Gujarat Maritime Board
Ahmedabad

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT - Final Report

Volume III : Reports on Model Studies and Field Investigations

HARRIS **Frederic R. Harris, Inc.**
in association with
I.I.T., Madras
I.C.T. Pvt. Ltd., New Delhi
W.I.I.T. Ltd., Mumbai

DEVELOPMENT OF PORT FACILITIES AT POSITRA
DETAILED PROJECT REPORT

VOLUME III :- REPORTS ON MODEL STUDIES & FIELD INVESTIGATIONS

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OCEAN ENGINEERING CENTRE,
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TOPOGRAPHIC SURVEY REPORT

BY

INTERCONTINENTAL CONSULTANTS AND TECHNOCRATS PVT. LTD., NEW DELHI.

DEVELOPMENT OF PORTS AT POSITRA
IN
STATE OF GUJARAT

TOPOGRAPHIC SURVEY REPORT

June 1997

Intercontinental Consultants and Technocrats Pvt. Ltd.
A-11, Green Park, New Delhi - 110 016, INDIA

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DEVELOPMENT OF PORTS AT POSITRA
IN
STATE OF GUJARAT

TOPOGRAPHIC SURVEY REPORT

1. General

The Gujarat Maritime Board is planning to develop ports and related facilities at Positra, at a distance of about 30 km from Okha Port in the Rann of Kutch area of the State of Gujarat. The Port development at Positra will comprise two parts : Positra-II and Positra-III. Both these ports will handle containers as well as petroleum products and LPG including coal. The infrastructure will comprise a central platform and breasting and mooring dolphins complete with cargo handling equipment as required. On shore, container yard facilities for storage and transhipment and storage tanks for different petroleum products as well as special facilities for storage of LPG will be provided. It will also be fully equipped for the off loading and through transport of coal to the stacking yard.

This part of the Report covers Topographic Survey of the on shore areas for providing on shore facilities.

2. Area Surveyed

The area surveyed is near Positra village in the North-East direction as shown in **Fig.-1.** It is surrounded by sea on three sides. The area is approximately 9.5 sq. km. and covers the sand dunes on North and Eastern sides.

3. Methodology for Land Survey Works

3.1 Scope

The methodology for carrying out the land surveys covered the following :

a) Preparation of contour survey maps, with spot levels. The levels were carried over from Survey of India Bench Mark (BM) of the area.

b) Establishment of base line and grid system for defining the coordinates of the various areas.

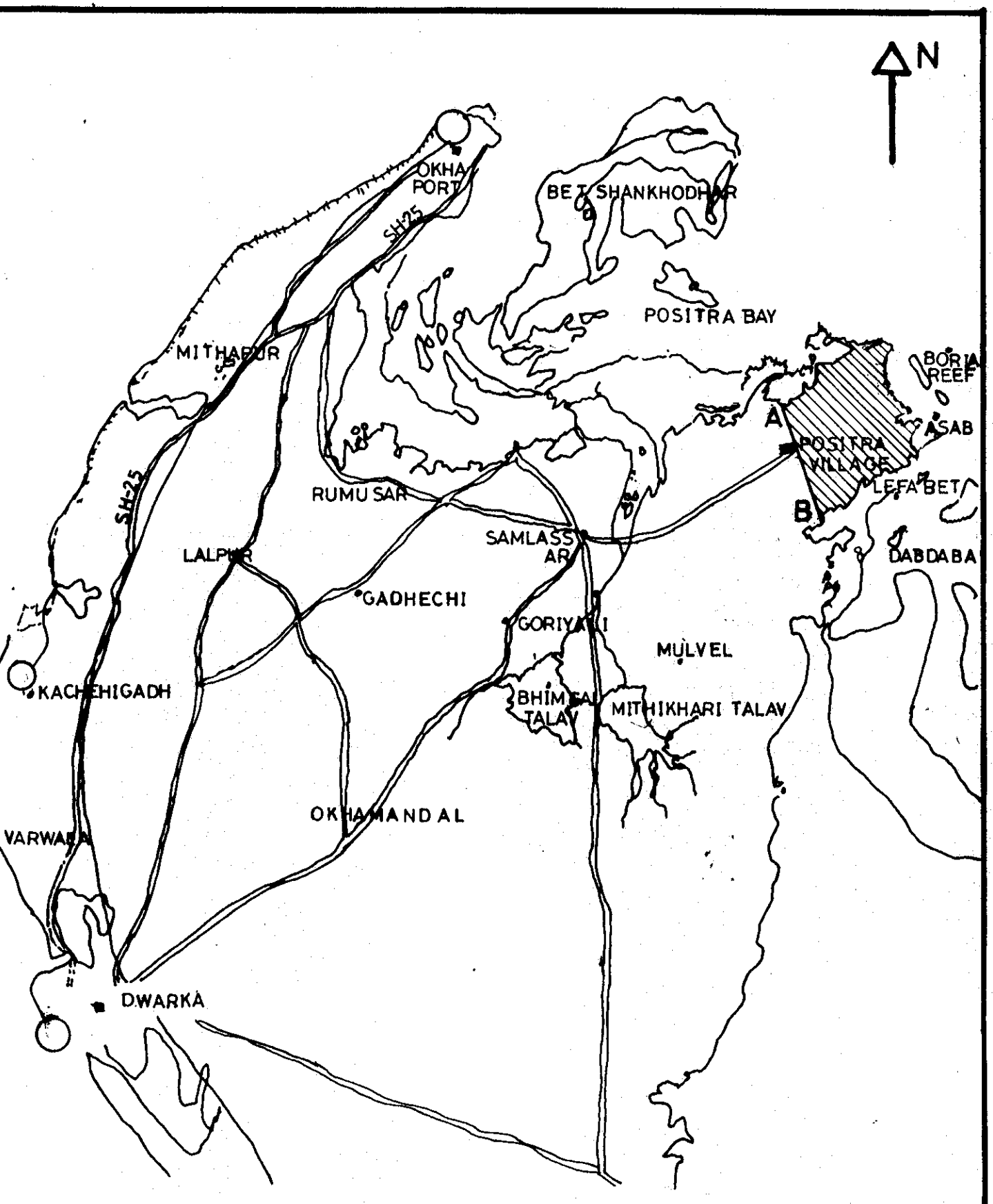
c) Preparation of survey map indicating all structures and prominent features, high water and low water levels, low tide, high tide and mean tide levels.

d) Preliminary survey to identify existing control points to ensure their correctness.

e) The horizontal control was fixed by :

   i) Closed traverse

f) The vertical control points were fixed by auto levels and closed by coming back to the starting point



AERA SURVEYED FOR POSITRA PORTS-STATE OF GUJARAT

SCALE-150000

FIG-1

g) **Spot levels and contour plans**

For taking the spot level, the area was divided with main grids of 50 m x 50 m and levels observed at every intersection.

h) Boundary Pillars were provided at 500 metres centre to centre and at all corners. These were of size 300 x 300 x 1000 mm deep. Permanent pillars of size 1500 x 1500 x 2000 mm, 2 nos. were provided with steel plates of 150 x 150 x 10 mm embedded in concrete with 12 mm dia x 150 mm long anchor bolts. These were provided with punch lines and painted with anticorrosive paint.

i) Survey map indicating the contours, boundary pillars, permanent pillars and all permanent feature were prepared.

4. Land Survey Operations

4.1 Survey Team

The Consultants M/s Intercontinental Consultants and Technocrats Pvt. Ltd. mobilised the survey team at the end of March, 1997 consisting of the following personnel.

1. Survey Expert - 1 No.
2. Survey Engineer - 1 No.
3. Surveyors - 3 No.
4. Support Staff - as necessary

In addition to the members of the team, guidance was also available from Shri H.S. Verma, General Manager of the Consultants and Shri Avinash Patil, Dy. Project Manager (Ports) of M/s Fredric R. Haris (India) Pvt. Ltd. who visited the site during survey operations. Full cooperation was available from GMB technical staff posted at Okha port.

The entire survey work was completed in 2 months time.

4.2 Survey Instruments

The following survey instruments were used :

a - Auto levels - 2 Nos.

b - Theodolite - 1 No.

c - Total Station - 1 No. (Topcorn GTS-304)

d - Plane Tabling - 2 No.

e - Measuring tapes - 50m - 3 Nos.

4.3 Transfer of Levels

The nearest Survey of India Bench Mark was available at Okha Port at a distance of about 30 km. The levels were transferred from this bench mark to the bench marks established at site (2 nos.) shown as A and B in **Fig-1**.

The correctness of the levels was ensured by starting and closing on the Survey of India Bench Mark at Okha port.

4.4 **Horizontal Control**

The horizontal control was fixed by Closed Traverse. Since about 1/3 area was covered by thorny thick bushes, triangulation was not possible. First grid pillars were provided and base line AB, indicated in Fig.-1, was established. The traversing followed along the boundary of the area surveyed. The closed traverse was set by measurement of coordinates directly read from Total Station. The number of traverse stations was 48.

4.5 **Vertical Control**

Vertical control points were fixed by auto level on all the traverse stations and were closed by coming back to the starting point. The closing error was 5 mm. The levels of the control points (boundary pillars) are given in **Table-1**.

4.6 **Spot Levels and Contour Plans**

For taking the spot levels, the area was divided into main grids of 50m x 50m, with reference to the base line AB, indicated in Fig.- 1.

The levels were observed at every intersection. For locating prominent physical features of the terrain, these grids were further divided into smaller grids of 25m x 25m. The field levels were so obtained as to get a contour interval of 0.5 metre. All the contours are indicated in the Map at **Annexure-A**. All spot heights in a mesh of 50m x 50m are also shown therein.

4.7 **Coordinates**

M/s Comaco Ltd., Bombay established coordinates of bore hole no. 10 at site with the help of G.P.S. All the coordinates of the permanent pillars and boundary pillars were transferred from this bore hole with the help of Total Station. The coordinates of permanent pillars and boundary pillars are given in **Table-2**.

4.8 **Survey Map**

The Survey Map has been prepared to a scale of 1:5000. All the boundary pillars and permanent pillars have been shown in the map. Important features of the area are also shown. The Survey Map is enclosed at **Annexure-B**. This also shows the 100m grid for defining the coordinates of various areas. The spot levels and contours are shown in the map at **Annexure-A** as mentioned in para 4.6 above.

TABLE - 1

Bench Marks List
Based on Survey of India Bench Mark R.L. 6.5487 (GTS)
Near Deputy Executive Engineer, Civil, Office – Okha Port

S.No.	Bench Marks No.	Reduced Levels (m)	Remarks
1.	B.M. –1	8.548	On Pillar No.1
2.	B.M. –2	10.020	On Pillar No.2
3.	B.M. –3	9.220	On Pillar No.3
4.	B.M. –4	6.013	On Pillar No.4
5.	B.M. –5	6.303	On Pillar No.5
6.	B.M. –6	5.258	On Pillar No.6
7.	B.M. –7	4.192	On Pillar No.7
8.	B.M. –8	4.425	On Pillar No.8
9.	B.M. –9	5.071	On Pillar No.9
10.	B.M. –10	6.344	On Pillar No.10
11.	B.M. –11	6.994	On Pillar No.11
12.	B.M. –12	6.990	On Pillar No.12
13.	B.M. –13	8.020	On Pillar No.13
14.	B.M. –14	8.557	On Pillar No.14
15.	B.M. –15	7.760	On Pillar No.15
16.	B.M. –16	7.306	On Pillar No.16
17.	B.M. –17	8.488	On Pillar No.17
18.	B.M. –18	9.055	On Pillar No.18
19.	B.M. –19	12.397	On Pillar No.19
20.	B.M. –20	14.984	On Pillar No.20
21.	B.M. –21	16.844	On Pillar No.21
22.	B.M. –22	16.097	On Pillar No.22
23.	B.M. –23	22.843	On Pillar No.23
24.	B.M. –24	21.530	On Pillar No.24
25.	B.M. –25	21.030	On Pillar No.25
26.	B.M. –26	12.673	On Pillar No.26
27.	B.M. –27	11.708	On Pillar No.27
28.	B.M. –28	5.587	On Pillar No.28
29.	B.M. –29	6.634	On Pillar No.29
30.	B.M. –30	4.883	On Pillar No.30
31.	B.M. –31	5.640	On Pillar No.31
32.	B.M. – A	7.014	A & B Pillars on Base line
33.	B.M. – B	16.705	And both are Main Pillars

Note : The Bench Mark height pertains to the top of the pillar. The height of the pillars above ground level is as under –

BMs A & B = 1.00 m
BM-1 to BM-31 = 0.50 m

TABLE - 2

List of Stations with Coordinates on Modified Everest Spheroid
Reference Station - Bore hole No. 10

Stations	Latitude				Longitude			
	°	'	"		°	'	"	
Bore hole No. 10 T 10	22	25	03	N	69	11	16	E
P2	22	24 69	17.858237	N	69	10	42.110706	E
B	22	22	46.785307	N	69	10	49.019813	E
P-21	22	22	55.953570	N	69	10	45.765693	E
P-22	22	23	5.393646	N	69	10	42.201001	E
P-23	22	23	17.032404	N	69	10	38.213783	E
P-24	22	23	34.953758	N	69	10	31.726758	E
P-25	22	23	48.735783	N	69	10	26.884814	E
P-26	22	24	0.251670	N	69	10	22.928305	E
P-27	22	24	19.558759	N	69	10	16.214053	E
A	22	24	31.480973	N	69	10	11.885133	E
P-1	22	24	24.913104	N	69	10	27.454226	E
P-3	22	24	12.103503	N	69	10	57.054686	E
P-4	22	24	8.448397	N	69	11	0.892242	E
P-5	22	24	3.524022	N	69	11	25.397553	E
P-6	22	23	58.712743	N	69	11	37.939065	E
P-7	22	23	58.417789	N	69	11	46.845110	E
P-8	22	24	4.204084	N	69	12	2.183467	E
P-9	22	23	56.093611	N	69	11	53.697490	E
P-10	22	23	49.192010	N	69	11	50.354513	E
P-11	22	23	41.346748	N	69	11	51.902417	E
P-12	22	23	38.377276	N	69	11	48.024783	E
P-13	22	23	32.778476	N	69	11	55.698179	E
P-14	22	23	26.633037	N	69	11	57.307554	E
P-15	22	23	27.761471	N	69	11	53.873488	E
P-16	22	23	22.041786	N	69	11	48.173062	E
P-17	22	23	15.347947	N	69	11	41.356058	E
P-18	22	23	14.304757	N	69	11	24.292604	E
P-19	22	23	5.502901	N	69	11	8.192822	E
P-20	22	22	58.739114	N	69	10	54.809884	E
P-28	22	24	49.288671	N	69	10	29.796946	E
P-29	22	25	8.672866	N	69	11	1.036021	E
P-30	22	25	13.494733	N	69	11	36.764115	E
P-31	22	24	36.889686	N	69	11	26.068672	E

APPENDIX B

REPORT ON METEOROLOGICAL DATA FOR OKHA PORT

BY

OCEAN ENGINEERING CENTRE,
I.I.T., MADRAS, CHENNAI.

DETAILED PROJECT PROPOSAL FOR POSITRA , GUJARAT

REPORT ON METEOROLOGICAL DATA FOR OKHA PORT

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INDIAN INSTITUTE OF TECHNOLOGY
MADRAS

NOVEMBER 1996

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1. INTRODUCTION

Gujarat Maritime Board has plans to develop various ports along the Gujarat coast as shown in Fig. 1. Gujarat Maritime Board has appointed **Frederic R. Harris India private limited** to prepare the detailed project report for **Positra Port**. Frederic R. Harris Inc. have appointed **IIT, Madras** to perform certain tasks in connection with the development of master plan. This report gives all the details of analysis of meteorological data at **Okha Port** which is the nearest meteorological observatory for the location of Positra.

The port development at Positra is comprising of Positra I and Positra II. Positra I is approximately located **22°28'24" N** and **69°08'48"E**. Positra II is located at **22°25'15"** N and 69°11'24".

2. DATA COLLECTION

The meteorological data at **Okha** have been collected from **I.M.D.** Pune and are given in Annexure I.

a. Fig I.1 and Fig I.2 gives the wind rose diagram collected from **I.M.D** Pune for the period 1969-1985 for 0830hrs and 1730hrs respectively for January to December.

b. Fig I.3 gives the Wind rose diagram for 0830 hrs and 1730 hrs for the period 1969 - 1985, for Jan, Feb & March.

c. Fig.I.4gives the wind rose diagram for 0830 hrs and 1730 hrs for the period 1969-1985 for Oct, Nov & Dec.

d. Fig. I.5 gives the wind rose diagram for 0830 hrs and 1730 hrs for the period 1969 - 1985 for July, Aug & Sept.

e. Fig. I.6 gives the wind rose diagram for 0830 hrs and 1730 hrs for the period 1969 - 1985 for Oct, Nov & Dec.

f. Fig. I.7 gives the representative wind rose diagram considering all the months for the period 1969 - 1985 which can be used for design purposes.

3. WIND

The Wind Rose diagram shown in Fig 1.1 to Fig 1.7 should be read considering the wind directions shown in Fig. 2.

The wind rose diagram shown in Fig. I.3 indicates that during the month of January the wind direction in the morning is from North East and in the evening it is from the North West. The mean wind speed during the month is generally under 22 Kmph.

During February to April, from the Fig I.3 and Fig I.4 the wind direction generally changes from North to NorthWest in the morning and in the evening it is from the NorthWest.The mean wind speed during this period is generally under 24 Kmph which can be read from the above Figures.

From May to September the predominant direction of the winds in the morning and in the evening it is SouthWest to West. The mean wind speed is usually under 30 Kmph during this period.

The predominant wind direction during the months of October to December the wind direction change in the morning from North to NorthEast and it is NorthWest in the evening. The mean wind speed during this period is generally below 23 Kmph.

The wind rose diagram shown in figure 1.7 is prepared using the method of probability percentage for the whole period, including all seasons. The wind rose diagram shows that general direction of the wind is from West to North-west.

4. SEASONS

The climate in a year can be divided into four seasons comprising non-monsoon during Jan to May, southwest monsoon season during June to September and Northeast monsoon season during October toDecember as generally observed in the country.

5. CYCLONES AND DEPRESSIONS

Wind speed upto 60 Kmph is described as cyclonic depression, and in the range of 60 Kmph to 80 Kmph as storm, and wind speeds exceeding 80 Kmph, signal severe storm

TABLE 2

Frequency of Occurence of Depressions / Storm within 2.5^0 ofOkha during the Period 1891-1970

MONTH	DEPRESSION	STORM	SEVERE STORM	TOTAL
January	0	1	0	1
February	0	0	0	0
March	0	0	0	0
April	1	0	1	2
May	0	0	2	2
June	7	4	7	18
July	8	1	0	9
August	3	1	0	4
September	8	2	1	11
October	3	3	0	6
November	4	0	2	6
December	0	0	0	0
Total	**34**	**12**	**13**	**59**

The number of depressions is maximum in the months of June,July and September.The number of depressions and storms is zero in the months of February,March and December.The number of tropical storms in the month of January is zero.The storm in January does not pertain to a tropical storm. It relates to a western disturbance which attained 'storm' intensity while moving eastwards over the North Arabian sea. The diagrams (numbering 13) showing Tracks of storms depressions are enclosed as (Annexure II)

The total number of tropical disturbances within77km of Okha for the period 1891-1970 is shown in Table 3.

TABLE 3

Frequency of Occurrence of Depressions / Storms within 77kms of Okha during the Period 1891-1970

MONTH	DEPRESSION	STORM	SEVERE STORM	TOTAL
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	1	1
May	0	0	0	0
June	2	0	1	3
July	3	0	0	3
August	1	0	0	1
September	1	1	0	2
October	2	0	0	2
November	2	0	0	2
December	0	0	0	0
Total	**11**	**1**	**2**	**14**

Out of these 11 are depressions, 2are tropical storms and 2 are severe tropical storms.January, February, March, and December, are months with the number of tropical storms zero.In April and June one severe storm each has occured during the period 1891-1970.The maximum number of depressions recorded is in the month of July which also is the month with maximum rainfall.

6. RAINFALL

Rainfall varies from year to year. For example the total rainfall in the period from **October 1975** to **June 1980** was **0 mm.** The heaviest rainfall recorded in one day during the period **1967-1995** is **283.3 mm** which is recorded on **10-08-1973.**

The average monthly rainfall for the period **1967-1995** which is calculated using the method of average given below:

Average rainfall for a particular month for a certain period of years=$\Sigma x/n$

where Σx - is the total rainfall for a particular month for a certain period of years and n - the number of years.

The average rainfall for the month of July is **145.62mm** which is the wettest month of the year.

Average annual rainfall is **304.48mm**.

The average of 10% of the heaviest rainfall recorded during the period is **101.67mm**. These values are obtained from Fig. 3 which is drawn using Meteorological data.

The Average monthly rainfall and maximum number of rainy days is given in Table 2 which is as follows

TABLE 4

MONTH	RAINFALL IN MM	MAXIMUM NUMBER OF RAiNY DAYS
January	0.94	1
February	2.08	1
March	1.46	2
April	0.08	0
May	0.69	1
June	47.22	8
July	145.62	12
August	69.06	11
September	19.87	7
Ooctober	5.87	7
November	10.28	4
December	1.31	1
TOTAL	304.48	

7. TEMPERATURE

The mean temperatures recorded during the period of **1967-1985** are presented in Table 3 using the method of Average.

The mean maximum temperature are of the order of **33°c** while the mean minimum temperature is of the order of **18°c.**which is shown in Figure 4 which is drawn based on Table 3.

The highest maximum temperature recorded in the period **1967-1985** is **39.8°c,**recorded on **11-06-1969,** while the lowest minimum temperature is **10.9°c** recorded on **10-02-1968.**

TABLE 5

MONTH	MAXIMUM TEMPERATURE	MINIMUM TEMPERATURE
JANUARY	24	18.7
FEBRUARY	24.6	19.3
MARCH	27.3	21.8
APRIL	29.8	24.4
MAY	31.8	26.6
JUNE	32.5	27.7
JULY	31.1	26.7
AUGUST	30	25.7
SEPTEMPER	30.1	25.4
OCTOBER	30	24.8
NOVEMBER	28.6	23.5
DECEMBER	25.8	20.6

TABLE 6

Temperature variation in 24 hours

YEAR	MONTH	DATE	MAXIMUM	MINIMUM	DIFFERENCE
1967	October	22	33.4	22.4	11
1970	June	30	35.3		
	July	1		26.7	8.5
1973	June	9	36.2	27.3	8.9
	July	9	33.5		
		10		24.5	9
	October		33.4	22.3	
	November	30	31.6		3.8
	December	1		27.7	
1977	September	3	31.1	21.8	9.2
1981	September	24	31	24.4	6.6

From the above data it is clear that the maximum temperature variation within 24 hours is **11^0c**

8. VISIBILITY

The meteorological datas obtained for Okha port gives us the Number of Days with visibility in KM as follows:

a. Less than 1 KM

b. Between 01 - 10 KM

c. Between 10 - 20 KM

d. Greater than 20 KM

Based on this the visibility less than 1 KM, is sorted out from the Data and presented in Table 7. It is clear from the table that the visibility less than 1 KM in Okha area during the month of March and June has occured totally for 10 days between 1967 - 1985.

TABLE 7

No. Of days with visibility less than 1 KM

YEAR	1967	1971	1972	1973		1975	1984	TOTAL
TIME (hrs)	0830	0830	0830	0830	1730	0830	0830	
MONTH								
JANUARY	-	-	-	-	-	-	-	-
FEBRUARY	1	-	-	1	1	-	-	3
MARCH	-	-	2	2	2	1	3	10
APRIL	-	1	-	1	-	1	-	3
MAY	-	-	-	-	-	-	-	-
JUNE	-	-	-	4	6	-	-	10
JULY	-	-	-	-	-	-	-	-
AUGUST	-	-	-	-	-	-	-	-
SEPTEMBER	-	-	-	-	-	-	-	-
OCTOBER	-	-	1	-	-	-	1	2
NOVEMBER	1	-	-	-	-	-	-	-
DECEMBER	-	-	-	-	-	-	-	-

9. RELATIVE HUMIDITY

Using meteorological datas, the Relative Humidity at Okha port is maximum in the morning and minimum in the evening which can be seen from Table 8 and Figure 5 which is arrived by using the Methods of Average.

The relative humidity is maximum during the SouthWest monsoon season and is around **85%** and minimum during winter around **60%**.

TABLE 8

Relative Humidity

MONTH	08.30HRS %	17.30HRS %
JANUARY	63.7	60.6
FEBRUARY	71.8	66.8
MARCH	79.7	73.6
APRIL	83.8	77.4
MAY	80.4	77.2
JUNE	80.7	77
JULY	84.1	80.2
AUGUST	86.5	82.3
SEPTEMBER	84.8	80.7
OCTOBER	81	77.5
NOVEMBER	68.2	67.6
DECEMBER	62.8	59.8

10. SUMMARY

In order to prepare the detailed project report for Positra I & II, the meteorological data at Okha port, which is the nearest IMD, is collected from IMD, Pune for the period **1967 - 1995**. Based on the analysis of above data the following observations have been made.

