GEOTECHNICAL EVALUATIONS OF HALIÇ's SEDIMENTARY LAYERS

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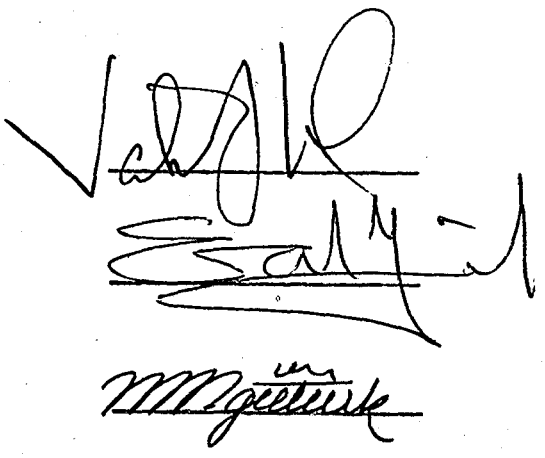

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Mahir KÖSELER

Istanbul, April 1984

ÖZET

Haliçteki yumuşak zemin tabakalarının varlığı, dip çamurunun taranması esnasında büyük boyutlarda geoteknik problemler ortaya çıkarır. Bu yüzden bu tabakaların taranması esnasında oluşabilecek kritik durumları önlemek için bazı geoteknik hesaplamalar yapmak zorunludur.

Bu tezde ilk olarak Haliç'in genel jeolojisi ve zemin durumları incelenir. Haliç boyunca 12 kesit halinde jeolojik oluşum(zemin durumu) verilir. Ayrıca bu tabakalarla ilgili geoteknik özellikler verilir. Haliç ve çevresindeki çevre problemleri ve Haliç'in taranması durumu araştırılır.Haliç'teki tabakaların çok yumuşak ve zayıf olmasından dolayı,kıyıların stabilitesi taranma yapılmadan önce araştırılması gerekir. Bu sebeble şev stabilitesi hakkında kısa bilgi ve bununla ilgili computer program(KÖSELER-I) geliştirildi.

Sonuç olarak, bazı jeolojik ve geoteknik sonuçlar ve taranma esnasında ve öncesinde oluşabilecek kritik durumları önlemek için neler yapabiliriz hakkında bazı tavsiyelerde bulunulacaktır.

ABSTRACT

GEOTECHNİCAL EVALUATIONS OF

HALIÇ's SEDIMENTARY LAYERS

The presence of soft layers in Haliç create a great deal of geotechnical problems during the dredging of Haliç. It is necessary to make geotechnical evaluations to prevent critical situations during dredging.

The general geology and soil conditions in the area are studied. Geological formation along Haliç is given by geological cross-sections. Geotechnical properties of these layers are documented. The environmental problems in the vicinity of Haliç and dredging of Haliç are investigated. Since the layers(bottom sludge and underlying clay formation) are very soft and weak, stability of the shores should be considered before dredging. So stability of slopes is studied and the computer program for slope stability (KÖSELER-I) are given.

Some geological and geotechnical conclusions and recommendations such as what can we do to prevent critical situations that may arise before dredging and during dredging are given.

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TABLE 3.2 Volume and Location of Previous Dredgings in Haliç

CHAPTER I

INTRODUCTION

Geotechnical problems ,having serious effects on people and buildings,generally require alarge amount of investment and have to be handled urgently. On the other hand,the nature of the problems varies depending on the type of the sources and environmental conditions,and that variations mostly makes necessary to study geological study and the geotechnical properties of the site.

Generally,environmental problems are to be handled and solved together with geoteehnical problem.In fact,each geotechnical problem at the inhabited sites,has a tendency to be an environmental problem. The outcomes of geotechnical problems such as erosion,slope stability and dredging have an importance for people.The large amount of investment and urgency is necessary for the solution of such kind of problem

Haliç is 7.5 kilometers long natural inlet of the Bosphorous strait.The maximum width is 900 meters at the mounth,which is between Sarayburnu and Tophane Mosque,and the minimum width is 150 meters on th upstream side at the outlet of Alibey and Kağıthane Creeks.Its surface area is a total of 2.6 million square meters.Maximum depth in Haliç is 36 meters and it shallows down to a few meters deep near Kağıthane Cre

Haliç has begn a center of attraction and recreation in forn times.It has a very significant historical back ground, and is surroun ded by buildings dating from Ottoman and Roman days.

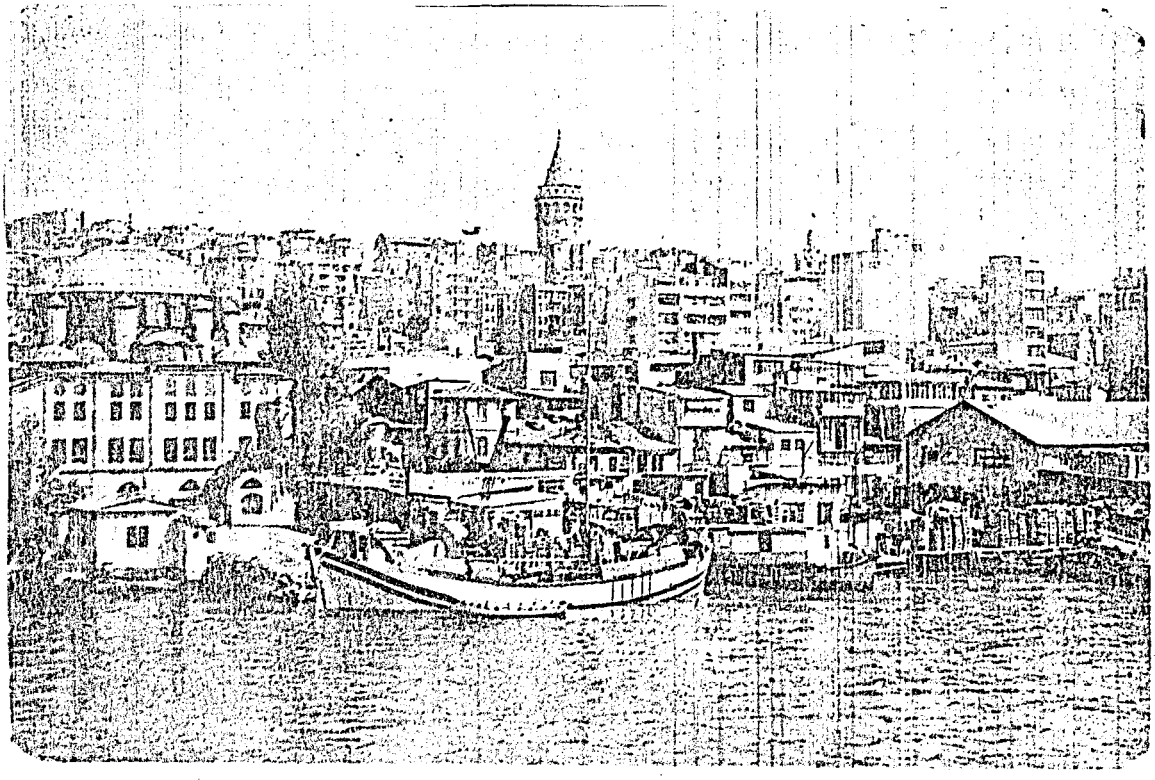


FIG. I.I General view from Azapkapı

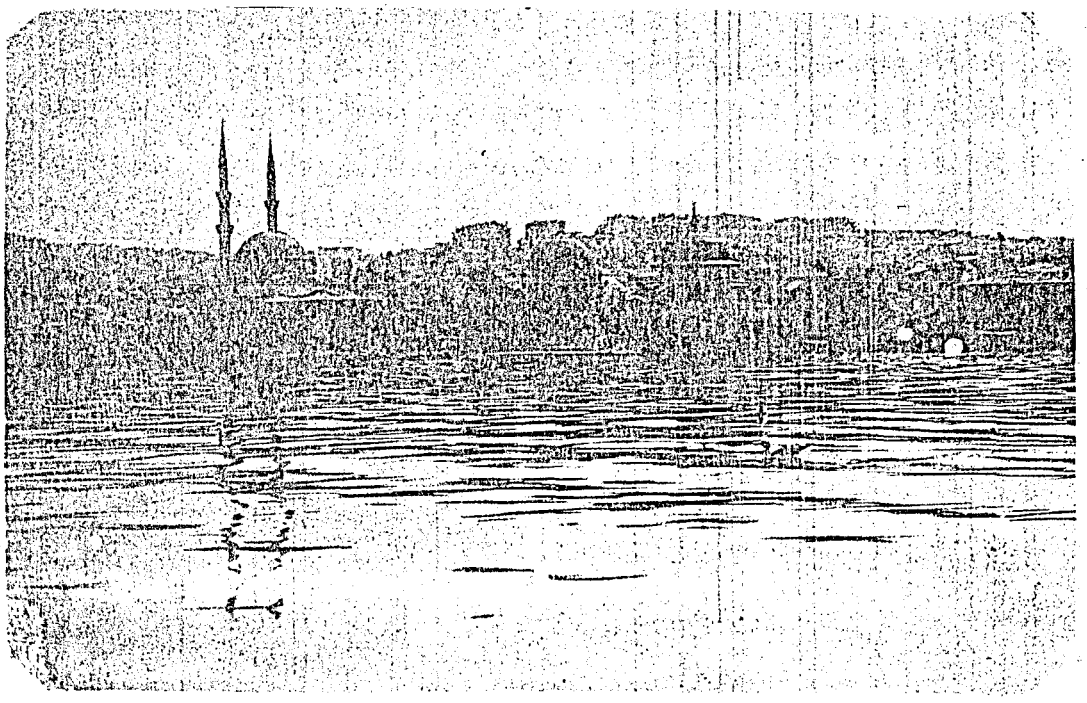


FIG.I.2 Historical view from Eyüp

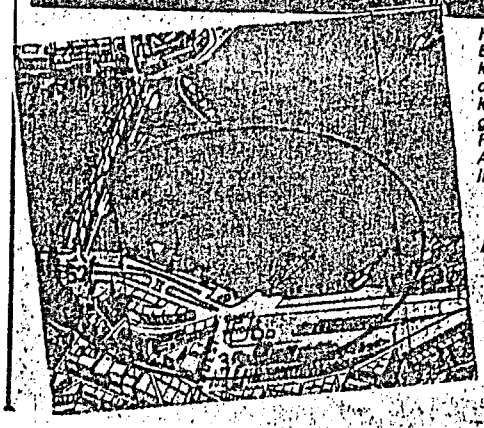
Over the years,industrial and domestic wastes,erosion,uncontrolled fill and garbage,shipyard wastes and sewage have polluted Haliç.So it has developed into an unbearable and unhealty condition.Additionaly,soft layers encountered in the vicinity of Haliç create special geotechnical problems to the area.

The soil conditions in Haliç will cause some geotechnical problems dnring dredging.Therefore,prior to any construction,development alteration of conditions and dredging the existing soil conditions and soil properties should be determined in chapter II, the general geology of the area is documented.All previous borings drilled in the area are given.The soil conditions are determined based on the available informations.The avarage soil properties are estimated based on many measuraments reported previously.

In chapter III,environmental problems of Haliç and water pollution is summarized.Also volume and location of previous dredgings and types are given.

The presence of soft fills brings a great deal of geotechnical problems to the area.The considerable amount of increase in thickness of this formation towards the sea causes stability problems,(Fig.I.3 , Fig.I.4).The geotechnical conditions in the vicinity of Haliç make necessary for a preliminary study of slopes before and during dredging.In chapter 4, stability of slopes are studied. Also computer program for slope stability (KÖSELER-I)is developed.It makes easier to solve and compute problems.

Based on the findings and the results of this study recommendations for future construction and to prevent critical situations dnring dredging are summarized in chapter 5.



Haliç'in, planda işaretlendiği gibi, özellikle Eminönü ile Sirkeci arasındaki bölümündeki kayma daha belirgin şekilde oluyor. Sirkeci'deki arabalı vapur iskelelerinden birinde kayma yüzünden büyük çatlamalar meydana geldi. İstanbul Üniversitesi Yer Bilimleri Fakültesi öğretim üyesi Prof. Dr. Mehmet Akartuna, kullanılmaz duruma gelen iskelede incelemeler yaptı (yukarda). (Ali BOSTANCI)

Haliç kıyıları denize kayıyor

Piza kulesi gibi binalar

Haliç'in Eminönü kıyısında bulunan ve "Yağ iskelesi" olarak bilinen kesimdeki 100'e yakın binanın denize kaydığı bildirildi. Duvarlarında derin çatlaklar meydana gelen ve denize eğilerek Piza Kulesini andıran binalarda oturulamayacağı ileri sürüldü.

Yağ iskelesinin denize kaydığı tespit edildi

HALİÇ YUTUYOR!

Fig.I.3 , I.4 News from Turkish Newspapers about sliding of Haliç shores.(Milliyet,1981and Hürriyet,1980)

CHAPTER II

GEOLOGY AND SOIL CONDITIONS

2 .I INTRODUCTION

In following chapters,the environmental problems and the relations with geotechnical problems in the vicinity of Haliç will be explained. In order to find reasonable solutions of the stability problems and to make reliable investments,geological conditions should be known. In this chapter geological conditions and geotechnical considerations in the vicinity of Haliç will be given.The extend of soil layering along Haliç will be given.Also geotechnical properties of each soil layer will be summarized.

2 . 2 GEOLOGY

The geology in the vicinity of Haliç has been studied by many investigators. One of them,Penck(I9I9), was first to recognize the graywackes ,"Tharace series", as the oldest formations in the area.They belong to the Lower Devonian to Upper Devonian periods of Paleozoic era.After that Packelman(I925) changed that as upper Devonian.But the existance of various litological and paleontological zones in the Thrace series was indicated by later research.They belonged to the Lower Carboniferous(Upper Paleozoic) period of the same era.

Recently, a complete geological map of Haliç and its vicinity was given by Sayar (I976),Figure 2.I . It is seen from this figure that the oldest rocks in the area,in Upper Paleozoic (Lower Carboniferous) age and consist of shales and graywackes.

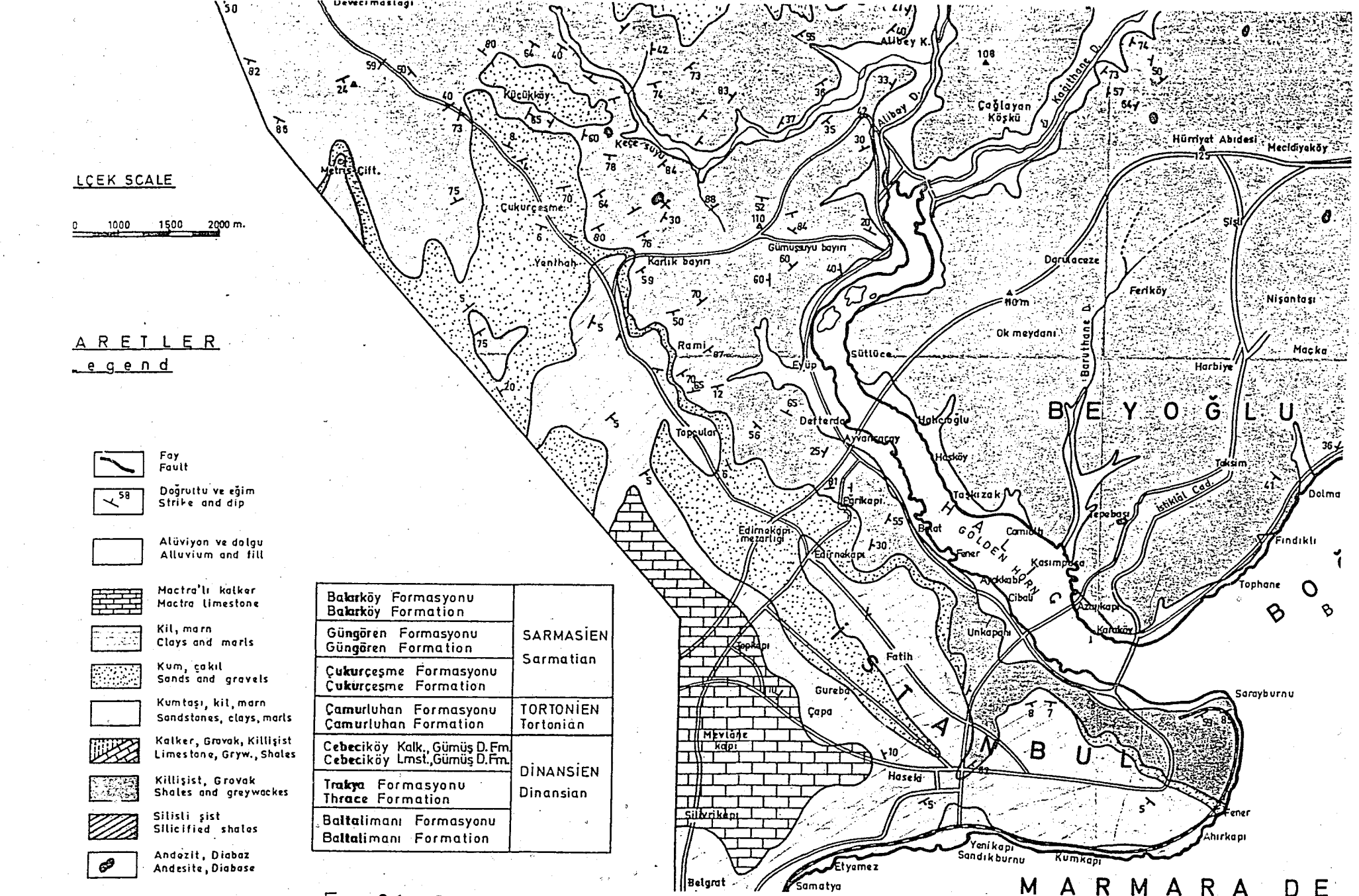


Fig. 2.1 Geological map of Haliç and its vicinity (Sayar, 1976)

At the southern part of Haliç on the top of the Paleozoic formations the middle and upper Miocene formations of sand and gravels, clays and marls mactra limestones are encountered. Along the shore lines and below the water of Haliç and Creeks however, the Quaternary alliviums are found.

A . UPPER PALEOZOIC (Lower carboniferous)

Most of the information concerning this information is obtained from comparatively shallow borings and excavations a few meters deeps at various places in the Istanbul Area. In the detailed studied of recent years , the paleozoic formations in the vicinity of Haliç are classified.

Baltalimanı Formation :

This formation is observed at both sides of Northern part of the Bosphorus and around İçerenkoy. It consists of black silicified and intensively folded shales.

Trakya Formation :

Found in a large part of the area and consist of graywackes and shales. Some parts are decomposed by atmospheric effects taking on a green - grey or yellow-brown colour. The alternation of layers of coarse and fine grains shows the sedimentary structures such as cross-bedding, slumbing etc.

Cebeciköy Limestone:

This formation found on top of Trakya Formation covers an area of about 1,000,000 square meters around Cebeciköy. It consists of crystalized massive limestones and dolomatic limestones containing numerous calcite veins.

Gümüşdere Formation :

It is observed that near Cebeciköy Formation and consist of shales, silicified shales and tuff.

B . MIDDLE AND UPPER MIOCENE

The formations belonging to the middle and upper Miocene are not common in the vicinity of Haliç. But middle Miocene (Tortonien) formation is encountered in a limited area near Çamurhan, 7 to 8 kilometers from Eyüp. The formation consists of grey coloured marls, sands,yellow coloured clays, micaons sand stones,and grenish sandy clays. The thickness of the formations was found to be 30 to 40 meters.

To the south and south west of Haliç the Paleozoic base is overlain by a thick upper Miocene (Sarmacien) formation. It is thickness reaches I50 meters at places. Upper Miocene was divided into three units by Sayar (I976). Each unit has the name of the area where the characteristics of the unit is observed.

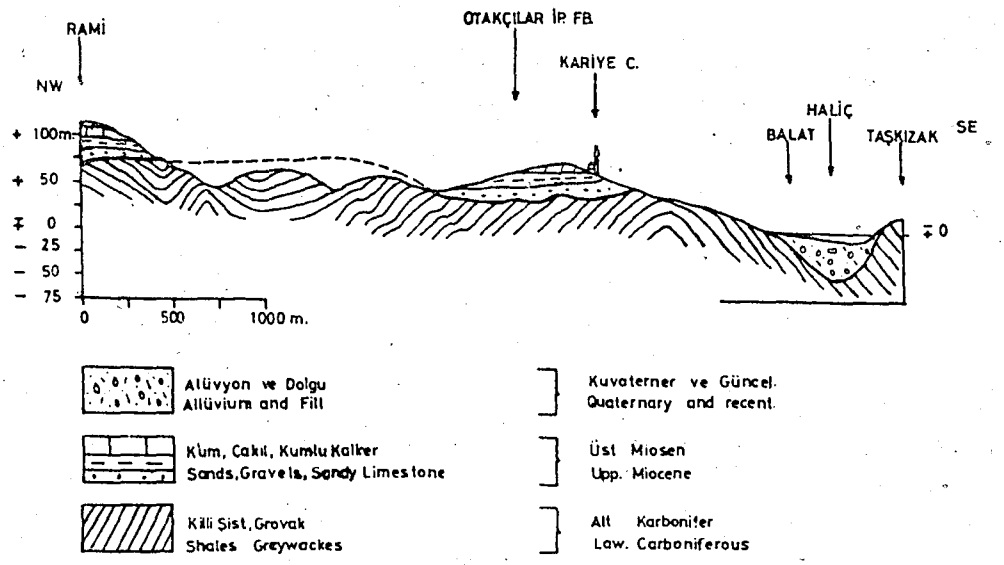


Fig 2.2 Geological cross-section between Rami-Taşkızak(Sayar,I976

I) Sand and gravel beds of Çukurçeşme formation consists of fine sand bands and lenses.

2) Marl and green clay beds of Güngören formation are generally found on top of the sand and gravel beds. At the western part of the walled city marl and clay bed are overlain by limestone beds. Güngören formation consist of vertebrateand mollusc fossils.

3)Limestone beds of Bakırköy formation may easily be recognized by the variety of mactra species they contain.Thick beds of limestone exist in the Bakırköy area.

C) QUATERNARY AND CURRENT SEDIMENTS (Recent) :

The youngest geological formations in the area are alliviums in the beds of creeks and sediments at the shore of Haliç and the bottom of the sea.Artificial fills along the shore will be classified in this group also. These may be classified according to their characteristics as follows:

a) River Alliviums (Flood-plain deposits):

They are observed in the bottoms of the valleys of Alibey and Kağıthane Creeks. They are commonly consist of continuous layers of sand and clay laid down during the high-water season.

b) Marine Deposits :

At the shores and the bottom of Haliç on the paleozoic base a silty-clay layer containing marine organism is found. The extent of these sediments might be overlooked since the coast line has been greately changed over the years. The thickness of this layer varies from I to I2 meters at the shores and 40 to 50 meters at the bottom of Haliç.

c) Bottom Sludge (Recent) :

Borings carried out in the middle part of Haliç showed the existence of a mud layer. The thickness of the bottom sludge decreases near the shores. It is formed by sedimentation of erosed materials and pollutant in the water. It is also explained in chapter III.

d) Artificials fills (Recent):

They are found atthe shores and around Haliç just below the ground level. They consist of stones ,bricks,pieces of concrete,wood,rubble,etc. The thickness of that decreases away from the shore line. Between Galata and Unkapanı Bridges,the thickness of artificial fills are 30 - 40 meters.

2 . 3 SOIL CONDITIONS

There have been many geotechnical investigations related to various contructions at the vicinity of Haliç. The locations of some of the boreholes drilled for the determination of soil condition in these investigations are shown in Fig. 2. and table 2.I These boreholes are shown in Appendix A.

Also a list of these borings with their references are given in table 2.I. I2 typical geotechnical cross-sections,along Haliç, determined from the results of these borings are given as Figures in Appendix.

TABLE 2.I

LIST OF GEOTECHNICAL BORINGS LOCATED IN THE VICINITY OF HALIÇ

Boring Group No	LOCATION	REFERENCE
I	Silahtarağa Power Plant	Peynircioğlu,I975
2	Istanbul Mill , Sütlüce	Peynircioğlu,I965
3	Golden Horn Bridge	S. Maden,I975
4	Istanbul Sewage Project	Temel Araştırma,I982
5	Istanbul Sewage Project	CAMP-TEK-SER-I974
6	Taşkızak Shipyard, Hasköy	Special Report
7	Camialtı Shipyard, Kasımpaşa	Special report
8	Haliç Shipyard, Azapkapı	Special report
9	Draper Market, Unkapanı	Sayar, I962
I0	Social Security Department Complex,Unk.	Peynircioğlu,I973
II	Chamber of Commerce House, Eminönü	Peynircioğlu,I973
I2	Preliminary Subway Study	Sayar, I962
I3	Preliminary Subway Study (I978)	General Dir.Of Highway
I4	Silahtarağa Stell Plant,Alibeyköy	Special Report

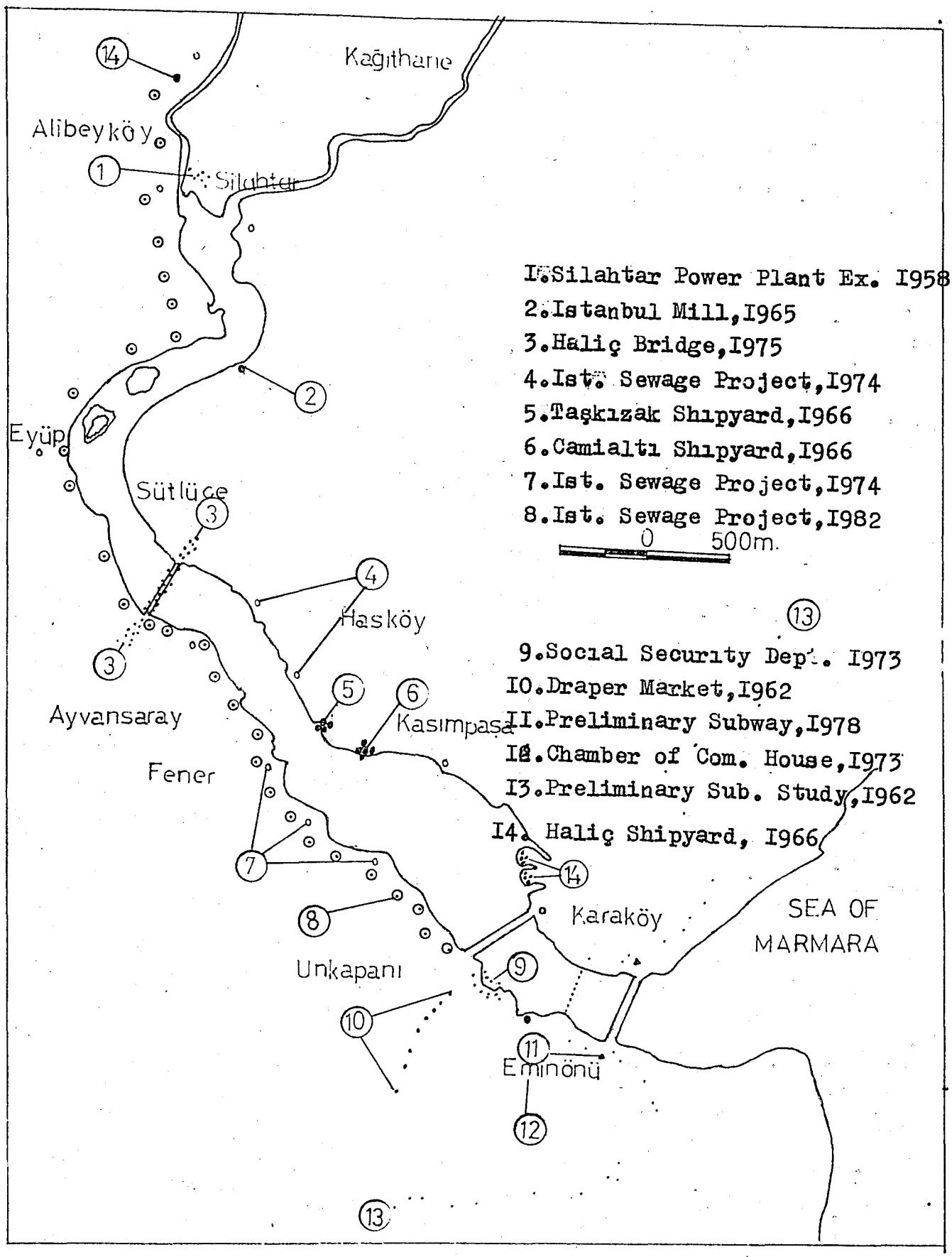


Fig.2.3 Geotechnical Borings Located In The vicinity of Haliç

A. BEDROCK FORMATION

It is seen from cross-sections the depth of the bedrock formation varies considerably at various locations and the dipping of the bedrock surface towards the sea varies between 20 and 45 degrees. This steep slope is the main cause of lateral movements across the shdre.

The graywackes and shales contain local fault zones with various strike planes and dip angles. The layers which are close to the surface are highly weathered and fractured. The colour of the weathered parts are yellow and brown.

The thickness of the weathered zone of the graywackes and shales is not homogenous,but varies from place to place.The thickness of the weathered zone of the graywacke ,in Eminönü, 30 meters.(Sayar,1975) It decreases along upper part of Haliç. As a result , the graywacke formation is mainly fissured and upper part is decomposed.

The engineering properties of the graywackes and shales have been investigated by many researchers. The engineering properties and unconfined compressive strengths of graywacke samples,from two different locations,are given table 2.2,(Toğrol,1975).

Table 2.4

STRENGTH TEST ON GRAYWACKE SAMPLES (Toğrol, I975)

	Zeyrek Underground Passage Construction	Test pit near Istanbul Technical Univers.	Zincirlikuyu Office Building Construction
Depth, m	4-6	0-2	6-I0
γ_n , gr/cm^3	2.36-2.46	2.38-2.54	2.42-2.54
γ_s , gr/cm^3	2.74	2.78-2.82	2.78-2.80
w , %	7.3-8.3	2.3I-8.05	5.92-7.23
n , %	0.I75-0.I85	0.I42-0.I70	0.I42-0.I95
e , %	0.2I2-0.227	0.I66-0.205	0.I70-0.242
γ_{dry}, gr/cm^3	2.23-2.26	2.32-2.40	2.26-2.40
s , %	98.5-I00.0	32.5-I00.0	83.5-97.6

γ_n , Natural Unit Weight

γ_s , Unit Weight of solid particul.

n , Porosity

e , Void Ratio

s , Degree of Saturation

w , Water Content

B . SEDIMENTARY LAYERS-QUARTERNARY AND RECENT ALLIVIUMS

I) Artificial fills:

The thickness of such fills decreases with increasing distance from the shore. Along Haliç shores, artificial fills vary in thickness from a few meters to almost 40 meters.The artificial fill contains gravels, sand, boulders, silt, shells, wooden pieces, concrete and all kind of city debris.

The existance of this uncontrolled fill is very important from various points:

i) The thickness of the fill increases towards the sea. Therefore, it causes uneven settlements for buildings constructed on top of the fill layer.

ii) The properties of this fill is not known and varies considebably from one point to another. The properties of some of them are given in table 2.5.

iii) The existance oif this layer in land alter the grey silty clay properties due to consolidation of silty clay under the the weight of the fill.

Fig. 2.4 Borings taken from Haliç Shipyard (special report, 1966)

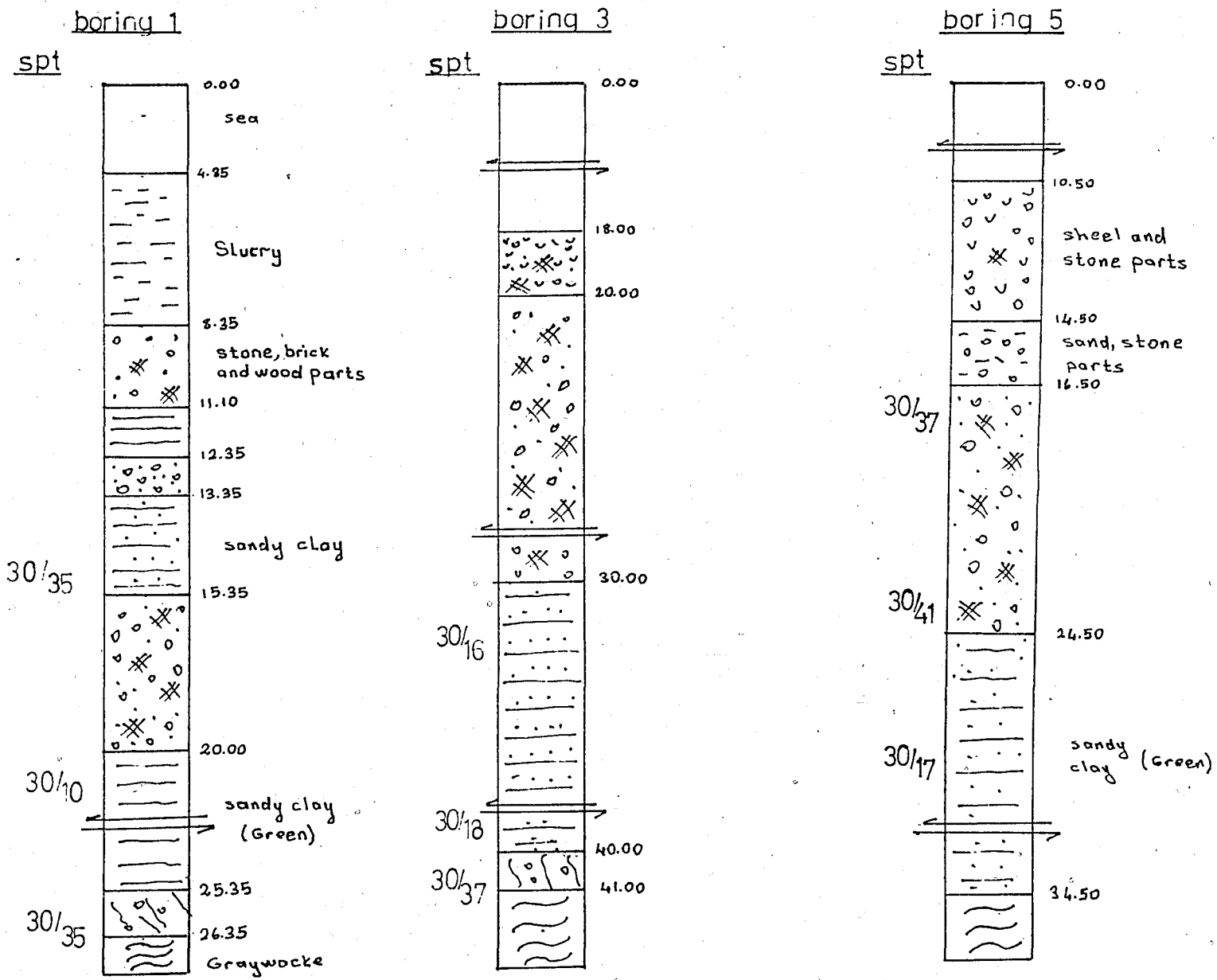


Table 2.5

LAB.REPORTS TAKEN FROM HALIÇ SHIPYARD BORINGS

(Special Report,1966)

Boring No:	Depth,m.	W_l	W_p	I_p	W_n	γ_s
I	18.00	35	21.7	13.3	36.9	2.7
3	23.00	-	-	-	-	2.78
5	18.00	61	30.3	30.7	33.4	2.73

W_l , Liquid Limit

W_p , Plastic Limit

I_p , Plasticity Index

W_n , Natural Water Content

γ_s , Unit Weight of Solids

γ_n , Natural Unit Weight

Table 2.6

Boring No:	q_u , kg/cm^2	γ_n , t/m^3
I	0.06	1.73

q_u , Unconfined Compressive Strength

Fig. 2.5 Borings taken from Taşkızak Shipyard (special report, 1980)

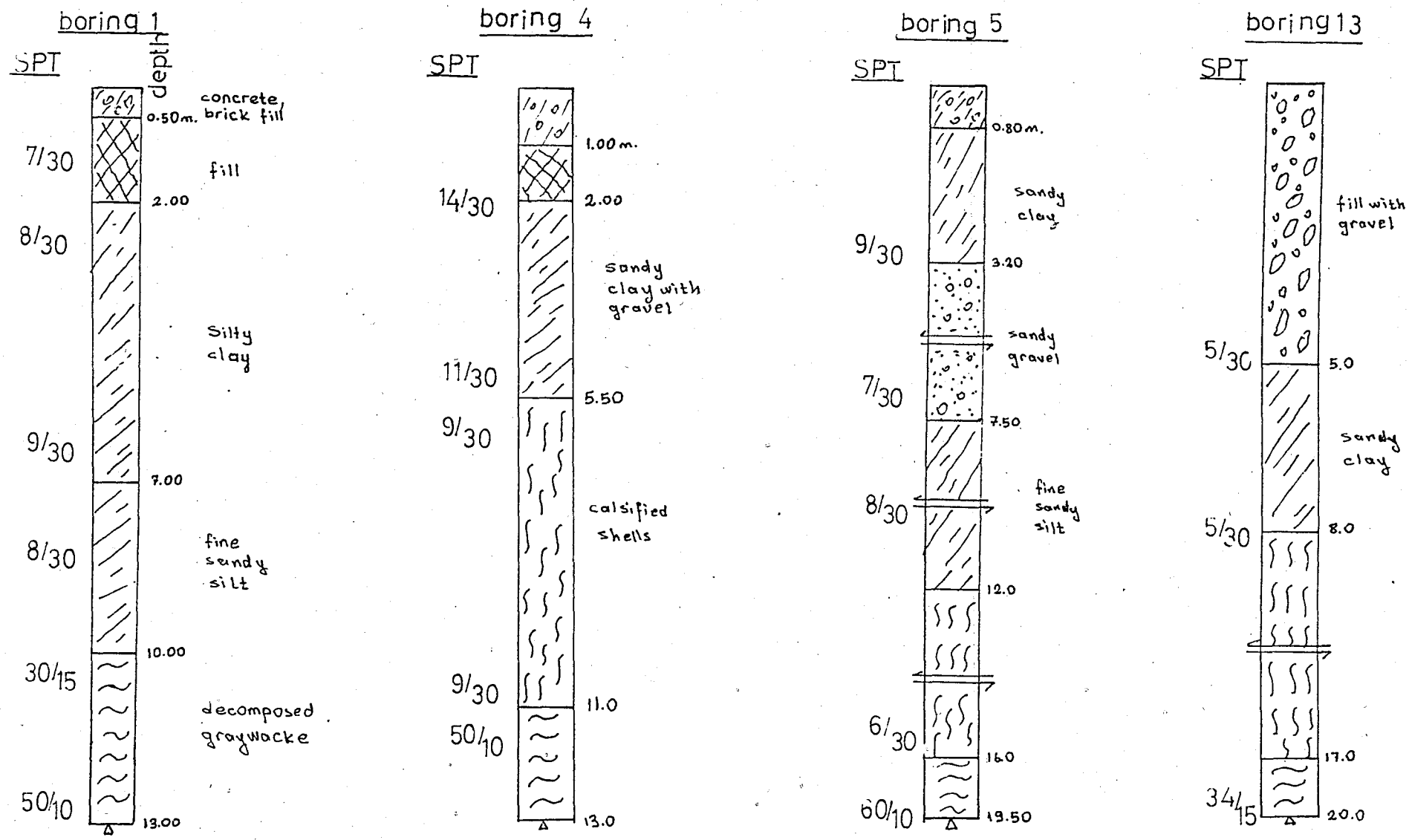


Table 2.7

LAB. REPORTS TAKEN FROM TAŞKIZAK SHIPYARD BORINGS

(Special Report,1980)

	Boring No:1 (Depth 3m.)	Boring No:4 (Depth 3m.)	Boring No:5 (Depth 3m.)	Boring No:13 (Depth 3m.)
W_n (%)	21.4	18.4	21.3	22.0
W_l (%)	30.9	28.0	27.1	32.7
W_p (%)	19.0	15.00	19.6	22.3
I_p (%)	11.9	13.4	7.5	10.4
I_c (%)	0.85	0.74	0.77	1.03
ϕ_u(°)	12 (.)	7 (..)	-	27 (.)
C_u	0.60 (.)	0.30 (..)	-	0.20 (.)
W_n(%)	20.4 (.)	20 (.)	-	20.60 (.)
γ_n	1.97(.)	2.07(..)	-	1.97(.)

(.) Quick Shear Test

(..) Triaxial Test

2) Sedimentary Layers :

The sedimentary layers which are found under the artificial fill consists of sandy, clayey silts, contain large amount of organic matter and sheels. The thickness of this layer varies from 6.0 meters, near Galata Bridge, up to 35.0 meters, near the Creek outlets. (Kumbasar and Ülker, I975)

This formation contains organic matters in high percantage and the water content is around Liquid Limit.

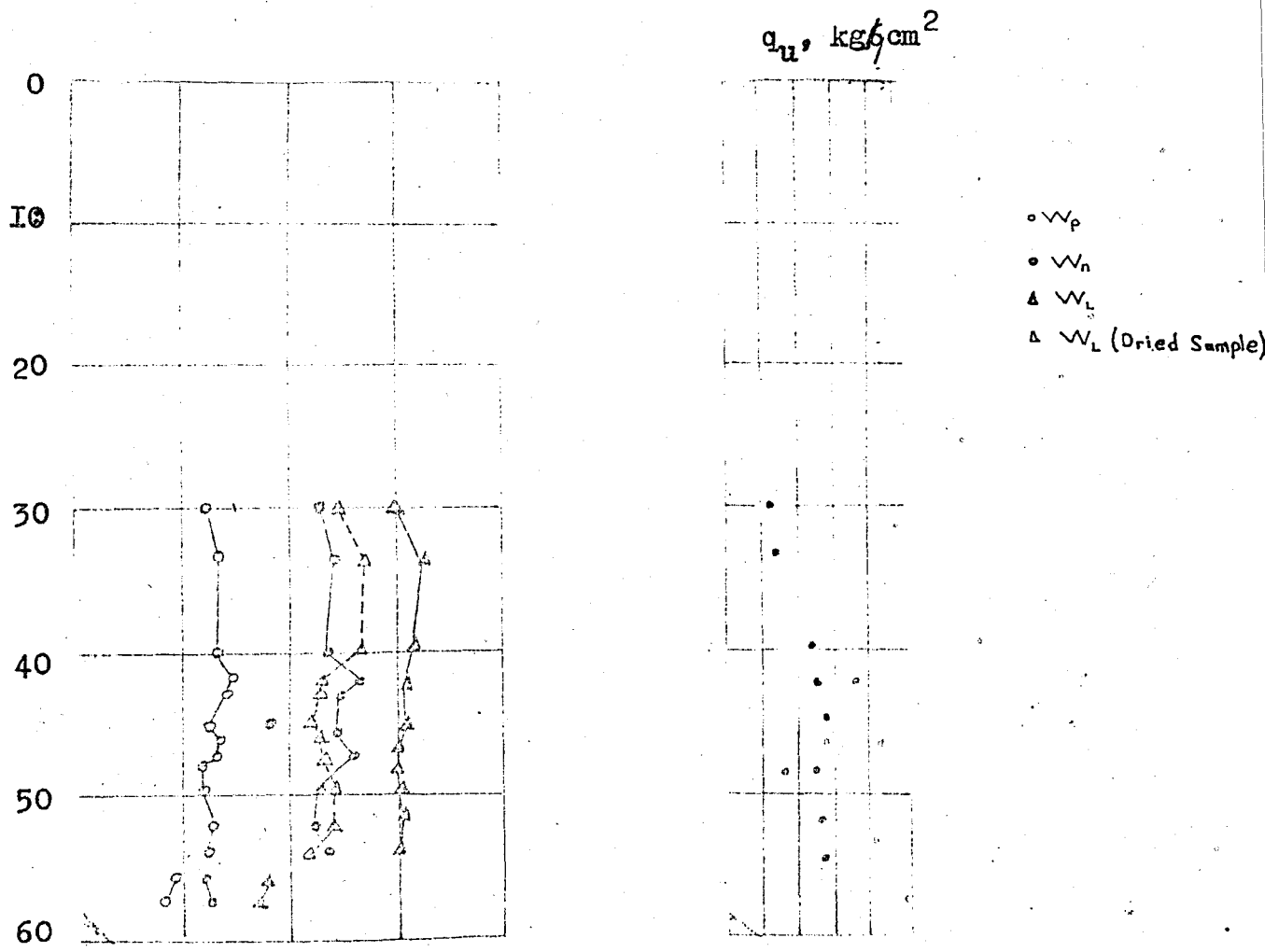


Fig Unkapanı, Properties of samples (Peynircioğlu, I96I)

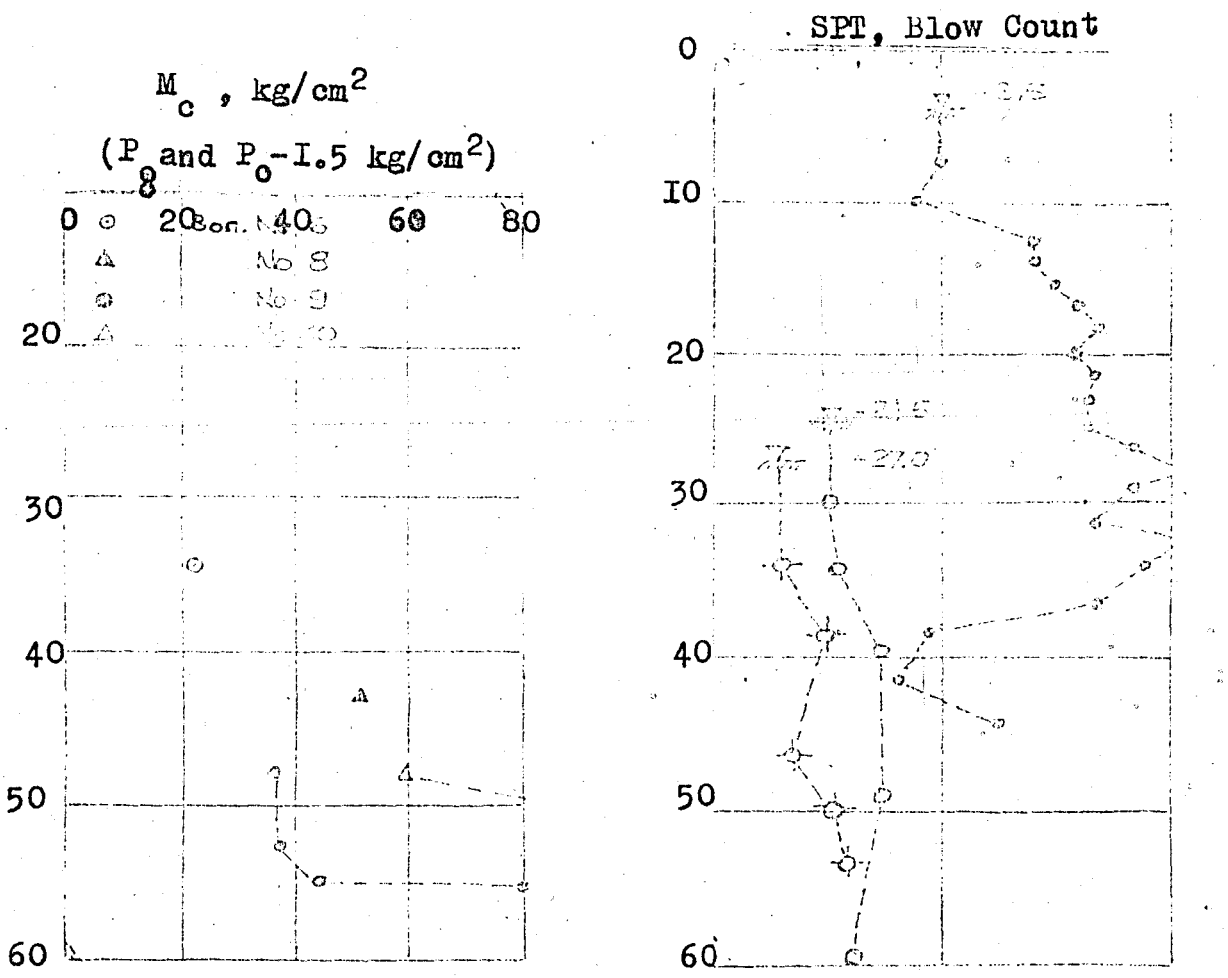


Fig. 2.6 Unkapanı, Properties of samples (Peynircioğlu,I96I)

Borings which were carried out at Silahtarağa Power Plant shows that Natural Water Content is nearly equal to liquid limit. (Table 2.8)

Table 2.8

Properties of samples taken from Silahtarağa Power Plant, Toğrol, I967

Sample	Depth, m	W_n (%)	W_l (%)	c , kg/cm^2
3/6	9	82	96	0.I0
3/I0	I7	79	94	0.I0
4/I	5	88	9I	0.I3
9/7	20	67	83	0.I0
9/6	I8	73	77	0.I0
7/8	I8	6I	6I	0.I0
7/6	I4	60	60	0.I0
I/4	8	92	56	0.05
7/5	I2	6I	55	0.I2
9/3	I2	46	5I	0.20
7/I	4	55	45	0.45
I/I	2	39	38	0.40

Also, typical variation of test results on samples obtained from boring No: I at Hasköy Şark Değirmenleri site is given in Table 2.9 . (Toğrol, I967)

Table 2.9

Laboratory Test Result on Samples Obtained From Hasköy Şark Mills (Toğrol,I967)

No.of Samp.	Depth (m.)	W_l (%)	W_p (%)	I_p (%)	W_n (%)	q_u kg/cm^2
I	I3	68	34	34	54	0.7
2	I6	73	35	39	53	0.7
3	I8	72	35	32	53	0.7
4	20	75	37	40	60	0.4
5	22	72	35	35	6I	0.6
6	24	77	35	42	62	0.3
7	26	76	36	40	6I	0.7
8	28	70	36	34	55	0.8
9	30	63	32	3I	50	0.8
I0	33	64	34	30	50	I.0

There are great amount of information related to the properties of sedimentary layer. These values from various sources are systematically compiled and represented in Table 2.I0 .

Table 2.IO

Avarage Properties of Samples

Obtained at Various Sites

Location	Depth (m.)	W_l (%)	W_p (%)	W_n (%)	q_u (kg/cm^2)	Reference
Eyüp,Hasköy,Sütlüce	0-60	60-80	30-40	50-75	0.I5-I.	Peynirc?I962
Sütlüce,Ist.Mill	-	85-90	40-45	60	0.2-0.3	Toğrol,I975
Taşkızak Shıpy.	I2-35	50	27	50-66	0.64	Spe. Report
Unk.,Old Found.	30-60	50-60	25	50	0.2-I.	Peynirci,I96I
Silahtarağa Power Plant	0-30	40-95	3I	70	0.2-I.	Peynirci,I96I
3.Haliç Bridge	0-60	50-65	20-27	50-65	0.4-0.8	Dada,I970
Extension of Power Plant	-	67	3I	67	0.I-0.2	Toğrol,I975
Hasköy Şark Mills	0-50	70-80	35	50-60	0.5-I.0	Peynirci,I965

W_n , Natural Water Content

W_l , Liquid Limit

W_p , Plastic Limit

q_u , Unconfined Compressive Strength

The odeometer tests indicate that the clay is in a Normally Consalitated state.The sensetivity of the clay ranges between 3 and 6 which indicates that a large deformation of the clay can cause a decrease in the strength of the soil layer (Toğrol,I975).

Also, Tests conducted on the samples obtained from Taşkızak Shipyard Borings are seen in table 2.II .

Table 2.II

Laboratory Test Results on Samples Obtained from Taşkızak Shipyard, (Special Report,I980)

	Boring I (I0.90)	Boring 4 (5.00m.)	Boring 5 (I6.50m.)	Boring I3 (I8.50m.)
W_n	I5.0	2I.5	22.9	20.7
W_l	32.3	34.3	37.0	34.2
W_p	2I.7	I8.8	I8.6	I7.6
I_p	I0.6	I5.5	I8.4	I6.6
I_c	I.63	0.83	0.77	0.8I
γ_s	-	-	2.86	-
ϕ_u (.)	-	-	0	I
c_u (.)	-	-	0.50	0.68
γ_n (.)	-	-	2.06	2.I
ϕ_u (..)	-	-	2I	27
c_u (..)	-	-	0.50	0.20
γ_n (..)	-	-	I.74	I.97

CHAPTER III

WATER POLLUTION AND DREDGING OF BOTTOM SLUDGE

3.1 WATER POLLUTION

The history of the water pollution in the vicinity of Haliç goes back to 15th century. The problem was erosion on the hills of Kağıthane and Alibeyköy Creeks and accumulation of erosed material on the bottom of Haliç. After 1950, industrial settlements have started in the vicinity of Haliç and environmental pollution has been observed.

The water body in Haliç is the mostly polluted part of vicinity. The rate of pollution increased by increase of population and industrial settlement and the problem developed into an unbearable and unhealty conditions.

