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FEASIBILITY STUDY

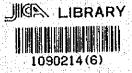
ON

SEWERAGE AND DRAINAGE IMPROVEMENT PROJECT

PHUKET MUNICIPALITY

THE KINGDOM OF THAILAND

SOIL INVESTIGATION REPORT



JANUARY 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

22293

国際協力事業団

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1. Report of Soil Investigation by JICA Study Team in October 1989.

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SEWERAGE AND DRAINAGE IMPROVEMENT PROJECT	
FOR	
PHUKET MUNICIPALITY, PHUKET PROVINCE	
REPORT NO. 32098 OCTOBER 1989	

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1 6	TMAKODOGATON		146 1
2.	Investigation	AND TESTING PROCEDURES	4-61
3.	COMMENT		7
	TABLE 1	SUMMARY OF SOIL ENGINEERING PROPERTIES	8-11
	TABLE 2	GAIN SIZE DISTRIBUTION	
	FIG.1-9	SOIU BORING	13-21
	FIG.10	GENERALIZED SOIL PROFILE	22
	FIG.11-16	UNCONSOLIDATED UNDRAINED TRIAXIAL (UU) TEST RESULT	23-28
2173 3173 3173	FIG.17-20	UNCONFINED COMPRESSION TEST, RESULTS	29-32
	F1G.21-28	GRAIN SIZE DISTRIBUTION	33-40
	FIG. 29	BORING LOCATION MAP	41
	APPENDIX A PH	OTOGRAPHS .	343080
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## 1. INTRODUCTION

This report presents the subsoil investigation for the proposed "Sewerage and Drainage improvement Project" for Phuket Municipality in Phuket Province, Thailand.

Nine borings were drilled along the main road in the Phuket City. The boring was stopped when the standard penetration test revealed of high resistance. The general soil engineering properties were carried out on the selective samples, i.e. water content, total unit weight, specific gravity, grain size, unconfined compressive strength, unconsolidated undrained triaxial test, Liquid limit and Plastic limit.

The field investigation and testing results are presented here in the report.

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### 2. INVESTIGATION AND TESTING PROCEDURES

## 2.1 General

The drilling was performed in accordance with the conventional wash boring method. The bore hole was advanced by a chopping bit and pressurized water. Whenever the soft clay or loose sand encounters, the steel casing was driven into the weak layer to stabilize the bore hole.

#### 2.2 Undisturbed Soil Sampling

A 3.0 inches diameter thin wall seamless steel tube was statically pushed into the cohesive soil. The recovery



undisturbed samples were carefully sealed with wax and stored in the cool place.

#### 2.3 Standard Penetration Test (SPT)

A standard split barrel sampler (ASTM D-1586) was used. The sampler was seated at the bottom of stiff cohesive soil or 推進。最後數位後日朝日的景場和其他 cohesionless soil, and a 140 pounds hammer was freely dropped from 30 inches vertical distance (through a guide security was flavour and Continue pipe). The number of blows at every 6-inch of penetration with the state of the enterior was recorded. Each test was stopped at 18 inches of penetration. The sum of blows of the last two tests (per foot) is taken as the standard penetration resistance; N value, which is an indication of the relative in - situ soil resistance. The test results are presented in the boring log figure 1~9. 

#### 2.4 Water Content and Total Unit Weight

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Each representative soil specimen from the standard penetration was cut and shaped into a known volume. After the wet weight of soil was determined, the sample was oven dry for overnight and the dry weight was rescaled. The Total Unit Weight and water content were computed from the testing data, The testing results are presented in table 1.

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#### 2.5 Liquid Limit (ASTM D-423)

A clay sample was aired dry for overnight, the water was added and thoroughly mixed until the clay sample was in the paste state and placed into the Atterberg device. Count and drop the cup until to close the clay groove space of about 1 cm. The liquid limit of a clay sample is the water content

The Service S



when the groove closes at 25 drops. The test results are presented in table 1.

# 2.6 Plastic Limit (ASTM D-424)

The excess sample from the liquid limit test was used in the test by rolling the clay sample on the glass surface, until the clay thread (1/8" diameter) appeared to crumble then the water content was taken and defined the plastic limit. The testing results are presented in table 1.

## 2.7 Grain Size Test

A sandy soil sample was oven dried for overnight, about 200 g of dry sample was washed through no.200 sieve, the sample retained on the 200 sieve was reoven dried and sieved on a series number sieves. The sample retained on each sieve was weighed. The testing results are presented in table 2 and figure 21~28.

#### 2.8 Unconfined Compression Test

The tests were carried out with 3.5 cm diameter by 7.1 cm hight undisturbed samples. The axial load was applied at the constant strain rate of 0.7 mm per minutes. The unconfined compressive strength  $(q_u)$  was defined at failure or when 20% of strain was reached. The testing results are presented in the boring log and figure 17~20.

#### 2.9 Unconsolidated Undrained Triaxial Test (UU)

The clay specimen was 3.5 cm in diameter with 7.0 cm hight. The confining pressure were approximately equal to  $\sigma$ ,  $2\sigma$ ,  $4\sigma$ 



where a was the total overburden pressure. After applying the confining pressure, the specimen was slowly sheared to failure. The strength envelopes of the test results are presented in figure 11~16:

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and a company of the content of the

- 3.1 The nine borings reveal that, the soil profile along one section is varied; the uniform pattern of soil profile is hardly concluded from the investigation. The variation of soil statra can be the geological formation and disturbed by the past mining excavation and tail filling. However, figure 10 presents the generalized soil profile along one section for the preliminary study.
- 3,2 In order to verify the better soil profile, the shallw hand augering to 3~5 m deep should be carried out between the deep borings.
- 3.3 In the implement stage of the project, the intensive soil investigation should be carried out as recommended following;

Depth of boring: not over 10 m deep, except where the heavy structure is located.

Field Testing : Observation well, field permeability, density.

Soil Testing : Compaction, permeability, some consolidation.



Project i Sewerage and Drainage Improvement Project Location: Phuket Municipality
Date : October 14 1989

Boring No.	Depch (m)	Total Unit Leight	Later Content	Liquid Limit 7	Plastic Limmet	Specific Grevity	Theonfined Services
	1.5 - 1.95 3.0 - 3.45 4.5 - 5.0 5.0 - 5.45		17.2 26.7 32.6	59.4	28.2	2,68 2.67	3.6
B11-1	6.0 - 6.45 7.5 - 7.95 9.0 - 9.45 10.5 - 10.95 12.0 - 12.45 13.5 - 13.95	2.02 2.01 1.67 1.75	20.6 15.1 18.5 19.6 18.8 16.3	35.0	17.9		
	15.05 - 15.5 3.0 - 3.45 6.0 - 6.45	1.69 2.18 2.06	16.0 13.7 21.2			2.66	
)	7,5 ~ 7.95 9.0 ~ 9.45 10.0 ~ 10.45	1.87	13.1 19.0 16.7	33.0	15.3	2.68	
) 	3.0 - 3.45 4.5 - 4.95 6.0 - 6.45 7.5 - 7.95	2.10 2.18 2.11	41.6 20.6 16.0 22.8	43.6	22.9	2.68	
	$ \begin{vmatrix} 10.5 & - & 10.95 \\ 12.0 & - & 12.5 \\ 12.5 & - & 12.95 \end{vmatrix} $		27.2	27.0	14.8	2.66	20.



Project (Sewerage and Drainage Improvement Project
Location: Phulet Municipality

		, Da	te : Octo	ber 14, 1	989		
Boring No.	Dépth (m)	Total Unit Weight L/m <sup>3</sup>	Water Content	Elguid Limit. %	Plastic Lifeit	Specific Gravity	"nconfined Strength t/m <sup>2</sup>
	13.5 - 13.95	1,81	19.3				
	15.0 - 15.5			27.4	15.5		
	n5.5 - 15.95	1.80	17.3				
	16.5 - 16.95	1.75	19.1				
	18,0 - 18,45	1.75	18.2				
	19.55 - 20.00	1.73	17.8				
	1.5 - 1.95	1.87	30.6				
	3.0 - 3.45	2.18	17.2				
	6.0 - 6:5					2.67	
	6.5 - 6.95	2.06	17.3				
	9.0 - 9.45	1.90	20.6				
	10.5 - 10.95	1.71	39.8				
ВН-4	12.0 - 12.5			27.2	15.7		19,1
	12.5 - 12.95	1.73	25.5				
	13.5 - 13.95	1.76	25.6				
	15.0 - 15.45		31.8				
	16.5 - 16.95		24.2	30.4	16.3	2.66	
	18.0 - 18.45	1.79	22.5				
	19.55 - 20.00		22.7				
	6.0 - 6.50	1.67	58.3	56.6	27.1	2.66	3.9
	9.0 - 9.45	2.05,	26.0				
BH-5	10.5 - 10.95	2.15	13.9			2.68	
	12.0 - 12.5			30,6	15.5		28.8
	12.5 - 12.95	1.60	27.5				
	13.5 - 13.95	1.77	31.8				
	15.05 - 15.50	1.50	22.1				



Project (Sewerage and Drainage Improvement Project Location: Phuket Numicipality

والمنافقة الأنافق		Dal	e   Octo	ber 14, 1	107	المتنافعة وتستدينها والمدومة	أأوادنا فاستحداده والمتحدث
Boring No.	Dëpth (m)	Total Unit Weight t/m <sup>3</sup>	Vater Content	Liquid Limit %	Piestic Limit	Specific Gravity	inconfined Strength
	4.5 - 4.95	1.84	36.9	60.6	28.3	2.69	
	7.5 - 7.95		33.8				
	9,0 - 9,50	1.86	44.2	35.4	19.6		
	10,5 - 10.95	1.54	80.9				
	12.5 - 12.95	2.06	16,2				
вн-6	13.5 - 13.95	1.75	24.4				
	15.0 - 15.45	1.66	17.4	34.2	17.9	2.68	
	16.5 - 16.95	1.67	18.6				
	18.05 - 18.5	0 1.79	24.6				
	0.0 - 0.00		4.1				
	1.5 - 1.95	1.80	44.3				
	3.0 - 3.5			49.4	22.7	2.67	3.9
	3.5 - 3.95	1.80	25,9				
	4,5 - 4.95	1.77	26.9				
	6.0 - 6.45	1.66	31.6	62.6	28.3		
вн-7	7.5 - 7.95	2.00	31.3				
	9.5 - 9.95	1.98	16.5				
	12.0 - 12.45	1,84	22.0				
	13.5 - 13.95	1.95	19.5				
	15.0 - 15.45	1,99	17.8			2.67	
	16.5 - 16.95	1.74	13.7				
				In the transfer		1	



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Project : Sewerage and Drainage Improvement Project Location: Phuket Nunicipality

		Dat	e Octo	ber 14, 1	989		
Boring No.	Depth (m)	Total Unit Weight trans	.Vater Content	Timit Diabil	Plestic Limit %	Specific Gravity	woonfimed Strength
вн-8	1.5 - 1.95 3.0 - 3.45 4.5 - 4.95 6.0 + 6.50	1.97 1.72 1.72 1.55	29.5 55.7 57.0 57.2	25.0 28.2	13.6 15.7	2.67 2.67	3 3
BH-9	0.0 - 0.00 0.0 - 1.00 1.5 - 1.95 3.0 - 3.5 3.5 - 3.95 4.5 - 4.95 6.05 - 6.5	2.07	3.01 14.1 28.5 23.0 20.7 16.8		21.0 27.3	2.70 2.69	

