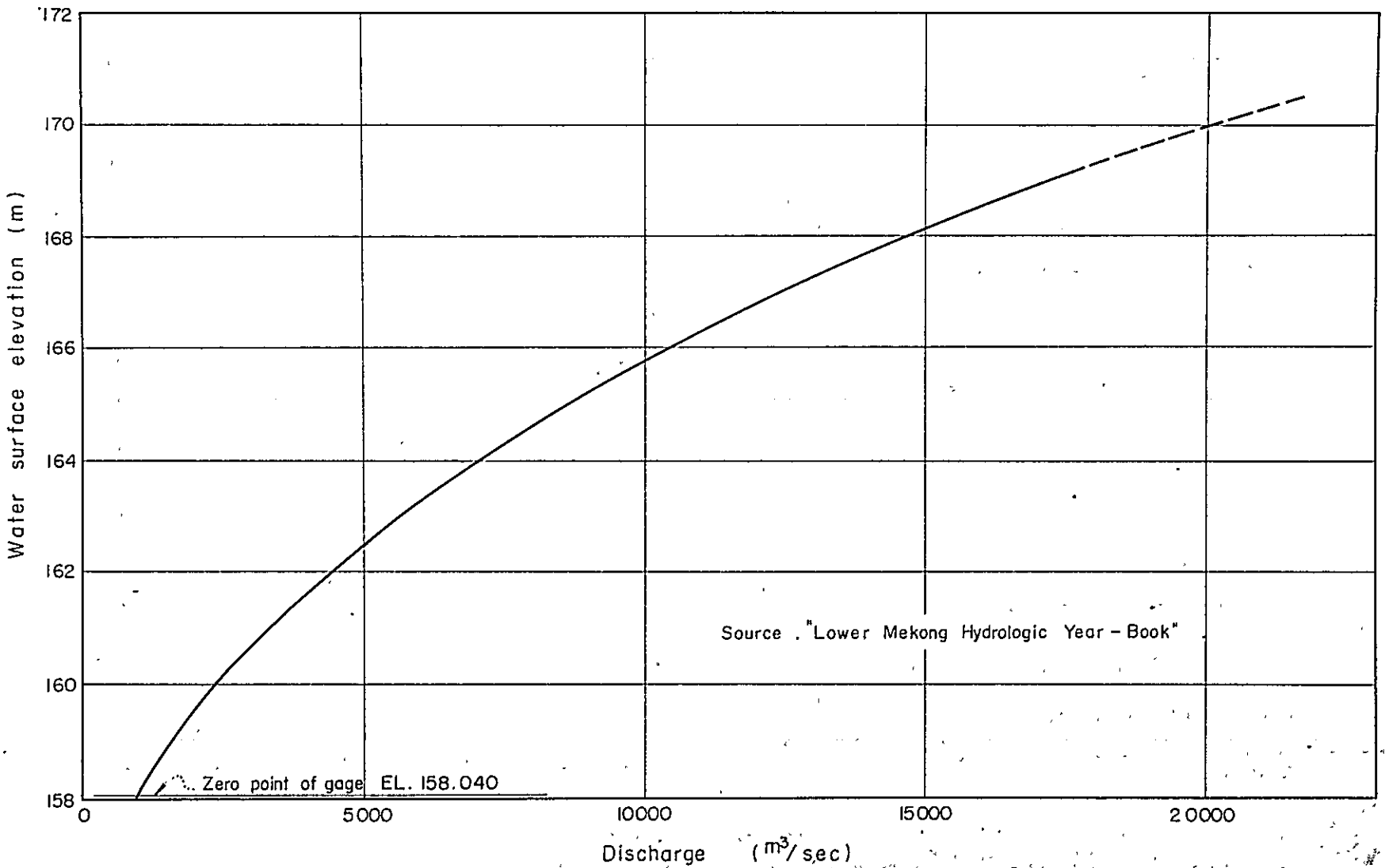


Remarks : Zero point of gage EL. 158.040 m

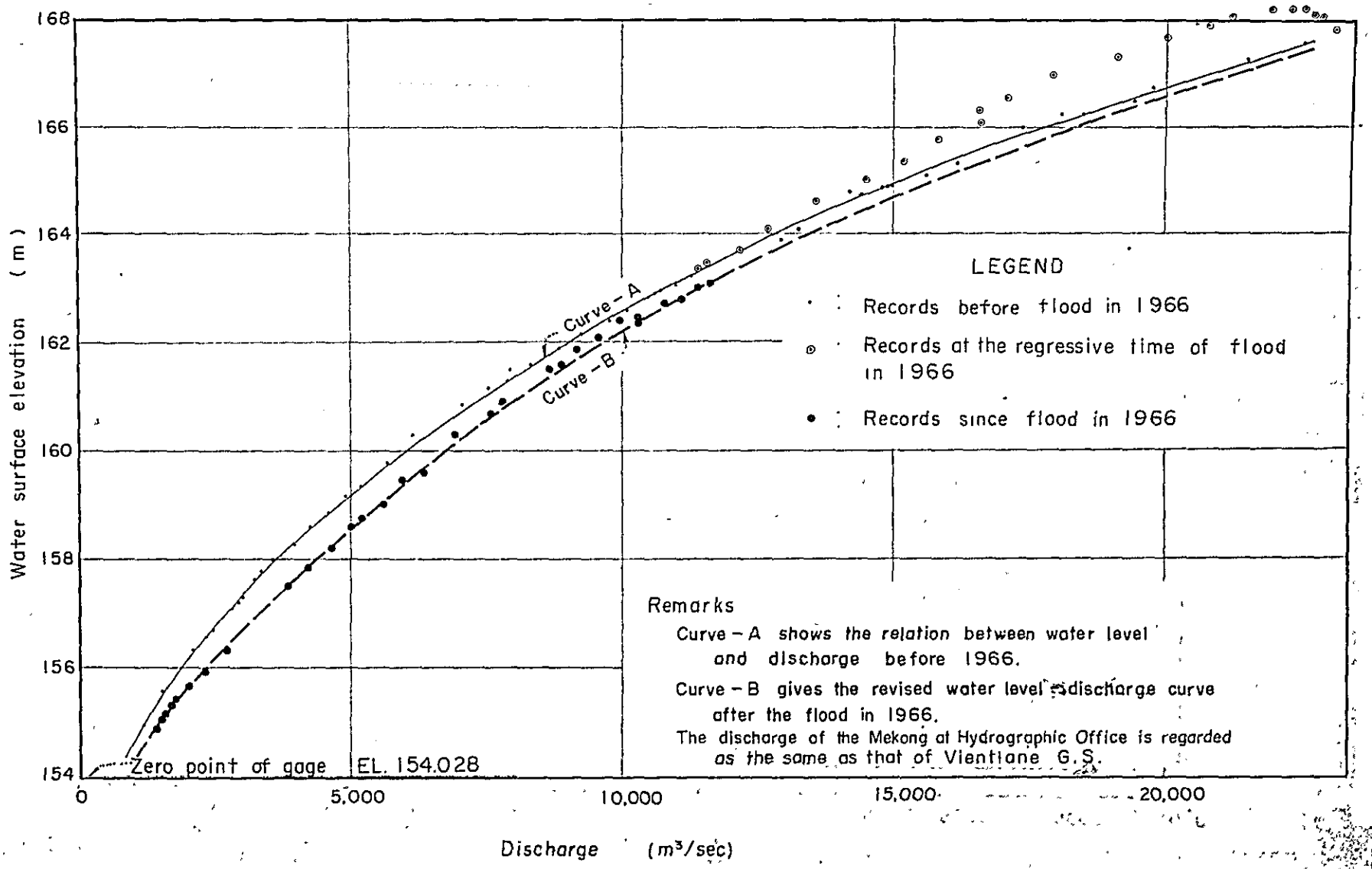
WATER TEMPERATURE OF THE MEKONG NEAR VIENTIANE



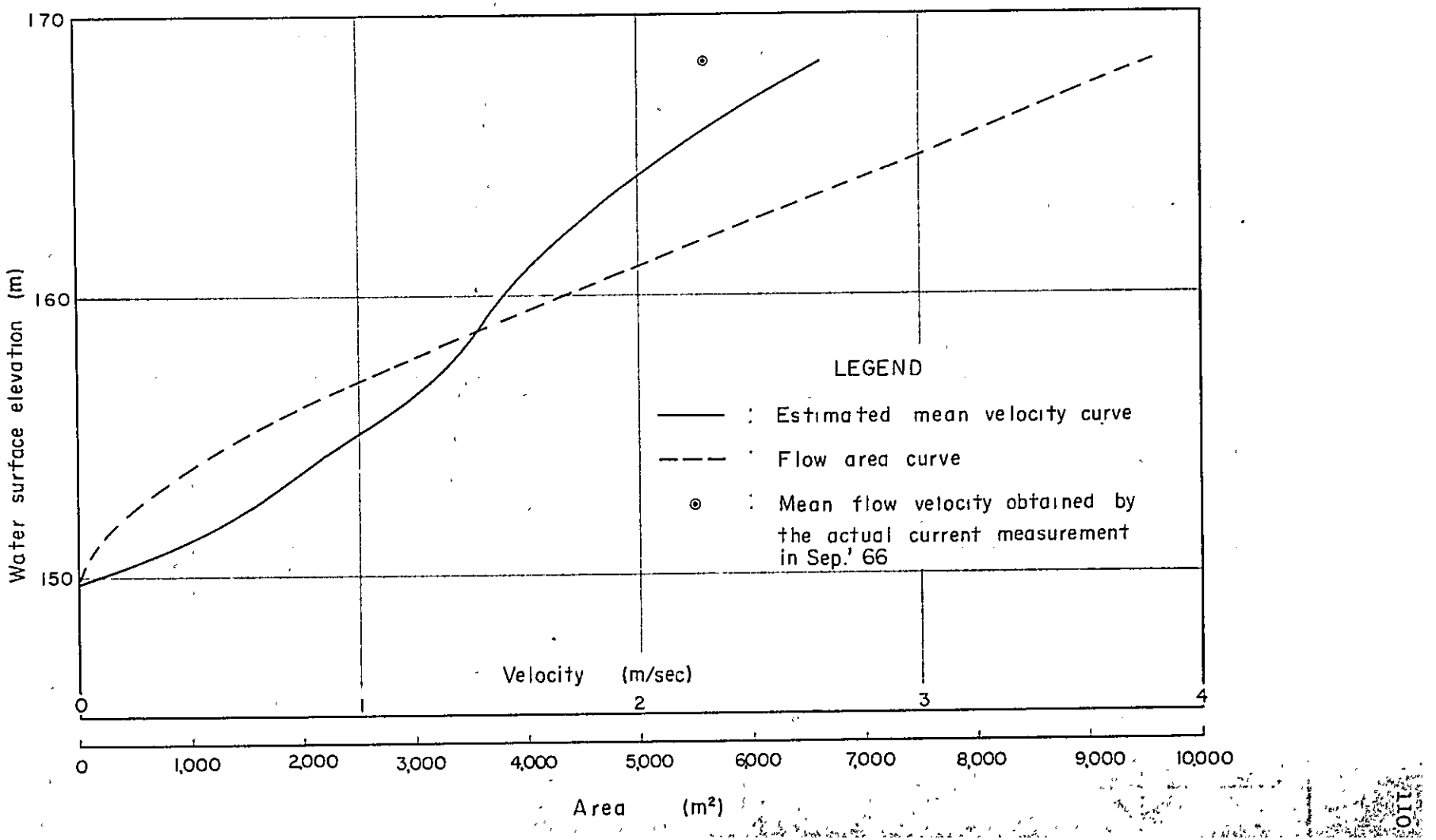
WATER LEVEL – DISCHARGE CURVE AT VIENTIANE (WAT SOP) G.S.