The wind rose Diagrams show the maximum mean wind speed is 30 Kmph during the month of May to September. When Severe Storms & Depression occurs the wind speed is more than 60 Kmph which occurs mostly during in the month of May, June, October and November. So, extra precautions should be taken in these months. During the month of February the occurrence of Storm and Depression is nil. These observations

are taken from the Table 1 which is obtained from Tracks of Storms and Depressions published by IMD, Pune.

The heaviest Rainfall occured in the month of July for the period **1967 - 1995** and the month of April is having zero rainy days. The work can be carried out almost through out the year except for the month of July and August. Number of Rainy days during the month of June, September and October is less than 10. The average of 10% of the heaviest rainfall recorded during the period 1967 - 1985 is 101.67 mm.

The visibility less than 1 KM has occured totally for ten days during the month of March and June between 1967 - 1985.

The maximum temperature recorded on June 11th 1969, is 39.8°C and the minimum temperature recorded in February 10th 1968 is 10.9°C.

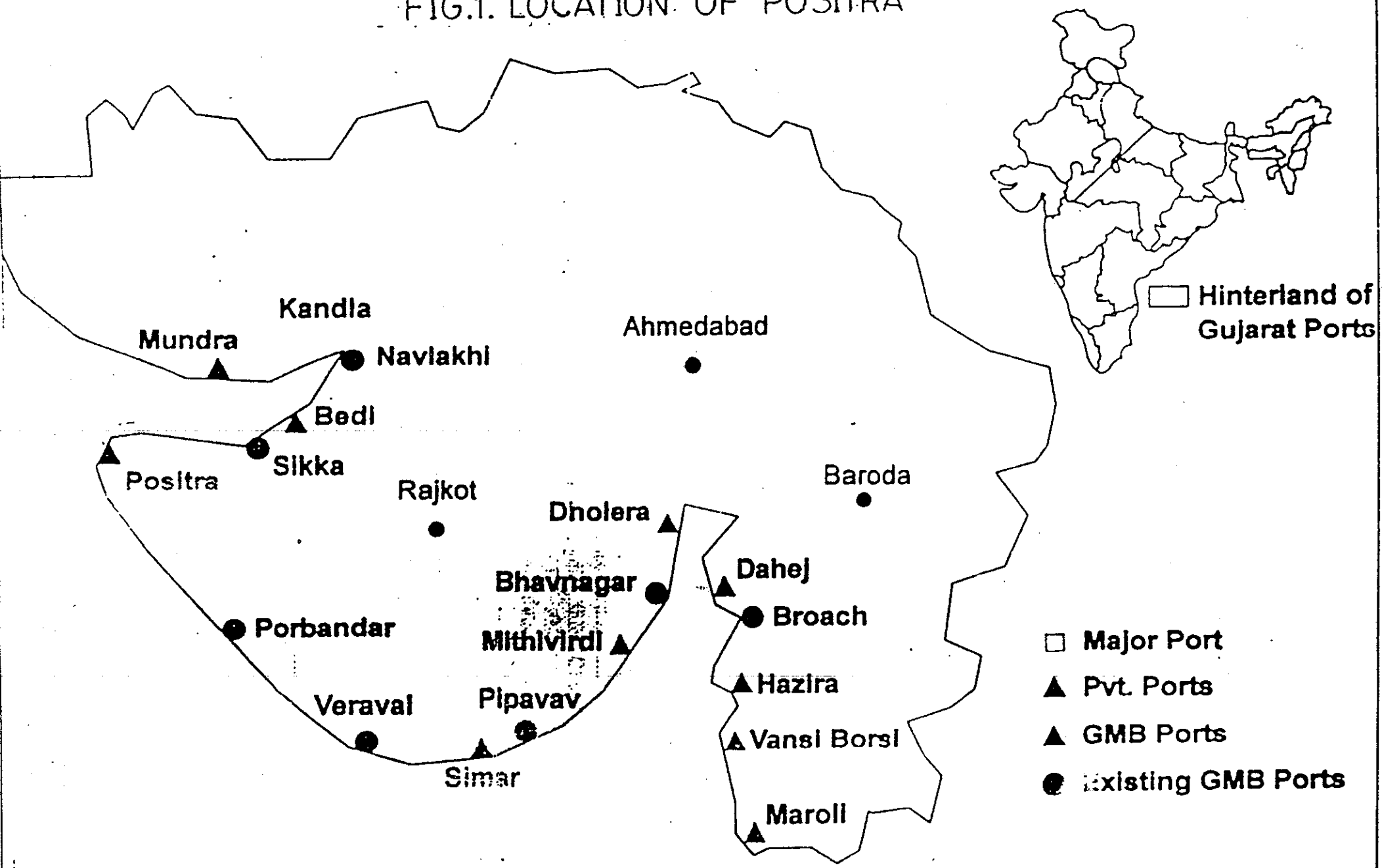
The maximum variation in temperature in 24 hours is 11^{0}C.

In general, Relative Humidity is almost above 80 % during the month of March to October at 0830 hrs.

(Dr. V. SUNDAR) **(Dr. R. SUNDARAVADIVELU)** **(Dr. R. NATARAJAN)**

(Dr. S.R. GANDHI) **(Dr. S. MEENAKSHISUNDARAM)**

FIG.1. LOCATION OF POSITRA



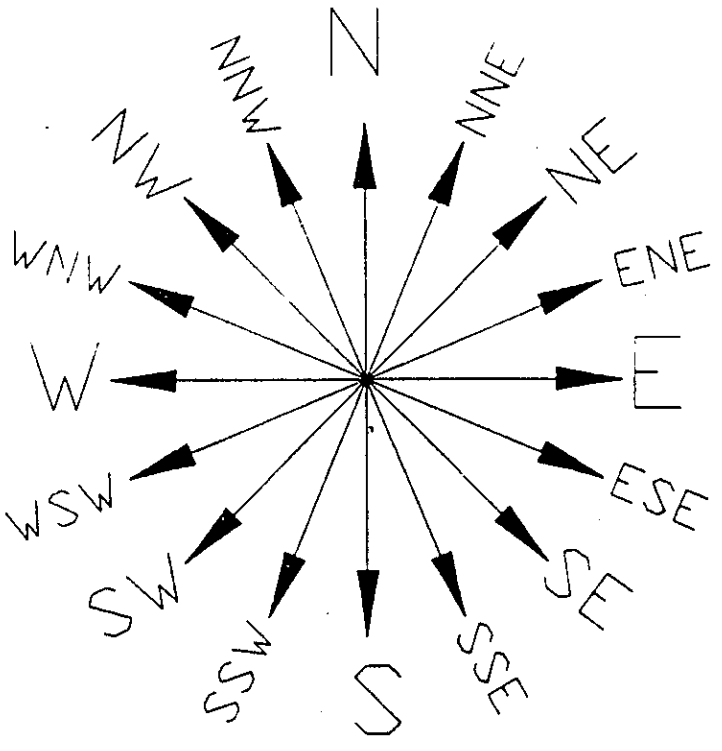


Fig.2 WIND DIRECTIONS

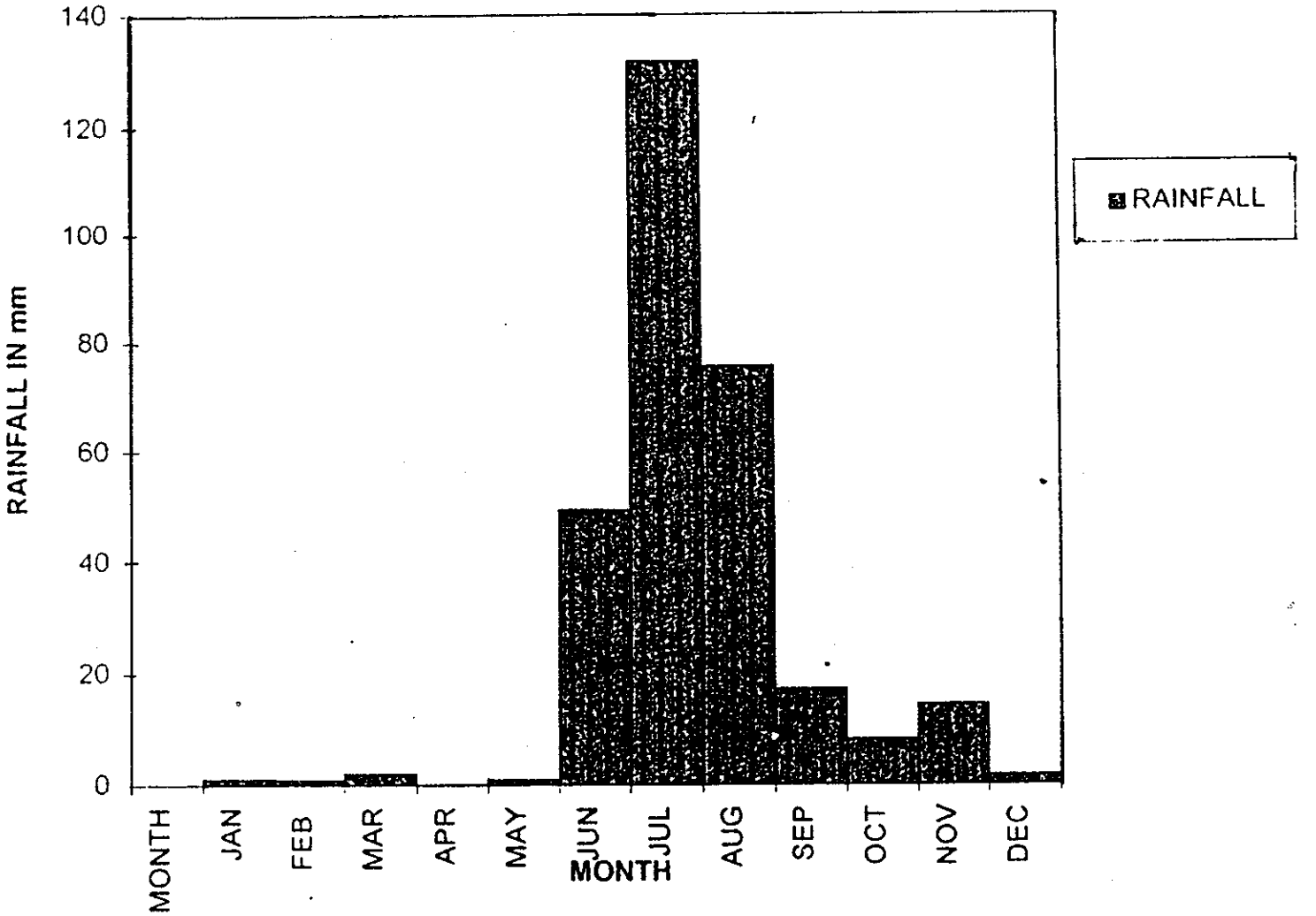


FIGURE 3 RAINFALL

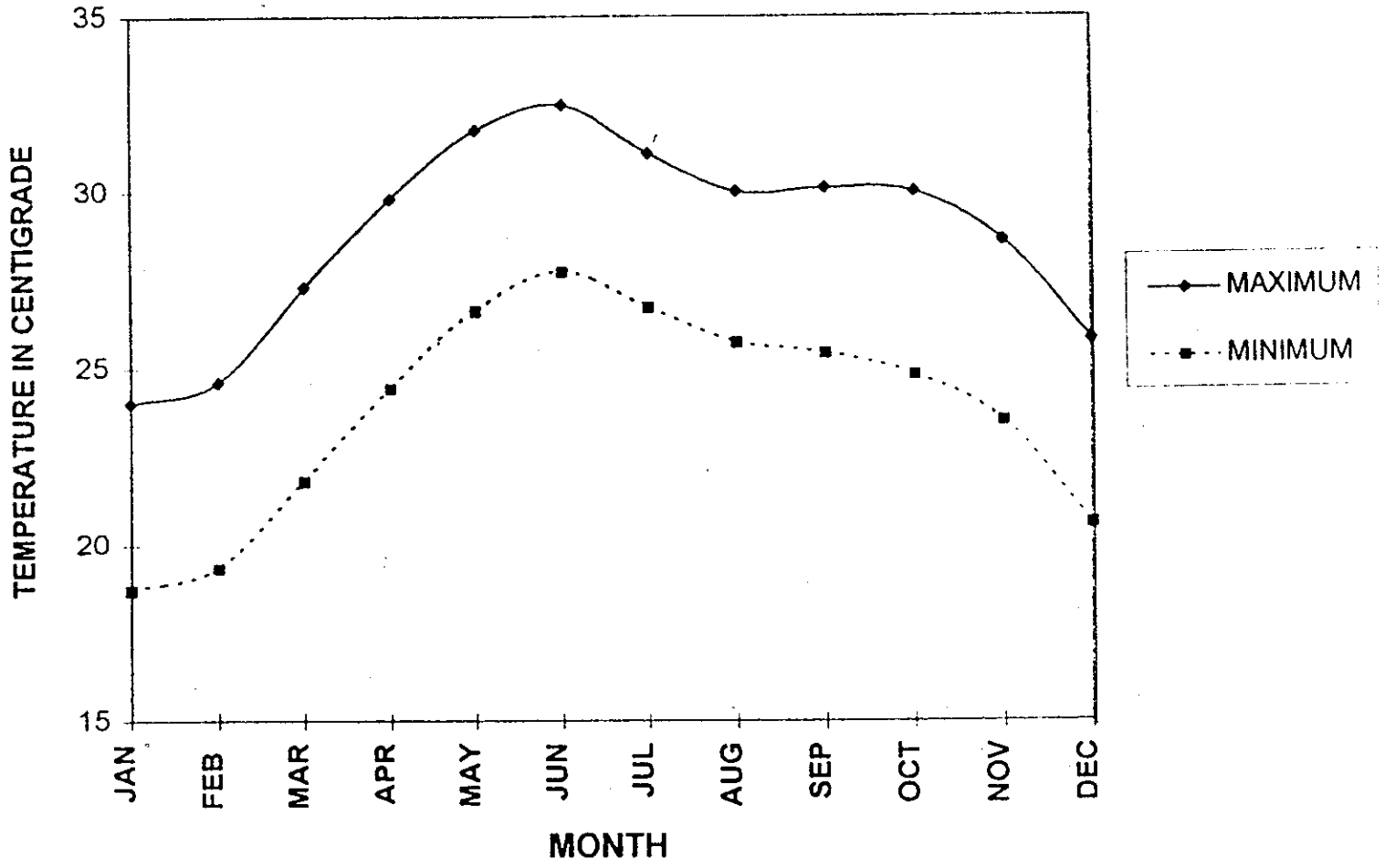


FIGURE 4 MINIMUM AND MAXIMUM TEMPERATURE

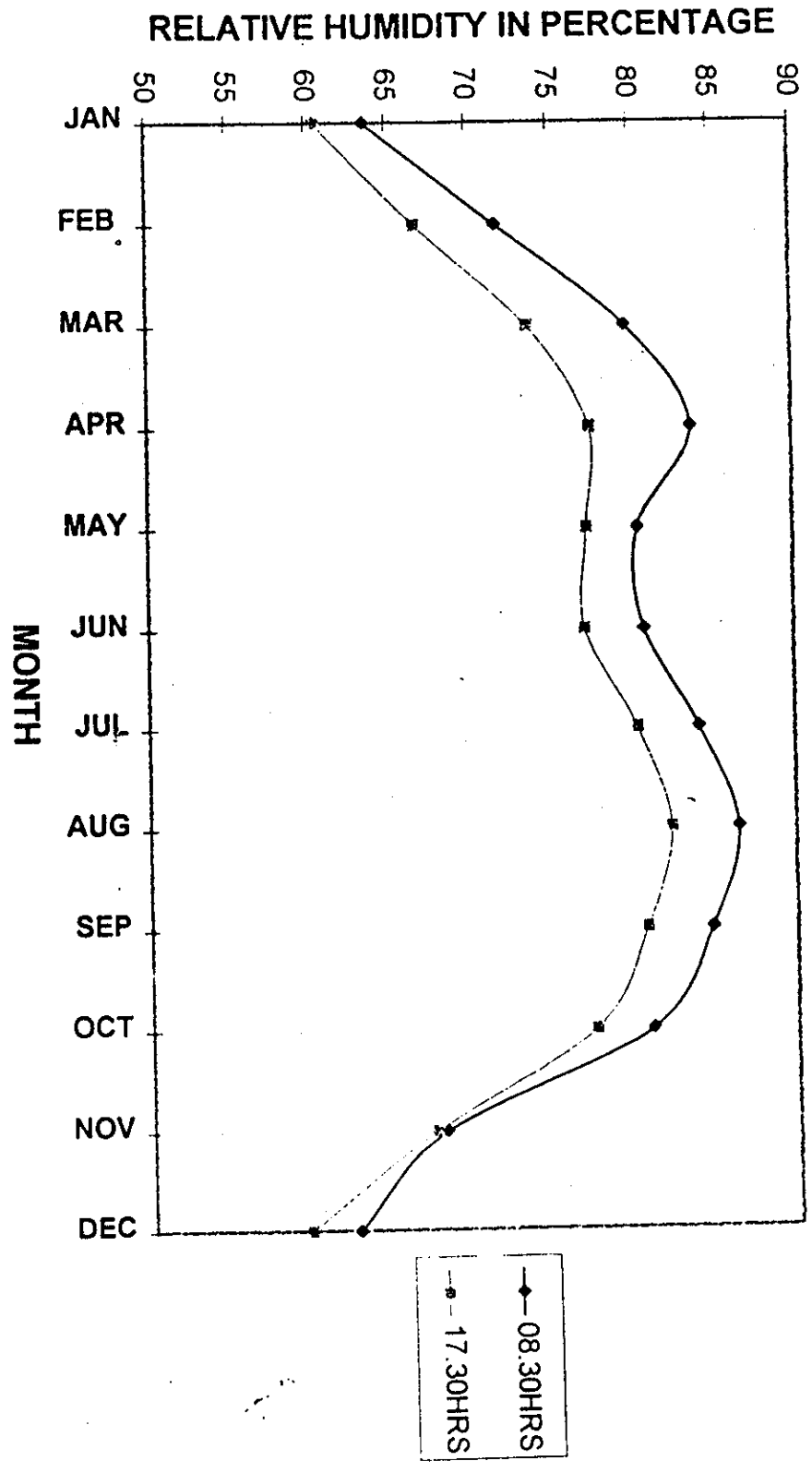
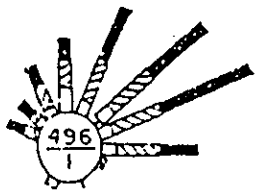


FIGURE 5 RELATIVE HUMIDITY

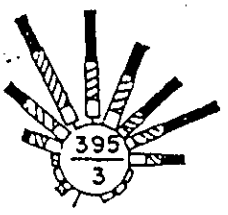
WIND ROSES

FOR: OKHA

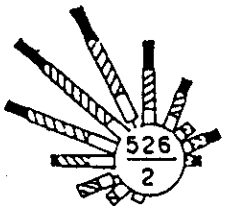
0830 HRS. I.S.T.



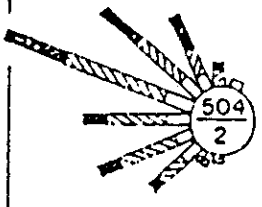
JANUARY



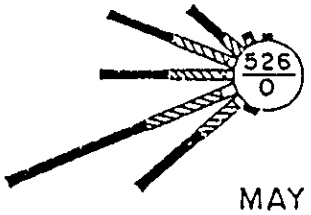
FEBRUARY



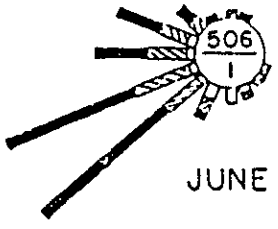
MARCH



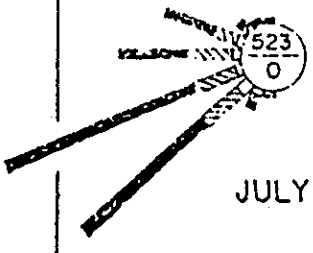
APRIL



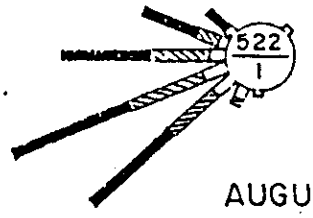
MAY



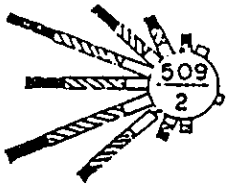
JUNE



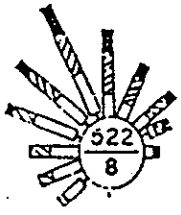
JULY



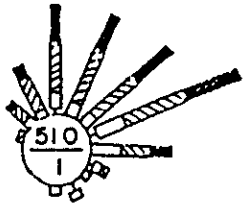
AUGUST



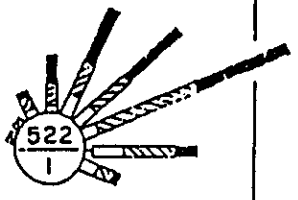
SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

FIG. 1.1

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N / C

1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

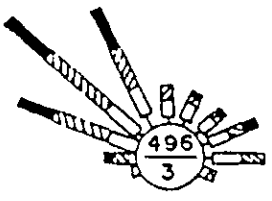
N: TOTAL NUMBER OF OBSERVATIONS.

C: TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES.

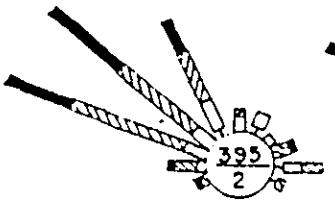
PERIOD: 1969 – 85

WIND ROSES

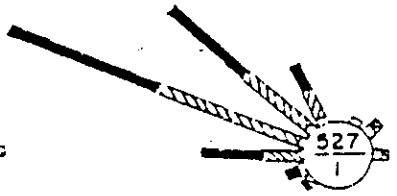
FOR : OKHA 1730 HRS. I.S.T.



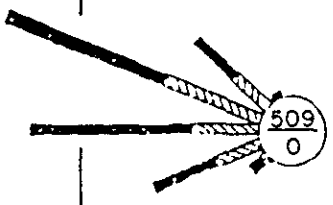
JANUARY



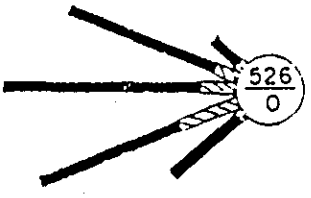
FEBRUARY



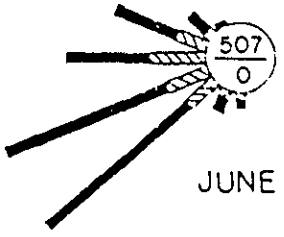
MARCH



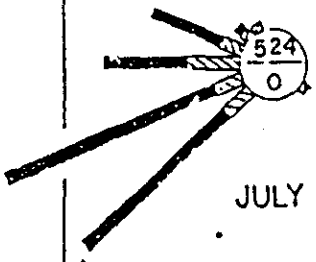
APRIL



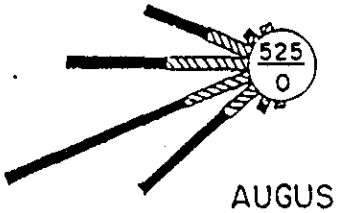
MAY



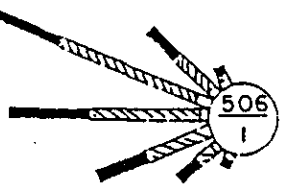
JUNE



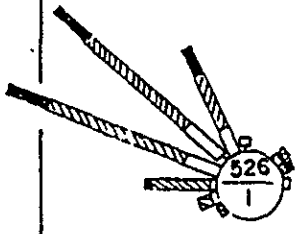
JULY



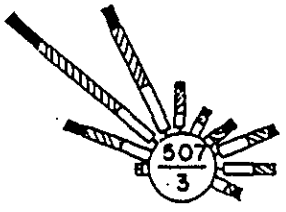
AUGUST



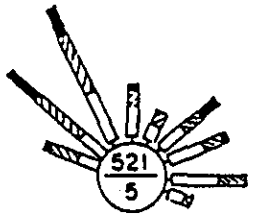
SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

FIG. 1.2

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N / C

1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

N : TOTAL NUMBER OF OBSERVATIONS.