Borring No.         Depth         3 No. 1/2"         3/8"         4         10         20         40         60         100           1         3.0 - 3.45         1.00.00         98.28         68.25         40.25         31.06         20.21         40         60         100           2         3.0 - 3.45         1.00.00         99.52         88.89         68.25         31.06         20.21         40.25         31.06         20.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         40.25         31.06         30.21         31.06         30.20         40.25         31.06         30.21         31.06         30.20         31.06         30.21         31.06         30.21         31.06         30.26         31.06         30.26         31.06         30.28         31.21         31.21         31.21         31.21         31.21         31.21         31.21         31.21         31.21         31.21         31.21		PROJECT : Sewerage LOCATION: Phuket :	Sewerage and Drainage Phuket Province		Improvement	Project	10 10 10	Phuket Municipality  Date: Octo	nicipality Date: October	ber 1989	
3.0 - 3.45	on gar	Depth				FINER	LEJ CHI	11 - 12 - 12 - 12 - 12 - 12 - 12 - 12 -	¢		
3.0 - 3.45         100.00         98.28         88.89         68.25         46.25         31.06         21.21           7.5 - 7.95         100.00         99.55         98.04         56.00         47.64         25.75           3.0 - 3.45         -         100.00         86.12         55.33         37.77         30.27         23.16           6.0 - 6.45         -         100.00         94.36         74.35         49.77         99.42           6.0 - 6.45         -         100.00         94.36         74.35         49.77         99.42           10.5 - 10.95         -         100.00         94.36         74.35         49.26         25.26           10.5 - 10.95         -         100.00         94.36         74.35         49.26         25.27           10.5 - 10.95         -         100.00         97.66         78.26         25.26         25.27           10.5 - 10.95         -         100.00         99.22         98.81         99.75         94.95           10.5 - 10.95         -         100.00         95.04         97.56         74.31         59.26         99.23           10.5 - 10.95         -         -         -         -         -			1/2"		7	10	. 20	0,	09	100	200
3.0 - 3.45         100.00         99.55         98.04         65.00         47.64         23.75           3.0 - 3.45         -         100.00         99.55         98.04         65.00         47.64         23.75           3.0 - 3.45         -         100.00         99.53         30.27         30.27         33.16           6.0 - 6.45         100.00         84.36         74.35         34.26         27.21           6.0 - 6.50         -         100.00         94.96         74.35         34.26         25.26           6.0 - 6.50         -         100.00         94.96         74.35         39.42         30.45           10.5 - 10.95         -         100.00         97.01         71.01         44.36         29.98         20.76           10.5 - 10.95         -         100.00         95.66         78.25         30.48         20.76           10.5 - 10.95         -         100.00         95.66         74.91         55.28         30.48           10.5 - 10.95         -         100.00         95.66         74.91         55.42         30.48           10.5 - 10.95         -         100.00         95.06         90.55         99.25         99.25		3.0 - 3.45		00 00		100.00	99 17	97.30	87.37	60 09	49.64
3.0 - 3.45     - 100.00     99.55     98.04     65.00     47.64     25.75       3.0 - 3.45     - 100.00     86.12     55.33     37.77     30.27     23.16       6.0 - 6.45     100.00     8.50     74.35     49.84     99.77     99.42       7.0 - 6.45     100.00     94.96     74.35     49.86     37.26     27.26       6.0 - 6.50     - 100.00     97.91     71.01     44.36     29.75     29.78       10.5 - 10.95     - 100.00     97.01     71.01     44.36     29.78     20.76       10.5 - 10.95     - 100.00     97.01     71.01     44.36     29.98     20.76       10.5 - 10.95     - 100.00     95.04     97.66     78.23     30.48     20.08       10.5 - 10.95     - 100.00     95.04     91.56     74.91     55.69     40.27     25.42       10.5 - 12.50     - 100.00     95.04     91.56     74.91     55.69     40.27     25.42       15.0 - 15.45     - 100.00     95.00     91.56     74.91     55.69     40.27     25.09       15.0 - 15.45     - 100.00     95.00     92.62     86.27     84.94     20.08       15.0 - 15.45     - 100.00     95.00     92.62     86.27		0.00 miles	3	Ω7.28 	χς. Χχ.	C7:80	40.72	2 5 7	77-77	14.42	11.12
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	<b>X</b>	3.0 - 3.45 7.5 - 7.95		100,00	99.55 86.12	98.04 55.33	65.00 37.77	47.64 30.27	25.75 23.16	15.76 16.16	10.95
6.0 - 6.45         109.00         84.50         74.35         44.36         35.61         30.68         27.21           3.0 - 3.45         - 3.45         - 100.00         94.96         74.35         49.86         34.26         25.26           6.0 - 6.50         - 100.00         97.01         71.01         44.36         29.98         20.76           10.5 - 10.95         - 100.00         97.01         71.01         44.36         29.98         20.76           10.5 - 10.95         - 100.00         95.04         97.56         78.23         30.48         20.06           10.5 - 10.95         - 100.00         95.04         91.56         74.91         55.89         40.27         25.42           12.0 - 12.50         - 100.00         95.05         - 100.00         99.05         98.27         84.94         28.00           15.0 - 1.95         - 1.95         - 100.00         95.05         82.90         77.11         59.09           1.5 - 1.95         - 1.95         - 100.00         97.84         84.90         77.11         59.09           1.00 - 0.50         - 1.00.00         97.84         84.00         77.11         59.09           1.00 - 0.50         - 1.00.00         97.	3	۱, (				100.00	48.66	99:77	99.42	96.93	7. 68
3.0 - 3.45     - 3.4     - 100.00     94.96     74.35     49.26     34.26     25.26       6.0 - 6.50     - 100.00     97.01     71.01     44.36     29.98     20.76       10.5 - 10.95     - 100.00     97.01     71.01     44.36     29.98     20.76       10.5 - 10.95     - 100.00     95.04     91.56     74.91     55.89     20.78     20.08       12.0 - 12.50     1.00.00     95.04     91.56     74.91     55.89     40.27     25.42       15.0 - 12.50     1.00.00     95.04     91.56     74.91     55.89     40.27     25.42       15.0 - 13.45     - 100.00     95.00     92.62     86.82     83.93     77.11     59.09       1.5 - 1.95     0.0 - 6.50     - 100.00     97.84     84.00     71.10     54.68     47.33       3.0 - 3.50     - 100.00     97.84     84.00     71.10     54.68     47.33	and the second second second second	)	.100.00	8: 50	63.26	75.55	35.61	30.68	27.21	23.94	21.81
6.0 - 6.50     -     100.00     97.01     71.01     44.36     29.98     20.76       10.5 - 10.95     -     100.00     95.52     98.81     97.75     94.97       10.5 - 10.95     -     100.00     95.66     78.23     50.28     30.48     20.08       12.0 - 12.50     100.00     95.04     91.56     74.91     55.69     40.27     25.42       15.0 - 12.50     -     -     -     -     -     -     99.55     99.53     99.53       15.0 - 15.45     -     -     -     -     -     -     -     -     -       15.0 - 15.45     -     -     -     -     -     -     -     -     -       15.0 - 15.45     -     -     -     -     -     -     -     -     -     -       15.0 - 15.45     - <td>7</td> <td>J.</td> <td></td> <td>100.00</td> <td>96.46</td> <td>74.35</td> <td>96.67</td> <td>34.26</td> <td>25.26</td> <td></td> <td>18.32</td>	7	J.		100.00	96.46	74.35	96.67	34.26	25.26		18.32
10.5 - 10.95 - 10.95 - 100.00 99.52 88.81 97.75 94.97   10.5 - 10.95 - 100.00 95.66 778.23 50.28 30.48 20.08   12.0 - 12.50		ij		100.00	10.76	71.01	96.44	29.98	20.76		13.02
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		1 ;		And the second s	100.00	99.52	98.81	97.75	76.36	75.68	85.60
12.0 — 12.50     10.00     96.04     91.56     74.91     55.69     40.27     25.42       3.0 — 3.50     100.00     96.05     99.95     99.85     99.85     99.85       15.0 — 15.45     100.00     95.00     92.62     86.82     84.94     28.60       1.5 — 1.95     100.00     95.00     92.62     86.82     83.93     77.11     59.09       3.0 — 3.45     -     -     -     -     100.00     99.97       6.0 — 6.50     -     100.00     97.84     84.00     71.10     54.68     47.33	5	1		100.00	95.66	78.23	50.28	30.48	20.08	EL. 24	10.48
3.0 - 3.50 15.0 - 15.45 1.5 - 1.95 1.5 - 1.95 1.00.00 3.0 - 5.50 3.0 - 5.50 3.0 - 3.50 3.0 - 3	ó	Μ,	100,001	9.6.04	91.56	74.91	5569	40.27	25.42	15.10	12.08
9.0 - 9.50 15.0 - 15.45 15.0 - 15.45 15.0 - 15.45 100.00 95.00 92.62 86.82 87.93 77.11 59.09 97.75 6.0 - 6.50 - 100.00 97.84 84.00 71.10 54.68 47.33	The second secon	ı,					99.93	59.85	59.33	98,39	97.93
15.0 - 15.45		J.			160.00	99.05	98.27	76.78	28,00	13.60	<u>(1.6</u>
1.5 - 1.95 3.0 - 3.45 6.0 - 6.50 3.0 - 3.50 - 100.00 95.00 92.62 86.82 83.93 77.11 59.09 99.77 99.37 - 100.00 97.84 84.00 71.10 54.68 47.33	A Company of the Comp				100.00	87.90	. 70 09	74-82	37.76	29.41	24.80
3.0 - 3.45. 6.0 - 6.50 3.0 - 3.50 	8	1	100.00	95.00	92.62	85.82	83.93	77.11	59.09	23.44	8.56 56
6.0 - 6.50 3.0 - 3.50 - 100.00 - 97:84 84.00 71:10 54.68 47.33		ı			•			100.00	72.66	91.60	21.08
3.0 - 3.50		1:	1			C.	100.00	76.66	99.87	76.95	92.68
	6	J	. <b>)</b>	100.00	97.84	84.00	71:10	-54.68-	•	38.25	35.24
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は関するのは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代のは、1990年代の											
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그 일을 경우했다면 살아보고 있는 사람들은 경우를 받는데 하는데 그는 사람들이 되었다. 그는 사람들이 없는데 그를 살아보는데 그렇다면 살아보다면 살아보	B(	)RIA prov	G N emen	
ASSET VATIONS  ST. SUNDISTURBED SAMPLING SP. STANDARD PENETHATION TEST WATER TABLE WATER TABLE VS. MELD WATER TEST VS. MELD WATER TEST  VS. MELD WATER TEST  VS. MELD WATER TEST  M. M	907. DE	0 <b>CP</b> 7.8	SAMPLING METHOD	UNCONFINE COMPRESSIVE STRENGTH 17 m²      STANGARD PERETRATION TEST BL 730 c.      FIELD VANE SHEAR STRENGTH 1/ m²
SOIL DESCRIPTION Brown, very loose cearse (S A N D (SP)			WO	
Brown, very loose fine S A N D (SP) Gray, medium C L A Y			WO SP WO	
(CH) Gray, soft fine sandy C L A Y (CL)	\	5.	ST SP WO SP WO	
Gray, loose coarse \$ A N D (SP)		10	SP WO SP WO	
Brown, hard silty C L A Y with gravel Sand and	/:  /:		SP WO SP	P
coarse Sand (CL-GĈ)			WO SP WO	O
End of Boring	1/4	15	SP	
		20		

## REGIONAL ENGINEERING CONSULTANTS CO., LTD. LOG BORING NO. BH-2 Sewerage and Drainage Improvement pate commences Sep. 30, 1989 PROJECT ... Phuket Municipality, Thepkasattri Road DATE FINISHED Sep. 30, 1989 LOCATION GROUND ELEV 1/102 **ADDREVIATIONS** · UKCONFINE COMPRESSIVE STRENGTH 3.033 et \*Undisturblo sampling 818/70 cm SP & STANDARD PERETRATION TEST A STANDARD PENETALTION TEST WATER TABLE WO # WAS HOUY 1,50 va - field vane shear test 1/m2 # FIELD VANE SHEAR STRENGTH SOIL DESCRIPTION 100 Earth fill of laterite C L A Y (GC) WO Black, dense fine S A N D (SP) ŞP WO Gray, loose clayey SP S A N D (SC) WO. WO Gray, loose coarse S A N D (SP) Gray-brown, stiff silty C L A Y (CL) WO 10. Hard weathered rock SP End of Boring 15.