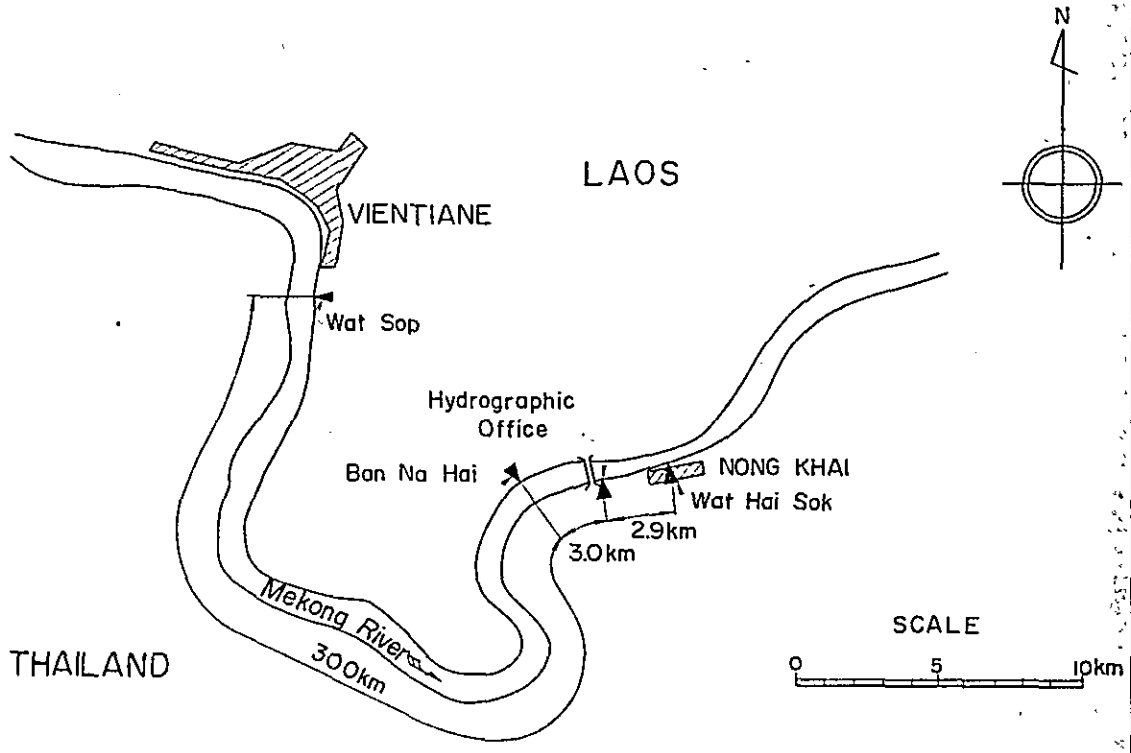
WATER LEVEL—DISCHARGE CURVES AT HYDROGRAPHIC OFFICE G. S.

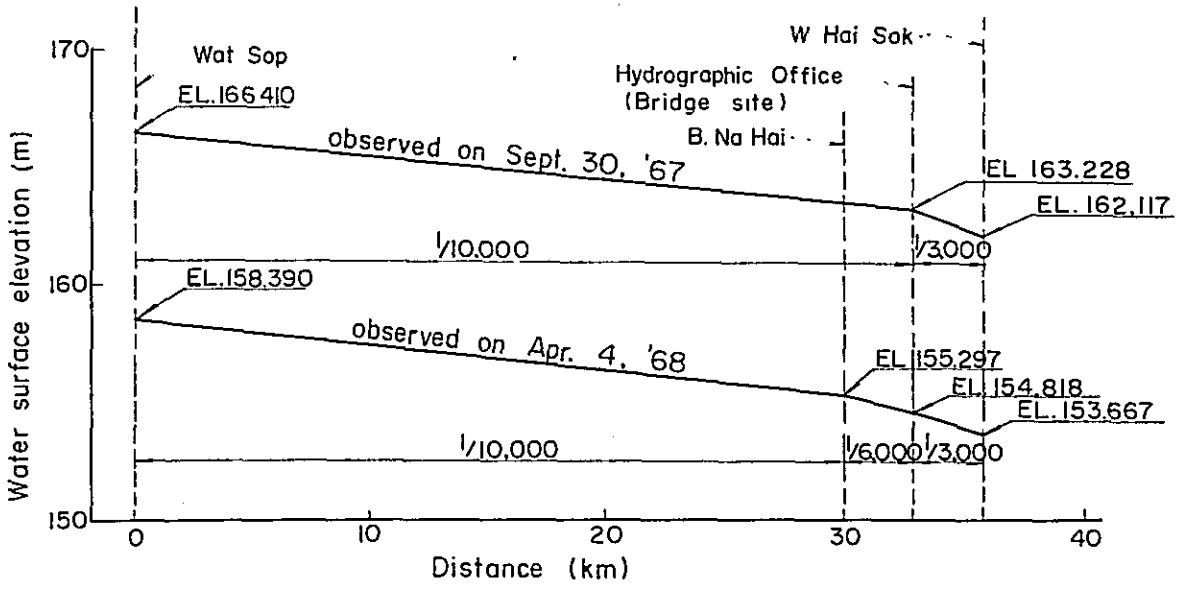


FLOW AREA AND MEAN FLOW VELOCITY OF THE MEKONG AT THE BRIDGE SITE



OBSERVATION OF WATER SURFACE GRADE





Remarks :

In both the first and second phase investigations, water stages were observed simultaneously at different places up-and downstream from the bridge site.

Based on the results of survey and the Manning's formula, the roughness coefficients "n" of the Mekong at the immediately up and downstream reaches of the bridge site were estimated at 0.032 and 0.046 in the dry season and 0.025 and 0.049 in the rainy season respectively.

4.2. 確率高水位計算

この確率計算は架橋計画に必要な設計高水位を求めるためのメヨン河架橋地点の確率高水位を推定するものである。

確率高水位計算

1. 一般

調査運用計画書によればメコン河の舟運コースとビエンチャン架橋の何処かに最も起りうる高水位上10mの桁下高を設けなければならない。この規定はすなわち舟運コースを設ける径間の橋桁の下部から最も起りうる高水位の水面迄が10m以上なければならないことを意味している。従ってこの最も起りうる高水位は橋の設計基準の1つになっている。この観念に基づいて以下この水位を設計高水位と呼ぶ。

設計高水位は過去におけるメコン河の水位記録を使った確率計算によって推定される。

2. 条件

架橋地点附近には2つの測水所があり1つは架橋地点下流約135mにあるハイドログラフィック・オフィス、もう1つは下流約3kmのR.I.D.ワット・ハイ・ソック測水所である。

ハイドログラフィック・オフィスの測水所は1964年6月に設立されたものであり R.I.D 測水所は1937年に設置されている。従ってR.I.D.測水所には長期に亘る測水記録が在りこの水位記録とハイドログラフィックオフィスの記録から設計高水位が以下の要領に従って推定される。

1) R.I.D. 測水所の水位記録を基に確率高水位を推定する。

2) 上記2つの測水所間の水位の関係を知る。

3) この関係からハイドログラフィック・オフィスにおける確率高水位を推定する。

4) 最後に、このハイドログラフィック・オフィスの確率高水位から乾期、雨期共に1/3000～1/4000のメコン河水面勾配を参考にして栄橋地点の確率高水位を推定する。

R.I.D. 測水所の水位記録は 1943年、1950年、1953年及び1959年の4ケ年を除いて 1937年から1967年迄が有効な資料である。

この水位記録から各年の最高水位を抜き出しこの抜粋資料が対数正規分布に載るものとして順序確率法による確率高水位計算を行なった。

計算式は以下に示す通りである。

$$\varepsilon = \alpha (\log x - \log x_0)$$

又は $$\log x = \frac{1}{\alpha}\varepsilon + \log x_0$$

ここに x ：確率高水位
x_0 ：年間最高水位の幾何平均値
ε ：任意年の正規変数

正規変数は次の公式によって計算される

$$\phi_0(\varepsilon) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\varepsilon} e^{-\varepsilon} d\varepsilon = 1 - W_0(\varepsilon)$$

ここに ϕ_0 ：非超過確率（ガウスの誤差関数）
W_0 ：超過確率

α は資料の散乱の度合を表わすパラメーターであり次式によって求められる

$$\frac{1}{\alpha} = \frac{G_{\log x}}{G_\varepsilon}$$

ここに G_ε ：観測値の起る確率の積率

$$\sigma_{\log x} = \sqrt{\frac{1}{n}\Sigma(\log_e x_i)^2 - (\log x_0)^2}$$

ここに x_i ： 観測値
n ： 資料の数

3 確率計算

1) R.I.D. 測水所に於ける確率高水位
表A.4.2.2.1. 与えられる基本計算は記録から抜粋した27のデータを基にして行なわれ以下の計算に移る

$$\sigma_{\log x} = \sqrt{\frac{1}{27} \times 12.3261 - 0.66524^2} = 0.1182$$

ξ の値は Hazen's Method により データ27個に対し 0.6908 である.

$$\frac{1}{\alpha} = \frac{0.1182}{0.6908} = 0.1711$$

故に

$$\log x = 0.1711\xi + 0.66524$$

上式より8つの生起年に関する確率高水位を求めると次表の通りである.

表A.4.2.1 R.I.D 測水所の確率高水位

生起年	ξ	$\log x$	x	W.L
2	0	0.66524	4.63	EL. 164.63 m
5	0.5951	0.76707	5.85	165.85
10	0.9062	0.82030	6.61	166.61
20	1.1630	0.86426	7.32	167.32
40	1.3859	0.90237	7.99	167.99
50	1.4520	0.91372	8.20	168.20
100	1.6450	0.94670	8.85	168.85
200	1.8215	0.97690	9.48	169.48

Table A.4.2.2 Basic calculation

i	Year	H.W.L.	x_i	log x_i	$(\log x_i)^2$
1	1966	167.58	7.58	0.87967	0.77382
2	1946	166.40	6.40	0.80618	0.64993
3	1942	165.95	5.95	0.77452	0.59988
4	1945	165.95	5.95	0.77452	0.59988
5	1937	165.84	5.84	0.76641	0.58737
6	1960	165.72	5.72	0.75740	0.57365
7	1939	165.60	5.60	0.74819	0.55979
8	1948	165.55	5.55	0.74429	0.55397
9	1938	165.43	5.43	0.73480	0.53993
10	1952	165.30	5.30	0.72428	0.55128
11	1941	165.20	5.20	0.71600	0.51266
12	1949	165.08	5.08	0.70586	0.49823
13	1955	165.02	5.02	0.70070	0.49098
14	1940	164.95	4.95	0.69461	0.48248
15	1964	164.90	4.90	0.69020	0.47638
16	1954	164.80	4.80	0.68124	0.46409
17	1963	164.39	4.39	0.64246	0.41275
18	1947	164.30	4.30	0.63347	0.40128
19	1951	164.30	4.30	0.63347	0.40128
20	1962	164.21	4.21	0.62428	0.38972
21	1949	163.80	3.80	0.57978	0.33614
22	1956	163.77	3.77	0.57634	0.33217
23	1944	163.55	3.55	0.55023	0.30275
24	1958	163.04	3.04	0.48283	0.23312
25	1965	162.98	2.98	0.47422	0.22488
26	1967	162.97	2.97	0.47276	0.22350
27	1957	162.47	2.47	0.39270	0.15421
Total				17.96141	12.32613

$$\log x_o = \frac{1}{n} \sum \log x_i = \frac{1}{27} \times 17.96141 = 0.66524$$

(2) ハイドログラフィック・オフィスの確率高水位

R.I.D. のハイドログラフィック・オフィスの 1964年6月から 1968年4月迄の水位記録の関係は図4.2.2. に示される通りである。

この両測水所間の距離は 2,865m しかなく両者間の流量の増減は極く僅かなものと思われる。この関係から、ハイドログラフィック・オフィスの確率高水位は R.I.D. 測水所のそれから求めることができる。(表A.4.2.1. 参照) この推定値は表A.4.2.3 に示される通りである。

(3) 栄橋地点の確率高水位

栄橋地点はハイドログラフィック・オフィスの上流 135m に位置する。この間のメコン河水面勾配は 1/3,000 ないしは 1/4,000 と推定され栄橋地点とオフィスとの水位差は 4cm 程度と思われる。

従ってこの水位差から栄橋地点の確率高水位が算出され表A.4.2.3. に示された。

表A4.2.3 R.I.D., オフィス及び栄橋地点の確率高水位

生起率	R.I.D.	ハイドログラフィック・オフィス	栄橋地点
2	EL. 164.63 m	EL. 165.49 m	EL. 165.53 m
5	165.85	166.68	166.72
10	166.61	167.41	167.45
20	167.32	168.10	168.14
40	167.99	168.74	168.78
50	168.20	168.95	168.99
100	168.85	169.60	169.64
200	169.48	170.20	170.24

注 この水位はコラックの平均海水面上の標高を表わす。

(4) 結論

R.I.D. 測水所の水位記録に基づき，過去のデータが表A.4.2.3. に示される確率洪水位を超える年間の日数及び超過継続日数が設計洪水位決定に関して検討された。

表 A.4.2.4 超過日数及び超過継続日数

生起年 / 確率洪水位 / 年	2	5	10	20	50	100	200
	164.63	165.85	166.61	167.32	168.20	168.85	169.48
1937	25	0	0	0	0	0	0
1938	11	0	0	0	0	0	0
1939	14	0	0	0	0	0	0
1940	2	0	0	0	0	0	0
1941	12	0	0	0	0	0	0
1942	25	3	0	0	0	0	0
1943	—	—	—	—	—	—	—
1944	0	0	0	0	0	0	0
1945	21	4	0	0	0	0	0
1946	10	5	0	0	0	0	0
1947	0	0	0	0	0	0	0
1948	9	0	0	0	0	0	0
1949	0	0	0	0	0	0	0
1950	—	—	—	—	—	—	—
1951	0	0	0	0	0	0	0
1952	11	0	0	0	0	0	0
1953	—	—	—	—	—	—	—
1954	4	0	0	0	0	0	0
1955	6	0	0	0	0	0	0
1956	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	10
1959	—	—	—	—	—	—	—

1960	6	0	0	0	0	0	0
1961	4	0	0	0	0	0	0
1962	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0
1964	3	0	0	0	0	0	0
1965	0	0	0	0	0	0	0
1966	31	20	14	7	0	0	0
1967	0	0	0	0	0	0	0
合計	194	32	14	7	0	0	0
比	1/50	1/310	1/700	1/1000	0	0	0
超過継続日数	29	20	14	7	0	0	0

上表A4.2.4に5川は過去に於ける水位記録は2年確率高水位に対して50日に1日の割合で超えており5年確率において310日に1日また10年確率に対して700日に1日の割合でそれぞれ確率高水位を超えている。

2年確率高水位を超える割合はかなり大きくその他の高水位においてはそれ程でもない。

1966年には最大超過日数記録が生まれているがこの年の洪水は25年確率高水位に匹敵する。この年の水位記録によると2年確率高水位を29日間連続超過しており5年確率に対して20日間，10年確率に対して14日間それぞれ連続超過している。

この事実からみて架橋地点に於ける水位がEL 166.72mとなる5年確率高水位を設計高水位として決定するのが最も好ましいと思われる。

従って架橋計画の設計水位として上記水位に28cmの余裕を考慮したEL.167.00mを採用する。

Fig. 4.2.1. PROBABLE HIGH-WATER LEVEL AT R.I.D. (WAT HAI SOK) G. S.