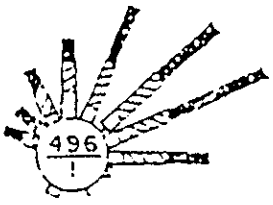
C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

PERIOD : 1969 – 85

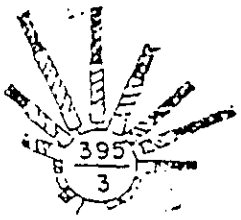
WIND ROSES

FOR : OKHA

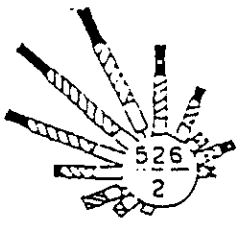
0830 HRS. I.S.T



JANUARY

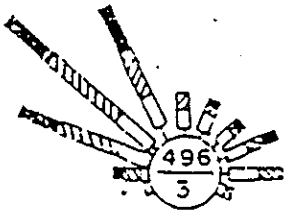


FEBRUARY

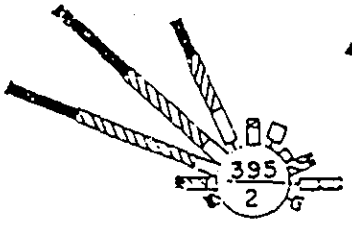


MARCH

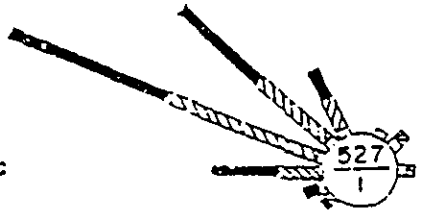
1730 HRS. I.S.T.



JANUARY



FEBRUARY



MARCH

FIG 1.3

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N/C 1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

N : TOTAL NUMBER OF OBSERVATIONS.

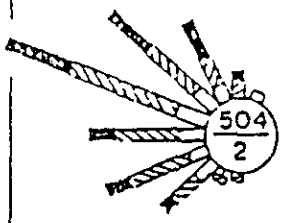
C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

PERIOD : 1969 – 85

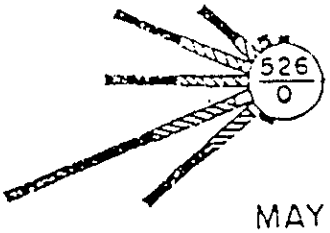
WIND ROSES

FOR : OKHA

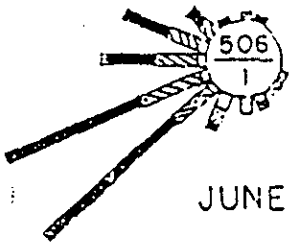
0830 HRS. I.S.T.



APRIL

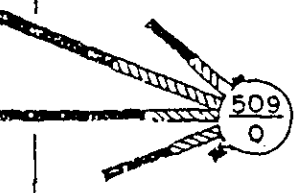


MAY

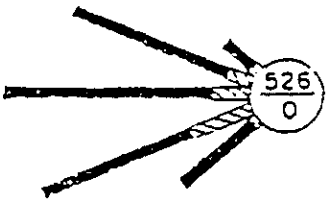


JUNE

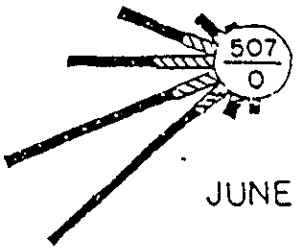
1730 HRS. I.S.T.



APRIL



MAY



JUNE

FIG. 1.4

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N / C

1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

N : TOTAL NUMBER OF OBSERVATIONS.

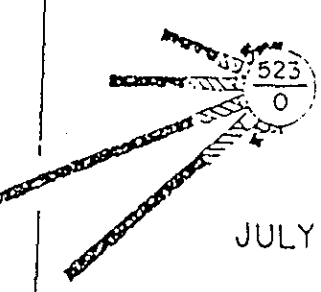
C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

PERIOD : 1969 – 85

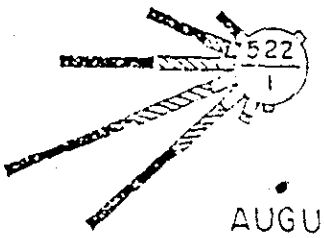
WIND ROSES

FOR : OKHA

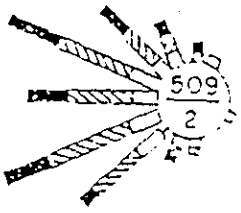
0830 HRS. I.S.T.



JULY

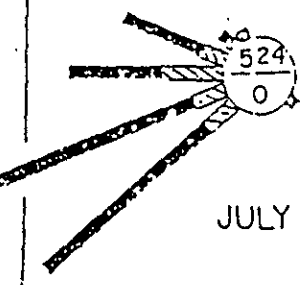


AUGUST

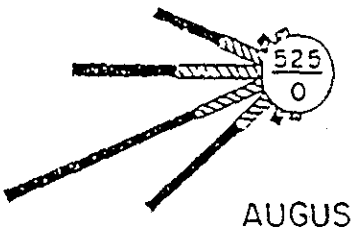


SEPTEMBER

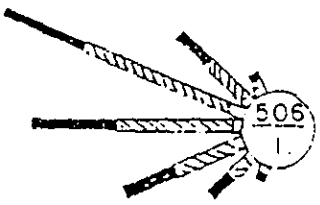
1730 HRS. I.S.T



JULY



AUGUST



SEPTEMBER

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N/C 1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

FIG. I.5

N : TOTAL NUMBER OF OBSERVATIONS.

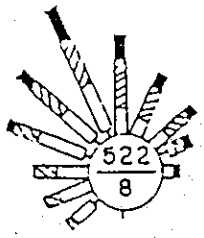
C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

PERIOD : 1969 – 85

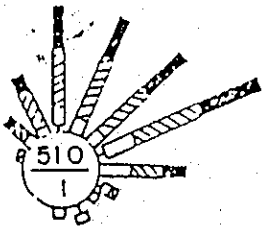
WIND ROSES

FOR : OKHA

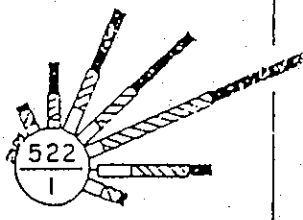
0830 HRS. I.S.T.



OCTOBER

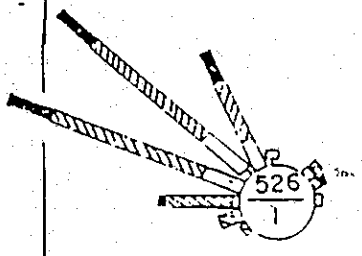


NOVEMBER

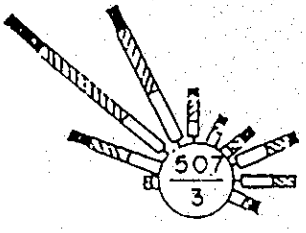


DECEMBER

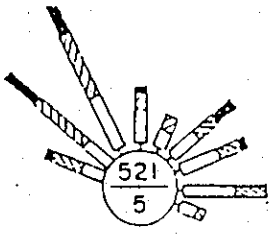
1730 HRS. I.S.T



OCTOBER



NOVEMBER



DECEMBER

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

N / C

1-5 6-11 12-19 > 19 kmph.

1-3 4-6 7-10 > 10 knots.

FIG. 1.6

N : TOTAL NUMBER OF OBSERVATIONS.

C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

PERIOD : 1969 – 85

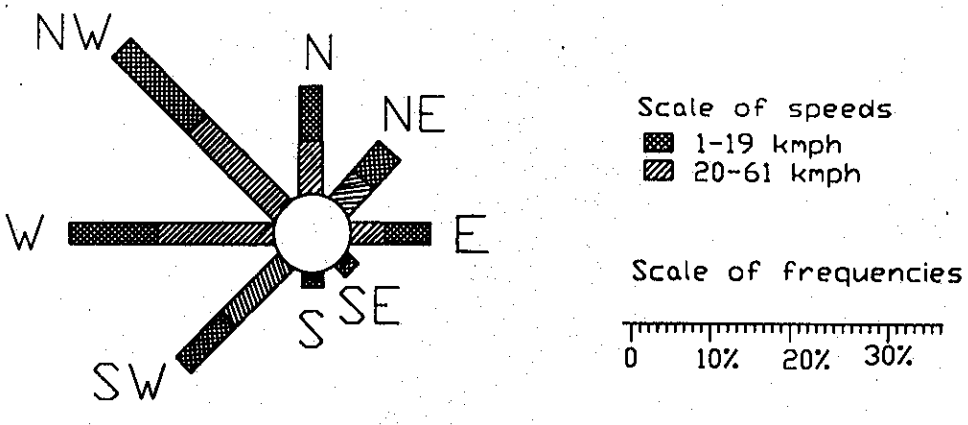


Fig. I.7 Wind rose diagram for Okha port(annual)

ANNEXURE I

METEOROLOGICAL DATA

The following table which is obtained from I.M.D.Pune, for Okha port for the period 1967 to 1985, in Tabulated form is given below and which is to be read as follows:

Abbreviations used for Monthly Surface Data:

MN	-	Month
MMAX	-	Mean Maximum Temperature
HMAX	-	Heaviest Maximum Temperature
DT	-	Date
MMIN	-	Mean Minimum Temperature
LMIN	-	Lowest Minimum Temperature
DT	-	Date
MRF	-	Total Rainfall in the Month
HVVRF	-	Heaviest Rainfall in 24 hrs
DT	-	Date
RD	-	Number of Rainy Days
MWS	-	Mean wind speed in (Kmph)

INDEX	YEAR	MN	MMAX	HMAX	DT	MMIN	LMIN	DT	...MRF	HVYRF	DT	RD	MWS
42730	1967	1	23.2	26.2	23	17.2	15.1	13	0	0		0	21.5
		2	25.2	27	21	19.2	17.1	11	0	0		0	16.7
		3	27.7	30.4	19	22.4	20.5	16	39.4	36.6	24	2	18.1
		4	29.4	31.7	27	24.1	21.7	4	0	0		0	20.5
		5	31.7	34	17	26.5	25	12	0	0		0	24.8
		6	32	34.6	14	27.1	25	26	114.4	77.4	26	7	21.1
		7	30.9	32.7	2	26	22.9	26	538.3	135.8	5	12	27.2
		8	30	31.1	31	25.6	24.2	1	127.1	76.6	23	3	21.9

	9	30.3	31.1	2	25.7	23.9	18	5.8	4	17	1	20.7
	10	30.1	33.4	22	24.4	22.4	22	0	0		0	13.9
	11	28.2	30.3	5	23.3	21.3	8	0	0		0	15.9
	12	25.3	27.5	1	19.5	16.4	30	27.8	24.2	16	1	21.5
1968	1	23.8	28.4	6	17.8	14.1	23	7	7	28	1	20.5
	2	23.9	29.8	26	18	10.9	10	4.5	4.5	19	1	18.9
	3	27.2	29.8	19	21.4	20	13	0	0	0	0	20.3
	4	28.9	30.2	22	23.5	22	8	0	0	0	0	19.7
	5	30.8	32.2	25	25.4	23.3	10	0				23.7
	6	32.5	35.1	17	27.3	26	1	0.2	0.2	18	0	26.1
	7	31.9	32.9	4	27	25.9	29	9	4.1	5	1	26.5
	8	29.3	30.6	4	25.2	24	8	131.1	78	8	4	28.5
	9	30.5	31.7	25	25.1	23.9	1	0.7	0.5	7	0	14.6
	10	30.6	33.6	22	25.2	23.9	7	0	0	0	0	17
	11	29.6	30.9	10	23.7	21.9	2	0	0		0	15.4
	12	25.8	28.5	9	20.4	16.5	27	0	0		0	18.3
1969	1	24.1	26	25	18	15.2	14	0	0	31	0	18.1
	2	24.7	27.4	20	19.1	17.1	5	0	0	28	0	19.1
	3	27.5	33.2	30	21.9	19.7	10	0	0	31	0	19.7
	4	30.1	31.4	21	24.3	22.3	5	0	0	30	0	20.6
	5	31.9	32.9	30	26.5	25	8	0	0	31	0	25.2
	6	33.1	39.8	11	27.5	26.5	6	0	0	30	0	22.8
	7	31.8	33.4	14	26.7	24.2	22	204	156.8	22	8	26.4
	8	29.5	30.6	7	25	23.3	16	13.2	4.3	16	1	23.3
	9	29.9	31.3	3	24.4	22.5	28	0	0	30	0	20.9
	10	29.5	31	23	23.4	21.3	12	0	0	31	0	13.3
	11	29	32.5	9	23.3	20	30	1.3	1.3	30	0	17.6
	12	26.8	28.8	10	21.1	18.6	28	0	0	31	0	16.4

1970	1	24.7	26.5	5	19.7	16.3	20	1.8	1.8	25	0	18.8
	2	25	27.4	28	19.8	16.9	3	0	0	28	0	17.5
	3	26.9	28.7	31	21.8	20.2	3	0	0	31	0	20.2
	4	29.8	31.5	30	24.6	22.4	6	2	2	15	0	18.9
	5	31.7	32.5	27	27	24	31	19.7	19.7	31	1	23.9
	6	32.8	35.3	1	28.3	26.7	30	10.5	8.4	30	1	20.6
	7	31	33	1	26.8	22.9	6	223.8	75.2	6	7	25.1
	8	30.2	32	8	25.9	23.6	29	284.1	91.5	15	11	21.3
	9	29.6	32	24	25.5	23.9	8	64.3	23.7	8	6	16.1
	10	30.3	33.5	13	26.1	24.6	24	0	0	31	0	15.8
	11	28.4	31.8	1	23	18.4	20	0	0	30	0	15.6
	12	25.2	26.9	6	20	16.6	23	0	0	31	0	17.2
1971	1	23.6	26	1	18.5	16	28	0	0	31	0	19.3
	2	24.8	29.4	25	19.1	16.6	2	0	0	28	0	17.9
	3	27.2	31.9	15	21.3	18.1	6	0	0	31	0	17.6
	4	30.6	36.4	20	24.7	22.7	1	0	0	30	0	17.8
	5	31.8	33	22	27	25.5	1	0	0	31	0	24.8
	6	31.5	34.3	3	27.2	23.3	25	71.8	55	25	4	28.2
	7	29.9	31.3	7	26	23.8	14	55	17.4	17	7	24.4
	8	29.8	30.9	27	25.6	23.4	31	41.4	10.5	31	7	25
	9	30.1	30.8	30	25.1	23.7	1	10.3	9	1	1	15.3
	10	29.6	33.3	24	23.9	21.6	29	0	0	31	0	
	11	28	29.9	18	22.7	20.4	23	0	0	30	0	14.3
	12	26.1	27.8	6	20.8	18	20	0	0	31	0	16.1
1972	1	24.5	26.2	21	19.7	15.7	26	0	0	31	0	17.2
	2	23.1	25.6	21	18	15.8	13	6.3	4.4	5	1	23.9
	3	26.4	31.1	15	21	18.7	3	0	0	31	0	18.3

	4	29	30	30	24.2	22.1	3	0.3	0.3	23	0	21.8
	5	31.9	35.2	19	26.6	24.9	3	0	0	31	0	23
	6	32.8	34.8	26	28	24.8	30	126.2	96.6	30	4	21
	7	31.2	32.3	9	27.4	24.9	3	51	18.9	3	5	29.5
	8	30.7	31.6	3	26.6	25.6	31	1.5	0.5	9	0	26.4
	9	29.9	31	18	25.5	24	30	0	0	30	0	18.7
	10	29.7	34.5	7	24.5	22	26	0	0	31	0	11.9
	11	28.9	31.5	4	23.8	20.8	28	0	0	30	0	19.5
	12	25.5	27.5	6	20.5	17.1	30	0	0	31	0	20.7
1973	1	22.9	25.5	19	18.2	15.9	21	1.9	1.9	5	0	20.9
	2	24.3	27.4	26	19.2	17.2	15	0	0	28	0	17.7
	3	27.6	33.2	25	21.8	18.3	12	0	0	31	0	18.8
	4	30.2	32.2	8	24.8	22.9	1	0	0	30	0	18.9
	5	31.7	32.5	28	27.3	25.6	18	0	0	31	0	25.8
	6	32.4	36.2	9	28.2	27.3	9	10.5	4.6	7	1	29.7
	7	30.7	33.5	9	26.5	24.5	10	351	283.3	10	8	26.9
	8	30	31	15	26.2	24.6	29	26.4	16.2	5	3	22.5
	9	29.5	30.8	4	25.2	24.1	14	7.6	3.9	12	2	17.6
	10	29.8	33.4	23	24.3	22.3	24	0	0	31	0	12.3
	11	28.4	31.6	1	23.7	21.8	30	0	0	30	0	16.5
	12	25.3	27.7	1	20.2	17.1	19	0	0	31	0	22.2
1974	1	23.8	25.6	6	18.8	15.5	28	0	0	31	0	15.9
	2	24	28.2	19	18.5	14.6	9	0	0	28	0	20.3
	3	27.8	31.8	27	22.7	20.7	2	0	0	31	0	18.1
	4	29.9	31.4	16	25.2	23	6	0	0	30	0	21.9
	5	31.7	34.9	21	27	25.6	19	0	0	31	0	23.4
	6	31.8	33.6	1	28	27.3	28	0.2	0.2	22	0	29.5
	7	31.8	32.9	11	28.1	27.1	30	0.6	0.3	10	0	26

	8	30.9	32.1	27	27	23.3	9	20.2	15.9	2	1	25.1
	9	30.9	34.1	24	26.6	25.7	11	1.2	0.6	27	0	19.7
	10	31.3	33.2	12	26.5	22.6	18	30.6	30.4	18	1	16.7
	11	28.4	30.7	13	24.2	22	29	0	0	30	0	19.1
	12	24.9	26.5	1	20.2	17.4	20	1.2	1.2	16	0	19
1975	1	23.1	26.1	8	18.2	16.5	9	12.6	12.6	9	1	20.2
	2	24.3	25.9	25	19.3	16.9	18	0	0	28	0	18.1
	3	26.3	31.8	30	20.8	18.6	12	0	0	31	0	18.5
	4	29.1	31.6	21	24.2	22.4	1	0	0	30	0	19.4
	5	31.7	32.9	29	26.9	24.9	2	0	0	31	0	22.9
	6	32.3	33.9	18	27.9	24.7	21	19.1	7	24	3	23.7
	7	31.2	33.3	25	27.4	25.7	14	38.8	20.4	14	3	24.2
	8	30.2	32	7	26.1	23.1	29	178.6	34.7	30	11	21.4
	9	29.3	30.5	9	25.6	23.2	13	96.6	31	3	7	17
	10	29.6	32	1	25.4	23.2	31	98.7	43.2	23	7	16.2
	11	27.9	30	10	23.4	20.6	12	0	0	30	0	15.6
	12	25.7	26.5	15	21.2	18.4	27	0	0	31	0	14.6
1976	1	24.4	26.1	30	19.6	16.5	19	6.5	6.2	30	1	17.1
	2	25.4	27.3	22	20.5	18	1	0	0	29	0	17.1
	3	27.4	31.1	16	22.6	20.3	18	0	0	31	0	19
	4	29.3	30.9	24	24.5	21.4	1	0	0	30	0	23.3
	5	31.5	37.5	25	26.8	24.9	1	0	0	31	0	27.6
	6	32.6	33.8	30	28.2	27.3	2	0	0	30	0	25.1
	7	31.7	34.4	8	27.3	23	19	155	110	23	4	27.6
	8	29.7	31.4	4	26	23.5	31	0	0	26	0	22.5
	9	30	30.9	29	25.4	23.7	1	0	0	30	0	16.9

	10	30.1	31.9	18	25.6	24.1	27	0	0	31	0	14.1
	11	29.4	32.1	7	25	21.9	17	0	0	29	0	16.4
	12	25.8	27.4	4	21.5	18.8	10	0	0	31	0	18.2
1977	1	24.1	27	24	18.8	15.6	28	0	0	31	0	17.9
	2	24.8	27.4	26	20.1	17.1	6	0	0	28	0	13.5
	3	29	32.7	21	22.8	20.5	4	0	0	31	0	14.4
	4	30.6	32.7	26	25.3	24.1	5	0	0	30	0	19.3
	5	32	33.2	30	27.1	25.6	2	0	0	31	0	23.8
	6	32.7	35	13	28	26.9	30	0	0	29	0	22.6
	7	30.8	32.8	25	26.7	24	8	0	0	31	0	23.6
	8	30.1	31.1	30	25.8	23.8	10	0	0	30	0	20.1
	9	29.6	31.1	3	24.8	21.8	3	0	0	30	0	16.6
	10	30.4	31.9	21	25	23.1	25	0	0	31	0	10.7
	11	30	33.1	12	24.6	22.2	19	0	0	30	0	14.2
	12	27.1	29.2	1	21.7	18.5	30	0	0	31	0	14.6
1978	1	24.5	25.9	27	19	15.8	3	0	0	31	0	15.1
	2	24.8	27.9	26	19.4	16.6	18	0	0	28	0	15.9
	3	26.8	30	8	21.4	19.8	3	0	0	31	0	17.5
	4	30	32.4	25	24.2	21.7	2	0	0	30	0	14.4
	5	32.2	33.2	25	26.4	25	7	0	0	31	0	19.8
	6	32.7	36.5	5	27.2	25.3	20	0	0	30	0	18.1
	7	30.2	31.7	8	25.9	23.5	2	0	0	31	0	21.9
	8	29.7	30.9	6	25.1	22.8	18	0	0	27	0	18.9
	9	29.9	30.4	16	24.5	23.6	25	0	0	29	0	12.5
	10	29.5	31.4	24	23.9	22.2	21	0	0	31	0	9.5
	11	28.9	33.3	11	23.5	20.6	27	0	0	30	0	16
	12	25.9	27.4	25	20.4	17.7	30	0	0	31	0	15

1979	1	24.1	26.1	13	18.8	14.3	31	0	0	31	0	17.2
	2	23.8	26.8	19	18.8	17.1	15	0	0	28	0	17.2
	3	26.2	28.2	31	20.6	16.8	9	0	0	31	0	15.3
	4	29.5	32.8	29	23.6	21.7	11	0	0	30	0	15.6
	5	31.2	32.1	14	25.7	23.8	3	0	0	31	0	19.8
	6	32.5	35.6	20	26.8	24.1	29	0	0	25	0	18.5
	7	31.5	32.4	13	26.8	25.5	24	0	0	31	0	21.4
	8	29.3	32.2	1	24.6	22.5	13	0	0	31	0	21.6
	9	30.8	33.2	23	25.4	22.4	18	0	0	30	0	15.2
	10	30	31.3	4	24.3	22.9	23	0	0	31	0	11.5
	11	29	32.2	6	24.5	21.4	21	0	0	30	0	16
	12	26.1	28.3	7	21.6	19.5	2	0	0	31	0	15.3
1980	1	23.9	26.3	1	19.2	16.9	6	0	0	31	0	17.9
	2	25.2	28.3	29	20.3	16.4	5	4.9	4.9	3	1	14.3
	3	27.6	30.4	14	22.6	20.1	7	0	0	31	0	14.4
	4	30.8	33.1	21	25.3	23.4	10	0	0	30	0	13.5
	5	32.6	33.1	27	27.1	25.9	2	0	0	31	0	18.4
	6	32.9	35.7	4	27.8	24	23	432.2	190	30	8	17.8
	7	30.6	31.7	19	26.1	20.9	4	206	125.2	2	6	22.3
	8	30.6	33	20	25.8	24.4	29	5.9	4.5	26	1	16.5
	9	30.6	31.4	3	25.3	24	24	0	0	30	0	13.3
	10	29.9	31.8	1	24.3	22.8	27	0	0	31	0	10.3
	11	28.5	30.7	6	23.4	21.5	29	0.2	0.2	18	0	13.4
	12	25.6	28.3	3	20.3	17.2	23	5.3	5.3	22	1	16.7
1981	1	24.3	26.7	6	19.3	16.6	8	0	0	31	0	14.8
	2	25.6	28.2	28	19.8	16.4	5	0	0	28	0	13.9
	3	28	29.9	5	22.7	19.9	16	0.9	0.5	16	0	15.8
	4	30	31.7	21	24.6	23	6	0	0	30	0	16.9