#### REGIONAL ENGINEERING CONSULTANTS CO., LTD. LOG BORING NO. BH-3 PROJECT : Sewerage and Drainage Improvement DATE COMMENCED Sep . 26, 1989 LOCATION: Phuket Municipality, Ratanakosin 200 Roadoute FINISHED Sep. 26, 1989 GROUND ELEV ASSET VIATIONS . UNCONFINE COMPRESSIVE STREYOTH 9 ST . Undis turbed bampling SP = Btandard Pene Tration test Wo = Wash Out Vs = Pield Vane Shear test 2,781 WATER TABLE B13/30 cm A STANDARD PERETRATION TEST 1/102 1.81 M FIELD VANE SHEAR STRENOTH SOIL DESCRIPTION Brown, loose clayey fine WO S A N D (SC) ST WO Gray, very loose silty clayey coarse S A N D (\$M-SC) WO SP WO Red to dark gray, medium SP gravelly C L A Y and WO coarse Sand SP (CL-GC) WO Loose coarse S A N D (SP) 10 WO Yellow, medium clayey silt WO (MH) ST SP Yellow, stiff fine sandy. WO SP silt (ML) WO 15. ST SP WO Brown-yellow, hard sandy silt SP with some gravel WO (ML-GC) SP WO SP End of Boring

Fig. 3 SOIL BORING

ASSECUTIONS GROUNDELEY.	7	3.1//		Road . DATE FINISHED Sep. 29, 1989  • UNCONFINE CONFESSIVE STRENGTH 1/m2
ST FUNDISTURGED SAMPLING 2.519 M. SP & STANDARD PENETRATION TEST WATER YABLE		HLGEC	SAMPLING NETHOD	A STANDARD PENETRATION TEST \$15/30 cm
IVO + WARH OUT Va = Field wase shear test 1.10 M	FRAPHIC	36	X.	# FIELD VANE SHEAR SYNEHOTH 1/m2
SOIL DESCRIPTION	1	н,	इ	50 100
Gray-brown, very loose fine			WO	
S A N D (SP)				
		•	SP	(A) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1
	1:		WO	/ BERESSERABILE DE LE COMPANIO
	j.		SP.	
Dark gray, very loose			WO	
coarse S A N D (SP)	1.	5	ST	No recovery
			SP	A (D) No recovery   1
			WO ST	
(1) (1) 12 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			SP	A 2 (1,1,52) (1   1   1   1   1   1   1   1   1   1
			MŎ.	
			SP WO	(111,1)) No recovery
	\[\frac{1}{2}\]		]	
			SP	[ <b>AX</b> 7] (2,3,4); [1,1] [1,1] [1,1] [1,1]
		1.0	WO	
			SP	1 (8 12 (3,4 8) 1 1 2 2 2 1 1 1 1 1 1 1 1
			NO.	
			- ST	
			( S)	11, 101 10, 3 20 28, 12, 22 1 1 1 1 1 2 2 2 2
	//		WO SP	1111112 22 (91, 18, 25)
Dark brown, hard silty	$V_{i}$		WO	
C L A Y (CL)		15		
			SP	1 1 63 63 2 7 2 20 1 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
			MO	
			\$P	52 (8, 19, 33)
	//		WO	
			SP	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	//		\ WO	
	1/	20	SP	(15:30,5074)
End of Boring	A de	<sup>∠</sup> ∪	{-:`	

BRREVIATIONS  If a undisturbed sampling  If a standard penetration test	GROUNDELEV. 1.60 m.		*.	METHOD		UNC		•			-			∦at	H		ببنيت	1 / m	*******		-
VO . WASH OUT VS . PIELD WANE SHEAR TEST	WATER TABLE 0.31 M	GRAPHIC	DEPTH	SAMPLING	-	FIE		100	100	. (	· • • •	<del>نەرگەنچ</del> دەرى		بىنىت دەرى	د. مفرعات			1 / 11	7	ر دېدند	7
SOIL DESCRI	PTION	. <b>.</b>	M,	* 8		Na in	is is produced Angles	1, 1, 1857)	,	.5(		141			1	20 00	es Suuta	وحود		77	
Garbage;⊕F[][		17.		WO																	
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		$V_{I}$	٤ ٤	ST		N	3 T	ęç	q٧		Ϋ́ E		1	†   	1	11			ij		-
Dark gray, very so	off cility	//		₩Ö	1						-	$\downarrow\downarrow$	11	$\downarrow \downarrow$		ł	<u> </u>		H	11	
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c L A Y (cl		$V_{I}$	1	WÓ			Ϊ		Ť		ŢŢ	П	Ţį					$\prod$	Π		7
		$V_{i}$		SŤ			() (2)	3.	o o	$\downarrow \downarrow$	<u> </u>		1			1			44		4
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Section 1	^^^^	- -		SP	1		X	20	) (	9	13	,7)						وسوره			
Dark gray, loose o	New York Street Control			WO.				1				-	1	-							
		+		ST	-	-		1	-		با						<u>.</u>	20	्ह	( (()	
Red-gray, very st	iff to		ľ	1 57		ÌŢ			1	24	~ ~~	_4	6	)	1		(**** }\\;	<i>X</i> .		دو. موسد	***
hard silty C L			Ì	WO SP		-	-	-				+	-	-	8	<u>.</u> 617	112		<u>.</u> .S.	57	<u>i.</u> }
				WO		$\dagger \dagger$		Ħ	1	i		j				ÌŢ	li				
			15		_[			$\prod_{i \in \mathcal{N}}$		7	7.7			, ,	<u> </u> የአለ		116	-	خممم	A part ( )	
	ne ne autorioris de la comp	- -	1	SP			þ,	(9 	,\3 	./. T	9 () 	-	{		14	11	1	-		+	
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						Ш		$\prod$	11	-		<u> </u>					++	-		$\!$	-
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				[		<u> </u>	İ						$\prod$	- ا برند،	] [					ĮŢ.	
						$\coprod$		$\prod$	$\frac{1}{1}$	<u> </u>		-			+	H	+			╁	
			20		}			╁	$\parallel$			+		<del> </del>		什	$\uparrow \uparrow$			†	1
			20		ľ	T	11	Ϊ	TÌ						Π	Ű	$\prod$				

ROJECT: Sewerage and Drainag OCATION: Phukst Municipality,										
APPREVIATIONS ST + UNDIS TURBED SAMPLING S) = STANDARD PENETHATION TEST WO - WASH OUT VS = PIELD WHESHEAR TEST 1,06 M.	ě	X 7-430	KPLING METHOD	• UNCONFINE COMPRESSIVE STRENGTH						
	ERAPHIC LOS			A STANDARD PENETRATION TEST ELS/30 cm						
	RAPH			# FIELD VANE SHEAR STRENGTH 1/m2						
SOIL DESCRIPTION		Н	8	50 100						
gan and keling and a company of the second										
Garbage Fill	77		WO							
	7		\$T							
	$V_{I}$		WO							
	1/	<b>1</b>	SP	A ((0)) No recovery						
	1/	•	WO							
	1//									
Dark gray, very soft	1/	5.	SP							
C L A Y (CH) with	1/		WO							
현실, 경화 변경, 경험을 하는 일반 하는 사람들은 일본 일본 등 이 전에 되었다. 한편 전환 경험을 보고 보고 함께 있는 역 원모, 11 경험 10 10 10 10 10 10 10 10 10 10 10 10 10	- 1/		SP	A (O) No Mecovery						
some shell		-	WO.							
	//		SP	/\(\(\frac{1}{3}\) (0) (0) (0) (0) (0) (0)						
	SP (100)   Wo   1111									
	Y	10-								
			ST SP	& (o) No recovery						
	1/		W0							
	1/	1	ST	Medium clay						
	_ /		WO							
Dark-grey-brown, very loose			ST							
보이를 발한 네. 그림으를 반비하여 뭐 되어			SP	1 A. 18 (3.0 8) 12 6 1 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3						
coarse S A N D (SP)			W0	7 1 1 1 1 1 1 2 1 de 7 2 4 20 22 Y						
			SP	(4,22,33)						
Brown-yellow, very hard sil	CA	15	WO							
C L A Y (CH)		╽ ゙.	SP	A 50 (9.22 42)   1 1 1						
			l wo							
	$\setminus$		SP	(12,32,63) 90 1 6						
建国家 医乳状皮肤	V Jwo William in the first									
	$\mathbb{I}$	.								
Single state of the	∮ .	SP	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							
End of Boring										
		20								

PROJECT: Sewerage and Drainage LOCATION Phuket Municipality;	Sam	Kon	g .	DATE COMMENCED Oct. 2, 1989  DATE FINISHED Oct. 2, 1989:						
ABBREVIATIONS ST PUNDISTURBED SAMPLING SP = STANDAND PENETRATION TEST WO = WASH OUT VS = PIECD WHESHEAN TEST  1.30  M.	RAPHIC LOG	DEP TH	OOMUSH SHITHOO	• UNCONTINE COMPASSIVE STARNETH 1/m2						
				A STANDARD PENETRATION TEET PLS/30 cm						
	GRAP		N.P.	# FIECO VANE SKEAR STAEKOTH C/m²						
SOIL DESCRIPTION		ù.	á	10 20 50 100						
Earth fill of clayey	(,)		WO							
gravel	1									
			SP							
Brown-gray, soft silty			WO							
č"t A Y (ct)			ŞŤ	NUNE DE PRESENTATION DE LA COMPANION DE LA COM						
			SP	<b>(A</b> ((o))						
	/	c	WO SP							
	$\langle \cdot  $	5.	WO							
	$\left  \cdot \right $									
Gray-Red, medium silty			SP							
C L A Y (CL) some		•	WO							
sand	1		SP	[ [A ] [ (4,5 (4) ]   1   1   1   1   1   1   1   1   1						
Yellow loose fine S A'N D (SP)	Ι.		WO							
			ST							
	1.4.	10		7 28 ( 6 , 16 ( 2 )						
White-gray, loose coarse			WO	(8.5.4) No recovery						
S A N D (SP)			SI							
	;·		<u>                                      </u>							
	k ri		SP	111 1 (\$ 12) (12) (3.76) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						
			WO							
Brown, hard clayey silt (MH)			SP	1 14 69 (14, 17, 22)						
			W0							
Brown, very dense silty	13:	15	SP	1111111126 1371 (12320) 277 111111						
			WO							
coarse SAND some gravel(SM)	1:		<b>]</b> ,							
			SP SP	(A) 30V ) No recovery						
Col of Double	+		)							
End of Boring										
		20	<b>}</b>							