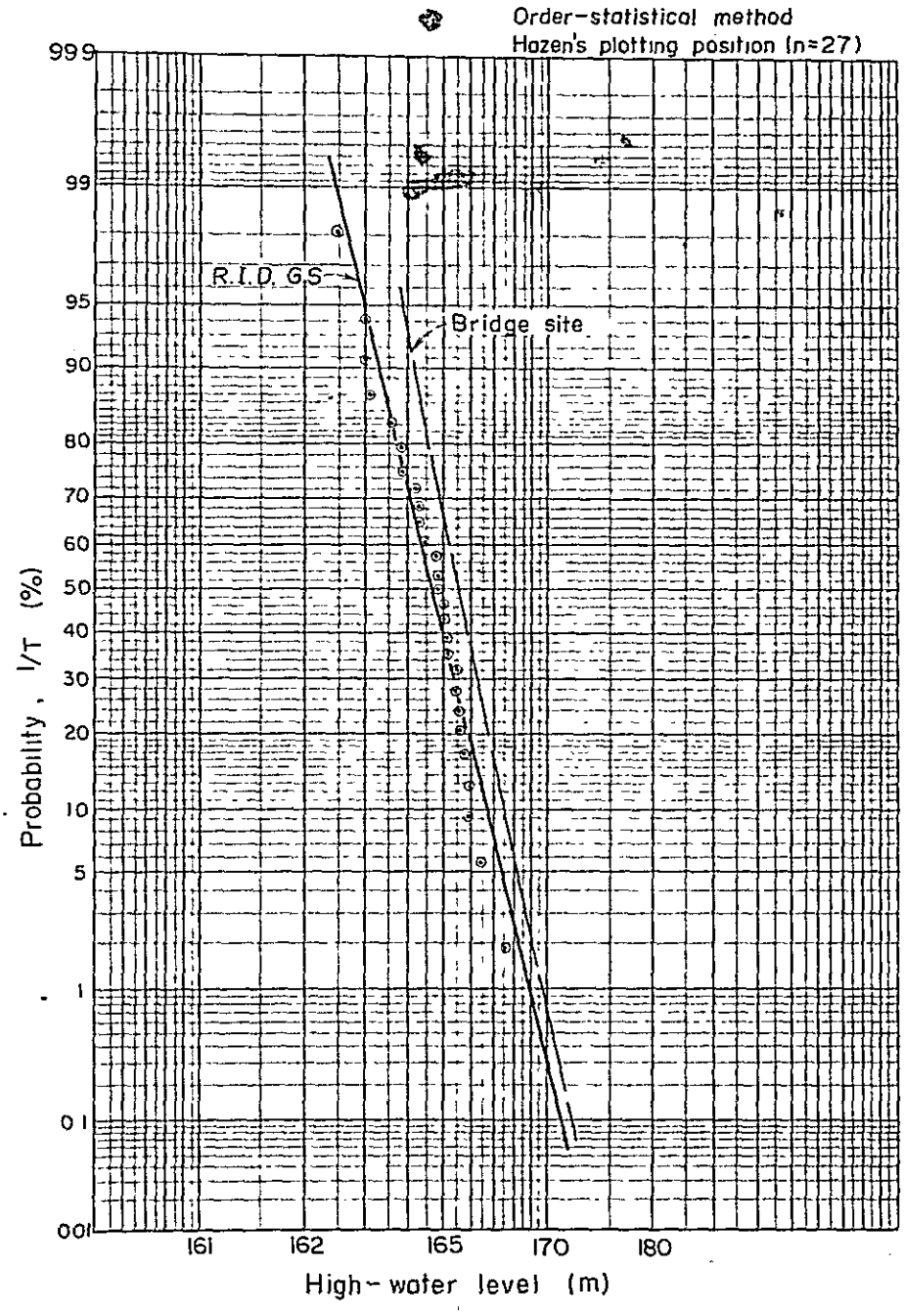
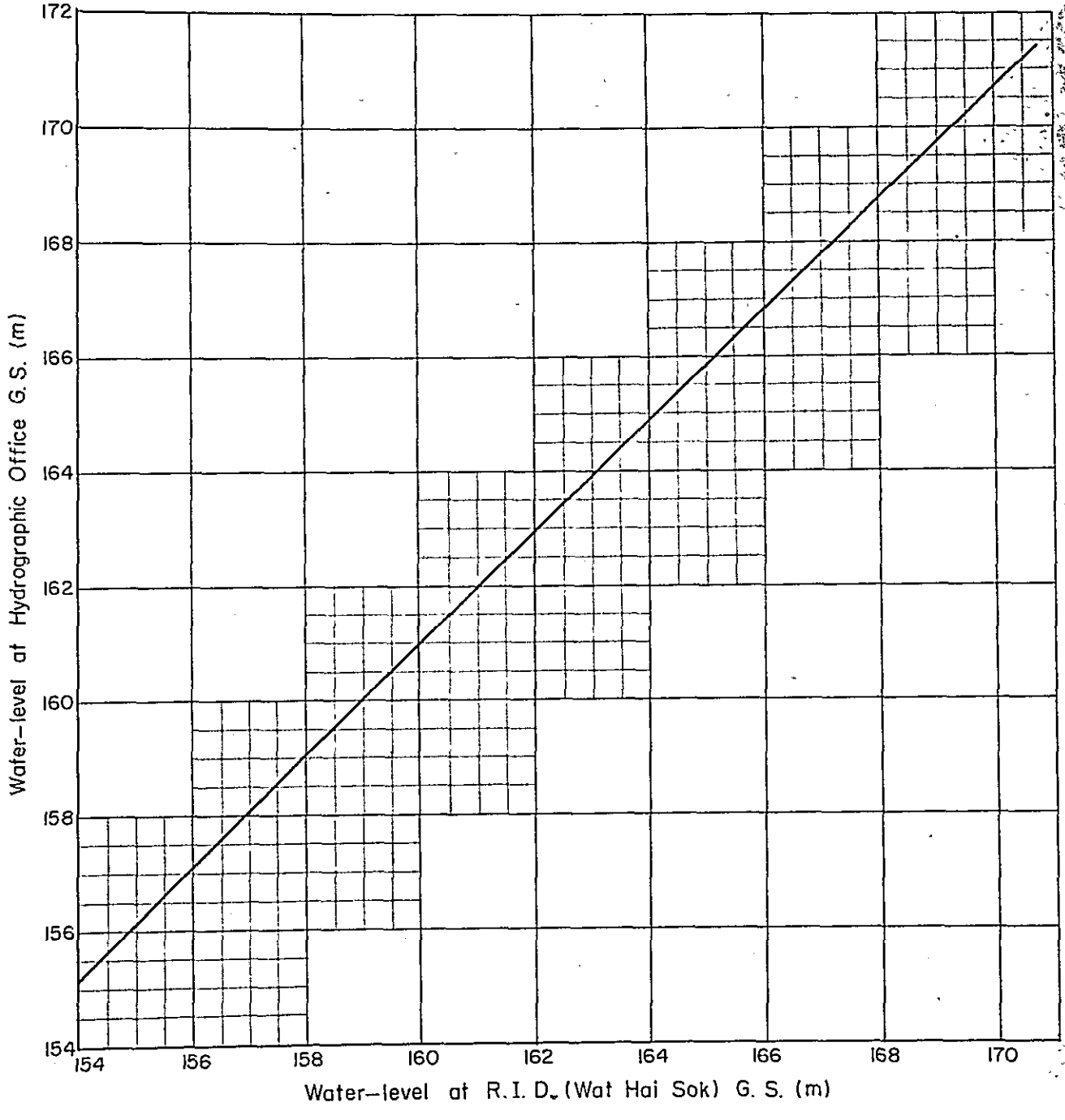


Fig.4.2.2 RELATION OF WATER-LEVEL BETWEEN R.I.D.(WAT HAI SOK) G.S. AND HYDROGRAPHIC OFFICE G. S.



第五章

気象

目次

注．測候所の位置は 93 ページの附図を参照．

Meteorological Data Collected in the First and Second Phase Investigations

Data	Available Period		
	Vientiane	Nong Khai	K.I.D. /1
Air temperature	Jan.'58-Feb.'68*	Mar.'64-Dec.'67	Jan.'65-Apr.'68*
Daily rainfall	Jan.'58-May '68*	Jan.'64-Dec.'67*	Apr.'55-Apr.'68
Relative humidity	Jan.'58-Feb.'68*	Mar.'64-Dec.'67	-
Evaporation	Jan.'58-Feb.'68*	-	-
Prevailing wind direction and wind velocity	Jan.'58-Apr.'68	Feb.'66-Dec.'67	-

Remarks

/1 ..... K.I.D. Meteorological station at Nong Khai

* ..... The data asterished were not compiled in Appendices because they were not available for the meteorological analysis on the Second Phase Report.

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. Annual total: 1157.5 Year 1958

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1									27.6				1
2				3.2	57.6								2
3													3
4					6.9		4.4	19.0					4
5						24.5							5
6					7.4	31.2		16.2	2.8				6
7						3.4	9.0		30.0				7
8							18.0	13.6					8
9							11.5						9
10				10.3				8.1	45.5				10
11					1.4	5.2		17.5	2.6				11
12					4.8	14.6		14.1					12
13					6.7	13.1				4.6			13
14						7.7				14.2			14
15								50.6		6.4			15
16						1.8		2.2					16
17					8.3	52.5			9.5				17
18						8.0		6.4	8.2				18
19						1.5			1.4				19
20							61.2						20
21						10.6	9.0		7.0				21
22					1.5		6.0		2.4				22
23							9.7						23
24					35.3	56.7	11.7						24
25						1.1	2.0	5.5					25
26						40.9							26
27						62.6		34.6					27
28							7.8	70.0					28
29							85.0						29
30					1.8		12.5						30
31								9.1					31
Max				10.3	57.6	62.6	85.0	70.0	45.5	14.2			Max
Days				2	10	16	13	13	10	3			Days
Total				13.5	131.7	335.4	247.8	266.9	137.0	25.2			Total

Unit: m.m

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. Annual total: 1607.2 Year 1959

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	D \ M
1						2.9			7.7				1
2						9.3	7.3	12.1	5.9				2
3		4.3					9.0	3.6					3
4								4.6	34.0				4
5		0.7			2.0		2.6		23.1				5
6									116.5				6
7									10.0				7
8							3.0		122.2				8
9								3.7	60.5				9
10			0.5		12.8		82.4		132.3				10
11							19.2						11
12			0.2				20.3		67.2				12
13									26.8				13
14									25.4				14
15					1.0				16.0				15
16				26.3		0.8	11.0	40.0					16
17					46.8	11.8		18.0					17
18							10.1	1.3	6.7				18
19			0.8				7.3	12.6					19
20							2.2	0.9	57.4				20
21					5.0		2.9	40.7					21
22			5.6	27.6	43.5	7.8			3.9				22
23				9.2	10.9	10.0		1.5					23
24					21.5	0.3	13.9	25.6	3.6				24
25							2.2	7.8	8.2				25
26			2.8					3.2					26
27			1.3		20.5	16.6	34.5	11.8					27
28						23.7	9.7	44.5					28
29							1.1	8.1					29
30							59.0						30
31					15.6								31
Max		4.3	5.6	27.6	46.8	23.7	82.4	44.5	132.3				Max
Days		2	6	3	9	9	18	17	18				Days
Total		5.0	11.2	63.1	179.6	83.2	297.7	240.0	727.4				Total