The main causes of the water pollution may be stated as follows:

I. Industrial Wastes: About hundred plants are giving their wastes directly to Haliç and Creeks. The water pollution due to industrial activities is equal to the pollution due to 3 million population,(Kor,1975). Industrial wastes are polluting Haliç physically, chemically, chemically, and biologically. Values of basic parameters of water pollution at certain locations in Haliç are given in table 3.1 Karpuzcu (1974), Baykut (1946) and Kor (1963) .

Table 3.I

VALUES OF BASIC PARAMETERS ON WATER POLLUTION

Location	Water Depth	Turbidity (cm)	Temperature in April	Dissolved Oxygen (mgr/lt)	Heavy Metals		BOD (mgr/lt)
					Zn	Cd	
Kağıthane Creek	I.0	20	20	I.I	0.2I-.73	0.0	-
Alibeyköy Creek	0.9	24	24	I.4	0.03-.II	0.0	I0.0
Eyüp-Sütlüce	3.I	20	I8	0.35	-	-	I5.0
Haliç Bri.	3.3	22	I8	0.30	0.05-.07	0.05	8.5
Atatürk Bridge	27.5	I00	I5	I.9	-	-	-
Galata Bridge	26.0	I30	I4	4.0	0.02	0.05	3.5

2. Domestic Wastes : The other important pollutant of the water in Haliç is domestic wastes of 600.000 population in the vicinity. Most of the districts in the vicinity are in lack of a proper sewage system. A new sewage system is designed by DAMOC (1971) and it is modified by CAMP-TEKSER (1975). The wastes which cannot be treated biologically must be treated previously in discharcing plants. Haliç district has the third priority in the construction schedule of the project. Therefore, the water pollution by domestic wastes will continue for a period of time,(Fig. 3.I) .

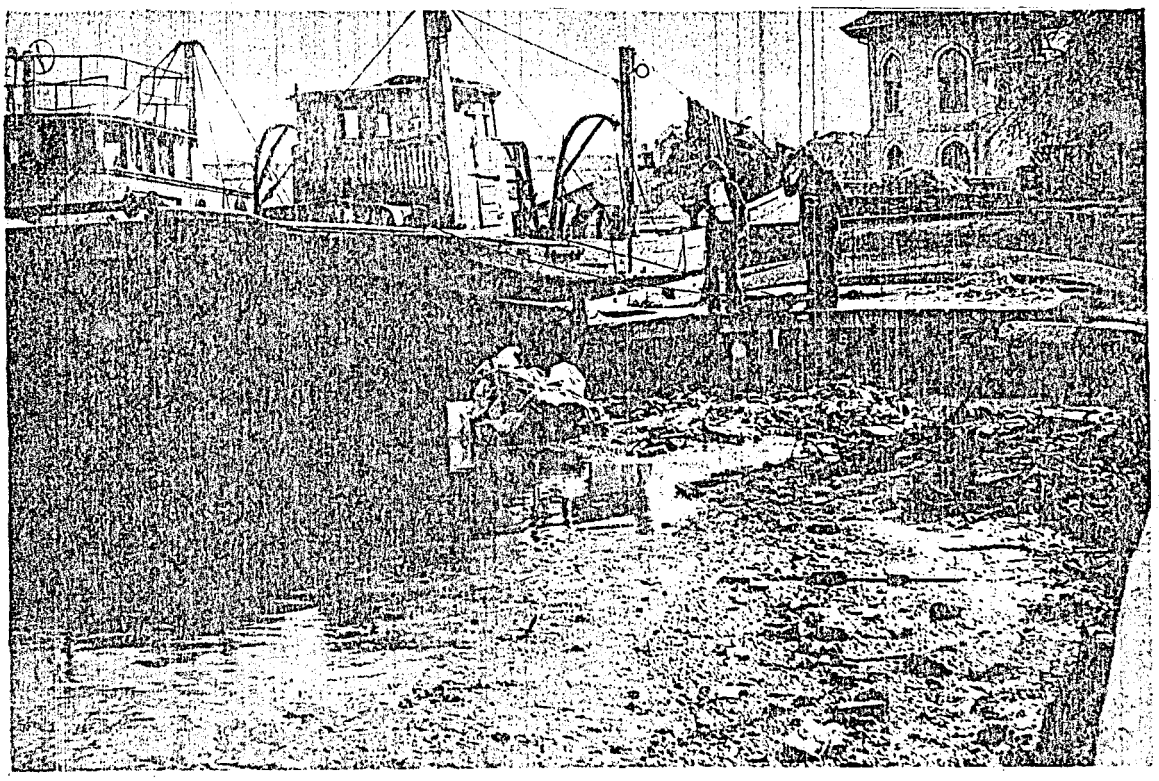


Fig. 3.I Domestic wastes on the shore at Eyüp

3. Erosion and Sedimentation : Fine materials of the ep hills of Alibey and Kağıthane Creeks are tranported during ra- seasons and sedimented at the bottom of Haliç at a rate of IO cm. year and constitute almost all of the sedimented material. These iments are called Bottom Sludge and contains organic materials heavy metals. These contents contribute also to the pollution of er and the geotechnical problems of the area,(Fig.3.2).

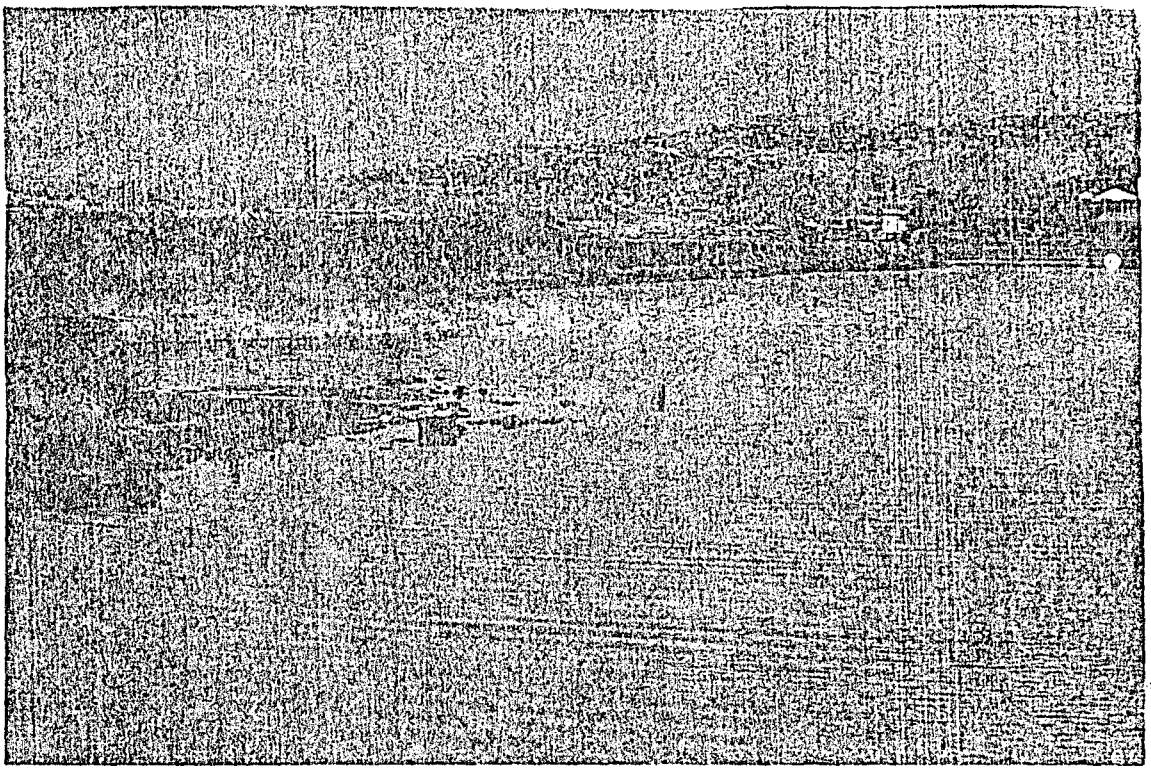


Fig.3.2 Sedimentation in Haliç, near Sütlüce

4. Ships and Wrecks: Ships are polluting the water by heir wastes and abondoned wrecks impede the circulation of water n Haliç,(Fig.3.3).

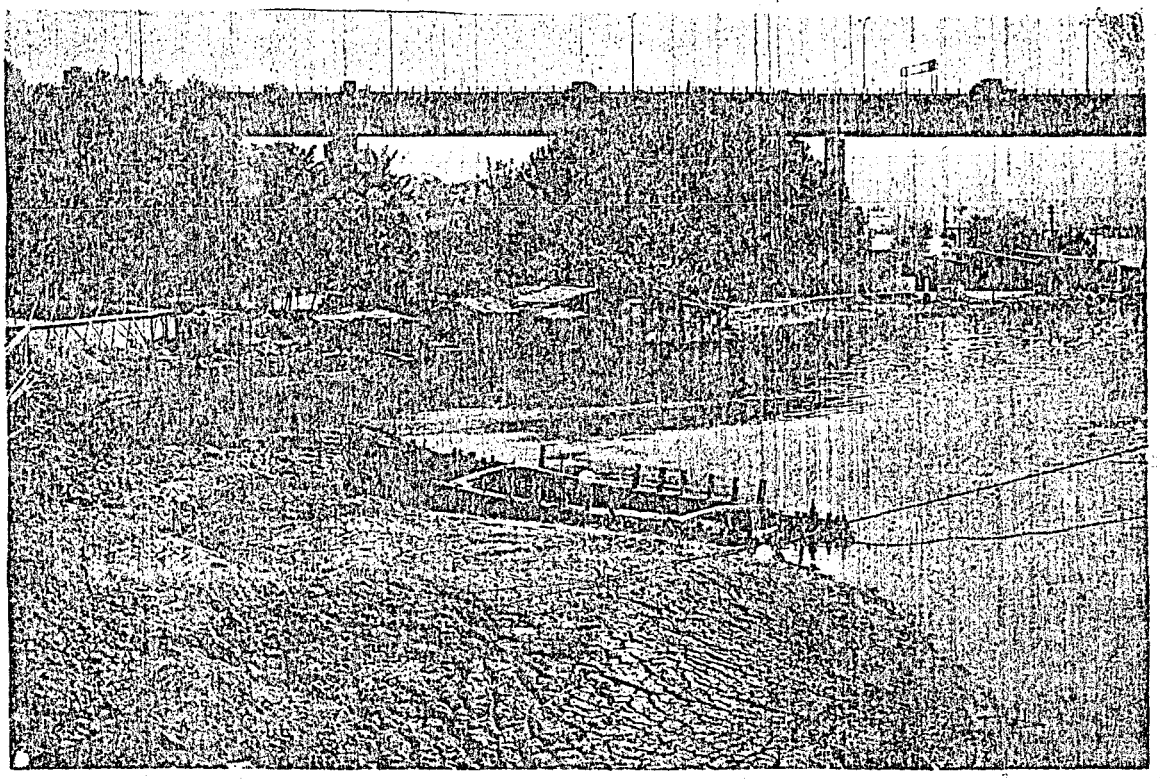


Fig. 3.3 An abondoned wreck on the shore

3.2 DREDGİNG OF BOTTOM SLUDGE

Based on numerous measurements at various times it has been determined that sedimentation of fine materials is on the order of IO cm. per year. Therefore, it may be concluded that due to sediments a total of 260.000 m^3 of fine material is transported by the creeks to Haliç every year.

The bottom sediments have basically three undesired features :

I. They contribute to the pollution of the water.

2. They impede sea transportation to the area.

3. They contribute a great deal to the geotechnical problems of the area.

These sediments are almost in a liquid state in the upper 5 to 7 meters zone and have unit weight of γ = I.IO to I.I5 t/m^3 (Becan, I974)

The geographical location of Haliç is providing many facilities in the sea transportation if the industrial plants keep their existance in the area, the sea transportation on Haliç will be the cheapest way for the transportation of row materials and goods.

The present conditions are not suitable for an efficient sea transportation in Haliç. So the dredging of bottom sludge to obtain sufficient depth and to prevent pollution of water are necessary. But the geotechnical conditions in the vicinity of Haliç makes a preliminary study about stability of shores necessary.

There are many types of dredging equipment for different materials to be dredged. Over I.000.000 m^3 of dredging was done in previous years in Haliç, (Table 3.2).

The amount of accumulation of sedimented material will decrease to 200.000 m^3 per year after the completion of Alibeyköy Dam construction. The amount of material to be dredged is about 2.5 million m^3 in Haliç,(Arıcan,I976). Therefore,total volume of material will be 3.5 million m^3 at the and of the next four years.

Table 3.2

Volume and Location of Previous dredgins in Haliç (Arıcan,I976)

Location	Year	Volume, m^3
Sütlüce-Silahtar	I96I	494.000
Hasköy-Halıcıoğlu	I965	250.000
Alibey Creek	I965	25.000
Eyüp - Silahtar	I974	330.000
TOTAL	-	I.094.000

Since the bottom sludge and underlying clay formation are very soft and very weak, stability of these formations should be evaluated. Also the stability of shores should be considered before dredging, (See chapter 4 and 5).

CHAPTER 4

SLOPE STABILITY

4.I INTRODUCTION

Every mass of soil located beneath a sloping ground surface or beneath the sloping sides has tendency to move downward and outward under the influence of gravity. If this tendency is counteracted by shearing resistance of the soil, the slope is stable. Otherwise a slide occurs.

The failure of a mass of soil located beneath a slope is called a "Slide". Usually, slides are due to excavation or to undercutting the foot of an existing slope. Slides may occur in almost every conceivable manner, slowly or suddenly.

4.2 SLIDES IN COHESIVE SOILS

A cohesive material having a shearing resistance, s ,

$$s = c + p \tan \phi \qquad \text{.....(4.I)}$$

where c denotes cohesion

p denotes normal stress

ϕ denotes angle of shearing resistance.

can stand with a vertical slope at least for a short time, pro-

vided the height of the slope is somewhat less than critical height, H_c. If the height of aslope is greater than H_c, the slope is not stable unless it makes an angle with the vertical. If the height is very great compared to H_c, the slope will fail unless the slope angle is equal to or less than ϕ.

If the failure occurs along a surface of sliding that intersects the slope at or above its toe (Fig. 4.Ia), the slide is known as a " Slope Failure " . On the other hand, if the soil beneath the level of the toe of the slope is unable to sustain the weight of the overlying material, the failure occurs along a surface that passes at some distance below the toe of the slope. A failure of this type is known as " Base failure", Fig(4.I6).

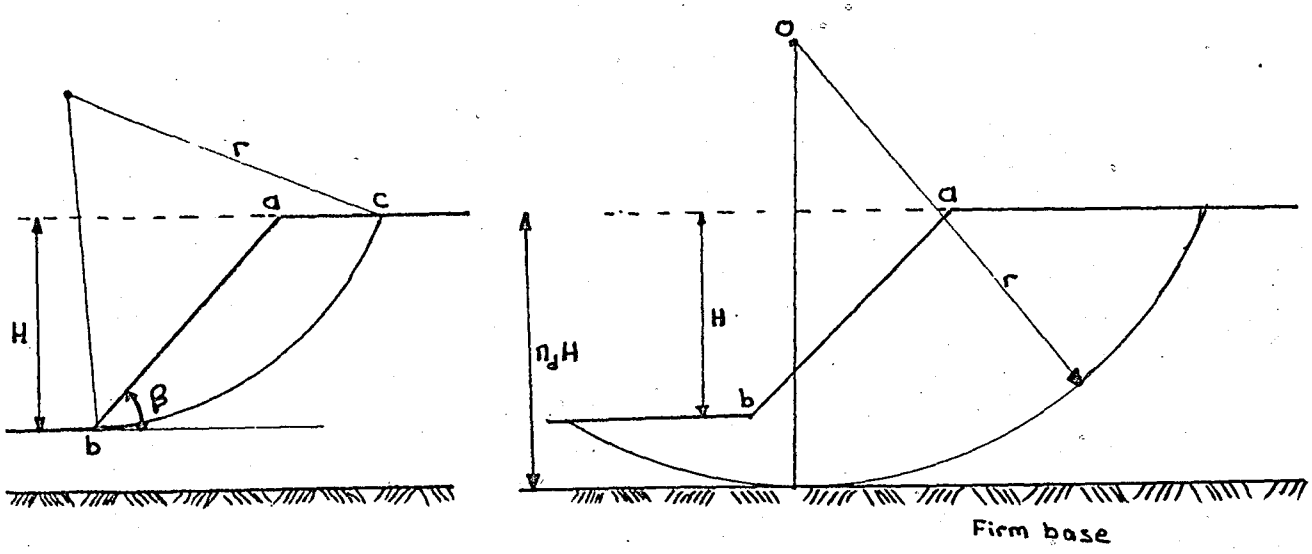


Fig. 4.I Position of critical circle for (a) slope failure (b) Base failure

4.3 PROCEDURE FOR INVESTIGATING STABILITY OF SLOPES

The general procedure is to determine the position of the surface of the sliding, to estimate the veights of the various parts of the sliding mass that tended to procedure or to oppose the slide; and to compute the avarage shearing resistance,s,of the soil necessary to satisfy the conditions for equilibrium of the mass.

In order to investigate whether or not a slope on soil with known shear characteristics will be stable, it is necessary to determine the diameter and position of the circle that represent the surface along which sliding will occurs.This circle known as the " Critical Circle ", must satisfy the requirement that the ratio between the shearing strength of the soil along the surface of sliding and the shearing force tending to produce the sliding must be a minimum.

After the diameter and position of the critical circle have been determined, The Factor of Safety,F , of the slope with respect to failure may be computed.

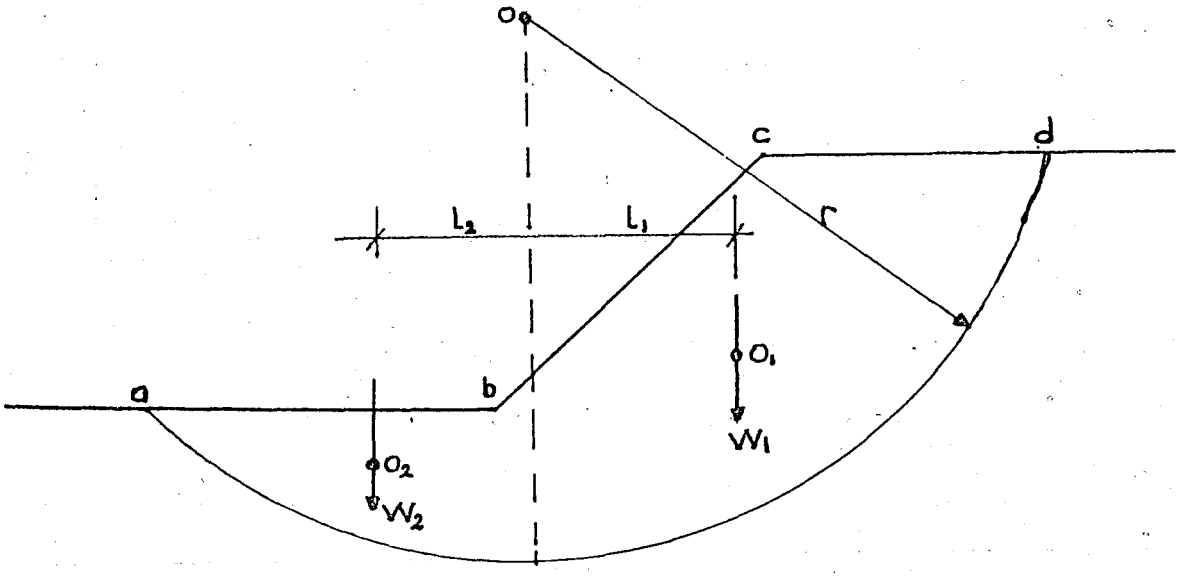


Fig. 4.2 Slope Failure

$$F = \frac{s r \widehat{da}}{W_1 l_1 - W_2 l_2} \qquad \text{.....(4.2)}$$

Where r denotes the radius of the criticital circle

$\widehat{da}$ denotes the length of the surface of sliding.

The slope stability may be investigated by trial. To make the investigation by trial, different circles are selected, each representing a potential surface of sliding. For each circle, the value of F (Eq.4.2) is computed. The minimum value represents the factor of safety of the slope with respect to sliding, and the corresponding circle is the critical circle.

4.4 SLOPES ON SOFT CLAY

The avarage shearing resistance ,s , per unit of area of a potential surface of sliding in homogenous clay under undrained conditions ($\phi = 0$) :

$$s = \frac{1}{2} q_u = c \qquad \text{.....(4.3)}$$

q_u denotes Unconfined Compressive Strength

c denotes Cohesion.

If c is known, the critical height H_c of slope having a given slope angle β can be expressed by the equation,

$$H_c = N_s \frac{c}{\gamma} \qquad \text{.....(4.4)}$$

where N_s denotes stability factor.

N_s is a pure number. Its value depends only on the slope angle β and on the depth factor n_d (Fig.4.Ib) which express the

depth at which the clay rests on a firm base. If a slope failure occurs, the critical circle is usually a " Toe Circle " that passes through the toe of the slope. However, if the firm base is located at a short distance below base the level of toe , the critical circle may be a " Slope Circle " that is tangent to the firm base and that intersects the slope above the toe.

The position of the critical circle with reference to a given slope depends on the slope angle β and the depth factor n_d.

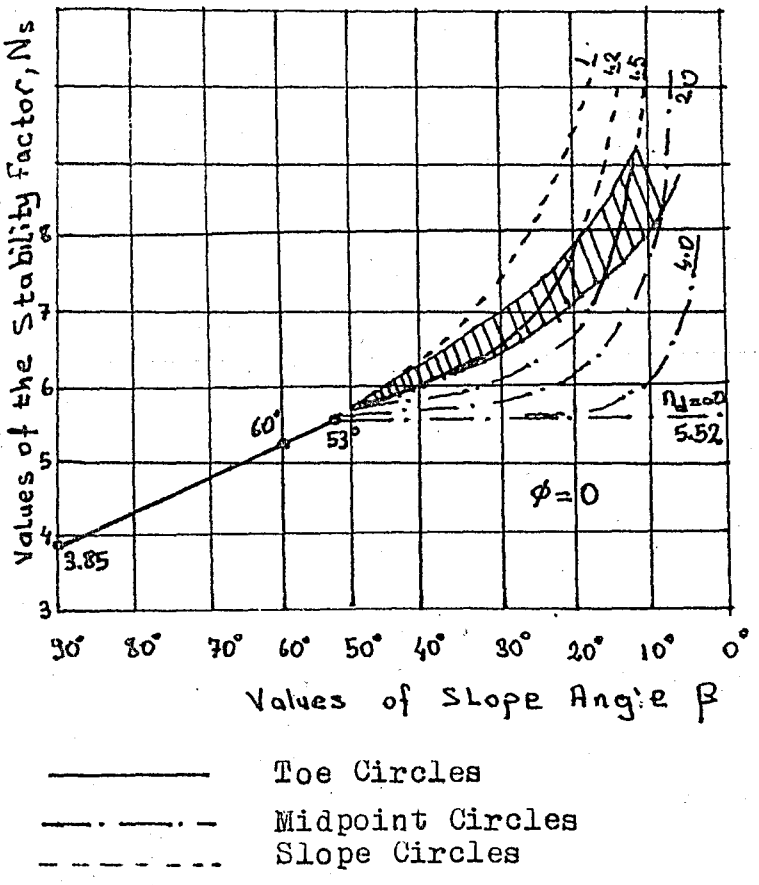


Fig. 4.3 Relation between slope angle and stability factor N_s, for different values of depth factor n_d (After Taylor, 1937)

According to fig.4.3 , the failure of all slopes rising at an angle of more than 53° occurs along a toe circle. If β is smaller than 53°, the type of failure depends on the value of the depth factor n_d and, at low values of n_d, also on the slope angle β. If n_d is equal to I.0 , failure occurs along a slope circle.

If n_d is greater than about 4.0 , the slope fails along a midpoint circle tangent to the firm base. If n_d is intermediate in value between I.0 and 4.0 , failure occurs along a slope circle if the point representing the values of n_d and β lies above shaded area in Fig. 4.3 . If the point lies within the shaded area, failure occurs a toe circle.

4.5 THE USE OF THE SLIP CIRCLE IN THE STABILITY ANALYSIS OF SLOPES

A. If slope is located above water table:

If a slope has an irregular surface that cannot be represented by a straight line , or if the surface of sliding is likely to pass through several materials with different values of c and ϕ , the stability can be investigated conviniently by the " Method of Slices " . According to this procedure , a trial circle is selected, (fig 4.4), and the sliding mass subdivided into a number of vertical slices I,2,3 etc.

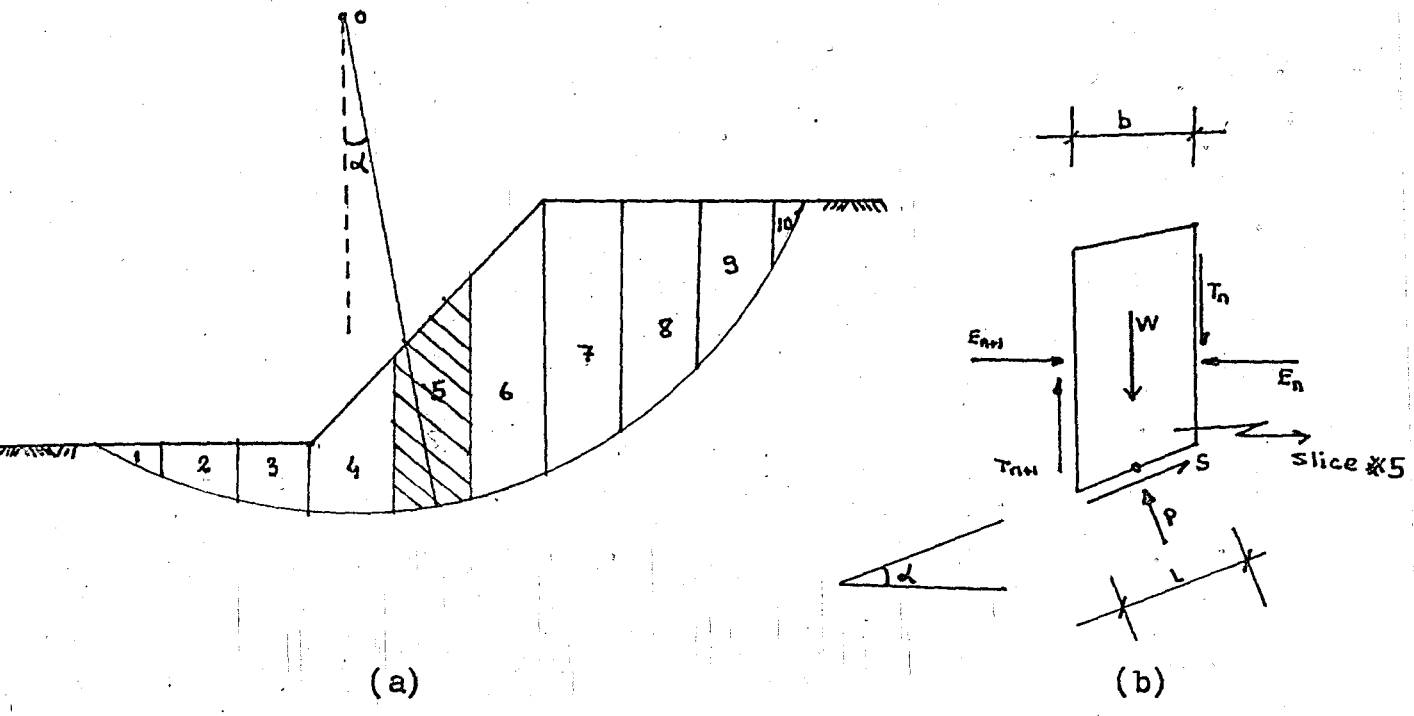


Fig 4.4 Method of slices for investigating equilibrium of slope located above water table

Each slice , such as slice 5 shown Fig 4.4b, is acted upon by its weight W, by shear forces T and normal forces E on its sides, and by a set of forces on its bases. These include the shearing force S and the normal force P.

The forces on each slice must satisfy the conditions of equilibrium. However, the forces T and E depend on the deformation and the stress-strain characteristics of the slice material and cannot be evaluated rigously. They can be approximated with sufficient accuracy for practical purposes. The simplest approximation consists of setting these forces equal to zero. Under these circumstances, if the entire trial circle is located above water table and there no excess pore pressures?

The equilibrium of the entire sliding mass requires that

$$r \Sigma W \sin\alpha = r \Sigma S \qquad \ldots\ldots\ldots\ldots (4.5)$$

If s is the shearing strength of the soil along t, then

$$S = \frac{s}{F} l = \frac{S}{F} \frac{b}{\cos\alpha} \qquad \ldots\ldots\ldots\ldots (4.6)$$

and

$$r \Sigma W \sin\alpha = \frac{r}{F} \Sigma \frac{s b}{\cos\alpha} \qquad \ldots\ldots\ldots\ldots (4.7)$$

Whence

$$F = \frac{\Sigma (sb/\cos\alpha)}{\Sigma W \sin\alpha} \qquad \ldots\ldots\ldots\ldots (4.8)$$

The shearing strength s , however , is determined by

$$s = c + p \tan\phi \qquad \ldots\ldots\ldots\ldots (4.9)$$

Where p is the normal stress across the surface of sliding l . To evaluate p we consider the vertical equilibrium of the slice (Fig 4.4b) ,whence

$$W = S \sin\alpha + P \cos\alpha \qquad \ldots\ldots\ldots\ldots (4.10)$$

$$P = \frac{P}{l} = \frac{P \cos\alpha}{b} = \frac{W}{b} - \frac{S}{b} \sin\alpha \ldots\ldots (4.11)$$

therefore

$$s = c + \left(\frac{W}{b} - \frac{S}{b} \sin\alpha\right) tg\phi = c + \left(\frac{W}{b} - \frac{S}{F} tg\alpha\right) tg\phi \ldots (4.12)$$

and

$$S = \frac{c + (W/b)\, tg\phi}{1 + (tg\alpha\, tg\phi)/F} \qquad \ldots\ldots\ldots\ldots (4.13)$$

Let

$$m_\alpha = \left(\frac{F + tg\alpha \cdot tg\phi}{F} \right) Cos\alpha \quad \ldots\ldots\ldots\ldots (4.I4)$$

Then

$$F = \frac{\sum \frac{[c + (w/b)\, tg\phi]b}{m_\alpha}}{\sum w \sin\alpha} \quad \ldots\ldots\ldots (4.I5)$$

Equation 4.I5, which gives the factor of safety, F, for the trial circle under investigation contains on the right-hand side the quantity m_α(Eq.4.I4) which is itself a function of F. Therefore Eq.4.I5 must be solved by successive approximations in which a value of $F = F_I$ is assumed and used for calculation of m_α, whereupon F is then computed. If the value of F differs significantly from F_I, the calculation is repeated. The calculations are facilitated by the chart from which values of m_α can be taken, (Janbu, I956)

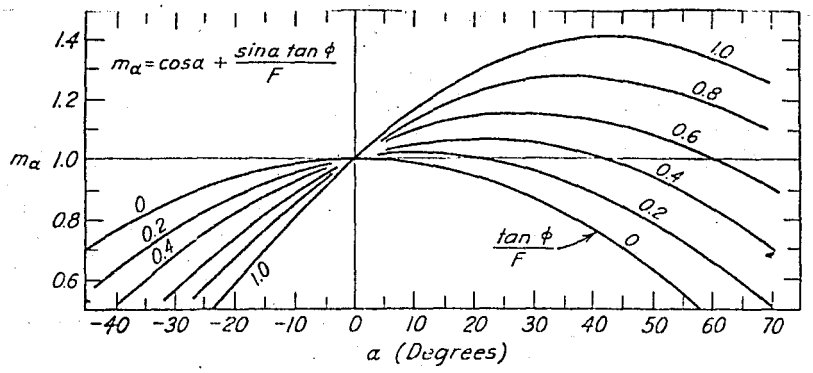


Fig 4.5 Chart for evaluating factor m_α

B. If the slope is partly submerged :

In general, the slope may be partly submerged and there will be pore pressures acting along the trial circle , (Fig 4.6)

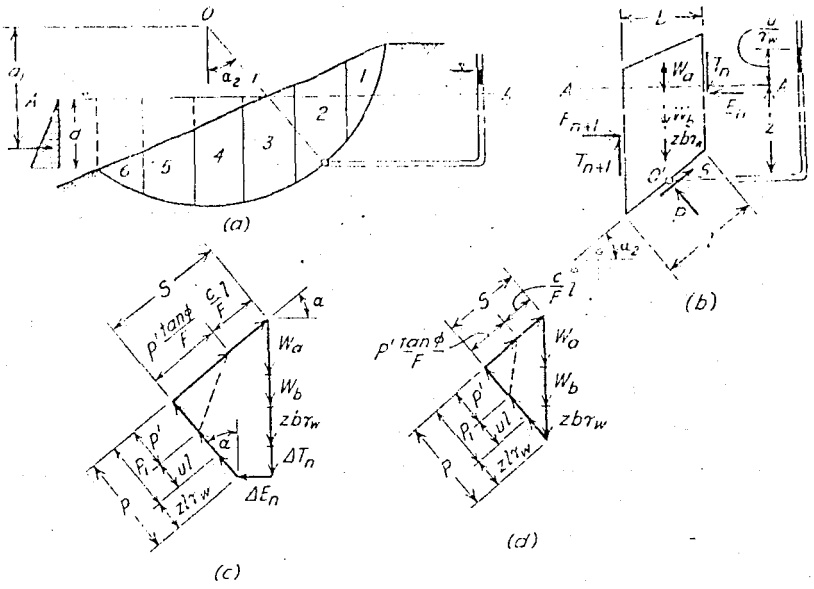


Fig 4.6 Method of slices for investigating equilibrium of slope for partly submerged slopes (d) Force polygon for slice 2 if forces T and E on sides of slice are considered to be zero.

The magnitudes of the pore pressures depend upon the conditions of the problem. In some intances they may be estimated by means of a flow net or field observations. If the level of external water surfaceis denoted by A–A , the weight,W, of the slice may be written as,

$$W = W_a + W_b + z b \gamma_w \qquad \text{.....(4.16)}$$

where W_a is the weight of that part below A–A , And W_b is the submerged weight of the part below A–A and $zb\gamma_w$ is the

weight of a volume of water equal to submerged portion of the slope . If entire slice is located beneath the water level , as slice 3, the weight of the water above the slice must be includedin $zb\gamma_w$ The pore pressure at the midpoint 0^4 of the base of the slice is $z\gamma_w+u$, where u is the excess pore pressure with respect to external water level. If the external water level A-A is located below $0'$ on the base of the slice , the pore pressure at 0^4 is h/γ_w , where h is the height to which the water would rise in a piozemeter at $0'$. If the pore pressure is due to capillarity, h is negative. The shearing stress , t, along the surface of sliding is,

$$t = \frac{s}{F} = \frac{1}{F}\left(c + \bar{p}\, tg\phi\right) = \frac{1}{F}\left[c + \left(\frac{p}{l} - z\gamma_w - u\right) tg\phi\right]$$

whence

$$S = t.l = \frac{1}{F}\left[cl + \left(p - zl\gamma_w - ul\right) tg\phi\right] = \frac{1}{F}\left(cl + p' tg\phi\right)$$

Equilibrium of the entire slide with respect to moments about the centre of the trial circle requires that

$$\Sigma\left(W_a + W_b + zb\gamma_w\right) r \sin\alpha = \Sigma S.r + \frac{1}{2}\gamma_w d^2 a_1$$

$$= \frac{1}{F}\Sigma\left(cl + p' tg\phi\right) r + \frac{1}{2}\gamma_w d^2 a_1 \quad \ldots\ldots\ldots (4.19)$$

However , the water below level A-A is in equilibrium, whence

$$\Sigma z b \gamma_w r \sin\alpha = \frac{1}{2}\gamma_w d^2 a_1 \qquad \text{.....(4.20)}$$

Therefore,

$$\Sigma(W_a + W_b) r \cdot \sin\alpha = \frac{1}{F}\Sigma(cL + P' tg\phi) r \text{..(4.2I)}$$

And

$$F = \frac{\Sigma(cL + P' tg\phi)}{\Sigma(W_a + W_b)\sin\alpha} \qquad \text{.....(4.22)}$$

$$W_a + W_b + 2b\gamma_w = [2l\gamma_w + P' + uL)\cos\alpha +$$

$$\left(P' \frac{tg\phi}{F} + \frac{cL}{F}\right)\sin\alpha \qquad \text{.....(4.23)}$$

and

$$P' = \frac{W_a + W_b - ub - \frac{cl}{F}\sin\alpha}{m_\alpha} \qquad \text{.....(4.24)}$$

Substition of eq. 4.24 in to 4.22

$$F = \frac{\sum \frac{[cb + (W_a + W_b - ub)\ \tan\phi]}{m_\alpha}}{\sum (W_a + W_b) \sin\alpha} \qquad \ldots\ldots\ldots (4.25)$$

It may be noted that the influence of the external water level is fully taken into account by the the use of the submerged weight, W_b , and that the excess pore pressure ,u , is calculated for the base of each slice. The procedure described in the preceeding paragraphs may be modified to take into account the forces T and E between the slices (Bishop, I955).

4.6 COMPUTER PROGRAM FOR SLOPE STABILITY

This computer program (KÖSELER-I) is developed using Bishop's (I955) Modified Procedure. The program uses a circular -arc failure surface. First the intersection coordinates of soil layers and the potential failure surface are found then the areas, angles, etc., can be calculated.

The program will solve any slope stability problem where the ground surface can be described by a series of straight lines. Any number of lines and soil types can be used The program allows for describing the pore pressure by use of saturated soil unit weights. The program computes both the total and effective slice weights;

It is necessary in using this program to :

I. Number all line intersections in increasing X

coordinates from left to right.

2. Number the upper external (closest to arc center) soil lines first in order mfrom left to right. Interior soil lines may be numbered in any order.

3. The different soils in the mass may be numbered in any order.

4. Compute all line intersections accurately to 0.005 to SMLNO=0.OI will properly test coordinates.

The program locates all line intersections inside the trial arc including those lines intersecting the arc. A slice is located on every intersection point. Distances between intersection points are divided according to the slice-width specification (SWIDTH).

This program will compute in either metric or fps units. Use meters and kilonewtons or feet and pounds. The unit card contains three entries:

M	CM	0.807
FT	IN	62.500

4.7 OPERATION OF COMPUTER PROGRAM

LINE	OPERATION
I-5	Bookkeeping
6	READ TITLE and work units(Two cards)
I3	READ(I5I5)
	NOL: total number of soil lines NLIT: total number of line intersections(The end of any line whether or not intersected by another line is a line intersection) NOS: number of soil lines in mass(Same soil submerged is counted twice) NOLE: number of top external soil lin ITX-ITY: number of circle centre points in X,Y directions to be analyzed for a single entrance point PCODE: plot subroutine used if> 0 NP: plot control counter DIMEN: control number of slices as 75,80,90 ,etc. LIST: control to obtain extra output(after test run use 0 to converse paper)
I4	READ(5,*)
	CX,CY: initial trial circle centre coordinates ENTX ENTY: trial circle entrance coordinates DELX,DELY: centre X,Y coordinates increments for each trial SWIDTH: initial slice width(DIMEN may increase value
I5	READ(5,*)
	SCALE: plotting scale as 20,30 for I inch.
	HAH : top X coordinates of slope
	YAY : distributed load on soil(q = 2 t/m)

LINE	OPERATION
27-52	READ problem data on line intersections, soils , etc., and forms arrays for later use, also writes data for checking
28	READ NLI: number of line intersections of each line in turn one entry per card
29	READ (C(I,J),(NOLIT(I,N),N=I,NLI) C(I,J) : line data including line number , number of line intersections for the lines, the X,Y coordinates of the end points left to right(6 entries) NOLIT(I,N): all the line intersection numbers on the i^{th} line including the end values(NLI entries)
30	Gives vertical lines the slope value of BIGNO so computer doesnot divide by 0.0
39-40	READ INTAR(J,K) INTAR(J,K): line intersection X,Y coordinates in increasing intersection numbers
47	READ soil data on DO loop NSLIN(I): number of soil lines defining the boundary of the soil. Include lines terminating at a joint. If a line intersection a soil-boundary between the ends count the soil boundary between the ends, twice G(I): unit weight either saturated or wet PHI(I): ϕ angle COHES(I): cohesion SAT: I.if saturated,0.if wet
52	READ LINSOL: soil line number , INTL-INTR: intersection number on left and right and of line(if a soil line ter-

LINE	OPERATION
	minates ta a joint on a soil boundary, that line is included, the joint number is used for both INTL and INTR.
62	Begins DO to test circles
69-I40	Computes trial circle , line intersections, find lines not used LNU(I) , those in circle but not intersected by circle
I4I-I96	Sets up arc intersection array ARCINT
I97-22I	Find slice width and checks total number of slices agains t DIMEN and increments slice width if necessary
222-285	Finds coordinates of all line intersecting slices in slice array SLIC (I,J,K). Note that lines not intersected in a slice area given same coordinates as last line intersected and stacked at a point. This so routine for both coordinates test and area computations can be used using all lines. SLIC array is sorted for decreasing Y coordinates.
286-352	Computes areas of slice parts and weights, both effectivem and total,sums slice weights, finds ø and and c for soil touching arc surface
353-39I	Computes safety factor

```
(I).GUL
      DIMENSION C(15,6),NOLIT(15,10),SLOPE(15),INTAR(15,2),EFFWT(100
     &NSLIN(10),G(10),PHI(10),COHES(10),SLICX(76),SOIL(8,9,4),SAT(10
     &RCINT(20,3),LNU(15),CO(100),ALPHA(100),TITLE(20),SLIC(76,10,2
     &P(100),B(100),AREA(100),WEIGH(100),ALLINT(30,3),IBUF(1000)
      INTEGER PCODE,DIMEN
      REAL INTAR,METER
      BIGNO=9999999.
      SMLNO=0.0
      READ(5,1000)TITLE,UT1,UT2,FU4
 1000 FORMAT(20A4/A4,6X,A4,6X,F10.4)
      WRITE(6,2000)TITLE
 2000 FORMAT('1',T5,20A4,//)
      READ(5,*)NOL,NLIT,NOS,NOLE,ITX,ITY,PCODE,NP,DIMEN,LIST
      READ(5,*)CX,CY,ENTX,ENTY,DELX,DELY,SWIDTH
      READ(5,*) SCALE,HAH,YAY
      WHOLD=SWIDTH
      NOSP1=NOS+1
      WRITE(6,2001)NOL,NLIT,NOS,NOLE,ITX,ITY,SWIDTH,UT1
 2001 FORMAT(T5,'NO OF LINES',I3,5X,'NO OF LINE INTERSECT=',I3,//,T5
     &'NO OF SOILS=',I3,5X,'NO OF EXTERNAL SOIL LINES=',I3,//T5,
     &'NO OF X-INCREMENTS=',I3,5X,'NO OF Y-INCREMENTS=',I3,//,T10,'I
     &ITIAL SLICE WIDTH=',F5.1,1X,A2//)
      WRITE(6,2003)
 2003 FORMAT(T5,'THE LINE END COORD MATRIX',/,T4,'LINE NO',T12,'NO I
     &T21,'X1',8X,'Y1',8X,'X2',8X,'Y2',6X,'SLOPE',5X,'LINE INTER NO'
      DO 333 I=1,NOL
C     NLI=NO OF INTERSECT ON ANY LINE-MUST HAVE AT LEAST 2 VALUES
      READ(5,*)NLI
      READ(5,*)(C(I,J),J=1,6),(NOLIT(I,N),N=1,NLI)
      SLOPE(I)=BIGNO
      IF(ABS(C(I,5)-C(I,3)).LE.0.00)GO TO 333
      SLOPE(I)=(C(I,6)-C(I,4))/(C(I,5)-C(I,3))
  333 WRITE(6,2004)(C(I,J),J=1,6),SLOPE(I),(NOLIT(I,KK),KK=1,NLI)
 2004 FORMAT(T6,F3.0,3X,F3.0,T15,4(2X,F8.2),G13.6,1X,6I5)
C     READ X AND Y COORDINATES TO BUILD LINE INTERSECT ARRAY (INTAR)
      WRITE(6,2005)
 2005 FORMAT(//,T5,'LINE INTERSECT ARRAY',/,T4,'INT NO',T16,'X',T28,
      DO 2 J=1,NLIT
      READ(5,*)(INTAR(J,K),K=1,2)
    2 WRITE(6,2006)J,(INTAR(J,K),K=1,2)
 2006 FORMAT(T6,I3,T12,F10.2,2X,F10.2)
C     BUILD SOIL INTERSECTION ARRAY USING (INTNO)
      WRITE(6,2008)
 2008 FORMAT(//,T5,'SOIL DATA ARRAY',/,T4,'SOIL NO',T13,'LINE #',T21,
     &'LEFT INT',3X,'RT. INT',3X,'SAT',3X,'UNIT WT',3X,'PHI',3X,'COH
     &ON')
C     NUMBER SOILS IN ANY ORDER
      DO 5 I=1,NOS
      READ(5,*)NSLIN(I),G(I),PHI(I),COHES(I),SAT(I)
      NS=NSLIN(I)
      DO 5 K=1,NS
      READ(5,*)LINSOL,INTL,INTR
      SOIL(I,K,1)=LINSOL
      SOIL(I,K,2)=INTL
      SOIL(I,K,3)=INTR
      SOIL(I,K,4)=SAT(I)
    5 WRITE(6,2009)I,(SOIL(I,K,MM),MM=1,4),G(I),PHI(I),COHES(I)
 2009 FORMAT(T5,I3,6X,F3.0,7X,F3.0,6X,F3.0,6X,F2.0,5X,F6.1,3X,F4.1,3
     &.1)
      PCOUN=0
C     BEGIN LOOP TO TEST TRIAL CIRCLES
  100 DO 350 IY=1,ITY
      IF(IY.GT.1)CY=CY+DELY
      DO 350 IX=1,ITX
      PCOUN=PCOUN+1
      NCOUN=PCOUN
      SWIDTH=WHOLD
      IF(IX.GT.1)CX=CX+DELX
C     COMPUTE RADIUS OF TRIAL CIRCLE
      R=SQRT((ENTX-CX)**2+(CY-ENTY)**2)
      WRITE(6,2121)NCOUN,CX,CY,ENTX,ENTY,R
 2121 FORMAT(//,T5,'TRIAL CIRCLE NO',I3,/,T5,'CIRCLE CTR COORDS:',2X
     &',2X,'X=',F10.2,2X,'Y=',F10.2,/,T5,'ENTRANCE PT. COORDS:',2X,'
     &',F10.2,2X,'Y=',F10.2,/,T10,'TRIAL ARC RADIUS=',F10.3,//)
      KJ=0
      DO 8 I=1,NOL
      LNU(I)=0
      IF(ABS(SLOPE(I)).LE.0.000)GO TO 9
      CON=C(I,3)-C(I,4)/SLOPE(I)
      AA=1.0/SLOPE(I)**2+1.0
      BB=2.0*CON/SLOPE(I)-2.0*CX/SLOPE(I)-2.0*CY
      CC=CON**2-2.*CX*CON+CX**2+CY**2-R**2
```

```
      DIFF=BB**2-4.0*AA*CC
      IF(DIFF.LT.0.0)GO TO 20
      YPR=(-BB+SQRT(DIFF))/(2.0*AA)
      YNR=(-BB-SQRT(DIFF))/(2.0*AA)
C
C     THIS PART COMPUTE X COORDS
      XPR=YPR/SLOPE(I)+CON
      XNR=YNR/SLOPE(I)+CON
      GO TO 10
C     FOLLOWING STEPS USED FOR HORIZANTAL LINES
9     DIFF=R**2-(CY-C(I,4))**2
      IF(DIFF.LT.0.)GO TO 20
      XPR=CX+SQRT(DIFF)
      XNR=CX-SQRT(DIFF)
      YPR=C(I,4)
      YNR=C(I,4)
10    J1=0
      J2=0
      IF(ABS(SLOPE(I)).GE.BIGNO)GO TO 11
      IF(XPR.GE.C(I,3).AND.XPR.LE.C(I,5)) J1=1
      IF(XNR.GE.C(I,3).AND.XNR.LE.C(I,5))J2=1
      GO TO 12
11    IF(SLOPE(I))66,66,666
66    IF(YPR.GE.C(I,6).AND.YPR.LE.C(I,4))J1=1
      IF(YNR.GE.C(I,6).AND.YNR.LE.C(I,4))J2=1
      GO TO 12
666   IF(YPR.GE.C(I,4).AND.YPR.LE.C(I,6))J1=1
      IF(YNR.GE.C(I,4).AND.YNR.LE.C(I,6))J2=1
12    IF(J2.EQ.0)GO TO 13
      K1=K1+1
      ARCINT(K1,1)=I
      ARCINT(K1,2)=XNR
      ARCINT(K1,3)=YNR
13    IF(J1.EQ.0)GO TO 7
      K1=K1+1
      ARCINT(K1,1)=I
      ARCINT(K1,2)=XPR
      ARCINT(K1,3)=YPR
      GO TO 8
7     IF(J1.NE.0.OR.J2.NE.0)GO TO 8
C     END OF LOOP FOR ARC&LINE INTERSECTIONS.....
20    LNU(I)=I
      WRITE(6,2101)I
2101  FORMAT(//,T5,'XXX LINE',I3,'NOT INTERSECTED BY TRIAL CIRCL')
8     CONTINUE
      DO 400 I=1,NOL
      IF(LNU(I).EQ.0)GO TO 400
      R1=SQRT((CX-C(I,3))**2+(CY-C(I,4))**2)
      R2=SQRT((CX-C(I,5))**2+(CY-C(I,6))**2)
      IF(R.LT.R1.AND.R.LT.R2)GO TO 400
      LNU(I)=0
      IF(SLOPE(I).EQ.BIGNO)LNU(I)=I
      IF(SLOPE(I).EQ.BIGNO)WRITE(6,403)LNU(I)
403   FORMAT(//,'**** LINE',I3,'IS IN ARC BUT VERT AND NOT USED')
      WRITE(6,401)I
401   FORMAT(//,T5,'***LINE',I3,'IS NOT INTERSECTED BUT IS IN ARC')
400   CONTINUE
C     FIND WIDTH OF ...K1=TOTAL ENTRIES IN CIRCLE-LINE INT.ARRAY
      K1M=K1-1
24    DO 26 KY=1,K1M
      IF(ARCINT(KY,2).LE.ARCINT(KY+1,2))GO TO 26
      DO 25 KX=1,3
      SAVE=ARCINT(KY,KX)
      ARCINT(KY,KX)=ARCINT(KY+1,KX)
      ARCINT(KY+1,KX)=SAVE
25    CONTINUE
      GO TO 24
26    CONTINUE
      WRITE(6,2112)
2112  FORMAT(//,T5,'ARC INTERSECT WITH LINE ARRAY',/,T4,'LINE NO'
     &,T19,'X',T32,'Y')
      WRITE(6,2114)((ARCINT(KZ,JJ),JJ=1,3),KZ=1,K1)
2114  FORMAT(T5,F3.0,T13,F10.3,2X,F10.2)
      LINE1=ARCINT(1,1)
      S1=ARCINT(1,2)
      S2=ARCINT(1,3)
      WRITE(6,8053)
8053  FORMAT(//,T5,'THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:')
      ICOUN=0
      K=1
      KK=0
      LL=NLIT+K
C     COMBINE ARCINT AND INTAR IN ORDER OF INC. X-VALUES
```

```
      DO 70 I=1,LL
      KK=KK+1
      DO 75 J=1,2
75    ALLINT(I,J)=INTAR(KK,J)
      IF(I.NE.1.AND.ALLINT(I-1,1).EQ.INTAR(KK,1))GO TO 70
      IF(ARCINT(K,2).GE.INTAR(KK,2))GO TO 70
      IF(ICOUN.GT.0)GO TO 70
72    DO 73 L=1,2
73    ALLINT(I,L)=ARCINT(K,L+1)
      IF(K.EQ.K1)ICOUN=1
      K=K+1
      IF(K.GT.K1)K=K1
      KK=KK-1
70    WRITE(6,8051)I,(ALLINT(I,J),J=1,2),K,KK
8051  FORMAT(T5,'I=',I3,2X,2F12.3,2X,'K=',I3,2X,'KK=',I3)
      WRITE(6,8052)
8052  FORMAT(//,T5,'THE APPLICABLE ARRAY ARCINT FOLLOWS:')
      LAL=0
      DO 77 I=1,LL
      R2=SQRT((CX-ALLINT(I,1))**2+(CY-ALLINT(I,2))**2)
      IF(R2.GT.(R*SMLNO))GO TO 77
      LAL=LAL+1
      DO 78 K=1,2
78    ARCINT(LAL,K)=ALLINT(I,K)
      WRITE(6,8051)LAL,(ARCINT(LAL,J),J=1,2),I,LAL
77    CONTINUE
C     ...CALCULATE THE WIDTH BETWEEN EACH INT. POINT.
33    SLICX(1)=S1
      SLIC(1,1,1)=S2
      SLIC(1,1,2)=LINE1
C      DIVIDE WIDTH(L) INTO SLICES OF SIZE.....
      WRITE(6,8057)
8057  FORMAT(//,T5,'FIND SLICE WIDTH AND NO OF SLICES')
98    N=1
      NOSLIC=1
      KM=1
      K=LAL-1
      DO 45 L=1,K
      MM=1
      IF((ARCINT(L+1,1)-ARCINT(L,1)).LE.SWIDTH)GO TO 46
      DO 47 MM=1,100
      AM=MM
      WIDTH=(ARCINT(L+1,1)-ARCINT(L,1))/AM
      IF(WIDTH.LE.SWIDTH)GO TO 49
47    CONTINUE
46    WIDTH=ARCINT(L+1,1)-ARCINT(L,1)
49    NOSLIC=NOSLIC+MM
C      CONTROL FOR DIMENSION OF 75 SPACES IN ...
      IF(NOSLIC.LT.DIMEN)GO TO 99
      SWIDTH=SWIDTH+0.5
      WRITE(6,9999)SWIDTH
9999  FORMAT('0',T5,'*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTE
     &D TO',F5.2,1X,A2)
      GO TO 98
99    NSM1=NOSLIC-1
      DO 51 I=N,NOLE
      IF(LNU(I).EQ.I)GO TO 51
101   DO 52 JJ=KM,NSM1
      SLICX(JJ+1)=SLICX(JJ)+WIDTH
      SLIC(JJ+1,1,1)=SLIC(JJ,1,1)+WIDTH*SLOPE(I)
      SLIC(JJ+1,1,2)=I
52    DIFF=SLICX(JJ+1)-C(I,5)
      IF(ABS(DIFF)-0.0)50,50,48
50    N=I+1
48    KM=NOSLIC
      GO TO 45
51    CONTINUE
45    CONTINUE
C      COMPLETE SLICE ARRAY.....
      NOLP1=NOL+1
      NOLEP1=NOLE+1
      DO 60 I=1,NOSLIC
      N=2
      ARCY=CY-SQRT(R**2-(CX-SLICX(I))**2)
      DO 59 J=NOLP1,NOL
      IF(LNU(J).EQ.J)GO TO 59
      SLIC(I,N,2)=J
      SLIC(I,N,1)=C(J,4)+(SLICX(I)-C(J,3))*SLOPE(J)
      IF(SLICX(I).LT.(C(J,3)-SMLNO).OR.SLICX(I).GT.(C(J,5)+SMLNO))SLI
     &C(I,N,1)=0.0
      IF(SLIC(I,N,1).GT.(SLIC(I,1,1)+SMLNO).OR.SLIC(I,N,1).LT.(ARCY
     &-SMLNO))SLIC(I,N,1)=0.0
57    N=N+1
```

```
   59    CONTINUE
         SLIC(I,N,1)=ARCY
   60    SLIC(I,N,2)=NOLP1
   C      SORT SLICE ARRAY IN DECREASING ORDER
         IF(LIST.NE.0)WRITE(6,216)
  216    FORMAT(T6,'SLICE#',2X,'X-COORD',4(2X,'LINE NO',2X,'Y-COORD'
        &))
         MCOUN=N
         N=MCOUN-1
         DO 81 KZ=1,NOSLIC
   84    NUM=1
         DO 85 KY=1,N
         IF(SLIC(KZ,KY,1).LE.-9.50)GO TO 82
         IF((SLIC(KZ,KY,1)+SMLNO).GE.SLIC(KZ,KY+1,1))GO TO 85
         SAVE=SLIC(KZ,KY,1)
         SLIC(KZ,KY,1)=SLIC(KZ,KY+1,1)
         SLIC(KZ,KY+1,1)=SAVE
         SAVE=SLIC(KZ,KY,2)
         SLIC(KZ,KY,2)=SLIC(KZ,KY+1,2)
         SLIC(KZ,KY+1,2)=SAVE
         GO TO 85
   82    SLIC(KZ,KY,1)=SLIC(KZ,KY-1,1)
         SLIC(KZ,KY,2)=SLIC(KZ,KY-1,2)
   85    IF(KY.NE.1.AND.SLIC(KZ,KY,1)-SMLNO.LE.SLIC(KZ,KY-1,1))NUM=NUM
        &+1
         IF(NUM.NE.N)GO TO 84
   81    IF(LIST.NE.0)WRITE(6,3)KZ,SLICX(KZ),(SLIC(KZ,KY,2),SLIC(KZ
        &,KY,1),KY=1,MCOUN)
    3    FORMAT(I6,I5,9F9.2,/,T20,8F9.2,/,T20,8F9.2,/,T20,8F9.2)
         DO 306 I=1,NSM1
         SAREA=0.0
         WEIGHT=0.0
         EFWT=0.
         ISOIL=0
         NN=MCOUN-1
         IF(LIST.NE.0)WRITE(6,350)I
  350    FORMAT(/,T5,'SLICE LINE NUMBER',I4)
         DO 303 J=1,NN
         DA=(SLIC(I,J,1)+SLIC(I+1,J,1)-SLIC(I,J+1,1)-SLIC(I+1,J+1,1))*
        &(SLICX(I+1)-SLICX(I))/2.0
         IF(DA.LE.SMLNO)GO TO 305
         DO 305 II=1,NOSP1
         IF(II.EQ.NOSP1)GO TO 308
         IF(ISOIL.EQ.II) GO TO 305
         N=NSLIN(II)
         ICOUNT=0
         JCOUNT=0
  311    DO 304 JJ=1,N
         IF(JCOUNT.EQ.2)GO TO 305
         INTL=SOIL(II,JJ,2)
         INTR=SOIL(II,JJ,3)
         IF(ICOUNT.EQ.1)GO TO 310
         IF(SLIC(I,J,2).NE.SOIL(II,JJ,1)) GO TO 304
         ICOUNT=1
         JSOIL=II
         IF((SLICX(I)+SMLNO).GE.INTAR(INTL,1).AND.(SLICX(I)-SMLNO).LE.
        &INTAR(INTR,1))GO TO 310
         ICOUNT=0
         GO TO 304
  310    IF(SLIC(I+1,J,2).NE.SOIL(II,JJ,1))GO TO 304
         IF((SLICX(I+1)+SMLNO).LT.INTAR(INTL,1).OR.(SLICX(I+1)-SMLNO).G
        &INTAR(INTR,1))GO TO 304
         ICOUNT=2
         IF(JSOIL.NE.II)GO TO 305
  302    ISOIL=II
  308    SAREA=SAREA+DA
         GSUB=G(ISOIL)
         IF(SAT(ISOIL).GT.0.1)GSUB=G(ISOIL)-FU4
         EFWT=EFWT+DA*GSUB
         WEIGHT=WEIGHT+DA*G(ISOIL)
         IF(LIST.EQ.0)GO TO 9092
         WRITE(6,351)J,I,DA
  351    FORMAT(T10,'DSLICE NO',I2,'OF SLICE ',I3,'WITH DA OF',F10.3)
         WRITE(6,352)ISOIL,J,SAREA,WEIGHT,EFWT
  352    FORMAT(T15,'SOIL',I3,'LIES IN DSLICE',I3,/,T15,'TOTAL AREA
        &=',F10.3,3X,'TOTAL WEIGHT=',G10.3,5X,'EFFECT. WT=',G10.3)
 9092    GO TO 303
  304    CONTINUE
         IF(ICOUNT.EQ.1)JCOUNT=JCOUNT+1
         IF(ICOUNT.EQ.2)GO TO 311
  305    CONTINUE
  303    CONTINUE
         ALPHA(I)=ARSIN(ABS(CX-((SLICX(I+1)-SLICX(I))/2.0+SLICX(I)))/R)
```

```
      AREA(I)=SAREA
      EFFWT(I)=EFWT
      WEIGH(I)=WEIGHT
      CO(I)=COHES(ISOIL)
306   P(I)=PHI(ISOIL)
      IF(LIST.EQ.0)GO TO 365
      WRITE(6,354)
354   FORMAT(T5,'SLICE#',3X,'AREA',3X,'WEIGHT',4X,'COHESION',3X,'P
     &HI',3X,'ALPHA')
      DO 307 I=1,NSMI
      IF(AREA(I).LE.SMLNO)GO TO 362
      WRITE(6,353)I,AREA(I),WEIGH(I),CO(I),P(I),ALPHA(I)
      GO TO 307
362   WRITE(6,353)I,AREA(I),WEIGH(I)
353   FORMAT(T7,I2,2X,3F10.3,F6.2,F9.4)
307   CONTINUE
C      SUM OVERTURN, MOMENT=0.0
365   DO 367 I=1,NSMI
      IF(AREA(I).LE.SMLNO)P(I)=0.00
      IF(AREA(I).LE.SMLNO)CO(I)=0.00
367   P(I)=P(I)/57.2928
      FI=1.0
387   ZUM=0.0
      TF=0.0
      DO 382 K=1,NSMI
      CENTR=(SLICX(K+1)-SLICX(K))/2.0+SLICX(K)
      IF((CENTR-CX).LT.0.0)T=-WEIGH(K)*SIN(ALPHA(K))
      IF((CENTR-CX).EQ.0.0)T=0.0
      IF((CENTR-CX).GT.0.0) T=WEIGH(K)*SIN(ALPHA(K))
      IF(CENTRE.GE.AAH)T=T+YAY*(SLICX(K+1)-SLICX(K))
394   TF=TF+T
      IF((CENTRE-CX).LT.0.) A=-1.*SIN(ALPHA(K))
      A=SIN(ALPHA(K))
      B(K)=(SLICX(K+1)-SLICX(K))/COS(ALPHA(K))
      Z=(CO(K)*B(K)+EFFWT(K)*TAN(P(K)))/(COS(ALPHA(K))+TAN(P(K))*A/FI
382   ZUM=ZUM+Z
      FO=ZUM/TF
      WRITE(6,116)FI,FO
116   FORMAT(20X,'FI=',F10.5,3X,'FO=',F10.5)
      IF(ABS(FI-FO).001)385,385,383
385   WRITE(6,108)NCOUN,FO
108   FORMAT('0',15X,'THE SAFETY FACTOR FOR POINT',I3,'IS',F10.5)
      GO TO 360
383   FI=FO
      GO TO 387
389   IF(PCODE.EQ.0.OR.R.GE.CY)GO TO 360
      IF(NCOUN.GT.1)GO TO 405
      XAXIS=12.
      YAXIS=9.
      PSCALE=SCALE
      DATA METER/'M'/
      IF(UT.NE.METER)GO TO 405
      XAXIS=15.
      YAXIS=12.
      PSCALE=SCALE*2
405   IF(NCOUN.NE.1.AND.(NCOUN/NP*NP.NE.NCOUN).AND.NCOUN.NE.ITX*IT
     &Y)GO TO 360
360   IF(IX.EQ.ITX)CX=CX-(IX-1)*DELX
      STOP
      END
E*NE.GUL
```