## REGIONAL ENGINEERING CONSULTANTS CO., LTD. LOG BORING NO. BH-8 DATE COMMENCED Oct . 3, 1989 Sewerage and Orainage Improvement PHOJECT DATE FINISHED Oct . 3, 1989 Phyket Municipality, Kathy School LOCATION ! GROUND ELEV. • UNCONFINE COMPRESSIVE STRENGTH ABBREVIATIONS ST - UNDISTURBED SAMPLING SP - STANDARD PENETRATION TEST WO - WASH OUT V8 - PIELD WHE SHEAR TEST Nót known w. PLS/30 cm A STANDARD PERESEATION TEST SPAPHIC WATER TABLE 0.30 L/m2 M FIELD VANE SHEAR STRENGTH SOIL DESCRIPTION Brown, very loose fine WO S A N O (SP) SP WO Brown, soft fine sandy SP Y (CL) WO SP Brown, very stiff silty WO Y. (CL) \$T End of Boring 10

20 Figg 8 SOIL BORING

NOORO) \	e and Draina Municipality	ge	Impr	ovem	id. DATE FINISHED Oct . 3 , 1989								
ABBREVIATIONS ST = UNDIS TURBED BAMPLING SP = STANDARD PENETRATION TEST WO = WASH OUT. VS = FIELD WHESHEAR TEST  0.10  M.		RAPHIC LOG	OEPTH.	eperng method	◆ UNCONFINE CONTRESSIVE STRENGTH 1/m²  A STANDARD PENETRATION TEST ** ELS/30cm  WE FIELD VANE SHEAR STRENGTH 1/m²							<b>3</b>	
SOIL DESCRI			u,	3.64		1111	50 T 1 / 1	11 I	<u>r - [ 7</u> ,	1(	00	1177	
Earth fill of cru stone Brown, stiff coan				WÓ SP WO		10 (	2,616						
c L A, Y (CL)		7/		ST SP WO		10 (	4,4,6 1						
Brown, hard coars  C L A Y ()  End of Boring	CL)		5.	SP WO SP		\$ 1 G		51	(10	;20 ;20	31)		
			10										

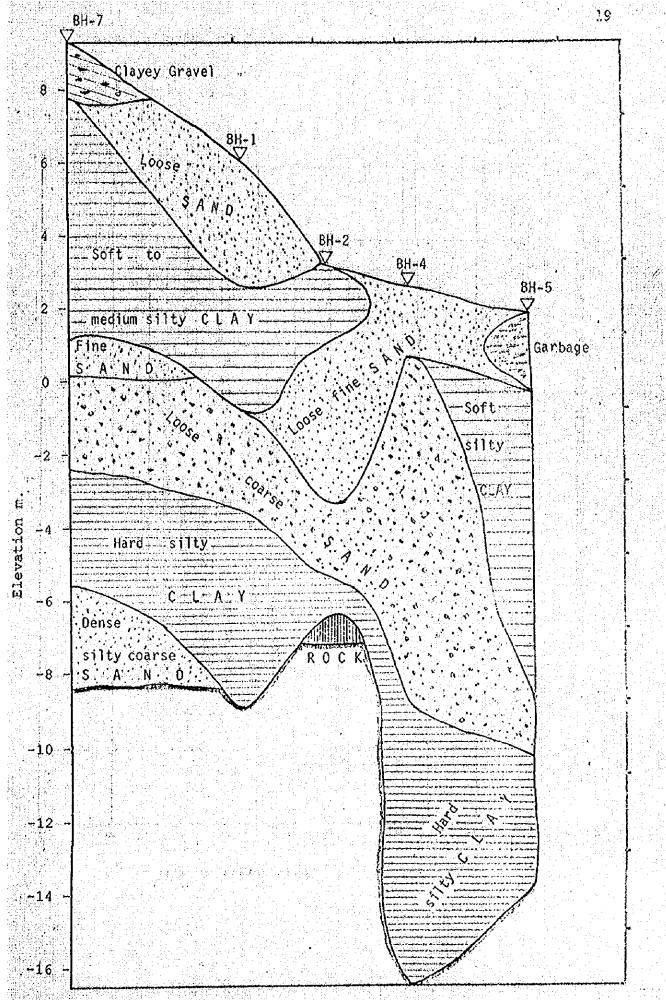
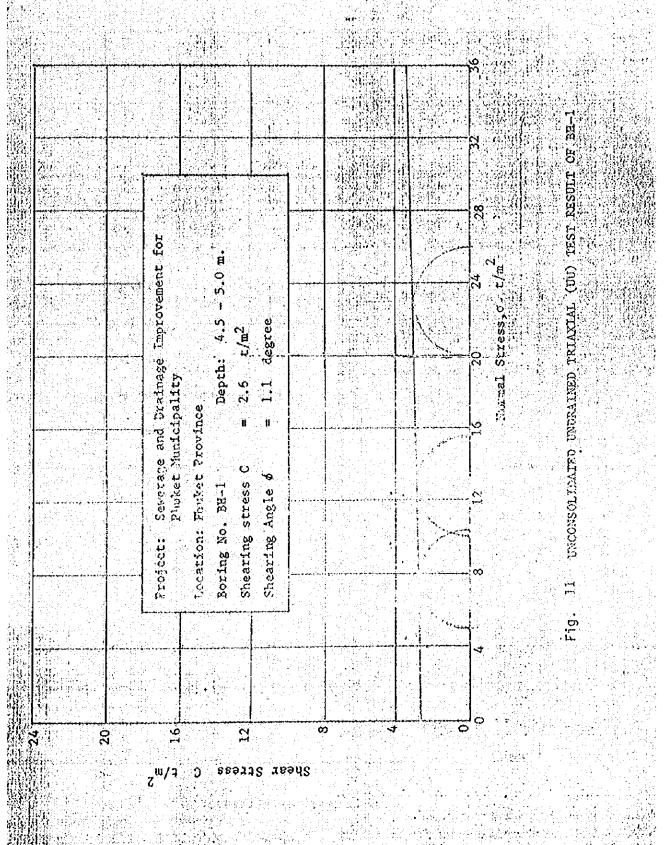
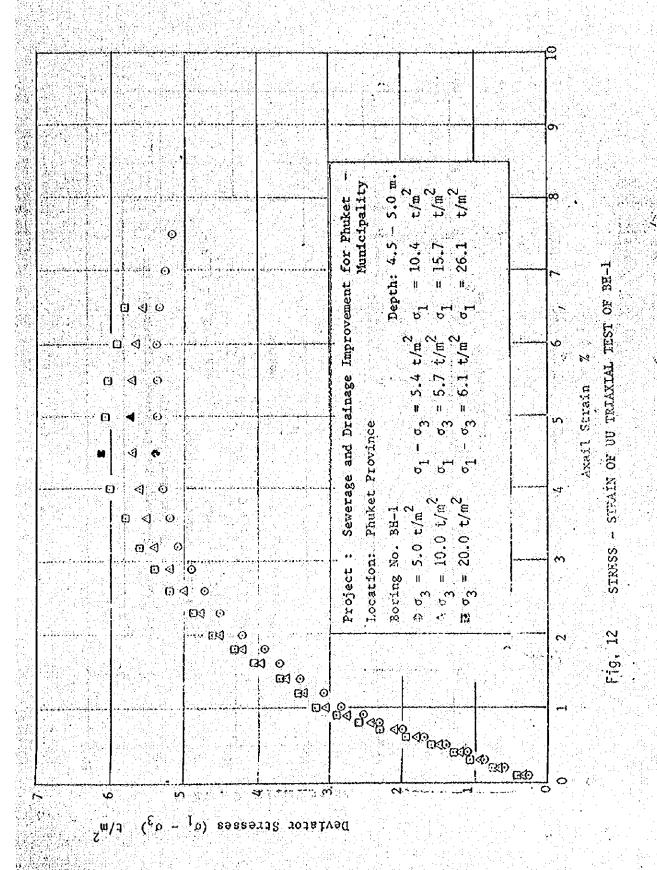


Figure 10 GENERALIZED SOIL PROFILE





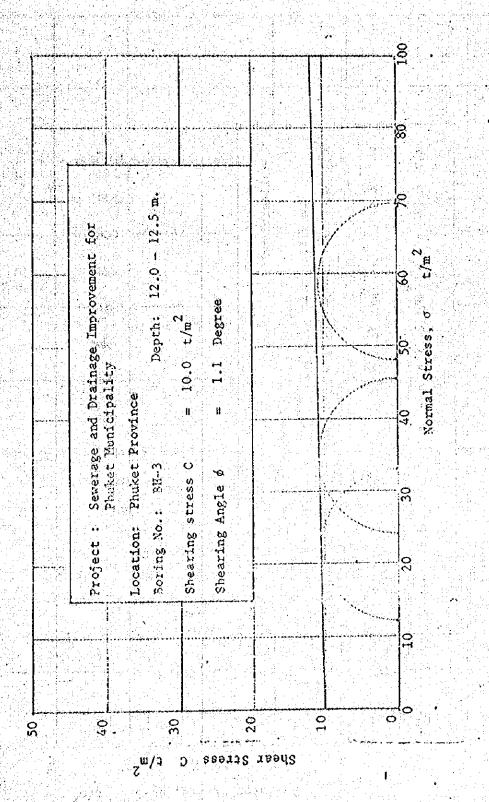
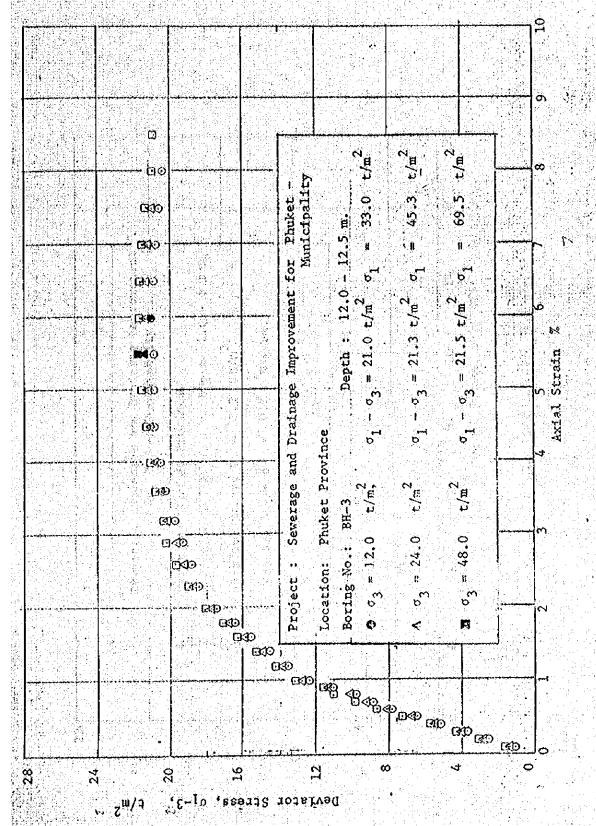