Unit: mm

N. F. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D.(Nong Khai)

El. Annual total: 1616.5 Year 1960

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	D \ M
1		3.4			3.0		1.7			4.3			1
2								3.2		1.8			2
3					12.5	62.0	53.1	42.1	0.2				3
4						9.0	10.1		8.5				4
5						0.6			4.2				5
6								5.4	11.8				6
7								23.0	54.0				7
8					4.9			34.0	152.8				8
9						12.1		38.7	19.4				9
10					19.1				2.5				10
11		4.6				2.0	18.4	2.0	20.5				11
12		4.4	8.3				20.0	3.5					12
13							4.0	25.1		18.3			13
14								14.5	45.2	8.5			14
15					3.1	1.3	15.2						15
16						0.7	13.5	4.9		3.5			16
17					1.4			8.1					17
18					3.8			52.7					18
19								66.7	13.1				19
20					39.4		17.5	14.1		23.0			20
21					3.7	8.7							21
22			7.0		20.3		26.2	44.6	4.8				22
23					13.3		1.5	2.0	26.3				23
24				4.2	17.0	5.8	16.9	58.2	5.5				24
25		3.0	2.4				27.7	3.2	11.8				25
26		1.0				1.3		3.0	8.9				26
27			34.7						31.6				27
28						8.1		3.8	9.3				28
29				14.3			35.6	0.5	12.6				29
30						1.3		24.9					30
31							23.1	9.7					31
Max		4.6	34.7	14.3	39.4	62.0	53.1	66.7	152.8	23.0			Max
Days		5	4	2	12	12	15	24	19	6			Days
Total		16.4	52.4	18.5	141.5	112.9	284.5	487.9	443.0	59.4			Total

Unit: mm

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R. I. D. (Nong Khai)

El. Annual total: 1686.5 Year 1961

M / D	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1			11.4				2.2		15.7	43.4			1
2								2.1	19.1	4.6			2
3					24.6								3
4			0.6					20.5	13.1				4
5						7.6		7.5	26				5
6			0.3				1.6	9.7	1.1				6
7			11.4			1.2	2.8		20.8				7
8						9.0	2.5		9.4				8
9				20.9		10.7	6.4	7.6	105.7	77.6			9
10						14.7	7.5		1.7				10
11				9.1	26.3	7.6		5.3	3.5				11
12						17.6		4.3					12
13						8.9		26.6	4.2				13
14						8.5		4.8	16.2				14
15						0.5		28.7	5.2				15
16						3.7	1.9		8.5				16
17					33.8	18.4	6.3	1.4	16.4				17
18					38.4		33.3		15.2				18
19				3.8	0.6		16.2	24.1	20.4				19
20					7.6		0.4	6.0	8.2				20
21					60.6		2.2	144.1	44.7				21
22					0.4								22
23						2.1		0.3					23
24					65.2	17.8			11.2				24
25					1.6	38.5			72.0				25
26				5.6		0.8		37.5	3.2				26
27					19.7	0.5	8.6	2.4					27
28					16.0		14.5	2.5					28
29		8.5			2.2	30.4	10.3	14.9	23.9				29
30				13.5	0.2		2.2		5.9				30
31							53.3	9.7					31
Max		8.5	11.4	20.9	65.2	38.5	53.3	144.1	105.7	77.6			Max
Days		1	4	5	14	18	17	20	24	3			Days
Total		8.5	23.7	52.9	297.2	198.5	172.2	360.0	447.9	125.6			Total

Unit: m m

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. Annual total: 1857.7 Year 1962

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1			1.6		4.6	49.7	48.2	21.9	2.6				1
2			0.2				0.8	12.6	5.3				2
3				10.9	4.6	1.6		31.4	33.4				3
4						12.9		11.5	5.8	13.9			4
5				2.4	16.9	4.7			0.7	8.9			5
6			1.0					9.2		79.1			6
7								45.1		11.4			7
8					56.9			13.3		29.6			8
9			0.7			24.4			8.3				9
10			11.1			20.0	11.5	5.5	10.6	1.2			10
11						0.8	6.7	60.0	17.3	0.8			11
12				19.3	14.2	29.5	4.7	35.6				1.3	12
13							48.0	11.5	4.4				13
14							31.8			10.7			14
15						4.2	38.6						15
16		5.2					1.4		0.5				16
17			9.3			68.6	3.0	12.4	21.6				17
18		10.0			73.9	28.7	16.2	3.1	19.2				18
19		1.3				5.7	27.1	29.0	0.1				19
20				0.1			1.6	13.3					20
21					20.0			6.3					21
22				5.5	26.5				74.5				22
23				6.9			0.6	20.0	19.7				23
24				10.0	4.3	1.5	16.3	2.4	21.0				24
25				6.4	2.3		4.3	39.4	0.7				25
26						19.7		28.6					26
27			2.4	2.9					29.8				27
28				1.2					40.8				28
29				26.2					1.2				29
30				22.5	3.2	0.2		6.8					30
31					5.8		5.7	35.4					31
Max		10.0	11.1	26.2	73.9	68.6	48.2	60.0	74.5	79.1		1.3	Max
Days		3	7	12	12	15	17	22	20	8		1	Days
Total		16.5	26.3	114.3	233.2	272.2	266.5	454.3	317.5	155.6		1.3	Total

Unit: MM

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. Annual total: 1308.0 Year 1963

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	D / M
1							0.2	5.3	2.4				1
2						1.0		0.8					2
3					12.6	40.4	1.6		2.8				3
4						38.6	29.8						4
5					11.7		0.2	2.0	13.0	24.0	18.6		5
6					12.4	1.4		21.1		2.3			6
7				75.0				20.6		0.7	4.5	1.1	7
8					1.3	7.7		25.9	4.3			0.8	8
9			0.4			48.2			33.1		41.5		9
10						33.8	0.5		37.4				10
11								6.2					11
12						2.2	3.4	11.4	0.5				12
13							14.9	0.8					13
14													14
15			0.7			27.9	24.3						15
16				1.3	1.1	6.2			6.0				16
17				1.3			1.7		11.7				17
18				4.0	15.8		3.7	6.1	55.9				18
19				2.2	64.8		5.5	12.4	8.3				19
20					5.5	38.5	7.6						20
21							6.8						21
22							2.7	4.1	6.3				22
23							3.0	11.2					23
24		0.7			17.8		16.1	0.5	4.0				24
25					0.8		33.1	0.7					25
26					33.3	42.6	9.7	36.0	3.6	4.4			26
27							6.4	3.9		18.1			27
28				15.9	2.6	6.7		1.5		0.2			28
29							4.9			9.7			29
30					10.7		56.7						30
31							24						31
Max		0.7	0.7	75.0	64.8	48.2	56.7	36.0	55.9	24.0	41.5	1.1	Max
Days		1	2	6	13	13	22	18	14	7	3	2	Days
Total		0.7	1.1	99.7	190.4	295.2	235.2	170.5	189.3	59.4	64.6	1.9	Total

N. K. Form No. 1101

Unit. m m

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. Annual total: 1585.5 Year 1964

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	D \ M
1				3.5	29.3				15.0	20.0			1
2					0.7		5.7		1.5	3.4			2
3					59.0	6.3	8.4		25.6	25.7			3
4					25.1		8.7	25.7	13.0	3.4			4
5						8.9			11.0				5
6						23.7		2.5	21.2				6
7			1.7			7.1	34.5	3.1	8.4				7
8				6.0	14.5		2.5			24.9			8
9						3.1		7.2		6.4			9
10				7.7	1.2			3.7		15.6			10
11				15.0	4.3	1.8	65.0						11
12				14.0		4.3			4.0				12
13				21.0		1.3		50.0	27.0	6.3			13
14			3.0				8.4	9.8					14
15					2.0	46.0		2.3	28.8	13.5			15
16					0.7	3.3			5.5				16
17				22.1			3.7		18.3				17
18					21.8	7.5			41.9				18
19									11.2				19
20			8.8			42.0							20
21				4.2	69.7	3.8	37.2	12.0					21
22			6.3			0.4	15.0	0.9	0.7	8.0			22
23					49.2	5.7		16.0	8.9	20.1			23
24				9.8	9.8			1.7		11.2			24
25					23.1	7.4	0.5	42.5					25
26						33.7		4.6					26
27					17.2	0.2		3.7	26.2				27
28				14.5	18.9	2.1		1.2	0.5				28
29					27.1			38.5					29
30				2.6	4.3			0.6					30
31								16.0					31
Max			8.8	22.1	69.7	46.0	65.0	50.0	28.8	25.7			Max
Days			4	11	18	19	11	19	18	12			Days
Total			19.8	120.4	377.9	208.6	189.6	242.0	268.7	158.5			Total

Unit: m m

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. Annual total: 1339.8 Year 1965

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	D \ M
1					1.9			6.6					1
2	5.2								26.7				2
3									1.6				3
4						5.2	10.0	4.2	5.0		2.2		4
5				16.6		5.7			0.9	4.0			5
6				2.0		13.1	7.9		6.3.3				6
7					0.2	2.9		0.6	20.5				7
8				15.1		1.5		1.0	5.6	3.2			8
9						2.2			55.0				9
10						3.7				3.5			10
11				2.8		32.1	21.8		5.5.5	1.9			11
12						9.8	11.4						12
13					8.7	2.3		65.6	20.3				13
14						10.4			10.8				14
15					1.0	44.2							15
16					118.0	59.1		1.4					16
17								1.5					17
18				33.7		2.3		14.6					18
19						0.3		14.5					19
20					4.2	32.2		29.1	11.5				20
21						9.1	57.8	16.0	1.1				21
22				40.5		8.2		1.8					22
23					0.4	1.4	9.2	56.2					23
24				36.5			8.7		14.3	7.2			24
25				0.8			1.5			0.7			25
26				12.9			6.4	19.2					26
27					2.1	0.4	14.2	0.7		2.5			27
28					16.8	12.1		0.9					28
29					2.6	12.3	12.2	4.5					29
30					4.1	11.8							30
31					14.6								31
Max	5.2			40.5	118.0	59.1	57.8	65.6	63.3	7.2	2.2		Max
Days	1			9	12	23	11	17	14	7	1		Days
Total	5.2			160.9	174.6	282.3	161.1	238.4	292.1	23.0	2.2		Total

Unit: m m

N K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. Annual total: 1529.7 Year 1966

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1				0.2			2.3	16.6					1
2							12.9	35.6	12.2				2
3			7.6		58.5	3.4	3.4	17.5					3
4					1.7	15.0	2.8	10.8					4
5				2.5		6.5.0		7.7					5
6					3.0.0	5.4			10.7				6
7								2.8					7
8						0.6		0.6					8
9					14.3	10.1		2.0	20.5	15.7			9
10								6.0		2.8			10
11								71.6					11
12				1.7				6.4					12
13				14.3			22.7		5.5				13
14					15.1				25.3				14
15					10.9	3.6.2	3.0.0	22.5	0.8				15
16				5.0	4.2.8		3.2	1.5.8.5					16
17					7.9		3.1						17
18					21.2		1.1						18
19					21.0	3.3.3	17.2						19
20				0.6	5.7		10.2	5.4					20
21				8.1.4			3.5	37.3					21
22						2.5.5	2.5	30.3					22
23					1.2.0		1.8.6	11.2					23
24				12.4	11.5			5.6					24
25					30.1	5.6		4.2		35.4			25
26					15.5	1.8		15.7		14.6			26
27				13.8	21.7	2.5		21.0					27
28							16.9	5.4					28
29						1.2	0.8						29
30								71.8					30
31								2.5					31
Max			7.6	81.4	58.5	65.0	30.0	158.5	25.3	35.4			Max
Days			1	9	16	13	16	24	6	4			Days
Total			7.6	131.9	319.9	205.6	151.2	569.0	75.0	68.5			Total

Unit: m m

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R.I.D. (Nong Khai)

El. Annual total: 1326.4 Year 1967

M / D	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1			1.2		22.3								1
2			19.0			1.9	26.3						2
3						6.0							3
4						0.2	2.6	0.1					4
5						3.2	3.5						5
6				4.0		21.8			3.4				6
7						4.3	2.0	4.5					7
8			7.2		0.2	26.2		12.9					8
9						0.5	20.9	5.2					9
10					9.5		11.0	24.0	16.3				10
11						3.2		5.8			17.3		11
12				3.0		11.0	4.8	2.3			4.5		12
13				22.0	0.5		25.0	3.5					13
14													14
15				18.1			26.2						15
16					13.5		10.0		36.8				16
17			4.5	2.5	14.7				18.8				17
18					21.3								18
19					4.1			49.1	27.0				19
20			16.1			53.5		221.2	8.4				20
21				0.4				7.0	31.8				21
22				52.5			12.3	56.9	2.8				22
23		2.6					2.9	3.4					23
24							13.5	11.7					24
25						0.5	3.8	2.2					25
26				47.5			11.9	2.5	20.8				26
27						0.3		4.7	3.6				27
28					2.8	62.0		21.0					28
29					12.2	3.0		8.4					29
30													30
31			12.2										31
Max		2.6	19.0	52.5	22.3	62.0	26.3	221.2	36.8		17.3		Max
Days		1	6	8	10	15	15	14	10		2		Days
Total		2.6	60.2	150.0	101.1	197.6	176.7	446.4	169.7		21.8		Total

Unit: mm

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R.I.D. (Nong Khai)