CHAPTER 5

RESULTS AND RECOMMENDATIONS

5.I RESULTS FROM THE COMPUTER PROGRAM

5.I.I Slope Stability Analysis For Existing Soil Profile

Results from the computer program and figures showing various cross-sections are given in figures and tables.

In cross-section (3-3)A , soil I is artificial fill, the thickness of these fills decreases with increasing distance from the shore. The artificial fill contains boulders, gravel, sand, silt, shells, wooden pieces, pieces of concrete, mortar and all kinds of city debris. The determination of engineering characteristics of such fills is very difficult. So soil parameters may be taken as : (Aras,I978 and Ünlü,I982)

γ_n : I.8 t/m^3

ϕ : 20°

c : $2t/m^2$

Soil II is a sedimentary layer. The sedimentary layers which are found under the artificial fill layer consists of sandy, clayey silts which contain large amount of organic matter and

shells.

To find characteristics parameters for such soils, we will make the following consideration accepting the soil to be normally consalidated. The value of ratio $c_u/\bar{p}$ is found by the formula:

$$s_u/\bar{p} = 0.11 + 0.0037\ PI$$

given by Skempton(1975), where s_u denotes the undrained shear strength at a depth where the effective overburden pressure is equal to $\bar{p}$. PI denotes the plasticity index. The avarage value of PI may be obtained from table 2.10 to be 35. When this avarage value is substituted in the equation, $s_u/\bar{p}$ ratio is found as:

$$s_u/\bar{p} = 0.11 + 0.0037 \times 35$$

$$s_u/\bar{p} = 0.24$$

For various depths :

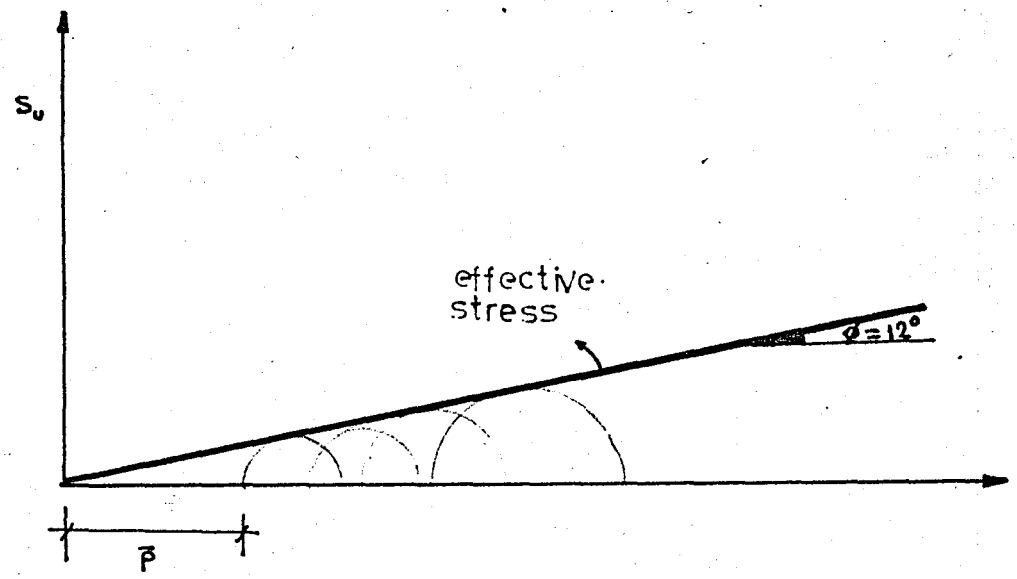
30m. ..... $s_u = 0.24 \times 30 \times 0.8 = 5.76\ t/m^3$

40m. ..... $s_u = 0.24 \times 40 \times 0.8 = 7.68\ t/m^3$

50m. ..... $s_u = 0.24 \times 50 \times 0.8 = 9.60\ t/m^3$

60m. ..... $s_u = 0.24 \times 60 \times 0.8 = 11.52\ t/m^3$

If we plot these values, we will obtain the angle of friction, $\phi = 12$ and the cohesion $c = 0$.

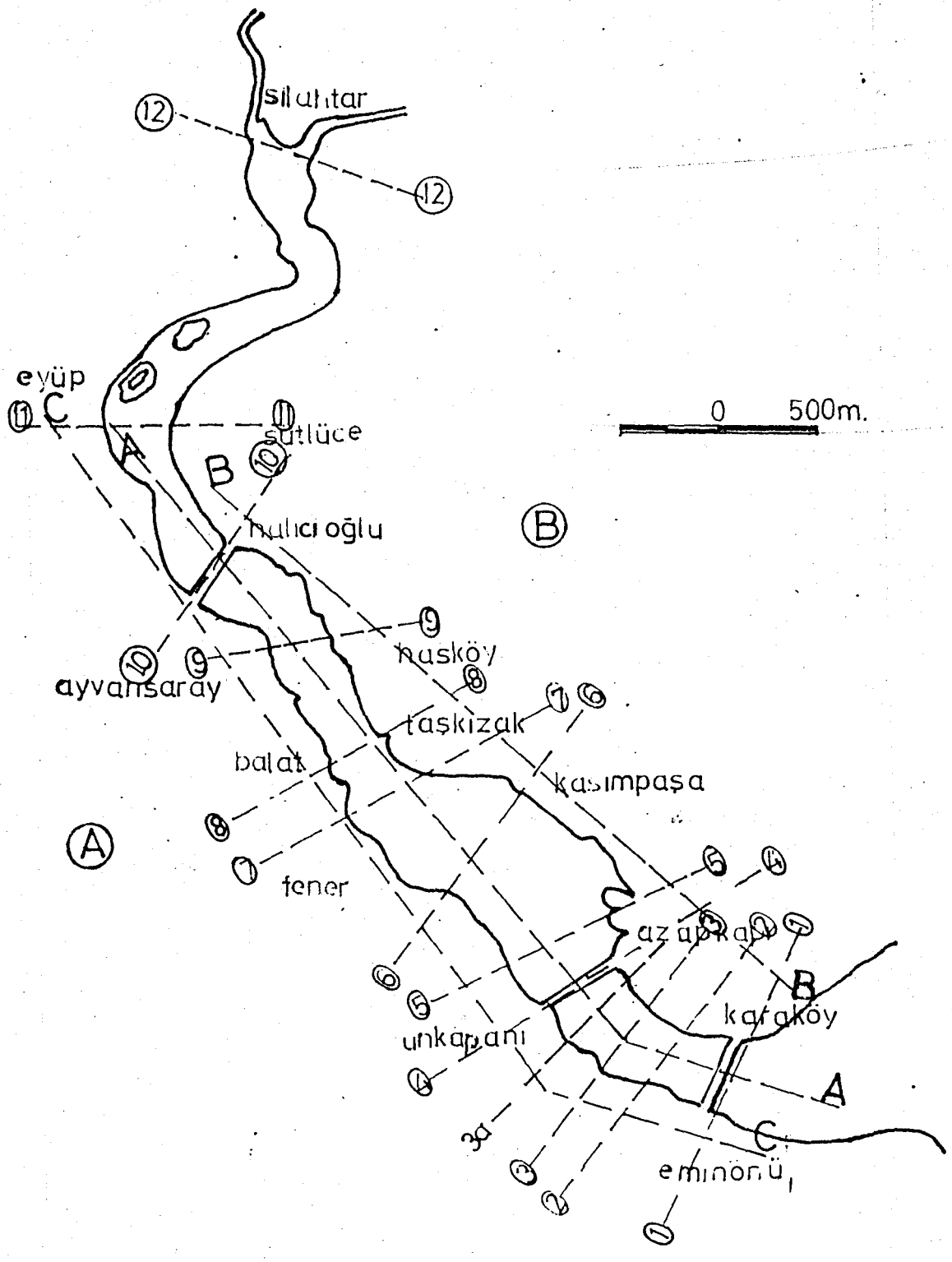


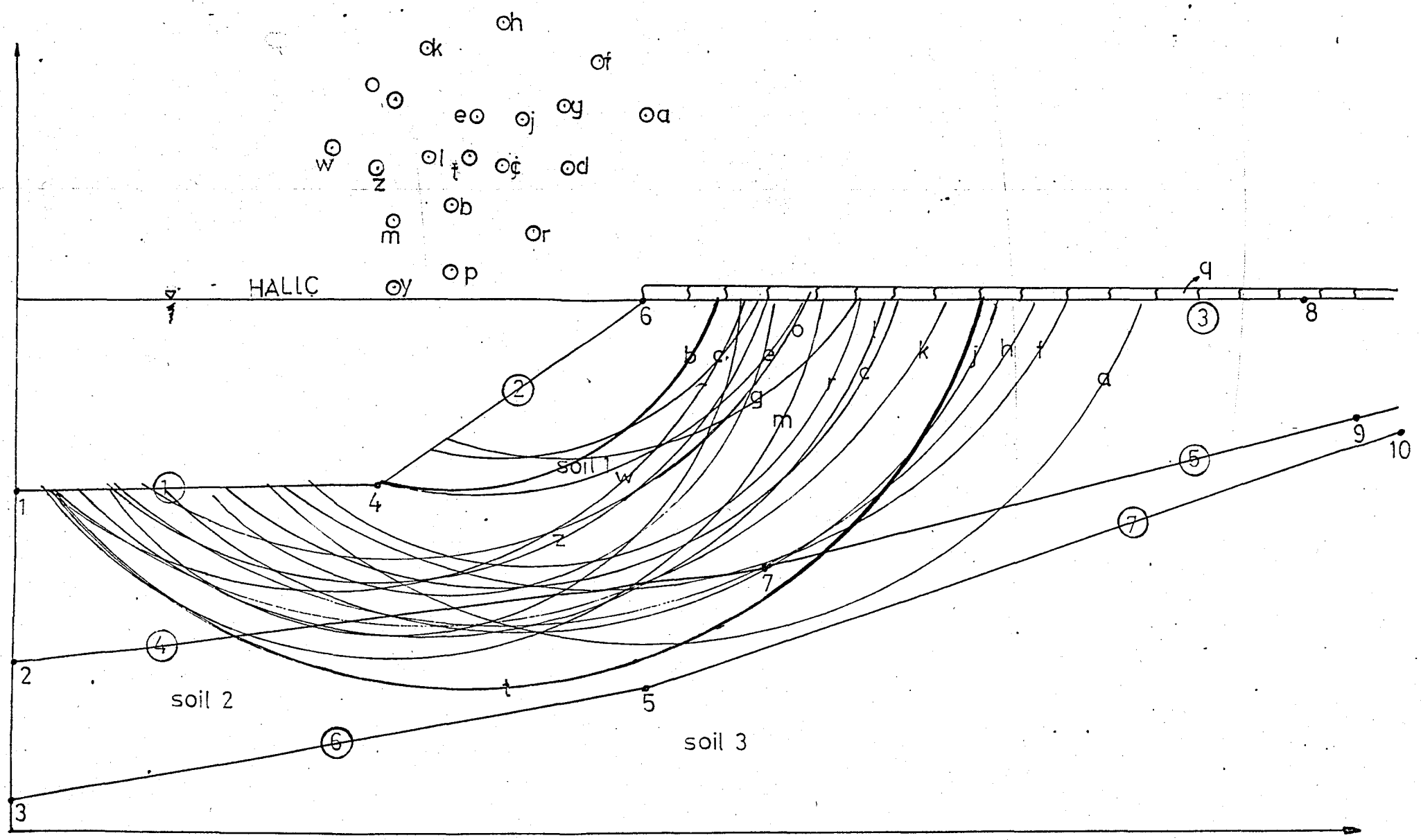
Soil III is decomposed graywacke. The engineering characteristics of this layer is given in table 2.2 .

As was stated before when a circle center and a entrance point is given as data to the computer program, it analysis further 8 potential failure circles by keeping the position of the entrance point constant , and changing the center of the circle in the X and Y directions. In the table only the slope circle which gives the minimum factor of safety for this set is given. So altogether I2x9 = I08 circles have been investigated.

If we run the computer program for cross-section(3-3)A , Wewill obtain the following results:

Circle NO	Circle center Coord		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	I22	I38	2I7	I05	I.73
b	84	II9	I34	I05	I.42
c	94	I26	I43	I05	I.60
d	I06	I25	I69	I05	2.00
e	89	I35	I5I	I05	I.50
f	II4	I47	202	I05	2.30
g	I06	I57	I6I	I05	2.I0
h	95	I53	I97	I05	I.55
j	98	I35	I89	I05	I.50
k	80	I48	I80	I05	I.54
l	80	I28	I68	I05	I.52
m	73	II6	I55	I05	I.6I
w	6I	I30	I40	I05	I.60
o	74	I38	I52	I05	I.49
z	69	I25	I45	I05	I.6I
t	88	I25	I86	I05	I.30
r	I00	I04	I62	I05	I.56
p	84	I07	I45	I05	I.76
y	73	I03	I40	I05	I.40


silahtar
eyüp
sütlüce
hulıcı oğlu
nasköy
ayvansaray
taşkızak
balat
kasımpaşa
fener
azapkapı
karaköy
unkapanı
eminönü
0 500m.
A
B
C


h
k
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3
8
2
9
10
5
4
soil 1
soil 2
soil 3
7

Fig : (3-3)A

= ...AIR ROSELER THESIS

F LINES 7 NO OF LINE INTERSECT= 10

F SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

F XINCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 2.0

LINE END COORD MATRIX

NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTER N	
2		.00	57.1	70.1	67.11	.142631	1	4
2		70.11	67.11	120.11	105.11	.760000	4	6
2		120.11	105.11	230.11	105.11	.000000	6	8
2		.00	30.11	143.11	54.11	.167702	2	7
2		143.11	54.11	235.11	80.11	.282609	7	9
2		.00	1.11	115.11	28.11	.234556	3	5
2		115.11	28.11	240.11	66.11	.304000	5	10

INTERSECT ARRAY

O	X	Y
	.00	57.1
	.00	30.11
	.00	1.11
	70.11	67.11
	115.11	28.11
	120.11	105.11
	143.11	54.11
	230.11	105.11
	235.11	80.11
	240.11	66.11

DATA ARRAY

NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	1	4	0	7.8	20.0	19.6
2	3	4	6	0	7.8	20.0	19.6
3	4	6	8	0	7.8	20.0	19.6
4	2	2	7	0	7.8	20.0	19.6
5	5	7	9	0	7.8	20.0	19.6
5	6	2	7	0	7.8	12.0	0
6	7	7	9	0	7.8	12.0	0
7	8	3	5	0	7.8	12.0	0
6	9	3	5	0	3.7	45.0	68.6
7	10	5	9	0	3.7	45.0	68.6

L CIRCLE NO 1
LE CTR COORDS: X= X= 88.1 Y= 25.11
ANCE PT. COORDS: X= 86.11 Y= 105.11
TRIAL ARC RADIUS= 100.020

LINE 2NOT INTERSECTED BY TRIAL CIRCL

LINE 6NOT INTERSECTED BY TRIAL CIRCL

LINE 7NOT INTERSECTED BY TRIAL CIRCL

INE 2IS NOT INTERSECTED BUT IS IN ARC

INTERSECT WITH LINE ARRAY

NO	X	Y
	3.177	58.98
	40.849	36.96
	164.063	60.07
	186.11	105.11

ARRAY WITH ALL INTERSECTIONS FOLLOWS:

1	.000	57.1	K= 1	KK= 1
2	.000	30.11	K= 1	KK= 2

```
      5          40.849          36.962     K=  3   KK=  3
      6          70.  1          67.  1     K=  3   KK=  4
      7         115.  1          28.  1     K=  3   KK=  5
      8         120.  1         105.  1     K=  3   KK=  6
      9         143.  1          54.  1     K=  3   KK=  7
     10         164.063          60.032     K=  4   KK=  7
     11         186.  1         105.  1     K=  4   KK=  7
     12         230.  1         105.  1     K=  4   KK=  8
     13         235.  1          80.  1     K=  4   KK=  9
     14         240.  1          66.  1     K=  4   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=    1          13.077          58.976     K=  4   KK=  1
I=    2          40.849          36.962     K=  5   KK=  2
I=    3          70.  1          67.  1     K=  6   KK=  3
I=    4         120.  1         105.  1     K=  8   KK=  4
I=    5         143.  1          54.  1     K=  9   KK=  5
I=    6         164.063          60.032     K= 10   KK=  6
I=    7         186.  1         105.  1     K= 11   KK=  7

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
              FI=    1.00000    FO=    1.25393
              FI=    1.25393    FO=    1.29647
              FI=    1.29647    FO=    1.30238
              FI=    1.30238    FO=    1.30318

          THE SAFETY FACTOR FOR POINT  1IS    1.30318

TRIAL CIRCLE NO  2
CIRCLE CTR COORDS:  X=  X=       9 .  1   Y=     125.  1
ENTRANCE PT. COORDS:  X=        86.  1   Y=     105.  1
    TRIAL ARC RADIUS=      97.082


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO             X                Y
  1              19.232           59.85
  4              47.947           38.  5
  5             162.836           59.69
  3             186.  1          105.  1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=    1            .000           57.  1    K=  1   KK=  1
I=    2            .000           30.  1    K=  1   KK=  2
I=    3            .000           30.  1    K=  1   KK=  3
I=    4          19.232           59.854    K=  2   KK=  3
I=    5          47.947           38.  52   K=  3   KK=  3
I=    6          70.  1           67.  1    K=  3   KK=  4
I=    7         115.  1           28.  1    K=  3   KK=  5
I=    8         120.  1          105.  1    K=  3   KK=  6
I=    9         143.  1           54.  1    K=  3   KK=  7
I=   10         162.836           59.686    K=  4   KK=  7
I=   11         186.  1          105.  1    K=  4   KK=  7
I=   12         230.  1          105.  1    K=  4   KK=  8
I=   13         235.  1           80.  1    K=  4   KK=  9
I=   14         240.  1           66.  1    K=  4   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=    1          19.232           59.854    K=  4   KK=  1
I=    2          47.947           38.  52   K=  5   KK=  2
```

```
5      143.1?        54?.1?    K=  9   KK=  5
6      152.836       59.686    K= 10   KK=  6
7      186.11        105.11    K= 11   KK=  7

ND SLICE WIDTH AND NO OF SLICES

***MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
          FI=  1.00000   FO=  1.25802
          FI=  1.25802   FO=  1.30167
          FI=  1.30167   FO=  1.30777
          FI=  1.30777   FO=  1.30860

     THE SAFETY FACTOR FOR POINT  2IS    1.30860

IAL CIRCLE NO  3
RCLE CTR COORDS:  X=  X=     88.11    =    128.11
TRANCE PT. COORDS:  X=       86.11    Y=   105.11
   TRIAL ARC RADIUS=   100.663


X LINE  2NOT INTERSECTED BY TRIAL CIRCL

X LINE  6NOT INTERSECTED BY TRIAL CIRCL

X LINE  7NOT INT RSECTED BY TRIAL CIRCL

*LINE  2IS NOT INTERSECTED BUT IS IN ARC

C INTERSECT WITH LINE ARRAY
E NO        X              Y
          14.723         59.21
          44.21          37.53
          161.622        59.34
          186.11         105.11

E ARRAY WITH ALL INTERSECTIONS FOLLOWS:
 1         .000       57.11    K= 1   KK=  1
 2         .000       30.11    K= 1   KK=  2
 3         .000       .11      K= 1   KK=  3
 4       14.723       59.21    K= 2   KK=  3
 5       44.21        37.525   K= 3   KK=  3
 6       70.11        67.11    K= 3   KK=  4
 7       115.11       28.11    K= 3   KK=  5
 8       120.11       105.11   K= 3   KK=  6
 9       143.11       54.11    K= 3   KK=  7
10       161.622      59.342   K= 4   KK=  7
11       186.11       105.11   K= 4   KK=  7
12       230.11       105.11   K= 4   KK=  8
13       235.11       80.11    K= 4   KK=  9
14       240.11       66.11    K= 4   KK= 10

E APPLICABLE ARRAY ARCINT FOLLOWS:
 1       14.723       59.21    K= 4   KK=  1
 2       44.21        37.525   K= 5   KK=  2
 3       70.11        67.11    K= 6   KK=  3
 4       120.11       105.11   K= 8   KK=  4
 5       143.11       54.11    K= 9   KK=  5
 6       161.622      59.342   K= 10  KK=  6
 7       186.11       105.11   K= 11  KK=  7

ND SLICE WIDTH AND NO OF SLICES

***MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
          FI=  1.00000   FO=  1.24127
          FI=  1.24127   FO=  1.28123
          FI=  1.28123   FO=  1.28675
          FI=  1.28675   FO=  1.28750

     THE SAFETY FACTOR FOR POINT  3IS    1.28750
```

```
CIRCLE CTR COORDS:  X=   X=       9 .1   Y=      28.1
ENTRANCE PT COORDS:  X=          86.1   Y=      105.1
     TRIAL ARC RADIUS=     97.745


(XX LINE   2NOT INTERSECTED BY TRIAL CIRCL

(XX LINE   6NOT INTERSECTED BY TRIAL CIRCL

(XX LINE   7NOT INTERSECTED BY TRIAL CIRCL

**LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
INE NO          X              Y
  1          20.914         60.09
  4          51.508         38.75
  5         160.161         58.93
  3         186.111         105.1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         57.1     K=  1   KK=  1
I=  2          .000         30.1     K=  1   KK=  2
I=  3          .000                  K=  1   KK=  3
I=  4        20.914         60.094   K=  2   KK=  3
I=  5        51.508         38.749   K=  3   KK=  3
I=  6        70.1           67.1     K=  3   KK=  4
I=  7       115.1           28.1     K=  3   KK=  5
I=  8       120.1           105.1    K=  3   KK=  6
I=  9       143.1           54.1     K=  3   KK=  7
I= 10       160.161         58.930   K=  4   KK=  7
I= 11       186.111         105.1    K=  4   KK=  7
I= 12       230.1           105.1    K=  4   KK=  8
I= 13       235.1           80.1     K=  4   KK=  9
I= 14       240.1           66.1     K=  4   KK=  0

THE APpLICABLE ARRAY ARCINT FOLLOWS:
I=  1        20.914         60.094   K=  4   KK=  1
I=  2        51.508         38.749   K=  5   KK=  2
I=  3        70.1           67.1     K=  6   KK=  3
I=  4       120.1           105.1    K=  8   KK=  4
I=  5       143.1           54.1     K=  9   KK=  5
I=  6       160.161         58.930   K=  0   KK=  6
I=  7       186.111         105.1    K=  1   KK=  7

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTE          D TO 2.50
                FI=     1.000000    FO=     1.24876
                FI=     1.24876     FO=     1.29036
                FI=     1.29036     FO=     1.29613
                FI=     1.29613     FO=     1.2969

          THE SAFETY FACTOR FOR POINT  41S    1.29691
KPT PRINT$
```

In cross-section(3-3) B soil types are given as:

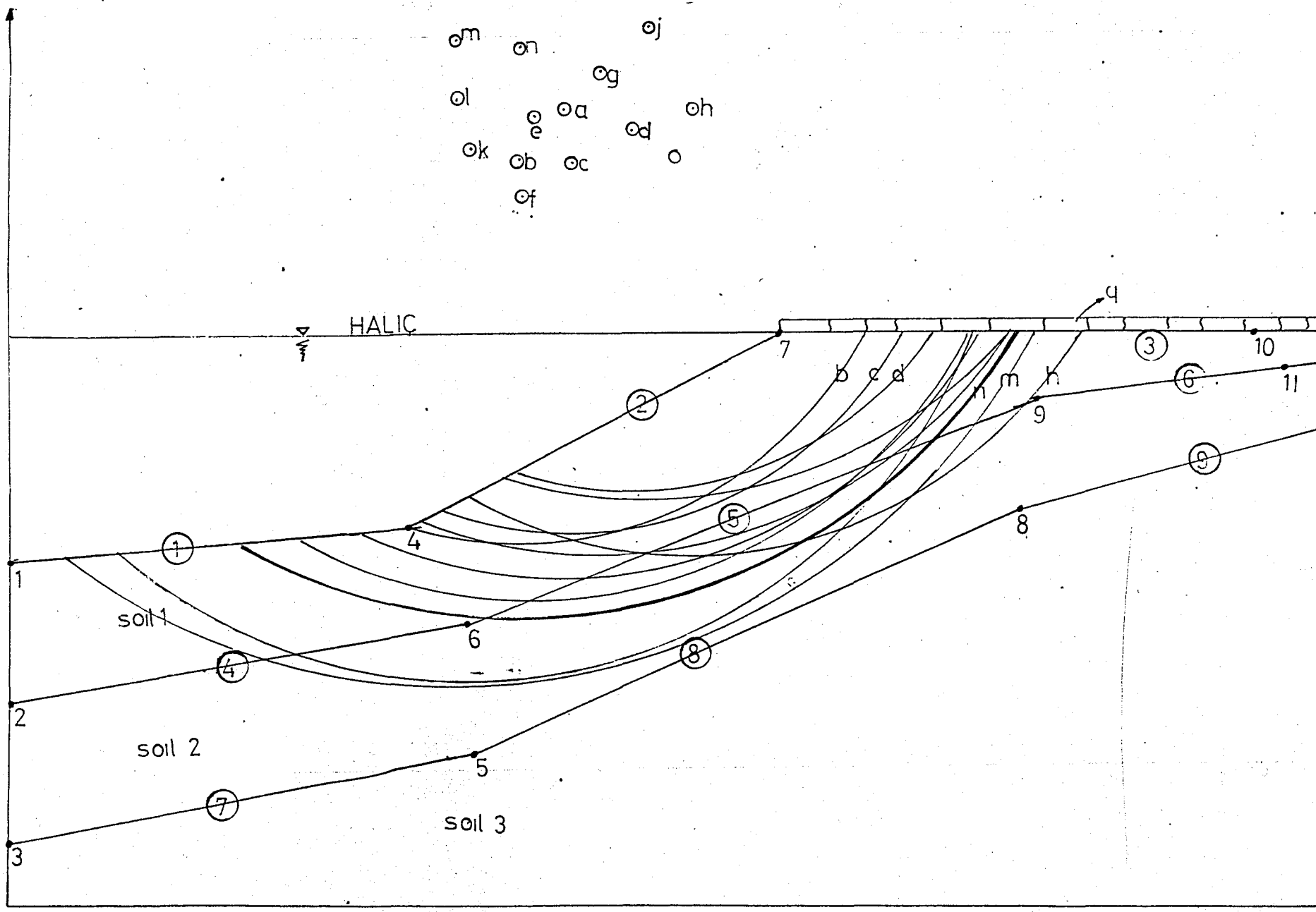
Soil I : Artificial Fill

Soil II : Sedimentary Layer

Soil III : Decomposed Graywacke

The results taken from the computer for cross-section(3-3) B are:

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	I05	I48	I83	I07	I.29
b	96	I39	I60	I07	I.65
c	I06	I39	I67	I07	I.80
d	II7	I46	I73	I07	2.20
e	99	I46	I8I	I07	I.I3
f	III	I55	I88	I07	I.36
h	I27	I49	200	I07	I.50
j	II9	I63	I88	I07	2.I2
k	86	I4I	I80	I07	I.I2
l	83	I50	I74	I07	I.I9
m	82	I6I	I92	I07	I.35
n	95	I60	I89	I07	I.II6


m
n
j
g
l
a
h
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k
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c
o
f
HALIÇ
q
7
3
10
b c d
h m n
6
11
2
9
5
4
8
1
soil 1
6
4
8
2
soil 2
5
7
soil 3
3

Fig: (3-3)B

```
OPE STABILITY FOR UNKAP(IT) M K THESIS

 OF LINES  9          NO OF LINE INTERSECT= 12
 OF SOILS=  3          NO OF EXTERNAL SOIL LINES=  3
 OF X INCREMENTS=  2          NO OF Y INCREMENTS=  2
   IN   ITIAL SLICE WIDTH=  2.0

E LINE END COORD MATRIX
E NO NO INT     X1         Y1         X2         Y2        SLOPE        LINE INTER
1    2          .00       64.1       74.1       69.1      .674664E00     1    4
2    2        74.1        69.1       144.1      107.1     .542857        4    7
3    2       144.1       107.1       233.1      107.1     .000000        7    10
4    2          .00       36.1        86.1       50.1     .162581        2    6
5    2        86.1        50.1        194.1      94.1     .407407        6    9
6    2       194.1        94.1       237.1      101.1     .162791        9    11
7    2          .00       10.1        84.1       27.1     .202114        3    5
8    2        84.1        27.1       188.1       73.1     .442308        5    8
9    2       188.1        73.1       244.1       90.1     .303571        8    12

NE INTERSECT ARRAY
 NO        X          Y
 1        .00       64.1
 2        .00       36.1
 3        .00       10.1
 4      74.1        69.1
 5      84.1        27.1
 6      86.1        50.1
 7     144.1       107.1
 8     188.1        73.1
 9     194.1        94.1
10     233.1       107.1
11     237.1       101.1
12     244.1        90.1

IL DATA ARRAY
L NO   LINE #   LEFT INT    RT INT    SAT    UNIT WT    PHI    COHESION
1        1          1          4       0       7.8      20.0      19.6
1        2          4          7       0       7.8      20.0      19.6
1        3          7         10       0       7.8      20.0      19.6
1        4          2          6       0       7.8      20.0      19.6
1        5          6          9       0       7.8      20.0      19.6
1        6          9         11       0       7.8      20.0      19.6
2        4          2          6       0       7.8      12.0        .0
2        5          6          9       0       7.8      12.0        .0
2        6          9         11       0       7.8      12.0        .0
2        7          3          5       0       7.8      12.0        .0
2        8          5          8       0       7.8      12.0        .0
2        9          8         12       0       7.8      12.0        .0
3        7          3          5       0      13.7      45.0      18.6
3        8          5          8       0      13.7      45.0      18.6
3        9          8         12       0      13.7      45.0      18.6

IAL CIRCLE NO  1
RCLE CTR COORDS:  X=  X=       95.1    Y=     160.1
TRANCE PT. COORDS:   X=        89.1    Y=     107.1
   TRIAL ARC RADIUS=   107.92


X LINE  2NOT INTERSECTED BY TRIAL CIRCL

X LINE  4NOT INTERSECTED BY TRIAL CIRCL

X LINE  6NOT INTERSECTED BY TRIAL CIRCL

X LINE  7NOT INTERSECTED BY TRIAL CIRCL

X LINE  8NOT INTERSECTED BY TRIAL CIRCL
```

X LINE 9NOT INTERSECTED BY TRIAL CIRCL

*LINE 2IS NOT INTERSECTED BUT IS IN ARC

C INTERSECT WITH LINE ARRAY

E NO	X	Y
	40.798	66.86
	91.393	52.26
	173.137	85.57
	189.1	07.1

E ARRAY WITH ALL INTERSECTIONS FOLLOWS:

1	.000	64.1	K=	1	KK=	1
2	.000	36.1	K=	1	KK=	2
3	.000	10.1	K=	1	KK=	3
4	40.798	66.863	K=	2	KK=	3
5	74.1	69.1	K=	2	KK=	4
6	84.1	27.1	K=	2	KK=	5
7	86.1	50.1	K=	2	KK=	6
8	91.393	52.263	K=	3	KK=	6
9	44.1	07.1	K=	3	KK=	7
10	173.137	85.566	K=	4	KK=	7
11	188.1	73.1	K=	4	KK=	8
12	189.1	07.1	K=	4	KK=	8
13	194.1	94.1	K=	4	KK=	9
14	233.1	07.1	K=	4	KK=	0
15	237.1	0	K=	4	KK=	1
16	244.1	90.	K=	4	KK=	2

E APPLICABLE ARRAY ARCINT FOLLOWS:

1	40.798	66.863	K=	4	KK=	1
2	74.1	69.1	K=	5	KK=	2
3	9.393	52.263	K=	8	KK=	3
4	44.1	07.1	K=	9	KK=	4
5	173.137	85.566	K=	0	KK=	5
6	189.1	07.1	K=	2	KK=	6

ND SLICE WIDTH AND NO OF SLICES

***MAXIMUM SLICE WIDTH HAS BEEN INCREMENTE D TO 2.50

FI=	.00000	FO=	.0345
FI=	.0345	FO=	.1504
FI=	.1504	FO=	.1623
FI=	.1623	FO=	.1635

THE SAFETY FACTOR FOR POINT IS 1.1635

IAL CIRCLE NO 2
RCLE CTR COORDS: X= X= 98.1 Y= 60.1
TRANCE PT. COORDS: X= 89.1 Y= 07.1
TRIAL ARC RADIUS= 105.309

X LINE 2NOT INTERSECTED BY TRIAL CIRCL

X LINE 4NOT INTERSECTED BY TRIAL CIRCL

X LINE 6NOT INTERSECTED BY TRIAL CIRCL

X LINE 7NOT INTERSECTED BY TRIAL CIRCL

X LINE 8NOT INTERSECTED BY TRIAL CIRCL

X LINE 9NOT INTERSECTED BY TRIAL CIRCL

*LINE 2IS NOT INTERSECTED BUT IS IN ARC

C INTERSECT WITH LINE ARRAY

```
NO          X                   Y
          48.230              67.336
          97.628              54.380
         172.048              85.122
         189.111              107.111

ARRAY WITH ALL INTERSECTIONS FOLLOWS:
 1          .000              64.111   K=  1   KK=  1
 2          .000              36.111   K=  1   KK=  2
 3          .000              10.111   K=  1   KK=  3
 4        48.230              67.365   K=  2   KK=  3
 5        74.111              69.111   K=  2   KK=  4
 6        84.111              27.111   K=  2   KK=  5
 7        86.111              50.111   K=  2   KK=  6
 8        97.628              54.803   K=  3   KK=  6
 9        44.111              07.111   K=  3   KK=  7
10        72.048              85.122   K=  4   KK=  7
11        88.111              73.111   K=  4   KK=  8
12        89.111              07.111   K=  4   KK=  8
13        94.111              94.111   K=  4   KK=  9
14       233.111              07.111   K=  4   KK=  0
15       237.111              10.111   K=  4   KK=  1
16       244.111              90.111   K=  4   KK=  2

APPLICABLE ARRAY ARCINT FOLLOWS:
 1        48.230              67.365   K=  4   KK=  1
 2        74.111              69.111   K=  5   KK=  2
 3        97.628              54.803   K=  8   KK=  3
 4        44.111              07.111   K=  9   KK=  4
 5        72.048              85.122   K=  0   KK=  5
 6       189.111             107.111   K=  2   KK=  6

D SLICE WIDTH AND NO OF SLICES
                FI=   1.00000   FO=    .1025
                FI=    .1025    FO=    .2241
                FI=    .2241    FO=    .2363
                FI=    .2363    FO=    .2375

          THE SAFETY FACTOR FOR POINT  2IS    1.12375

AL CIRCLE NO  3
CLE CTR COORDS:  X=   X=      95.111   Y=      63.111
RANCE PT. COORDS:  X=       189.111   Y=     107.111
   TRIAL ARC RADIUS=   109.447

 LINE  2NOT INTERSECTED BY TRIAL CIRCL

 LINE  4NOT INTERSECTED BY TRIAL CIRCL

 LINE  6NOT INTERSECTED BY TRIAL CIRCL

 LINE  7NOT INTERSECTED BY TRIAL CIRCL

 LINE  8NOT INTERSECTED BY TRIAL CIRCL

 LINE  9NOT INTERSECTED BY TRIAL CIRCL

LINE  2IS NOT INTERSECTED BUT IS IN ARC

 INTERSECT WITH LINE ARRAY
 NO          X                   Y
           42.817              67.100
           94.907              53.169
          171.720              84.199
          189.111             107.111

 ARRAY WITH ALL INTERSECTIONS FOLLOWS:
 1          .000              64.111   K=  1   KK=  1
```

```
I=  3        .000       10?.?1?   K=  1   KK=  3
I=  4      42.817       67?.000   K=  2   KK=  3
I=  5      74.?1?       69?.?1    K=  2   KK=  4
I=  6      84.?1?       27?.?1?   K=  2   KK=  5
I=  7      86.?1?       50?.?1?   K=  2   KK=  6
I=  8      94.907       53?.695   K=  3   KK=  6
I=  9      44.?1        07?.?1    K=  3   KK=  7
I= 10     ?71.720      ?84?.989   K=  4   KK=  7
I= 11     ?88.?1       73?.?1?    K=  4   KK=  8
I= 12     189.?1?      07?.?1?    K=  4   KK=  8
I= 13     ?94.?1?      ?94?.?1?   K=  4   KK=  9
I= 14     233.?1?      07?.?1?    K=  4   KK= ?0
I= 15     237.?1?      ?0?.?1?    K=  4   KK= ?1
I= 16     244.?1?      ?90?.?1?   K=  4   KK= ?2

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1      42.817       67?.000   K=  4   KK=  1
I=  2      74.?1?       69?.?1    K=  5   KK=  2
I=  3      94.907       53?.695   K=  8   KK=  3
I=  4     ?44.?1?       07?.?1    K=  9   KK=  4
I=  5     ?71.720      ?84?.989   K=  0   KK=  5
I=  6     ?89.?1?      ?07?.?1?   K= ?2   KK=  6

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTE          D TO 2?50
              FI=   ?.0000    FO=   ?.?353
              FI=   ?.?353    FO=   ?.2597
              FI=   ?.?2597   FO=   ?.?2720
              FI=   ?.?2720   FO=   ?.?2733

          THE SAFETY FACTOR FOR POINT  3IS    1.12733

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=     98?.?1   Y=    ?63?.?1
ENTRANCE PT. COORDS:  X=       89?.?1   Y=    ?07.?1
    TRIAL ARC RADIUS=   ?06.850


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO        X              Y
 1          50.387        67?5?
 5?        ?01.324        56?31
 5?        ?70.448        84?47
 3?        189.?1?        ?07?.?1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1        .000       64?.?1?   K=  1   KK=  1
I=  2        .000       36?.?1?   K=  1   KK=  2
I=  3        .000       10?.?1?   K=  1   KK=  3
I=  4      50.387       67?.510   K=  2   KK=  3
I=  5      74.?1?       69?.?1    K=  2   KK=  4
I=  6      84.?1?       27?.?1?   K=  2   KK=  5
I=  7      86.?1?       50?.?1?   K=  2   KK=  6
I=  8     ?0?.324       56?.309   K=  3   KK=  6
```

```
I=  10          170.448          84.247          K=   4   KK=   7
I=  11          188.[illegible]          73.[illegible]          K=   4   KK=   8
I=  12          189.[illegible]          07.[illegible]          K=   4   KK=   8
I=  13          194.[illegible]          94.[illegible]          K=   4   KK=   9
I=  14          233.[illegible]          07.[illegible]          K=   4   KK=   0
I=  15          237.[illegible]          00.[illegible]          K=   4   KK=   1
I=  16          244.[illegible]          90.[illegible]          K=   4   KK=   2

THE APPLICABLE ARRAY ARCINI FOLLOWS:
I=   1           50.387          67.510          K=   4   KK=   1
I=   2           74.[illegible]          69.[illegible]          K=   5   KK=   2
I=   3           01.324          56.309          K=   8   KK=   3
I=   4          144.[illegible]          07.[illegible]          K=   9   KK=   4
I=   5          170.448          84.247          K=   0   KK=   5
I=   6          189.[illegible]          07.[illegible]          K=   2   KK=   6

FIND SLICE WIDTH AND NO. OF SLICES
                FI=  .000000    FO=  .2758
                FI=  .2758      FO=  .4134
                FI=  .4134      FO=  .4267
                FI=  .4267      FO=  .4280

                THE SAFETY FACTOR FOR POINT  4IS    .14280
ARKPT PRINT
```

The results taken from the computer program for cross-section (4-4) A are:

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	85	II5	I37	85	I.83
b	92	III	I50	85	I.40
c	86	II0	I39	85	I.83
d	92	II7	I63	85	I.2I
e	I07	II9	I74	85	I.7I
f	77	II9	I34	85	I.74
g	8I	II2	I30	85	I.83
h	83	I27	I44	85	I.80
i	I0I	II5	I80	85	I.35
j	74	I04	I40	85	I.20
k	68	II8	I54	85	I.I6

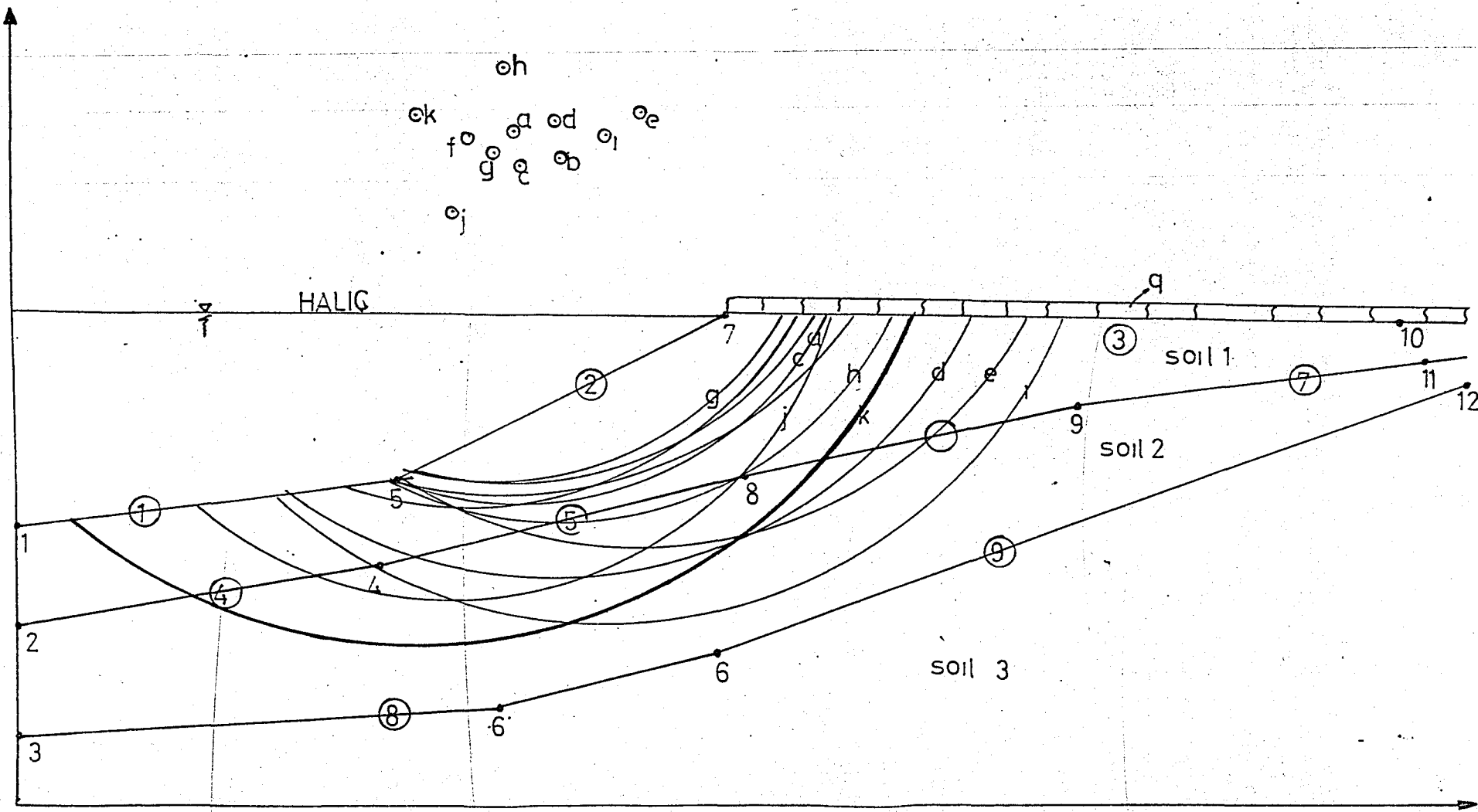


Fig : (4-4) A

OF LINES 9 NO OF LINE INTERSECT= 12

OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

OF X-INCREMENTS= 3 NO OF Y-INCREMENTS= 3

IN ITIAL SLICE WIDTH= 2.0

LINE END COORD MATRIX

NO	NO	INT	X1	Y1	X2	Y2	SLOPE	LINE	INTER
1	2		.00	49.	63.	55.	.950706-001	1	5
2	2		63.	55.	121.	85.	5.72413	5	7
3	2		121.	85.	239.	85.	.000000	7	10
4	2		.00	32.	6.	41.	1.47273	2	4
5	2		6.	41.	125.	57.	.250000	4	8
6	2		125.	57.	181.	69.	.214286	8	9
7	2		181.	69.	240.	77.	.355593	9	11
8	2		.00	25.	120.	25.	.999076-001	3	6
9	2		120.	25.	242.	73.	.393443	6	12

NE INTERSECT ARRAY

NO	X	Y
1	.00	49.
2	.00	32.
3	.00	41.
4	61.	41.
5	63.	55.
6	120.	25.
7	121.	85.
8	125.	57.
9	181.	69.
10	239.	85.
11	240.	77.
12	242.	73.