Fig: 13 unconsolidated undrained triaxial (eu) test result of be-3



10.14 STRESS - STRAIN OF UNIBLAXIAL TEST-OF 3E-3-

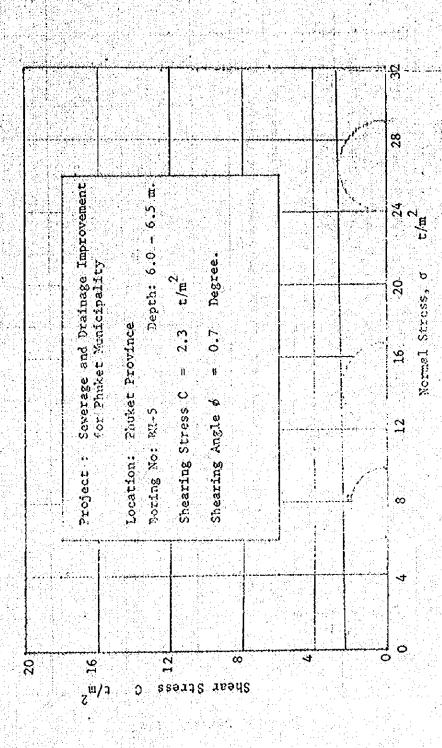
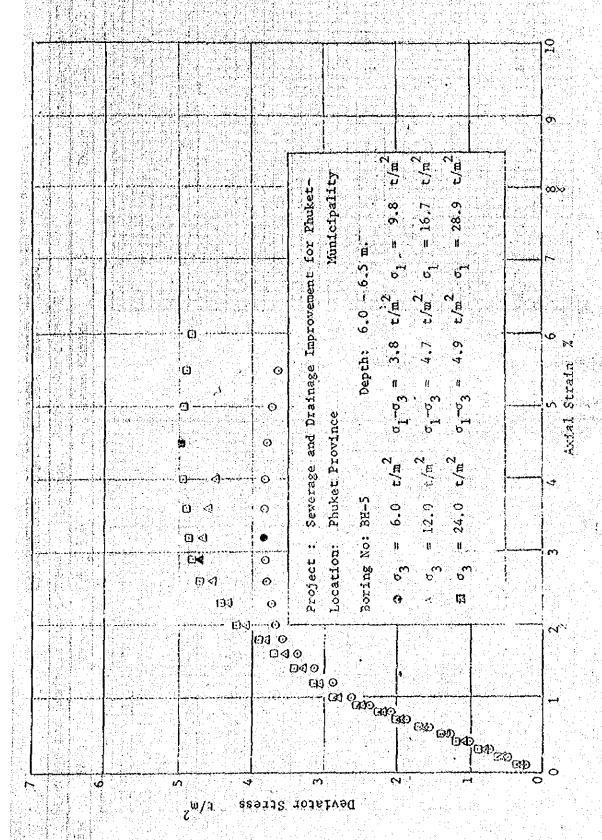
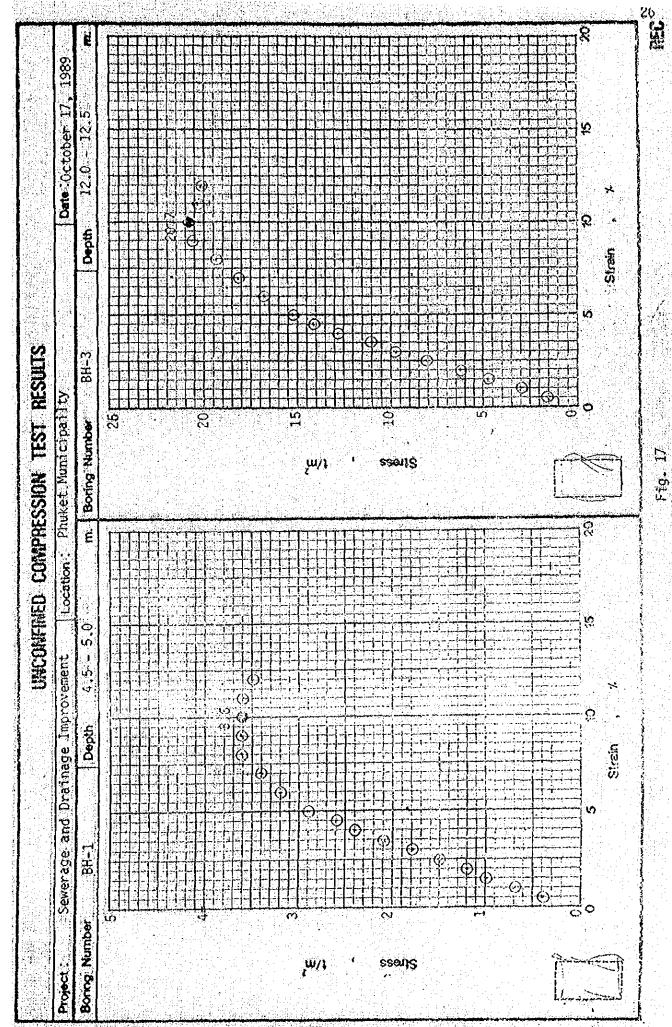
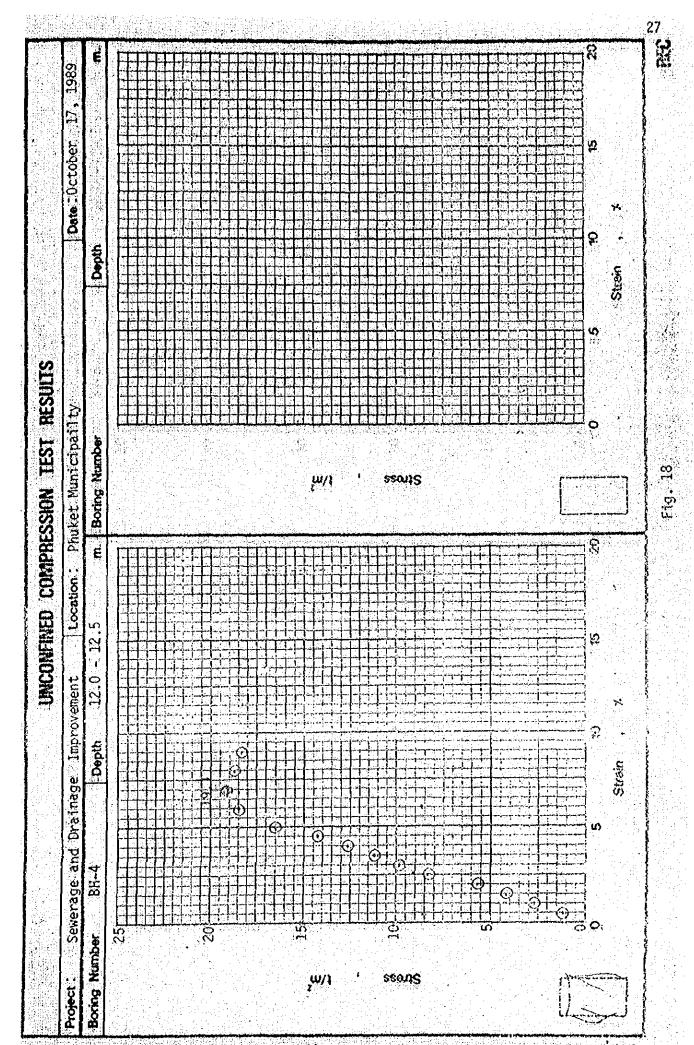


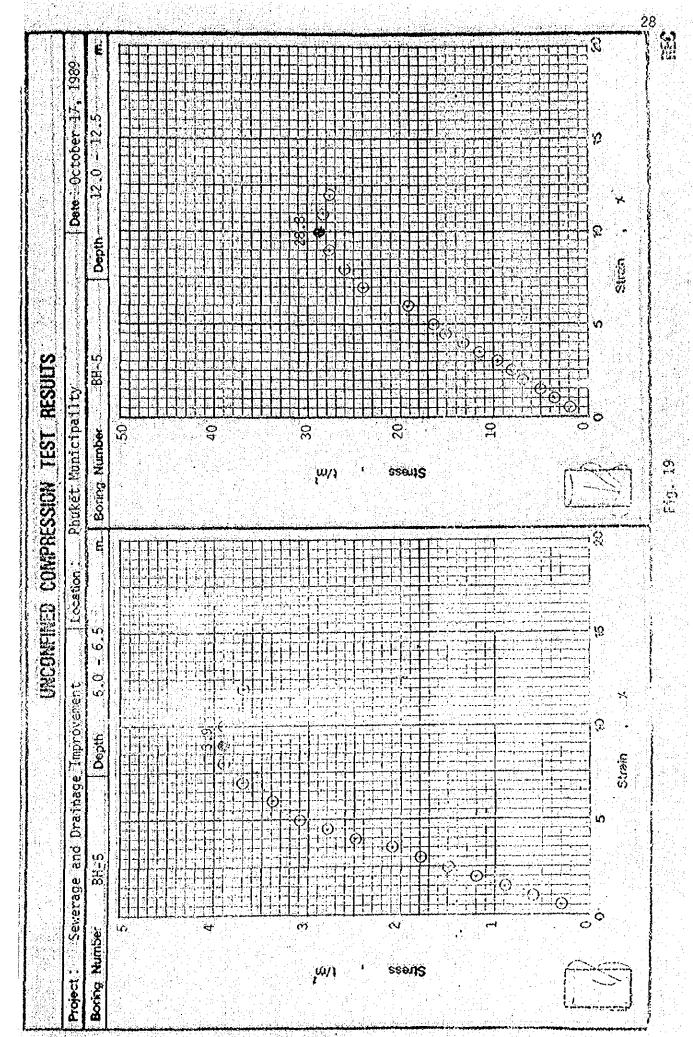
Fig. 15 UNCONSOLIDATED UNDRATIND TRIAXIAL (UU) TEST RESULT OF BH-5