	5	32	33.1	21	26.7	25.6	4	0	0	31	0	19.9
	6	32.7	33.9	9	27.7	25	28	31.4	28.4	28	1	19.7
	7	30.6	32.6	9	26.6	23.1	11	234.2	138.3	11	6	22.8
	8	29.3	30.8	2	25.2	23.4	11	147.7	119.8	11	4	17.5
	9	30.2	31	24	25.3	24.4	24	30.8	27.2	26	1	12.4
	10	29.8	31.5	28	24.6	22.7	7	0	0	31	0	10.6
	11	26.8	28.3	21	22	18.2	4	221.5	175.7	2	3	16.1
	12	25.1	26.2	4	20.2	17.5	19	0	0	31	0	14.6
1982	1	24	25.6	1	19	17.4	27	0	0	31	0	17.3
	2	24.7	26.3	12	19.8	17.4	1	0.1	0.1	28	0	13.7
	3	26.6	30	30	21.1	18.4	2	0	0	31	0	16.1
	4	29.4	31.1	28	24	22	10	0	0	30	0	17.5
	5	31.6	33.2	28	25.9	23.6	8	0.3	0.3	9	0	16.7
	6	33	34.1	11	27.8	26.1	2	0.7	0.4	14	0	19.6
	7	31.6	33.4	5	26.6	23.7	18	183.5	52.1	17	8	18.4
	8	30.3	31.6	14	26.1	24.9	15	77	43.6	15	5	19.3
	9	31.2	31.9	27	25.7	22.9	2	8.9	4.6	19	1	14
	10	30.7	31.8	28	25.6	22.5	29	0	0	31	0	12.7
	11	28.5	32.2	3	23.1	18.7	29	50.8	17.4	7	4	14.6
	12	26.3	28	19	21.2	19.4	29	0	0	30	0	15
1983	1	24.4	26.3	28	18.8	16.4	17	3.2	2.7	28	1	14.4
	2	24.5	27.7	27	19.2	17.3	15	3.4	3.4	14	1	15.1
	3	26.8	30.1	31	21.4	20	3	0	0	31	0	17.8
	4	28.9	31.2	28	23.1	20.8	3	0	0	30	0	16.4
	5	31.7	32.9	29	26	23.9	4	0	0	31	0	19.4
	6	32.2	33.5	18	27.6	24.6	20	112.6	50.5	22	3	19.3
	7	31.8	33	14	27	21.8	28	176.1	48.4	23	10	18.1
	8	30.4	31.6	11	26.2	24	7	158.1	29.8	3	8	19.5

	9	31.3	32.4	28	26.7	25.1	2	3.1	1.5	13	0	13.3
	10	30.3	32.2	3	25.1	21.2	30	4.2	3.7	9	1	13.8
	11	28	30.7	1	23.1	20.5	23p2181X0		0	30	0	13.5
	12	25.4	28.5	29	20.2	17.9	25	0	0	31	0	15.1
1984	1	23.3	24.8	5	17.9	13.3	20	0	0	31	0	17.1
	2	23.8	29.1	29	17.9	15.3	21	0	0	29	0	16.6
	3	27.3	30.4	31	21.3	18	4	0	0	31	0	12.2
	4	31	34.3	24	24.9	23.3	4	0	0	30	0	13.9
	5	32.3	33.3	18	26.8	25.3	3	0	0	31	0	18.9
	6	32.9	35.9	10	27.9	26.3	20	2.5	2.5	9	1	21.4
	7	30.7	32.6	1	26.1	22	25	29.1	12.6	19	3	20.1
	8		30.7	2		24	5	90.8	87.5	5	1	
	9	28.8	29.9	6	24.7	22	14	67.1	50.2	14	2	15.6
	10	29.2	31.5	7	23.8	21.9	16	0	0	31	0	9.3
	11	28.2	31	1	22.9	21.2	15	0	0	30	0	13
	12	25.9	28	1	20.7	17.6	24	0	0	31	0	16.5
1985	1	24	29.7	19	18.5	16.7	18	0	0	31	0	15
	2	25.3	27.3	27	19.9	17.9	18	0	0	28	0	14.7
	3	28	29.5	29	22.6	20.8	5	0	0	31	0	15
	4	30.1	31.6	29	24.5	22.3	16	0.1	0.1	21	0	17
	5	32	35.3	29	26.4	25.3	3	0	0	29	0	18.7
	6	32.4	33.3	14	27.9	25.6	2	8.7	6.8	1	1	22.4
	7	30.4	32	9	26.1	24	25	49.8	9.9	19	7	23.3
	8	29.6	30.7	30	25.2	23.6	19	136.3	79.3	2	5	15.9
	9	30.2	30.9	24	25.1	22.2	13	32.4	20.2	12	2	14.5
	10	29.5	32.1	5	24.5	21.5	10	21.4	18.7	7	2	13.6
	11	28.7	31.5	5	23.4	21.4	23	0	0	30	0	13.9
	12	25.7	28.8	2	20.3	17.5	13	0	0	31	0	16.7

1986	1	24.2	25.8	2	18.4	16.7	6	0	0	27	0	17
	2	25.4	31.4	15	19.2	17.4	12	0.5	0.5	21	0	16
	3	27.3	30.4	27	21.9	19.6	17	2.1	2.1	22	0	16.1
	4	30.1	32	25	24.5	23	2	0	0	30	0	16
	5	32.3	34.6	20	26.8	24.4	22	0	0	31	0	18.9
	12	24.4	28.4	7	18.9	16	14	3.1	3.1	12	1	18.2

The following datas based on Surface data collected from I.M.D. Pune, for the period 1967 to 1985 for Okha port, which is tabulated in table form for particularly relative humidity and Visibility is as follows and its abbreviations are given below:

Year
MN - Month,
HR - Hour at G.M.T.
RHNO - Relative humidity in terms of percentage with Number of Observations
V1 - Number of days with visibility less than 1 K.M.

YEAR - 1967

MN	"HR"	"RHNO"	V1
1	3	50	0
1	12	54	0
2	3	86	1
2	12	76	0
3	3	85	0
3	12	78	0
4	3	83	0
4	12	77	0
5	3	84	0
5	12	79	0
6	3	84	0
6	12	79	0
7	3	89	0
7	12	84	0
8	3	85	0
8	12	79	0
9	3	83	0
9	12	77	0
10	3	82	0
10	12	77	0
11	3	77	1
11	12	72	0
12	3	64	0
12	12	61	0

YEAR - 1968

1	3	61
1	12	55
2	3	70
2	12	61
3	3	77
3	12	70
4	3	87

4	12	78	
5	3	80	
5	12	77	
6	3	83	
6	12	77	
7	3	86	
7	12	79	
8	3	88	
8	12	83	
9	3	83	
9	12	78	
10	3	76	
10	12	74	
11	3	62	
11	12	69	
12	3	57	
12	12	57	

YEAR - 1969

1	3	6131	0
1	12	5931	0
2	3	7328	0
2	12	7028	0
3	3	8331	0
3	12	7731	0
4	3	8430	0
4	12	7830	0
5	3	8131	0
5	12	7731	0
6	3	8130	0
6	12	7830	0
7	3	8531	0
7	12	8231	0
8	3	9231	0
8	12	8931	0
9	3	8930	0
9	12	8630	0
10	3	8931	0
10	12	8931	0
11	3	7930	0
11	12	8430	0
12	3	7231	0
12	12	7131	0

YEAR - 1970

1	3	7331	0
1	12	7131	0

2	3	7028	0
2	12	7028	0
3	3	7831	0
3	12	7131	0
4	3	8430	0
4	12	7730	0
5	3	8131	0
5	12	7731	0
6	3	7930	0
6	12	7530	0
7	3	8231	0
7	12	7831	0
8	3	8531	0
8	12	8031	0
9	3	8430	0
9	12	7930	0
10	3	7831	0
10	12	7031	0
11	3	6630	0
11	12	6730	0
12	3	6131	0
12	12	5631	0

YEAR - 1971

1	3	6231	0
1	12	5831	0
2	3	7528	0
2	12	6727	0
3	3	7831	0
3	12	7031	0
4	3	8730	1
4	12	7730	0
5	3	8231	0
5	12	7931	0
6	3	8230	0
6	12	7830	0
7	3	8431	0
7	12	7931	0
8	3	8731	0
8	12	8230	0
9	3	8730	0
9	12	8130	0
10	3	8031	0
10	12	8031	0
11	3	7230	0
11	12	7330	0
12	3	6526	0
12	12	6126	0

YEAR - 1972

1	3	6831	0
1	12	6631	0
2	3	6329	0
2	12	5829	0
3	3	8631	0
3	12	8030	0
4	3	8630	0
4	12	7930	0
5	3	8231	0
5	12	7731	0
6	3	8130	0
6	12	7630	0
7	3	8331	0
7	12	7931	0
8	3	8431	0
8	12	7931	0
9	3	8730	0
9	12	8130	0
10	3	8631	1
10	12	8130	0
11	3	6730	0
11	12	6430	0
12	3	6531	0
12	12	5731	0

YEAR - 1973

1	3	6731	0
1	12	6031	0
2	3	7928	1
2	12	7828	1
3	3	7631	2
3	12	7231	2
4	3	8530	1
4	12	8130	0
5	3	8331	0
5	12	8331	0
6	3	8230	4
6	12	7830	6
7	3	8431	0
7	12	7931	0
8	3	8331	0
8	12	7931	0
9	3	8430	0
9	12	7830	0
10	3	8231	0

10	12	7431	0
11	3	6730	0
11	12	6630	0
12	3	5831	0
12	12	5630	0

YEAR - 1974

1	3	6531	0
1	12	6031	0
2	3	6328	0
2	12	5628	0
3	3	8431	0
3	12	7631	0
4	3	8230	0
4	12	7630	0
5	3	7731	0
5	12	7431	0
6	3	7829	0
6	12	7530	0
7	3	7931	0
7	12	7431	0
8	3	8230	0
8	12	7731	0
9	3	8430	0
9	12	7929	0
10	3	7631	0
10	12	7431	0
11	3	6730	0
11	12	6430	0
12	3	6931	0
12	12	6431	0

YEAR - 1975

1	3	6631	0
1	12	6431	0
2	3	6728	0
2	12	6628	0
3	3	7831	1
3	12	7231	0
4	3	8729	1
4	12	8030	0
5	3	8631	0
5	12	8431	0
6	3	8530	0
6	12	8130	0
7	3	8531	0
7	12	8131	0

5	3	7831	0
5	12	7630	0
6	3	8130	0
6	12	7830	0
7	3	8531	0
7	12	8131	0
8	3	8631	0
8	12	8131	0
9	3	8530	0
9	12	8230	0
10	3	8131	0
10	12	7931	0
11	3	6930	0
11	12	6629	0
12	3	6231	0
12	12	5331	0

YEAR - 1978

1	3	5531	0
1	12	5031	0
2	3	6628	0
2	12	6628	0
3	3	7531	0
3	12	6931	0
4	3	8730	0
4	12	7830	0
5	3	7931	0
5	12	7631	0
6	3	8129	0
6	12	7829	0
7	3	8631	0
7	12	8231	0
8	3	8831	0
8	12	8431	0
9	3	8230	0
9	12	7930	0
10	3	8131	0
10	12	7731	0
11	3	7530	0
11	12	7330	0
12	3	6131	0
12	12	5831	0

YEAR - 1979

1	3	6031	0
1	12	5831	0
2	3	7728	0

2	12	7028	0
3	3	8131	0
3	12	7531	0
4	3	8730	0
4	12	7830	0
5	3	8031	0
5	12	7431	0
6	3	8430	0
6	12	7930	0
7	3	8231	0
7	12	7831	0
8	3	8631	0
8	12	8131	0
9	3	8130	0
9	12	7830	0
10	3	7631	0
10	12	7231	0
11	3	6730	0
11	12	6930	0
12	3	6231	0
12	12	5931	0

YEAR - 1980

1	3	6231	0
1	12	5631	0
2	3	7729	0
2	12	6729	0
3	3	7531	0
3	12	6831	0
4	3	8730	0
4	12	7830	0
5	3	7831	0
5	12	7631	0
6	3	8030	0
6	12	7530	0
7	3	8331	0
7	12	8031	0
8	3	8531	0
8	12	8231	0
9	3	8830	0
9	12	8630	0
10	3	9031	0
10	12	8631	0
11	3	6329	0
11	12	6330	0
12	3	5631	0
12	12	5631	0

YEAR - 1981

1	3	6631	0
1	12	6031	0
2	3	7428	0
2	12	6828	0
3	3	7531	0
3	12	7231	0
4	3	8130	0
4	12	7730	0
5	3	7931	0
5	12	7731	0
6	3	8030	0
6	12	7729	0
7	3	8531	0
7	12	8331	0
8	3	8830	0
8	12	8331	0
9	3	8530	0
9	12	8030	0
10	3	8031	0
10	12	7831	0
11	3	6930	0
11	12	6230	0
12	3	6431	0
12	12	6131	0

YEAR - 1982

1	3	6329	0
1	12	6231	0
2	3	6927	0
2	12	6628	0
3	3	7531	0
3	12	6931	0
4	3	8130	0
4	12	7830	0
5	3	7931	0
5	12	7431	0
6	3	7430	0
6	12	7330	0
7	3	8431	0
7	12	8131	0
8	3	8331	0
8	12	7931	0
9	3	7930	0
9	12	7629	0
10	3	7830	0

10	12	7630	0
11	3	6630	0
11	12	6430	0
12	3	6431	0
12	12	6031	0

YEAR - 1983

1	3	6331	0
1	12	5931	0
2	3	6628	0
2	12	5728	0
3	3	7231	0
3	12	6731	0
4	3	7730	0
4	12	7430	0
5	3	8031	0
5	12	7631	0
6	3	8028	0
6	12	7729	0
7	3	8828	0
7	12	8431	0
8	3	8830	0
8	12	8530	0
9	3	8430	0
9	12	8128	0
10	3	7631	0
10	12	7231	0
11	3	6130	0
11	12	5730	0
12	3	5531	0
12	12	5531	0

YEAR - 1984 0

1	3	4	0
1	12	3	0
2	3	6527	0
2	12	6329	3
3	3	8531	0
3	12	7831	0
4	3	8228	0
4	12	7730	0
5	3	7631	0
5	12	7331	0
6	3	7529	0
6	12	7228	0
7	3	7930	0
7	12	7530	0

8	3	8729	0
8	12	8431	0
9	3	8529	0
9	12	8230	0
10	3	7731	1
10	12	7430	0
11	3	6930	0
11	12	7128	0
12	3	6630	0
12	12	6531	0

YEAR - 1985

1	3	6231	0
1	12	6331	0
2	3	7228	0
2	12	6928	0
3	3	8530	0
3	12	7731	0
4	3	7928	0
4	12	7229	0
5	3	7929	0
5	12	7631	0
6	3	7930	0
6	12	7629	0
7	3	8728	0
7	12	8527	0
8	3	9031	0
8	12	8631	0
9	3	8229	0
9	12	7830	0
10	3	8427	0
10	12	8231	0
11	3	6830	0
11	12	7129	0
12	3	5731	0
12	12	5630	0

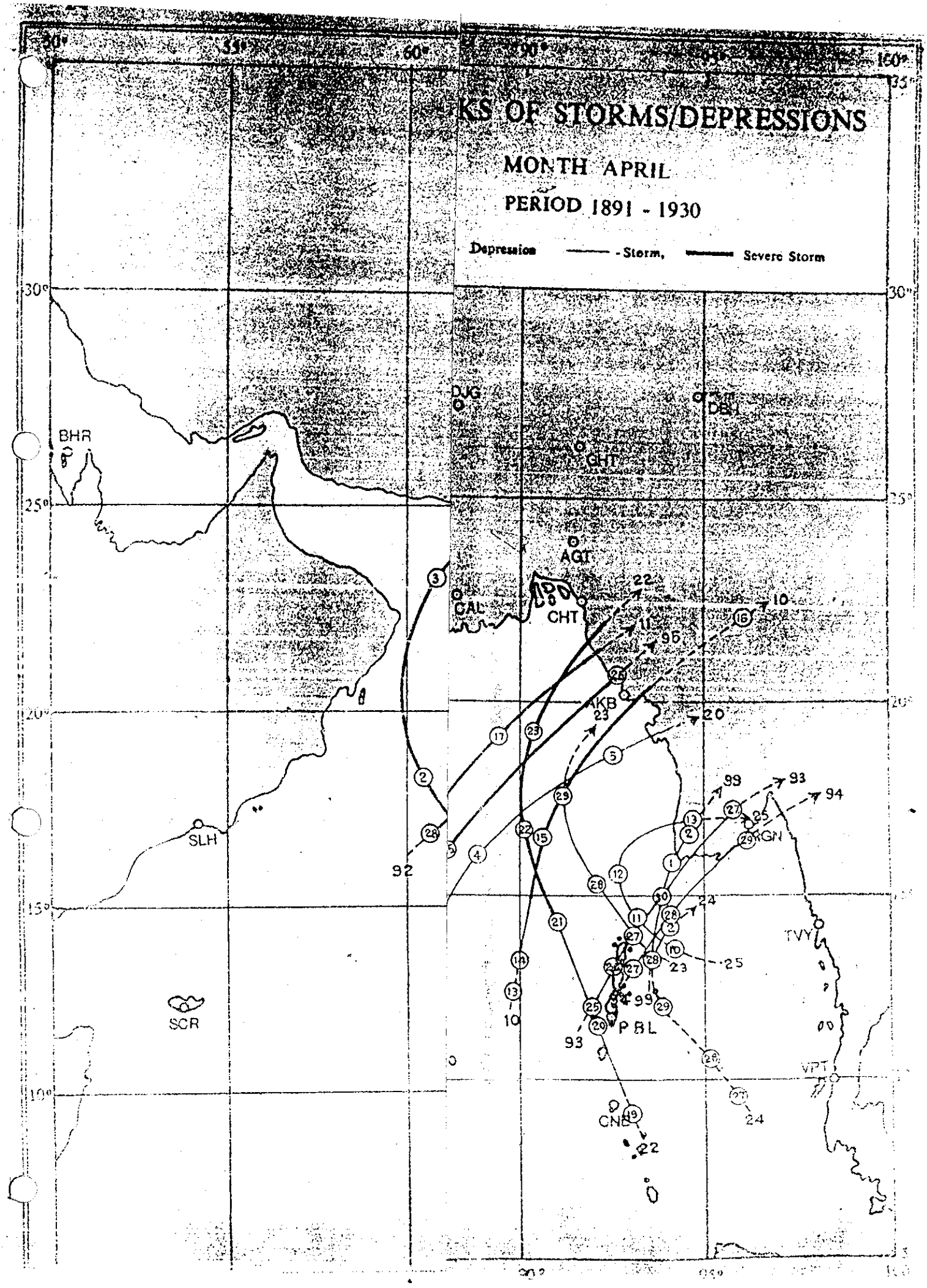
YEAR - 1986

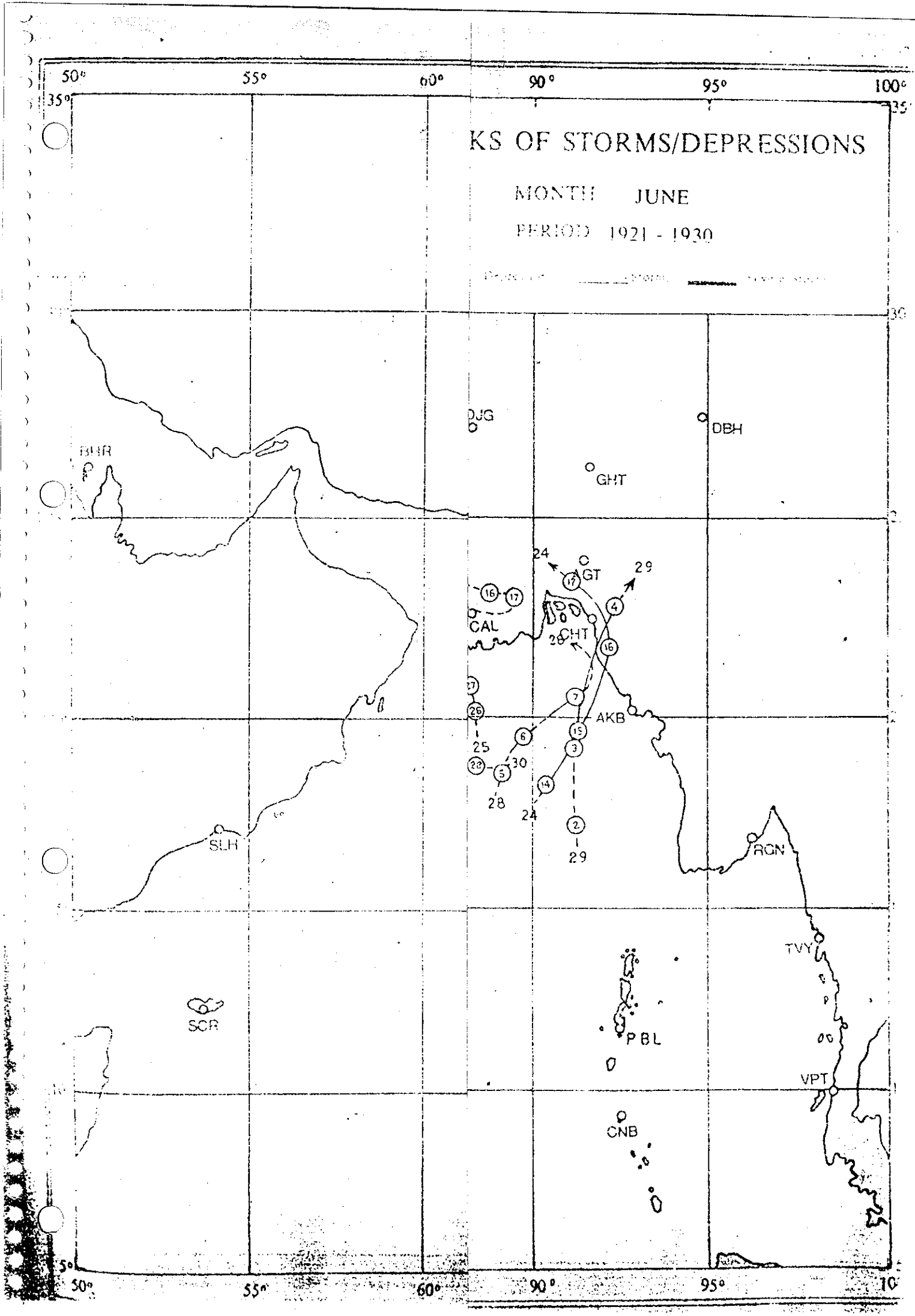
1	3	5630	0
1	12	6231	0
2	3	6628	0
2	12	6328	0
3	3	7930	0
3	12	7130	0
4	3	8429	0
4	12	7828	0
5	3	7826	0

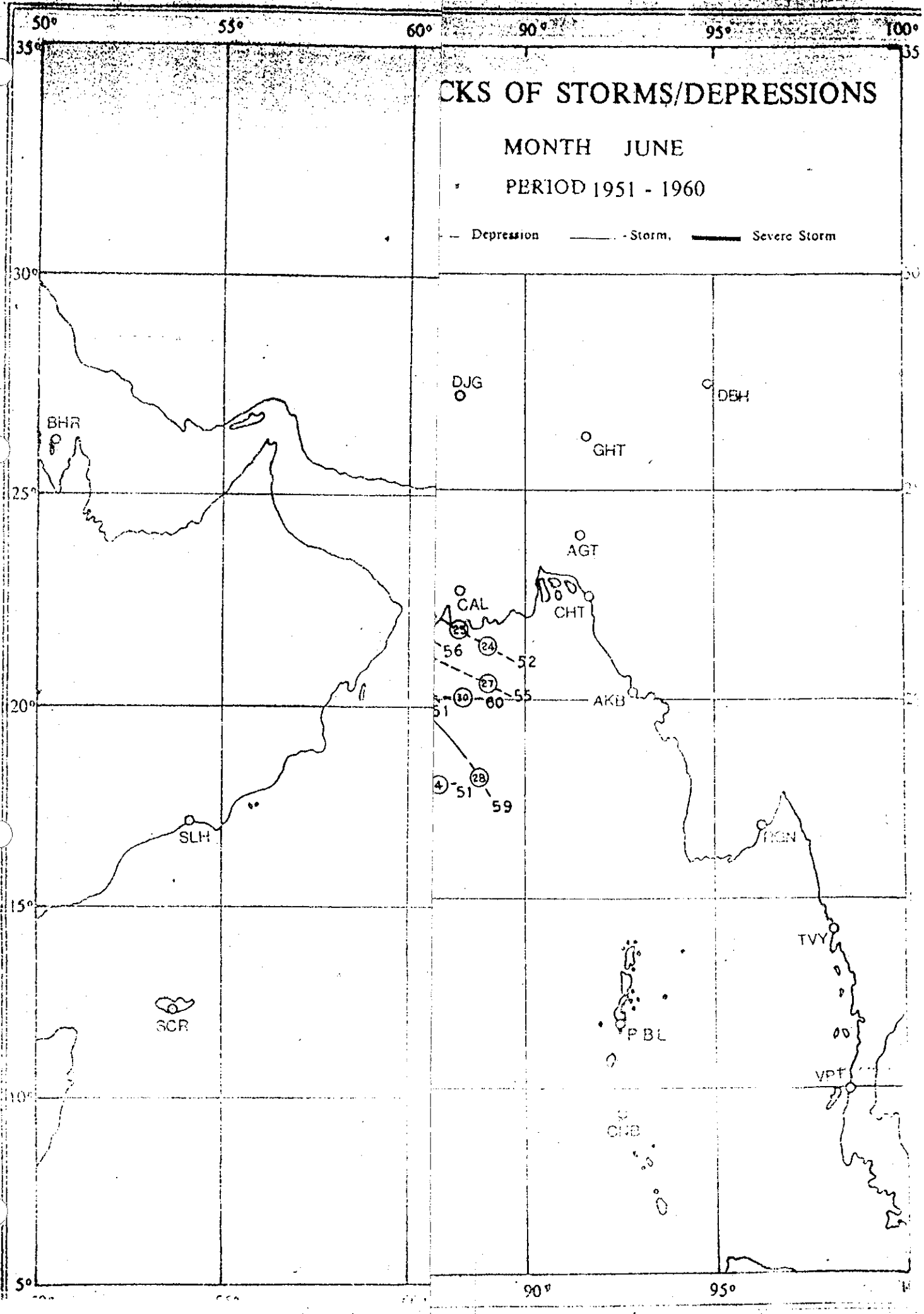
5	12	7227	0
6	3	8129	0
6	12	7728	0
7	3	8131	0
7	12	7829	0
8	3	8830	0
8	12	8531	0
9	3	8529	0
9	12	8030	0
10	3	8731	0
10	12	8331	0
11	3	6929	0
11	12	7128	0
12	3	5731	0
12	12	5931	0