IL DATA ARRAY

NO	LINE #	LEFT INT	PT INT	SAT	UNIT WT	PHI	COHESION
1	2	1	5	0	7.8	20.0	19.6
2	3	5	7	0	7.8	20.0	19.6
3	4	7	2	0	7.8	20.0	19.6
4	5	2	4	0	7.8	20.0	19.6
5	6	4	8	0	7.8	20.0	19.6
6	7	8	9	0	7.8	20.0	19.6
7	4	5	2	0	7.8	20.0	19.
8	5	2	4	0	7.8	12.0	.0
9	6	4	8	0	7.8	12.0	.0
10	7	8	9	0	7.8	12.0	.0
11	8	9	3	0	7.8	12.0	.0
12	9	3	6	0	7.8	12.0	.0
13	8	3	6	0	13.7	45.0	68.6
13	9	6	2	0	13.7	45.0	68.6

IAL CIRCLE NO 1

RCLE CTR COORDS: X= X= 68.11 Y= 118.11

TRANCE PT. COORDS: X= 154.11 Y= 85.11

TRIAL ARC RADIUS= 92.114

X LINE 2NOT INTERSECTED BY TRIAL CIRCL

X LINE 5NOT INTERSECTED BY TRIAL CIRCL

X LINE 7NOT INTERSECTED BY TRIAL CIRCL

X LINE 8NOT INTERSECTED BY TRIAL CIRCL

X LINE 9NOT INTERSECTED BY TRIAL CIRCL

```
*LINE  5IS NOT INTERSECTED BUT TS IN ARC

 INTERSECT WITH LINE ARRAY
 NO          X              Y
                6.405         49.72
               26.374         36.00
              139.790         60.26
              154.111         85.11

 ARRAY WITH ALL INTERSECTIONS FOLLOWS:
  1             .000         49.11   K=  1   KK=  1
  2             .000         32.11   K=  1   KK=  2
  3             .000         13.11   K=  1   KK=  3
  4            6.405         49.72   K=  2   KK=  3
  5           26.374         35.99   K=  3   KK=  3
  6            6.11          4.11   K=  3   KK=  4
  7           63.11          55.11   K=  3   KK=  5
  8           20.11          25.11   K=  3   KK=  6
  9          121.11          85.11   K=  3   KK=  7
 10          125.11          57.11   K=  3   KK=  8
 11          139.790         60.26   K=  4   KK=  8
 12          154.11          85.11   K=  4   KK=  8
 13          188.11          69.11   K=  4   KK=  9
 14          239.11          85.11   K=  4   KK=  0
 15          240.11          77.11   K=  4   KK= 11
 16          242.11          73.11   K=  4   KK= 12

E APPLICABLE ARRAY ARCINT FOLLOWS:
  1            6.405         49.72   K=  4   KK=  1
  2           26.374         35.99   K=  5   KK=  2
  3           61.11          4.11   K=  6   KK=  3
  4           63.11          55.11   K=  7   KK=  4
  5          121.11          85.11   K=  9   KK=  5
  6          125.11          57.11   K=  0   KK=  6
  7          139.790         60.26   K= 11   KK=  7
  8          154.11          85.11   K= 12   KK=  8

ND SLICE WIDTH AND NO OF SLICES

***MAXIMUM SLICE WIDTH HAS BEEN INCREMENTE          D TO 2.50
                FI=    1.00000    FO=    1.18874
                FI=    1.18874    FO=    1.21567
                FI=    1.21567    FO=    1.21898
                FI=    1.21898    FO=    1.21938

          THE SAFETY FACTOR FOR POINT  IIS    1.21938

IAL CIRCLE NO  2
RCLE CTR COORDS:  X=  X=       72.11   Y=      18.11
TRANCE PTS COORDS:  X=        54.11   Y=      85.11
    TRIAL ARC RADIUS=     88.391


X LINE  2NOT INTERSECTED BY TRIAL CIRCL

X LINE  5NOT INTERSECTED BY TRIAL CIRCL

X LINE  7NOT INTERSECTED BY TRIAL CIRCL

X LINE  8NOT INTERSECTED BY TRIAL CIRCL

X LINE  9NOT INTERSECTED BY TRIAL CIRCL

*LINE  2IS NOT INTERSECTED BUT IS IN ARC

*LINE  5IS NOT INTERSECTED BUT IS IN ARC
```

```
NE NO          X              Y
1              15.17          50.55
4              36.033         37.42
6              138.743        60.03
3              154.11         85.11

HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
=  1            .000           49.11     K=  1   KK=  1
=  2            .000           32.11     K=  1   KK=  2
=  3            .000           13.11     K=  1   KK=  3
=  4           15.17           50.548    K=  2   KK=  3
=  5           36.033          37.418    K=  3   KK=  3
=  6           61.11           4.11      K=  3   KK=  4
=  7           63.11           55.11     K=  3   KK=  5
=  8           120.11          25.11     K=  3   KK=  6
=  9           121.11          85.11     K=  3   KK=  7
= 10           125.11          57.11     K=  3   KK=  8
= 11           138.743         60.032    K=  4   KK=  8
= 12           154.11          85.11     K=  4   KK=  8
= 13           178.11          69.11     K=  4   KK=  9
= 14           239.11          85.11     K=  4   KK=  0
= 15           240.11          77.11     K=  4   KK= 11
= 16           242.11          73.11     K=  4   KK= 12

HE APPLICABLE ARRAY ARCINT FOLLOWS:
=  1           15.17           50.548    K=  4   KK=  1
=  2           36.033          37.418    K=  5   KK=  2
=  3           61.11           4.11      K=  6   KK=  3
=  4           63.11           55.11     K=  7   KK=  4
=  5           121.11          85.11     K=  9   KK=  5
=  6           125.11          57.11     K= 10   KK=  6
=  7           138.743         60.032    K= 11   KK=  7
=  8           154.11          85.11     K= 12   KK=  8

IND SLICE WIDTH AND NO OF SLICES
                FI=    1.000000     FO=    1.16084
                FI=    1.16084      FO=    1.8408
                FI=    1.8408       FO=    1.8694
                FI=    1.8694       FO=    1.873

          THE SAFETY FACTOR FOR POINT  2IS    1.18731

RIAL CIRCLE NO  3
IRCLE CTR COORDS:  X=  X=      76.11    Y=      18.11
NTRANCE PT. COORDS:  X=       154.11    Y=      85.11
     TRIAL ARC RADIUS=     84.694


XX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XX LINE  9NOT INTERSECTED BY TRIAL CIRCL

**LINE  2IS NOT INTERSECTED BUT IS IN ARC

**LINE  5IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY
NE NO          X              Y
1              23.948         51.39
4              46.124         38.90
6              137.502        59.77
3              154.11         85.11
```

```
THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
  1          .000          49.[illegible]    K=  1   KK=  1
  2          .000          32.[illegible]    K=  1   KK=  2
  3          .000          13.[illegible]    K=  1   KK=  3
  4        23.948          51.388            K=  2   KK=  3
  5        46.[illegible]24  38.904           K=  3   KK=  3
  6        6[illegible]      4[illegible]      K=  3   KK=  4
  7        63.[illegible]    55.[illegible]    K=  3   KK=  5
  8        [illegible]20     25.[illegible]    K=  3   KK=  6
  9        [illegible]21     85.[illegible]    K=  3   KK=  7
 10        [illegible]25     57.[illegible]    K=  3   KK=  8
 11        137.502           59.766            K=  4   KK=  8
 12        154.[illegible]   85.[illegible]    K=  4   KK=  8
 13        [illegible]81     69.[illegible]    K=  4   KK=  9
 14        239.[illegible]   85.[illegible]    K=  4   KK= 10
 15        240.[illegible]   77.[illegible]    K=  4   KK= 11
 16        242.[illegible]   73.[illegible]    K=  4   KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
  1        23.948          51.388            K=  4   KK=  1
  2        46.[illegible]24  38.904           K=  5   KK=  2
  3        6[illegible]      4[illegible]      K=  6   KK=  3
  4        63.[illegible]    55.[illegible]    K=  7   KK=  4
  5        [illegible]21     85.[illegible]    K=  9   KK=  5
  6        [illegible]25     57.[illegible]    K= 10   KK=  6
  7        137.502           59.766            K= 11   KK=  7
  8        154.[illegible]   85.[illegible]    K= 12   KK=  8

FIND SLICE WIDTH AND NO OF SLICES
                FI=  1.00000    FO=  1.4429
                FI=  1.4429     FO=  1.6527
                FI=  1.6527     FO=  1.6798
                FI=  1.6798     FO=  1.6833

          THE SAFETY FACTOR FOR POINT  3IS   1.6833

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=      68.[illegible]   Y=     22.[illegible]
ENTRANCE PT. COORDS:  X=        54.[illegible]   Y=     85.[illegible]
     TRIAL ARC RADIUS=    93.622


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

***LINE  5IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
  1            8.501           49.92
  4           30.[illegible]5  36.55
  6          138.[illegible]61  59.89
  3          154.[illegible]1   85.[illegible]1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
  1          .000          49.[illegible]    K=  1   KK=  1
  2          .000          32.[illegible]    K=  1   KK=  2
  3          .000          13.[illegible]    K=  1   KK=  3
  4        8.501           49.919            K=  2   KK=  3
```

In cross-section (4-4) B soil types are given as :

Soil I : Artificial fill

Soil II : Sedimentary Layer

Soil III: Decomposed Graywacke

The results taken from the computer for cross-section (4-4) B are :

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	85	I23	I42	90	I.90
b	82	II6	I35	90	I.94
c	99	II8	I59	90	I.60
d	89	II7	I50	90	I.I6
e	85	II2	I28	90	2.00
f	79	I23	I32	90	I.85
g	I05	I28	I59	90	I.95
h	92	I4I	I69	90	I.I8
j	72	II0	I37	90	I.I6
k	66	I27	I45	90	I.I4

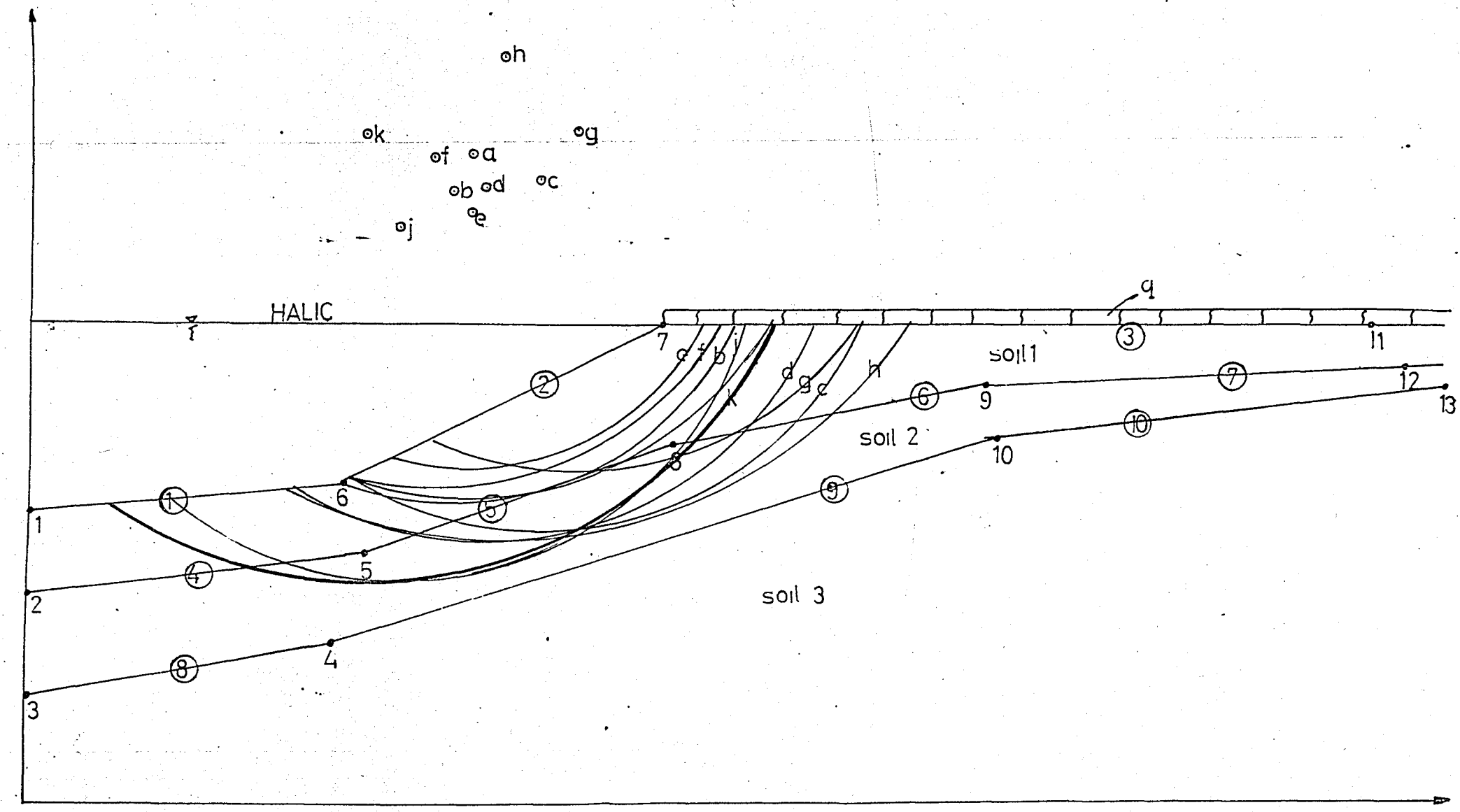


Fig : (4-4) B

) OF LINES 10 NO OF LINE INTERSECT= 13

) OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

) OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 200

JE LINE END COORD. MATRIX

JE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTE
1	2	00	55	60	60	.831795	1
2	2	60	60	2	90	.491803	6
3	2	12	90	225	90	.000000	7
4	2	00	40	59	46	.101504	2
5	2	59	46	23	67	.328125	5
6	2	123	67	8	79	.206897	8
7	2	8	79	227	82	.652174	9
8	2	00	20	57	30	.175098	3
9	2	57	30	182	69	.312000	4
10	2	182	69	230	80	.229167	10

INE INTERSECT ARRAY

T NO	X	Y
1	00	55
2	00	40
3	00	20
4	57	30
5	59	46
6	60	60
7	121	90
8	123	67
9	181	79
10	182	69
11	225	90
12	227	82
13	230	80

OIL DATA ARRAY

IL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	6	7	0	7.8	20.0	19.6
1	2	7	1	0	7.8	20.0	19.6
1	3	1	5	0	7.8	20.0	19.6
1	4	5	8	0	7.8	20.0	19.6
1	5	8	9	0	7.8	20.0	19.6
1	6	9	2	0	7.8	20.0	19.6
1	7	2	5	0	7.8	20.0	19.6
2	4	5	8	0	7.8	12.0	0.0
2	5	8	9	0	7.8	12.0	0.0
2	6	9	2	0	7.8	12.0	0.0
2	7	2	5	0	7.8	12.0	0.0
2	8	5	8	0	7.8	12.0	0.0
2	9	8	3	0	7.8	12.0	0.0
2	10	10	4	0	7.8	12.0	0.0
3	8	3	4	0	13.7	45.0	68.6
3	9	4	10	0	13.7	45.0	68.6
3	10	10	3	0	13.7	45.0	68.6

RIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 66.1 Y= 27.1

NTRANCE PT. COORDS: X= 45.1 Y= 90.1

TRIAL ARC RADIUS= 87.235

XX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

***LINE 5IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
4	39.295	44.00
6	130.930	68.73
3	145.11	90.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	55.11	K= 3	KK= 1	
I= 2	.000	40.11	K= 3	KK= 2	
I= 3	.000	20.11	K= 3	KK= 3	
I= 4	15.072	56.365	K= 3	KK= 3	
I= 5	39.295	44.00	K= 3	KK= 3	
I= 6	57.11	30.11	K= 3	KK= 4	
I= 7	59.11	46.11	K= 3	KK= 5	
I= 8	60.11	60.11	K= 3	KK= 6	
I= 9	21.11	90.11	K= 3	KK= 7	
I= 10	123.11	67.11	K= 3	KK= 8	
I= 11	130.930	68.729	K= 4	KK= 8	
I= 12	145.11	90.11	K= 4	KK= 8	
I= 13	81.11	79.11	K= 4	KK= 9	
I= 14	82.11	69.11	K= 4	KK= 10	
I= 15	225.11	90.11	K= 4	KK= 11	
I= 16	227.11	82.11	K= 4	KK= 12	
I= 17	230.11	80.11	K= 4	KK= 13	

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	15.072	56.365	K= 4	KK= 1	
I= 2	39.295	44.00	K= 5	KK= 2	
I= 3	59.11	46.11	K= 7	KK= 3	
I= 4	60.11	60.11	K= 8	KK= 4	
I= 5	21.11	90.11	K= 9	KK= 5	
I= 6	123.11	67.11	K= 10	KK= 6	
I= 7	130.930	68.729	K= 11	KK= 7	
I= 8	145.11	90.11	K= 12	KK= 8	

FIND SLICE WIDTH AND NO OF SLICES

FI= .00000	FO= 2.33
FI= 2.33	FO= 3825
FI= 3825	FO= 4039
FI= 4039	FO= 4065

THE SAFETY FACTOR FOR POINT 1 IS 1.I4065

TRIAL CIRCLE NO 2
CIRCLE CTR COORDS: X= X= 70.11 Y= 27.11
ENTRANCE PT. COORDS: X= 45.11 Y= 90.11
TRIAL ARC RADIUS= 83.630

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XX LINE 10NOT INTERSECTED BY TRIAL CIRCL

**LINE 2IS NOT INTERSECTED BUT IS IN ARC

**LINE 5IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY
NE NO X Y
1 24.316 57.134
4 52.237 45.413
6 [illegible]29.751 68.[illegible]48
3 [illegible]145.[illegible]1 90.[illegible]7

HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
1 .000 55.[illegible] K= 1 KK= 1
2 .000 40.[illegible] K= 1 KK= 2
3 .000 20.[illegible] K= 1 KK= 3
4 24.316 57.134 K= 2 KK= 3
5 52.237 45.413 K= 3 KK= 3
6 57.[illegible] 30.[illegible] K= 3 KK= 4
7 59.[illegible] 46.[illegible] K= 3 KK= 5
8 60.[illegible] 60.[illegible] K= 3 KK= 6
9 2.[illegible] 90.[illegible] K= 3 KK= 7
10 23.[illegible] 67.[illegible] K= 3 KK= 8
11 29.75[illegible] 68.485 K= 4 KK= 8
12 45.[illegible] 90.[illegible] K= 4 KK= 8
13 78.[illegible] 79.[illegible] K= 4 KK= 9
14 82.[illegible] 69.[illegible] K= 4 KK= 10
15 225.[illegible] 90.[illegible] K= 4 KK= 11
16 227.[illegible] 82.[illegible] K= 4 KK= 12
17 230.[illegible] 80.[illegible] K= 4 KK= 13

HE APPLICABLE ARRAY ARCINT FOLLOWS:
1 24.316 57.134 K= 4 KK= 1
2 52.237 45.413 K= 5 KK= 2
3 59.[illegible] 46.[illegible] K= 7 KK= 3
4 60.[illegible] 60.[illegible] K= 8 KK= 4
5 2.[illegible] 90.[illegible] K= 9 KK= 5
6 23.[illegible] 67.[illegible] K= 10 KK= 6
7 29.75[illegible] 68.485 K= 11 KK= 7
8 145.[illegible] 90.[illegible] K= 12 KK= 8

FIND SLICE WIDTH AND NO OF SLICES
FI= .00000 FO= .1946
FI= .1946 FO= .3620
FI= .3620 FO= .3832
FI= .3832 FO= .3858

THE SAFETY FACTOR FOR POINT 2IS 1.13858

TRIAL CIRCLE NO 3
CIRCLE CTR COORDS: X= X= 74.[illegible] Y= 27.[illegible]
ENTRANCE PT. COORDS: X= 145.[illegible] Y= 90.[illegible]
TRIAL ARC RADIUS= 8[illegible].062

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

```
***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1              33.822         57.92
  5              63.944         47.70
  6             128.315         68.88
  3             145.111         90.00

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000          55.11   K=  1   KK=  1
I=  2            .000          40.11   K=  1   KK=  2
I=  3            .000          20.11   K=  1   KK=  3
I=  4          33.822          57.92   K=  2   KK=  3
I=  5          57.11           30.11   K=  2   KK=  4
I=  6          59.11           46.11   K=  2   KK=  5
I=  7          60.11           60.11   K=  2   KK=  6
I=  8          63.944          47.697  K=  3   KK=  6
I=  9         121.11           90.11   K=  3   KK=  7
I= 10         123.11           67.11   K=  3   KK=  8
I= 11         128.315          68.88   K=  4   KK=  8
I= 12         145.11           90.11   K=  4   KK=  8
I= 13         178.11           79.11   K=  4   KK=  9
I= 14         182.11           69.11   K=  4   KK= 10
I= 15         225.11           90.11   K=  4   KK= 11
I= 16         227.11           82.11   K=  4   KK= 12
I= 17         230.11           80.11   K=  4   KK= 13

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1          33.822          57.924  K=  4   KK=  1
I=  2          60.11           60.11   K=  7   KK=  2
I=  3          63.944          47.697  K=  8   KK=  3
I=  4         121.11           90.11   K=  9   KK=  4
I=  5         123.11           67.11   K= 10   KK=  5
I=  6         128.315          68.88   K= 11   KK=  6
I=  7         145.11           90.11   K= 12   KK=  7

FIND SLICE WIDTH AND NO OF SLICES
                F I=   .000000    FO=    .12695
                F I=   .12695     FO=    .14467
                F I=   .14467     FO=    .14689
                F I=   .14689     FO=    .14716

          THE SAFETY FACTOR FOR POINT  3IS    1.14716

TRIAL CIRCLE NO.  4
CIRCLE CTR COORDS:   X=   X=      66.11   Y=     31.11
ENTRANCE PT. COORDS:  X=        145.11   Y=     90.11
      TRIAL ARC RADIUS=     89.006


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

***LINE  5IS NOT INTERSECTED BUT IS IN ARC
```

```
ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
 1            17.481           56.57
 4            44.904           44.67
 6           129.254           68.38
 3           145.11            90.1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000           55.111    K=  1    KK=  1
I=  2            .000           40.111    K=  1    KK=  2
I=  3            .000           20.111    K=  1    KK=  3
I=  4          17.481           56.565    K=  2    KK=  3
I=  5          44.904           44.669    K=  3    KK=  3
I=  6          57.111           30.111    K=  3    KK=  4
I=  7          59.111           46.111    K=  3    KK=  5
I=  8          60.111           60.111    K=  3    KK=  6
I=  9         121.111           90.111    K=  3    KK=  7
I= 10         123.111           67.111    K=  3    KK=  8
I= 11         129.254           68.382    K=  4    KK=  8
I= 12         145.111           90.111    K=  4    KK=  8
I= 13         181.111           79.111    K=  4    KK=  9
I= 14         182.111           69.111    K=  4    KK= 10
I= 15         225.111           90.111    K=  4    KK= 11
I= 16         227.111           82.111    K=  4    KK= 12
I= 17         230.111           80.111    K=  4    KK= 13

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1          17.481           56.565    K=  4    KK=  1
I=  2          44.904           44.669    K=  5    KK=  2
I=  3          59.111           46.111    K=  7    KK=  3
I=  4          60.111           60.111    K=  8    KK=  4
I=  5         121.111           90.111    K=  9    KK=  5
I=  6         123.111           67.111    K= 10    KK=  6
I=  7         129.254           68.382    K= 11    KK=  7
I=  8         145.111           90.111    K= 12    KK=  8

FIND SLICE WIDTH AND NO OF SLICES
             FI=      1.000000     FO=      1.2465
             FI=      1.2465       FO=      1.14.77
             FI=      1.14.77      FO=      1.14389
             FI=      1.14389      FO=      1.14415

        THE SAFETY FACTOR FOR POINT  4IS     1.14415

TRIAL CIRCLE NO  5
CIRCLE CTR COORDS:  X=  X=        70.11    Y=      31.11
ENTRANCE PT. COORDS:  X=         145.11    Y=      90.11
     TRIAL ARC RADIUS=     85.475


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
 1            26.921           57.35
 5            59.529           46.28
 6           127.358           68.09
 3           145.11            90.1
```

In cross-section (8-8) A soil types are given as :

Soil I is Bottom Sludge? It has been determined that it is formed by sedimentation of erosed materials and pollutant in water. The engineering characteristics has been taken as :

γ_n : I.I5 t/m^3

: I2

c : 0

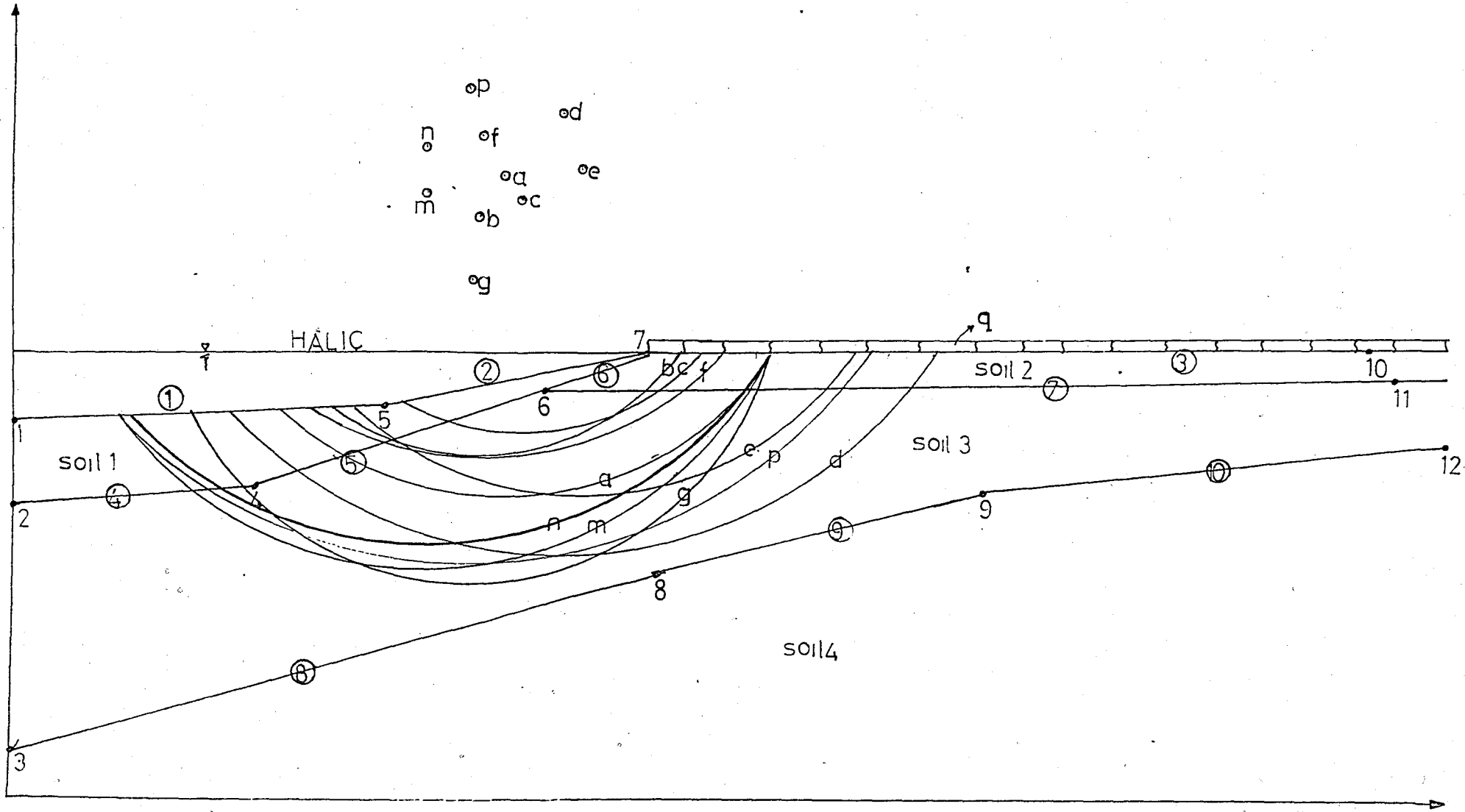
Soil II : Artificial Fill

Soil III : Sedimentary Layer

Soil 4 : Decomposed Graywacke

The results taken from the computer for cross-section (8-8)A ar

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	86	III	I35	8I	I.I8
b	83	I05	II8	8I	I.I4
c	9I	I08	I24	8I	I.50
d	98	I23	I65	8I	I.60
e	I0I	II3	I53	8I	I.60
f	84	I20	I27	8I	I.I4
g	82	93	I33	8I	I.30
m	72	I08	I36	8I	I.24
n	74	II7	I36	8I	I.I3
p	8I	I28	I57	8I	I.35


p
d
n
f
a
e
m
c
b
g
HALIC
q
7
soil 2
soil 1
soil 3
soil4
bc f
a
e
p
d
g
n
m
1
2
3
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6
8
9
10
11
12

Fig : (8-8)A

SLOPE STABILITY FOR TASKIZAK(I) MAHIR KOSELER THESIS

NO OF LINES 10 NO OF LINE INTERSECT= 12

NO OF SOILS= 4 NO OF EXTERNAL SOIL LINES= 3

NO OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 2.0

THE LINE END COORD MATRIX

LINE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INT
1	2	.00	68.1	65.1	7.1	.460752	1
2	2	65.1	7.1	240.1	8.1	.208333	5
3	2	240.1	8.1	240.1	53.1	.000000	7
4	2	240.1	53.1	95.1	55.1	.498616	2
5	2	40.1	55.1	95.1	74.1	.345455	4
6	2	95.1	74.1	240.1	81.1	.388889	6
7	2	95.1	74.1	240.1	77.1	.204082	3
8	2	240.1	8.1	175.1	41.1	.285680	8
9	2	175.1	41.1	175.1	54.1	.216557	9
10	2	175.1	54.1	244.1	66.1	.173913	

LINE INTERSECT ARRAY

INT NO	X	Y
1	.00	68.1
2	.00	53.1
3	.00	8.1
4	40.1	55.1
5	65.1	7.1
6	95.1	74.1
7	175.1	81.1
8	175.1	41.1
9	175.1	54.1
10	240.1	81.1
11	240.1	77.1
12	244.1	66.1

SOIL DATA ARRAY

SOIL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	5	5	.0	115.0	12.0	.0
1	2	7	7	.0	115.0	12.0	.0
1	3	2	4	.0	115.0	12.0	.0
1	4	6	6	.0	115.0	12.0	.0
1	5	6	7	.0	115.0	12.0	.0
1	6	7	7	.0	115.0	12.0	.0
2	2	7	7	.0	117.8	20.0	19.6
2	3	6	6	.0	117.8	20.0	19.6
2	5	6	7	.0	117.8	20.0	19.6
2	6	6	7	.0	117.8	20.0	19.6
3	3	6	6	.0	117.8	12.0	.0
3	4	6	6	.0	117.8	12.0	.0
3	5	6	8	.0	117.8	12.0	.0
3	6	8	8	.0	117.8	12.0	.0
3	7	8	9	.0	117.8	12.0	.0
3	8	9	9	.0	117.8	12.0	.0
4	8	3	8	.0	133.7	45.0	58.6
4	9	8	9	.0	133.7	45.0	58.6
4	10	9	12	.0	133.7	45.0	58.6

TRIAL CIRCLE NO 1

CIRCLE CTR COORDS: X= X= 84.1 Y= 20.1

ENTRANCE PT. COORDS: X= 27.1 Y= 8.1

TRIAL ARC RADIUS= 58.052

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

***LINE 6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
1	53.816	70.59
5	67.367	64.53
7	125.171	74.62
3	127.111	8.[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	68.[illegible]	K= 1	KK= 1
I= 2	.000	53.[illegible]	K= 1	KK= 2
I= 3	.000	8.[illegible]	K= 1	KK= 3
I= 4	40.[illegible]	55.[illegible]	K= 1	KK= 4
I= 5	53.816	70.59	K= 2	KK= 4
I= 6	65.[illegible]	7.[illegible]	K= 2	KK= 5
I= 7	67.367	64.527	K= 3	KK= 5
I= 8	95.[illegible]	74.[illegible]	K= 3	KK= 6
I= 9	113.[illegible]	8.[illegible]	K= 3	KK= 7
I= 10	115.[illegible]	4.[illegible]	K= 3	KK= 8
I= 11	120.[illegible]	74.622	K= 4	KK= 8
I= 12	127.[illegible]	8.[illegible]	K= 4	KK= 8
I= 13	175.[illegible]	54.[illegible]	K= 4	KK= 9
I= 14	240.[illegible]	8.[illegible]	K= 4	KK= 10
I= 15	242.[illegible]	77.[illegible]	K= 4	KK= 11
I= 16	244.[illegible]	66.[illegible]	K= 4	KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	53.816	70.59	K= 5	KK= 1
I= 2	65.[illegible]	7.[illegible]	K= 6	KK= 2
I= 3	67.367	64.527	K= 7	KK= 3
I= 4	95.[illegible]	74.[illegible]	K= 8	KK= 4
I= 5	113.[illegible]	8.[illegible]	K= 9	KK= 5
I= 6	120.[illegible]	74.622	K= 11	KK= 6
I= 7	127.[illegible]	8.[illegible]	K= 12	KK= 7

FIND SLICE WIDTH AND NO OF SLICES

FI= 1.00000	FO= [illegible].3258
FI= [illegible].3258	FO= [illegible].4675
FI= [illegible].4675	FO= [illegible].4811
FI= [illegible].4811	FO= [illegible].4823

THE SAFETY FACTOR FOR POINT 1IS 1.14823

TRIAL CIRCLE NO 2
CIRCLE CTR COORDS: X= X= 88.[illegible] Y= 120.[illegible]
ENTRANCE PT. COORDS: X= 127.[illegible] Y= 81.[illegible]
TRIAL ARC RADIUS= 55.754

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

```
XX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XX LINE 10NOT INTERSECTED BY TRIAL CIRCL

**LINE  2IS NOT INTERSECTED BUT IS IN ARC

**LINE  6IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY
NE NO          X              Y
 1.          62.983          7.501
 5.          73.958         66.804
 7.         119.266         74.604
 3.         127.111          8.111


HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         68.111   K=  1   KK=  1
I=  2          .000         53.111   K=  1   KK=  2
I=  3          .000          8.111   K=  1   KK=  3
I=  4        40.111         55.111   K=  1   KK=  4
I=  5        62.983          7.073   K=  2   KK=  4
I=  6        55.111          7.111   K=  2   KK=  5
I=  7        73.958         66.804   K=  3   KK=  5
I=  8        95.111         74.111   K=  3   KK=  6
I=  9       113.111          8.111   K=  3   KK=  7
I= 10       115.111         41.111   K=  3   KK=  8
I= 11       119.266         74.604   K=  4   KK=  8
I= 12       127.111          8.111   K=  4   KK=  8
I= 13       175.111         54.111   K=  4   KK=  9
I= 14       240.111          8.111   K=  4   KK= 10
I= 15       242.111         77.111   K=  4   KK= 11
I= 16       244.111         66.111   K=  4   KK= 12


HE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        62.983          7.073   K=  5   KK=  1
I=  2        65.111          7.111   K=  6   KK=  2
I=  3        73.958         66.804   K=  7   KK=  3
I=  4        95.111         74.111   K=  8   KK=  4
I=  5       113.111          8.111   K=  9   KK=  5
I=  6       119.266         74.604   K= 11   KK=  6
I=  7       127.111          8.111   K= 12   KK=  7


IND SLICE WIDTH AND NO OF SLICES
                FI=    1.000000    FO=    1.022606
                FI=    1.022606    FO=    1.025148
                FI=    1.025148    FO=    1.025385
                FI=    1.025385    FO=    1.025407

          THE SAFETY FACTOR FOR POINT  2IS    1.25407


RIAL CIRCLE NO  3
IRCLE CTR COORDS:  X=  X=      92.111   Y=     120.111
NTRANCE PT. COORDS:  X=       127.111   Y=      81.111
     TRIAL ARC RADIUS=     52.402


XX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XX LINE 10NOT INTERSECTED BY TRIAL CIRCL
```

***LINE 6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
2	70.711	72.28
5	80.409	69.03
7	118.038	74.58
3	127.11	81.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	68.11	K= 1	KK= 1
I= 2	.000	53.11	K= 1	KK= 2
I= 3	.000	8.11	K= 1	KK= 3
I= 4	40.11	55.11	K= 1	KK= 4
I= 5	65.11	7.11	K= 1	KK= 5
I= 6	70.711	72.278	K= 2	KK= 5
I= 7	80.409	69.032	K= 3	KK= 5
I= 8	95.11	74.11	K= 3	KK= 6
I= 9	113.11	8.11	K= 3	KK= 7
I= 10	115.11	4.11	K= 3	KK= 8
I= 11	118.038	74.579	K= 4	KK= 8
I= 12	127.11	81.11	K= 4	KK= 8
I= 13	175.11	54.11	K= 4	KK= 9
I= 14	240.11	8.11	K= 4	KK= 10
I= 15	242.11	77.11	K= 4	KK= 11
I= 16	244.11	66.11	K= 4	KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	70.711	72.278	K= 6	KK= 1
I= 2	80.409	69.032	K= 7	KK= 2
I= 3	95.11	74.11	K= 8	KK= 3
I= 4	113.11	8.11	K= 9	KK= 4
I= 5	118.038	74.579	K= 11	KK= 5
I= 6	127.11	81.11	K= 12	KK= 6

FIND SLICE WIDTH AND NO OF SLICES

FI= 1.00000	FO= .40689
FI= .40689	FO= .45530
FI= .45530	FO= .45948
FI= .45948	FO= .45984

THE SAFETY FACTOR FOR POINT 3IS 1.45984

TRIAL CIRCLE NO 4
CIRCLE CTR COORDS: X= X= 84.11 Y= 124.11
ENTRANCE PT. COORDS: X= 127.11 Y= 81.11
TRIAL ARC RADIUS= 60.81

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

***LINE 6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y

```
                55.127          70.765
                69.194          65.216
             119.422            74.261
             127.111            81.211

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000             68.211    K=  1   KK=  1
I=  2          .000             53.211    K=  1   KK=  2
I=  3          .000              8.211    K=  1   KK=  3
I=  4       40.211              55.211    K=  1   KK=  4
I=  5       55.127              70.765    K=  2   KK=  5
I=  6       65.211               7.211    K=  2   KK=  6
I=  7       69.194              65.258    K=  3   KK=  7
I=  8       95.211              74.211    K=  3   KK=  8
I=  9      113.211               8.211    K=  3   KK=  9
I=  10     115.211              41.211    K=  3   KK=  10
I=  11     119.422              74.607    K=  4   KK=  11
I=  12     127.211               8.211    K=  4   KK=  12
I=  13     175.211              54.211    K=  4   KK=  13
I=  14     240.211              81.211    K=  4   KK=  14
I=  15     242.211              77.211    K=  4   KK=  15
I=  16     244.211              66.211    K=  4   KK=  16

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1       55.127              70.765    K=  5   KK=  1
I=  2       65.211               7.211    K=  6   KK=  2
I=  3       69.194              65.258    K=  7   KK=  3
I=  4       95.211              74.211    K=  8   KK=  4
I=  5      113.211               8.211    K=  9   KK=  5
I=  6      119.422              74.607    K=  1   KK=  6
I=  7      127.211               8.211    K=  2   KK=  7

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.000000    FO=    1.016048
                FI=   1.016048    FO=    1.017765
                FI=   1.017765    FO=    1.017925
                FI=   1.017925    FO=    1.017940

          THE SAFETY FACTOR FOR POINT  4IS    1.017940

TRIAL CIRCLE NO  5
CIRCLE CTR COORDS:  X=  X=      88.211    Y=     124.211
ENTRANCE PT COORDS:  X=        127.211    Y=      81.211
     TRIAL ARC RADIUS=    58.052


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

***LINE  6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
  4           64.490           71.208
  5           75.593           67.240
  7          118.391           74.259
  3          127.111           81.211
```

In cross-section (8-8) B soil types are given as :

Soil I : Bottom Sludge (Slurry)

Soil II : Artificial Fill

Soil III : Sedimentary Layer

Soil 4 : Decomposed Graywacke

The results taken from the computer for cross-section(8-8)B a

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	IOI	IIO	I43	64	I.67
b	97	I03	I33	64	3.II
c	I07	IOI	I39	64	3.62
d	93	I08	I36	64	I.54
e	I09	I08	I52	64	I.67
f	86	III	I33	64	I.44
g	88	I03	I39	64	I.I6

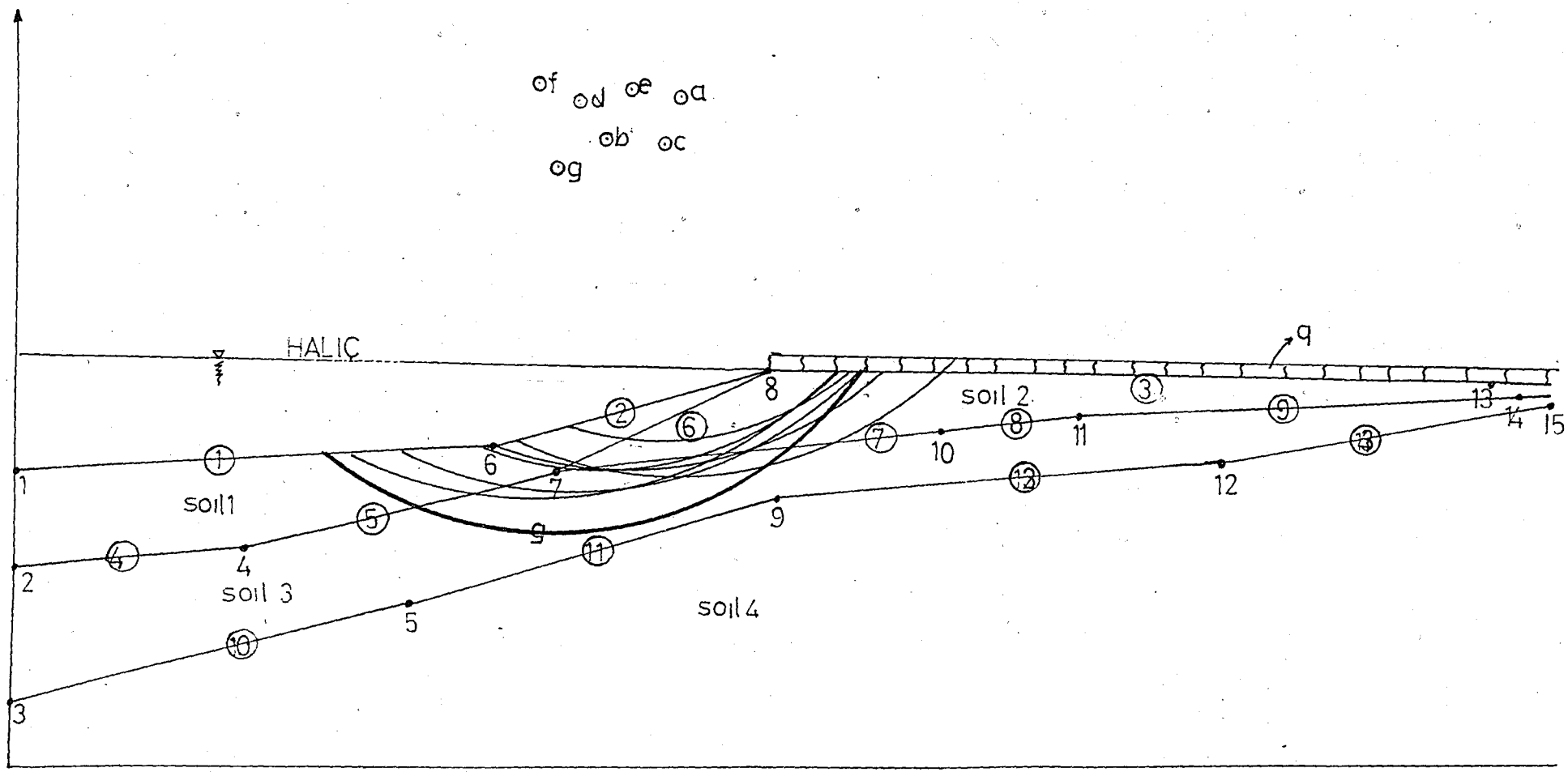

Fig : (8-8) B

PE STABILITY FOR TASKIZAK(TI)MAHIR KOSELER THESIS.

OF LINES 13 NO OF LINE INTERSECT= 15

OF SOILS= 4 NO OF EXTERNAL SOIL LINES= 3

OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 2.0

LINE END COORD MATRIX

LINE NO	END NO	INT	X1	Y1	X2	Y2	SLOPE	LINE INTER
1	2		0	50	77	52	.2593562-001	6
2	2		77	52	124	64	.2553191	8
3	2		124	64	224	64	.0000000	8
4	2		0	33	36	36	.8307722-001	2
5	2		36	36	89	49	.2452283	4
6	2		89	49	89	64	.4285714	7
7	2		89	64	148	54	.8474584-001	7
8	2		148	54	174	56	.7692311-001	10
9	2		174	56	224	64	.3571453-001	14
10	2		0	26	64	44	.2339969	5
11	2		64	44	125	49	.2950820	9
12	2		125	49	199	56	.6756756-001	12
13	2		199	56	224	56	.2121212	12

E INTERSECT ARRAY

NO	X	Y
1	0	50
2	0	33
3	0	26
4	36	36
5	64	44
6	77	52
7	89	49
8	124	64
9	148	54
10	174	56
11	199	56
12	224	64
13	224	58
14	232	56

L DATA ARRAY

NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	0	6	0	120	0	0
2	2	0	8	0	120	0	0
3	3	0	8	0	120	0	0
4	4	0	2	0	120	0	0
5	5	0	4	0	120	0	0
6	6	0	7	0	120	0	0
7	7	0	7	0	120	0	0
8	8	0	10	0	120	0	0
9	9	0	14	0	120	0	0
10	10	0	5	0	120	0	0
11	11	0	9	0	120	0	0
12	12	0	12	0	120	0	0
13	13	0	12	0	120	0	0
14	1	1	7	0	120	0	0
15	2	1	8	0	120	0	0
16	3	1	8	0	120	0	0
17	4	1	3	0	120	0	0
18	5	1	5	0	120	0	0
19	6	1	8	0	120	0	0
20	7	1	8	0	120	0	0
21	8	1	11	0	120	0	0
22	9	1	15	0	120	0	0
23	10	1	6	0	120	0	0
24	11	1	10	0	120	0	0
25	12	1	13	0	120	0	0
26	13	1	13	0	120	0	0
27	1	2	8	0	120	0	0
28	2	2	8	0	120	0	0
29	3	2	8	0	120	0	0
30	4	2	4	0	120	0	0
31	5	2	6	0	120	0	0
32	6	2	9	0	120	0	0
33	7	2	9	0	120	0	0
34	8	2	12	0	120	0	0
35	9	2	16	0	120	0	0
36	10	2	7	0	120	0	0
37	11	2	11	0	120	0	0
38	12	2	14	0	120	0	0
39	13	2	14	0	120	0	0
40	1	3	9	0	120	0	0
41	2	3	9	0	120	0	0
42	3	3	9	0	120	0	0
43	4	3	5	0	120	0	0
44	5	3	7	0	120	0	0
45	6	3	10	0	120	0	0
46	7	3	10	0	120	0	0
47	8	3	13	0	120	0	0
48	9	3	17	0	120	0	0
49	10	3	8	0	120	0	0
50	11	3	12	0	120	0	0
51	12	3	15	0	120	0	0
52	13	3	15	0	120	0	0
53	1	4	10	0	120	0	0
54	2	4	10	0	120	0	0
55	3	4	10	0	120	0	0
56	4	4	6	0	120	0	0
57	5	4	8	0	120	0	0
58	6	4	11	0	120	0	0
59	7	4	11	0	120	0	0
60	8	4	14	0	120	0	0
61	9	4	18	0	120	0	0
62	10	4	9	0	120	0	0
63	11	4	13	0	120	0	0
64	12	4	16	0	120	0	0
65	13	4	16	0	120	0	0
66	1	5	11	0	120	0	0
67	2	5	11	0	120	0	0
68	3	5	11	0	120	0	0
69	4	5	7	0	120	0	0
70	5	5	9	0	120	0	0
71	6	5	12	0	120	0	0
72	7	5	12	0	120	0	0
73	8	5	15	0	120	0	0
74	9	5	19	0	120	0	0
75	10	5	10	0	120	0	0
76	11	5	14	0	120	0	0
77	12	5	17	0	120	0	0
78	13	5	17	0	120	0	0
79	1	6	12	0	120	0	0
80	2	6	12	0	120	0	0
81	3	6	12	0	120	0	0
82	4	6	8	0	120	0	0
83	5	6	10	0	120	0	0
84	6	6	13	0	120	0	0
85	7	6	13	0	120	0	0
86	8	6	16	0	120	0	0
87	9	6	20	0	120	0	0
88	10	6	11	0	120	0	0
89	11	6	15	0	120	0	0
90	12	6	18	0	120	0	0
91	13	6	18	0	120	0	0
92	1	7	13	0	120	0	0
93	2	7	13	0	120	0	0
94	3	7	13	0	120	0	0
95	4	7	9	0	120	0	0
96	5	7	11	0	120	0	0
97	6	7	14	0	120	0	0
98	7	7	14	0	120	0	0
99	8	7	17	0	120	0	0
100	9	7	21	0	120	0	0
101	10	7	12	0	120	0	0
102	11	7	16	0	120	0	0
103	12	7	19	0	120	0	0
104	13	7	19	0	120	0	0
105	1	8	14	0	120	0	0
106	2	8	14	0	120	0	0
107	3	8	14	0	120	0	0
108	4	8	10	0	120	0	0
109	5	8	12	0	120	0	0
110	6	8	15	0	120	0	0
111	7	8	15	0	120	0	0
112	8	8	18	0	120	0	0
113	9	8	22	0	120	0	0
114	10	8	13	0	120	0	0
115	11	8	17	0	120	0	0
116	12	8	20	0	120	0	0
117	13	8	20	0	120	0	0
118	1	9	15	0	120	0	0
119	2	9	15	0	120	0	0
120	3	9	15	0	120	0	0
121	4	9	11	0	120	0	0
122	5	9	13	0	120	0	0
123	6	9	16	0	120	0	0
124	7	9	16	0	120	0	0
125	8	9	19	0	120	0	0
126	9	9	23	0	120	0	0
127	10	9	14	0	120	0	0
128	11	9	18	0	120	0	0
129	12	9	21	0	120	0	0
130	13	9	21	0	120	0	0
131	1	10	16	0	120	0	0
132	2	10	16	0	120	0	0
133	3	10	16	0	120	0	0
134	4	10	12	0	120	0	0
135	5	10	14	0	120	0	0
136	6	10	17	0	120	0	0
137	7	10	17	0	120	0	0
138	8	10	20	0	120	0	0
139	9	10	24	0	120	0	0
140	10	10	15	0	120	0	0
141	11	10	19	0	120	0	0
142	12	10	22	0	120	0	0
143	13	10	22	0	120	0	0
144	1	11	17	0	120	0	0
145	2	11	17	0	120	0	0
146	3	11	17	0	120	0	0
147	4	11	13	0	120	0	0
148	5	11	15	0	120	0	0
149	6	11	18	0	120	0	0
150	7	11	18	0	120	0	0
151	8	11	21	0	120	0	0
152	9	11	25	0	120	0	0
153	10	11	16	0	120	0	0
154	11	11	20	0	120	0	0
155	12	11	23	0	120	0	0
156	13	11	23	0	120	0	0
157	1	12	18	0	120	0	0
158	2	12	18	0	120	0	0
159	3	12	18	0	120	0	0
160	4	12	14	0	120	0	0
161	5	12	16	0	120	0	0
162	6	12	19	0	120	0	0
163	7	12	19	0	120	0	0
164	8	12	22	0	120	0	0
165	9	12	26	0	120	0	0
166	10	12	17	0	120	0	0
167	11	12	21	0	120	0	0
168	12	12	24	0	120	0	0
169	13	12	24	0	120	0	0
170	1	13	19	0	120	0	0
171	2	13	19	0	120	0	0
172	3	13	19	0	120	0	0
173	4	13	15	0	120	0	0
174	5	13	17	0	120	0	0
175	6	13	20	0	120	0	0
176	7	13	20	0	120	0	0
177	8	13	23	0	120	0	0
178	9	13	27	0	120	0	0
179	10	13	18	0	120	0	0
180	11	13	22	0	120	0	0
181	12	13	25	0	120	0	0
182	13	13	25	0	120	0	0

AL CIRCLE NO 1

CLE CTR COORDS: X= X= 88.[illegible] Y= .03[illegible]

RANCE PT. COORDS: X= .39[illegible] Y= 64.[illegible]

TRIAL ARC RADIUS= 64.203

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 12NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 13NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

***LINE 6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
1	50.048	51.441
5	65.024	43.220
7	127.433	52.336
3	139.111	64.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	50.111	K= 1	KK= 1
I= 2	.000	33.333	K= 1	KK= 2
I= 3	.000	11.111	K= 1	KK= 3
I= 4	36.111	36.111	K= 1	KK= 4
I= 5	50.048	51.409	K= 2	KK= 4
I= 6	64.111	26.111	K= 2	KK= 5
I= 7	65.024	43.203	K= 3	KK= 5
I= 8	77.111	52.111	K= 3	KK= 6
I= 9	89.111	49.111	K= 3	KK= 7
I= 10	24.111	64.111	K= 3	KK= 8
I= 11	25.111	44.111	K= 3	KK= 9
I= 12	127.433	52.359	K= 4	KK= 9
I= 13	139.111	64.111	K= 4	KK= 9
I= 14	48.111	54.111	K= 4	KK= 10
I= 15	174.111	56.111	K= 4	KK= 11
I= 16	199.111	49.111	K= 4	KK= 12
I= 17	229.111	64.111	K= 4	KK= 13
I= 18	230.111	58.111	K= 4	KK= 14
I= 19	232.111	56.111	K= 4	KK= 15

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	50.048	51.409	K= 5	KK= 1
I= 2	65.024	43.203	K= 7	KK= 2
I= 3	77.111	52.111	K= 8	KK= 3
I= 4	89.111	49.111	K= 9	KK= 4
I= 5	24.111	64.111	K= 10	KK= 5
I= 6	127.433	52.359	K= 12	KK= 6
I= 7	139.111	64.111	K= 13	KK= 7

FIND SLICE WIDTH AND NO. OF SLICES.