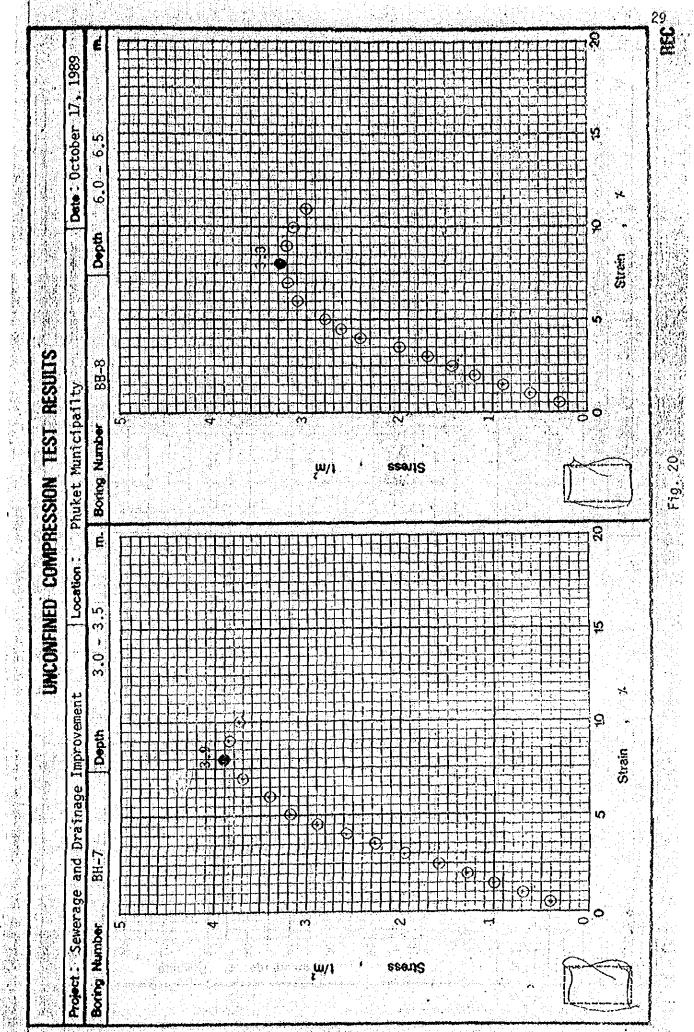


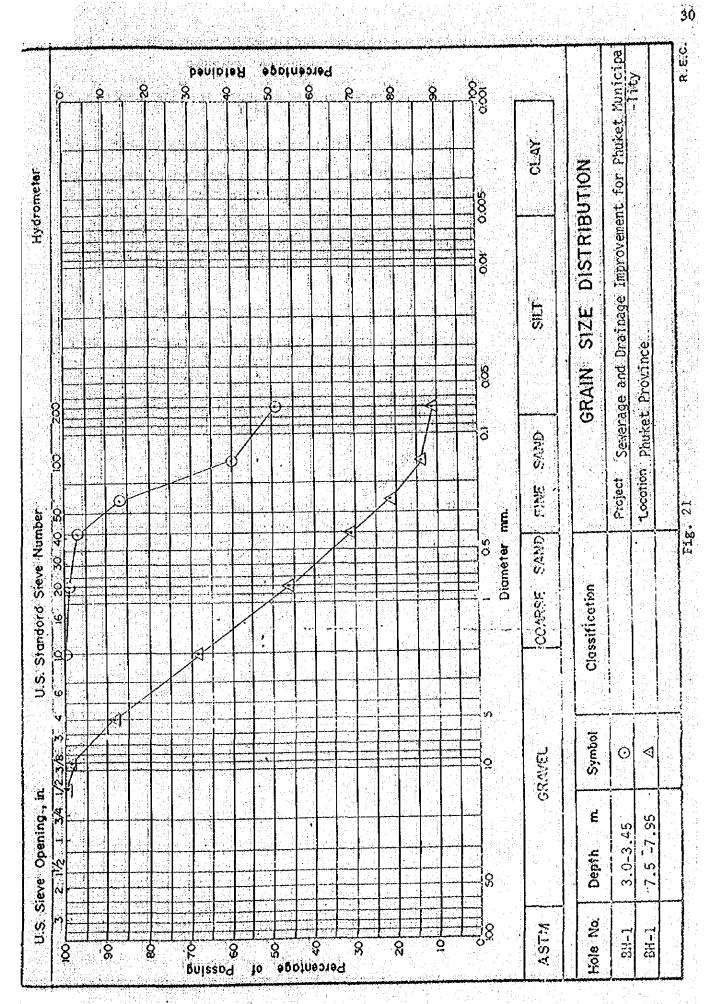
io. 15 stress - stealn of bu triaxial test of BH-5