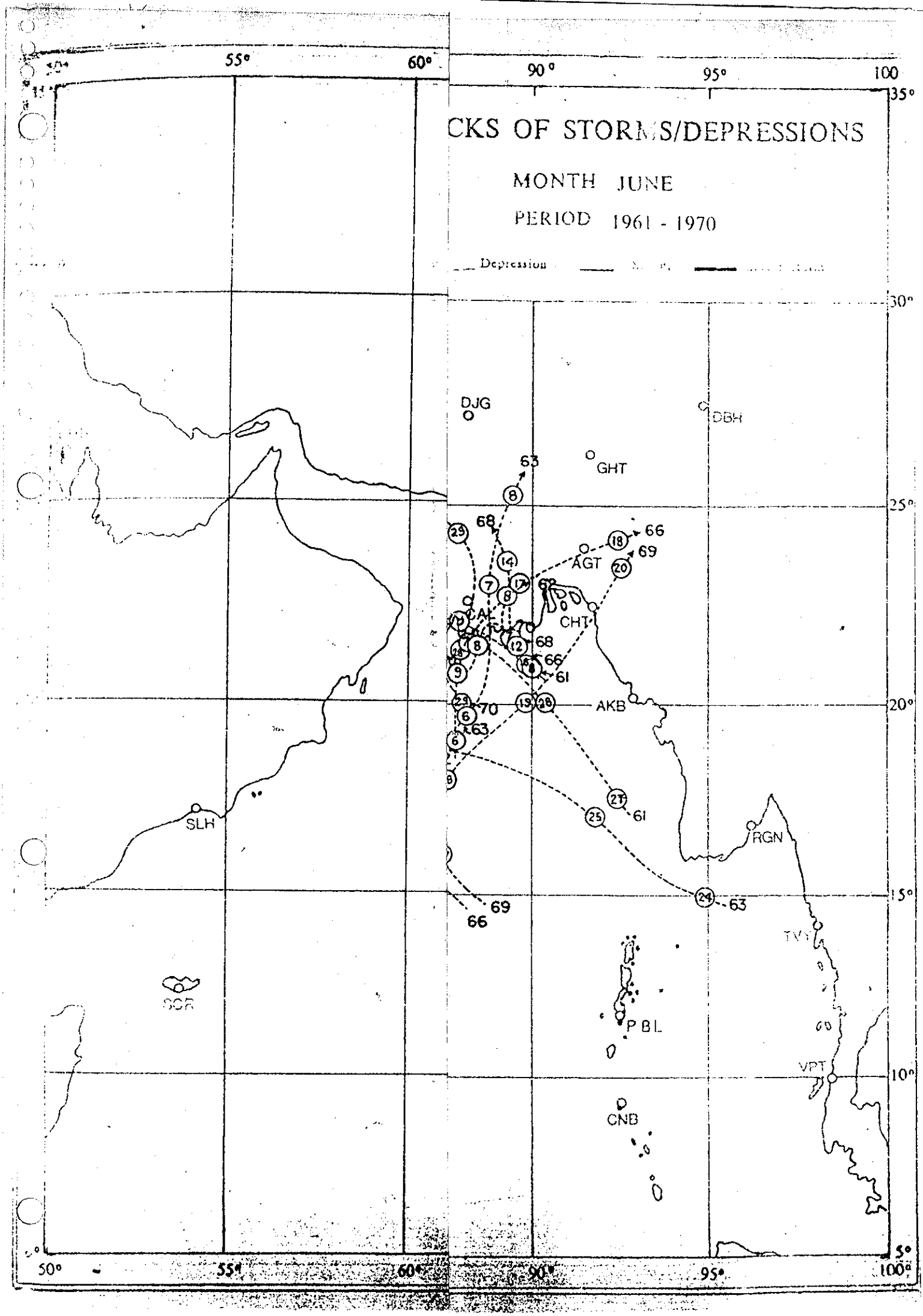
ANNEXURE II

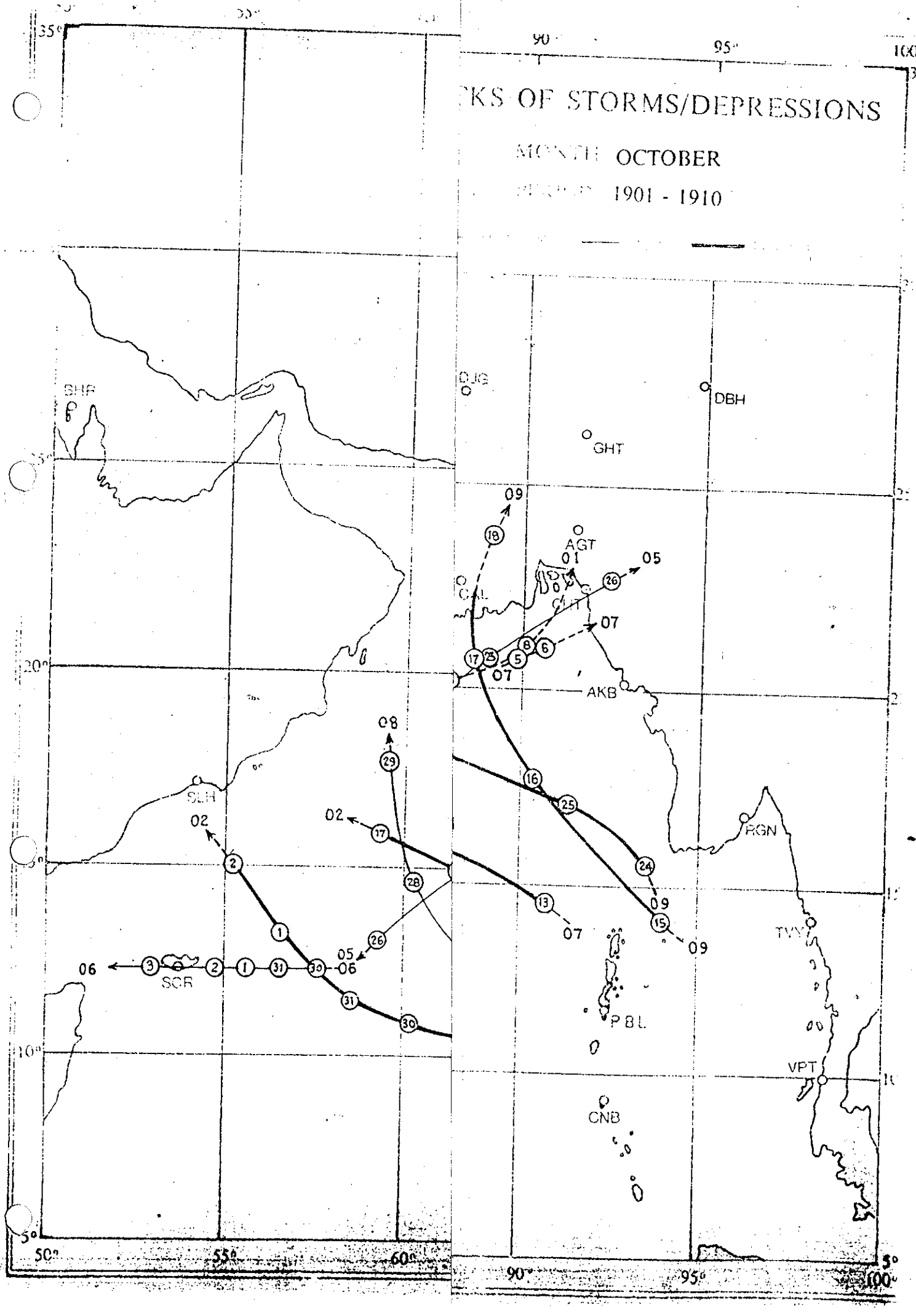
DIAGRAMS SHOWING
TRACKS OF STORMS / DEPRESSIONS


KS OF STORMS/DEPRESSIONS
MONTH APRIL
PERIOD 1891 - 1930
Depression - Storm, Severe Storm
BHR
DJG
DBJ
GHT
AGT
CAL
CHT
VKB
SLH
SCR
PBL
CNB
VPT
TVY
RGN
92
93
94
95
96
99
10
20
22
23
24
25


KS OF STORMS/DEPRESSIONS
MONTH JUNE
PERIOD 1921 - 1930
50°
55°
60°
90°
95°
100°
35°
30°
DJG
DBH
BHR
GHT
GT
CAL
CHT
AKB
SLH
SCR
PBL
RGN
TVY
VPT
CNB
24
29
25
30
28
24
29

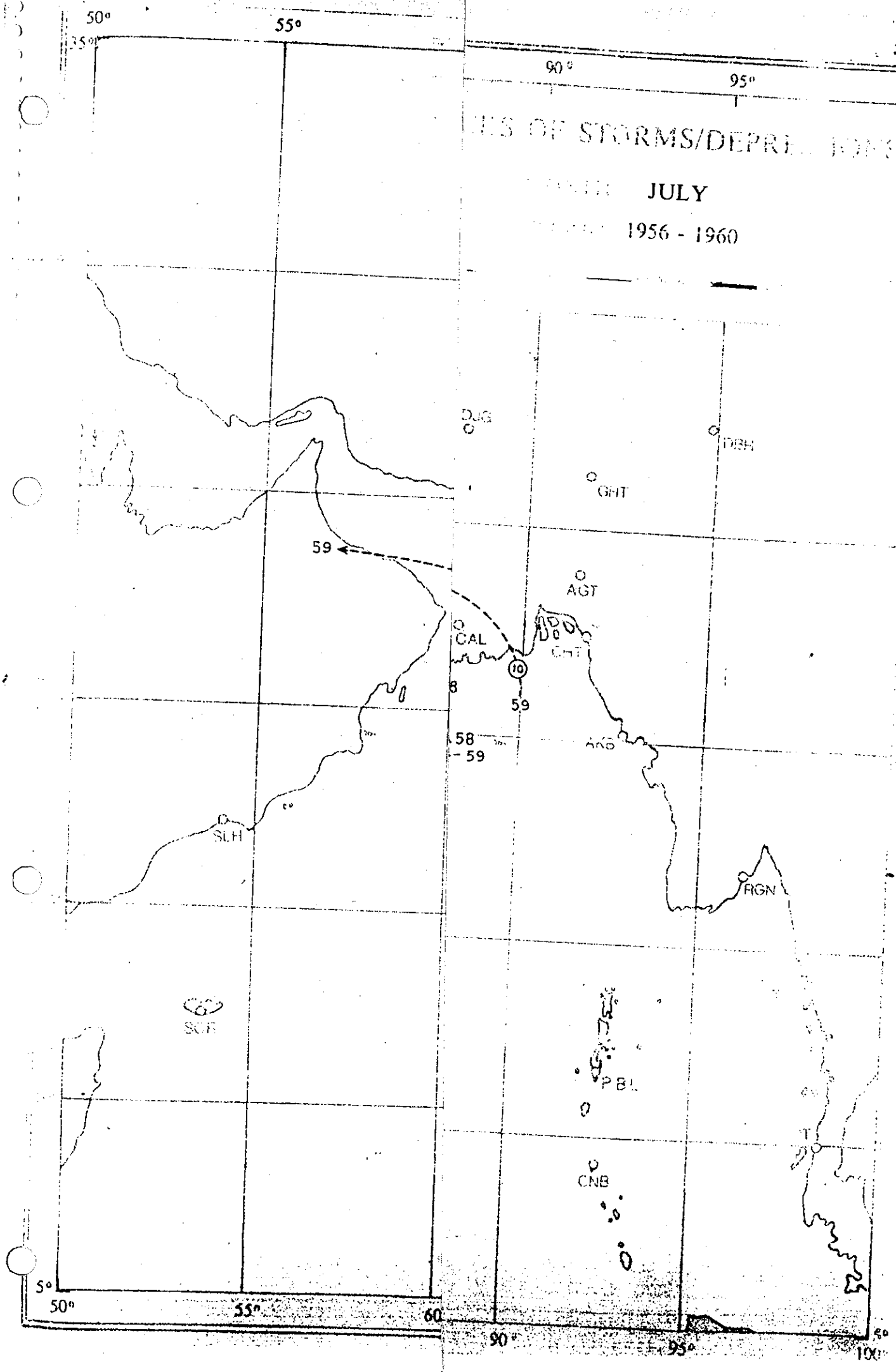

CKS OF STORMS/DEPRESSIONS
MONTH JUNE
PERIOD 1951 - 1960
Depression
Storm,
Severe Storm
50°
55°
60°
90°
95°
100°
35°
30°
25°
20°
15°
10°
5°
BHR
DJG
DBH
GHT
AGT
CAL
CHT
AKB
SLH
SCR
PBL
TVY
VPT
CNB
56
52
55
60
51
51
59

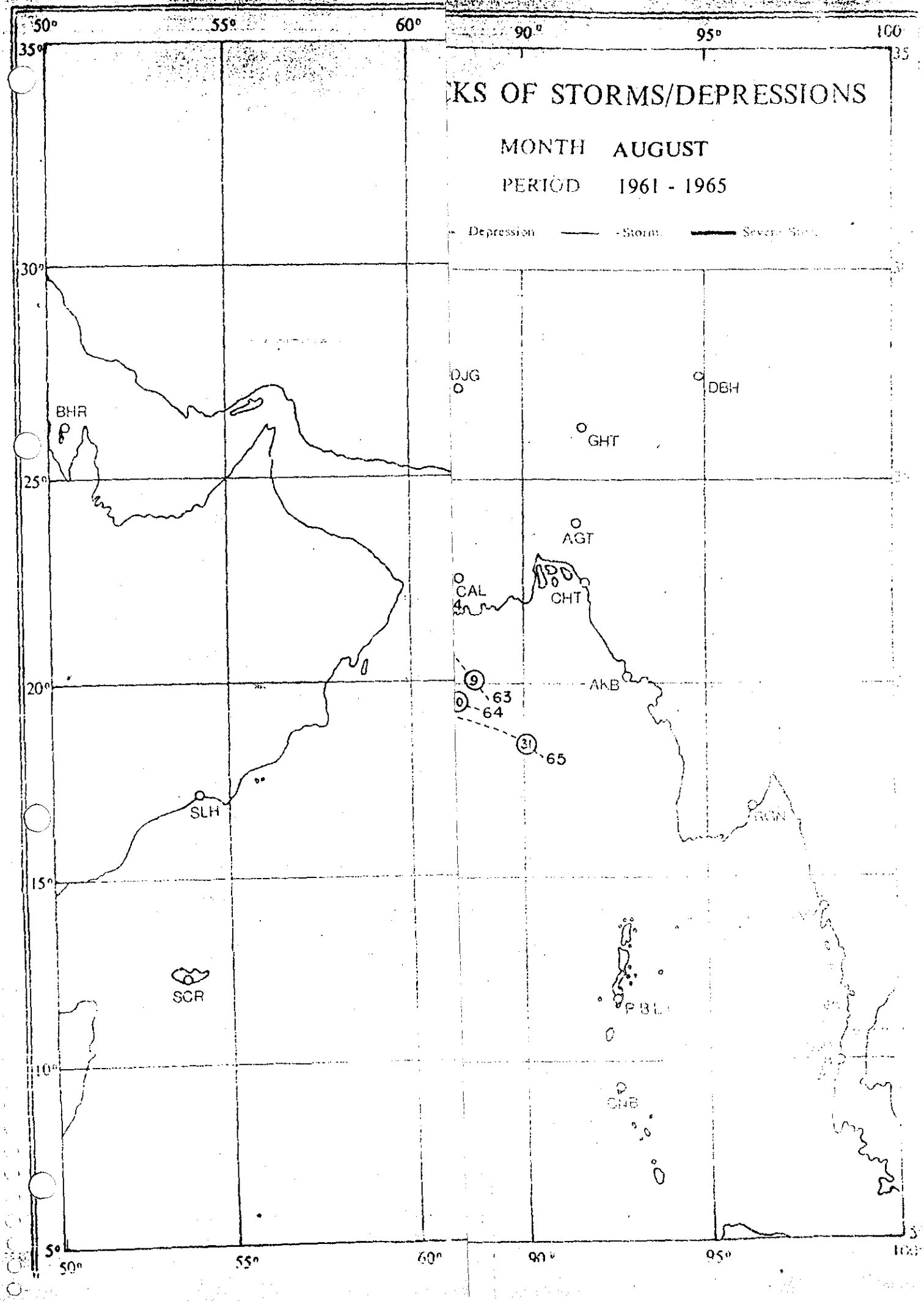

CKS OF STORMS/DEPRESSIONS
MONTH JUNE
PERIOD 1961 - 1970
Depression
55°
60°
90°
95°
100
35°
30°
25°
20°
15°
10°
5°
50°
DJG
DBH
GHT
AGT
CHT
AKB
SLH
SCR
RGN
TVY
PBL
VPT
CNB
63
66
69
68
61
70

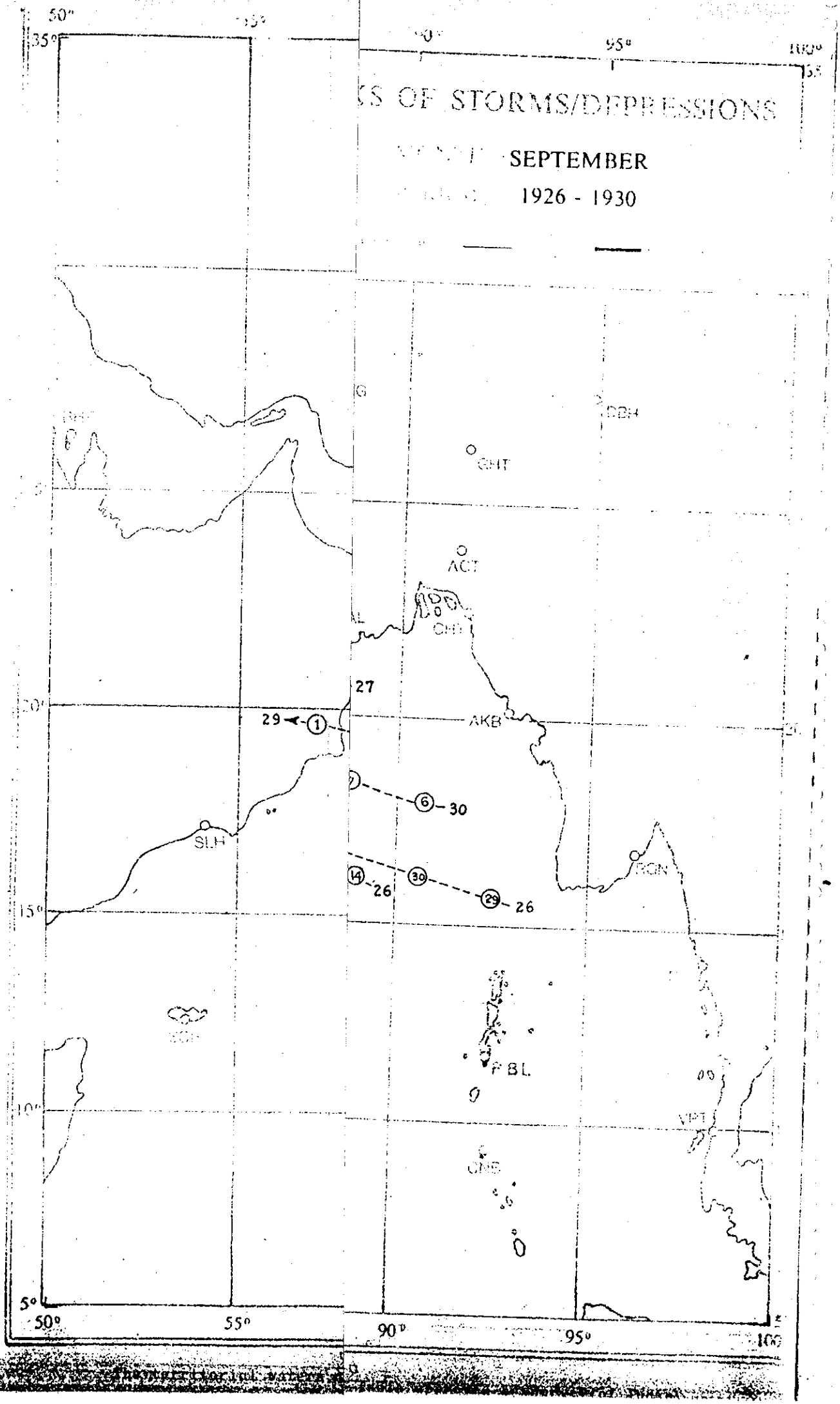

KS OF STORMS/DEPRESSIONS
OCTOBER
1901 - 1910
SHR
DJG
DBH
GHT
AGT
CHL
AKB
SLH
SCR
RGN
TVY
PBL
VPT
CNB
35°
30°
25°
20°
15°
10°
5°
50°
55°
60°
90°
95°
100°