FI=	1.00000	FO=	14.467
FI=	14.467	FO=	15.963
FI=	15.963	FO=	16.165
FI=	16.165	FO=	16.288

THE SAFETY FACTOR FOR POINT IIS 1.16188

RIAL CIRCLE NO 2
IRCLE CTR COORDS: X= X= 92.[illegible] Y= 103.11
NTRANCE PT. COORDS: X= 39.[illegible] Y= 64.11
TRIAL ARC RADIUS= 61.074

XX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XX LINE 11NOT INTERSECTED BY TRIAL CIRCL

XX LINE 12NOT INTERSECTED BY TRIAL CIRCL

XX LINE 13NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

***LINE 6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

INE NO	X	Y
1	59.228	51.65
5	72.905	45.14
7	125.888	52.23
3	139.[illegible]	64.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	50.[illegible]	K= 1	KK= 1
I= 2	.000	33.[illegible]	K= 1	KK= 2
I= 3	.000	1[illegible].[illegible]	K= 1	KK= 3
I= 4	36.[illegible]	36.[illegible]	K= 1	KK= 4
I= 5	59.228	51.647	K= 2	KK= 4
I= 6	64.[illegible]	26.[illegible]	K= 2	KK= 5
I= 7	72.905	45.[illegible]36	K= 3	KK= 5
I= 8	77.[illegible]	52.[illegible]	K= 3	KK= 6
I= 9	89.[illegible]	49.[illegible]	K= 3	KK= 7
I= 10	124.[illegible]	64.[illegible]	K= 3	KK= 8
I= 11	125.[illegible]	44.[illegible]	K= 3	KK= 9
I= 12	125.888	52.228	K= 4	KK= 9
I= 13	139.[illegible]	64.[illegible]	K= 4	KK= 9
I= 14	148.[illegible]	54.[illegible]	K= 4	KK= 10
I= 15	174.[illegible]	56.[illegible]	K= 4	KK= 11
I= 16	199.[illegible]	49.[illegible]	K= 4	KK= 12
I= 17	229.[illegible]	64.[illegible]	K= 4	KK= 13
I= 18	230.[illegible]	58.[illegible]	K= 4	KK= 14
I= 19	232.[illegible]	56.[illegible]	K= 4	KK= 15

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	59.228	51.647	K= 5	KK= 1
I= 2	72.905	45.[illegible]36	K= 7	KK= 2
I= 3	77.[illegible]	52.[illegible]	K= 8	KK= 3
I= 4	89.[illegible]	49.[illegible]	K= 9	KK= 4
I= 5	124.[illegible]	64.[illegible]	K= 10	KK= 5
I= 6	125.888	52.228	K= 12	KK= 6
I= 7	139.[illegible]	64.[illegible]	K= 13	KK= 7

```
FIND SLICE WIDTH AND NO OF SLICES
                FI=    .00000    FO=    .18968
                FI=    .18968    FO=    .21496
                FI=    .21496    FO=    .21784
                FI=    .21784    FO=    .21816

          THE SAFETY FACTOR FOR POINT  2IS    1.21816

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:   X=   X=      96.41   Y=     103.11
ENTRANCE PT. COORDS:  X=         39.41   Y=      64.17
     TRIAL ARC RADIUS=     58.052


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 12NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 13NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

***LINE  6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1          68.783         51.895
  5          80.882         47.093
  7         123.718         52.044
  3         139.161         64.171


THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          50.171    K=  1   KK=  1
I=  2          .000          33.171    K=  1   KK=  2
I=  3          .000          17.171    K=  1   KK=  3
I=  4        36.171          36.171    K=  1   KK=  4
I=  5        64.171          26.171    K=  1   KK=  5
I=  6        68.783          51.895    K=  2   KK=  5
I=  7        77.171          52.171    K=  2   KK=  6
I=  8        80.882          47.093    K=  3   KK=  6
I=  9        89.171          49.171    K=  3   KK=  7
I= 10       123.718          52.044    K=  4   KK=  7
I= 11       124.171          64.171    K=  4   KK=  8
I= 12       125.171          44.171    K=  4   KK=  9
I= 13       139.161          64.171    K=  4   KK=  9
I= 14       148.171          54.171    K=  4   KK= 10
I= 15       174.171          56.171    K=  4   KK= 11
I= 16       199.171          49.171    K=  4   KK= 12
I= 17       229.171          64.171    K=  4   KK= 13
I= 18       230.171          58.171    K=  4   KK= 14
I= 19       232.171          56.171    K=  4   KK= 15


THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        68.783          51.895    K=  6   KK=  1
```

```
I=   2          77.[illegible]1          52.[illegible]1    K=   7   KK=   2
I=   3          80.882          47.095    K=   8   KK=   3
I=   4          89.[illegible]11          49.[illegible]1    K=   9   KK=   4
I=   5         123.718          52.044    K=  10   KK=   5
I=   6         124.[illegible]11          64.[illegible]1    K=  11   KK=   6
I=   7         139.[illegible]1          64.[illegible]1    K=  13   KK=   7

FIND SLICE WIDTH AND NO OF SLICES
                FI=    .[illegible]00001    FO=    .[illegible]30652
                FI=    .30652    FO=    .[illegible]3495[illegible]
                FI=    .3495[illegible]    FO=    .35422
                FI=    .35422    FO=    .35472

          THE SAFETY FACTOR FOR POINT  3IS    .35472

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=      88.[illegible]1    Y=     107.[illegible]1
ENTRANCE PT. COORDS:  X=      139.[illegible]1    Y=     64.[illegible]1
     TRIAL ARC RADIUS=     66.708

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 12NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 13NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

***LINE  6IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X          Y
  1**          51.356          5[illegible].44
  5**          67.249          43.75
  7**         126.049          52.[illegible]24
  3**         139.[illegible]1          64.[illegible]1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=   1          .000          50.[illegible]1    K=   1   KK=   1
I=   2          .000          33.[illegible]1    K=   1   KK=   2
I=   3          .000          [illegible].[illegible]1    K=   1   KK=   3
I=   4          36.[illegible]1          38.[illegible]1    K=   1   KK=   4
I=   5          51.356          5[illegible].443    K=   2   KK=   4
I=   6          64.[illegible]1          26.[illegible]1    K=   2   KK=   5
I=   7          67.249          43.749    K=   3   KK=   5
I=   8          77.[illegible]1          52.[illegible]1    K=   3   KK=   6
I=   9          89.[illegible]1          49.[illegible]1    K=   3   KK=   7
I=  10         124.[illegible]1          64.[illegible]1    K=   3   KK=   8
I=  11         125.[illegible]1          44.[illegible]1    K=   3   KK=   9
I=  12         126.049          52.[illegible]24    K=   4   KK=   9
I=  13         139.[illegible]1          64.[illegible]1    K=   4   KK=   9
I=  14         148.[illegible]1          54.[illegible]1    K=   4   KK=  10
I=  15         174.[illegible]1          56.[illegible]1    K=   4   KK=  11
I=  16         199.[illegible]1          49.[illegible]1    K=   4   KK=  12
```

In cross-section (IO-IO)A soil types are given as :

Soil I : Bottom Sludge

Soil II : Artificial Fill

Soil III : Sedimentary Layer

Soil 4 : Decomposed Graywacke

The results taken from the computer for cross-section(IO-IO)A are:

Circle NO	Circle Center Coordinates		Entrance Points		Factor Of Safety
	X	Y	X	Y	
a	II7	III	I4I	90	I.24
b	I25	II6	I59	90	I.58
c	III	II7	I49	90	I.3I
d	II9	IOI	I68	90	3.05
e	II9	I30	I82	90	2.77
f	II6	I43	I87	90	2.54
g	IO8	I29	I6I	90	2.3I
h	IO4	I52	I84	90	3.34
k	II9	I23	I45	90	I.54

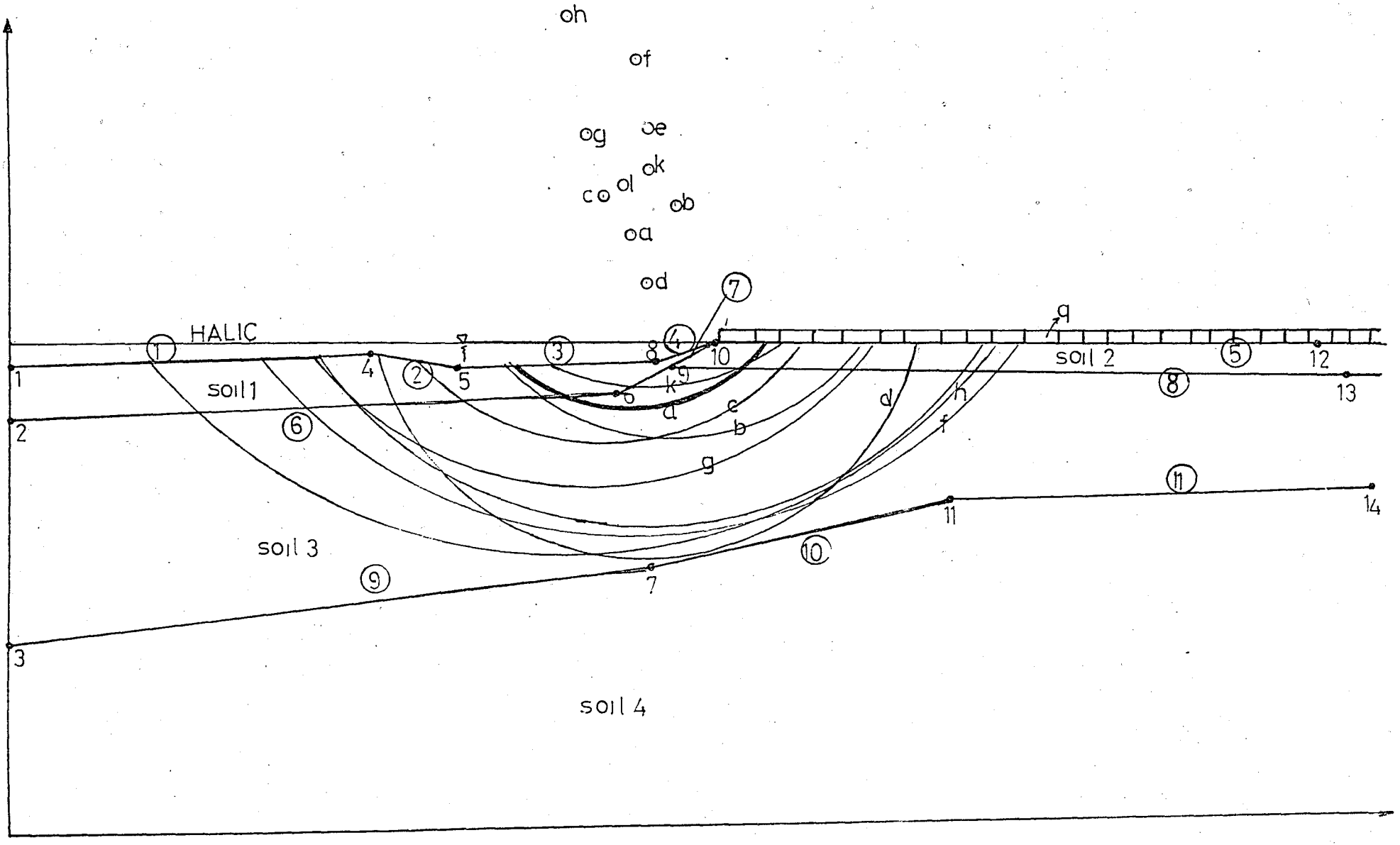
oh
of
og
oe
ok
co
ol
ob
oa
od
HALIC
soil 1
soil 2
soil 3
soil 4
1
2
3
4
5
6
7
8
9
10
11
12
13
14
a
b
c
d
e
f
g
h
i
k

Fig : (10-10)A

OPE STABILITY FOR [illegible] THESIS.

OF LINES 11 NO OF LINE INTERSECT= 14

OF SOILS= 4 NO OF EXTERNAL SOIL LINES= 5

OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 2.0

IE LINE END COORD MATRIX

IE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTE
1	2	.00	87.[illegible]	67.[illegible]	88.[illegible]	[illegible]49007E-001	1 [illegible]
2	2	67.[illegible]	88.[illegible]	84.[illegible]	86.[illegible]	[illegible]117647	4
3	2	84.[illegible]	86.[illegible]	122.[illegible]	86.[illegible]	.000000	5
4	2	122.[illegible]	86.[illegible]	132.[illegible]	90.[illegible]	.400000	8
5	2	132.[illegible]	90.[illegible]	229.[illegible]	90.[illegible]	.000000	10 [illegible]
6	2	.00	78.[illegible]	1[illegible].[illegible]	80.[illegible]	.180000E-001	2
7	2	1[illegible].[illegible]	80.[illegible]	132.[illegible]	90.[illegible]	.476190	6
8	2	125.[illegible]	87.[illegible]	230.[illegible]	83.[illegible]	[illegible]380952E-001	9 [illegible]
9	2	.00	35.[illegible]	120.[illegible]	47.[illegible]	.999076E-001	3
10	2	120.[illegible]	47.[illegible]	175.[illegible]	59.[illegible]	.218182	7 [illegible]
11	2	175.[illegible]	59.[illegible]	232.[illegible]	60.[illegible]	.175439E-001	11 [illegible]

INE INTERSECT ARRAY

T NO	X	Y
1	.00	87.[illegible]
2	.00	78.[illegible]
3	.00	35.[illegible]
4	67.[illegible]	88.[illegible]
5	84.[illegible]	86.[illegible]
6	1[illegible].[illegible]	80.[illegible]
7	120.[illegible]	47.[illegible]
8	122.[illegible]	86.[illegible]
9	125.[illegible]	87.[illegible]
10	132.[illegible]	90.[illegible]
11	175.[illegible]	59.[illegible]
12	229.[illegible]	90.[illegible]
13	230.[illegible]	83.[illegible]
14	232.[illegible]	60.[illegible]

OIL DATA ARRAY

IL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	[illegible]	4	0	1[illegible].5	12.0	.0
1	2	4	5	0	1[illegible].5	12.0	.0
1	3	5	8	0	1[illegible].5	12.0	.0
1	4	8	10	0	1[illegible].5	12.0	.0
1	5	10	10	0	1[illegible].5	12.0	.0
1	6	2	6	0	1[illegible].5	12.0	.0
1	7	6	10	0	1[illegible].5	12.0	.0
1	8	9	9	0	1[illegible].5	12.0	.0
2	5	10	[illegible]	0	7.8	20.0	19.6
2	4	[illegible]	[illegible]	0	7.8	20.0	19.6
2	7	9	10	0	7.8	20.0	19.6
2	8	9	13	0	7.8	20.0	19.6
3	6	2	6	0	7.8	12.0	.0
3	7	6	9	0	7.8	12.0	.0
3	8	9	13	0	7.8	12.0	.0
3	9	3	7	0	7.8	12.0	.0
3	10	7	14	0	7.8	12.0	.0
3	11	1[illegible]	[illegible]	0	7.8	12.0	.0
4	9	3	7	0	13.7	45.0	68.6
4	10	7	11	0	13.7	45.0	68.6
4	11	11	14	0	13.7	45.0	68.6

RIAL CIRCLE NO 1
IRCLE CTR COORDS: X= X= 17[illegible] Y= 1[illegible]
NTRANCE PT. COORDS: X= [illegible]4[illegible] Y= 90.[illegible]
, TRIAL ARC RADIUS= 3[illegible].890

XX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE 4IS NOT INTERSECTED BUT IS IN ARC

***LINE 7IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
3	97.312	86.[illegible]
6	109.740	80.009
8	137.557	86.[illegible]64
5	141.[illegible]	90.[illegible]1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	87.[illegible]	K= 1	KK= 1
I= 2	.000	78.[illegible]	K= 1	KK= 2
I= 3	.000	35.[illegible]	K= 1	KK= 3
I= 4	67.[illegible]	88.[illegible]	K= 1	KK= 4
I= 5	84.[illegible]	86.[illegible]	K= 1	KK= 5
I= 6	97.312	86.[illegible]	K= 2	KK= 5
I= 7	109.740	80.086	K= 3	KK= 5
I= 8	[illegible]	80.[illegible]	K= 3	KK= 6
I= 9	[illegible]20	47.[illegible]	K= 3	KK= 7
I= 10	[illegible]22	86.[illegible]	K= 3	KK= 8
I= 11	[illegible]25	87.[illegible]	K= 3	KK= 9
I= 12	[illegible]32	90.[illegible]	K= 3	KK= [illegible]0
I= 13	137.557	86.637	K= 4	KK= [illegible]0
I= 14	141.[illegible]	90.[illegible]	K= 4	KK= [illegible]1
I= 15	[illegible]75	59.[illegible]	K= 4	KK= [illegible]2
I= 16	229.[illegible]	90.[illegible]	K= 4	KK= [illegible]3
I= 17	230.[illegible]	83.[illegible]	K= 4	KK= [illegible]4
I= 18	232.[illegible]	60.[illegible]	K= 4	KK= [illegible]

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	97.312	86.[illegible]	K= 6	KK= 1
I= 2	109.740	80.086	K= 7	KK= 2
I= 3	[illegible]	80.[illegible]	K= 8	KK= 3
I= 4	[illegible]22	86.[illegible]	K= 10	KK= 4
I= 5	[illegible]25	87.[illegible]	K= [illegible]1	KK= 5
I= 6	[illegible]32	90.[illegible]	K= [illegible]2	KK= 6
I= 7	137.557	86.637	K= [illegible]3	KK= 7
I= 8	[illegible]41	90.[illegible]	K= [illegible]4	KK= 8

FIND SLICE WIDTH AND NO OF SLICES

FI= [illegible].00000	FO= [illegible].21473
FI= [illegible].21473	FO= [illegible].24381
FI= [illegible].24381	FO= [illegible].24771
FI= [illegible].24771	FO= [illegible].24747

THE SAFETY FACTOR FOR POINT 11S 1.24747

TRIAL CIRCLE NO 2
CIRCLE CTR COORDS: X= [illegible] X= [illegible]20.[illegible] Y= [illegible]11.[illegible]
ENTRANCE PT. COORDS: X= [illegible]4[illegible].[illegible] Y= [illegible]90.[illegible]
TRIAL ARC RADIUS= 29.698

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

```
XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE  4IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
INE NO          X              Y
  3          104.080        86.[illegible]
  7          114.836        8[illegible].88
  8          136.967        86.66
  5          141.[illegible]        90.[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000           87.[illegible]    K=  3   KK=  1
I=  2          .000           78.[illegible]    K=  3   KK=  2
I=  3          .000           35.[illegible]    K=  3   KK=  3
I=  4         67.[illegible]          88.[illegible]    K=  1   KK=  4
I=  5         84.[illegible]          86.[illegible]    K=  1   KK=  5
I=  6        104.080          86.[illegible]    K=  2   KK=  5
I=  7        114.836          80.[illegible]    K=  2   KK=  6
I=  8        114.836          8[illegible].885   K=  3   KK=  6
I=  9        120.[illegible]          47.[illegible]    K=  3   KK=  7
I= 10        122.[illegible]          86.[illegible]    K=  3   KK=  8
I= 11        125.[illegible]          87.[illegible]    K=  3   KK=  9
I= 12        132.[illegible]          90.[illegible]    K=  3   KK= 10
I= 13        136.967          86.659         K=  4   KK= 10
I= 14        141.[illegible]          90.[illegible]    K=  4   KK= 10
I= 15        175.[illegible]          59.[illegible]    K=  4   KK= 11
I= 16        229.[illegible]          90.[illegible]    K=  4   KK= 12
I= 17        230.[illegible]          83.[illegible]    K=  4   KK= 13
I= 18        232.[illegible]          60.[illegible]    K=  4   KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        104.080          86.[illegible]    K=  6   KK=  1
I=  2        114.836          8[illegible].885   K=  8   KK=  2
I=  3        122.[illegible]          86.[illegible]    K= 10   KK=  3
I=  4        125.[illegible]          87.[illegible]    K= 11   KK=  4
I=  5        132.[illegible]          90.[illegible]    K= 12   KK=  5
I=  6        136.967          86.659         K= 13   KK=  6
I=  7        141.[illegible]          90.[illegible]    K= 14   KK=  7

FIND SLICE WIDTH AND NO. OF SLICES
                FI=  1.00000    FO=  1.37942
                FI=  1.37942    FO=  1.43394
                FI=  1.43394    FO=  1.43972
                FI=  1.43972    FO=  1.44032

          THE SAFETY FACTOR FOR POINT  2IS   1.44032

TRIAL CIRCLE NO.  3
CIRCLE CTR COORDS:  X=  X=      [illegible]23.[illegible]1   Y=      [illegible]1.[illegible]1
ENTRANCE PT. COORDS:  X=        [illegible]41.[illegible]1   Y=      90.[illegible]1
     TRIAL ARC RADIUS=    27.659

XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL
```

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE 4IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO X Y
3 111.279 86.[illegible]
7 118.828 83.79
8 136.102 86.69
5 141.[illegible] 90.[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I= 1 .000 87.[illegible] K= [illegible] KK= 1
I= 2 .000 78.[illegible] K= [illegible] KK= 2
I= 3 .000 35.[illegible] K= 1 KK= 3
I= 4 67.[illegible] 88.[illegible] K= [illegible] KK= 4
I= 5 84.[illegible] 86.[illegible] K= [illegible] KK= 5
I= 6 [illegible] 80.[illegible] K= 1 KK= 6
I= 7 111.279 86.[illegible] K= 2 KK= 6
I= 8 118.828 83.786 K= 3 KK= 5
I= 9 120.[illegible] 47.[illegible] K= 3 KK= 7
I= 10 122.[illegible] 86.[illegible] K= 3 KK= 8
I= 11 125.[illegible] 87.[illegible] K= 3 KK= 9
I= 12 132.[illegible] 90.[illegible] K= 3 KK= 10
I= 13 136.102 86.692 K= 4 KK= 10
I= 14 141.[illegible] 90.[illegible] K= 4 KK= 10
I= 15 175.[illegible] 59.[illegible] K= 4 KK= 11
I= 16 229.[illegible] 90.[illegible] K= 4 KK= 12
I= 17 230.[illegible] 83.[illegible] K= 4 KK= 13
I= 18 232.[illegible] 60.[illegible] K= 4 KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I= 1 111.279 86.[illegible] K= 7 KK= 1
I= 2 118.828 83.786 K= 8 KK= 2
I= 3 122.[illegible] 86.[illegible] K= 10 KK= 3
I= 4 125.[illegible] 87.[illegible] K= 11 KK= 4
I= 5 132.[illegible] 90.[illegible] K= 12 KK= 5
I= 6 136.102 86.692 K= 13 KK= 6
I= 7 141.[illegible] 90.[illegible] K= 14 KK= 7

FIND SLICE WIDTH AND NO OF SLICES
FI= .000000 FO= .875605
FI= .875605 FO= .886865
FI= .886865 FO= .887845
FI= .887845 FO= .887926

THE SAFETY FACTOR FOR POINT 3IS .887926

TRIAL CIRCLE NO 4
CIRCLE CTR COORDS: X= X= 117.[illegible] Y= 14.[illegible]
ENTRANCE PT. COORDS: X= [illegible] Y= 90.[illegible]
TRIAL ARC RADIUS= 33.941

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

E 9NOT INTERSECTED BY TRIAL CIRCL

E 10NOT INTERSECTED BY TRIAL CIRCL

E 11NOT INTERSECTED BY TRIAL CIRCL

4IS NOT INTERSECTED BUT IS IN ARC

ERSECT WITH LINE ARRAY

X	Y
97.928	86.1
112.036	80.55
137.067	86.66
141.11	90.11

AY WITH ALL INTERSECTIONS FOLLOWS:

.000	87.11	K= 1	KK= 1
.000	78.11	K= 1	KK= 2
.000	35.11	K= 1	KK= 3
57.11	88.11	K= 1	KK= 4
84.11	86.11	K= 1	KK= 5
97.928	86.1	K= 2	KK= 5
111.11	80.11	K= 2	KK= 6
112.036	80.55	K= 3	KK= 6
120.11	47.11	K= 3	KK= 7
122.11	86.11	K= 3	KK= 8
125.11	87.11	K= 3	KK= 9
132.11	90.11	K= 3	KK= 10
137.067	86.656	K= 4	KK= 10
141.11	90.11	K= 4	KK= 11
175.11	59.11	K= 4	KK= 12
229.11	90.11	K= 4	KK= 13
230.11	83.11	K= 4	KK= 14
232.11	60.11	K= 4	KK= 15

LICABLE ARRAY ARCINT FOLLOWS:

97.928	86.1	K= 6	KK= 1
112.036	80.55	K= 8	KK= 2
122.11	86.11	K= 0	KK= 3
125.11	87.11	K= 1	KK= 4
132.11	90.11	K= 2	KK= 5
137.067	86.656	K= 3	KK= 6
141.11	90.11	K= 4	KK= 7

ICE WIDTH AND NO OF SLICES

FI= .000000	FO= .028964
FI= .028964	FO= .032874
FI= .032874	FO= .033292
FI= .033292	FO= .033335

THE SAFETY FACTOR FOR POINT 4IS 1.33335

IRCLE NO 5
CTR COORDS: X= X= 120.11 Y= 14.11
E PTS COORDS: X= 4.11 Y= 90.11
IAL ARC RADIUS= 31.890

NE 1NOT INTERSECTED BY TRIAL CIRCL

NE 2NOT INTERSECTED BY TRIAL CIRCL

NE 4NOT INTERSECTED BY TRIAL CIRCL

NE 5NOT INTERSECTED BY TRIAL CIRCL

NE 9NOT INTERSECTED BY TRIAL CIRCL

```
XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE  11S NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  3.          104.847          86.411
  7.          116.079          82.148
  8.          136.376          86.868
  5.          141.111          90.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          87.111   K=  1   KK=  1
I=  2          .000          78.111   K=  1   KK=  2
I=  3          .000          35.111   K=  1   KK=  3
I=  4           67.111       88.111   K=  1   KK=  4
I=  5           84.111       86.111   K=  1   KK=  5
I=  6          104.847       86.111   K=  2   KK=  5
I=  7          111.111       80.111   K=  2   KK=  6
I=  8          116.079       82.148   K=  3   KK=  6
I=  9          120.111       47.111   K=  3   KK=  7
I= 10          122.111       86.111   K=  3   KK=  8
I= 11          125.111       87.111   K=  3   KK=  9
I= 12          132.111       90.111   K=  3   KK= 10
I= 13          136.376       86.682   K=  4   KK= 10
I= 14          141.111       90.111   K=  4   KK= 10
I= 15          175.111       59.111   K=  4   KK= 11
I= 16          229.111       90.111   K=  4   KK= 12
I= 17          230.111       83.111   K=  4   KK= 13
I= 18          232.111       60.111   K=  4   KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1          104.847          86.111   K=  6   KK=  1
I=  2          116.079          82.148   K=  8   KK=  2
I=  3          122.111          86.111   K= 10   KK=  3
I=  4          125.111          87.111   K= 11   KK=  4
I=  5          132.111          90.111   K= 12   KK=  5
I=  6          136.376          86.682   K= 13   KK=  6
I=  7          141.111          90.111   K= 14   KK=  7

FIND SLICE WIDTH AND NO OF SLICES
                FI=    .00000    FO=    1.52322
                FI=    .52322    FO=    1.59756
                FI=    .59756    FO=    1.60466
                FI=    .60466    FO=    1.60531

          THE SAFETY FACTOR FOR POINT  5IS    1.60531

TRIAL CIRCLE NO  5
CIRCLE CTR COORDS:  X=  X=      123.111  Y=      114.111
ENTRANCE PT= COORDS:  X=        41.111  Y=       90.111
      TRIAL ARC RADIUS=     30.000

XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL
```

In cross-section (IO-IO)B soil types are given as :

Soil I : Bottom Sludge

Soil II : Artificial Fill

Soil III : Sedimentary Layer

Soil 4 : Decomposed Graywacke

The results taken from the computer for cross-section(IO-IO)B a

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	I23	II3	I47	9I	I.80
b	I29	II2	I49	9I	2.56
c	I25	I23	I58	9I	2.30
d	II6	I28	I57	9I	2.95
e	I2I	I37	I65	9I	2.78
f	I07	I52	I69	9I	3.07
g	I09	I37	I8I	9I	4.0I
h	II4	II5	I60	9I	4.47

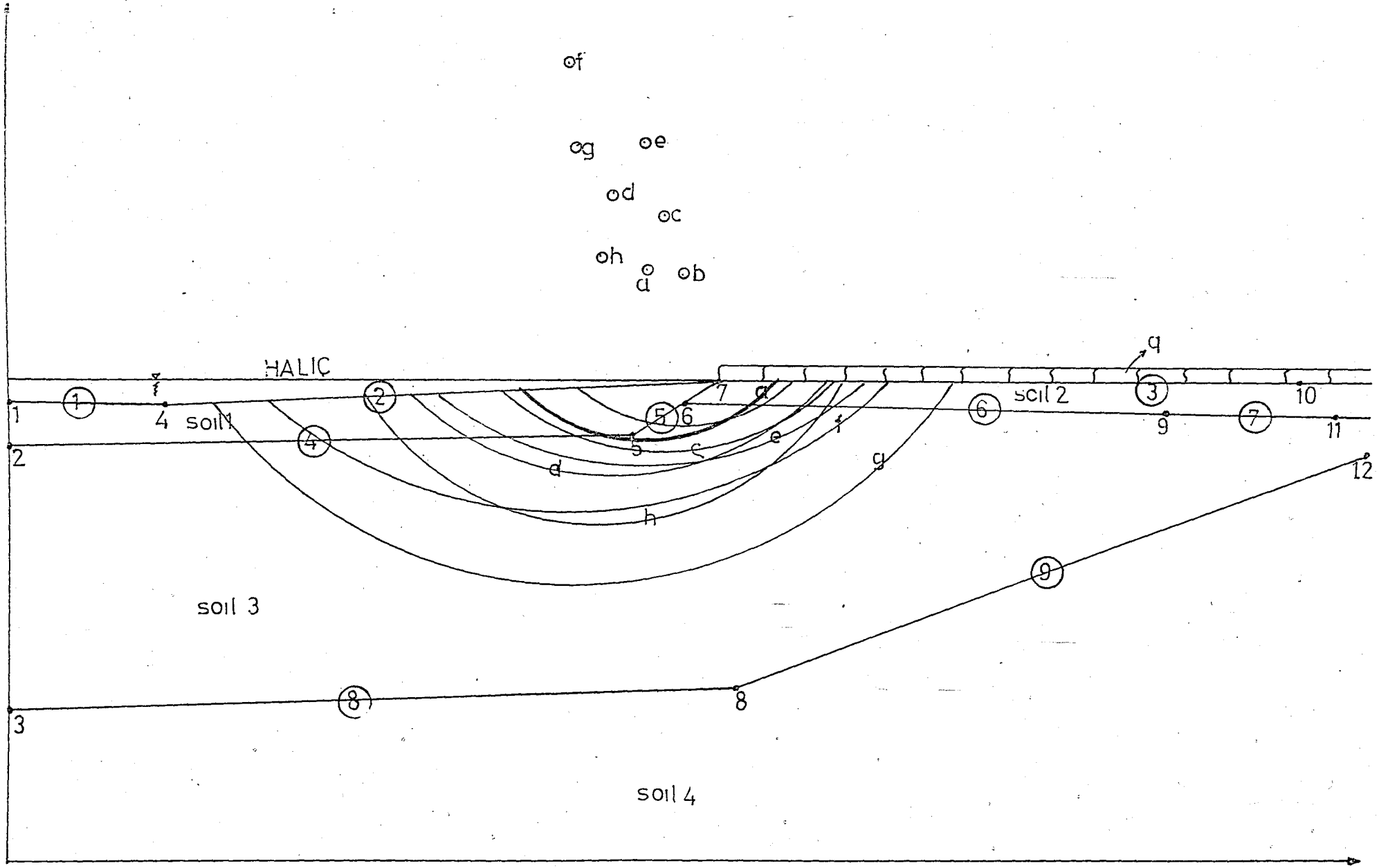
of
og
oe
od
oc
oh
d
ob
HALIC
q
soil 1
soil 2
soil 3
soil 4
1
2
3
4
5
6
7
8
9
10
11
12
a
b
c
d
e
f
g
h

Fig : (10-10) B

LOPE STABILITY FOR HALIC KOPRU(II) MAHIR KOSELER THESIS

IO OF LINES 9 NO OF LINE INTERSECT= 12

IO OF SOILS= 4 NO OF EXTERNAL SOIL LINES= 3

IO OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 200

HE LINE END COORD MATRIX

NE NO	NO INT	X	Y	X2	Y2	SLOPE	LINE INTE
1	2	0	89	27	88	.368854	4
2	2	27	88	36	9	.275229	7
3	2	136	9	233	9	.000000	2
4	2	0	88	118	8	.000000	5
5	2	118	88	128	9	.555556	6
6	2	128	88	214	83	.348837	9
7	2	214	83	236	83	.000000	3
8	2	0	3	138	8	.362028	8
9	2	138	3	240	73	.411765	

INE INTERSECT ARRAY

NT NO	X	Y
1	0	89
2	0	88
3	0	88
4	27	88
5	118	88
6	128	88
7	136	9
8	138	8
9	214	83
10	233	9
11	236	83
12	240	73

SOIL DATA ARRAY

OIL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	2	4	7	0	115	12.00	0
1	3	7	7	0	115	12.00	0
1	4	7	5	0	115	12.00	0
1	5	5	6	0	115	12.00	0
1	6	6	7	0	115	12.00	0
2	3	7	6	0	118	20.00	19.6
2	4	6	7	0	118	20.00	19.6
2	5	7	7	0	118	20.00	19.6
2	6	2	5	0	118	20.00	19.6
3	5	6	9	0	115	12.00	0
3	6	9	8	0	115	12.00	0
3	7	3	3	0	115	12.00	0
4	8	3	2	0	137	45.00	68.6
4	9	8	2	0	137	45.00	68.6

TRIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 23.11 Y= 113.11

NTRANCE PT COORDS: X= 147.11 Y= 91.11

TRIAL ARC RADIUS= 32.558

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

***LINE 5IS NOT INTERSECTED BUT IS IN ARC

ARC LINE NO	INTERSECT WITH LINE ARRAY X	Y
2	100.058	90.12
4	117.11	8[illegible]
6	140.638	85.67
3	147.11	9[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I= 1	.000	89[illegible]	K= 1	KK= 1
I= 2	.000	8[illegible]	K= 1	KK= 2
I= 3	.000	3[illegible]	K= 1	KK= 3
I= 4	27.[illegible]	88[illegible]	K= 1	KK= 4
I= 5	100.058	90.19	K= 2	KK= 4
I= 6	117.[illegible]	8[illegible]	K= 3	KK= 4
I= 7	118.[illegible]	8[illegible]	K= 3	KK= 5
I= 8	128.[illegible]	86.[illegible]	K= 3	KK= 6
I= 9	136.[illegible]	9[illegible]	K= 3	KK= 7
I= 10	138.638	3[illegible]	K= 3	KK= 8
I= 11	140.638	85.674	K= 4	KK= 8
I= 12	147.[illegible]	9[illegible]	K= 4	KK= 8
I= 13	214.[illegible]	83.[illegible]	K= 4	KK= 9
I= 14	233.[illegible]	9[illegible]	K= 4	KK= 10
I= 15	236.[illegible]	83.[illegible]	K= 4	KK= 11
I= 16	240.[illegible]	73.[illegible]	K= 4	KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	100.058	90.19	K= 5	KK= 1
I= 2	117.[illegible]	8[illegible]	K= 6	KK= 2
I= 3	118.[illegible]	8[illegible]	K= 7	KK= 3
I= 4	128.[illegible]	86.[illegible]	K= 8	KK= 4
I= 5	136.[illegible]	9[illegible]	K= 9	KK= 5
I= 6	140.638	85.674	K= 12	KK= 6
I= 7	147.[illegible]	9[illegible]	K= 12	KK= 7

FIND SLICE WIDTH AND NO OF SLICES

FI= 1.00000	FO= 1.68864
FI= 1.68864	FO= 1.79457
FI= 1.79457	FO= 1.80455
FI= 1.80455	FO= 1.80544

THE SAFETY FACTOR FOR POINT 11S 1.80544

TRIAL CIRCLE NO 2
CIRCLE CTR COORDS: X= X= 126.11 Y= 73.11
ENTRANCE PT. COORDS: X= 147.11 Y= 9[illegible].11
TRIAL ARC RADIUS= 30.414

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

ARC LINE NO	INTERSECT WITH LINE ARRAY X	Y
2	106.02	90.28
5	121.578	83.04
6	139.330	85.72
3	147.11	9[illegible]

```
THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          89.[illegible]   K=  1   KK=  1
I=  2          .000          8[illegible]     K=  1   KK=  2
I=  3          .000          3[illegible]     K=  1   KK=  3
I=  4        27.[illegible]  88.[illegible]   K=  1   KK=  4
I=  5       106.012          90.283           K=  2   KK=  4
I=  6       118.[illegible]  8[illegible]     K=  2   KK=  5
I=  7       121.578          83.037           K=  3   KK=  5
I=  8       128.[illegible]  86.[illegible]   K=  3   KK=  6
I=  9       136.[illegible]  9[illegible]     K=  3   KK=  7
I= 10       138.[illegible]  3[illegible]     K=  3   KK=  8
I= 11       139.330          85.720           K=  4   KK=  8
I= 12       147.[illegible]  9[illegible]     K=  4   KK=  8
I= 13       214.[illegible]  83.[illegible]   K=  4   KK=  9
I= 14       233.[illegible]  9[illegible]     K=  4   KK= 10
I= 15       236.[illegible]  83.[illegible]   K=  4   KK= 11
I= 16       240.[illegible]  73.[illegible]   K=  4   KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1       106.012          90.283           K=  5   KK=  1
I=  2       121.578          83.037           K=  7   KK=  2
I=  3       128.[illegible]  86.[illegible]   K=  8   KK=  3
I=  4       136.[illegible]  9[illegible]     K=  9   KK=  4
I=  5       139.330          85.720           K= 11   KK=  5
I=  6       147.[illegible]  9[illegible]     K= 12   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                FI=    1.000000      FO=    27.5906
                FI=    2.759060      FO=    2.733855
                FI=    2.733855      FO=    2.735186
                FI=    2.735186      FO=    2.735278

          THE SAFETY FACTOR FOR POINT  21S    2.35278

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:  X=  X=      129.[illegible]   Y=      134.[illegible]
ENTRANCE PT. COORDS:  X=        147.[illegible]   Y=      9[illegible]
     TRIAL ARC RADIUS=     28.425

XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  2          111.953          90.45
  5          125.066          84.97
  6          135.997          85.80
  3          147.[illegible]  9[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          89.[illegible]   K=  1   KK=  1
I=  2          .000          8[illegible]     K=  1   KK=  2
I=  3          .000          3[illegible]     K=  1   KK=  3
I=  4        27.[illegible]  88.[illegible]   K=  1   KK=  4
I=  5       111.953          90.446           K=  2   KK=  4
I=  6       118.[illegible]  8[illegible]     K=  2   KK=  5
I=  7       125.066          84.975           K=  3   KK=  5
I=  8       128.[illegible]  86.[illegible]   K=  3   KK=  6
I=  9       136.[illegible]  9[illegible]     K=  3   KK=  7
I= 10       136.997          85.80            K=  4   KK=  7
I= 11       138.[illegible]  3[illegible]     K=  4   KK=  8
I= 12       147.[illegible]  9[illegible]     K=  4   KK=  8
I= 13       214.[illegible]  83.[illegible]   K=  4   KK=  9
```

```
I=  14          233.111          91.111    K=   4   KK=  10
I=  15          236.111          83.111    K=   4   KK=  11
I=  16          240.111          73.111    K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1          111.953          90.446    K=   5   KK=   1
I=   2          125.066          84.975    K=   7   KK=   2
I=   3          128.111          86.111    K=   8   KK=   3
I=   4          136.111          91.111    K=   9   KK=   4
I=   5          136.997          85.805    K=  10   KK=   5
I=   6          147.111          91.111    K=  12   KK=   6

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=   3.29465
                FI=   3.29465    FO=   3.62594
                FI=   3.62594    FO=   3.64087
                FI=   3.64087    FO=   3.64148

           THE SAFETY FACTOR FOR POINT  3IS    3.64148

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=        123.111   Y=      161.111
ENTRANCE PT. COORDS:  X=          47.111    Y=       91.111
      TRIAL ARC RADIUS=     34.655


XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO          X                 Y
  2          100.183          90.122
  5          119.142          81.684
  6          139.740          85.771
  3          147.111          91.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=   1            .000          89.111    K=   1   KK=   1
I=   2            .000          81.111    K=   1   KK=   2
I=   3            .000          31.111    K=   1   KK=   3
I=   4          27.111          88.111    K=   1   KK=   4
I=   5         100.183          90.122    K=   2   KK=   4
I=   6         118.111          81.111    K=   2   KK=   5
I=   7         119.142          81.684    K=   3   KK=   5
I=   8         128.111          86.111    K=   3   KK=   6
I=   9         136.111          91.111    K=   3   KK=   7
I=  10         138.111          31.111    K=   3   KK=   8
I=  11         139.740          85.705    K=   4   KK=   8
I=  12         147.111          91.111    K=   4   KK=   8
I=  13         214.111          83.111    K=   4   KK=   9
I=  14         233.111          91.111    K=   4   KK=  10
I=  15         236.111          83.111    K=   4   KK=  11
I=  16         240.111          73.111    K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1         100.183          90.122    K=   5   KK=   1
I=   2         119.142          81.684    K=   7   KK=   2
I=   3         128.111          86.111    K=   8   KK=   3
I=   4         136.111          91.111    K=   9   KK=   4
I=   5         139.740          85.705    K=  11   KK=   5
I=   6         147.111          91.111    K=  12   KK=   6

FIND SLICE WIDTH AND NO OF SLICES
```

```
                    FI=    1.000000    FO=    1.388869
                    FI=    1.388869    FO=    2.002186
                    FI=    2.002186    FO=    2.003277
                    FI=    2.003277    FO=    2.003361

          THE SAFETY FACTOR FOR POINT  41S    2.003361

TRIAL CIRCLE NO   5
CIRCLE CTR COORDS:   X=    X=      126.111   Y=      16.111
ENTRANCE PT. COORDS:   X=          147.111   Y=       9.111
      TRIAL ARC RADIUS=     32.650


XXX LINE   1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   9NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO            X              Y
  2          106.134         90.229
  5          122.669         83.364
  6          138.151         85.776
  3          147.111          9.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=   1          .000         89.111   K=   1   KK=   1
I=   2          .000          8.111   K=   1   KK=   2
I=   3          .000          3.111   K=   1   KK=   3
I=   4        27.111         88.111   K=   1   KK=   4
I=   5       106.134         90.286   K=   2   KK=   4
I=   6       118.111          8.111   K=   2   KK=   5
I=   7       122.669         83.643   K=   3   KK=   5
I=   8       128.111         86.111   K=   3   KK=   6
I=   9       136.111          9.111   K=   3   KK=   7
I=  10       138.111          3.111   K=   3   KK=   8
I=  11       138.555         85.776   K=   4   KK=   8
I=  12       147.111          9.111   K=   4   KK=   8
I=  13       214.111         83.111   K=   4   KK=   9
I=  14       233.111          9.111   K=   4   KK=  10
I=  15       236.111         83.111   K=   4   KK=  11
I=  16       240.111         73.111   K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1       106.134         90.286   K=   5   KK=   1
I=   2       122.669         83.643   K=   7   KK=   2
I=   3       128.111         86.111   K=   8   KK=   3
I=   4       136.111          9.111   K=   9   KK=   4
I=   5       138.111         85.776   K=   1   KK=   5
I=   6       147.111          9.111   K=  12   KK=   6

FIND SLICE WIDTH AND NO. OF SLICES
                    FI=    1.000000    FO=    2.052911
                    FI=    2.052911    FO=    2.755517
                    FI=    2.755517    FO=    2.776877
                    FI=    2.776877    FO=    2.776952

          THE SAFETY FACTOR FOR POINT  51S    2.776952

TRIAL CIRCLE NO   6
CIRCLE CTR COORDS:   X=    X=      129.111   Y=      16.111
ENTRANCE PT. COORDS:   X=          147.111   Y=       9.111
      TRIAL ARC RADIUS=     30.806
```

5.I.2 Stability Analysis After Dredging

As mentioned in chapter III, the insufficient depth for navigation and contribution to the water pollution of bottom sludge make necessary dredging in Haliç.

Since the bottom and underlying clay formations are very soft and weak, stability of these formations should be evaluated.

Considering the sufficient depth for navigation, the height of dredging will be minimum 6.5 meters between Taşkızak and Haliç Bridge and 4.0 meters from the Haliç Bridge upstream, (Arıcan,I976). At Taşkızak, The height of bottom sludge is nearly I5 meters. Around Haliç Bridge, it is 6-I0 meters.

At Taşkızak, we first analyzed the condition when all of the bottom sludge is dredged and then the case when 6 meters of bottom sludge is dredged. Around Haliç Bridge, dredging of all bottom sludge is necessary for navigation.

So for these cases, stability analysis has been conducted?The conclusions of these results will be discussed in next section.