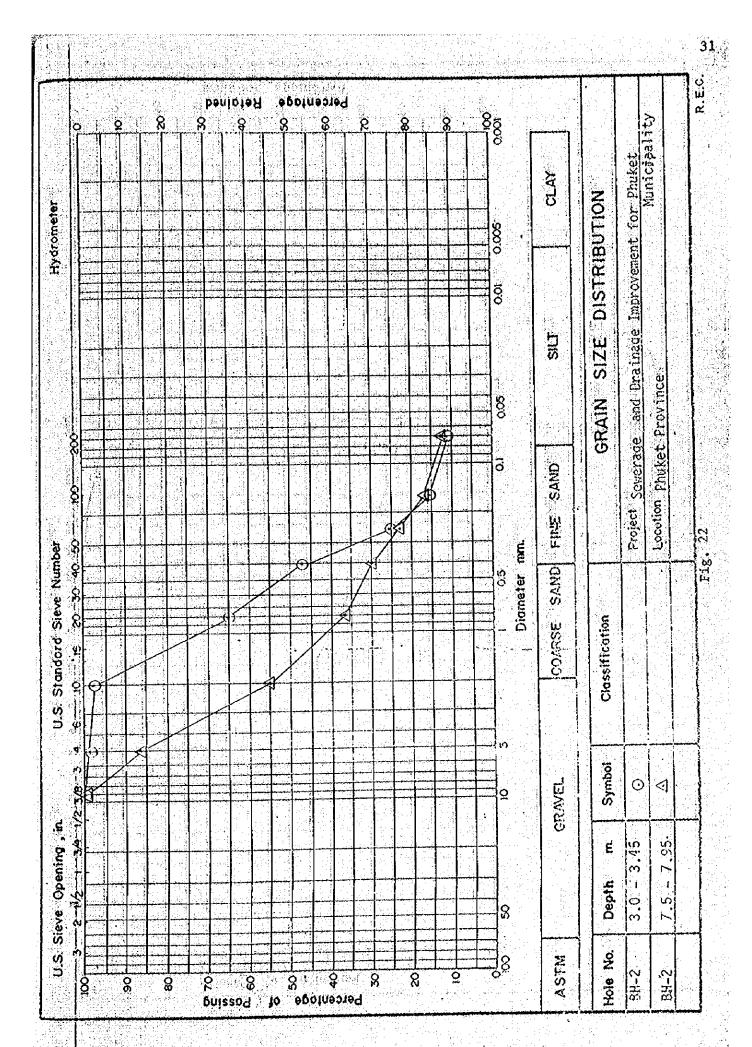


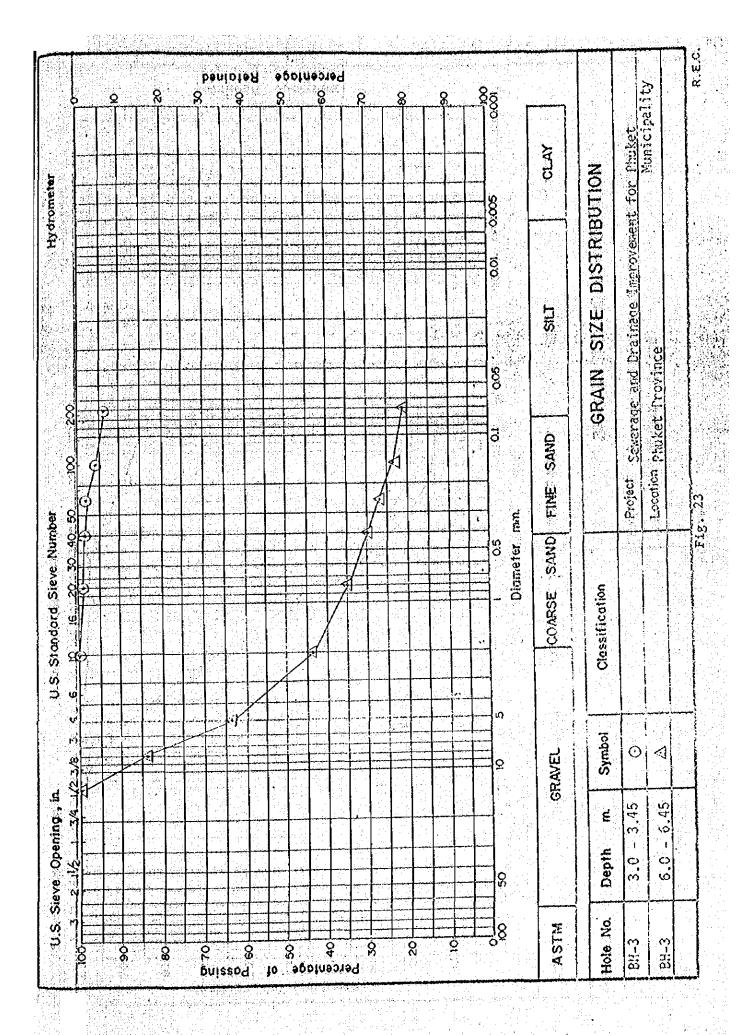


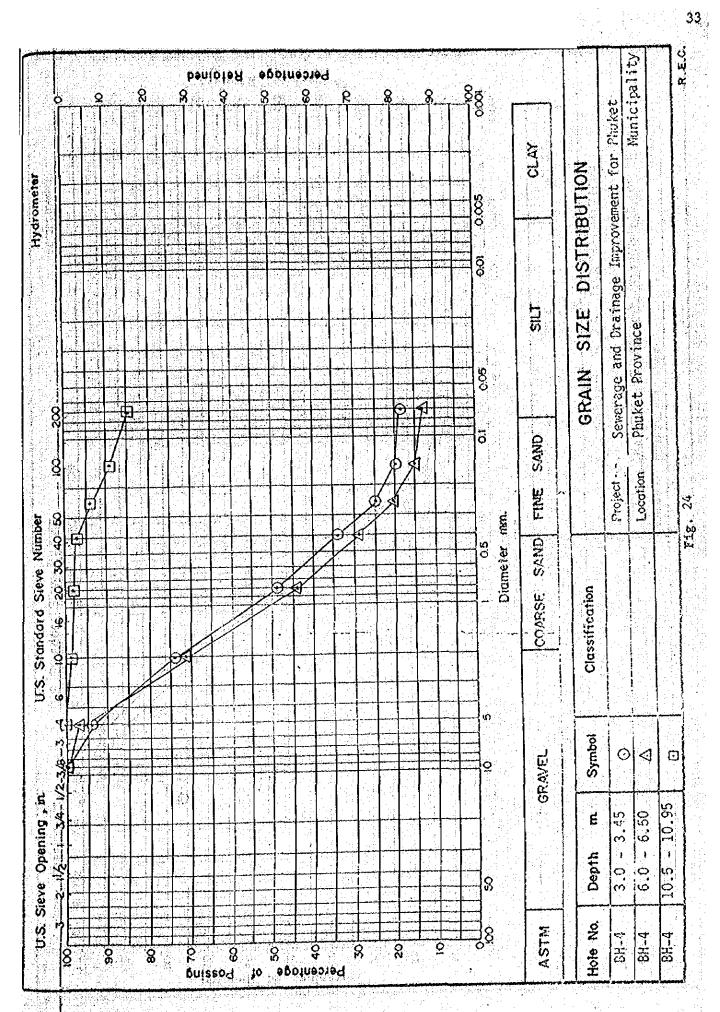


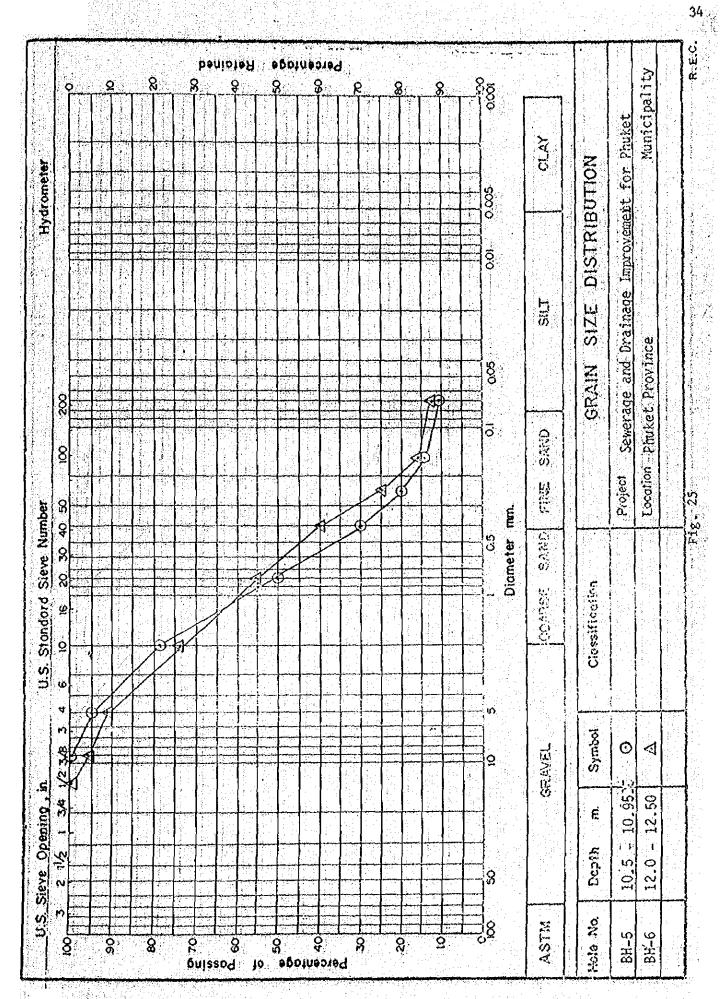


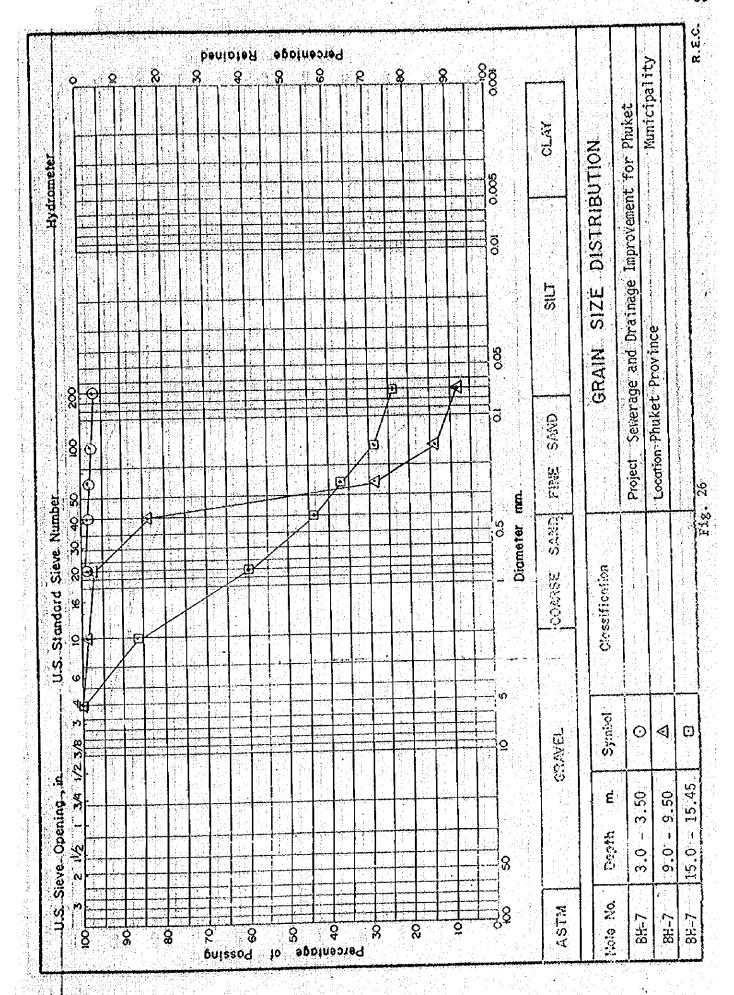


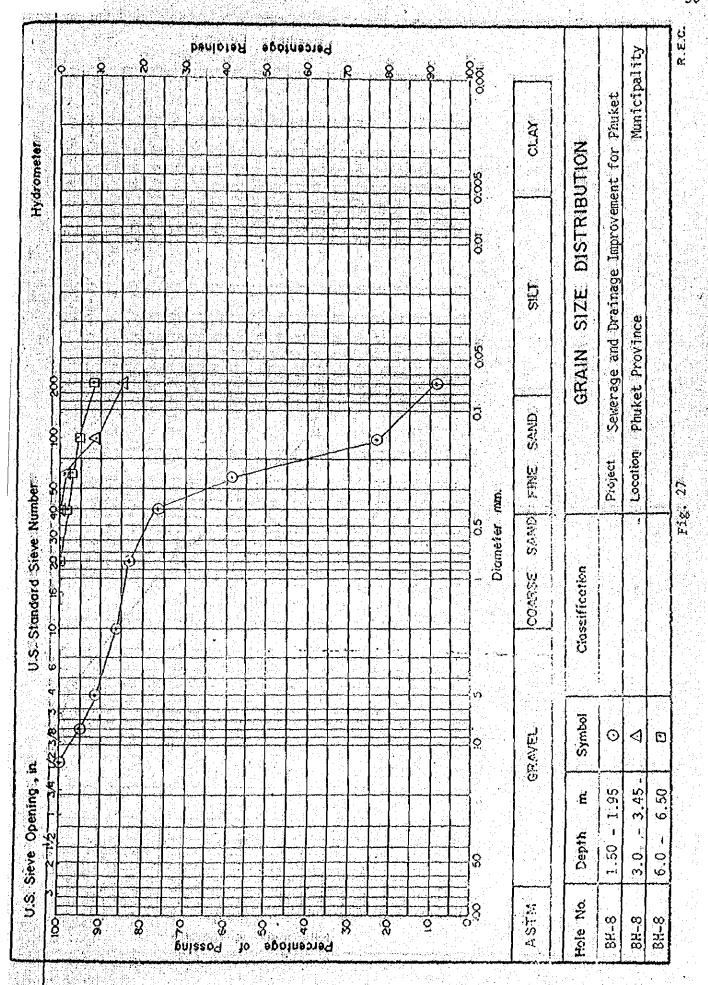


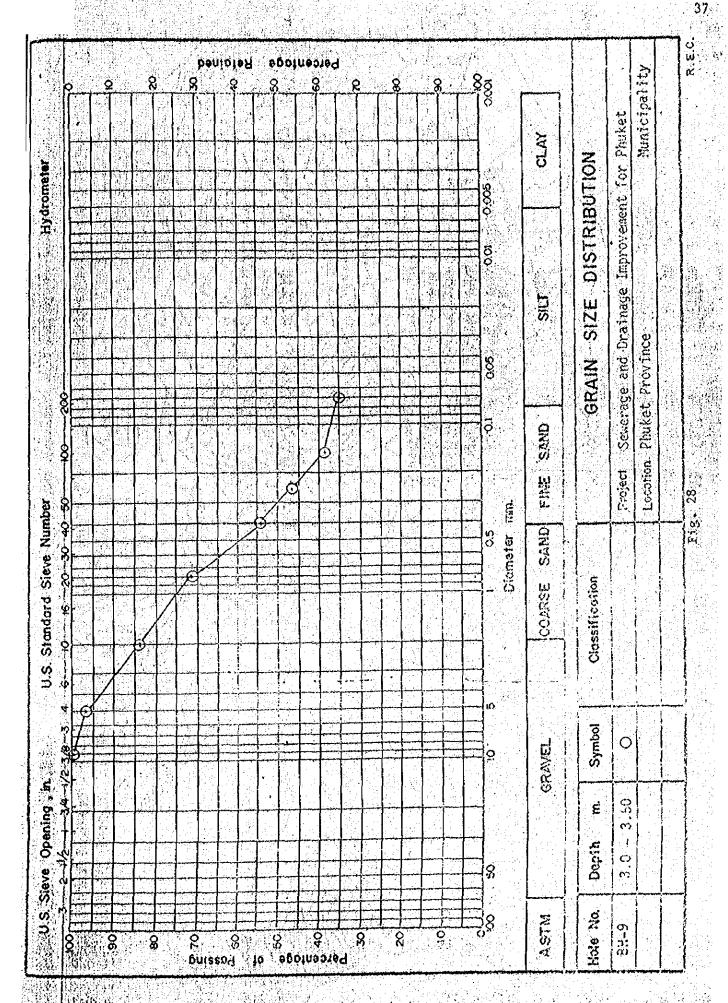












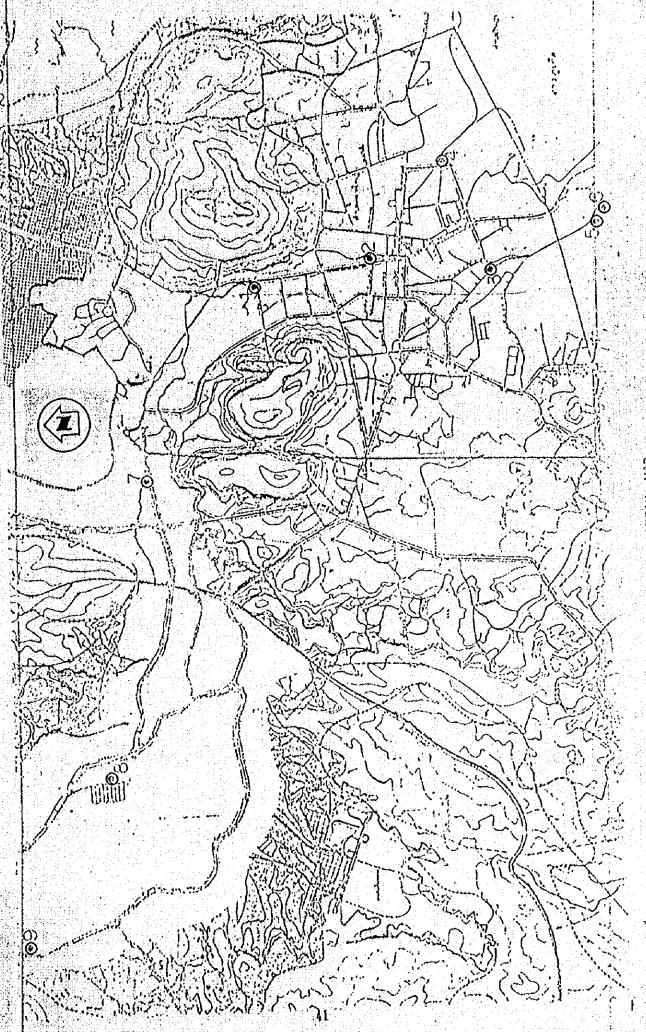


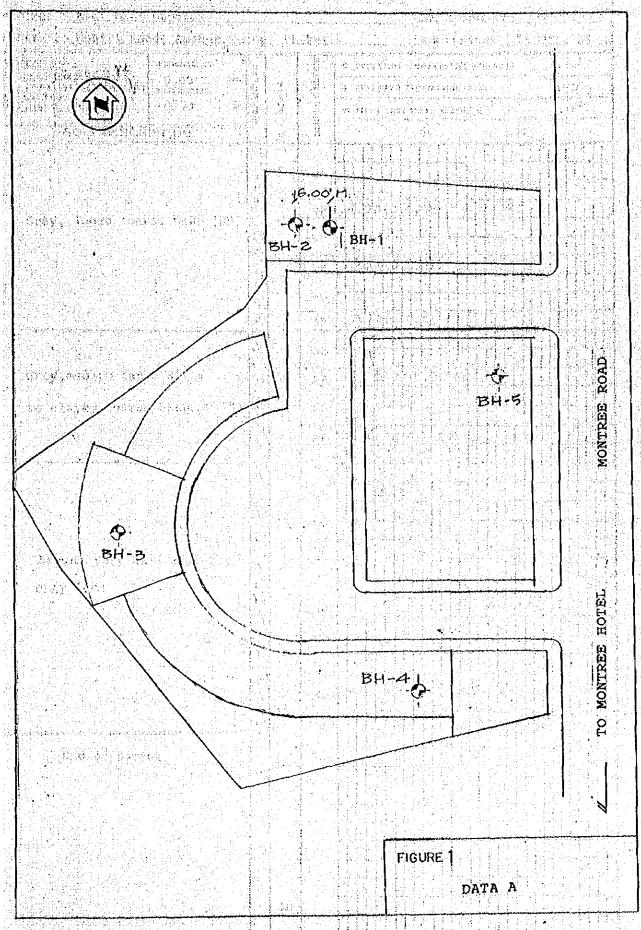
Fig. 29 SCAIMS LECATION MAR

2. Existing Geologecal Data Before JICA Study Team.

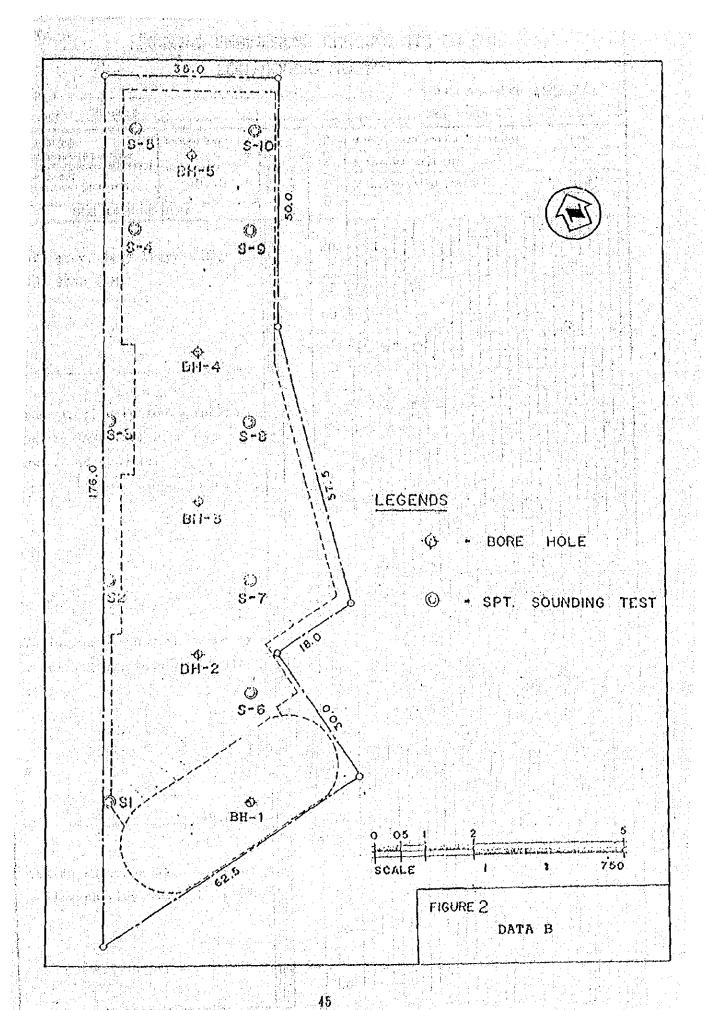
Data A

Data B

Data C



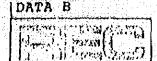
PROJECT : A.R. Mini Complex		\$ (1) sh		О. вн	DATE	COMMENCE	12	Oct.,	88
LOCATION: Montri Road, Amphur Mi ABBATYNTIONS   GROUNDELEY,	E \$50	P1	-					1/62	=
ST DUNDISTURBED SAMPLING 0.00 M	24	DEPTH	SUMPLING DETROO		iaro penetra	SSIVE STRENOTA TION TEST	بعد الإستاب	8(8/30 EM	
và è melo wwe shean test   - 0, 70 M	GRAP		XI.	e eleco	YANE SHEAR S	وب خومست الكالمات الماليسانية والأ		1/m2	
SOIL DESCRIPTION		¥.			50		00 		$\forall$
			wo						$\blacksquare$
Grey, loose coarse SAND (SP)	*		SP	<b>A</b> 10	(3 4,6)				力
			WO						$\mathbf{H}$
			\$P	<b>A</b> ji	(5 5,6)				#
			٧O						$\mathbb{H}$
	: 	5	sr	<b>A</b> 12	(\$ 6,6)				Щ
			WO						
Grey, medium dense silty	100		SP		22(8,B)	34)			
to clayey coarse SAND(SC-SM)	1		200						
	i \		SP	4	186,6,8	2)			4
	7.		VO						
	1.		SP		k (2) (9, 1 a	139111			$\mathbb{H}$
	6.	10	WO						$\prod_{i}$
Brown, very hard gravelly			SP			111111			
CLAY (EG)	(;)		KO SP				1/56	B 47	
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	Ţ,	•	NO SP			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	28 4		
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PROJECT :: Location : Phukee:			./  \		O <u>, BI-1</u> DATE COMMENCED <u>Feb. 12, 8</u> DATE FINISHED <u>Feb. 13, 8</u>
ST ) UNDISTURBED SAMPLING	ACUND ELEV. :  MATER TABLE  0 . 9 0 . M.  ON	ğ	riago M	SAMPLING METHOD	● UNCONFINED COMPRESSIVE STRENGTH 1/m <sup>2</sup> A STANDARO PENETRATION TEST BL6/FT  M FIELD VANE SHEAR STRENGTH 1/m <sup>2</sup> 50 100