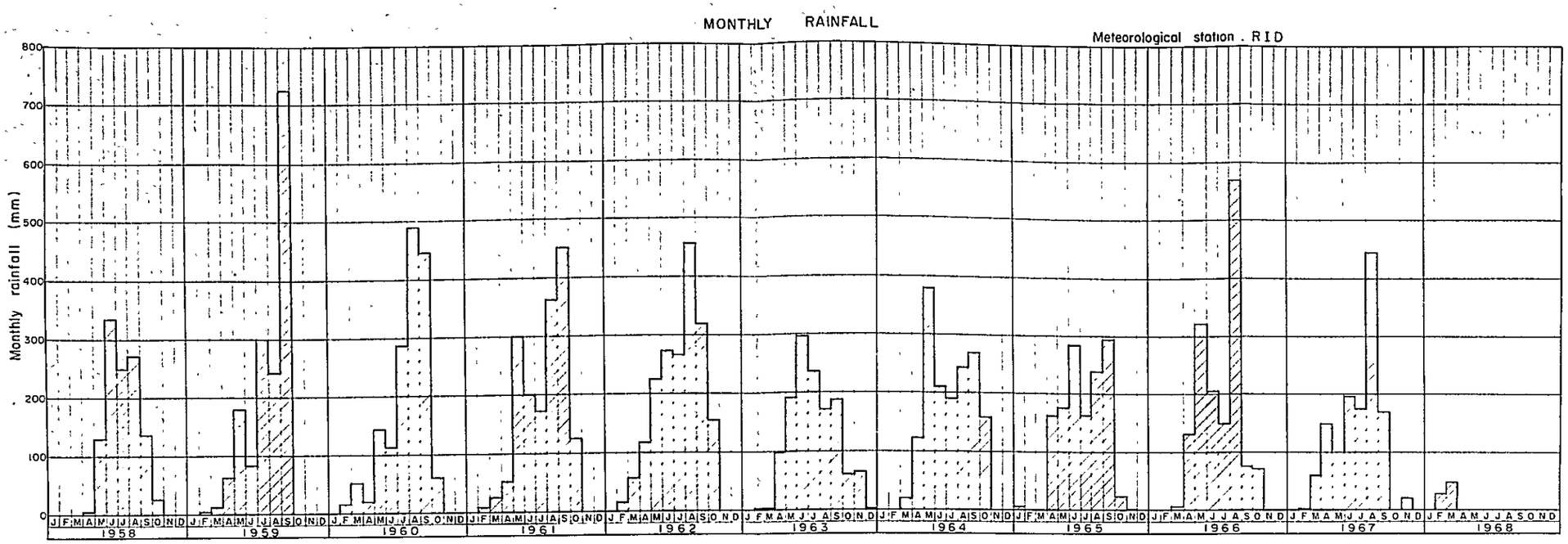
El. Annual total: Year 1968

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1													1
2													2
3													3
4				2.7									4
5				19.5									5
6													6
7			25.0	23									7
8			3.2										8
9													9
10			1.0										10
11													11
12			3.5										12
13													13
14													14
15				25.2									15
16													16
17													17
18													18
19													19
20													20
21													21
22													22
23													23
24													24
25													25
26													26
27													27
28													28
29													29
30													30
31													31
Max			25.0	19.5									Max
Days			4	4									Days
Total			32.7	49.7									Total

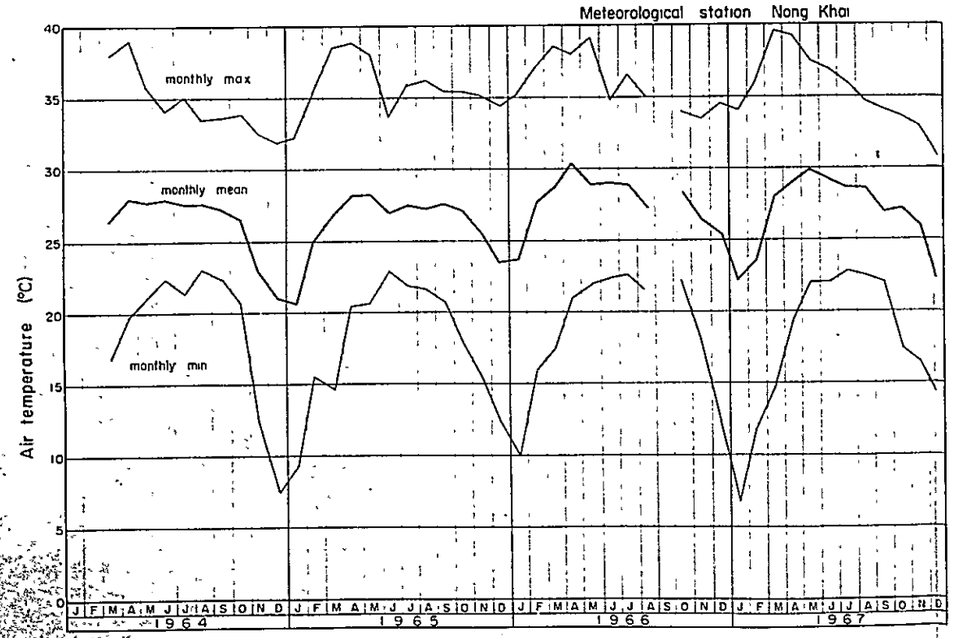
Unit: m.m.

N. K. Form No. 1101

RAINFALL, AIR TEMPERATURE AND RELATIVE HUMIDITY

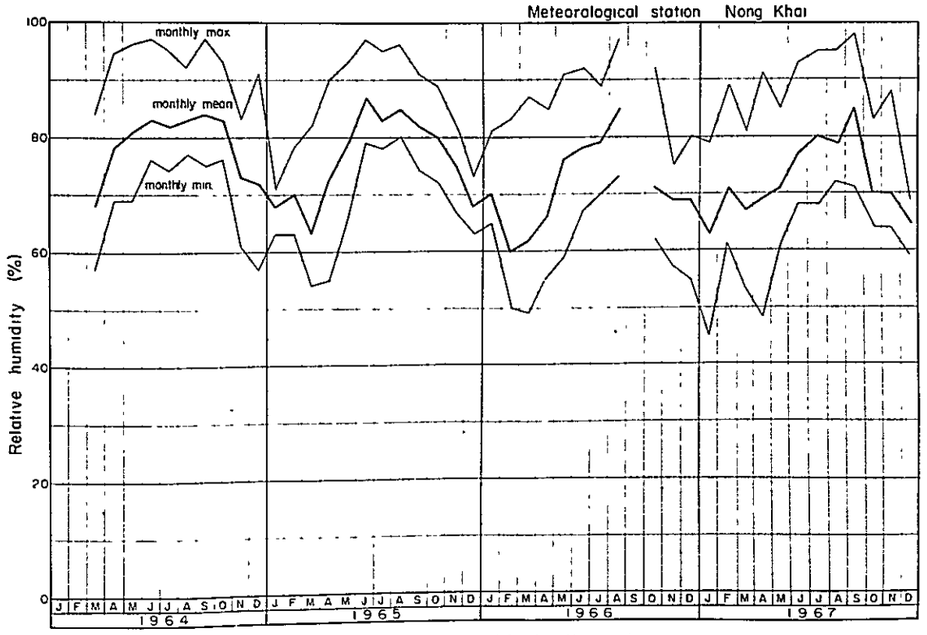


AIR TEMPERATURE



Remarks These lines are described based on the daily-max, daily-mean and daily-min air temperature records
It was due to flood that records in September 1966 were not registered

RELATIVE HUMIDITY



Remarks These lines are described based on the daily-mean relative humidity records
It was due to flood that records in September 1966 were not registered

Daily Prevailing Wind Direction and Mean Wind Velocity at Nonthaburi Meteorological Station

Year: 1966

Date	Jan/1		Feb.		Mar.		Apr.		May		Jun.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1			W	0.6	NE	1.4	SE	1.9	SE	2.3	SW	1.2
2			W	0.5	NE	2.1	SW	1.6	SE	1.4	SW	2.3
3			W	0.6	SE	0.6	SW	1.2	E	3.3	SW	1.2
4			W	0.6	SW	1.0	SE,SW	1.2	NE	1.2	SW	1.2
5			E	1.0	W	0.6	SW	1.4	SE	1.2	SW	1.2
6			NE	1.9	N	1.0	E	1.9	SW	1.2	SW	0.6
7			E	1.0	SW	0.8	SW	1.4	NE	1.2	SW	1.2
8			E	0.8	N	2.3	NE	1.6	NE	1.2	SW	1.9
9			E	1.0	NE	0.4	SW	1.2	SW	1.6	SW	1.6
10			W	1.2	S	1.2	NE	1.9	SW	2.0	SW	1.9
11			NE	0.6	NE	0.8	N	1.0	SW	1.2	SW	1.9
12			NE	2.3	NW	1.0	NE	2.1	SW	1.6	SW	2.5
13			SE	2.3	W	1.0	SW	1.4	SW	1.0	SW	2.5
14			E	1.6	NW	1.2	SW	1.4	SW	2.3	S	1.4
15			W	1.0	W	1.4	SW	1.4	L	1.2	SW	1.2
16			W	0.8	W	1.0	SW	1.6	SW	1.2	SW	1.0
17			W	0.8	E	1.2	S,W	1.9	SW	2.7	SW	1.0
18			NE	1.0	SW	1.0	NE	3.9	SW	2.5	NE	2.9
19			W	1.4	SE	2.4	SW	1.2	SW	1.6	SW	1.6
20			W	0.8	E	1.6	SW	2.7	NE	2.9	SW	1.0
21			NE	0.8	SW	1.2	E	3.5	E	3.9	SW	1.9
22			SW	1.4	SW	2.9	NE	0.8	E	1.0	SW	1.2
23			E	3.7	SW	1.0	W	1.0	SW	0.8	SW	2.5
24			NE	2.1	SW	1.0	SW	1.4	SW	2.7	SW	1.0
25			W	0.8	SW	1.0	SW	1.0	E	1.2	SW	1.4
26			NE	1.2	E	2.3	SW	2.1	NE,SW	3.5	SW	1.0
27			NE	1.6	E	2.5	SW	2.1	SW	1.4	SW	0.6
28			E	1.2	SE	1.0	SW	0.8	SW	1.6	NE,SW	1.2
29					SW	1.0	SW	1.2	SW	1.5	SW	1.2
30					E	2.0	NE	3.1	SW	1.8	SW	2.1
31					E	1.2			SW	1.2		

/1 : No available data in January

Abbreviation:

Dir. ..... Prevailing direction

Vel. ..... Mean wind velocity in m/sec.

- continued

Year: 1966

Date	Jul.		Aug.		Sep./1		Oct.		Nov.		Dec.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	SW	0.4	E	1.4	-	-	NE	1.3	WE	2.4	NE	3.6
2	SW	1.0	SW	2.1	-	-	NE	0.4	E	3.5	NE	5.6
3	SW	1.6	NE	0.6	-	-	NE	0.6	NW	1.0	NE,SW	0.5
4	SW	1.2	SE	1.0	-	-	NE	1.6	NE	1.2	N	0.7
5	SW	1.4	SW	0.6	-	-	NE	0.9	NE	2.1	NE	0.7
6	SW	1.2	W	0.8	-	-	NE	1.8	SW	4.7	E	0.8
7	SW	1.0	SW	0.8	-	-	NE	1.3	NE	0.6	N	0.5
8	SW	1.6	SW	2.3	-	-	NE	0.9	NE	0.2	NE	0.2
9	SW	1.6	SW	0.4	-	-	NE	0.8	NE	0.1	NE	0.2
10	SW	1.2	SW	1.2	-	-	E	0.9	NE	0.4	NE	0.4
11	SW	1.0	SW	0.8	-	-	W	2.1	NE	0.3	E	0.6
12	SW	1.4	SW	1.0	-	-	NE	0.7	E	0.4	NE	1.1
13	SW	1.6	SW	1.0	-	-	SW	0.8	E	0.4	NE	0.7
14	SW	1.4	SW	1.2	-	-	SW,NE	0.6	E	0.9	NE	0.4
15	NW	1.2	SW	1.4	-	-	E,W	1.0	NE	1.1	E	0.5
16	SW	0.8	SW	1.0	-	-	E	0.8	NE	0.3	E	0.5
17	NE,SW	1.4	NE	1.2	-	-	NE	1.5	NE	1.5	ESE	0.2
18	S	1.4	SW	1.0	-	-	NE	1.8	NE	0.9	NW	0.4
19	E	1.4	W	2.5	-	-	NE	2.5	NE	0.4	W	0.2
20	SW	2.1	SW	1.6	-	-	NE	1.9	NE	0.9	E	0.4
21	SE,SW	1.4	SW	1.2	-	-	NE	2.4	NE	3.9	E,S	1.1
22	SW	1.4	SW	2.9	-	-	NE	1.4	NE	1.8	W	0.8
23	SW	1.4	SW	1.0	-	-	SW	1.2	NE	0.4	N	0.2
24	SW	1.6	C	1.0	-	-	SW	0.8	NE	0.5	ENE	0.8
25	SW	2.9	SW	1.0	-	-	SE	0.6	NE	1.1	NE	0.7
26	NW,SW	3.3	SW	2.3	-	-	E	1.8	NE	2.3	NE	0.7
27	SW	2.8	SW	2.5	-	-	E	1.0	NE	0.2	NE	1.8
28	SW	1.0	SW	0.8	-	-	E	1.8	ENE	0.2	NE	1.1
29	SW	1.9	E	1.0	-	-	NE	1.4	NW	0.6	NE	0.2
30	SW	1.9	SW	2.1	-	-	NE	0.6	NE	2.6	NE	0.4
31	SW	1.9	SE	1.2	-	-	NE	1.1			NE	0.6

/1 : No observation due to flood in September.