After dredging of bottom sludge of IO meters :

The results taken from the computer for cross-section(3-3)B:

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
ß(a)	99	I46	I8I	I07	I.09
k(b)	86	I4I	I80	I07	0.99
l(c)	83	I50	I74	I07	I.06
m(d)	82	I6I	I92	I07	0.95
n(e)	95	I60	I89	I07	I.07

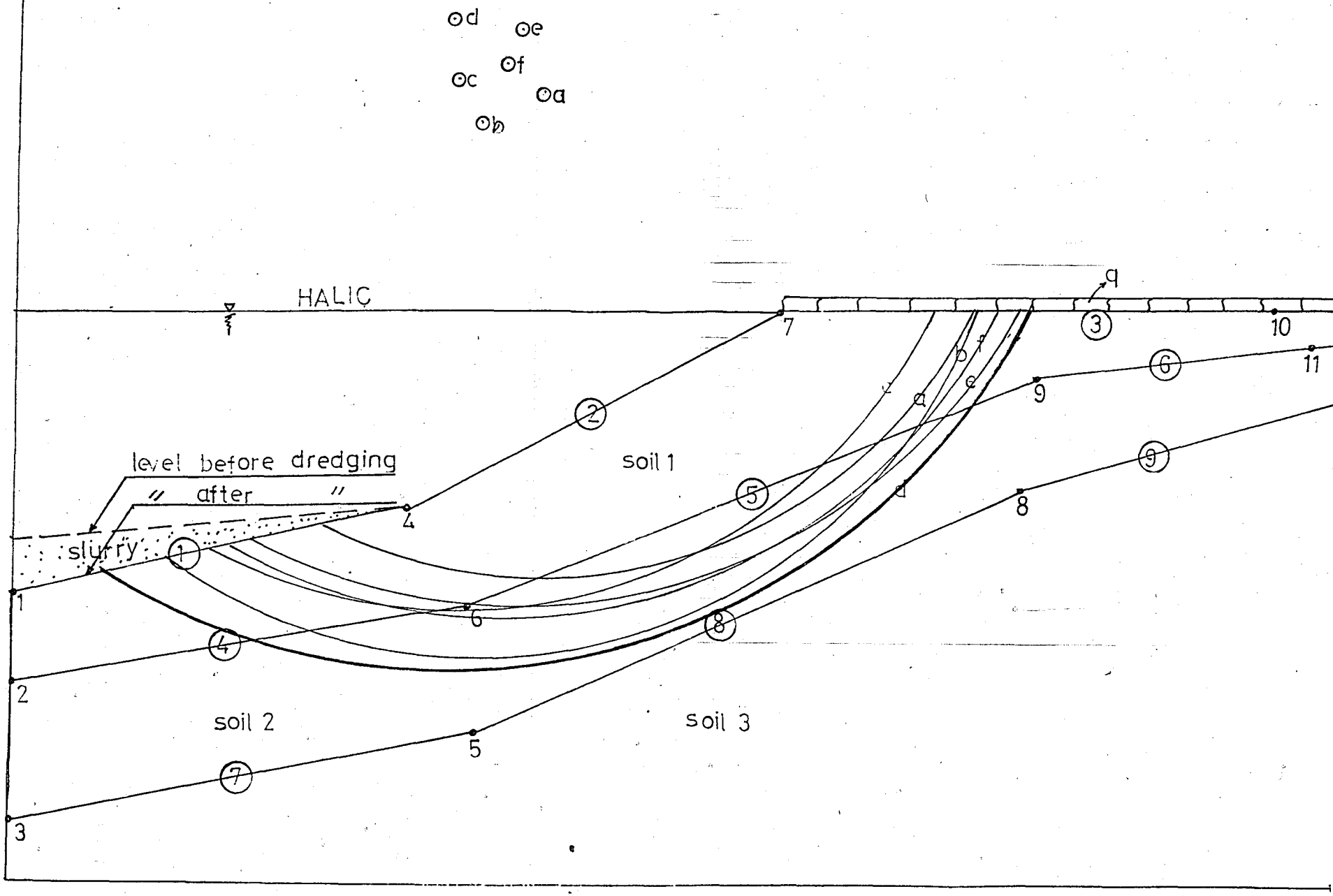

Fig: (3-3) B After dredging

SLOPE STABILITY FOR UNKAP(IT)EXCAVAT M.K. THESIS

NO OF LINES= 9 NO OF LINE INTERSECT= 12
NO OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3
NO OF X-INCREMENTS= 2 NO OF Y INCREMENTS= 2
IN ITIAL SLICE WIDTH= 2.0

THE LINE END COORD MATRIX

LINE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INT
1	2	.00	54.1	74.1	69.1	.202399	1
2	2	74.1	69.1	44.1	07.1	.542857	4
3	2	44.1	07.1	233.1	07.1	.000000	7
4	2	00	36.1	86.1	50.1	.162581	2
5	2	86.1	50.1	94.1	94.1	.407407	6
6	2	194.1	94.1	237.1	01.1	.162791	9
7	2	.00	10.1	84.1	27.1	.202174	3
8	2	34.1	27.1	88.1	73.1	.442308	5
9	2	188.1	73.1	244.1	90.1	.303571	8

LINE INTERSECT ARRAY

INT NO	X	Y
1	.00	54.1
2	.00	36.1
3	.00	.0
4	74.1	69.1
5	84.1	27.1
6	86.1	50.1
7	144.1	107.1
8	188.1	73.1
9	194.1	94.1
10	233.1	107.1
11	237.1	101.1
12	244.1	90.1

SOIL DATA ARRAY

SOIL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	4	4	0	7.8	20.0	19.6
1	2	7	7	0	7.8	20.0	19.6
1	4	2	6	0	7.8	20.0	19.6
1	5	6	9	0	7.8	20.0	19.6
1	6	9	2	0	7.8	20.0	19.6
2	2	5	6	0	7.8	12.0	.0
2	3	5	9	0	7.8	12.0	.0
2	4	5	5	0	7.8	12.0	.0
2	5	7	8	0	7.8	12.0	.0
2	6	8	3	0	7.8	12.0	.0
3	7	3	5	0	3.7	45.0	18.6
3	8	5	8	0	3.7	45.0	18.6
3	9	8	2	0	3.7	45.0	18.6

TRIAL CIRCLE NO 1
CIRCLE CTR COORDS: X= X= 99.1 Y= 46.1
ENTRANCE PT. COORDS: X= .8 Y= 07.1
TRIAL ARC RADIUS= 90.802

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

3	74.11	69.11	K=	6	KK=	3
4	86.11	50.11	K=	8	KK=	4
5	144.11	107.11	K=	9	KK=	5
6	167.69	83.347	K=	10	KK=	6
7	180.11	107.11	K=	11	KK=	7

ND SLICE WIDTH AND NO OF SLICES

***MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50

FI= 1.00000 FO= .98488
FI= .98488 FO= .98289
FI= .98289 FO= .98262

THE SAFETY FACTOR FOR POINT 1IS .98262

IAL CIRCLE NO 2
RCLE CTR COORDS: X= X= 89.11 Y= 41.11
ITRANCE PT. COORDS: X= 180.11 Y= 107.11
TRIAL ARC RADIUS= 97.144

X LINE 2NOT INTERSECTED BY TRIAL CIRCL

X LINE 6NOT INTERSECTED BY TRIAL CIRCL

X LINE 7NOT INTERSECTED BY TRIAL CIRCL

X LINE 8NOT INTERSECTED BY TRIAL CIRCL

X LINE 9NOT INTERSECTED BY TRIAL CIRCL

**LINE 2IS NOT INTERSECTED BUT IS IN ARC

C INTERSECT WITH LINE ARRAY

E NO	X	Y
1	34.135	61.102
2	65.791	46.81
5	167.010	83.07
3	180.111	107.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I=	1	[illegible]	[illegible]	K=	1	KK= 1
I=	2	[illegible]	[illegible]	K=	1	KK= 2
I=	3	[illegible]	[illegible]	K=	1	KK= 3
I=	4	34.135	6[illegible]020	K=	2	KK= 3
I=	5	65.[illegible]79	46[illegible]807	K=	3	KK= 3
I=	6	74.[illegible]11	69[illegible]11	K=	3	KK= 4
I=	7	84.[illegible]11	27[illegible]11	K=	3	KK= 5
I=	8	86.[illegible]11	50[illegible]11	K=	3	KK= 6
I=	9	144.[illegible]11	107.[illegible]11	K=	3	KK= 7
I=	10	167.[illegible]010	83.070	K=	4	KK= 7
I=	11	180.[illegible]11	107.[illegible]11	K=	4	KK= 7
I=	12	188.[illegible]11	73.[illegible]11	K=	4	KK= 8
I=	13	194.[illegible]11	94.[illegible]11	K=	4	KK= 9
I=	14	233.[illegible]11	107.[illegible]11	K=	4	KK= 10
I=	15	237.[illegible]11	10[illegible]11	K=	4	KK= 11
I=	16	244.[illegible]11	90.[illegible]11	K=	4	KK= 12

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I=	1	34.135	6[illegible]020	K=	4	KK= 1
I=	2	65.[illegible]79	46[illegible]807	K=	5	KK= 2
I=	3	74.[illegible]11	69[illegible]11	K=	6	KK= 3
I=	4	86.[illegible]11	50[illegible]11	K=	8	KK= 4
I=	5	144.[illegible]11	107.[illegible]11	K=	9	KK= 5
I=	6	167.[illegible]010	83.070	K=	10	KK= 6
I=	7	180.[illegible]11	107.[illegible]11	K=	11	KK= 7

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50

FI= [illegible] FO= .99209
FI= .99209 FO= .99104
FI= .99104 FO= .99090

THE SAFETY FACTOR FOR POINT 2IS .99090

TRIAL CIRCLE NO 3
CIRCLE CTR COORDS: X= X= 86.[illegible]1 Y= 144.11
ENTRANCE PT. COORDS: X= 80.[illegible]1 Y= 107.[illegible]7
TRIAL ARC RADIUS= 101.020

XXX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 9NOT INTERSECTED BY TRIAL CIRCL

***LINE 2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY

LINE NO	X	Y
1	29.[illegible]4	60[illegible]7
4	61.561	46.[illegible]2
5	156.[illegible]2	82.[illegible]3
3	180.[illegible]1	107.[illegible]1

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:

I=	1	[illegible]	[illegible]	K=	1	KK= 1
I=	2	[illegible]	[illegible]	K=	1	KK= 2
I=	3	[illegible]	[illegible]	K=	1	KK= 3
I=	4	29.[illegible]4	60.[illegible]65	K=	2	KK= 3
I=	5	61.[illegible]56	46.[illegible]20	K=	3	KK= 3
I=	6	74.[illegible]11	69[illegible]11	K=	3	KK= 4
I=	7	84.[illegible]11	27[illegible]11	K=	3	KK= 5
I=	8	86.[illegible]11	50.[illegible]11	K=	3	KK= 6

```
=  9          144.111          107.111    K=   3   KK=   7
=  10         166.420          82.830     K=   4   KK=   7
=  11         180.111          107.111    K=   4   KK=   7
=  12         88.111           73.111     K=   4   KK=   8
=  13         94.111           94.111     K=   4   KK=   9
=  14         233.111          107.111    K=   4   KK=  10
=  15         237.111          10.111     K=   4   KK=  11
=  16         244.111          90.111     K=   4   KK=  12


HE APPLICABLE ARRAY ARCINT FOLLOWS:
=  1          29.914           60.165     K=   4   KK=   1
=  2          61.561           46.120     K=   5   KK=   2
=  3          74.111           69.111     K=   6   KK=   3
=  4          86.111           50.111     K=   8   KK=   4
=  5          44.111           107.111    K=   9   KK=   5
=  6          166.420          82.830     K=  10   KK=   6
=  7          180.111          107.111    K=  11   KK=   7


IND SLICE WIDTH AND NO OF SLICES
****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
                FI=    1.000000    FO=     .998383
                FI=     .98383     FO=     .98372
                FI=     .98372     FO=     .98344

          THE SAFETY FACTOR FOR POINT  3IS      .98344


RIAL CIRCLE NO   4
IRCLE CTR COORDS:   X=   X=        89.111    Y=      44.111
NTRANCE PT. COORDS:   X=           80.111    Y=      107.111
     TRIAL ARC RADIUS=     98.234


XX LINE   2NOT INTERSECTED BY TRIAL CIRCL

XX LINE   6NOT INTERSECTED BY TRIAL CIRCL

XX LINE   7NOT INTERSECTED BY TRIAL CIRCL

XX LINE   8NOT INTERSECTED BY TRIAL CIRCL

XX LINE   9NOT INTERSECTED BY TRIAL CIRCL

**LINE   2IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY
INE NO          X               Y
 1          36.088          61.542
 4          70.733          47.561
 5          165.629         82.551
 3          180.111         107.111


HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
=  1          .000            54.111     K=   1   KK=   1
=  2          .000            36.111     K=   1   KK=   2
=  3          .000            10.111     K=   1   KK=   3
=  4          36.088          61.475     K=   2   KK=   3
=  5          70.733          47.561     K=   3   KK=   3
=  6          74.111          69.111     K=   3   KK=   4
=  7          84.111          27.111     K=   3   KK=   5
=  8          86.111          50.111     K=   3   KK=   6
=  9          44.111          107.111    K=   3   KK=   7
=  10         165.629         82.507     K=   4   KK=   7
=  11         180.111         107.111    K=   4   KK=   7
=  12         88.111          73.111     K=   4   KK=   8
=  13         94.111          94.111     K=   4   KK=   9
=  14         233.111         107.111    K=   4   KK=  10
=  15         237.111         10.111     K=   4   KK=  11
=  16         244.111         90.111     K=   4   KK=  12
```

THE APPLICABLE ARRAY ARCINT FOLLOWS:

I= 1	36.088	61.415	K= 4	KK= 1		
I= 2	70.733	47.561	K= 5	KK= 2		
I= 3	74.[illegible]	69.[illegible]	K= 6	KK= 3		
I= 4	86.[illegible]	50.[illegible]	K= 8	KK= 4		
I= 5	144.[illegible]	07.[illegible]	K= 9	KK= 5		
I= 6	165.629	82.507	K= 10	KK= 6		
I= 7	180.[illegible]	07.[illegible]	K= 11	KK= 7		

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50

FI= 1.00000 FO= .99654

FI= .99654 FO= .99609

THE SAFETY FACTOR FOR POINT 4IS .99609

ID PROGRAM EXECUTION

After Dredging of All Bottom Sludge:

The results taken from the computer for cross-section(8-8)A:

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	86	III	I35	8I	I.09
b	83	I05	II8	8I	I.03
c	9I	I08	I24	8I	I.I9
d	98	I23	I65	8I	I.48
e	I0I	II3	I53	8I	I.52
f	84	I20	I27	8I	I.05
g	82	93	I33	8I	I.I7
m	72	I08	I36	8I	I.02
n	74	II7	I36	8I	0.97
p	8I	I28	I57	8I	I.I6

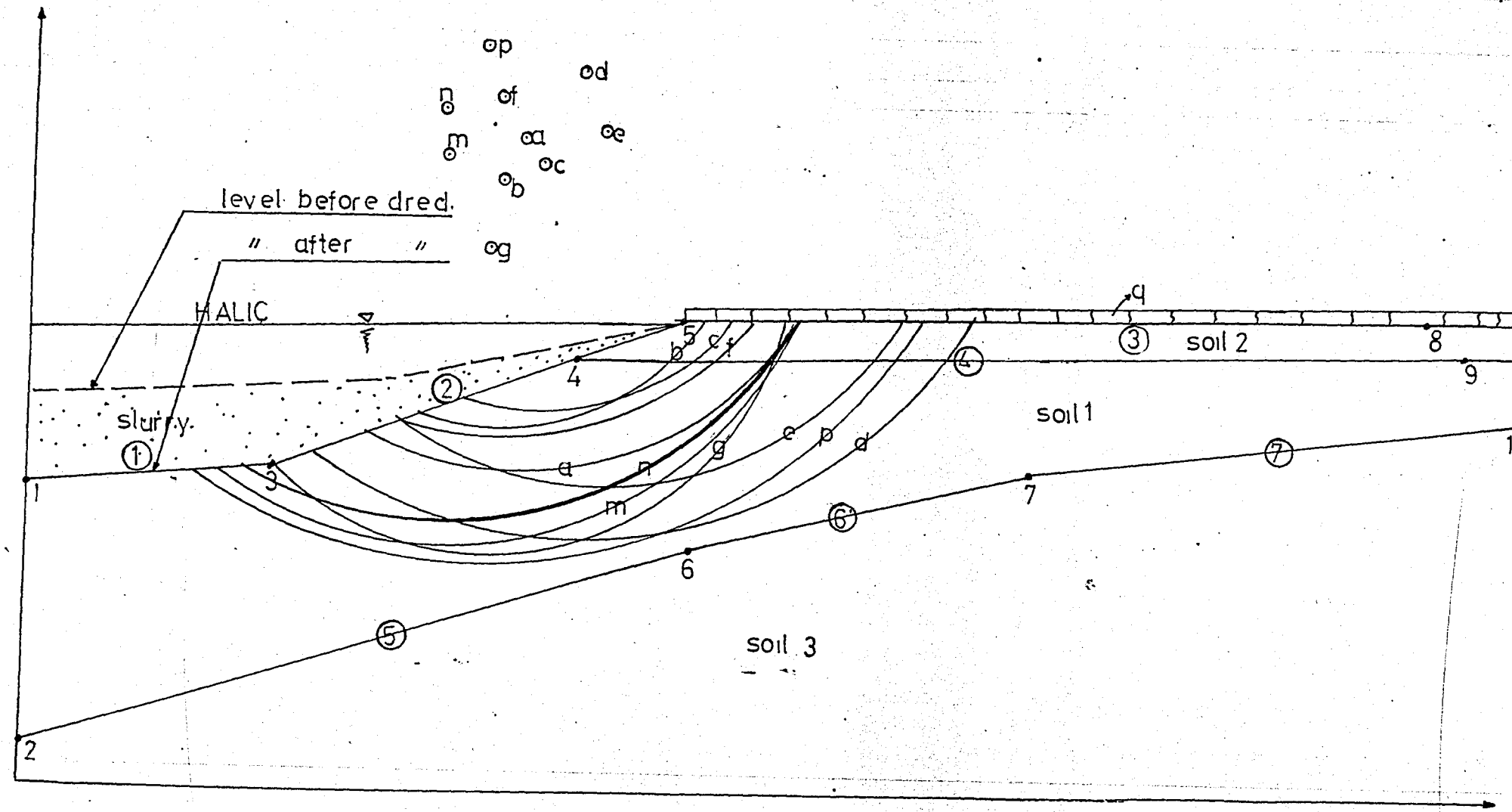

Fig : (8-8) A After dredging of all bottom sludge

OPE STABILITY FOR TASKIZAK(I)EXCAVE:MAHIR KOSELER THESIS.

OF LINES 7 NO OF LINE INTERSECT= 10

OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

OF X-INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 2.0

E LINE END COORD MATRIX

NO	NO	INT	X1	Y1	X2	Y2	SLOPE	LINE	INTER
1	2		.00	53.11	40.11	55.11	.498616E-001	1	3
2	3		40.11	55.11	113.11	81.11	.356164	3	4
3	2		113.11	8.11	240.11	81.11	.000000	5	8
4	2		95.11	74.11	242.11	77.11	.204082E-001	4	9
5	2		.00	8.11	115.11	41.11	.286680	2	6
6	2		115.11	41.11	175.11	54.11	.216667	6	7
7	2		175.11	54.11	244.11	66.11	.173913	7	10

NE INTERSECT ARRAY

NO	X	Y
1	.00	53.11
2	.00	8.11
3	40.11	55.11
4	95.11	74.11
5	113.11	81.11
6	115.11	41.11
7	175.11	54.11
8	240.11	81.11
9	242.11	77.11
10	244.11	66.11

IL DATA ARRAY

L NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	3	4	0	7.8	12.0	.0
2	2	3	4	0	7.8	12.0	.0
3	4	5	6	0	7.8	12.0	.0
4	5	6	7	0	7.8	12.0	.0
5	6	7	5	0	7.8	12.0	.0
6	7	2	5	0	7.8	20.0	19.6
7	2	3	4	0	7.8	20.0	19.6
8	3	4	5	0	7.8	20.0	19.6
9	4	5	2	0	13.7	45.0	68.6
10	5	6	7	0	13.7	45.0	68.6
11	7	7	1	0	13.7	45.0	68.6

IAL CIRCLE NO 1
RCLE CTR COORDS: X= X= 74.11 Y= 77.11
TRANCE PT. COORDS: X= 136.11 Y= 81.11
TRIAL ARC RADIUS= 71.694

X LINE 2NOT INTERSECTED BY TRIAL CIRCL

```
 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 ***LINE  2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1          38.270         55.02
  4         132.033         74.86
  3         136.711         81.41



 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         53.11   K=  1   KK=  1
I=  2          .000          8.11   K=  1   KK=  2
I=  3        38.270         55.079  K=  2   KK=  2
I=  4        40.111         55.111  K=  2   KK=  3
I=  5        95.111         74.111  K=  2   KK=  4
I=  6       113.111          8.111  K=  2   KK=  5
I=  7       115.111          4.111  K=  2   KK=  6
I=  8       132.033         74.865  K=  3   KK=  6
I=  9       136.111          8.111  K=  3   KK=  6
I= 10        75.111         54.111  K=  3   KK=  7
I= 11       240.111          8.111  K=  3   KK=  8
I= 12       242.111         77.111  K=  3   KK=  9
I= 13       244.111         66.111  K=  3   KK= 10

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        38.270         55.079  K=  3   KK=  1
I=  2        40.111         55.111  K=  4   KK=  2
I=  3        95.111         74.111  K=  5   KK=  3
I=  4       113.111          8.111  K=  6   KK=  4
I=  5       132.033         74.865  K=  8   KK=  5
I=  6       136.111          8.111  K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                FI=    1.000000    FO=     .998907
                FI=     .998907    FO=     .998806
                FI=     .998806    FO=     .998796

          THE SAFETY FACTOR FOR POINT  IS     .998796

 TRIAL CIRCLE NO  2
 CIRCLE CTR COORDS:  X=  X=       77.111  Y=      77.111
 ENTRANCE PT. COORDS:  X=        136.111  Y=       8.111
      TRIAL ARC RADIUS=     69.176



 XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  2          43.941         56.47
  4         131.807         74.86
  3         136.111          8.11



 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         53.11   K=  1   KK=  1
I=  2          .000          8.11   K=  1   KK=  2
```

```
I=  6          113.111          81.111          K=  2   KK=  5
I=  7          115.111          41.111          K=  2   KK=  6
I=  8          131.807          74.860          K=  3   KK=  6
I=  9          136.111          81.111          K=  3   KK=  6
I= 10          175.111          54.111          K=  3   KK=  7
I= 11          240.111          81.111          K=  3   KK=  8
I= 12          242.111          77.111          K=  3   KK=  9
I= 13          244.111          66.111          K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1           43.941          56.475          K=  4   KK=  1
I=  2           95.111          74.111          K=  5   KK=  2
I=  3          113.111          81.111          K=  6   KK=  3
I=  4          131.807          74.860          K=  8   KK=  4
I=  5          136.111          81.111          K=  9   KK=  5



FIND SLICE WIDTH AND NO OF SLICES
                FI=    .00000    FO=    .00237
                FI=    .00237    FO=    .00259
            THE SAFETY FACTOR FOR POINT  21S    1.00259

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:  X=  X=      74.111  Y=      20.111
ENTRANCE PT. COORDS:  X=        136.111  Y=      81.111
      TRIAL ARC RADIUS=    73.246

XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
  2           40.251          55.116
  4          131.702          74.086
  3          136.111          81.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000          53.111          K=  1   KK=  1
I=  2            .000           8.111          K=  1   KK=  2
I=  3           40.114          55.111          K=  1   KK=  3
I=  4           40.251          55.116          K=  2   KK=  3
I=  5           95.111          74.111          K=  2   KK=  4
I=  6          113.111          81.111          K=  2   KK=  5
I=  7          115.111          41.111          K=  2   KK=  6
I=  8          131.702          74.858          K=  3   KK=  6
I=  9          136.111          81.111          K=  3   KK=  6
I= 10          175.111          54.111          K=  3   KK=  7
I= 11          240.111          81.111          K=  3   KK=  8
I= 12          242.111          77.111          K=  3   KK=  9
I= 13          244.111          66.111          K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1           40.251          55.116          K=  4   KK=  1
I=  2           95.111          74.111          K=  5   KK=  2
I=  3          113.111          81.111          K=  6   KK=  3
I=  4          131.702          74.858          K=  8   KK=  4
I=  5          136.111          81.111          K=  9   KK=  5

FIND SLICE WIDTH AND NO OF SLICES
                FI=    .00000    FO=    .97779
                FI=    .97779    FO=    .97578
                FI=    .97578    FO=    .97559
```

```
 TRIAL CIRCLE NO.  4
 CIRCLE CTR COORDS:   X=          X=          77.11    Y=          20.11
 ENTRANCE PT. COORDS:  X=                    136.11    Y=          81.11
       TRIAL ARC RADIUS=      70.725


 XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL


 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 ARC INTERSECT WITH LINE ARRAY
 LINE NO          X                Y
   2          45.282           56.95
   4          131.456          74.85
   3          136.11           81.11

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
 I=  1          .000           53.11    K=  1   KK=  1
 I=  2          .000            8.11    K=  1   KK=  2
 I=  3         40.11           55.11    K=  1   KK=  3
 I=  4         45.282          56.953   K=  2   KK=  3
 I=  5         95.11           74.11    K=  2   KK=  4
 I=  6        113.11           81.11    K=  2   KK=  5
 I=  7        115.11            4.11    K=  2   KK=  6
 I=  8        131.456          74.853   K=  3   KK=  6
 I=  9        136.11           81.11    K=  3   KK=  6
 I= 10        175.11           54.11    K=  3   KK=  7
 I= 11        240.11           81.11    K=  3   KK=  8
 I= 12        242.11           77.11    K=  3   KK=  9
 I= 13        244.11           66.11    K=  3   KK= 10

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
 I=  1         45.282          56.953   K=  4   KK=  1
 I=  2         95.11           74.11    K=  5   KK=  2
 I=  3        113.11           81.11    K=  6   KK=  3
 I=  4        131.456          74.853   K=  8   KK=  4
 I=  5        136.11           81.11    K=  9   KK=  5

 FIND SLICE WIDTH AND NO OF SLICES
                  FI=    1.00000    FO=     .99321
                  FI=     .99321    FO=     .99259

                 THE SAFETY FACTOR FOR POINT  4IS      .99259
@BRKPT PRINT$
```

After Dredging of 6m. of Bottom Sludge:

The results taken from the computer for cross-section (8-8)A are:

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	86	III	I35	8I	0.99
b	83	I05	II8	8I	0.95
c	9I	I08	I24	8I	I.II
d	98	I23	I65	8I	I.45
e	I0I	II3	I53	8I	I.40
f	84	I20	I27	8I	I.I2
g	82	93	I33	8I	I.I9
m	72	I08	I36	8I	I.09
n	74	II7	I36	8I	I.00
p	8I	I28	I57	8I	I.I9

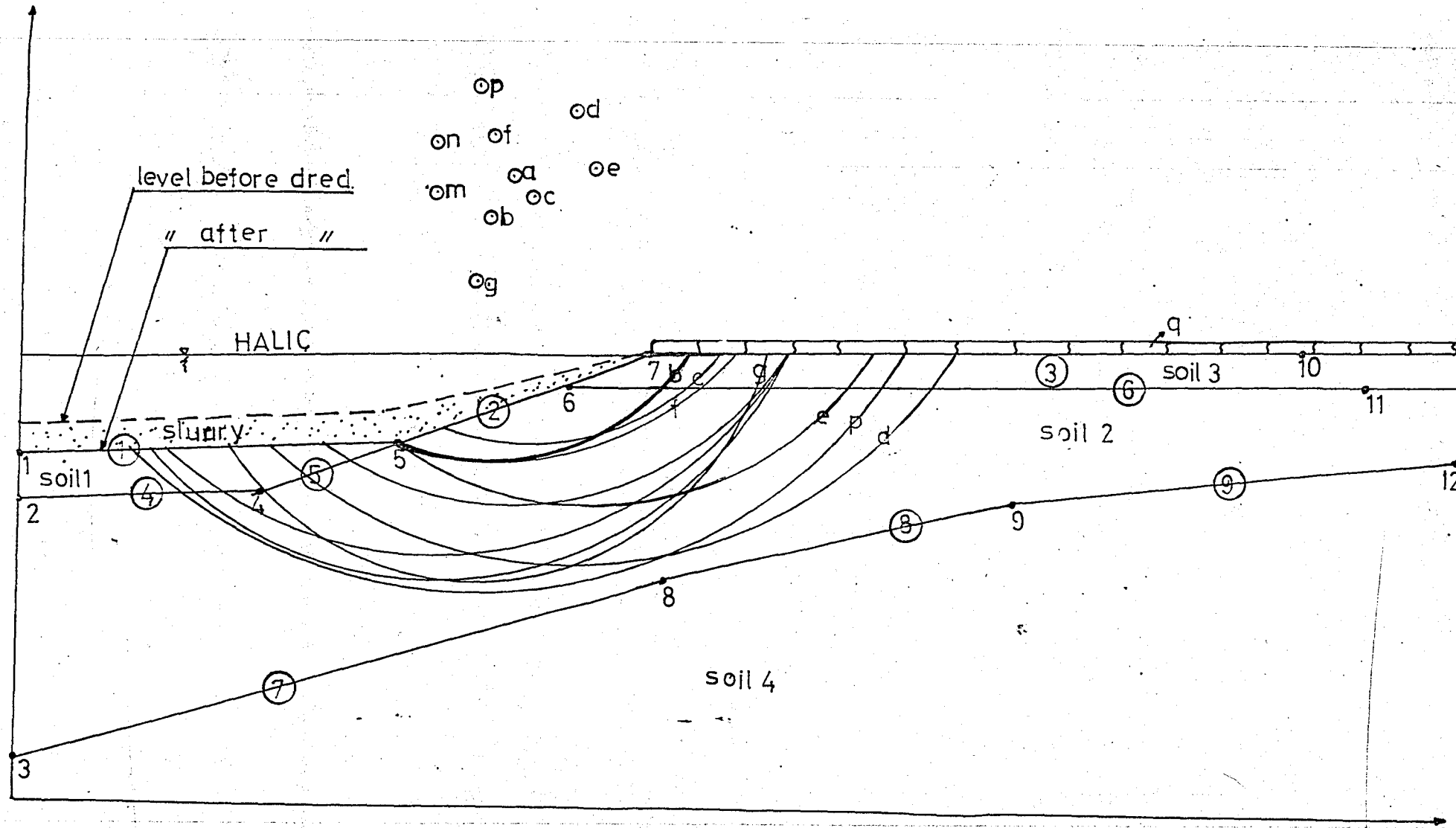

Fig : (8-8)A After Dredging of 6 m. of Bottom Sludge

LOPE STABILITY FOR TASKIZAK(I)EXCAVA(2) MAHIR KOSELER THESIS

0 OF LINES 9 NO OF LINE INTERSECT= 12

0 OF SOILS= 4 NO OF EXTERNAL SOIL LINES= 3

0 OF X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 2.0

HE LINE END COORD MATRIX

NE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTE
1	2	.00	62.11	65.11	62.11	.000000	1
2	3	65.11	62.11	113.	8.111	.395833	5
3	2	113.	8.111	240.	8.111	.000000	7
4	2	.00	53.111	40.111	55.111	.498616E-001	2
5	2	40.111	55.111	65.111	62.111	.280000	4
6	2	95.	74.111	242.111	77.111	.204082E-001	6
7	2	.00	8.111	115.111	41.111	.286680	3
8	2	115.111	41.111	175.111	54.111	.216667	8
9	2	175.111	54.111	244.111	66.111	.173913	9

INE INTERSECT ARRAY

T NO	X	Y
1	.00	62.111
2	.00	53.111
3	.00	8.111
4	40.111	55.111
5	65.111	62.111
6	95.111	74.111
7	113.111	8.111
8	115.111	41.111
9	175.111	54.111
10	240.111	8.111
11	242.111	77.111
12	244.111	66.111

OIL DATA ARRAY

IL NO	LINE #	LEFT INT	RT. INT	SAT	UNIT WT	PHI	COHESION
1	1	5	5	0	115.	12.0	0
1	2	5	5	0	115.	12.0	0
1	5	5	5	0	115.	12.0	0
2	2	4	5	0	117.8	12.0	0
2	4	5	6	0	117.8	12.0	0
2	5	4	5	0	117.8	12.0	0
2	6	6	8	0	117.8	12.0	0
2	7	3	8	0	117.8	12.0	0
2	8	8	9	0	117.8	12.0	0
2	9	9	2	0	117.8	12.0	0
3	2	6	7	0	117.8	20.0	19.6
3	3	7	10	0	117.8	20.0	19.6
3	6	6	11	0	117.8	20.0	19.6
4	7	3	8	0	113.7	45.0	68.6
4	8	8	9	0	113.7	45.0	68.6
4	9	9	12	0	113.7	45.0	68.6

RIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 83.11 Y= 105.11

NTRANCE PT. COORDS: X= 118.11 Y= 81.11

TRIAL ARC RADIUS= 42.438

XXX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 7NOT INTERSECTED BY TRIAL CIRCL

(X LINE 8NOT INTERSECTED BY TRIAL CIRCL

(X LINE 9NOT INTERSECTED BY TRIAL CIRCL

RC INTERSECT WITH LINE ARRAY
NE NO X Y
2 70.994 64.44
3 1.12460 74.47
3 118.11 8.11

HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
1 .000 62.11 K= 1 KK= 1
2 .000 53.11 K= 1 KK= 2
3 .000 8.11 K= 1 KK= 3
4 40.11 55.11 K= 1 KK= 4
5 65.11 62.11 K= 1 KK= 5
6 70.994 64.440 K= 2 KK= 5
7 95.11 74.11 K= 2 KK= 6
8 1.12460 74.465 K= 3 KK= 6
9 113.11 8.11 K= 3 KK= 7
10 115.11 4.11 K= 3 KK= 8
11 118.11 8.11 K= 3 KK= 8
12 175.11 54.11 K= 3 KK= 9
13 240.11 8.11 K= 3 KK= 10
14 242.11 77.11 K= 3 KK= 11
15 244.11 66.11 K= 3 KK= 12

HE APPLICABLE ARRAY ARCINT FOLLOWS:
1 70.994 64.440 K= 6 KK= 1
2 95.11 74.11 K= 7 KK= 2
3 1.12460 74.465 K= 8 KK= 3
4 113.11 8.11 K= 9 KK= 4
5 118.11 8.11 K= 11 KK= 5

IND SLICE WIDTH AND NO OF SLICES
FI= 1.00000 FO= .9639
FI= .9639 FO= .95874
FI= .95874 FO= .95797

THE SAFETY FACTOR FOR POINT TIS .95797

RIAL CIRCLE NO 2
IRCLE CTR COORDS: X= X= 86.11 Y= 105.11
NTRANCE PT. COORDS: X= 118.11 Y= 8.11
TRIAL ARC RADIUS= 40.000

XX LINE 1NOT INTERSECTED BY TRIAL CIRCL

XX LINE 4NOT INTERSECTED BY TRIAL CIRCL

XX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XX LINE 7NOT INTERSECTED BY TRIAL CIRCL

XX LINE 8NOT INTERSECTED BY TRIAL CIRCL

XX LINE 9NOT INTERSECTED BY TRIAL CIRCL

RC INTERSECT WITH LINE ARRAY
NE NO X Y
2 75.983 66.41
6 1.13797 74.45
3 118.11 8.11

HE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
1 .000 62.11 K= 1 KK= 1
2 .000 53.11 K= 1 KK= 2

```
I=  3                .000          8.111    K=  1   KK=  3
I=  4              40.111         55.111    K=  1   KK=  4
I=  5              65.111         62.111    K=  1   KK=  5
I=  6              75.983         66.414    K=  2   KK=  5
I=  7              95.111         74.111    K=  2   KK=  6
I=  8             111.797         74.452    K=  3   KK=  6
I=  9              113.111        81.111    K=  3   KK=  7
I=  10             115.111        4.111     K=  3   KK=  8
I=  11             118.111        8.111     K=  3   KK=  8
I=  12             175.111        54.111    K=  3   KK=  9
I=  13             240.111        8.111     K=  3   KK=  10
I=  14             242.111        77.111    K=  3   KK=  11
I=  15             244.111        66.111    K=  3   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1              75.983         66.414    K=  6   KK=  1
I=  2              95.111         74.111    K=  7   KK=  2
I=  3             111.797         74.452    K=  8   KK=  3
I=  4              113.111        81.111    K=  9   KK=  4
I=  5              118.111        8.111     K=  11  KK=  5

FIND SLICE WIDTH AND NO OF SLICES
                FI=  1.00000    FO=  1.04952
                FI=  1.04952    FO=  1.05709
                FI=  1.05709    FO=  1.05820
                FI=  1.05820    FO=  1.05837

          THE SAFETY FACTOR FOR POINT  2IS   1.05837

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:   X=   X=      83.111   Y=     108.111
ENTRANCE PT. COORDS:  X=          18.111   Y=      8.111
     TRIAL ARC RADIUS=    44.204


XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL


ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  2            72.756         65.414
  6           111.756         74.745
  3           118.111         8.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1                .000          62.111    K=  1   KK=  1
I=  2                .000          53.111    K=  1   KK=  2
I=  3                .000          8.111     K=  1   KK=  3
I=  4              40.111         55.111    K=  1   KK=  4
I=  5              65.111         62.111    K=  1   KK=  5
I=  6              72.756         65.37     K=  2   KK=  5
I=  7              95.111         74.111    K=  2   KK=  6
I=  8             111.756         74.45     K=  3   KK=  6
I=  9              113.111        8.111     K=  3   KK=  7
I=  10             115.111        4.111     K=  3   KK=  8
I=  11             118.111        8.111     K=  3   KK=  8
I=  12             175.111        54.111    K=  3   KK=  9
I=  13             240.111        8.111     K=  3   KK=  10
I=  14             242.111        77.111    K=  3   KK=  11
I=  15             244.111        66.111    K=  3   KK=  12
```

```
THE APPLICABLE ARRAY ARCINI FOLLOWS:
I=  1        72.756        65.137    K=  6   KK=  1
I=  2        95.411        74.111    K=  7   KK=  2
I=  3       110.756        74.435    K=  8   KK=  3
I=  4       113.111        81.111    K=  9   KK=  4
I=  5       118.111        81.111    K= 11   KK=  5

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=    .99844
                FI=    .99844    FO=    .99821

          THE SAFETY FACTOR FOR POINT  3IS     .99821

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=   X=      86.111  Y=     108.111
ENTRANCE PT. COORDS:  X=         118.111  Y=      81.111
     TRIAL ARC RADIUS=    41.869


XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO          X             Y
  2          77.703        67.095
  6         110.981        74.043
  3         118.111        81.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000        62.111    K=  1   KK=  1
I=  2          .000        53.111    K=  1   KK=  2
I=  3          .000         8.111    K=  1   KK=  3
I=  4        40.111        55.111    K=  1   KK=  4
I=  5        65.111        62.111    K=  1   KK=  5
I=  6        77.703        67.095    K=  2   KK=  5
I=  7        95.111        74.111    K=  2   KK=  6
I=  8       110.981        74.435    K=  3   KK=  6
I=  9       113.111         8.111    K=  3   KK=  7
I= 10       115.111        41.111    K=  3   KK=  8
I= 11       118.111         8.111    K=  3   KK=  8
I= 12       175.111        54.111    K=  3   KK=  9
I= 13       240.111         8.111    K=  3   KK= 10
I= 14       242.111        77.111    K=  3   KK= 11
I= 15       244.111        66.111    K=  3   KK= 12

THE APPLICABLE ARRAY ARCINI FOLLOWS:
I=  1        77.703        67.095    K=  6   KK=  1
I=  2        95.111        74.111    K=  7   KK=  2
I=  3       110.981        74.435    K=  8   KK=  3
I=  4       113.111         8.111    K=  9   KK=  4
I=  5       118.111         8.111    K= 11   KK=  5

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=    1.11305
                FI=   1.11305    FO=    1.13058
                FI=   1.13058    FO=    1.13305
                FI=   1.13305    FO=    1.13339

          THE SAFETY FACTOR FOR POINT  4IS    1.13339

RKPT PRINTS
```

After Dredging of all Bottom Sludge:

The results taken from the computer for cross-section (8-8)B are:

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	IOI	IIO	I43	64	I.55
b	97	I03	I33	64	I.99
c	I07	IOI	I39	64	2.59
d	93	I08	I36	64	I.42
e	I09	I08	I52	64	I.58
f	86	III	I33	64	I.35
g	88	I03	I39	64	I.I5

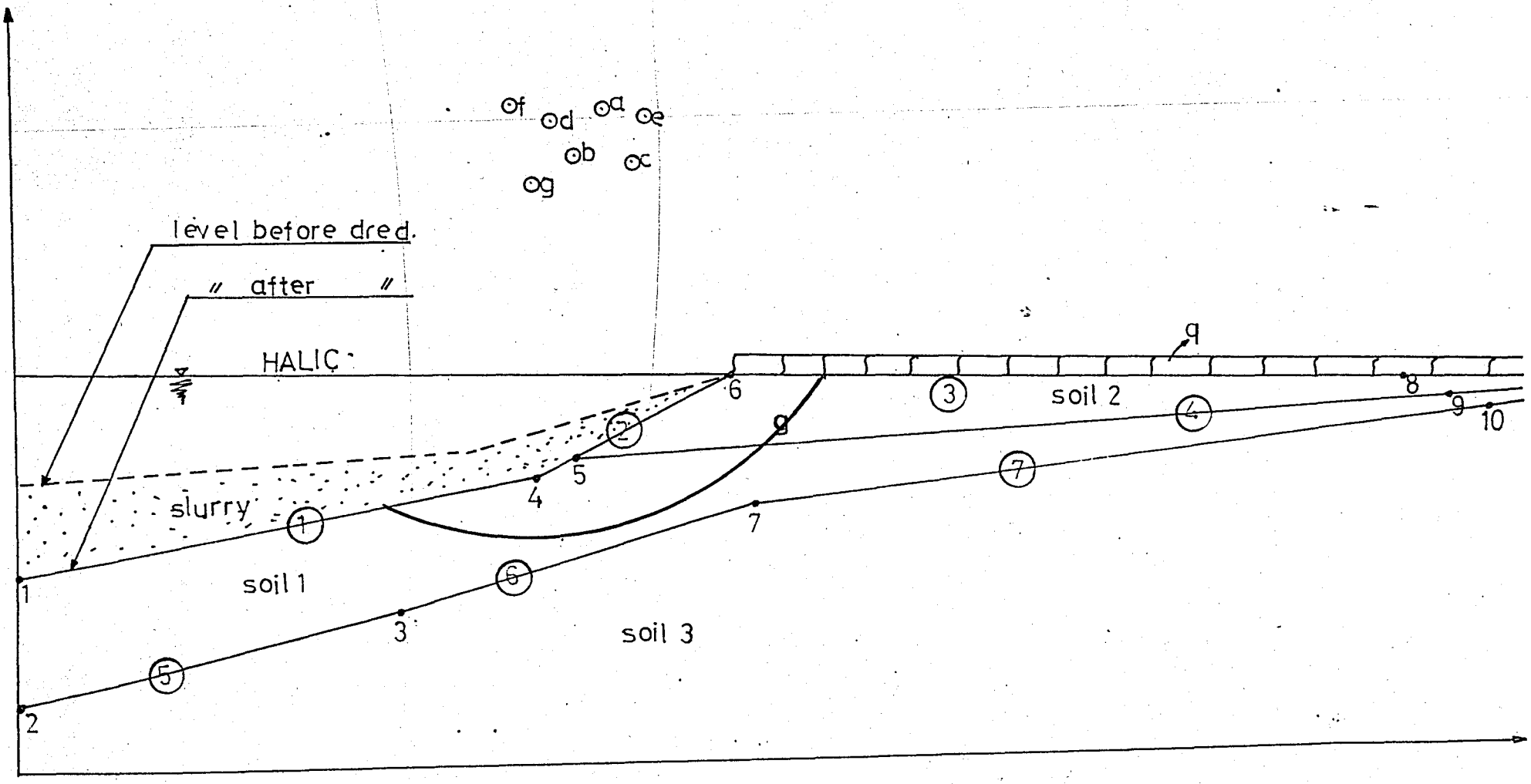

Fig : (8-8) B After Dredging of all bottom Sludge.

OPE STABILITY FOR TASKIZAK(II)EXCAVA(I) MAHIR KOSELER THESIS

) OF LINES 7 NO OF LINE INTERSECT= 10

) OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

) OF X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 2.0

HE LINE END COORD MATRIX

NE NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INT
1	2	00	33	89	49	.179551	4
2	3	89	49	24	64	.428571	
3	2	124	64	229	64	.000000	6
4	2	94	52	230	58	.441176	5
5	2	00	12	64	26	.233969	2
6	2	64	28	25	44	.295082	3
7	2	125	44	232	56	.112150	7

INE INTERSECT ARRAY

NO	X	Y
1	00	33
2	00	12
3	64	26
4	89	49
5	94	52
6	124	64
7	125	44
8	229	64
9	230	58
10	232	56

OIL DATA ARRAY

IL NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	2	4	5	0	7.8	12.0	0
2	4	5	9	0	7.8	12.0	0
3	5	2	3	0	7.8	12.0	0
4	6	3	7	0	7.8	12.0	0
5	7	7	0	0	7.8	12.0	0
2	3	5	6	0	7.8	20.0	19.6
2	4	5	8	0	7.8	20.0	19.6
2	5	5	9	0	7.8	20.0	19.6
3	5	2	3	0	3.7	45.0	68.6
3	6	3	7	0	3.7	45.0	68.6
3	7	7	0	0	3.7	45.0	68.6

RIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 88.1 Y= 03.1

NTRANCE PT. COORDS: X= 39.1 Y= 64.1

TRIAL ARC RADIUS= 64.203

XX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XX LINE 7NOT INTERSECTED BY TRIAL CIRCL

**LINE 2IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY

NE NO	X	Y
1	62.345	44.31
4	129.048	53.65
3	139.1	64.1

```
THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          33.11          K=  1   KK=  1
I=  2          .000          11.11          K=  1   KK=  2
I=  3        62.345          44.305         K=  2   KK=  2
I=  4        64.11           26.11          K=  2   KK=  3
I=  5        89.11           49.11          K=  2   KK=  4
I=  6        94.11           52.11          K=  2   KK=  5
I=  7       124.11           64.11          K=  2   KK=  6
I=  8       125.11           44.11          K=  2   KK=  7
I=  9       129.048          53.652         K=  3   KK=  7
I= 10       139.11           64.11          K=  3   KK=  7
I= 11       229.11           64.11          K=  3   KK=  8
I= 12       230.11           58.11          K=  3   KK=  9
I= 13       232.11           56.11          K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        62.345          44.305         K=  3   KK=  1
I=  2        89.11           49.11          K=  5   KK=  2
I=  3        94.11           52.11          K=  6   KK=  3
I=  4       124.11           64.11          K=  7   KK=  4
I=  5       129.048          53.652         K=  9   KK=  5
I=  6       139.11           64.11          K= 10   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                FI=    .00000    FO=    15.3250
                FI=   15.3250    FO=    30.4830
                FI=   30.4830    FO=    45.4999
                FI=   45.4999    FO=    60.5016

          THE SAFETY FACTOR FOR POINT  TIS    1.15016

TRIAL CIRCLE NO  2
CIRCLE CTR COORDS:  X=  X=       9.11     Y=      103.11
ENTRANCE PT. COORDS:  X=        39.11     Y=       64.11
     TRIAL ARC RADIUS=     61.847


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
  1          68.738          45.45
  4         128.194          53.61
  3         139.11           64.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          33.11          K=  1   KK=  1
I=  2          .000          11.11          K=  1   KK=  2
I=  3        64.11           26.11          K=  1   KK=  3
I=  4        68.738          45.453         K=  2   KK=  3
I=  5        89.11           49.11          K=  2   KK=  4
I=  6        94.11           52.11          K=  2   KK=  5
I=  7       124.11           64.11          K=  2   KK=  6
I=  8       125.11           44.11          K=  2   KK=  7
I=  9       128.194          53.615         K=  3   KK=  7
I= 10       139.11           64.11          K=  3   KK=  7
I= 11       229.11           64.11          K=  3   KK=  8
I= 12       230.11           58.11          K=  3   KK=  9
I= 13       232.11           56.11          K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        68.738          45.453         K=  4   KK=  1
I=  2        89.11           49.11          K=  5   KK=  2
```

```
I=  3          94.11          52.11          K=  6   KK=  3
I=  4         124.11          64.11          K=  7   KK=  4
I=  5         128.194         53.615         K=  9   KK=  5
I=  6         139.11          64.11          K= 10   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                    FI=   1.00000    FO=   1.15468
                    FI=   1.15468    FO=   1.17353
                    FI=   1.17353    FO=   1.17554
                    FI=   1.17554    FO=   1.17575

               THE SAFETY FACTOR FOR POINT  2IS    1.17575

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:   X=   X=        88.11    Y=       106.11
ENTRANCE PT. COORDS:   X=           39.11    Y=        64.11
     TRIAL ARC RADIUS=     66.068


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1              63.995         44.60
  4             128.227         53.62
  3             139.11          64.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000           33.11          K=  1   KK=  1
I=  2            .000           11.11          K=  1   KK=  2
I=  3          63.995           44.60          K=  2   KK=  2
I=  4          54.11            26.11          K=  2   KK=  3
I=  5          89.11            49.11          K=  2   KK=  4
I=  6          94.11            52.11          K=  2   KK=  5
I=  7         124.11            64.11          K=  2   KK=  6
I=  8         125.11            44.11          K=  2   KK=  7
I=  9         128.227           53.616         K=  3   KK=  7
I= 10         139.11            64.11          K=  3   KK=  7
I= 11         229.11            64.11          K=  3   KK=  8
I= 12         230.11            58.11          K=  3   KK=  9
I= 13         232.11            56.11          K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1          63.995           44.60          K=  3   KK=  1
I=  2          89.11            49.11          K=  5   KK=  2
I=  3          94.11            52.11          K=  6   KK=  3
I=  4         124.11            64.11          K=  7   KK=  4
I=  5         128.227           53.616         K=  9   KK=  5
I=  6         139.11            64.11          K= 10   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                    FI=   1.00000    FO=   1.4.43
                    FI=   1.4.43     FO=   1.5831
                    FI=   1.5831     FO=   1.6010
                    FI=   1.6010     FO=   1.6029

               THE SAFETY FACTOR FOR POINT  3IS    1.16029

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:   X=   X=         9.11    Y=       106.11
ENTRANCE PT. COORDS:   X=           39.11    Y=        64.11
     TRIAL ARC RADIUS=     63.781
```

```
XXX LINE   2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

***LINE   2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO            X                Y
  1.            70.467           45.763
  4.           127.276           53.574
  3.           139.111           64.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000            33.111   K=  1   KK=  1
I=  2            .000            11.111   K=  1   KK=  2
I=  3          64.111            26.111   K=  1   KK=  3
I=  4          70.467            45.763   K=  2   KK=  3
I=  5          89.111            49.111   K=  2   KK=  4
I=  6          94.111            52.111   K=  2   KK=  5
I=  7         124.111            64.111   K=  2   KK=  6
I=  8         125.111            44.111   K=  2   KK=  7
I=  9         127.276            53.574   K=  3   KK=  7
I= 10         139.111            64.111   K=  3   KK=  7
I= 11         229.111            64.111   K=  3   KK=  8
I= 12         230.111            58.111   K=  3   KK=  9
I= 13         232.111            56.111   K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1          70.467            45.763   K=  4   KK=  1
I=  2          89.111            49.111   K=  5   KK=  2
I=  3          94.111            52.111   K=  6   KK=  3
I=  4         124.111            64.111   K=  7   KK=  4
I=  5         127.276            53.574   K=  9   KK=  5
I=  6         139.111            64.111   K= 10   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                  FI=   1.00000    FO=    1.7563
                  FI=   1.17563    FO=    1.9711
                  FI=   1.19711    FO=    1.9937
                  FI=   1.19937    FO=    1.9961

                THE SAFETY FACTOR FOR POINT  4IS    1.1996
@BRKPT PRINTS
```

After dredging of 8m. of Bottom Sludge.