Dark grey, very loos find SAND (SM)  Dark grey, very loos coarse SAND (SP) with reddish grey, very so (ML)  Yellowish brown with yellowish grey, har.	4.00 m.  a to loose h some  10.00 m.  seams of stiff SILT			WO SP WO SP WO SP WO SP WO SP WO SP WO SP WO SP WO SP WO SP WO SP WO SP	\$\frac{12}{3}\frac{3}{12}\frac{1}{3}\frac{1}{2}\frac{1}{3}\frac{1}{2}\frac{1}{3}\frac{1}{2}\frac{1}{3}\frac{1}{2}\frac{1}{3}\frac{1}{2}\frac{1}{3}\frac{1}

roject : ocation : <u>Phuket</u>	LOG		-, ,,,,\	N IY	94 G. 3								b. ] b. 1.		
<u>iduneviationis</u> IT : Vikuistungeo Sampling IP : Standano Penetration Test VO: Vash Out S : Field Vane Shear Test	GRÖUND ELEV. M. WATER TABLE -0.90 M.	GRAPHC toc	ОЕРТЫ	SWIPUNG METHOD	T	ИСОН БТАНО/	7.3	СОМРІ НЕТВ/	ESSIV	E STI TEST	LENGTH		BL:	/ m <sup>2</sup> /FT /m <sup>2</sup>	
SOIL DESCRIP	TION	;;;)	14.	3	 	111	<b>-11</b>	50	<b>'''</b> ''	7	ш	100 TTT	<u> </u>		ستهم
Yallowish brown wit	h seams of			WO						╢.	}-}-	-  -	111		
yellowish grey, hai	d silt (ML)			SP					(3	17	, <u>5</u> 0	131	越	21.1	11 /
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			254	WO						$\prod$			Ш		
	26.00 m			SP	$\left  \cdot \right $	4	$\left  \cdot \right  +$		- -	- -	$\{\cdot\}$	+		11,	
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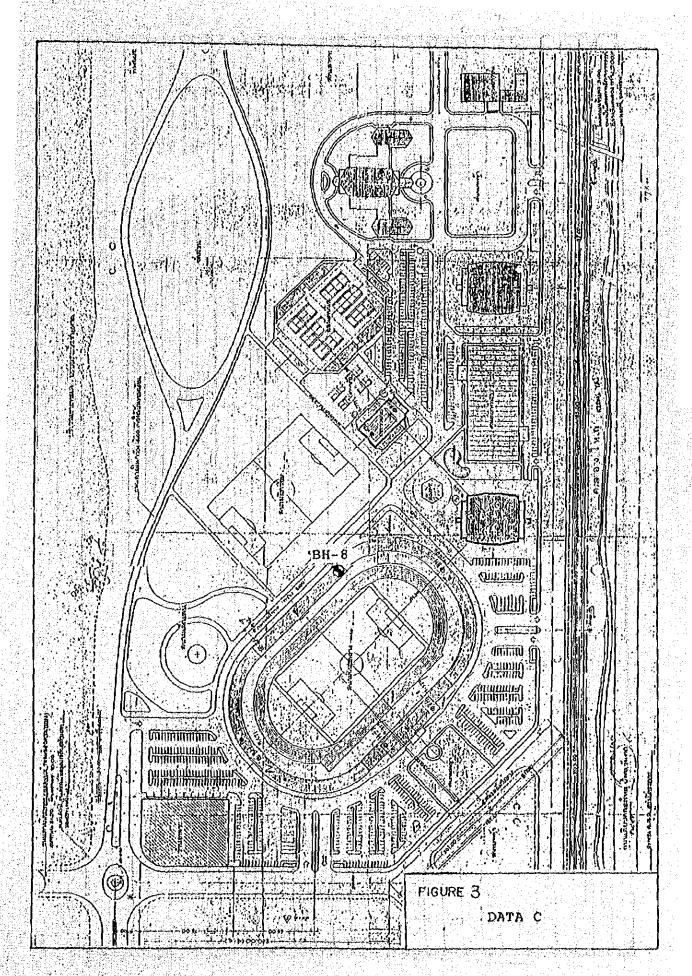


## TABLE 1 GENERAL SOIL ENGINEERING PROPERTIES

Project :

Location: Phuket

Dore Hole No.	Depth n	Water Content %	Total Unit Weight t/m <sup>3</sup>	Liquid Limit %	Plastic Limit %	Plasticity Index 2
	1.5 - 2.0	38.2	2.07			
	3.0 - 3.5	32.1	2.00			
	4.5 5.0	20\1	2.11			
	6,0 - 6:5	16.6	2.16			
	7.5 + 8.0	13.8	2.20			
	9.0 - 9.5	23,3	2.18			
	10.5 - 11.0	26.2	1.76	24.6	15.0	9.6
BN-1	12.0 - 12.5	22.4	1.90			
	13.5 - 14.0	20.5	2,00			
	15.0 - 15.5	16,8	2,00			
	16.5 - 17.0	20.7	2,06	22.8	14,3	8,4
	10.0 - 18.5	19.7	2.03			
	19.5 - 20.0	18.3	2.09	24.4	14.5	9.8
	21.0 - 21.5	16.2	2.02			
	22,5 - 23,0	18.6	2.07			
***	24.0 - 24.5	17.8	1.84	1		



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