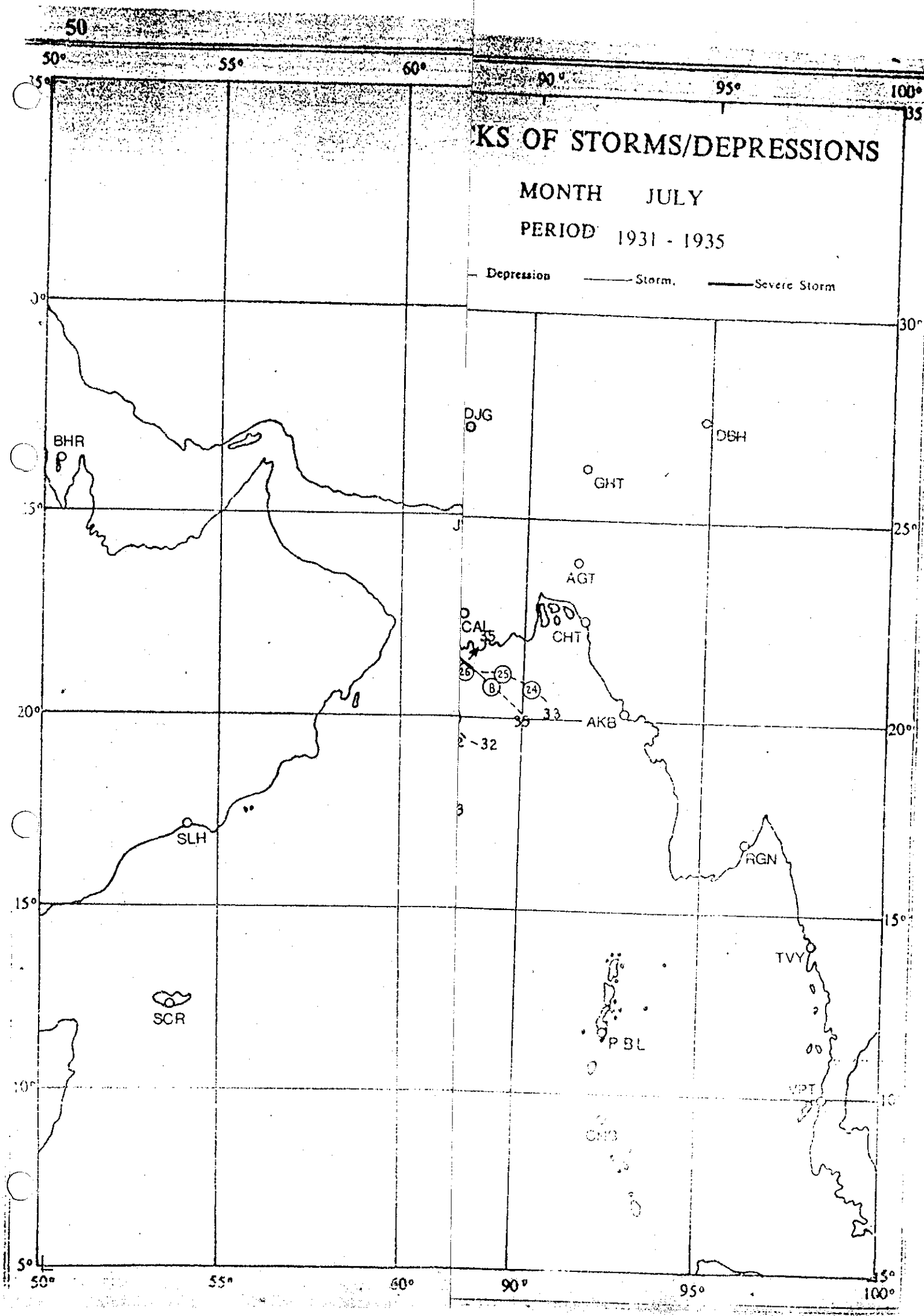
...KS OF STORMS/DEPR... JULY

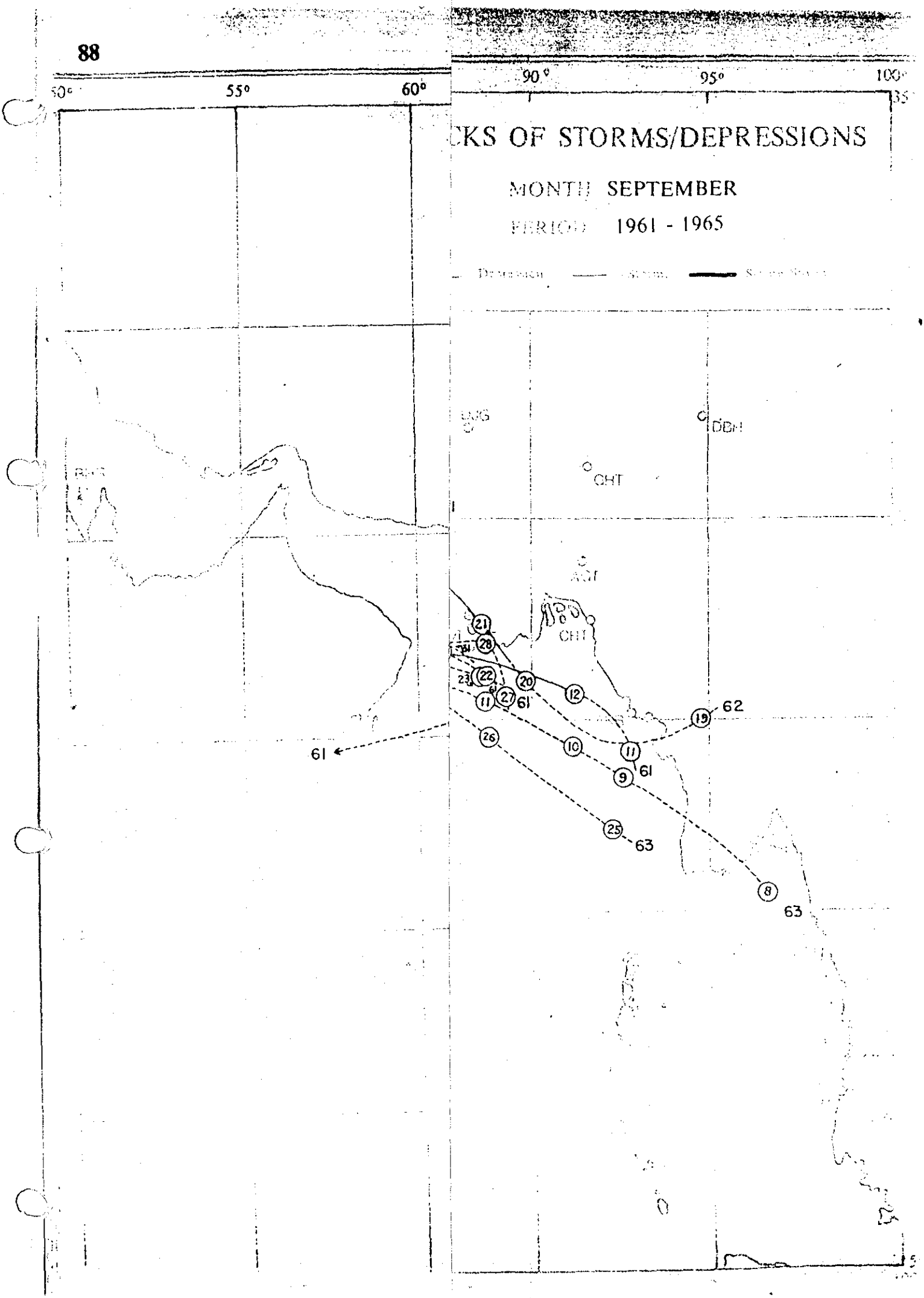
1956 - 1960

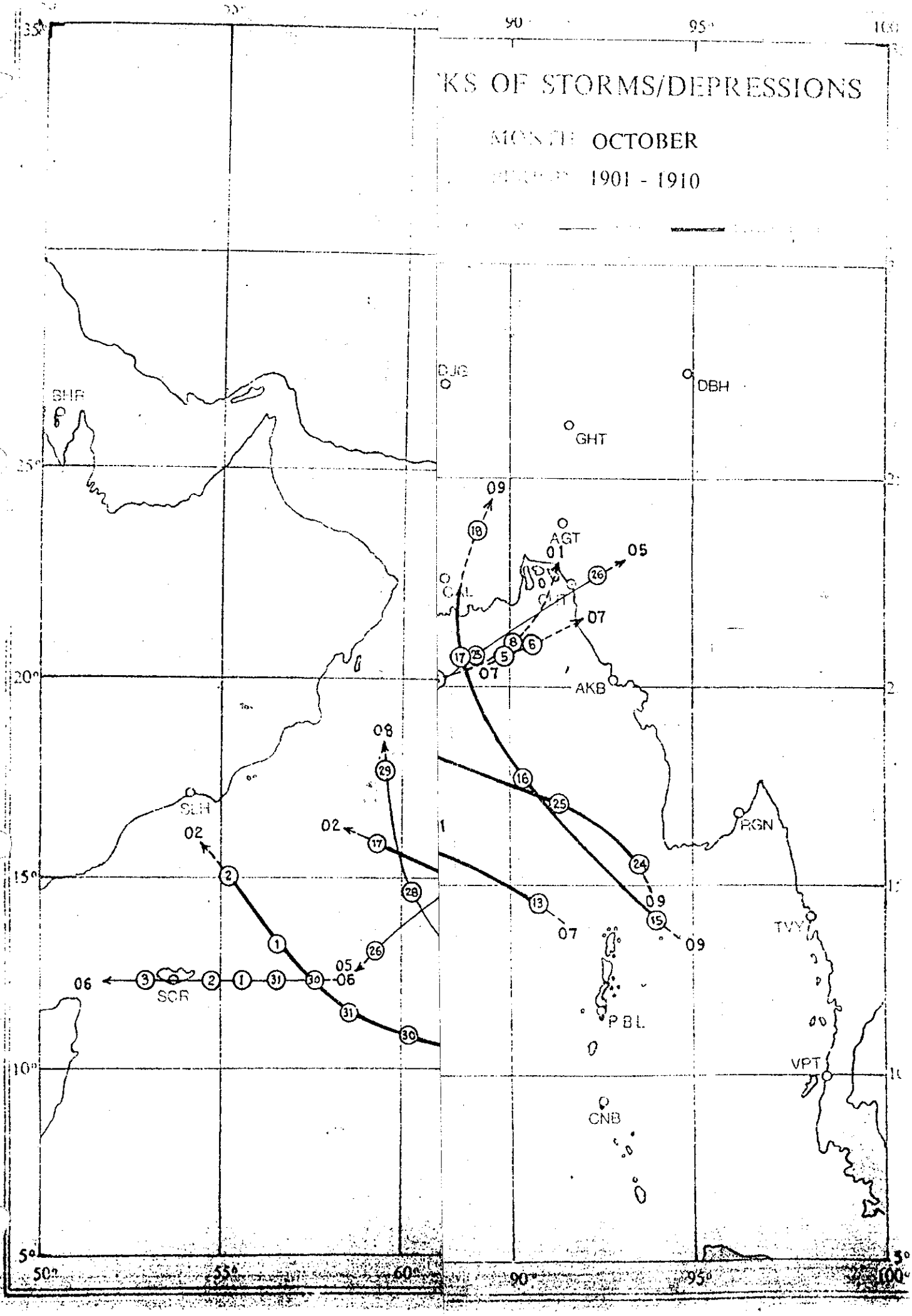


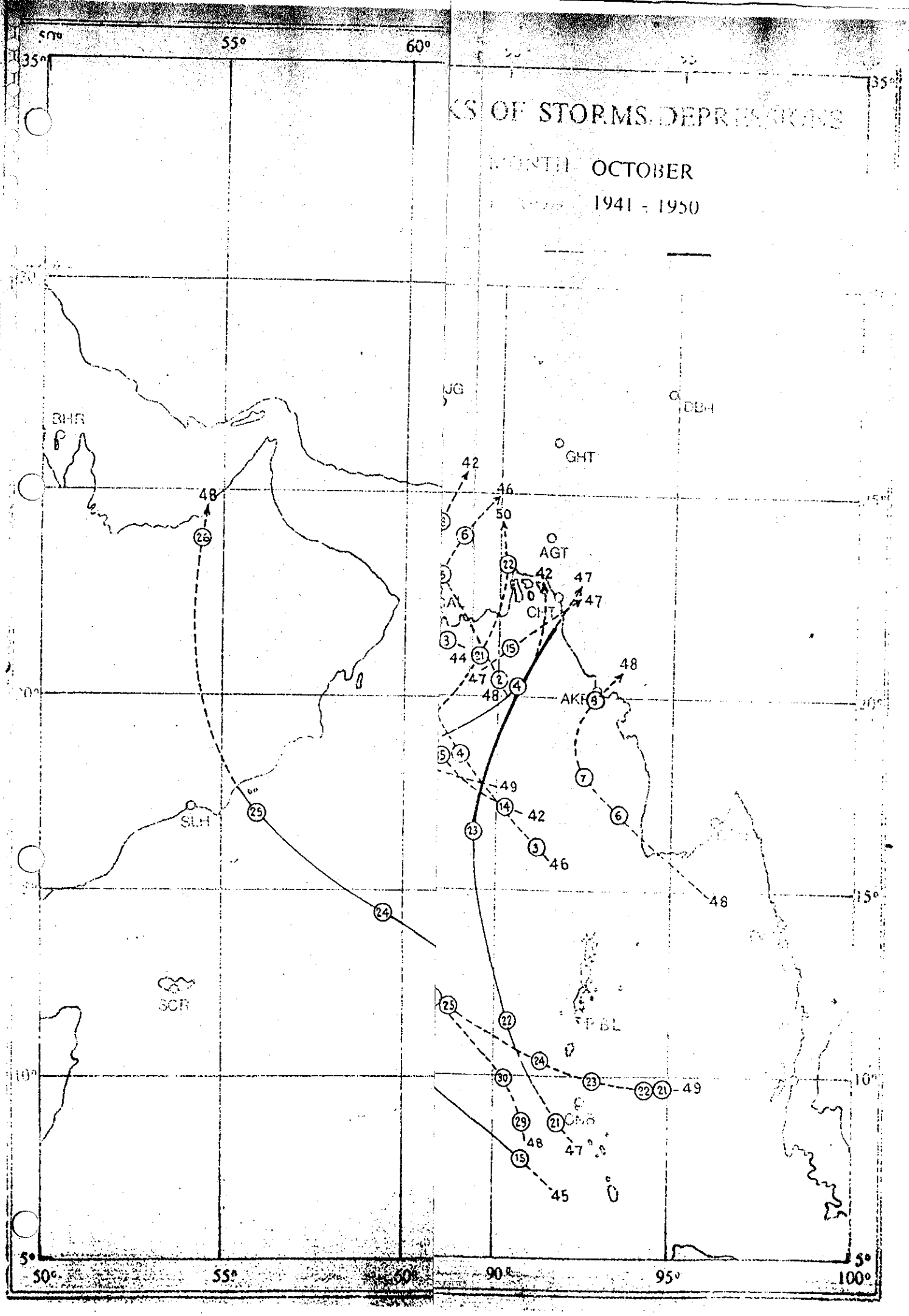

KS OF STORMS/DEPRESSIONS
MONTH AUGUST
PERIOD 1961 - 1965
Depression
Storm
50°
55°
60°
90°
95°
100
35°
30°
25°
20°
15°
10°
5°
BHR
DJG
DBH
GHT
AGT
CAL
CHT
AKB
63
64
65
SLH
SCR
PBL
CNB


CS OF STORMS/DEPRESSIONS
SEPTEMBER
1926 - 1930
50°
55°
90°
95°
100°
35°
30°
25°
20°
15°
10°
5°
GHT
DBH
ACT
CHP
AKB
SLH
TRN
PBL
VPT
CMB
27
29
30
26
26


KS OF STORMS/DEPRESSIONS
MONTH JULY
PERIOD 1931 - 1935
Depression
Storm.
Severe Storm
BHR
DJG
DSH
GHT
AGT
CAL
CHT
AKB
SLH
RGN
SCR
PBL
TVY
VPT
50°
55°
60°
90°
95°
100°
35°
30°
25°
20°
15°
10°
5°


50°
55°
60°
90°
95°
100°
CKS OF STORMS/DEPRESSIONS
MONTH SEPTEMBER
PERIOD 1961 - 1965
Depression
Storm
Severe Storm
BBS
DBH
CHT
AGT
CHT
21
28
22
20
12
11
27
61
19
62
26
10
11
61
9
25
63
8
63
61


'KS OF STORMS/DEPRESSIONS
OCTOBER
1901 - 1910
BHR
DJG
DBH
GHT
AGT
CCL
AKB
SLH
SCR
PGN
TVY
PBL
VPT
CNB
09
18
01
05
26
07
17
25
5
8
6
07
16
25
24
09
15
09
13
07
08
29
02
17
28
26
05
02
2
1
06
3
2
1
31
30
06
31
30
35°
30°
25°
20°
15°
10°
5°
50°
55°
60°
90°
95°
100°


CS OF STORMS, DEPRESSIONS
MONTH OCTOBER
1941 - 1950
BHR
JG
DBH
GHT
AGT
CHT
AKP
SLH
SCR
TPBL
50°
55°
60°
90°
95°
100°
35°
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25°
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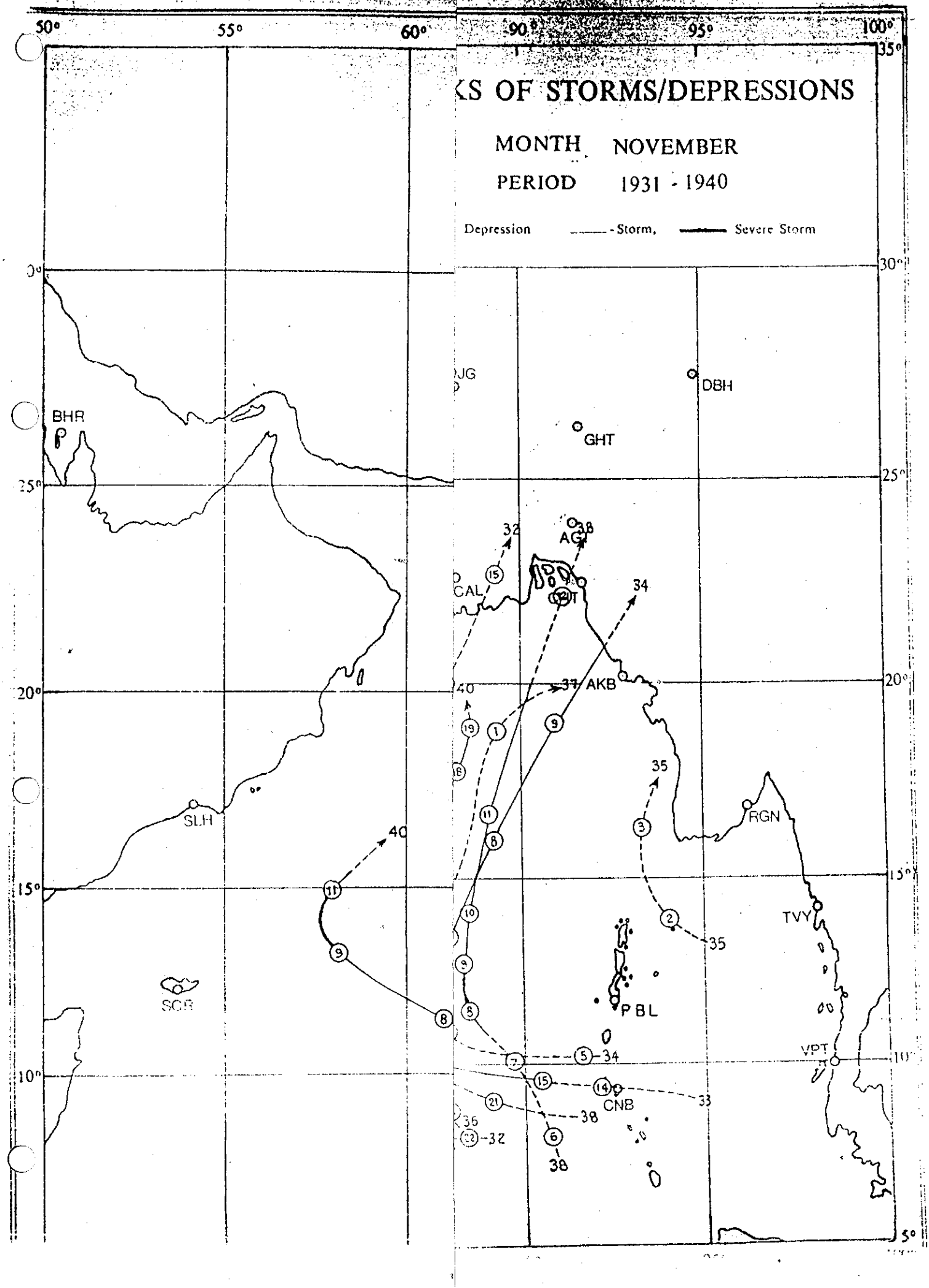
10°
5°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PERIOD 1931 - 1940
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55°
60°
90°
95°
100°
35°
30°
25°
20°
15°
10°
5°
BHR
SLH
SCR
GHT
DBH
CAL
AKB
RGN
PBL
TVY
VPT
CNB
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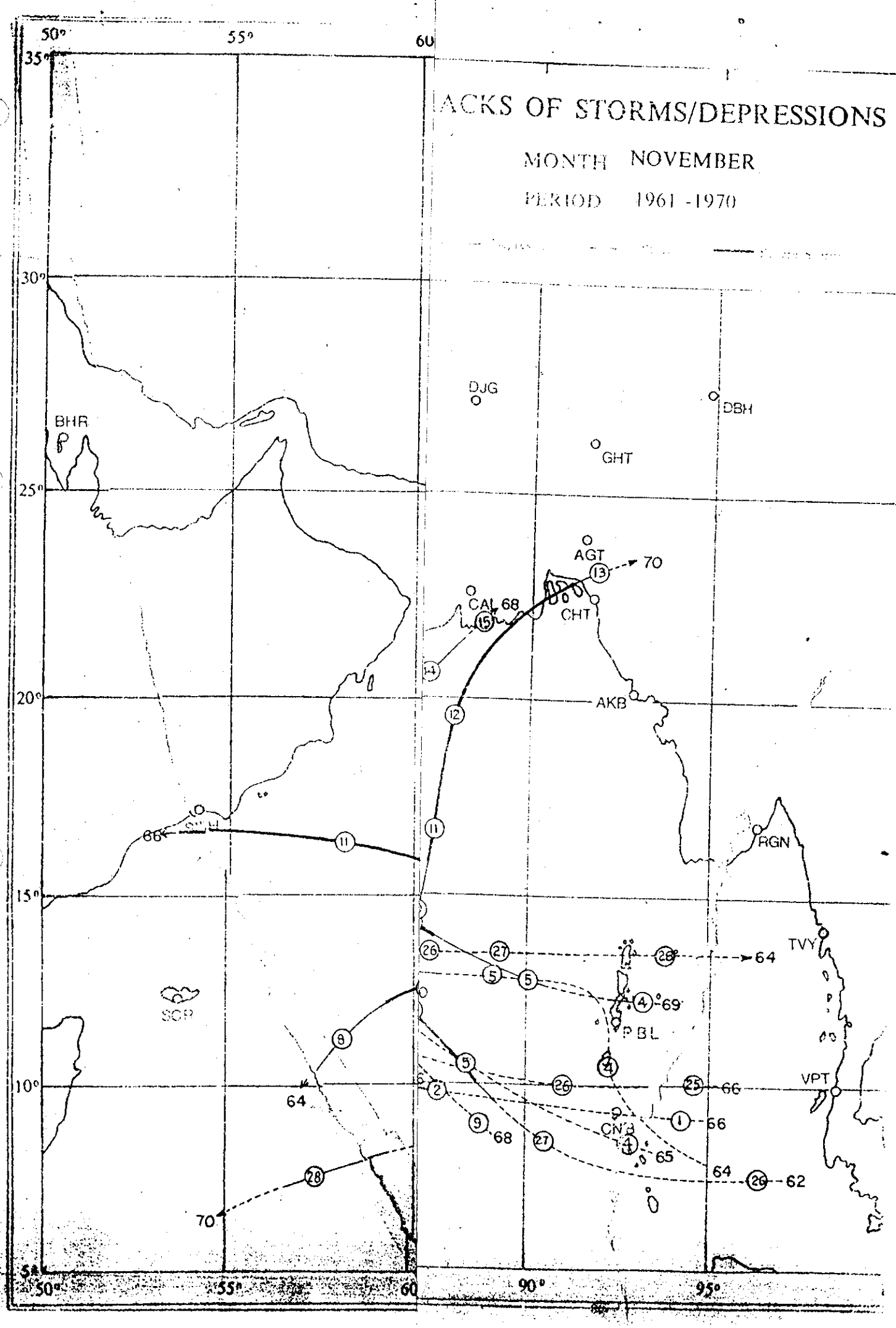
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55°
60
35°
30°
25°
20°
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5°
90°
95°
BHR
DJG
DBH
GHT
AGT
CAL
CHT
AKB
RGN
TVY
VPT
PBL
CNB
SCP
70
68
66
64
69
65
62

APPENDIX C

REPORT ON WIND, WAVE CHARACTERISTICS, DESIGN WAVE AND NUMERICAL MODELLING ON WAVE PENETRATION

BY

OCEAN ENGINEERING CENTRE,
I.I.T., MADRAS, CHENNAI.

DEVELOPMENT OF PORTS IN GUJARAT

CONSULTANCY PROPOSAL
FOR
ENGINEERING PRE-FEASIBILITY/
DETAILED PROJECT REPORT

Report on Wind Wave Characteristics, Design Wave and Numerical modeling on wave penetration

CLIENT

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MADRAS - 600 036

NOVEMBER 1996

CONTENTS

1.0 INTRODUCTION

Gujarat Maritime Board has plans to develop various ports along the Gujarat coast as shown in Fig. 1(a).Gujarat Maritime Board has appointed Frederic R. Harris India Private Limited to prepare the detailed report for Positra Port. Frederic R. Harris Inc. have appointed IIT, Madras to perform certain tasks in connection with the development of master plan.

The port development at Positra is comprising of Positra I (location 1)and Positra II (location 2) and Positra III (location 3). Positra I is approximately located $22^0$28'24" N and $69^0$08'48" E. Positra II is located at $22^0$25'15" N and $96^0$11'24". The locations are as shown in Fig. 1(b). The bathymetry along with these locations are shown in Fig. 1(c).

The available data on the wind climate based on the meteorological data for the study area for the period 1967-1986 have been obtained, the salient results of which, have been brought out in our report submitted in August 96 to Frederic R.Harris Inc. New Delhi. A critical analysis of the above data have been made in order to pictorially represent the percentage of occurrence of wind speeds during the different months. A season wise analysis is also performed and the results are reported for the different seasons, namely, Non monsoon(Jan-May),S-W monsoon(June-Sep),N-E monsoon(Oct-Dec) and for the annual(Jan-Dec). The data compiled by Indian Meteorological Department reports the monthly wind speeds measured at 3.00 hrs and 12.00 hrs.