The results taken from the computer for cross-section (8-8)B are:

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	IOI	IIO	I43	64	I.46
b	97	I03	I33	64	2.0I
c	I07	IOI	I39	64	3.35
d	93	I08	I36	64	I.33
e	I09	I08	I52	64	I.46
f	86	III	I33	64	I.24
g	88	I03	I39	64	I.0I

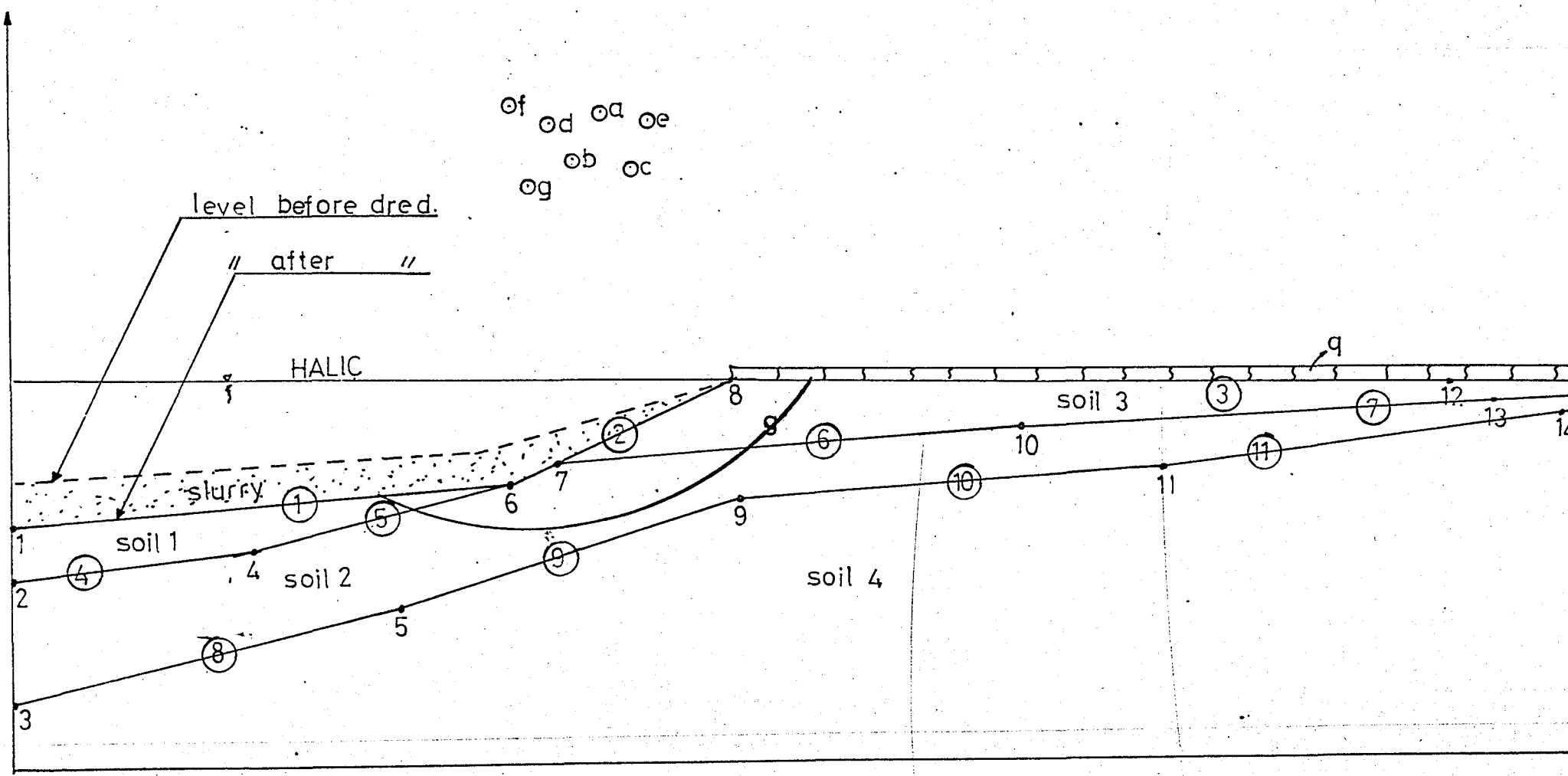

Fig : (8-8) B Dredging of 8m. of Bottom Sludge

E STABILITY FOR TASKIZAK(II)EXCAVA(2) MAHIR KOSELER THESIS

F LINES 11 NO OF LINE INTERSECT= 14

F SOILS= 4 NO OF EXTERNAL SOIL LINES= 3

F X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 20

LINE END COORD MATRIX

NO	NO	INT	X1	Y1	X2	Y2	SLOPE	LINE	INTER
2			0	42	89	48	.673378-001	1	6
3			89	48	124	64	.457143	6	7
2			124	64	229	64	.000000	8	12
2			0	33	36	36	.830772-001	2	4
2			36	36	89	48	.226415	4	6
2			96	54	148	58	.576923-001	7	10
2			148	58	230	64	.487805-001	10	13
2			0	26	64	44	.233969	3	5
2			64	44	125	49	.295082	5	9
2			125	49	199	64	.675676-001	9	11
2			199	49	232	56	.212121	11	14

INTERSECT ARRAY

O	X	Y
	0	42
	0	33
	0	36
	36	36
	64	26
	89	48
	96	54
	124	64
	125	44
	148	54
	199	49
	229	64
	230	58
	232	56

DATA ARRAY

NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
	1	1	6	0	115	12.0	0
	2	6	6	0	115	12.0	0
	4	2	4	0	115	12.0	0
	5	4	6	0	115	12.0	0
	2	6	6	0	118	12.0	0
	4	2	4	0	118	12.0	0
	5	4	6	0	118	12.0	0
	6	7	7	0	118	12.0	0
	7	10	10	0	118	12.0	0
	8	3	3	0	118	12.0	0
	9	5	5	0	118	12.0	0
	10	9	9	0	118	12.0	0
	11	11	11	0	118	12.0	0
	2	7	7	0	118	20.0	196
	3	8	8	0	118	20.0	196
	6	7	7	0	118	20.0	196
	7	10	10	0	118	20.0	196
	8	3	3	0	137	45.0	686
	9	5	5	0	137	45.0	686
	10	9	9	0	137	45.0	686
	11	11	11	0	137	45.0	686

AL CIRCLE NO 1
CLE CTR COORDS: X= X= 88.11 Y= 103.1
RANCE PT. COORDS: X= 139.1 Y= 64.11
TRIAL ARC RADIUS= 64.203

LINE 2NOT INTERSECTED BY TRIAL CIRCL

LINE 4NOT INTERSECTED BY TRIAL CIRCL

```
XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
INE NO          X               Y
  1          58.661          46.806
  5          65.928          42.86
  6         128.200          52.96
  3         139.111          64.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          42.11   K=  1   KK=  1
I=  2          .000          33.11   K=  1   KK=  2
I=  3          .000          11.11   K=  1   KK=  3
I=  4        36.111          36.11   K=  1   KK=  4
I=  5        58.661          46.806  K=  2   KK=  4
I=  6        64.111          26.11   K=  2   KK=  5
I=  7        65.928          42.862  K=  3   KK=  5
I=  8        89.111          48.11   K=  3   KK=  6
I=  9        96.111           5.11   K=  3   KK=  7
I= 10       124.111          64.11   K=  3   KK=  8
I= 11       125.111          44.11   K=  3   KK=  9
I= 12       128.200          52.962  K=  4   KK=  9
I= 13       139.111          64.11   K=  4   KK=  9
I= 14       148.111          54.11   K=  4   KK= 10
I= 15       199.111          49.11   K=  4   KK= 11
I= 16       229.111          64.11   K=  4   KK= 12
I= 17       230.111          58.11   K=  4   KK= 13
I= 18       232.111          56.11   K=  4   KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        58.661          46.806  K=  5   KK=  1
I=  2        65.928          42.862  K=  7   KK=  2
I=  3        89.111          48.11   K=  8   KK=  3
I=  4        96.111           5.11   K=  9   KK=  4
I=  5       124.111          64.11   K= 10   KK=  5
I=  6       128.200          52.962  K= 12   KK=  6
I=  7       139.111          64.11   K= 13   KK=  7

FIND SLICE WIDTH AND NO OF SLICES
                FI=    1.00000   FO=     .01086
                FI=     .01086   FO=     .01225
                FI=     .01225   FO=     .01243

          THE SAFETY FACTOR FOR POINT  1IS    1.01243

TRIAL CIRCLE NO  2
CIRCLE CTR COORDS:  X=  X=       9.111  Y=      .03111
ENTRANCE PT. COORDS:  X=       139.111  Y=      64.111
     TRIAL ARC RADIUS=.    67.847

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL
```

```
XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1          66.072         46.56
  5          72.099         44.26
  6         127.229         52.91
  3         139.11          64.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          42.11    K=  1   KK=  1
I=  2          .000          33.11    K=  1   KK=  2
I=  3          .000          1.11     K=  1   KK=  3
I=  4        36.111          36.11    K=  1   KK=  4
I=  5        64.111          26.11    K=  1   KK=  5
I=  6        66.072          46.560   K=  2   KK=  5
I=  7        72.099          44.259   K=  3   KK=  5
I=  8        89.11           48.11    K=  3   KK=  6
I=  9        96.111          5.11     K=  3   KK=  7
I= 10       124.111          64.11    K=  3   KK=  8
I= 11       125.111          44.11    K=  3   KK=  9
I= 12       127.229          52.906   K=  4   KK=  9
I= 13       139.11           64.11    K=  4   KK=  9
I= 14       148.111          54.11    K=  4   KK= 10
I= 15       199.111          49.11    K=  4   KK= 11
I= 16       229.111          64.11    K=  4   KK= 12
I= 17       230.111          58.11    K=  4   KK= 13
I= 18       232.111          56.11    K=  4   KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        66.072          46.560   K=  6   KK=  1
I=  2        72.099          44.259   K=  7   KK=  2
I=  3        89.11           48.11    K=  8   KK=  3
I=  4        96.111          5.11     K=  9   KK=  4
I=  5       124.111          64.11    K= 10   KK=  5
I=  6       127.229          52.906   K= 12   KK=  6
I=  7       139.11           64.11    K= 13   KK=  7

FIND SLICE WIDTH AND NO. OF SLICES
                FI=   1.00000    FO=   1.03397
                FI=   1.03397    FO=   1.03851
                FI=   1.03851    FO=   1.03910
          THE SAFETY FACTOR FOR POINT  2IS    1.03910

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:  X=  X=       88.11    Y=      106.11
ENTRANCE PT. COORDS:  X=         39.11    Y=       64.11
     TRIAL ARC RADIUS=    66.068


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL
```

```
XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 11NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1          60.319         46.172
  5          67.721         43.268
  6         127.285         52.910
  3         139.111         64.011

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         42.111   K=  1   KK=  1
I=  2          .000         33.111   K=  1   KK=  2
I=  3          .000         11.111   K=  1   KK=  3
I=  4        36.111         36.111   K=  1   KK=  4
I=  5        60.319         46.172   K=  2   KK=  4
I=  6        64.111         26.111   K=  2   KK=  5
I=  7        67.721         43.268   K=  3   KK=  5
I=  8        89.111         48.111   K=  3   KK=  6
I=  9        96.111         51.111   K=  3   KK=  7
I= 10       124.111         64.111   K=  3   KK=  8
I= 11       125.111         44.111   K=  3   KK=  9
I= 12       127.285         52.910   K=  4   KK=  9
I= 13       139.111         64.111   K=  4   KK=  9
I= 14       148.111         54.111   K=  4   KK= 10
I= 15       199.111         49.111   K=  4   KK= 11
I= 16       229.111         64.111   K=  4   KK= 12
I= 17       230.111         58.111   K=  4   KK= 13
I= 18       232.111         56.111   K=  4   KK= 14

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        60.319         46.172   K=  5   KK=  1
I=  2        67.721         43.268   K=  7   KK=  2
I=  3        89.111         48.111   K=  8   KK=  3
I=  4        96.111         51.111   K=  9   KK=  4
I=  5       124.111         64.111   K= 10   KK=  5
I=  6       127.285         52.910   K= 12   KK=  6
I=  7       139.111         64.111   K= 13   KK=  7

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000   FO=   1.02236
                FI=   1.02236   FO=   1.02525
                FI=   1.02525   FO=   1.02561

          THE SAFETY FACTOR FOR POINT  3IS    1.0256I

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=      91.111   Y=      106.111
ENTRANCE PT. COORDS:  X=        139.111  Y=       64.111
     TRIAL ARC RADIUS=    63.781

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL
```

```
XXX LINE 1 NOT INTERSECTED BY TRIAL CIRCL

***LINE  2 IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO              X                Y
   1              67.945           46.769
   5              73.958           44.768
   6             126.195           52.785
   3             139.111           64.111

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1              .000           42.111   K=  1   KK=  1
I=  2              .000           33.111   K=  1   KK=  2
I=  3              .000           [illegible]   K=  1   KK=  3
I=  4            36.111           36.111   K=  1   KK=  4
I=  5            64.111           26.111   K=  1   KK=  5
I=  6            67.945           46.686   K=  2   KK=  5
I=  7            73.958           44.680   K=  3   KK=  5
I=  8            89.111           48.111   K=  3   KK=  6
I=  9            96.111           5[illegible].111   K=  3   KK=  7
I=  10          124.111           64.111   K=  3   KK=  8
I=  11          125.111           44.111   K=  3   KK=  9
I=  12          126.195           52.847   K=  4   KK=  9
I=  13          139.111           64.111   K=  4   KK=  9
I=  14          148.111           54.111   K=  4   KK=  10
I=  15          199.111           49.111   K=  4   KK=  11
I=  16          229.111           64.111   K=  4   KK=  12
I=  17          230.111           58.111   K=  4   KK=  13
I=  18          232.111           56.111   K=  4   KK=  14

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1            67.945           46.686   K=  6   KK=  1
I=  2            73.958           44.680   K=  7   KK=  2
I=  3            89.111           48.111   K=  8   KK=  3
I=  4            96.111           5[illegible].111   K=  9   KK=  4
I=  5           124.111           64.111   K=  10   KK=  5
I=  6           126.195           52.847   K=  12   KK=  6
I=  7           139.111           64.111   K=  13   KK=  7

 FIND SLICE WIDTH AND NO OF SLICES
                FI=    1.00000    FO=    1.05852
                FI=    1.05852    FO=    1.06642
                FI=    1.06642    FO=    1.06744
                FI=    1.06744    FO=    1.06757

                THE SAFETY FACTOR FOR POINT  4 IS    1.06757
BRKPT PRINT$
```

After Dredging of 9m. of Bottom Sludge:

The results taken from the computer for cross-section (IO-IO) A are:

Circle NO	Circle Center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	II7	III	I4I	90	I.0I
b	I25	II6	I56	90	I.4I
c	III	II7	I49	90	I.33
d	II9	I0I	I68	90	2.58
e	II9	I30	I82	90	2.33
f	II6	I43	I87	90	2.44
g	I08	I29	I6I	90	I.82
h	I04	I52	I84	90	2.68
k	II9	I23	I45	90	I.35
l	II4	I20	I47	90	I.I7

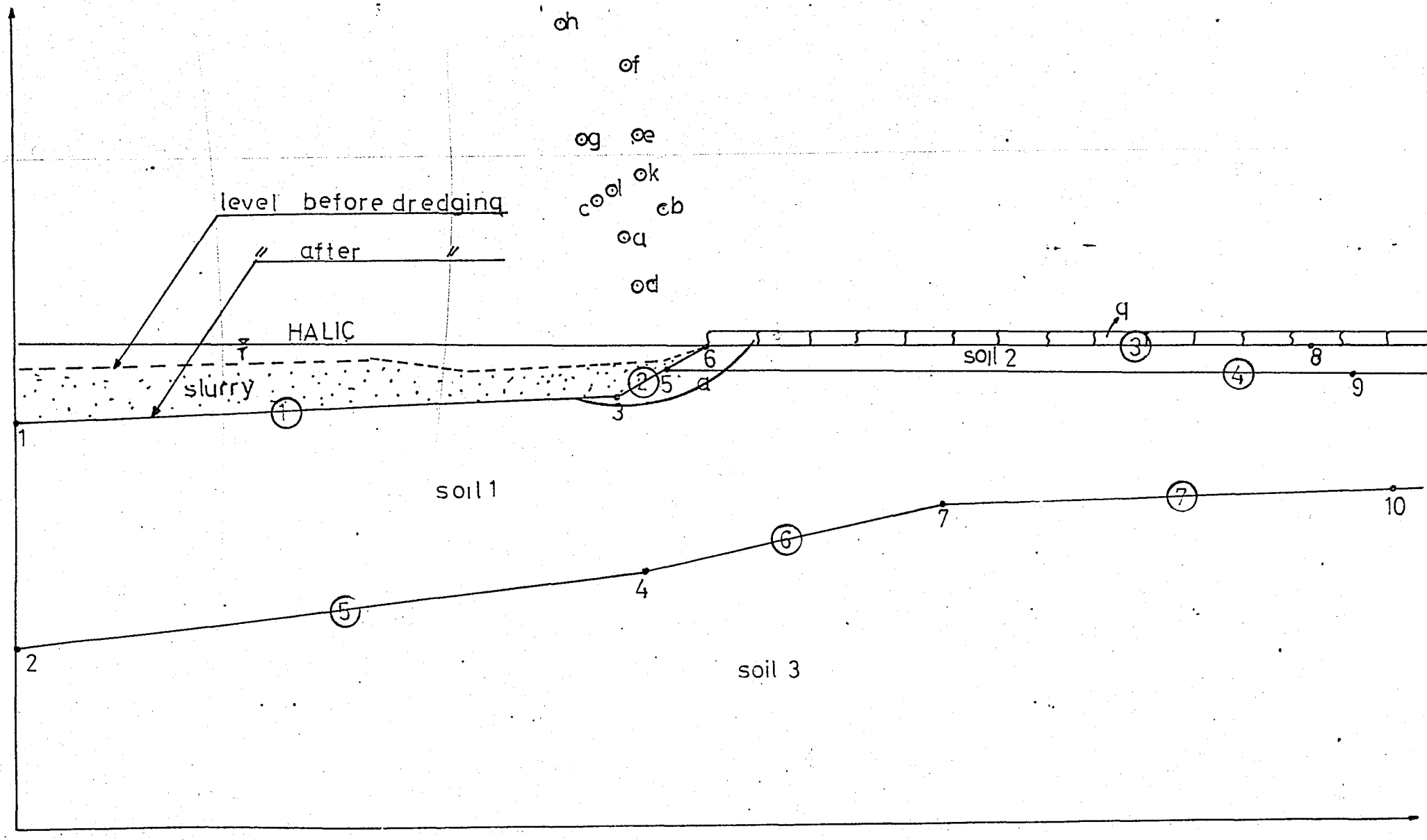

Fig (10-10)B After Dredging

OF LINES 7 NO OF LINE INTERSECT= 10

OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

OF X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 2.0

LINE END COORD MATRIX

NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTER	
	2	.00	78.	1.	80.	.180000E+01	1	3
	3	11.	80.	132.	90.	.476190	3	5
	2	132.	90.	229.	90.	.000000	6	8
	2	125.	87.	230.	83.	-.380952E+01	5	9
	2	.00	35.	120.	47.	.999076E+01	2	4
	2	120.	47.	175.	59.	.248182	4	7
	2	175.	59.	232.	60.	.175439E+01	7	10

E INTERSECT ARRAY

NO	X	Y
1	.00	78.
2	.00	35.
3	11.	80.
4	120.	47.
5	125.	87.
6	132.	90.
7	175.	59.
8	229.	90.
9	230.	83.
0	232.	60.

L DATA ARRAY

NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
	2	3	5	0.	7.8	12.0	0.
	4	5	9	0.	7.8	12.0	0.
	5	2	4	0.	7.8	12.0	0.
	6	7	7	0.	7.8	12.0	0.
	7	5	6	0.	7.8	12.0	0.
	2	3	8	0.	7.8	20.0	19.6
	3	5	9	0.	7.8	20.0	19.6
	4	5	7	0.	7.8	20.0	19.6
	5	2	4	0.	13.7	45.0	68.6
	6	4	7	0.	13.7	45.0	68.6
	7	7	10	0.	13.7	45.0	68.6

AL CIRCLE NO 1

CLE CTR COORDS: X= X= 111.1 Y= 117.1

RANCE PT. COORDS: X= 149.1 Y= 90.1

TRIAL ARC RADIUS= 46.615

LINE 2NOT INTERSECTED BY TRIAL CIRCL

LINE 5NOT INTERSECTED BY TRIAL CIRCL

LINE 6NOT INTERSECTED BY TRIAL CIRCL

LINE 7NOT INTERSECTED BY TRIAL CIRCL

LINE 2IS NOT INTERSECTED BUT IS IN ARC

INTERSECT WITH LINE ARRAY

NO	X	Y
	83.48	79.61
	146.103	86.31
	149.111	90.01

```
I=  2          .000          35.111     K=  1    KK=  2
I=  3        83.418          79.613     K=  2    KK=  2
I=  4       111.111          80.111     K=  2    KK=  3
I=  5       120.111          47.111     K=  2    KK=  4
I=  6       125.111          87.111     K=  2    KK=  5
I=  7       132.111          90.111     K=  2    KK=  6
I=  8       146.103          86.311     K=  3    KK=  6
I=  9       149.111          90.111     K=  3    KK=  6
I= 10       175.111          59.111     K=  3    KK=  7
I= 11       229.111          90.111     K=  3    KK=  8
I= 12       230.111          83.111     K=  3    KK=  9
I= 13       232.111          60.111     K=  3    KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        83.418          79.613     K=  3    KK=  1
I=  2       111.111          80.111     K=  4    KK=  2
I=  3       125.111          87.111     K=  6    KK=  3
I=  4       132.111          90.111     K=  7    KK=  4
I=  5       146.103          86.311     K=  8    KK=  5
I=  6       149.111          90.111     K=  9    KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                 FI=   1.00000    FO=    1.30020
                 FI=   1.30020    FO=    1.33068
                 FI=   1.33068    FO=    1.33311
                 FI=   1.33311    FO=    1.33330

          THE SAFETY FACTOR FOR POINT  1IS   1.33330

TRIAL CIRCLE NO  2
CIRCLE CTR COORDS:  X=  X=      147.11   Y=     177.11
ENTRANCE PT. COORDS:  X=        149.11   Y=      90.11
     TRIAL ARC RADIUS=     44.204


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
  1            90.513          79.74
  4           145.828          86.32
  3           149.111          90.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          78.111     K=  1    KK=  1
I=  2          .000          35.111     K=  1    KK=  2
I=  3        90.513          79.740     K=  2    KK=  2
I=  4       111.111          80.111     K=  2    KK=  3
I=  5       120.111          47.111     K=  2    KK=  4
I=  6       125.111          87.111     K=  2    KK=  5
I=  7       132.111          90.111     K=  2    KK=  6
I=  8       145.828          86.322     K=  3    KK=  6
I=  9       149.111          90.111     K=  3    KK=  6
I= 10       175.111          59.111     K=  3    KK=  7
I= 11       229.111          90.111     K=  3    KK=  8
I= 12       230.111          83.111     K=  3    KK=  9
I= 13       232.111          60.111     K=  3    KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        90.513          79.740     K=  3    KK=  1
I=  2       111.111          80.111     K=  4    KK=  2
```

```
I=  5          145.828          86.322          K=  8   KK=  5
I=  6          149.11           90.11           K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                    FI=    1.00000    FO=    1.18386
                    FI=    1.18386    FO=    1.20262
                    FI=    1.20262    FO=    1.20427
                    FI=    1.20427    FO=    1.2044

                THE SAFETY FACTOR FOR POINT  2IS    1.20441

 TRIAL CIRCLE NO  3
 CIRCLE CTR COORDS:   X=   X=        111.11    Y=       120.11
 ENTRANCE PT. COORDS:   X=           149.11    Y=        90.11
       TRIAL ARC RADIUS=     48.495


 XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 ***LINE  2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO              X               Y
  1                84.551          79.163
  4               145.787          86.32
  3               149.11           90.11

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1                .000           78.11           K=  1   KK=  1
I=  2                .000           35.11           K=  1   KK=  2
I=  3              84.55            79.633          K=  2   KK=  2
I=  4             111.11            80.11           K=  2   KK=  3
I=  5             120.11            47.11           K=  2   KK=  4
I=  6             125.11            87.11           K=  2   KK=  5
I=  7             132.11            90.11           K=  2   KK=  6
I=  8             145.787           86.323          K=  3   KK=  6
I=  9             149.11            90.11           K=  3   KK=  6
I= 10             175.11            59.11           K=  3   KK=  7
I= 11             229.11            90.11           K=  3   KK=  8
I= 12             230.11            83.11           K=  3   KK=  9
I= 13             232.11            60.11           K=  3   KK=  0

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1              84.55            79.633          K=  3   KK=  1
I=  2             111.11            80.11           K=  4   KK=  2
I=  3             125.11            87.11           K=  6   KK=  3
I=  4             132.11            90.11           K=  7   KK=  4
I=  5             145.787           86.323          K=  8   KK=  5
I=  6             149.11            90.11           K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                    FI=    1.00000    FO=    1.25794
                    FI=    1.25794    FO=    1.28340
                    FI=    1.28340    FO=    1.28544
                    FI=    1.28544    FO=    1.28560

                THE SAFETY FACTOR FOR POINT  3IS    1.28560

 TRIAL CIRCLE NO  4
 CIRCLE CTR COORDS:   X=   X=        114.11    Y=       120.11
 ENTRANCE PT. COORDS:   X=           149.11    Y=        90.11
       TRIAL ARC RADIUS=     46.098
```

```
 XXX LINE   2NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE   5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE   6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

 ***LINE   2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
 LINE NO              X                Y
    1                91.830           79.776
    4               145.481           86.335
    3               149.1             90.1

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
 I=  1                .000            78.1      K=  1   KK=  1
 I=  2                .000            35.1      K=  1   KK=  2
 I=  3              91.830            79.764    K=  2   KK=  2
 I=  4             111.1              80.1      K=  2   KK=  3
 I=  5             120.1              47.1      K=  2   KK=  4
 I=  6             125.1              87.1      K=  2   KK=  5
 I=  7             132.1              90.1      K=  2   KK=  6
 I=  8             145.481            86.335    K=  3   KK=  6
 I=  9             149.1              90.1      K=  3   KK=  6
 I= 10             175.1              59.1      K=  3   KK=  7
 I= 11             229.1              90.1      K=  3   KK=  8
 I= 12             230.1              83.1      K=  3   KK=  9
 I= 13             232.1              60.1      K=  3   KK=  0

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
 I=  1              9.830            79.764    K=  3   KK=  1
 I=  2             11.1              80.1      K=  4   KK=  2
 I=  3             25.1              87.1      K=  6   KK=  3
 I=  4             32.1              90.1      K=  7   KK=  4
 I=  5             45.481            86.335    K=  8   KK=  5
 I=  6             49.1              90.1      K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                   FI=    1.00000    FO=    1.15570
                   FI=    1.15570    FO=    1.17126
                   FI=    1.17126    FO=    1.17263
                   FI=    1.17263    FO=    1.17274

                 THE SAFETY FACTOR FOR POINT  4IS    1.17274
 PROGRAM EXECUTION

4567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234
```

After Dredging of Bottom Sludge:

The results taken from the computer for cross-section (IO-IO)B are:

Circle NO	Circle center Coordinates		Entrance Points		FACTOR OF SAFETY
	X	Y	X	Y	
a	I23	II3	I47	9I	I.28
b	I29	II2	I49	9I	2.0I
c	I25	I23	I58	9I	I.32
d	II6	I28	I57	9I	I.46
e	I2I	I37	I65	9I	I.52
f	I07	I52	I69	9I	2.I9
g	I09	I39	I8I	9I	2.93
h	II4	II5	I60	9I	I.I9

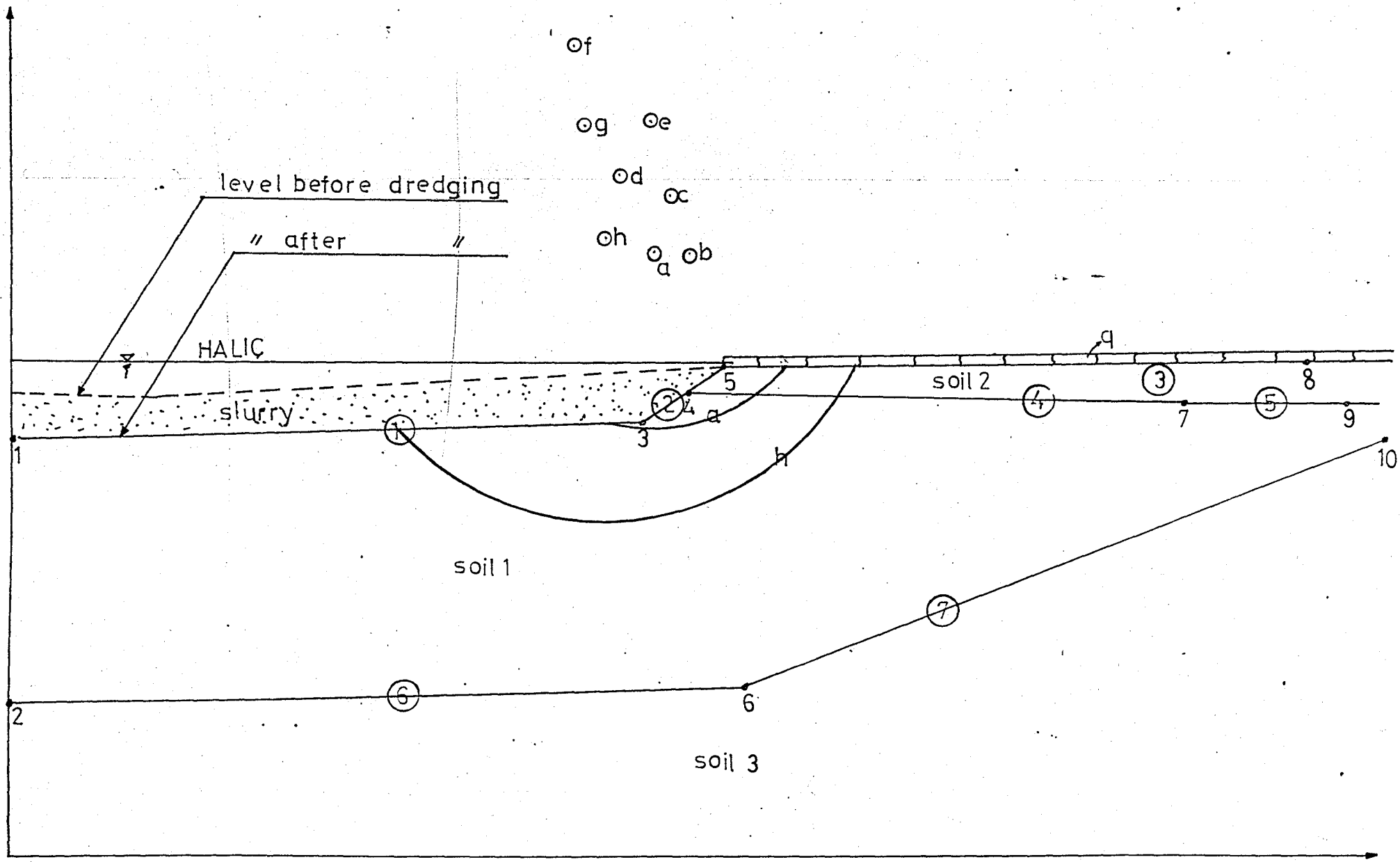

Fig (10-10)B After Dredging

OF LINES 7 NO OF LINE INTERSECT= 10

OF SOILS= 3 NO. OF EXTERNAL SOIL LINES= 3

OF X INCREMENTS= 3 NO OF Y INCREMENTS= 3

IN ITIAL SLICE WIDTH= 20

E LINE END COORD MATRIX

NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTE
1	2	0	81	118	81	.000000	1
2	3	118	81	136	91	.555556	5
3	2	136	91	233	91	.000000	5
4	2	128	86	214	83	.348837E-001	4
5	2	214	83	236	83	.000000	7
6	2	0	31	138	31	.000000	2
7	2	138	31	240	73	.411765	6

NE INTERSECT ARRAY

NO	X	Y
1	0	81
2	0	31
3	118	81
4	128	86
5	136	91
6	138	31
7	214	83
8	233	91
9	236	83
10	240	73

IL DATA ARRAY

L NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
1	1	0	3	0	78	12.0	0
2	2	3	4	0	78	12.0	0
3	4	4	7	0	78	12.0	0
4	5	7	9	0	78	12.0	0
5	6	2	6	0	78	12.0	0
6	7	6	5	0	78	12.0	0
2	2	3	5	0	78	20.0	196
2	3	5	8	0	78	20.0	196
2	4	8	7	0	78	20.0	196
2	5	7	9	0	78	20.0	196
3	6	2	6	0	137	45.0	68.6
3	7	6	0	0	137	45.0	68.6

RIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 114.1 Y= 115.1

NTRANCE PT. COORDS: X= 160.1 Y= 91.11

TRIAL ARC RADIUS= 51.884

XX LINE 2NOT INTERSECTED BY TRIAL CIRCL

XX LINE 5NOT INTERSECTED BY TRIAL CIRCL

XX LINE 6NOT INTERSECTED BY TRIAL CIRCL

XX LINE 7NOT INTERSECTED BY TRIAL CIRCL

**LINE 2IS NOT INTERSECTED BUT IS IN ARC

RC INTERSECT WITH LINE ARRAY

NE NO	X	Y
1	74.919	81.11
2	156.452	85.2
3	160.111	91.11

```
I=  2          .000          3          1    K=  1   KK=  2
I=  3        74.919          8          1    K=  2   KK=  2
I=  4       118.111          8          1    K=  2   KK=  3
I=  5       128.111          8          6    K=  2   KK=  4
I=  6       136.111          9          1    K=  2   KK=  5
I=  7       138.111          3          1    K=  2   KK=  6
I=  8       156.452          8          5    K=  3   KK=  6
I=  9       160.111          9          1    K=  3   KK=  6
I= 10       214.111          8          3    K=  3   KK=  7
I= 11       233.111          9          1    K=  3   KK=  8
I= 12       236.111          8          3    K=  3   KK=  9
I= 13       240.111          7          3    K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        74.919          8          1    K=  3   KK=  1
I=  2       118.111          8          1    K=  4   KK=  2
I=  3       128.111          8          6    K=  5   KK=  3
I=  4       136.111          9          1    K=  6   KK=  4
I=  5       156.452          8          5    K=  8   KK=  5
I=  6       160.111          9          1    K=  9   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=   1.88463
                FI=   1.88463    FO=   1.98694
                FI=   1.98694    FO=   1.99360
                FI=   1.99360    FO=   1.99401

            THE SAFETY FACTOR FOR POINT  1IS    1.9940I

TRIAL CIRCLE NO  2
CIRCLE CTR COORDS:   X=   X=      118.11   Y=      156.11
ENTRANCE PT. COORDS:  X=          160.11   Y=       91.111
      TRIAL ARC RADIUS=     48.374

XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1          83.702          8.111
  4         156.077         85.774
  3         160.111          9.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          8          1    K=  1   KK=  1
I=  2          .000          3          1    K=  1   KK=  2
I=  3        83.702          8          1    K=  2   KK=  2
I=  4       118.111          8          1    K=  2   KK=  3
I=  5       128.111          8          6    K=  2   KK=  4
I=  6       136.111          9          1    K=  2   KK=  5
I=  7       138.111          3          1    K=  2   KK=  6
I=  8       156.077         85.35       K=  3   KK=  6
I=  9       160.111          9          1    K=  3   KK=  6
I= 10       214.111          8          3    K=  3   KK=  7
I= 11       233.111          9          1    K=  3   KK=  8
I= 12       236.111          8          3    K=  3   KK=  9
I= 13       240.111          7          3    K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        83.702          8          1    K=  3   KK=  1
I=  2       118.111          8          1    K=  4   KK=  2
```

```
I=  5        156.077          85.435    K=  8   KK=  5
I=  6        160.111          91.711    K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=    1.63872
                FI=   1.63872    FO=    1.77216
                FI=   1.77216    FO=    1.77757
                FI=   1.77757    FO=    1.77795

          THE SAFETY FACTOR FOR POINT  2IS    1.77795

 TRIAL CIRCLE NO  3
 CIRCLE CTR COORDS:   X=   X=      122.11    Y=      115.11
 ENTRANCE PT. COORDS:   X=         160.11    Y=      91.711
      TRIAL ARC RADIUS=     44.944


 XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 ***LINE  2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1           92.717          81.711
  4           155.615         85.252
  3           160.111         91.711

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1            .000          81.711    K=  1   KK=  1
I=  2            .000          31.711    K=  1   KK=  2
I=  3         92.717           81.711    K=  2   KK=  2
I=  4        118.111           81.711    K=  2   KK=  3
I=  5        128.111           86.711    K=  2   KK=  4
I=  6        136.111           91.711    K=  2   KK=  5
I=  7        138.111           31.711    K=  2   KK=  6
I=  8        155.615           85.252    K=  3   KK=  6
I=  9        160.111           91.711    K=  3   KK=  6
I= 10        214.111           83.711    K=  3   KK=  7
I= 11        233.111           91.711    K=  3   KK=  8
I= 12        236.111           83.711    K=  3   KK=  9
I= 13        240.111           73.711    K=  3   KK= 10

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1         92.717           81.711    K=  3   KK=  1
I=  2        118.111           81.711    K=  4   KK=  2
I=  3        128.111           86.711    K=  5   KK=  3
I=  4        136.111           91.711    K=  6   KK=  4
I=  5        155.615           85.252    K=  8   KK=  5
I=  6        160.111           91.711    K=  9   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=    1.44986
                FI=   1.44986    FO=    1.50142
                FI=   1.50142    FO=    1.50566
                FI=   1.50566    FO=    1.50599

          THE SAFETY FACTOR FOR POINT  3IS    1.50599

 TRIAL CIRCLE NO  4
 CIRCLE CTR COORDS:   X=   X=      143.11    Y=      119.11
 ENTRANCE PT. COORDS:   X=         160.11    Y=      91.711
      TRIAL ARC RADIUS=     53.852
```

```
XXX LINE   2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

***LINE   2IS NOT INTERSECTED BUT IS IN ARC

 ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
  1           75.953         81.111
  4          155.897         85.114
  3          160.111         91.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         81.111   K=  1   KK=  1
I=  2          .000         31.111   K=  1   KK=  2
I=  3        75.953         81.111   K=  2   KK=  2
I=  4       118.111         81.111   K=  2   KK=  3
I=  5       128.111         86.111   K=  2   KK=  4
I=  6       136.111         91.111   K=  2   KK=  5
I=  7       138.111         31.111   K=  2   KK=  6
I=  8       155.897         85.042   K=  3   KK=  6
I=  9       160.111         91.111   K=  3   KK=  6
I= 10       214.111         83.111   K=  3   KK=  7
I= 11       233.111         91.111   K=  3   KK=  8
I= 12       236.111         85.111   K=  3   KK=  9
I= 13       240.111         73.111   K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        75.953         81.111   K=  3   KK=  1
I=  2       118.111         81.111   K=  4   KK=  2
I=  3       128.111         86.111   K=  5   KK=  3
I=  4       136.111         91.111   K=  6   KK=  4
I=  5       155.897         85.042   K=  8   KK=  5
I=  6       160.111         91.111   K=  9   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=   1.78490
                FI=   1.78490    FO=   1.87092
                FI=   1.87092    FO=   1.87647
                FI=   1.87647    FO=   1.87681

          THE SAFETY FACTOR FOR POINT  4IS    1.87681

TRIAL CIRCLE NO  5
CIRCLE CTR COORDS:   X=   X=      118.111   Y=    119.111
ENTRANCE PT. COORDS:   X=         160.111   Y=     91.111
      TRIAL ARC RADIUS=     50.478


XXX LINE   2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

***LINE   2IS NOT INTERSECTED BUT IS IN ARC
```

```
 1        84.885           8[illegible]
 4        155.462          85[illegible]6
 3        160.[illegible]          9[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000        8[illegible]      K=  1   KK=  1
I=  2          .000        3[illegible]      K=  1   KK=  2
I=  3        84.885        8[illegible]      K=  2   KK=  2
I=  4       118.[illegible]        8[illegible]      K=  2   KK=  3
I=  5       128.[illegible]        86[illegible]     K=  2   KK=  4
I=  6       136.[illegible]        9[illegible]      K=  2   KK=  5
I=  7       138.[illegible]        3[illegible]      K=  2   KK=  6
I=  8       155.462        85.[illegible]57   K=  3   KK=  6
I=  9       160.[illegible]        9[illegible]      K=  3   KK=  6
I= 10       214.[illegible]        83[illegible]     K=  3   KK=  7
I= 11       233.[illegible]        9[illegible]      K=  3   KK=  8
I= 12       236.[illegible]        83[illegible]     K=  3   KK=  9
I= 13       240.[illegible]        73.[illegible]    K=  3   KK= 10

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        84.885        8[illegible]      K=  3   KK=  1
I=  2       118.[illegible]        8[illegible]      K=  4   KK=  2
I=  3       128.[illegible]        86[illegible]     K=  5   KK=  3
I=  4       136.[illegible]        9[illegible]      K=  6   KK=  4
I=  5       155.462        85.[illegible]57   K=  8   KK=  5
I=  6       160.[illegible]        91.[illegible]    K=  9   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
                    FI=   1.00000    FO=   1.55968
                    FI=   1.55968    FO=   1.6209
                    FI=   1.6209     FO=   1.62537
                    FI=   1.62537    FO=   1.62569

            THE SAFETY FACTOR FOR POINT  5IS    1.62569

TRIAL CIRCLE NO  6
CIRCLE CTR COORDS:  X=  X=      22[illegible]    Y=    19[illegible]
ENTRANCE PT. COORDS:  X=        160.[illegible]    Y=    9[illegible]
      TRIAL ARC RADIUS=   47.202


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO            X                Y
 1        94.[illegible]           8[illegible]1
 4        154.922          85.[illegible]8
 3        160.[illegible]          9[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000        8[illegible]      K=  1   KK=  1
I=  2          .000        3[illegible]      K=  1   KK=  2
I=  3        94.[illegible]        8[illegible]      K=  2   KK=  2
I=  4       118.[illegible]        8[illegible]      K=  2   KK=  3
I=  5       128.[illegible]        86[illegible]     K=  2   KK=  4
I=  6       136.[illegible]        9[illegible]      K=  2   KK=  5
I=  7       139.[illegible]        3[illegible]      K=  2   KK=  6
I=  8       154.922        85.[illegible]76   K=  3   KK=  6
I=  9       160.[illegible]        9[illegible]      K=  3   KK=  6
I= 10       214.[illegible]        83[illegible]     K=  3   KK=  7
I= 11       233.[illegible]        9[illegible]      K=  3   KK=  8
```

5.2 CONCLUSIONS AND RECOMMENDATIONS

The summary of the geological and geotechnical evaluations may be stated as follows:

I. The main formations in the vicinity of Haliç are Paleozoic graywacke, clayey shist and limestone. Surfaces of these fissured and folded formations are decomposed and their compressive strength and unit weight increase with depth.

2. The tertiary formations of sands and gravels are not common in the area. The sand and clay formations, which are cross-bedded and not cemented, are erosed and transported easily.

3. The quarternary clay formations are very common in the whole vicinity of Haliç and an artificial fill is encountered above sedimentary layer and fill are not uniform.

4. the erosed materials from all formations are transported to Haliç. These erosed materials are mostly decomposed graywacke and shales and consist of fine quarst sands, silts, clays, muscovite particles and organic materials?

5. The origin of the geotechnical problems in the vicinity of Haliç is soft sedimentary layer (usually contains soft silty clay) over the graywacke bedrock.

6. The natural water content of this silty clay formation is very high and the shear strength is very low.

7. In the transverse direction to the shore line, the thicknessof clay layer increases in a considerably amount towards Haliç and causing differential settlement problems for the buildings which are located on the shore.

8. The steep slope of the bedrock surface towards Haliç causes stability problem for the clay formation.

9. from the evaluation of over I35 shear tests, it is determined that shear strength variation with depth is linear, (Akşit,I977) and therefore it is concluded that the silty clay formation is Normally Consalidated.

IO. It is determined that stability of shores is above dangerous limits. (In Fermeneciler, between Azapkapı and Karaköy, minimum factor of safety for slope stability is found as I.II6)(See slope stability analysis for cross-section(3-3)B) Also, it is determined that shores dredging of bottom sludge can cause slides along the shores. (in cross-section (8-8)B ,in Taşkızak, minimum factor of safety for slope-slope stability after dredging is found as 0.95) So we have to take the necessary precautions. These precautions are explained in Recommendations.

For future geological and geotechnical studies and dredging of bottom sludge in vicinity of Haliç, the following recommendations are given:

I. Deeper boreholes should be drilled at certain locations and the samples should be kept for investigators to obtain detailed informations about soil properties.

2. The quantity of the materials transported and de-

posited by Creeks should be estimated.

3. The basic parameters and variation of these parameters with depth in artificial fill and sedimentary layer should be determined at various locations.

4. Because the stability of shores is above dangerous limits, great care has to be given, when constructing any major building along the shore. If possiple the best solution is to leave a 100 to 200 meters wide band along the shore for parks, play grounds and picnic areas. This will contribute to the improvement of the touristic value of the area, and as well to the stability problem of the shores. Planted trees will help to decrease the water content of the soil and using this area as a park will reduce the distributed load which is present because of the existing structures. As an example the elimination of the surcharge will increase the Safety Factor from 1.116 to 1.21 at cross-section (3-3)B .

5. As it is seen from the results, during dredging, shores of Haliç may slide. To prevent sliding of shores, some precautions should be taken. Some methods used to prevent sliding are:

a) Loading on toe: (Masonary Waal)

The simplest way of toe loading is to built masonary wall. Better forms are to built reinforced retaining structure wood, concrete piles or sheet piles palplanges. These structures are useful if they are dimensioned conviniently and hammered down deeply enough and no excavations are made under these structures. On the other hand the depth of the critical slope circle should be known.

In the case of the stabilisation of Haliç's shore , difficulties such as working under sea water necessitates convinient equipment. This method may not be economical. The same result can also be achieved easily by spreading a layer of sand or rock material upon the slope.(Peynircioglu, I96I)

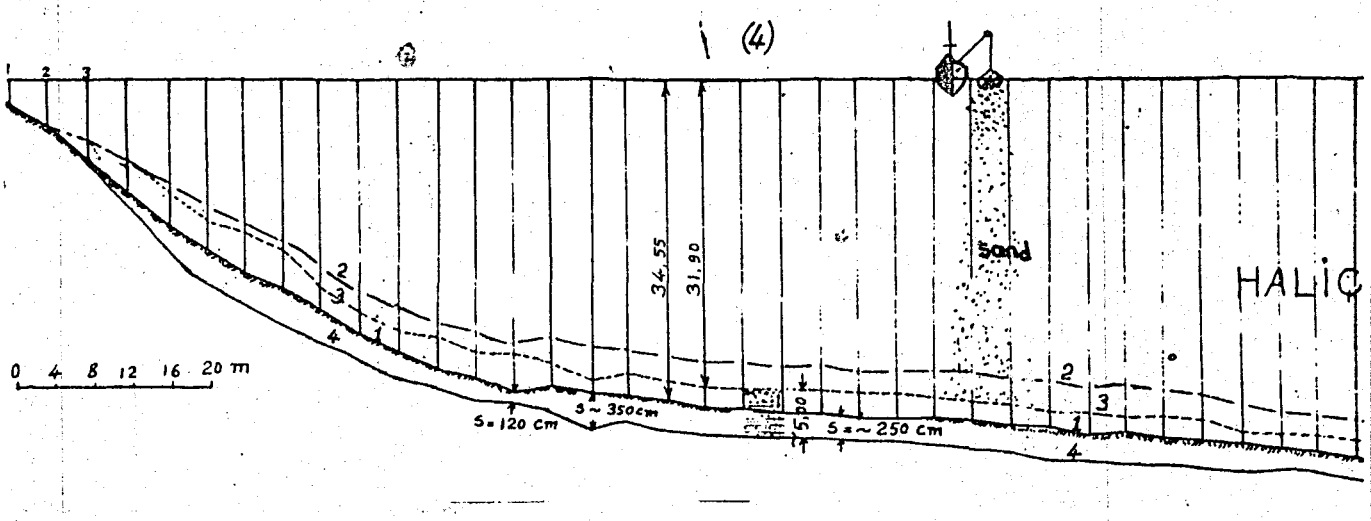

Fig. 5. Spreading layers of sand for stabilization of Ist. Commercial House's shore(Peynircioğlu,I96I)

The situation after spreading the layer of sand or rock material is controlled by means of computer program.(The unit weight for the material γ_n is taken as 2.2 t/m^3) It is observed that the factor of safety in the most critical region , Taşkızak (8-8)^A, changed from 0.95 to I.0I after this procedur This may be more economical than building a retaining wall.

) OF LINES 10 NO OF LINE INTERSECT= 13

) OF SOILS= 5 NO OF EXTERNAL SOIL LINES= 3

) OF X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 20

HE LINE END COORD MATRIX

NE NO	NO INT	X1	1	X2	2	LOPE	LINE INTE
1	3	.00	62	65	62	.000000	1
2	2	50	62	83	81	.301587	5
3	2	113	81	240	81	.000000	8
4	2	.00	53	40	55	.498616-001	2
5	2	40	55	65	62	.280000	4
6	2	65	62	95	81	.395833	6
7	2	95	74	242	77	.204082-001	7
8	2	.00	8	115	41	.286680	3
9	2	115	41	175	54	.216667	9
10	2	175	54	244	66	.173913	10

INE INTERSECT ARRAY

NO	X	Y
1	.00	62
2	.00	53
3	.00	8
4	40	55
5	50	62
6	65	62
7	95	74
8	113	81
9	115	41
10	175	54
11	240	81
12	242	77
13	244	66

OIL DATA ARRAY

L NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESI ON
1	2	5	6	0	115	120	0
1	5	6	5	0	115	120	0
1	6	5	4	0	115	120	0
2	6	6	5	0	115	120	0
2	8	5	6	0	115	120	0
2	8	6	8	0	115	120	0
2	8	8	6	0	115	120	0
2	8	6	8	0	115	120	0
2	8	8	7	0	115	120	0
2	8	7	8	0	115	120	0
2	8	8	8	0	115	120	0
3	8	8	7	0	115	200	0
3	8	7	8	0	115	200	0
3	8	8	8	0	115	200	0
3	8	8	7	0	115	120	0
4	8	7	6	0	115	120	0
4	8	6	4	0	115	120	0
4	8	4	6	0	115	120	0
4	8	6	7	0	115	120	0
4	8	7	9	0	115	120	0
4	8	9	10	0	115	120	0
5	8	10	9	0	137	450	68.6
5	9	9	10	0	137	450	68.6
5	10	10	3	0	137	450	68.6

RIAL CIRCLE NO 1

IRCLE CTR COORDS: X= X= 83.1 Y= 105.11

NTRANCE PT. COORDS: X= 118.1 Y= 81.

TRIAL ARC RADIUS= 42.438

XX LINE NOT INTERSECTED BY TRIAL CIRCL

```
 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

 ARC INTERSECT WITH LINE ARRAY
LINE NO          X              Y
   2          65.169         66.265
   6          70.994         64.144
   7         112.460         74.147
   3         118.111          8.011

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000         62.111   K=  1   KK=  1
I=  2          .000         53.111   K=  1   KK=  2
I=  3          .000          8.111   K=  1   KK=  3
I=  4        40.111         55.111   K=  1   KK=  4
I=  5        50.111         62.111   K=  1   KK=  5
I=  6        65.111         62.111   K=  1   KK=  6
I=  7        65.169         66.652   K=  2   KK=  6
I=  8        70.994         64.440   K=  3   KK=  6
I=  9        95.111         74.111   K=  3   KK=  7
I= 10       112.460         74.465   K=  4   KK=  7
I= 11       113.111          8.111   K=  4   KK=  8
I= 12       115.111          4.111   K=  4   KK=  9
I= 13       118.111          8.111   K=  4   KK=  9
I= 14       175.111         54.111   K=  4   KK=  0
I= 15       240.111          8.111   K=  4   KK= 11
I= 16       242.111         77.111   K=  4   KK= 12
I= 17       244.111         66.111   K=  4   KK= 13

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        65.169         66.652   K=  7   KK=  1
I=  2        70.994         64.440   K=  8   KK=  2
I=  3        95.111         74.111   K=  9   KK=  3
I=  4       112.460         74.465   K= 10   KK=  4
I=  5       113.111          8.111   K= 11   KK=  5
I=  6       118.111          8.111   K= 13   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                FI=   1.00000    FO=   1.02734
                FI=   1.02734    FO=   1.02950
                FI=   1.02950    FO=   1.02966

            THE SAFETY FACTOR FOR POINT  1 IS   1.02966

 TRIAL CIRCLE NO  2
 CIRCLE CTR COORDS:   X=   X=       86.111   Y=      105.111
 ENTRANCE PT. COORDS:   X=         118.111   Y=       81.111
       TRIAL ARC RADIUS=    40.000


 XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL
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```
 ARC INTERSECT WITH LINE ARRAY
LINE NO              X                   Y
   2              70.532              68.27
   6              75.983              66.41
   7             111.797              74.45
   3             118.111              81.31

 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1              .000              62.11   K=  1   KK=  1
I=  2              .000              53.11   K=  1   KK=  2
I=  3              .000               8.11   K=  1   KK=  3
I=  4            40.111              55.11   K=  1   KK=  4
I=  5            50.111              62.11   K=  1   KK=  5
I=  6            65.111              62.11   K=  1   KK=  6
I=  7            70.532              68.270  K=  2   KK=  6
I=  8            75.983              66.414  K=  3   KK=  6
I=  9            95.111              74.11   K=  3   KK=  7
I= 10           111.797              74.452  K=  4   KK=  7
I= 11           113.111               8.11   K=  4   KK=  8
I= 12           115.111               4.11   K=  4   KK=  9
I= 13           118.111               8.11   K=  4   KK=  9
I= 14           175.111              54.11   K=  4   KK= 10
I= 15           240.111               8.11   K=  4   KK= 11
I= 16           242.111              77.11   K=  4   KK= 12
I= 17           244.111              66.11   K=  4   KK= 13

 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1            70.532              68.270  K=  7   KK=  1
I=  2            75.983              66.414  K=  8   KK=  2
I=  3            95.111              74.11   K=  9   KK=  3
I=  4           111.797              74.452  K= 10   KK=  4
I=  5           113.111               8.11   K= 11   KK=  5
I=  6           118.111               8.11   K= 13   KK=  6

 FIND SLICE WIDTH AND NO OF SLICES
                    FI=    1.000000    FO=    1.002768
                    FI=    1.002768    FO=    1.002986
                    FI=    1.002986    FO=    1.003003

              THE SAFETY FACTOR FOR POINT  2IS    1.03003

 TRIAL CIRCLE NO  3
 CIRCLE CTR COO DS:   X=   X=        83.11     =      83.11
 ENTRANCE PT. COORDS:  X=             18.11     =       8.11
       TRIAL ARC RADIUS=     44.204


 XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

 ARC INTERSECT WITH LINE ARRAY
LINE NO              X                   Y
   2              66.632              67.09
   6              72.756              65.14
   7             111.756              74.45
   3             118.111              81.31
```

```
I=  2           .000          53.111    K=  1   KK=  2
I=  3           .000           8.111    K=  1   KK=  3
I=  4         40.111          55.111    K=  1   KK=  4
I=  5         50.111          62.111    K=  1   KK=  5
I=  6         65.111          62.111    K=  1   KK=  6
I=  7         66.632          67.093    K=  2   KK=  6
I=  8         72.756          65.137    K=  3   KK=  6
I=  9         95.111          74.111    K=  3   KK=  7
I= 10        111.756          74.451    K=  4   KK=  7
I= 11        113.111           8.111    K=  4   KK=  8
I= 12        115.111           4.111    K=  4   KK=  9
I= 13        118.111           8.111    K=  4   KK=  9
I= 14        175.111          54.111    K=  4   KK= 10
I= 15        240.111           8.111    K=  4   KK= 11
I= 16        242.111          77.111    K=  4   KK= 12
I= 17        244.111          66.111    K=  4   KK= 13

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1         66.632          67.093    K=  7   KK=  1
I=  2         72.756          65.137    K=  8   KK=  2
I=  3         95.111          74.111    K=  9   KK=  3
I=  4        111.756          74.451    K= 10   KK=  4
I=  5        113.111           8.111    K= 11   KK=  5
I=  6        118.111           8.111    K= 13   KK=  6

FIND SLICE WIDTH AND NO OF SLICES
               FI=     1.00000     FO=      1.00414
               FI=     1.00414     FO=      1.00446
        THE SAFETY FACTOR FOR POINT  3IS    1.00446

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=  X=      86.11   Y=     108.11
ENTRANCE PT. COORDS:   X=      118.11   Y=      81.11
    TRIAL ARC RADIUS=     41.869


XXX LINE  1NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  4NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  5NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

XXX LINE 10NOT INTERSECTED BY TRIAL CIRCL

ARC INTERSECT WITH LINE ARRAY
LINE NO          X             Y
 2           71.969        68.70
 6           77.703        67.10
 7          110.981        74.43
 3          118.11         81.11

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1           .000          62.111    K=  1   KK=  1
I=  2           .000          53.111    K=  1   KK=  2
I=  3           .000           8.111    K=  1   KK=  3
I=  4         40.111          55.111    K=  1   KK=  4
I=  5         50.111          62.111    K=  1   KK=  5
I=  6         65.111          62.111    K=  1   KK=  6
I=  7         71.969          68.703    K=  2   KK=  6
I=  8         77.703          67.095    K=  3   KK=  6
I=  9         95.111          74.111    K=  3   KK=  7
I= 10        110.981          74.435    K=  4   KK=  7
I= 11        113.111           8.111    K=  4   KK=  8
I= 12        115.111           4.111    K=  4   KK=  9
```

```
I= 14          175.[illegible]          54.[illegible]   K=  4   KK= 10
I= 15          240.[illegible]          8[illegible]     K=  4   KK= 11
I= 16          242.[illegible]          77.[illegible]   K=  4   KK= 12
I= 17          244.[illegible]          66.[illegible]   K=  4   KK= 13

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1           71.969          68.703   K=  7   KK=  1
I=  2           77.703          67.095   K=  8   KK=  2
I=  3           95.[illegible]           74.[illegible]   K=  9   KK=  3
I=  4          110.98[illegible]         74.435   K= 10   KK=  4
I=  5          113.[illegible]          81.[illegible]   K= 11   KK=  5
I=  6          118.[illegible]          81.[illegible]   K= 13   KK=  6

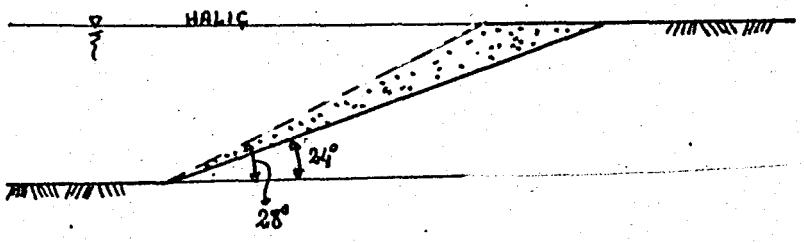
FIND SLICE WIDTH AND NO OF SLICES
                    FI=    1.00000   FO=     1.00946
                    FI=    1.00946   FO=     1.01019

               THE SAFETY FACTOR FOR POINT  4IS    1.01019
END PROGRAM EXECUTION
```

12345678901234567890123456789012345678901234567890123456789012345678

b) Rearranging of slopes:

Slope angle should be decreased in order to compensate for extra loading caused by dredging.