Abbreviation:

Dir. ..... Prevailing direction

Vel. ..... Mean wind velocity in m/sec.

Daily Prevailing Wind Direction and Mean Wind Velocity at Nong Khai Meteorological Station

Year: 1967

Date	Jan.		Feb.		Mar.		Apr.		May		Jun.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	NE	1.2	NW	2.1	NE	1.4	SW	1.0	S	1.1	SE	1.4
2	NE	3.1	E	1.4	SE	1.4	SW	1.2	S	1.3	SE,SW	1.2
3	NE	6.4	E	4.0	W	1.0	SW	1.9	W	1.2	SW	1.0
4	NE	3.0	NE	0.8	W	1.2	SW	1.0	N	1.4	SW	1.0
5	NE	1.5	NE	2.7	SE	1.6	SE	2.9	SW	0.8	SE	1.4
6	C	0.4	NE	3.5	SE	4.5	SE	1.2	S	1.4	E	1.2
7	C	0.7	NE	1.6	SE	3.1	SW	1.4	C	1.3	SW	1.2
8	NE	1.4	NE	1.0	SE	1.2	SW	0.8	SE	4.7	W	1.2
9	C	0.5	E	1.2	E	1.9	SW	1.4	SW	1.4	SE	3.5
10	NE	1.2	NE	1.0	E	2.7	SW	1.2	SE	1.6	SW	1.0
11	NE	3.7	SE	3.1	E	1.0	SW	1.2	SE	1.9	E	1.4
12	NE	1.2	NE	2.3	E	1.0	SW	1.9	W	0.6	E	1.4
13	NE	2.5	SE	1.0	E	1.2	SW	1.2	SW	1.6	SE	0.8
14	NE	0.7	NE	3.7	E	1.2	SW	1.4	SE	2.5	SW	0.8
15	NE	1.8	NE	1.9	E	2.1	E	2.1	SE	1.6	W	1.2
16	NE	2.8	NE	1.2	C	0.6	C	0.8	SE	4.1	SW	1.2
17	NE	2.2	NE	2.3	NE	1.2	SE	1.9	E	4.5	SW	2.1
18	NE	1.5	NE	3.1	C	0.6	SW	1.0	E	1.6	SW	2.1
19	SE	0.4	NE	1.2	SE	0.6	SW	1.9	W	2.5	SW	2.1
20	NE	0.8	NW	1.0	SW	0.8	SE,SW	1.6	SW	1.9	SW	1.9
21	E	1.0	C	0.6	S	0.8	SE	2.4	SE	0.8	SE,SW	1.0
22	E	0.8	NW	0.6	C	0.6	SW	1.8	SW	4.4	SW	1.2
23	C	2.7	W	1.0	C	0.2	SW	1.2	SW	4.1	W	1.2
24	SE	0.6	SE	1.0	E	1.9	SE	1.0	SW	2.3	SW	1.4
25	SW	0.5	E	1.4	E	1.9	SE	1.6	SW	2.4	E	1.0
26	SW	2.1	E	5.2	NW	0.8	SE,SW	2.1	SW	2.0	SW	2.5
27	SW	1.0	SE	4.7	W	0.8	SE	1.9	SW	0.8	SE	2.3
28	SW	1.0	E	2.1	SW	1.2	S	1.3	SE	3.7	SE	1.9
29	SW	1.0			SW	1.2	S	0.6	SW	1.9	SW	2.1
30	E	0.8			SW	0.8	SSW	1.2	SW	1.2	SW	1.4
31	NE	5.2			SW	1.2			SW	2.7		

Abbreviation:

Dir. ..... Prevailing direction

Vel. ..... Mean wind velocity in m/sec.

- continued

Year: 1967

Date	Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	SW	1.4	SW	1.9	SW	2.5	NE	1.4	E	2.9	NE	1.2
2	E	0.8	SW	3.3	SW	1.2	E	1.6	NE	4.3	NE	0.8
3	E	1.0	SW	4.3	SW	2.7	E	2.0	NE	4.0	NE	0.6
4	C	1.2	SW	3.1	W	2.1	NE	2.0	NE	2.4	NE	0.5
5	SW	2.5	SW	2.5	NE	1.2	E	1.2	NE	4.2	NE	0.3
6	SW	3.1	SW	2.1	SW	1.0	E	1.2	NE	2.9	NE	0.7
7	SW	1.2	SW	2.3	E	0.6	NE	1.2	NE	3.2	NE	1.0
8	SW	1.2	SW	1.0	NE	1.6	NE	0.8	NE	3.3	NE	1.2
9	SE	1.0	E	1.2	NE,SW	1.6	W	1.2	NE	2.1	NE	0.6
10	SW	1.2	E	1.2	NE	1.0	SW	0.8	NE	2.9	E	1.4
11	E	1.0	E,W	1.0	N	0.8	E	1.6	NE	5.2	E	0.6
12	SE,SW	1.6	SW	1.2	NE	0.6	SW	1.0	E	9.5	NE	1.0
13	SW	1.6	W	1.6	W	0.6	E	0.8	E	4.6	E	1.6
14	SE,SW	1.4	SW	2.0	W	0.6	E	0.8	NE	4.9	NE	0.6
15	E	1.0	W	1.0	NE	1.2	E	1.9	NE	3.2	NE	0.4
16	E	0.4	SE	1.2	E	1.2	W	1.0	NE	2.8	NE	0.4
17	SW	1.0	SW	1.6	NE	1.2	W	1.2	NE	3.2	NE	0.8
18	SW	1.4	SW	1.4	NE	1.2	E,W	0.8	NE	2.9	NE	0.6
19	S,W	1.4	SW	1.2	SW	0.8	NE	1.0	NE	2.9	NE	0.4
20	W	1.6	E	0.8	SW	2.1	E	1.0	NE	2.5	NE	0.3
21	NE	1.6	SW	1.4	SW	1.0	NE	1.2	NE	2.8	NE	0.3
22	E	1.2	SW	1.2	E	0.6	NE	1.6	NE	2.5	NE	0.3
23	W	1.4	SW	2.3	SE	1.4	NE	1.0	NE	2.5	NE	0.5
24	SW	1.4	SW	1.4	E	0.6	NE	2.1	W	2.1	NE	0.3
25	SW	1.9	E	1.0	E	0.8	NE	0.8	NE	3.1	NE	0.3
26	SW	1.2	W	0.8	E	1.0	NE	1.2	NE	2.8	NE	0.3
27	SW	1.4	E	2.3	E	1.4	NE	1.2	NE	0.8	NE	0.3
28	SW	3.1	SW	1.2	E	0.8	NE	1.2	NE	1.2	NE	0.3
29	SW	1.4	SW	3.1	C	0.2	NE	0.8	E	3.1	E	0.5
30	NE	1.2	W	1.9	W	1.0	W	1.2	E	3.1	NE	0.4
31	SW	1.2	SW	1.6			NE	0.8			NE	0.4

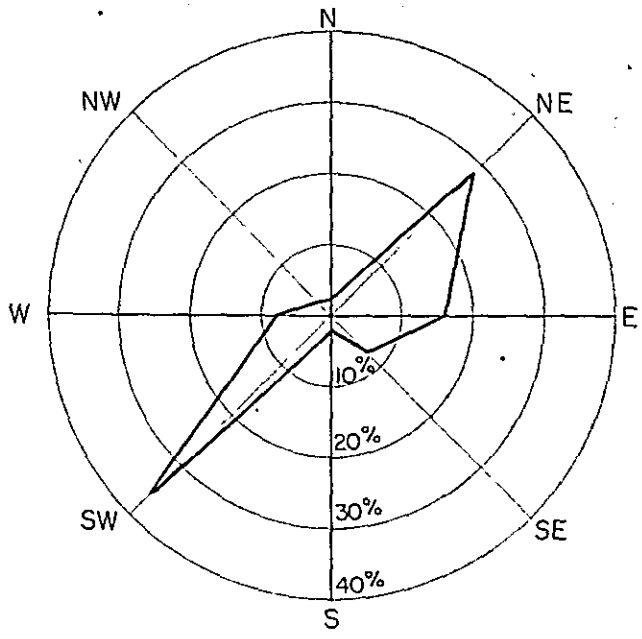
Abbreviation:

Dir. ..... Prevailing direction

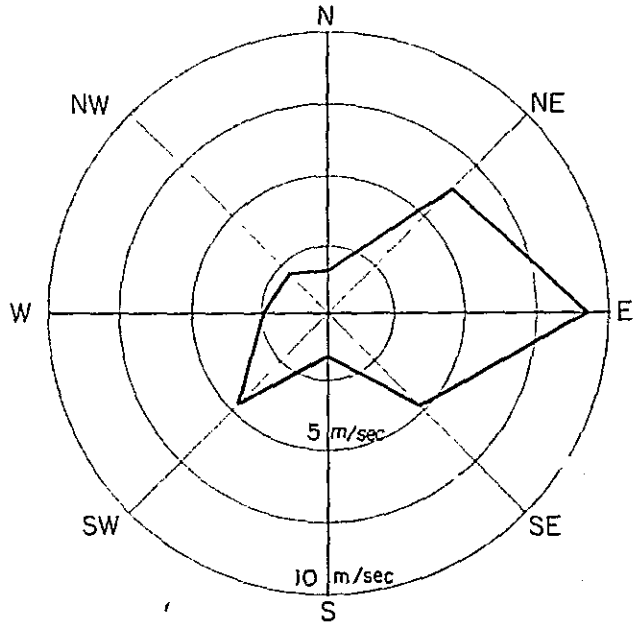
Vel. ..... Mean wind velocity in m/sec.

WIND DIAGRAM

Meteorological station : Nong Khai
Period : Feb. 1966 to Dec. 1967



DAILY PREVAILING DIRECTION



MAX WIND VELOCITY

Monthly Max. Wind Velocity and Its Direction at Vientiane Meteorological Station

Period : 1959 to 1968

	1959		1960		1961		1962		1963	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Jan.	ENE	5	ENE	4	SSW	4	SSE	3	SW	7
Feb.	NNW	4	E	8	E	3	ENE	3	E	4
Mar.	Var.	-	NW	4	ESE	4	E	3	Var.	-
Apr.	Var.	-	S	10	S	10	SSW	8	Var.	-
May	Var.	-	ENE	5	NNE	8	NW	3	SSE	3
Jun.	Var.	-	E	4	SW	4	N	3	N	3
Jul.	WNW	13	NE	3	ENE	6	W	8	SW	3
Aug.	WNW	5	ESE	4	SSW	3	ENE	8	N	3
Sep.	WSW	6	NE	4	WNW	3	W	4	WSW	4
Oct.	NE	5	SE	5	WNW	5	NE	1	SE	2
Nov.	E	5	ESE	3	NNW	4	N	6	N	2
Dec.	ESE	8	ENE	5	N	2	NNE	5	N	2

	1964		1965		1966		1967		1968	
	Dir.	Vel	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Jan.	ESE	3	E	3	NNW	4	E	8	SE	3
Feb.	SSW	6	S	3	NE	4	E	4	E	8
Mar.	ESE	3	S	4	W	4	S	9	ESE	27
Apr.	NNW	4	W	4	N	10	SSE	8	SSE	8
May	S	4	W	10	NE	4	N	9		
Jun.	NNW	4	N	3	NNW	4	NNW	7		
Jul.	SSE	3	W	8	SE	5	W	8		
Aug.	S	3	NW	20	N	3	SW	6		
Sep.	S	3	W	4	S	4	SW	7		
Oct.	SW	2	NE	7	ESE	4	ESE	6		
Nov.	W	3	E	4	N	S	E	6		
Dec.	SE	3	-	-	-	-	E	3		

Remarks : Dir. = Wind direction

Vel. = Monthly max. wand velocity in m/sec

第 六 章

経 済 調 査

ここに与えられる資料は将来交通量及び便益推定の対象となる地域から集められた一般経済資料である。

目 次

Population of Vientiane City in 1966

(by Census in 1966)

	Male	Female	Total
Laotian	50,348	45,768	96,116
Foreigner	18,518	17,619	36,137
Total	68,866	63,387	132,253

Population of Nong Khai Prefecture in 1966

(by Bureau of Statistics of Nong Khai Prefecture)

District	Population
Nong Khai	69,390
Phong Visay	69,789
Muang Kan	55,697
Saika	29,140
Sri Chieng Mai	28,967
Tha Bo	44,850
Total	297,833