The wind speeds reported are the Mean Wind Speeds (MWS). The report also presents the information on the number of days within a month, the wind speed $\geq$ 62kmph (W1),number of days in a month wind speed is 20-61kmph (W2),number of days in a month wind speed is 1-19kmph (W3)and number of days in a month calm condition prevails(W4). These data have been considered for a detailed analysis on the wind climate. The wave climate is also derived from the wind data assuming the duration of the wind is almost constant over a period of 3 hrs. The data measured by National Institute of Oceanography, Goa and the Wave Atlas prepared for the grid 15-25^0 N and 70^0 E-coast have indicated that for the study area the wave period is within a small range from 5-6 seconds. The details of these analysis along with the percentage occurrence of the wave characteristics are also reported by Narasimha Rao and Sundar(1982),a

copy of which is given in Annexure A. Instead of assuming the fetch it was felt more reasonable to assume the wave period to vary from 5-6 secs, in order to forecast the wave heights. The forecasting diagram prepared by World Meteorological Organisation in 1988 has been utilised for obtaining the significant wave heights.

2. WIND SPEED

The wind speed(MWS, W1, W2, W3, W4) are stated earlier has been averaged for the duration of observation 1967-1986. Since the data available is for 20 years i.e. for a sufficiently long duration, the short term statistics derived from such data is expected to be quite reliable. Accordingly, the averages obtained for 20 years have been derived.

The monthly variation of W1 measured at 3.00 hrs and at 12.00 hrs are reported in Fig. 2(a) and 2(b) respectively. The results suggest that the wind speed is mostly less than 62 kmph except for the months of June and August during which the number of occurrence is only one. The wind speed measured at 12.00 hrs indicate that the wind speed has been observed to be greater than 62kmph only once during the months of June, August, October and November.

The analysis of W2 measured at 3.00 hrs and 12.00 hrs shown in Fig. 3(a) and 3(b) indicate that the wind speed is between 20-61kmph, for about 400 to 500 days during the months May to August, i.e., the percentage of occurrence is approximately 5-6%.

The results on the variation of W3 measured at 3.00 hrs as shown in Fig. 4(a). show that during the month of May-August the no of days is less to the extent of 200-300. No regular trend in its variation is seen as observed for W3 taken at 12.00 hrs shown in Fig. 4(b), wherein, the number of days is seen to reduce till the month of May after which the trend shows an increase in the number of days.

The variation of W4, is presented for 3.00 hrs and 12.00 hrs in Fig. 5(a) and 5(b) Respectively. The trend in the variation for both the time of observation looks almost similar, except, for the months of February and December.

The variation of the average of monthly mean wind speed (MWS) measured at 3.00 hrs and 12.00 hrs are shown in Fig. 6(a) and 6(b) respectively. The results indicate that during the months May to July the MWS is approximately reaching to the extent of about 25kmph, which is observed to be the highest in a year. The results obtained for the observation taken for 3.00 hrs generally exhibits a slightly higher value compared to the observations made at 12.00 hrs.

3.0 WAVE HEIGHT

3.1 From wind data:

The monthly average wind speed obtained for the 20 yrs data and assuming that the wave period ranging from 5-6 sec, the significant wave height was derived based on the wave forecasting methodology proposed by World Meteorological Organisation(WMO) in 1988. The wave period has to be fixed since the fetch is not known. Similarly, the duration of the wind is assumed to be 3.00 hrs. The above assumptions are quite reasonable as stated earlier in this report. The significant wave height(H_S) defined as the average of the highest one - third of the wave heights is obtained and the monthly means for the wind speeds measured at 3.00 hrs shown in Fig. 7(a).and that for the measurements taken at 12.00 hrs as shown in Fig. 7(b).The trend in the variation of H_S is similar to the variation of mean wind speed as can be seen in the previous plots. The significant wave height is found to vary from 2-4 m. The maximum significant wave height is of the order of 4 m, occuring during the month May-July for the data measured at 12.00 hrs and occurring in the month of July for the data measured at 3.00 hrs.

In the absence of data, it is advantageous to make certain assumptions for the derivation of the wave statistics. Literature states that the maximum wave height is 1.6-2.0 times the significant wave height. In the present study a factor of 1.8 has been adopted for the calculation of maximum wave heights. The variation of the monthly mean of maximum wave heights computed from the wind data observed at 3.00 hrs and that for measured at 12.00 hrs is shown in Fig. 8(a) and 8(b) respectively. The plots indicate that the maximum varies from about 3.5-7.5 m. The mean maximum wave height is observed to be about 7.5m in the month of July. However, the wave heights observed for the data taken at 12.00 hrs indicate that the mean

monthly maximum wave height is maximum during the months May, June, July to the extent of 7.5m. The variation of the maximum wave heights as derived above and that reported by Narasimha Rao and Sundar (1982) is given in Table 1, which indicates that the maximum wave heights in all the three months May, June, July which is of the order of about 7.5m.

The mean monthly maximum wave heights has been considered for the extreme value analysis in order to obtain the design wave heights.

Table 1. Maximum wave heights for the study area

Months	Hmax from wind speed at 3.00 hrs	Hmax from wind speed at 12.00 hrs	Hmax from the report [Narasimha Rao and Sundar (1982)]
January	5.4	4.14	3.0
February	5.04	4.68	2.5
March	4.32	5.76	2.5
April	4.77	6.3	3.0
May	5.85	7.2	4.0
June	6.12	7.2	7.5
July	7.2	7.38	7.5
August	5.94	6.3	7.0
September	4.32	5.4	4.0
October	3.42	4.23	4.5
November	4.68	4.14	3.5
December	5.4	3.6	3.0

3.2 Short Term Statistics:

The percentage of occurrence of different class intervals of wave heights have been obtained. For the seasonwise variation please see Annexure A. Fig. 9(a).shows the percentage of occurrence of wave heights considering the data from the visually observed data compiled for

the year 1968-1973. It is seen that the wave height of about 1-1.5m is the most frequently occurring. It also reveals that nearly 60% of the time wave height is less than 1.5m. The percentage of occurrence of wave heights less than or equal to 3m is approximately 95%. The cumulative percentage of occurrence of wave height is as shown in Fig. 9(b).It is felt that the above figures may certainly be helpful in decision making for the operational conditions. It is to be stated that this plot is for the offshore location.

4.0 WAVE PERIOD:

The percentage of occurrence of wave period and cumulative percentage of occurrence is shown in Fig. 10(a) and 10(b). It is observed that the wave periods range 5-6 secs are the most frequently occurring one and this accounts for nearly 60% of the duration

5.0 DESIGN WAVE HEIGHT

For the calculation of design wave heights from the available maximum wave heights for the 20 year duration as shown in Table 2, Log Pearson Type III distribution method is used. In this method the statistical moments are computed by using logarithms of the wave heights instead of the natural numbers. Since, the wave heights cannot be negative and therefore cannot conform to the normal distribution, their logarithms are more nearly normally distributed than the wave heights expressed in natural numbers.

Table 2. Computed yearly maximum wave heights

Year	Maximum wave height Hmax(m)
1967	8.1
1968	8.1
1969	8.1
1970	7.38
1971	8.1
1972	8.1
1973	8.1
1974	8.1
1975	7.38
1976	8.1
1977	7.56
1978	7.38
1979	7.38
1980	6.66
1981	6.84
1982	6.12
1983	6.3
1984	6.66
1985	6.66
1986	6.12

As per the available and computed 20 years data of maximum wave heights, the design wave heights for three return periods 25 ,50 and 100 years are as shown in Table 3.

Table 3. Results of Log Pearson type III distribution method

Return period (years)	Log of Mean wave heights	Standard deviation	Coefficient of skewness	Skewness curve factor	Design wave height (m)
25	.86985	.0447	-.52697	1.556	8.6
50	.86985	.0447	-.52697	1.762	8.8
100	.86985	.0447	-.52697	1.935	9.0

From the Log Pearsontype III distribution method the **design wave height** for a structure whose life time is **100 years is 9m**.

6.0 WAVE CHARACTERISTICS REPORTED BY NIO, GOA.

The recent study on the wave characteristics carried out by NIO, Goa during the period December 1993 to January 1994, for the study area of Positra in the Gulf of Kachchh as indicated in the following. The significant wave height during the S-W monsoon (June-Sept) varies from 1.5m-3m, during N-E monsoon (Oct-Jan) and non-monsoon (Feb-May) from 0.5m-1.5m. The wave periods varies from 5-8 sec during S-W monsoon, and 5-6 sec during the rest of the year. The deep water waves predominantly approach from 230^0-240^0 with respect to north, during S-W monsoon, 350^0-30^0 during N-E monsoon and 300^0 during fair weather period. Salient features from NIO measurements are given in Table 4.

Table 4. Salient results from NIO measurements from Dec 93- Jan 94

Season	Wave height (m)	Period (sec)	Wave direction w.r.t North
S-W Monsoon (June-Sept)	1.5 to 3.0	5.0 to 8.0	230^0 to 240^0
N-E Monsoon(Oct-Jan)	0.5 to 1.5	5.0 to 6.0	350^0 to 30^0
Fair Weather (Feb-May)	0.5 to 1.5	5.0 to 6.0	300^0

Considering Table 4. and Table 2(of Annexure A), the input wave characteristics for running the numerical model have been arrived as shown in Table 5.

Table 5. Wave characteristics for numerical model

Monsoon	Wave Height(m)	Wave Period(s)	Wave Direction with respect to North	Number of Plots
SouthWest	7.5	7	240^0	1
NorthEast	4.5	5	67.5^0	1
		5	30^0	1
Non-monsoon	4	6	300^0	1

7.0 NUMERICAL MODEL

The objective of the study is to investigate, the wave climate modifications in and around Positra, Boria reef, Paga Reef and in the approaches to the above locations. Accordingly, the hydrographic chart No. **203**, for the Gulf of Kachchh region was considered for numerical

modelling. The stretch 69^0 5' E to 69^0 30' E and 22^0 15' N to 22^0 32' N was blown up to arrive at the depth contours. The study area consists of the stretch running around **45kms** east to west extending from about Gururshoal on the west to Chank Tapu in the east and about **32kms** running north-south, from Gurur shoal in the north to Lalpur in the south. The total area considered for numerical modelling is **1440km^2** . The entire area was discretized in fine intervals of **385.2m**. For each grid of size **385.2m×385.2m** the depths were obtained from the hydrographic charts on the four corners. The basic input for running the above numerical model are the co-ordinates of the corners of the grid, and the water depths in metres in each of the grid. The other input data includes the wave period, the wave height and the wave direction. Computations were done for south - west monsoon, north - east monsoon and for non-monsoon seasons. The numerical model predicts the wave heights corresponding to the co-ordinates taken.

The numerical model uses mild slope equation and finite difference method is used for the computations. The program includes combined diffraction and refraction. In order to include wave transformation within the surf zone energy dissipation term by **Dally et. al** (1984) is also incorporated. The numerical model was verified with **Berkhoff et. al** (1982)wave tank experimental results which consists of an elliptical shoal superimposed on a plane beach. The numerical model has been earlier applied for the prediction of the wave heights near the Pipavav port in Gujarat. This model has been applied for the development of a port in Tamilnadu. The salient results obtained for the present study area are herein reported.

The wave height distribution in and around the jetty locations for the south west monsoon is shown in Fig. 11(a). The results indicate that the wave heights near all the three proposed jetty locations is mostly to the extent of about 0.60m for a deep water wave height of 7.5m.

The results on the wave height distribution for the north east monsoon are shown in Figures 11(b) and 11(c) respectively. In the former plot, location 1 experiences waves of height upto a maximum of 2.0m whereas, at location 2 the wave height is about 0.5m and at location 3 the waves are occasionally to a height of about 1.0m. In the latter plot, both the locations 2 and

3 are observed to be calm with waves of height upto about 0.5m while, location 1 experiences occasional higher waves of height upto about 2.0m .

The plot for the wave height distribution during non monsoon is shown in Fig. 11(D). The results indicate that all the three locations experiences mostly waves of height about 0.4m. However, at location 3, the waves are occasionally to the extent of about 1.0m. Based on the present study the order of priority with relevance to the tranquility point of view would be location 3, location 2 and location 1.

8.0 REFERENCES

1. Berkhoff, J. C . W. , Booy, N. , and Radder A. C . 1982. "Verification of Numerical Wave propagation models for simple harmonic linear water waves " , Coastal Engineering , Vol. 6 , pp 225 - 279.

2. Dally , W. R., Dean, R. G., and Dalrymple, R. A. 1984. " Modelling Wave transformation in the surf zone. ", Miscellaneous paper CERC - 84 - 8, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

3. T. V . S . Narasimha Rao and V . Sundar . , 1982." Estimation of Wave Power potential along the Indian Coastal line" , Proc. Energy, Vol. y, No. 10, pp. 839 - 845.

9.0 SUMMARY

A detailed analysis of the variation of wind speeds reveals that during the months May-August the wind speeds are relatively higher compared to the other months. The mean monthly wind speeds during the months May-August is about 25kmph.

The monthly mean significant wave height varies from 2-4m and is observed to be maximum during the months of May-July to the extent of about 4m.

The monthly mean maximum wave height is of the order of 7.5m during the 3 months May, June and July.

From the visually observed data compiled for the year 1968-1973, it is seen that the most frequently occurring wave height is about 1-1.5m and the most frequently occurring wave period range 5-6 secs.

The design wave height for a structure whose life time is 100 years is obtained as 9m using the Log Pearson type III distribution method.

Though all the three locations are ideal for port development, based on the wave penetration tests, the order of priority in finalising the jetty locations for port development considering the tranquility conditions will be location 3, location 2 and finally location 1.

(Prof.V. SUNDAR) **(Dr.R. SUNDARAVADIVELU)**

(Dr.R. NATARAJAN) **(Dr.S.R. GANDHI)**

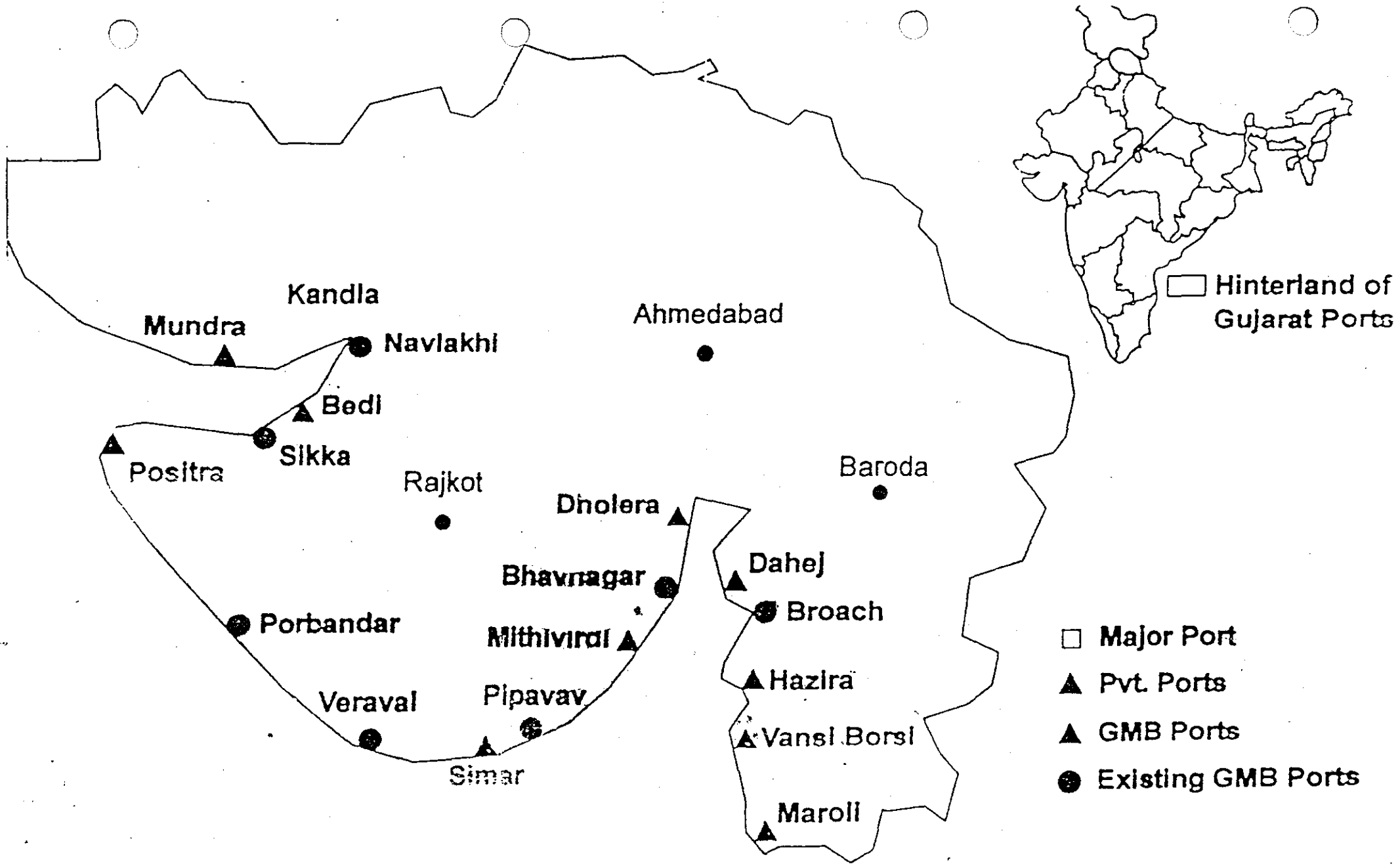
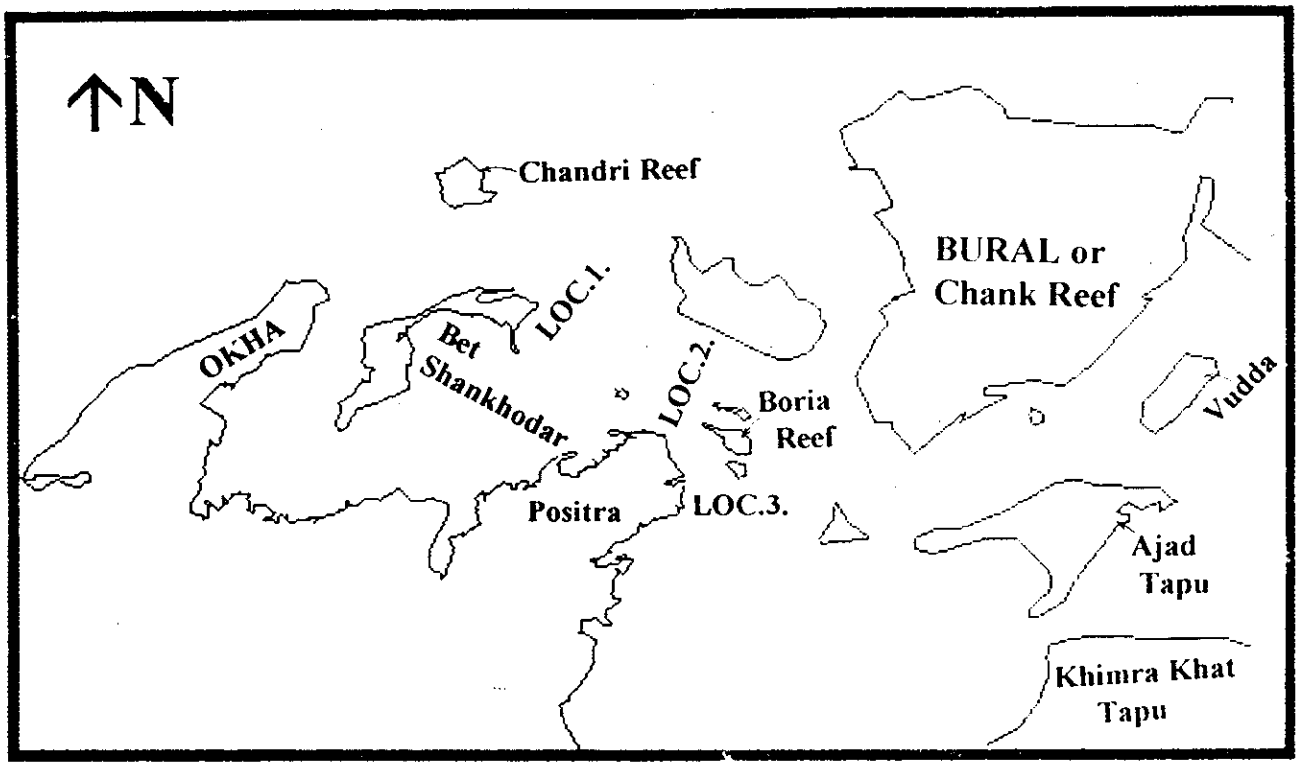


FIG. 1 (a) . LOCATION OF PORTS ALONG GUJARAT COAST



LOC → LOCATION

FIG. 1 (b) . LOCATION OF POSITRA

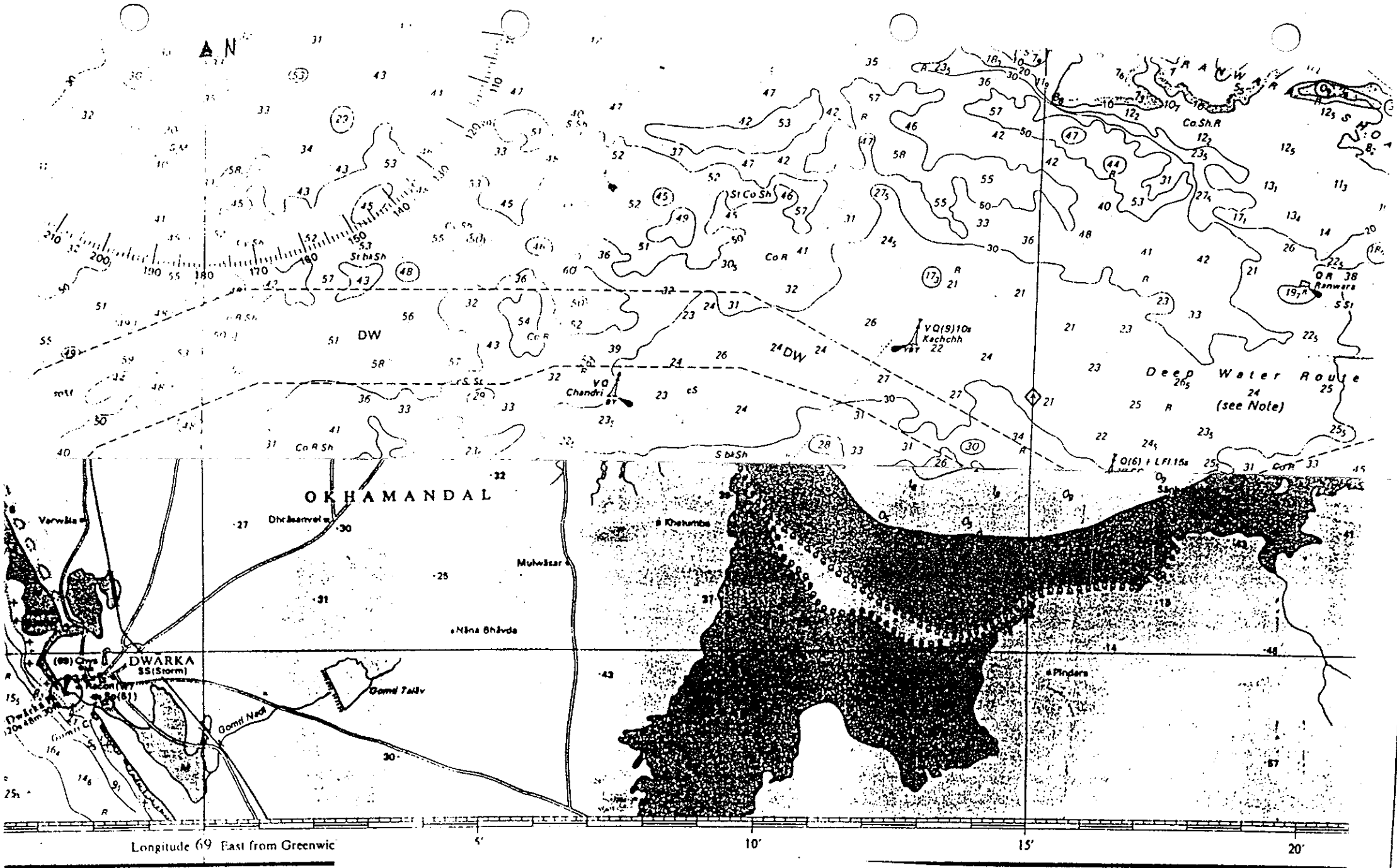


FIG. 1 (c) . HYDROGRAPHIC CHART SHOWING LOCATIONS OF POSITRA

1 : 150000

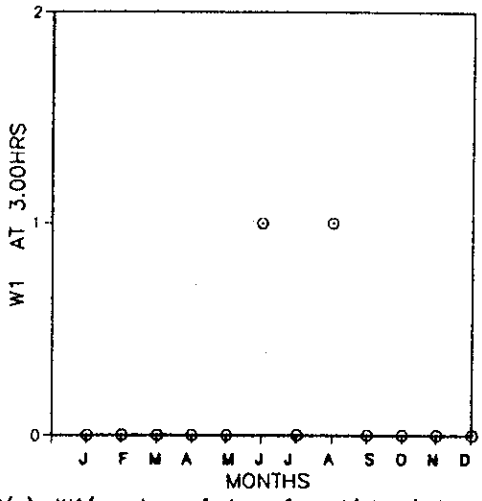


FIG.2(a). W1(number of days for which wind speed=62 kmph and above) based on 20 years data