This has been analyzed with the computer program. The slope angle is decreased from 28 to 24. It is observed that the factor of safety ,in cross-section (3-3)B , changed from 0.95 to I.006 . This may be also economical.

c) Protection of slopes:

The application of this method is impossible for Haliç shores because bottom sludge and clay layer are very soft and weak.

OF LINES 9 NO OF LINE INTERSECT= 12

OF SOILS= 3 NO OF EXTERNAL SOIL LINES= 3

OF X INCREMENTS= 2 NO OF Y INCREMENTS= 2

IN ITIAL SLICE WIDTH= 20.0

LINE END COORD MATRIX

NO	NO INT	X1	Y1	X2	Y2	SLOPE	LINE INTER
	2	.00	54.11	74.11	69.11	.202399	1 4
	2	74.11	69.11	163.11	107.11	.426966	4 7
	2	163.11	107.11	233.11	107.11	.000000	7 10
	2	.00	36.11	86.11	50.11	.162791	2 6
	2	86.11	50.11	194.11	94.11	.407407	6 9
	2	194.11	94.11	237.11	104.11	.162791	9 11
	2	.00	104.11	84.11	27.11	.202114	3 5
	2	84.11	27.11	188.11	73.11	.442308	5 8
	2	188.11	73.11	244.11	90.11	.303571	8 12

IE INTERSECT ARRAY

NO	X	Y
1	.00	54.11
2	.00	36.11
3	.00	104.11
4	74.11	69.11
5	84.11	27.11
6	86.11	50.11
7	163.11	107.11
8	188.11	73.11
9	194.11	94.11
10	233.11	107.11
11	237.11	101.11
12	244.11	90.11

IL DATA ARRAY

NO	LINE #	LEFT INT	RT INT	SAT	UNIT WT	PHI	COHESION
	1	4	4	0	7.8	20.0	19.6
	2	4	7	0	7.8	20.0	19.6
	3	7	10	0	7.8	20.0	19.6
	4	2	6	0	7.8	20.0	19.6
	5	6	9	0	7.8	20.0	19.6
	6	4	6	0	7.8	20.0	19.
	4	2	6	0	7.8	12.0	0
	5	6	9	0	7.8	12.0	0
	6	9	11	0	7.8	12.0	0
	7	3	5	0	7.8	12.0	0
	8	5	8	0	7.8	12.0	0
	9	8	12	0	7.8	12.0	0
	7	3	5	0	13.7	45.0	18.6
	8	5	8	0	13.7	45.0	18.6
	9	8	12	0	13.7	45.0	18.6

IAL CIRCLE NO 1

RCLE CTR COORDS: X= X= 82.11 Y= 161.11

TRANCE PT. COORDS: X= 192.11 Y= 107.11

TRIAL ARC RADIUS= 122.540

X LINE 2NOT INTERSECTED BY TRIAL CIRCL

X LINE 6NOT INTERSECTED BY TRIAL CIRCL

X LINE 7NOT INTERSECTED BY TRIAL CIRCL

X LINE 8NOT INTERSECTED BY TRIAL CIRCL

X LINE 9NOT INTERSECTED BY TRIAL CIRCL

```
 ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
   1          16.698          57.49
   4          46.906          43.74
   5         181.026          88.78
   3         192.111         107.1


 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=  1          .000          54.11   K=  1   KK=  1
I=  2          .000          36.11   K=  1   KK=  2
I=  3          .000          10.11   K=  1   KK=  3
I=  4        16.698          57.49   K=  2   KK=  3
I=  5        46.906          43.737  K=  3   KK=  3
I=  6        74.111          69.11   K=  3   KK=  4
I=  7        84.111          27.11   K=  3   KK=  5
I=  8        86.111          50.11   K=  3   KK=  6
I=  9       163.111         107.11   K=  3   KK=  7
I= 10       181.026          88.780  K=  4   KK=  7
I= 11       188.111          73.11   K=  4   KK=  8
I= 12       192.111         107.11   K=  4   KK=  8
I= 13       194.111          94.11   K=  4   KK=  9
I= 14       233.111         107.11   K=  4   KK= 10
I= 15       237.111          10.11   K=  4   KK= 11
I= 16       244.111          90.11   K=  4   KK= 12


 THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=  1        16.698          57.49   K=  4   KK=  1
I=  2        46.906          43.737  K=  5   KK=  2
I=  3        74.111          69.11   K=  6   KK=  3
I=  4        86.111          50.11   K=  8   KK=  4
I=  5       163.111         107.11   K=  9   KK=  5
I=  6       181.026          88.780  K= 10   KK=  6
I=  7       192.111         107.11   K= 12   KK=  7


 FIND SLICE WIDTH AND NO OF SLICES
 *****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
                FI=   1.00000   FO=   1.00037

            THE SAFETY FACTOR FOR POINT  1IS   1.00037


 TRIAL CIRCLE NO  2
 CIRCLE CTR COORDS:  X=  X=      85.11   Y=      61.11
 ENTRANCE PT COORDS:  X=        192.11   Y=     107.11
      TRIAL ARC RADIUS=   119.854


 XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

 XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

 ***LINE  2IS NOT INTERSECTED BUT IS IN ARC


 ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
   1          22.802          58.73
   4          55.114          45.07
   5         180.524          88.58
   3         192.111         107.1


 THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
```

```
I=   4          22.802          58.726          K=   2   KK=   3
I=   5          55.114          45.107          K=   3   KK=   3
I=   6          74.111          69.111          K=   3   KK=   4
I=   7          84.111          27.111          K=   3   KK=   5
I=   8          86.111          50.111          K=   3   KK=   6
I=   9         163.111         107.111          K=   3   KK=   7
I=  10         180.524          88.575          K=   4   KK=   7
I=  11         188.111          73.111          K=   4   KK=   8
I=  12         192.111         107.111          K=   4   KK=   8
I=  13         194.111          94.111          K=   4   KK=   9
I=  14         233.111         107.111          K=   4   KK=  10
I=  15         237.111          10.111          K=   4   KK=  11
I=  16         244.111          90.111          K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1          22.802          58.726          K=   4   KK=   1
I=   2          55.114          45.107          K=   5   KK=   2
I=   3          74.111          69.111          K=   6   KK=   3
I=   4          86.111          50.111          K=   8   KK=   4
I=   5         163.111         107.111          K=   9   KK=   5
I=   6         180.524          88.575          K=  10   KK=   6
I=   7         192.111         107.111          K=  12   KK=   7

FIND SLICE WIDTH AND NO OF SLICES
*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
                    FI=    1.00000    FO=    1.00228
                    FI=    1.00228    FO=    1.00253
              THE SAFETY FACTOR FOR POINT  2IS    1.00253

TRIAL CIRCLE NO  3
CIRCLE CTR COORDS:  X=  X=       82.111  Y=       64.111
ENTRANCE PT. COORDS:  X=        192.111  Y=      107.111
     TRIAL ARC RADIUS=    123.891


XXX LINE  2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE  9NOT INTERSECTED BY TRIAL CIRCL

***LINE  2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X               Y
   1          18.427          57.184
   4          50.498          44.432
   5         180.215          88.545
   3         192.111         107.111

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=   1           .000          54.111          K=   1   KK=   1
I=   2           .000          36.111          K=   1   KK=   2
I=   3           .000          10.111          K=   1   KK=   3
I=   4         18.427          57.184          K=   2   KK=   3
I=   5         50.498          44.432          K=   3   KK=   3
I=   6         74.111          69.111          K=   3   KK=   4
I=   7         84.111          27.111          K=   3   KK=   5
I=   8         86.111          50.111          K=   3   KK=   6
I=   9        163.111         107.111          K=   3   KK=   7
I=  10        180.215          88.450          K=   4   KK=   7
I=  11        188.111          73.111          K=   4   KK=   8
```

```
I=  14          233.[illegible]          107.[illegible]          K=   4   KK=  10
I=  15          237.[illegible]          101.[illegible]          K=   4   KK=  11
I=  16          244.[illegible]          90.[illegible]           K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1          18.427                   57.841                   K=   4   KK=   1
I=   2          50.498                   44.327                   K=   5   KK=   2
I=   3          74.[illegible]           69.[illegible]           K=   6   KK=   3
I=   4          86.[illegible]           50.[illegible]           K=   8   KK=   4
I=   5          163.[illegible]          107.[illegible]          K=   9   KK=   5
I=   6          180.215                  88.450                   K=  10   KK=   6
I=   7          192.[illegible]          107.[illegible]          K=  12   KK=   7

FIND SLICE WIDTH AND NO OF SLICES
*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
                FI=    1.00000    FO=     .99844
                FI=     .99844    FO=     .99826

            THE SAFETY FACTOR FOR POINT  3 IS      .99826

TRIAL CIRCLE NO  4
CIRCLE CTR COORDS:  X=   X=        85.[illegible]   Y=        164.[illegible]
ENTRANCE PT. COORDS:  X=           192.[illegible]  Y=        107.[illegible]
     TRIAL ARC RADIUS=    121.235

XXX LINE   2NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   6NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   7NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   8NOT INTERSECTED BY TRIAL CIRCL

XXX LINE   9NOT INTERSECTED BY TRIAL CIRCL

***LINE   2IS NOT INTERSECTED BUT IS IN ARC

ARC INTERSECT WITH LINE ARRAY
LINE NO          X
  1              24.557                   59.[illegible]
  4              59.046                   45.[illegible]
  5              179.657                  88.[illegible]
  3              192.[illegible]          107.[illegible]

THE ARRAY WITH ALL INTERSECTIONS FOLLOWS:
I=   1           .000                    54.[illegible]           K=   1   KK=   1
I=   2           .000                    36.[illegible]           K=   1   KK=   2
I=   3           .000                    10.[illegible]           K=   1   KK=   3
I=   4          24.557                   59.[illegible]           K=   2   KK=   3
I=   5          59.046                   45.[illegible]           K=   3   KK=   3
I=   6          74.[illegible]           69.[illegible]           K=   3   KK=   4
I=   7          84.[illegible]           27.[illegible]           K=   3   KK=   5
I=   8          86.[illegible]           50.[illegible]           K=   3   KK=   6
I=   9          163.[illegible]          107.[illegible]          K=   3   KK=   7
I=  10          179.657                  88.[illegible]           K=   4   KK=   7
I=  11          188.[illegible]          73.[illegible]           K=   4   KK=   8
I=  12          192.[illegible]          107.[illegible]          K=   4   KK=   8
I=  13          194.[illegible]          94.[illegible]           K=   4   KK=   9
I=  14          233.[illegible]          107.[illegible]          K=   4   KK=  10
I=  15          237.[illegible]          101.[illegible]          K=   4   KK=  11
I=  16          244.[illegible]          90.[illegible]           K=   4   KK=  12

THE APPLICABLE ARRAY ARCINT FOLLOWS:
I=   1          24.557                   59.[illegible]           K=   4   KK=   1
I=   2          59.046                   45.[illegible]           K=   5   KK=   2
I=   3          74.[illegible]           69.[illegible]           K=   6   KK=   3
```

I= 6 179.657 88.222 K= 10 KK= 6
I= 7 192.114 107.114 K= 12 KK= 7

FIND SLICE WIDTH AND NO OF SLICES

*****MAXIMUM SLICE WIDTH HAS BEEN INCREMENTED TO 2.50
FI= 1.00000 FO= 1.00348
FI= 1.00348 FO= 1.00387

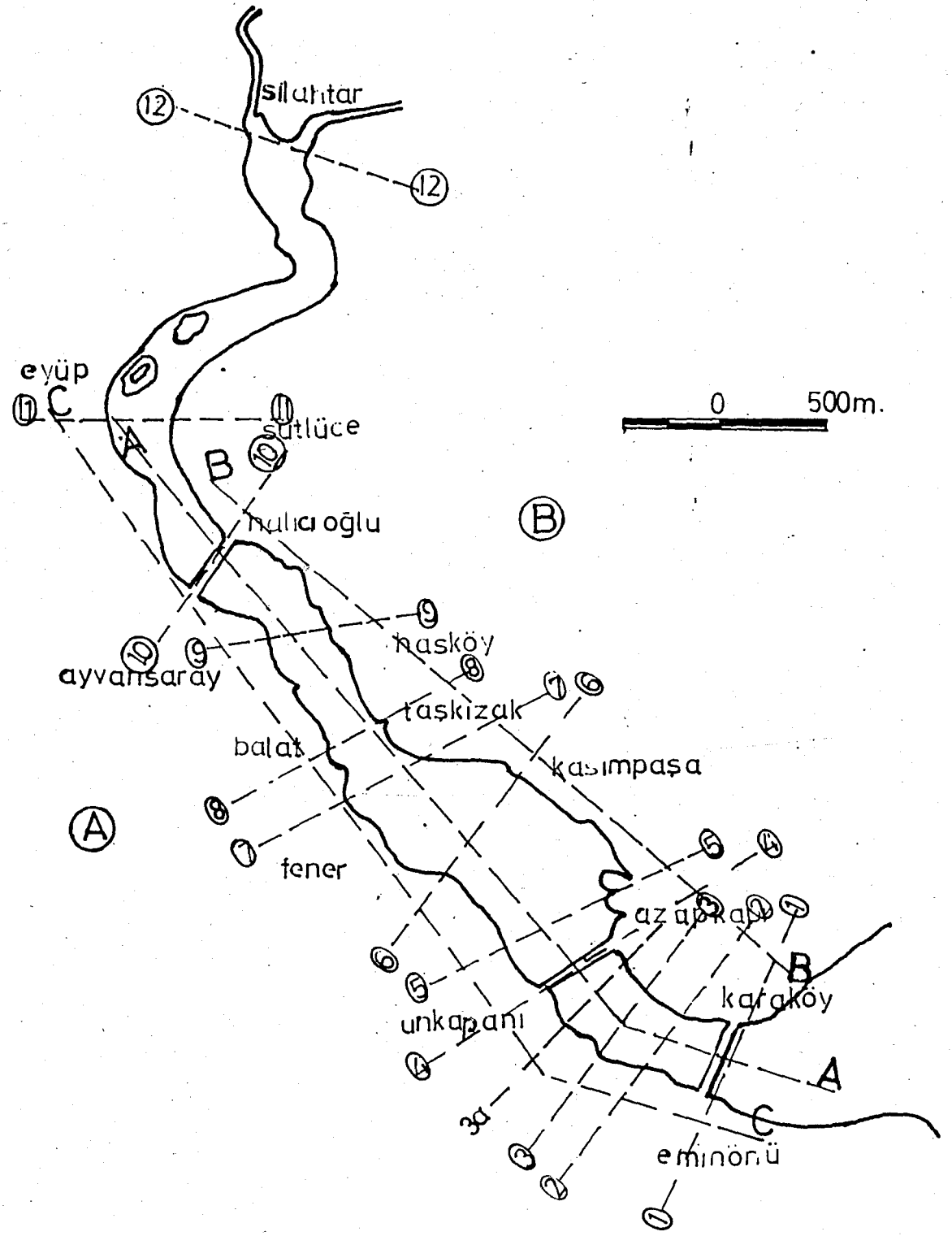
THE SAFETY FACTOR FOR POINT 41S 1.00387

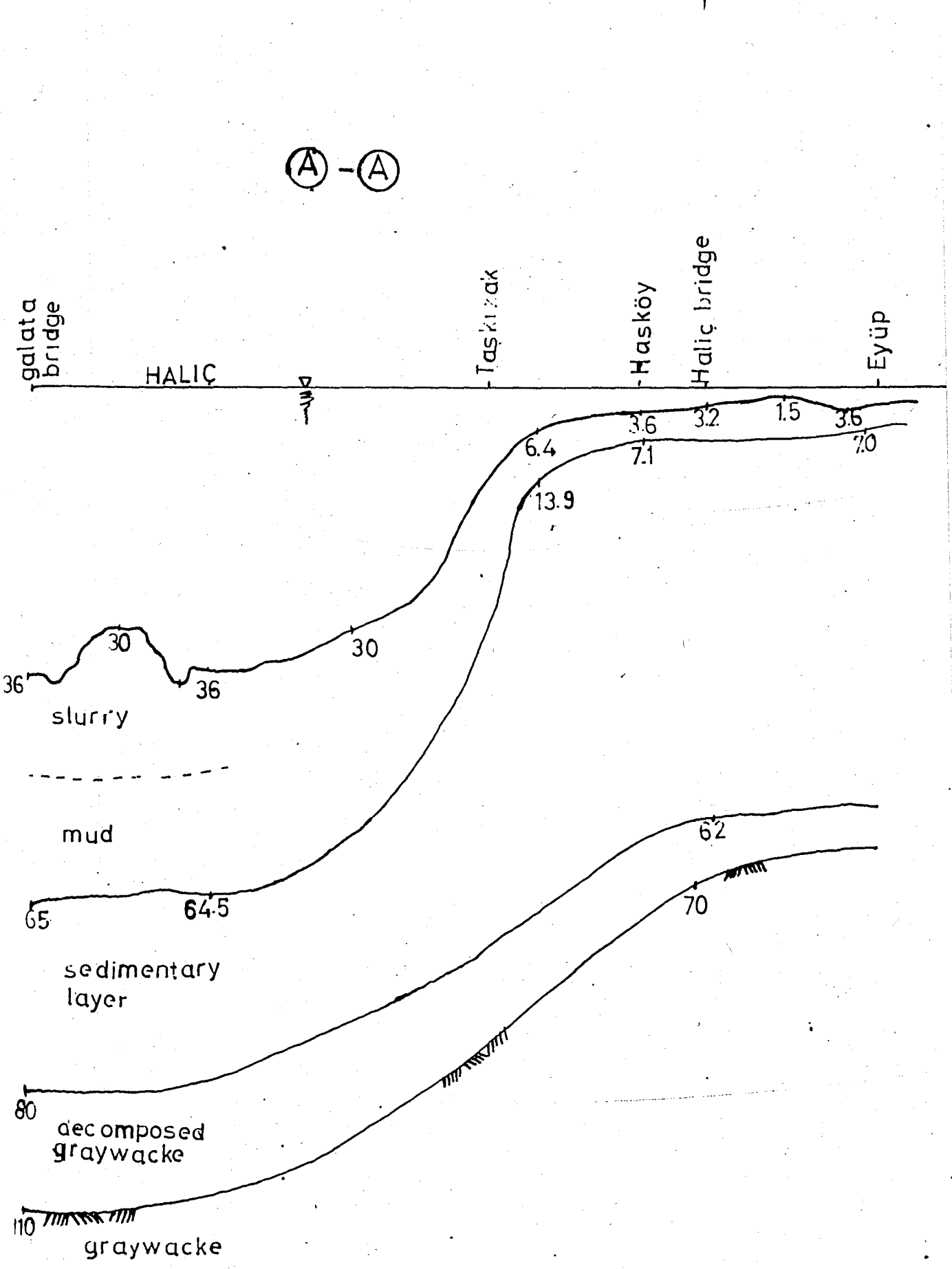
@BRKPT PRINTS

APPENDIX

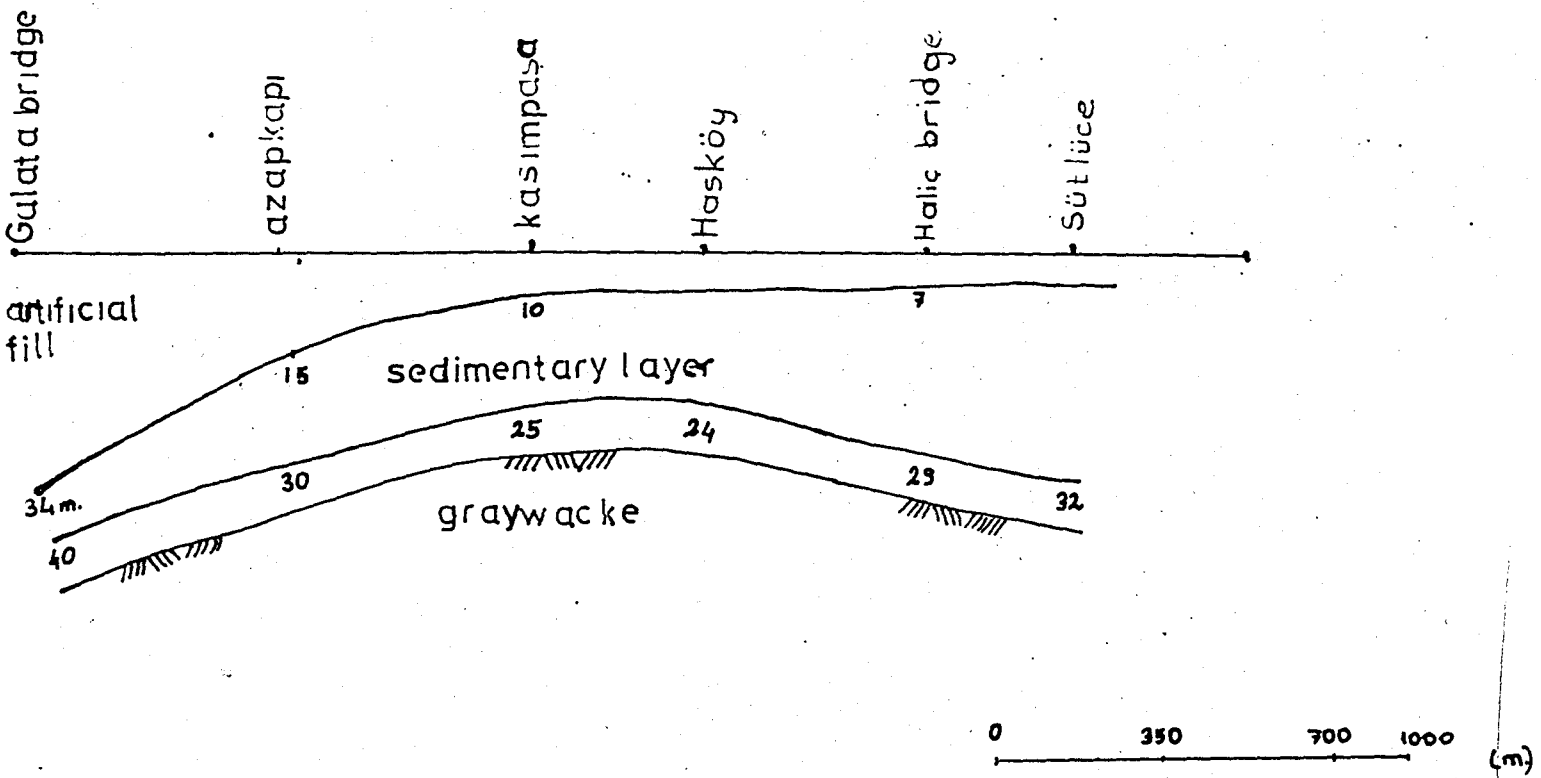
CROSS—SECTIONS

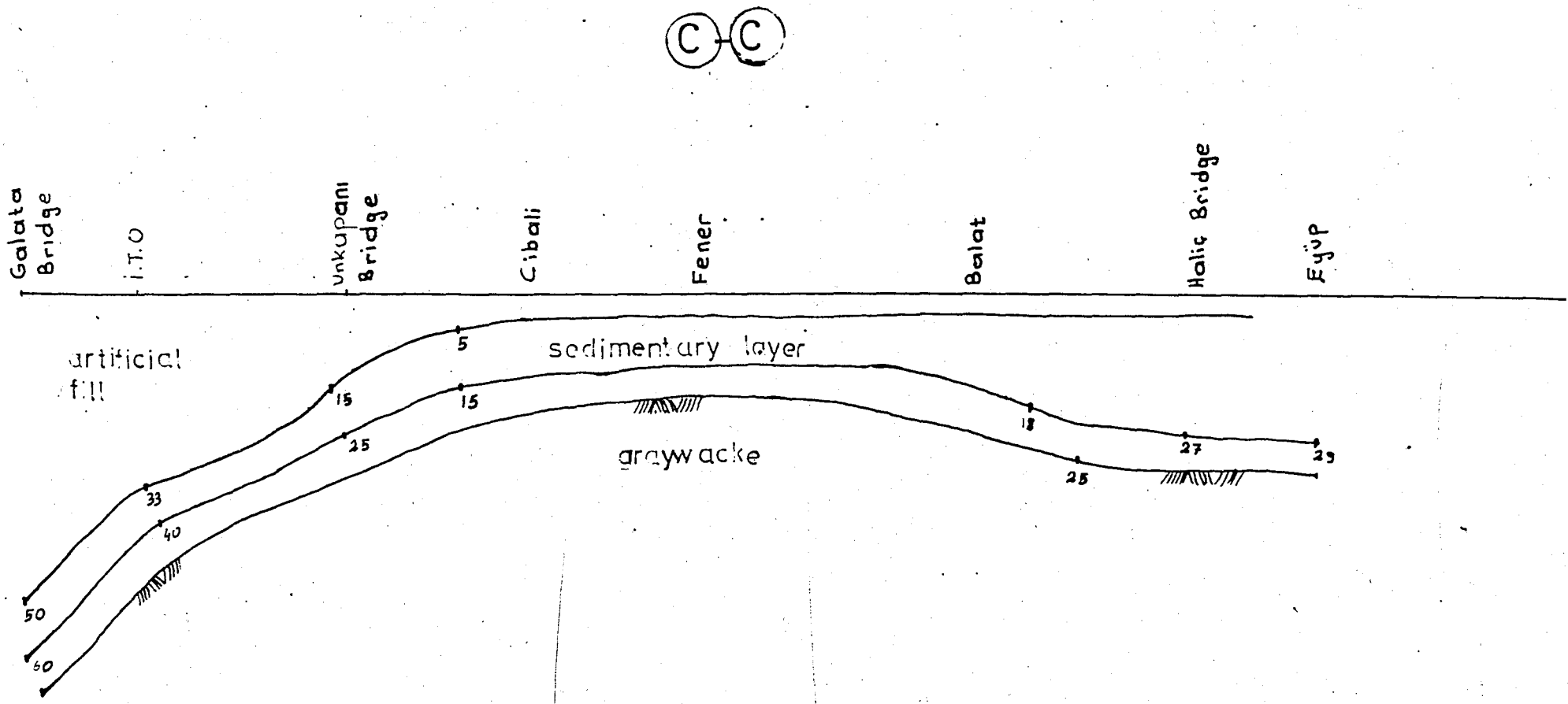
ALONG HALIC


silahtar
eyüp
sütlüce
halıcıoğlu
ayvansaray
hasköy
taşkızak
balat
kasımpaşa
fener
azapkapı
unkapanı
karaköy
eminönü
0
500m.
A
B
C

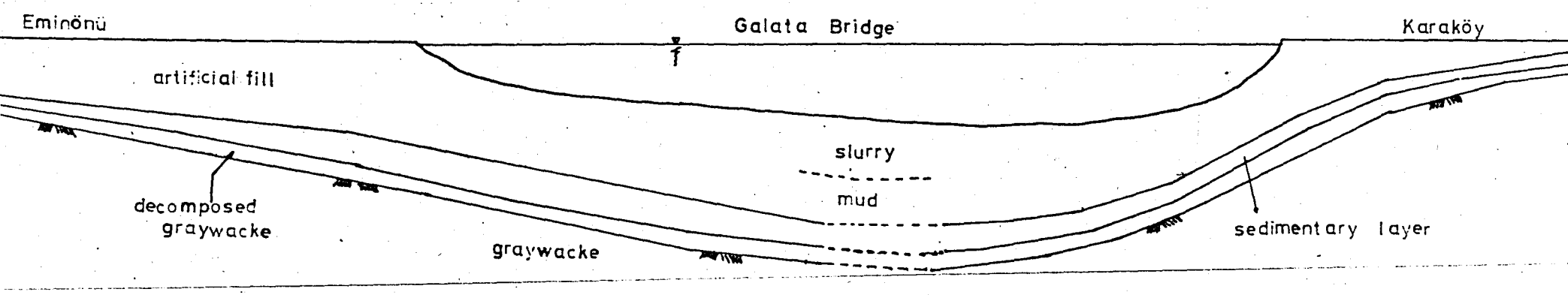

Ⓐ - Ⓐ
galata bridge
HALIÇ
Taşkızak
Hasköy
Haliç bridge
Eyüp
3.6
3.2
1.5
3.6
7.0
7.1
6.4
13.9
30
30
36
36
slurry
mud
62
65
64.5
70
sedimentary layer
80
decomposed graywacke
110
graywacke

(B) - (B)


Galata bridge
azapkapı
kasımpaşa
Hasköy
Haliç bridge
Sütlüce
artificial fill
10
7
15
sedimentary layer
25
24
30
29
32
34m.
graywacke
40
0
350
700
1000
(m)

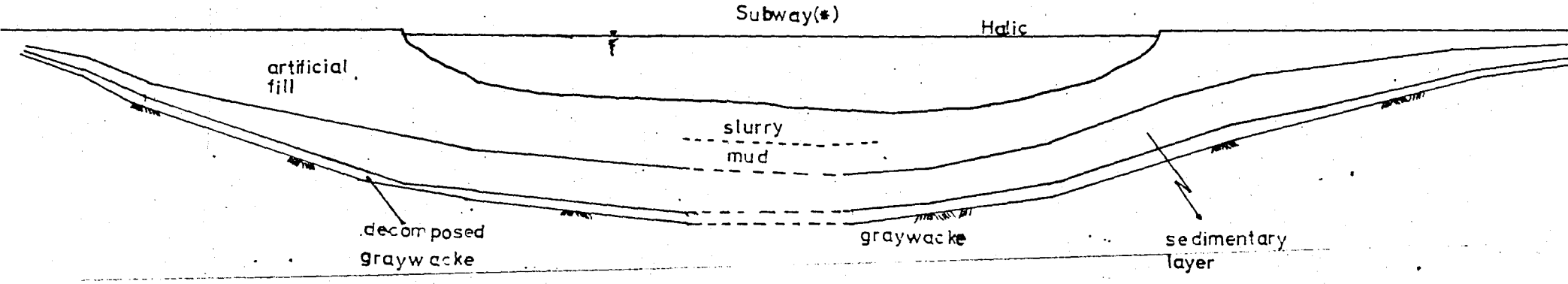

C-C
Galata Bridge
I.T.O
Unkapani Bridge
Cibali
Fener
Balat
Halic Bridge
Eyüp
artificial fill
sedimentary layer
graywacke
5
15
15
25
33
40
50
60
18
25
27
29

(I-I)

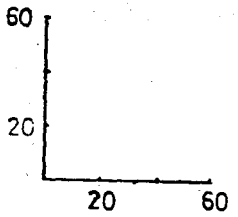

Eminönü
Galata Bridge
Karaköy
artificial fill
slurry
mud
decomposed
graywacke
graywacke
sedimentary layer

40 60 80

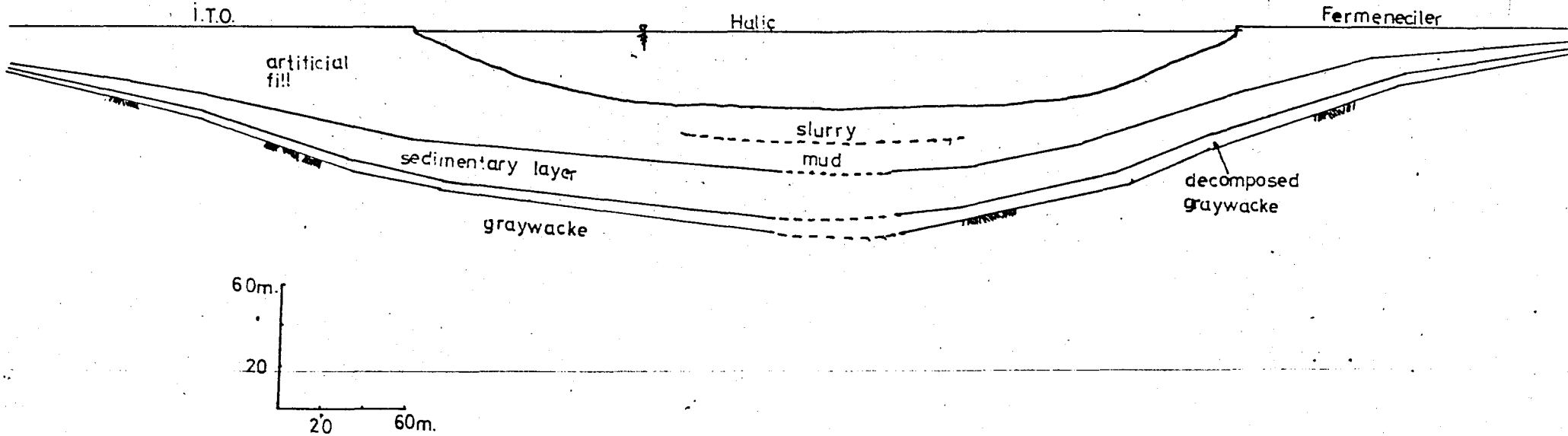
2-2



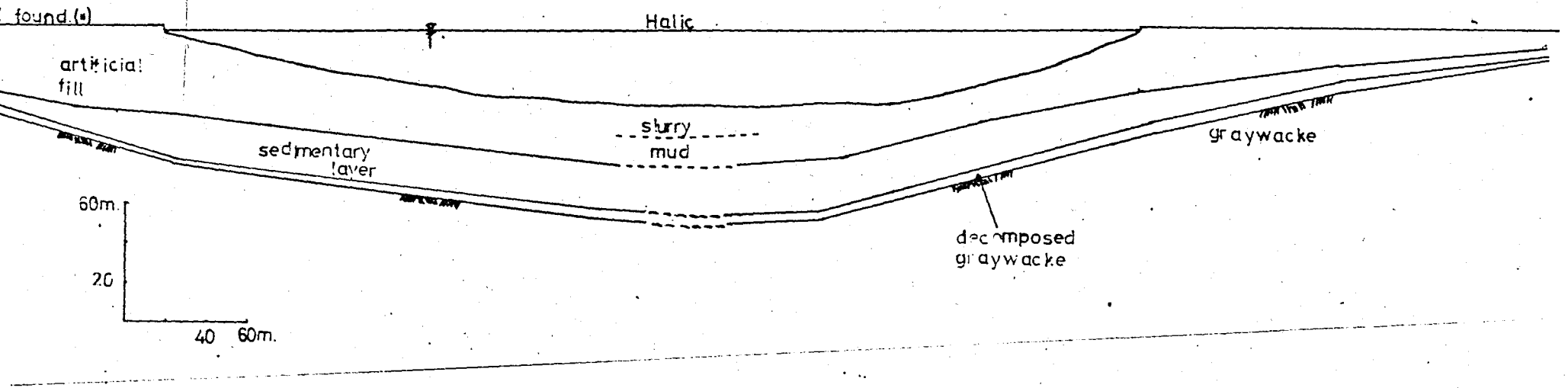
(*) Sayar, 1961



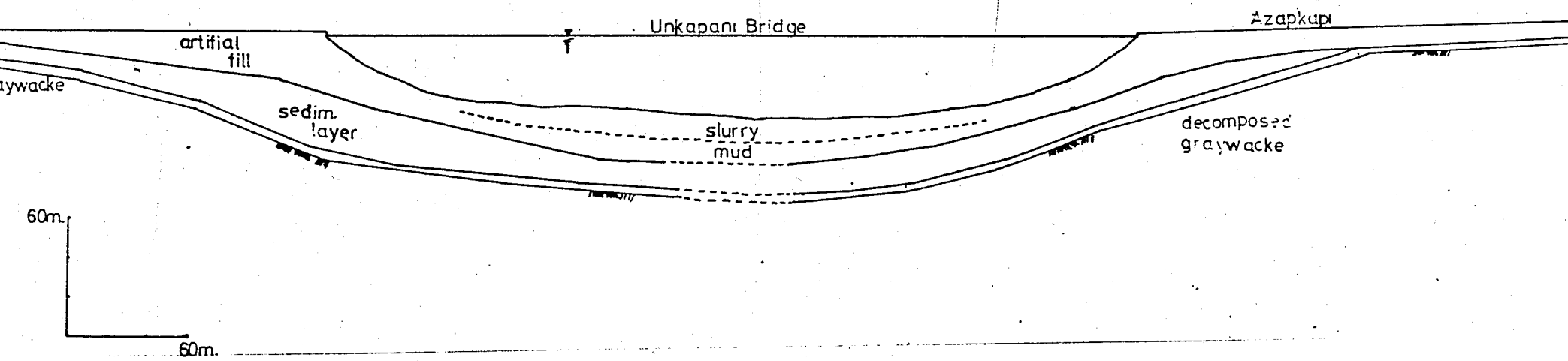
3-3


İ.T.O.
Halic
Fermeneciler
artificial fill
slurry
mud
sedimentary layer
graywacke
decomposed graywacke
60m.
20
20
60m.

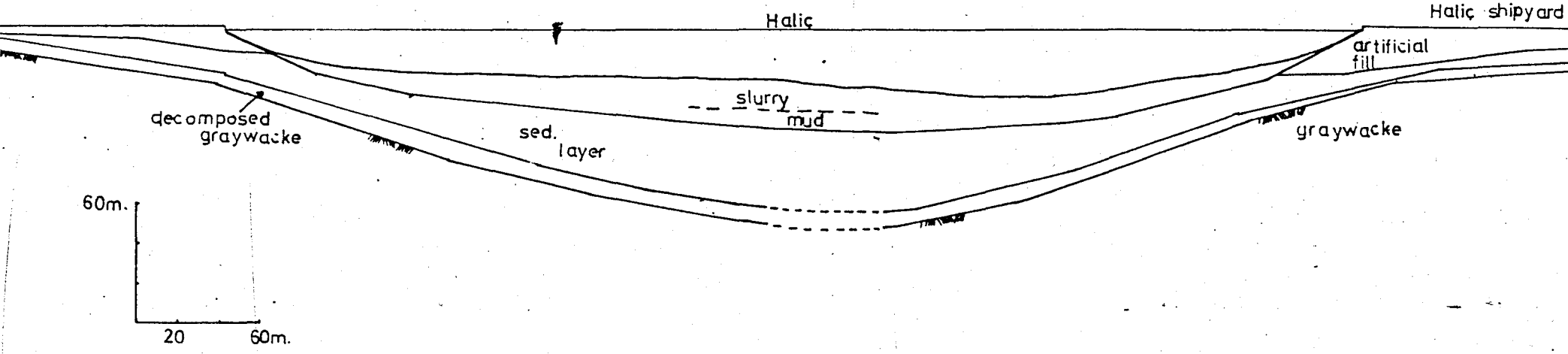
3a- 3a

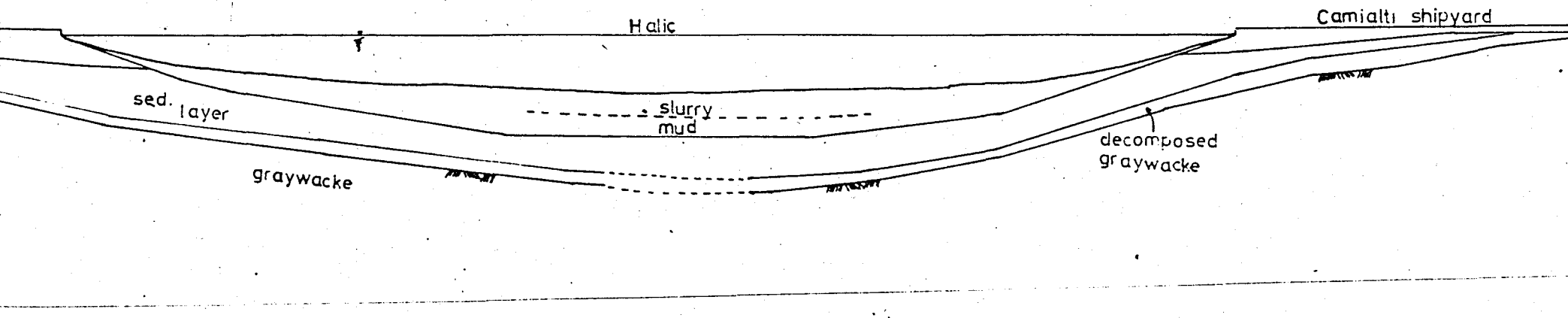


(•) Peynircioğlu,(1961)

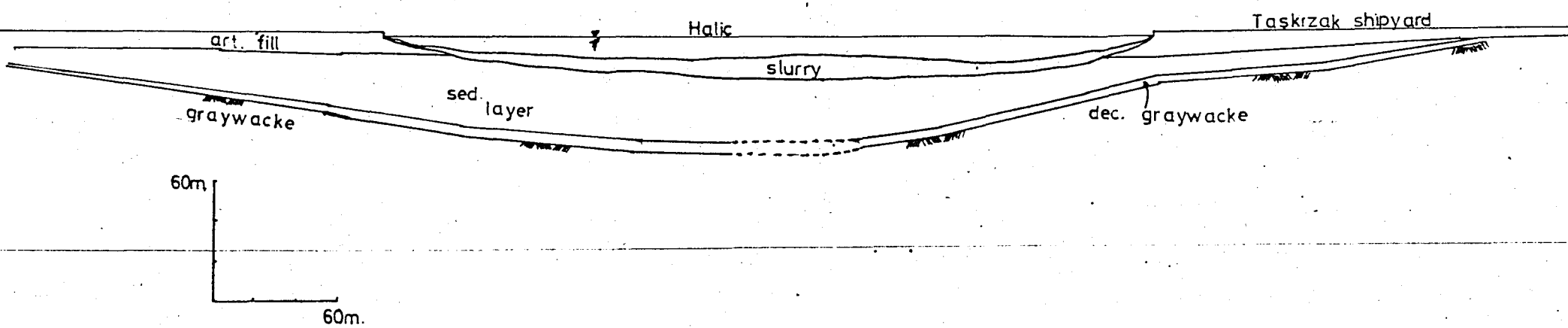

4-4
Unkapani Bridge
Azapkapı
artifial fill
aywacke
sedim. layer
slurry mud
decomposed graywacke
60m.
60m.

5-5

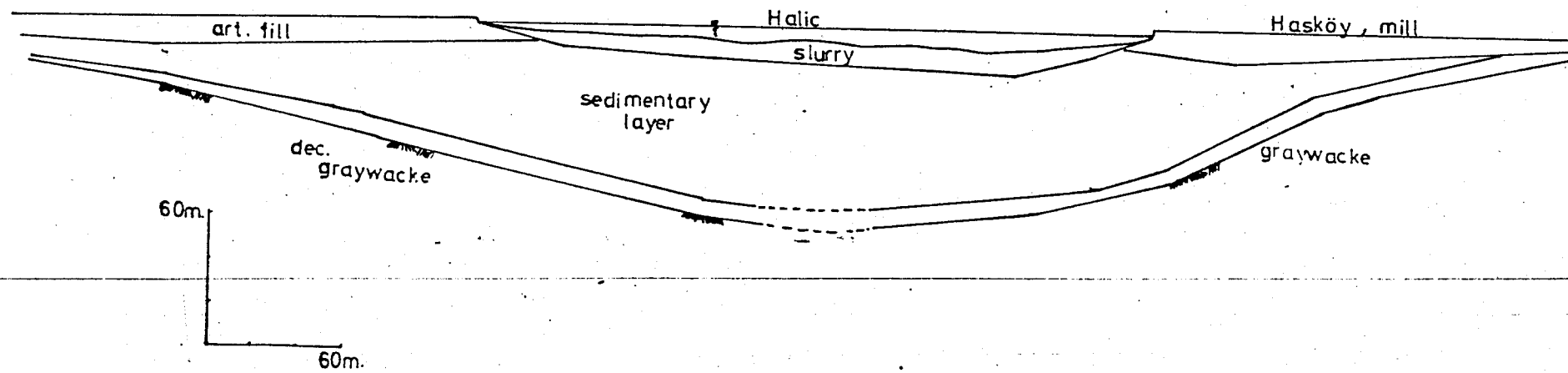

Haliç
Haliç shipyard
artificial fill
slurry mud
decomposed graywacke
sed. layer
graywacke
60m.
20
60m.


Halic
Camialti shipyard
sed. layer
slurry mud
graywacke
decomposed graywacke

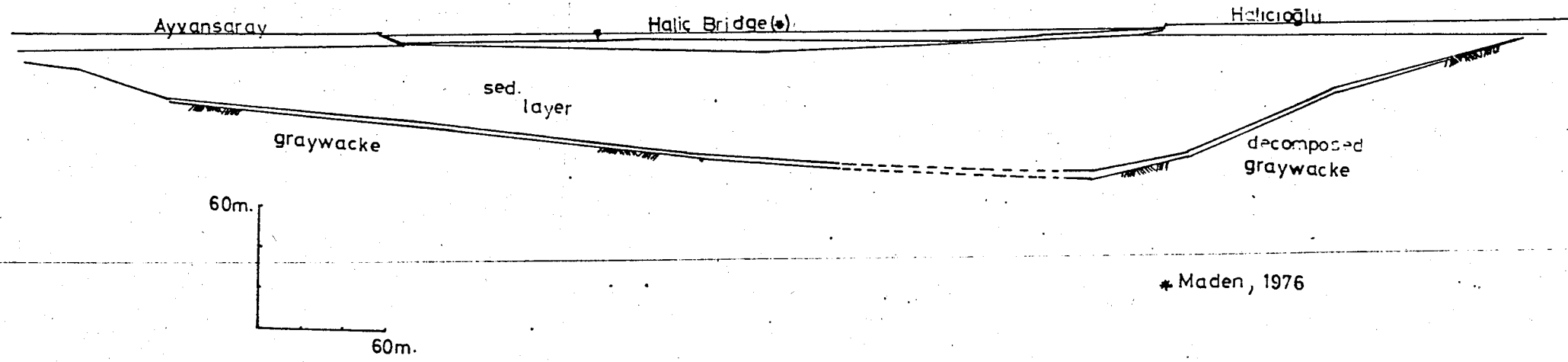
8-8


Halic
Taşkızak shipyard
art. fill
slurry
sed. layer
graywacke
dec. graywacke
60m.
60m.

9-9

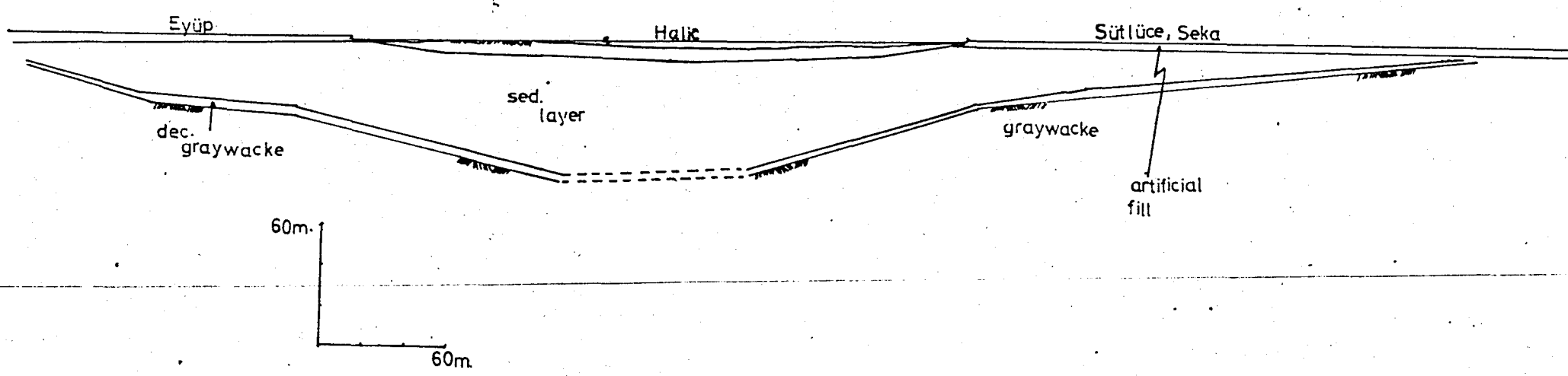

art. fill
Halic
slurry
Hasköy , mill
sedimentary
layer
dec.
graywacke
graywacke
60m.
60m.

10-10

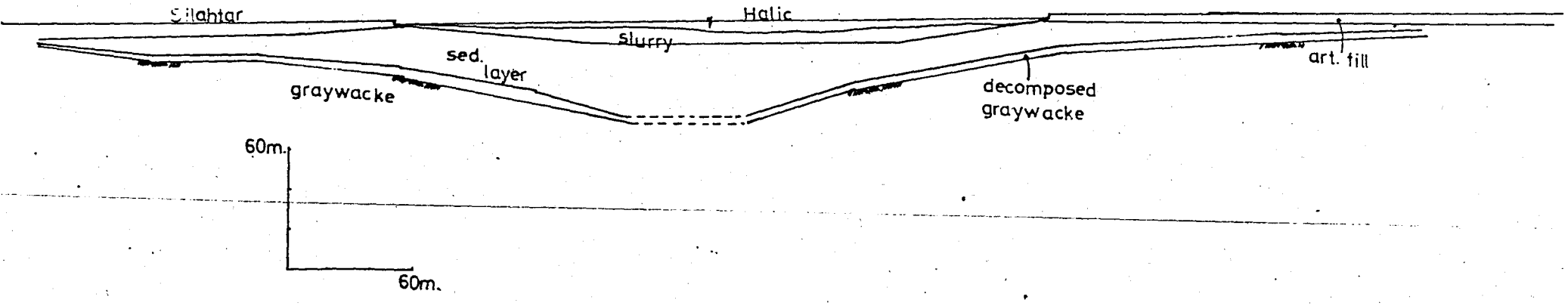


* Maden, 1976

11-11


Eyüp
Halic
Sütlüce, Seka
sed.
layer
dec.
graywacke
graywacke
artificial
fill
60m.
60m.

12-12


Silahtar
Halic
slurry
sed.
layer
graywacke
decomposed
graywacke
art. fill
60m.
60m.

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