Gross National Product of Laos

Year	Estimated gross national product (10^6 US$)				Population (10^3 persons)				Estimated gross national product per head (US$)	
	Laos	Self-supporting economy	Market economy	Vientiane	Laos	Self-supporting economy	Market economy	Vientiane	Self-supporting economy	Market economy
1962	159.6	115.4	44.2	-	2,450	2,082.5	367.5	-	55.43	120.20
1963	166.9 (1.046)	119.4 (1.035)	47.5 (1.075)	-	2,509 (1.024)	2,133 (1.024)	376 (1.024)	-	55.98 (1.01)	126.21 (1.05)
1964	174.5 (1.046)	123.5 (1.034)	51.0 (1.074)	-	2,569 (1.024)	2,184 (1.024)	385 (1.024)	-	56.54 (1.01)	132.52 (1.05)
1965	182.9 (1.048)	127.9 (1.036)	55.0 (1.078)	-	2,635 (1.026)	2,240 (1.026)	395 (1.026)	-	57.11 (1.01)	139.15 (1.05)
1966	187.4 (1.025)	131.0 (1.024)	56.4 (1.024)	18.4	2,698 (1.024)	2,293 (1.024)	405 (1.024)	132	57.11 (1.00)	139.15 (1.00)
1967	196.1 (1.046)	135.5 (1.034)	60.6 (1.074)	19.7 (1.071)	2,765 (1.025)	2,350 (1.025)	415 (1.025)	135 (1.025)	57.68 (1.01)	146.11 (1.05)
1973	261.3 (1.051)	166.9 (1.036)	94.4 (1.078)	30.7 (1.077)	3,207 (1.025)	2,725 (1.025)	482 (1.025)	157 (1.025)	61.23 (1.01)	195.80 (1.05)
1980	630.0 (1.056)	300.6 (1.035)	329.4 (1.076)	108.2 (1.086)	4,880 (1.025)	4,146 (1.025)	734 (1.025)	241 (1.025)	72.51 (1.01)	448.76 (1.05)

Remarks: Figures in the brackets show index to value of the foregoing year.

Major Industries in Laos

Item	Number of factory	Unit	Annual production ($\times 10^3$)						Remarks
			1962	1963	1964	1965	1966	1967	
Match manufactory	1	case	-	-	-	2.5	3.0	3.5	1 case = 7,200 boxes, 1 box = 50 matches
Ciparette manufactory	3	case	-	-	-	40.57	46.0	50.0	1 case = 50 cartoons, 1 cartoon = 10 packages, 1 package = 20 cigarettes
Rubber sandal manufactory	4	dz.	-	-	30	56	72	78	
Fizzy drink manufactory	6	btl.	5,400	5,700	6,300	6,800	7,200	8,000	1 at Saravane, 1 at Savannakhet, 3 in Vientiane, 1 at Luang Prang
Plastic bag manufactory	2	kg.	-	-	-	72.0	72.0	75.0	Polyethylene bags
Mechanical rice-mill	208	ton	-	-	88.2	100	110	110	8 of 1st class capable of annual production of 2,400 tons/year 10 of 2nd class capable of annual production of 1,500 tons/year 190 of 3rd class capable of annual production of 200 tons/year
Textile printing	1	m	-	-	-	-	600	600	
Alcohol distillery	14	litre	-	-	1,200	1,200	1,800	1,800	Small distilleries capable of production from 150 to 200 litres/day
Power sawmill	76	m^3	-	-	150	156	160	200	Sawn wood
Ice manufactory	8	ton	-	-	20	26	30	35	4 in Vientiane, 1 at Luang Prabang, 1 at Savannakhet, 1 at Pakse and 1 at Khammuane
Candle manufactory	3	case	-	36	36	40	40	45	1 case = 100 packages

Export of Laos in 1966

Articles	Weight (kg)	Destination	Amount (Kips)
Musical instrument "Kha drum"	35	England	50,000
Benzoin in bulk and dust	300	U.S.A.	1,700,000
- do -	1,000	France	5,712,400
Tin ore	12,040		3,363,640
Cardamon	114,608	Hongkong	10,008,800
Tin ore	480,700	Penang	218,680,800
Dried cuttle fish	6,680	Thailand	1,649,280
Vegetable	2,000	"	832,000
Dried fruit	580	"	340,000
Green coffee-bean	1,500	"	150,000
Tree-bark "Penak houg"	29,000	"	292,500
Benzoin in bulk and dust	1,800	"	9,529,500
Fruit preserved in can	9,950	"	1,760,000
Other preserved fruit	11,465	"	1,453,200
Crushed stone	1,050,000	"	1,290,000
Raw tin ore	2,000	"	60,000
Monosodium glutamate	6,220	"	2,100,000
Wood only barked and sawn of all kinds	7,087,097	"	37,825,074
Wooden furniture	500	"	20,000
Waste iron	78,126	"	277,000
Waste copper	72,800	"	1,150,000
Green coffee-bean	493,314	Singapore	53,558,080
Cardamom	57,780	"	5,342,400
Paddy bran	18,880	"	37,760
Soya seed	21,440	South Vietnam	343,000
	9,509,815		357,725,434

Import of Laos in 1966

Articles	Weight (kg)	Amount (kips)
Rice and other cereals	42,150,225	2,492,026,152
Foodstuff, sugar and other food preparations	2,077,025	266,133,592
All oil products (aircraft and motor-car gasoline, oil, grease)	81,131,828	1,381,481,563
Structural metal, cement asbestos, cement, bolt and nut, and spanner	19,744,472	587,266,751
Other electric machinery and apparatus	2,039,014	833,092,444
Motor cars, tractors and cycles	2,465,060	1,271,250,396
Total	170,089,248	10,017,158,506

Level of Monthly Consumption in Nong Khai and Vientiane

(Unit: tons)

	Gasoline	Cement	Rice	Steel bar	Beer	Hog	Refrig-erator	Water melon
Nong Khai Prefecture	600	250	2,500	150	16	-	2	3
Vientiane city	750	1,650	1,500	200	40	74	10	135

(Unit: tons/1,000 persons)

	Gasoline	Cement	Rice	Steel bar	Beer	Hog	Refrig-erator	Water melon
Nong Khai Prefecture	8.65	3.60	36.02	2.16	0.23	-	0.03	0.04
Vientiane city	5.67	12.47	11.34	1.51	0.30	0.56	0.08	1.02

Remarks: (1) The population of 69,400 as of December 1966 in Nong Khai Prefecture and the population of 132,300 as of July 1966 in Vientiane were used for the estimation of the quantity of consumption per 1,000 persons mentioned above.

(2) The figures of quantity of consumption regarding cement and water melon for Nong Khai Prefecture are not reliable.

Prices in Nong Khai and Vientiane - 1

Items	Unit	Nong Khai (Baht)	Nong Khai (kip)	Vientiane (Kip)
1. Miscellaneous cereals				
Rice (Laos)	kg	2.35	58.75	76
Rice (ordinary)	"	2.65	66.25	98
Bread	"		25	83
Cassava	"	2.5	62.5	70
Black bean	"	5	125	110
2. Vegetables				
Convalvulus	kg	2	50	80
Tomato	"	0.50	12.5	50
Chilipepper	"	6	150	300
War gourd	"	1	25	65
Chinese cabbage	"	3	75	100
Lettuce	"	2	50	50
Beefsteak plant	"	5	125	60
Cabbage	"	1	25	30
Green piece	"	6	150	200
Japanese onion	"	2	50	100
Garlics	"	6	150	150
Bean sprouts	"	2.5	62.5	50
Cucumber	"	1	25	130, 20
Dry onion	"	6	150	200
Potato	"	6	150	280
Manpao	"	0.75	18.75	25
Wild tomato	"	3	75	150
Long bean	"	4	100	100
3. Fruits				
Apple	kg	5	125	250
Banana	kg	4	100	150-200
Water melon	no.	5	125	300
Shaddock	"	3.5	87.5	120
Orange	kg	4	100	120-200
Pineapple	no.	4	100	180
Coconut	"	1.5	37.5	30
Grape	kg	12	300	400
4. Meat and eggs				
Beef	kg	14	350	450
Pork (with bone)	"	12	300	500
Pork (fat of meat)	"	12	300	500
Pork (high quality)	"	17	425	500
Port (with hide)	"	10	250	420
Chicken	no.	10	250	800-1000
Duck's egg	"	0.6	15	17
Fish	kg	14-15	350-375	600
		18-20	450-500	
Fish (salted)	"	20-25	550-625	700
5. Dry food and condiments				
Dried onion	kg	2.5	62.5	70
Dry cattle fish	"	17-28	425-700	650-800
Thin threads of beach-jelly	"	16	400	500-700
Salt	"	0.5	6.2	25
6. Other foodstuff				
Condensed milk	can	2.5-3.0	62.5-75	110

Prices in Nong khai and Vientiane - 2

Items	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
Lard	kg	12	300	300
Soup (Chinese style)	bottle	5-6	125-150	100
Black coffee	cup	0.5	12.5	15
Milk coffee	"	1	25	25
Ice		0.4	10	15
7. Electricity and fuel				
Electricity	kwh	1.30	32.5	40
Petroleum	lit.	50	2	36
Electric bulbs	no.	4-5	100-125	140
8. Daily commodities				
Saucer	no.	3-5	75-125	170
Nail	kg	5	125	150
Aluminum streaming basket	no.	18	450	450-550
washing soap	box	9	225	200
Toilet soap	no.	3	75	70
Vacuum bottle	"	70	1,750	1,350
		40	1,000	570
Soap	"	0.5	12.5	20
Powder soap	box	8	200	85
Toilet paper	no.	3	75	60
Match	10 boxes	2	50	50
9. Medicals				
Aspirin	tab.	0.10	2.5	7.5
Quinine	"	0.05	1.25	7.5
10. Charges				
Hair dressing (man)	person	5-7	125-175	150
Hair dressing (woman)	"	10-15	250-375	300

Item	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
City bus	km	0.50	12.5	30
Movie (2nd class)	person	3-5	75-125	100
Play (2nd class)	"	2-3	50-75	100
Drama and sports	"	"	"	100
11. Magazines and smoking				
Daily paper	no.	0.5-1.0	12.5-25	50
Weekly magazine	"	3.0-3.5	75-87.5	140
Tabbaco	box	2.5-3.5	62.5-87.5	20
12. Electric instruments				
Refrigerator	no.	3,675	91,875	60,000
Fan	"	604	15,100	16,000
13. Vehicles				
Bicycle (Thailand)	no.	550	13,750	14,500
Bicycle (Japan)	"	850	21,250	18,000
Motorcycle	"	6,200	155,000	135,000
14. Construction material				
Cement	ton	-	14,000	19,000
Steel bar (9 mm dia.)	"	3,080	77,000	78,000
Steel bar (6 mm dia.)	"	3,250	81,250	100,000
Steel plate		20.5		380
Veneer		50	1,250	1,400
Timber		900	22,500	12,800

Ferry Freight at Nong Khai

(Unit: tons)

Year	Freight from Laos	Freight to Laos
1962	2,511	30,045
1963	5,328	30,822
1964	32,524	30,766
1965	2,328	38,540
1966	10,463	42,459
1967	34,858	83,095

Ferry Freight at Sri Chieng Mai in 1967

(Unit: tons)

Month	Freight from Laos	Freight to Laos
Jan.	6.7	6.7
Feb.	8.7	21.7
Mar.	3.1	177.9
Apr.	9.7	7.6
May	0.1	90.0
June	1.8	212.0
July	0.2	34.4
Aug.	11.0	89.4
Sep.	1.6	48.4
Oct.	7.5	195.7
Nov.	3.6	82.2
Dec.	4.4	18.5
Total	58.8	985.2

第七章

その他の計画資料

目次

その他の計画資料

オー次及びオニ次調査に於いては以下に掲げる如く多くの計画資料が蒐集された。これらの資料はノンカイ・ヴィエンチャン間架橋計画の可能性研究において役に立つものばかりであるがこの膨大な量にのぼる資料を全て掲載することは難かしく本附属書には参考資料として特に重要なもののみを集めて収録した。

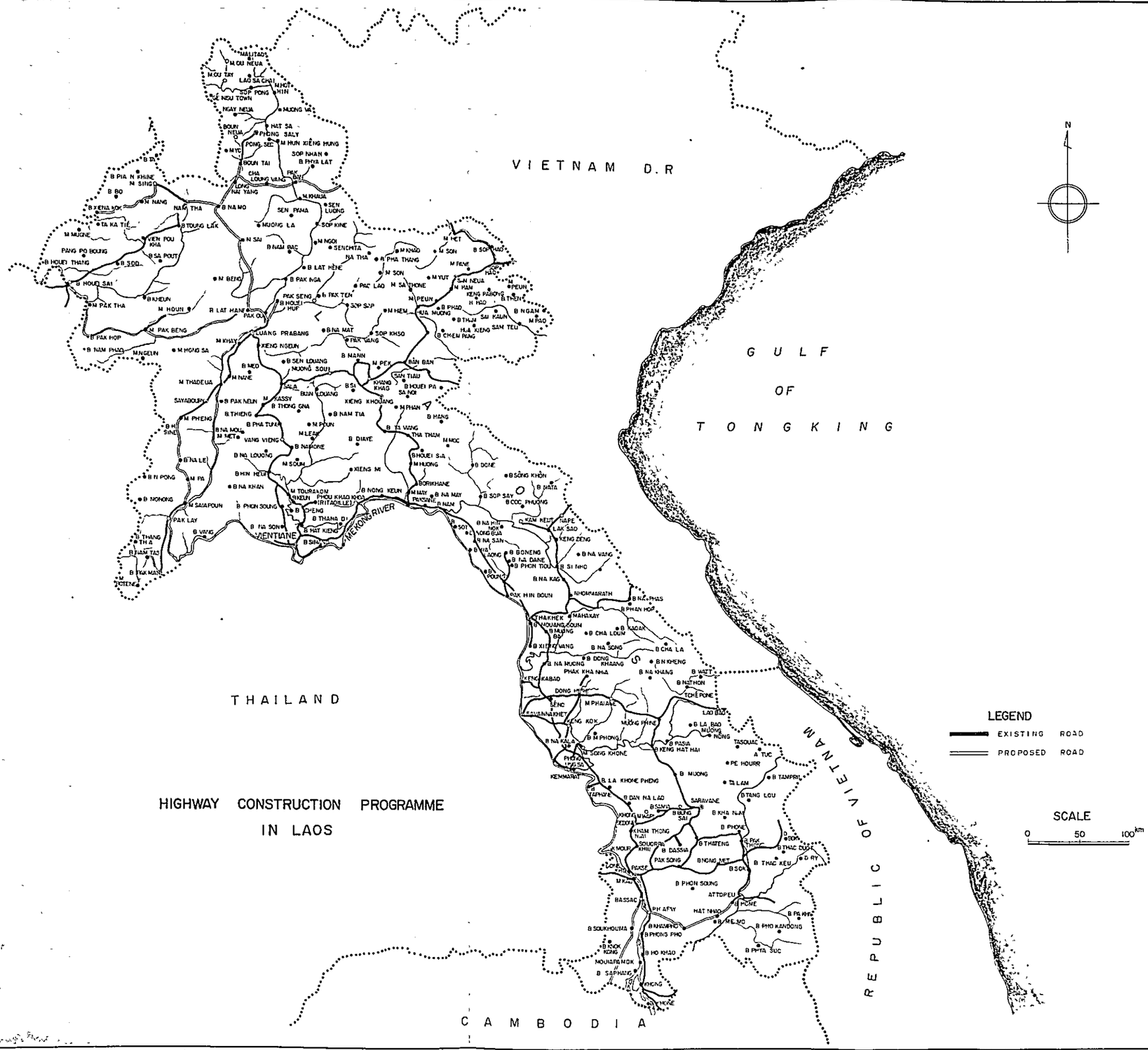
蒐集資料

1) タイ国道路及び鉄道設計基準
2) ラオス及びタイ両国の道路網図
3) ヴィエンチャン都市計画図
4) タイ国航空局規準
※5) 土地、家屋、値の高い樹木等の補償費、現地調達可能な物資の現在価格、ヴィエンチャン及びノンカイ周辺の技術者及び労務者の日当及び月給等これに関する資料
※6) タイレン・ノンカイ間の現行自動車フェリーに関するデータ
7) 架橋計画地域附近の利用可能な工業用電源
8) 河の中に建造された構造物によって起る河床洗掘作用に関するデータ
9) 地震資料
10) 計画地域の一部あるいは全域を含む地図

注.

※ これらのデータは架橋計画の建設費の推定及び架橋計画の比較案として考えられたフェリー設備増設計画の検討に際して使われたものであるが附属書にもオニ次報告書にも掲載されていない。

HIGHWAY CONSTRUCTION PROGRAMME IN LAOS



AROUND BANGKOK

AVERAGE DAILY TRAFFIC ON HIGHWAYS IN THAILAND (1964)

GRAPHIC SCALE

2 000 Vehicles
1 000
500
100

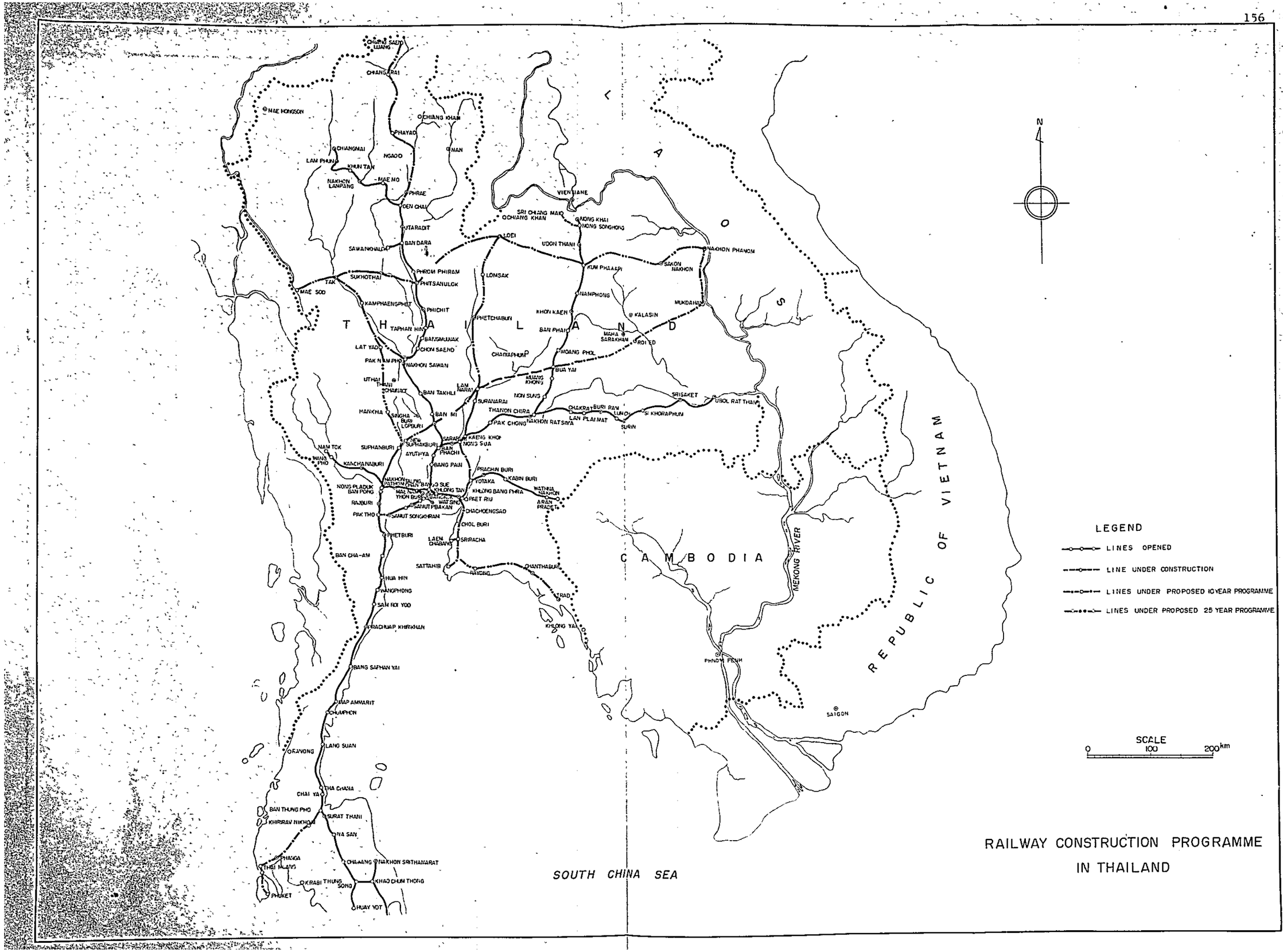
7-YEAR PLAN FOR HIGHWAY CONSTRUCTION AND IMPROVEMENT IN THAILAND (1965~71)

LEGEND

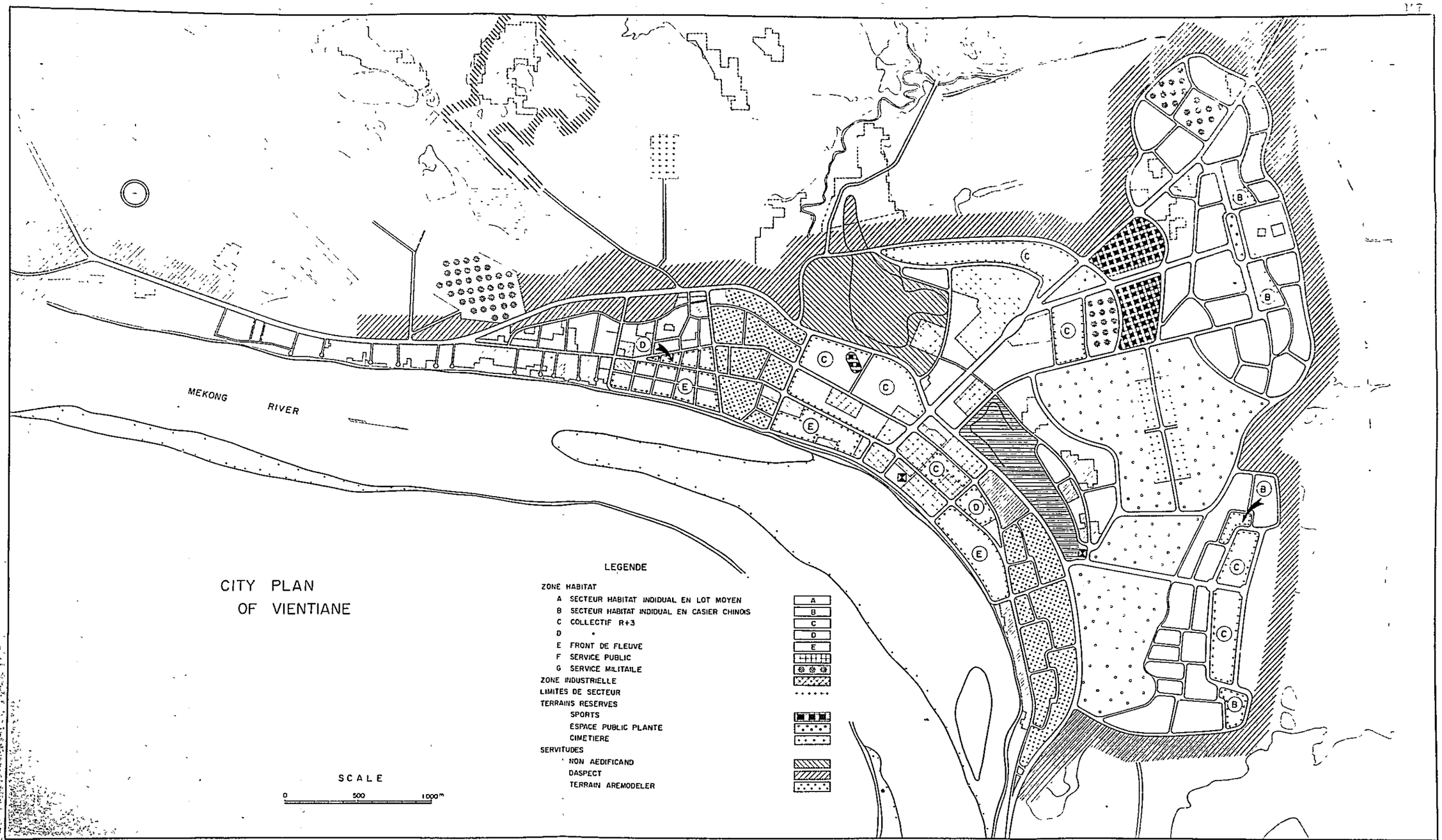
PRIMARY HIGHWAY
SECONDARY HIGHWAY
EXISTING PAVED HIGHWAYS
SURFACING PROGRAM (GOV BUDGET)
CONSTRUCTION PROGRAM (GOV BUDGET)
CONSTRUCTION PROGRAM (LOANS)
CONSTRUCTION PROGRAM (AIDS)

SCALE

0 50 100 150 200 KM



RAILWAY CONSTRUCTION PROGRAMME
IN THAILAND


MEKONG RIVER
CITY PLAN
OF VIENTIANE
LEGENDE
ZONE HABITAT
A SECTEUR HABITAT INDIDUAL EN LOT MOYEN
B SECTEUR HABITAT INDIDUAL EN CASIER CHINOIS
C COLLECTIF R+3
D •
E FRONT DE FLEUVE
F SERVICE PUBLIC
G SERVICE MILITAILE
ZONE INDUSTRIELLE
LIMITES DE SECTEUR
TERRAINS RESERVES
SPORTS
ESPACE PUBLIC PLANTE
CIMETIERE
SERVITUDES
NON AEDIFICAND
DASPECT
TERRAIN AREMODELER
SCALE
0 500 1000m