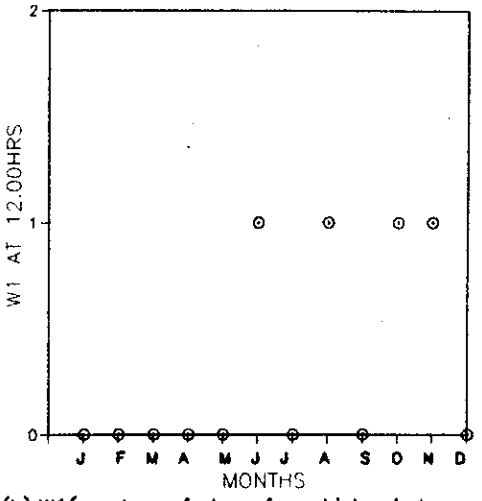


Fig.2(b).W1(number of days for which wind speed=62 kmph and above) based on 20 years data

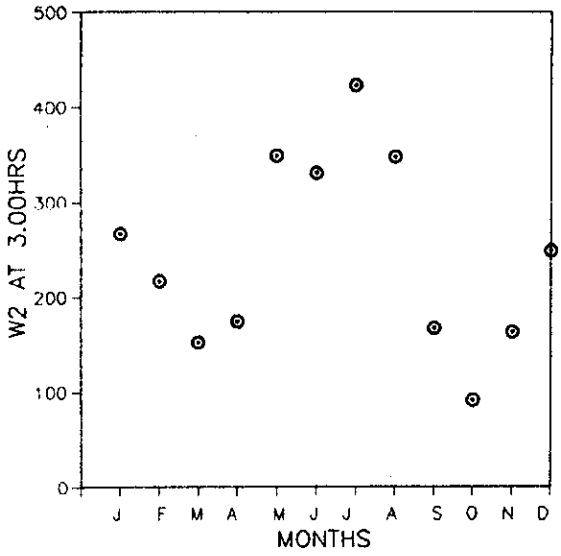


Fig.3(a).W2(number of days for which wind speed=20–61 kmph) based on 20 years data

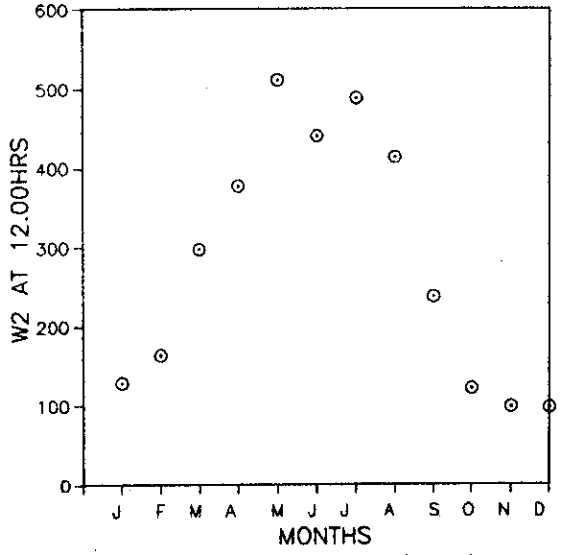


Fig.3(b).W2(number of days for which wind speed=20–61 kmph) based on 20 years data

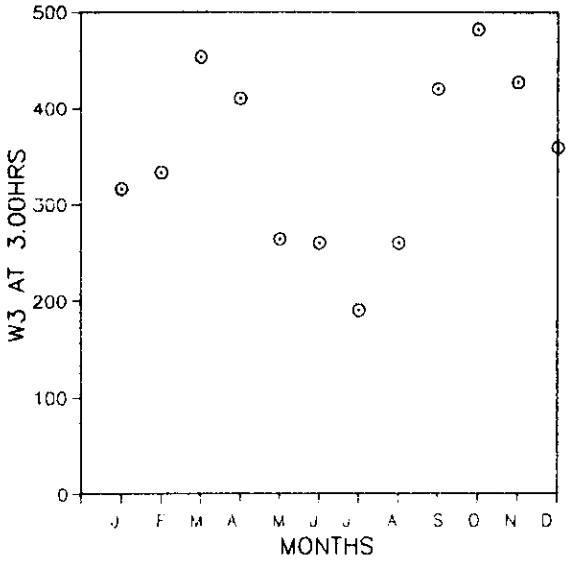


Fig.4(a).W3(number of days for which wind speed=1–19 kmph) based on 20 years data

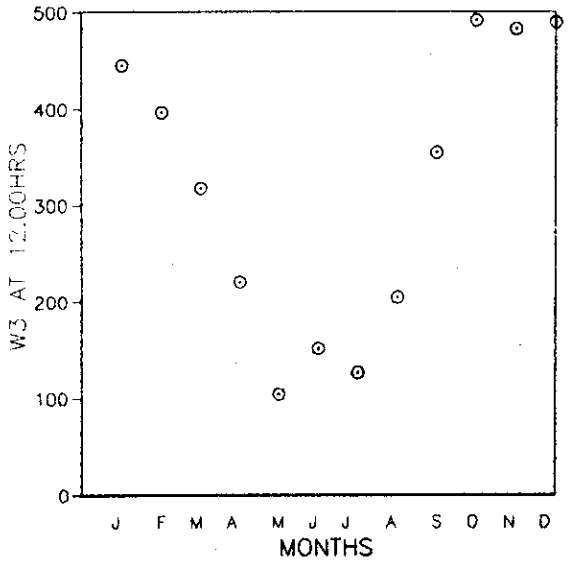


Fig.4(b).W3(number of days for which wind speed=1–19 kmph) based on 20 years data

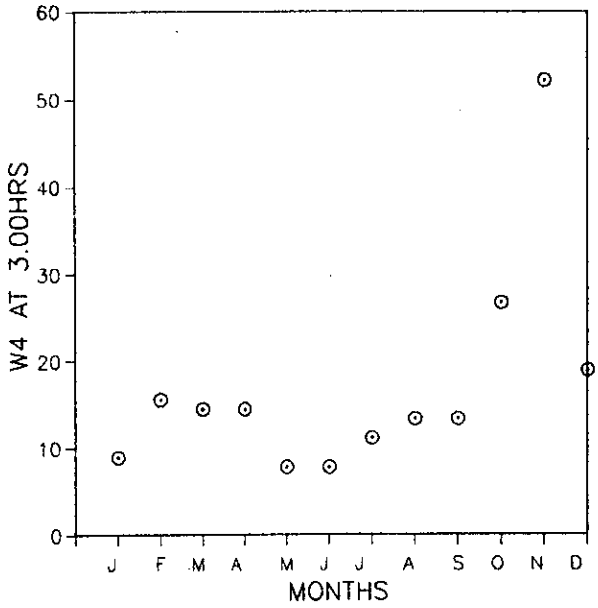


Fig.5(a).W4(number of days when calm condition prevails) based on 20 years data

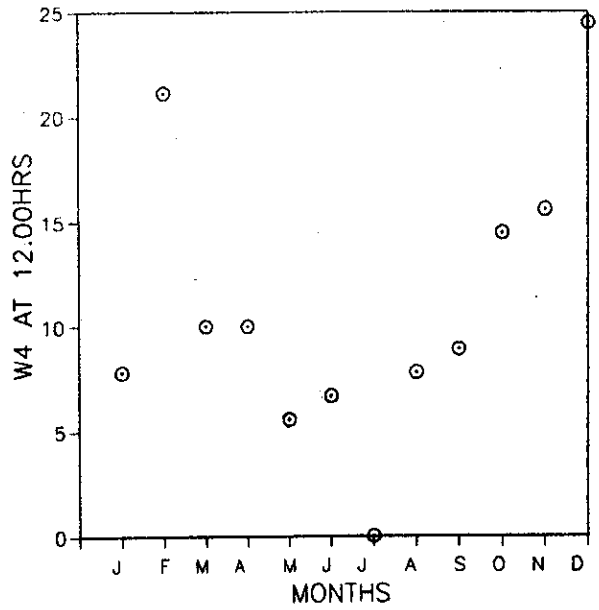


Fig.5(b).W4(number of days when calm condition prevails) based on 20 years data

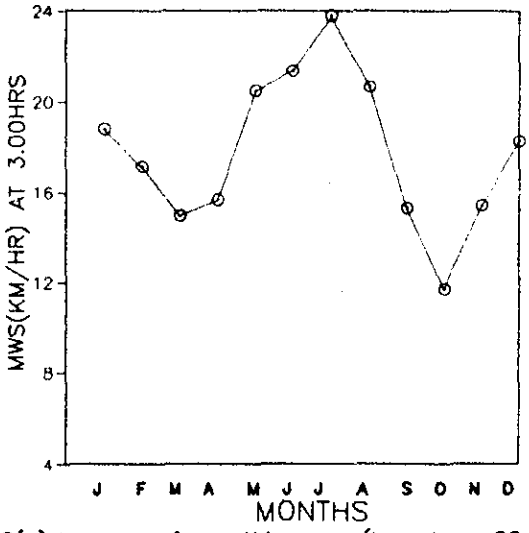


Fig.6(a).Average of monthly mean(based on 20 years data) of MWS

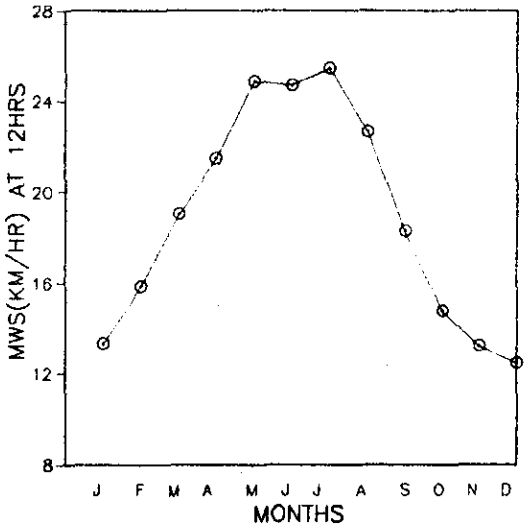


Fig.6(b).Average of monthly mean(based on 20 yrs data) of MWS

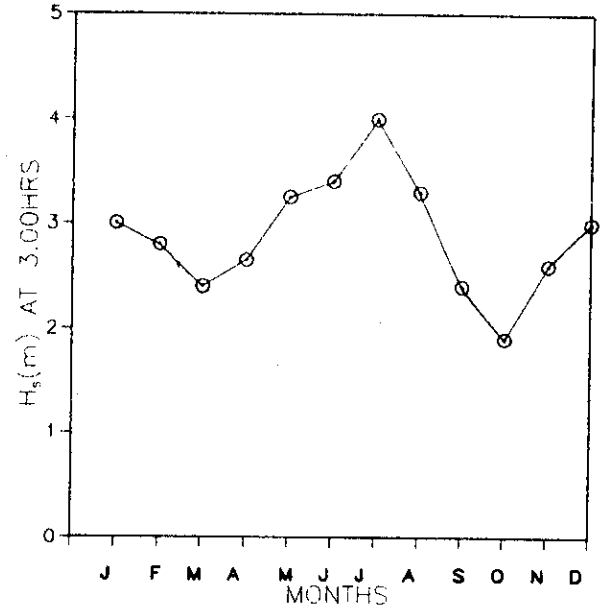


Fig.7(a).Significant wave heights based on the average of monthly mean wind speeds(MWS) of 20 years data

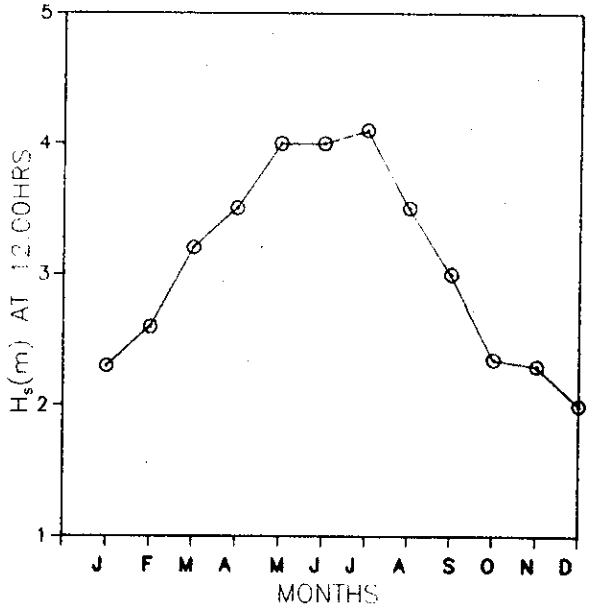


Fig.7(b).Significant wave heights based on the average of monthly mean wind speeds(MWS) of 20 years data

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH
Plastic Limit ○ / Water Content % □ / Liquid Limit ●	KN/CuM: Dry, Bulk	KG/CM²: VL, PP, UC, TU
20 40 60 80 100	15 20 25	200 400 600 800 1000

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
*All depths are in metres below bed level																			
0.00		0.00	0.10	6-Mar	19 00	19 00						10cm/50blows			>100	SPT			0.00
	1	0.10	0.40		20 30	21 20	NIL												
1.00																			
2.00	2	0.40	2.00	7-Mar	08 00	10 10	60%	45%	10%										
3.00																			
	3	2.00	3.50		11 10	12 30	NIL												
4.00																			
	4	3.50	5.50		12 40	14 00	NIL												
6.00																			
		5.50	5.85		14 30	14 45				8	4	9	5cm/14blows		>100	SPT			5.5
7.00																			
8.00	5	6.50	8.00		16 10	18 06	NIL												
		8.00	8.40		19 30	20 10				7	7	7	8	3/20	>100	SPT			8.00
9.00																			
10.00																			

VL FIELD VANE SHEAR TEST — UC : UNCONFINED COMP.

PP. POCKET PENETROMETER — TEST

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

BORE HOLE NO. MB- 2

Sheet 1 of 1

CO ORDINATES	69 14' 52.25" E 22 26' 26.04" N	Date: 8th Mar. 97 to 9th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	14.5 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT — Plastic Limit | Water Content % | Liquid Limit (20 40 60 80 100)

UNIT WT. — KN/CuM — Dry / Bulk (16 20 25)

SHEAR STRENGTH — VL / PP / UC / TU (25 50 75 100 125)

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	No of Blows PENETRATION 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					All depths are in metres below bed level
0.00	1	0.00	1.50	9-Mar	07 00	09 00	15%	15%	NIL												Light to dark yellow, fine grained, fractures are extremely closely to very closely spaced, weathered LIMESTONE. very poor.
1.00																					
2.00																					
3.00	2	1.50	3.60		13 45	15 20	25%	25%	NIL												
4.00		3.60	3.85		16 20	16 40				17	18	3/32			>100	SPT			3.6		Light yellowish brown, fine grained, highly fractured LIMESTONE. very poor.
5.00	3	3.60	5.10		19 45	20 25	NIL														
6.00		5.10	5.20		20 40	20 55				10/50					>100	SPT			6.1		END OF BOREHOLE
7.00																					
8.00																					
9.00																					
10.00																					

VL LAB VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY.

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-3

Sheet 1of 1

CO ORDINATES	69 10' 09.09" E 22 28'64.34" N	Date: 5 th Apr. 97 to 6 th Apr 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	10.80 M Below chart datum	
DIA. OF BORE HOLE	100MM	Core Dia 55MM

ATTERBERG LIMIT (Plastic Limit ○ / Water Content % □ / Liquid Limit ●) — 20 | 40 | 60 | 80 | 100

UNIT WT. (KN/CuM: Dry / Bulk) — 15 | 20 | 25

SHEAR STRENGTH (KG/CM²: VL / PP / UC / TU) — 200 | 400 | 600 | 800 | 1000

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.35	6-Apr	17 45	18 00				18	12	5cm/25 blows			>100	SPT			0.00		Light yellowish brown, cemented shell fragments, with traces of fine sand.
1.00		1.00	1.06		18 15	18 30				6cm/60 blows					>100	SPT			1.00		Dark to light yellow, fine to medium grained ,highly fractured , weathered LIMESTONE , very poor
2.00	1	1.00	2.50		18 45	20 00	5%														Light yellowish grey , fine grained , completely weathered , LIMESTONE , very poor
3.00																					
4.00	2	2.50	4.00		20 30	21 15	NR														
		4.00	4.45	6-Apr	23 30	00 05				9	11	7	9	13	40	SPT			4.00		
5.00																					
	3	4.00	5.50		00 30	01 30	NR														
6.00		5.50	5.83		01 40	02 00				22	30	3cm/25blows			>100	SPT			5.50		
	4	5.50	6.20		02 15	03 30	NR														
7.00		6.20	6.32		03 30	04 00				12 cm/ 28 blows					>100	SPT			6.20		
8.00																					END OF BOREHOLE
9.00																					
10.00																					

VL FIELD VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP. POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT | UNIT WT | SHEAR STRENGTH

Plastic Limit ○ | Water Content % □ | Liquid Limit ●

UNIT WT: KN/CuM — Dry / Bulk

SHEAR STRENGTH: c — VL, PP, UC, TU

20 40 60 80 100 | 15 20 25 | 25 50 75 100 125

BORE HOLE NO. MB- 4 Sheet 1of 1

CO ORDINATES	89 10' 41.49" E 22 27' 41.15" N	Date:	4th April 97 to 5th April 97
SITE	OFF POSITRA		
METHOD	Rotary		BY JACK-UP BARGE
REDUCED LEVEL	12.2 M below chart datum		
DIA. OF BORE HOLE	100 MM		Core dia. 65 mm

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.45		00 05	00 30				23	17	11	10	8	48	SPT			0.0		Light brown cemented shell fragments with trace of sand.
1.00		0.50	0.95		01 30	01 40				5/25			REFUSAL		>100	SPT			0.5		Light yellowish brown, fine to medium grained, slightly to completely weathered, LIMESTONE,
2.00		2.00	2.18		02 00	02 15				32	3/25				>100	SPT			2.0		with traces of loose silty sand.
3.00	1	2.00	3.50		02 30	03 15	NR														
		3.50	3.89		04 10	430				31	4/25				>100	SPT			3.5		
4.00																					
	2	3.50	4.90		04 45	05 15	NR														
5.00		4.90	4.86		05 30	05 45															
6.00																					
7.00																					
8.00																					
9.00																					
10.00																					

END OF BOREHOLE

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC UNCONFINED COMP TEST
NR: NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 7 — Sheet 1 of 3

CO ORDINATES	89 10' 05.47" E 22 25' 54.80" N	Date: 30th Mar. 97 to 2nd Apr. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	2.7 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT — Plastic Limit ○ — Water Content ✓ □ — Liquid Limit ● ⬚ — 20 40 60 80 100

UNIT WT — KN/CuM — Dry ⬚ Bulk ⬚ — 15 20 25

SHEAR STRENGTH — V L ⬚ P P ⬚ U C ⬚ T U ⬚ — 25 50 75 100 125

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORRNG CR %	CORRNG SCR %	CORRNG RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.30		18 15	18 30										DS			0.0		Very soft, dark grey, marine silty CLAY
2.00		1.80	1.90		18 42	18 00					Torque (M)=20Nm.					VS			1.80		
3.00		3.30	3.70		19 15	19 35	NR									UDS			3.3		
4.00		4.80	5.28		20 38	20 40				1	0	0	0	2	2	SPT			4.8		
5.00		5.30	5.31	31-Mar	02 25	02 45				1.5/25					>100	SPT			5.3		Light yellow, fine grained, fractures are extremely closely to
6.00	1	5.30	6.30		03 00	04 30	58%	56%	14%												very closely spaced slightly weathered LIMESTONE.
7.00	2	6.30	7.30	1 Apr	23 00	00 30	36%	36%	18%												
8.00	3	7.30	8.90		01 00	02 20	34%	34%	Nil												
9.00																					Light yellowish grey, fine grained, completely weathered
10.00	4	8.90	10.30		02 45	03 15	NR														LIMESTONE.
		10.30	10.42		03 35	03 50				12/50					>100	SPT			10.3		

VS FIELD VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 7 — **Sheet 2 of 3**

CO ORDINATES	69 10' 05.47" E 22 25' 54.80" N	Date: 30th Mar. 97 to 2nd Apr. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	2.7 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT — Plastic Limit ○ — Water Content % □ — Liquid Limit ○ (20 40 60 80 100)

UNIT WT — KN/CuM — Dry ☐ Bulk ☐ (15 20 25)

SHEAR STRENGTH — VL ☐ PP ☐ UC ☐ TU ☐ (25 50 75 100 125)

*All depths are in metres below bed level

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No. of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00	5	10.30	11.00		04 30	06 00	73%	68%	57%										
12.00																			
	6	11.00	12.80		06 25	07 50	10%	Nil											
13.00		12.80	12.87		08 10	08 20				8/50					>100	SPT			12.8
14.00	7	12.80	14.00		08 25	08 50	NR												
		14.00	14.45		09 00	09 15				8	7	8	11	12	38	SPT			14.0
15.00																			
	8	14.00	15.50		18 30	19 55	NR												
16.00		15.50	15.87		10 10	10 30				11	2/50				>100	SPT			15.5
17.00	9	15.50	17.00		10 45	11 35	NR												
		17.00	17.01		11 50	12 15				1/25					>100	SPT			17.0
18.00																			
	10	17.00	18.50		12 30	13 45	75%	75%	20%										
19.00																			
	11	18.50	20.00		14 00	14 35	NR												
20.00		20.00	20.35		14 40	14 55				7	11	8	5/26		>100	SPT			20.0

Symbol	DESCRIPTION
	Light to dark yellow, fine grained, fractures are closely to medium spaced, slightly weathered LIMESTONE.
	Light to dark yellow, fine grained, completely weathered LIMESTONE.
	Light yellow, fine grained, fractures are very closely to closely space, slightly weathered LIMESTONE.
	Becoming completely weathered from 18.5 m. onwards.

VL LAB VANE SHEAR TEST — UC : UNCONFINED COMP.

PP. POCKET PENETROMETER — TEST

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY.

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-7 Sheet 3 of 3

CO ORDINATES 69 10' 05.47" E / 22 25' 54.80" N Date: 30th Mar. 97 to 2nd Apr. 97
SITE OFF POSITRA
METHOD Rotary BY JACK-UP BARGE
REDUCED LEVEL 2.7 M below chart datum
DIA. OF BORE HOLE 100 MM Core dia. 55 mm

*All depths are in metres below bed level

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH	SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN -- METERS	Symbol	DESCRIPTION
			21.00	12	20.00	21.50		15.05	15.30	NR														
					21.50	21.95		15.40	16.00				17	14	24	26	26	90	SPT			21.6		Light yellowish grey, fine to medium grained, completely weathered
			22.00																					LIMESTONE
																								with considerable amount of silty fine sand.
			23.00	13	21.50	23.00		22.10	22.28	NR														
					23.00	23.45		22.45	23.00				9	8	8	11	10	35	SPT			23.0		
			24.00																					
				14	23.00	24.50	2-Apr	23.30	00.10	NR														
			25.00		24.50	24.95		00.25	00.30				4	5	6	6	4	21	SPT			24.5		
			26.00	15	24.50	26.30		01.00	01.15	NR														
					26.30	26.75		01.30	01.35				6	8	7	7	8	30	SPT			26.3		
			27.00																					END OF BOREHOLE
			28.00																					
			29.00																					
			30.00																					

FS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-8 — Sheet 1of 3

CO ORDINATES	69 09' 51.21" E 22 25'40.24" N	Date: 2nd April 97 to 3rd April 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	2.1M Below chart datum	
DIA. OF BORE HOLE	100MM	Core Dia 55MM

ATTERBERG LIMIT — Plastic Limit O — Water Content % □ — Liquid Limit ● — 20 40 60 80 100

UNIT WT — KN/CUM — Dry Bulk — 15 20 25

SHEAR STRENGTH — KG/CM² — V L / P P / UC / TU — 200 400 600 800 1000

SAMPLE DEPTH	RUN NO.	DEPTH" FROM	DEPTH" TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
"All depths are in metres below bed level																					
0.00		0.00		2-Apr	09 50	09 55										DS			0.00		Very soft, dark grey, marine silty CLAY
1.00		1.60			10 10	10 20				Torque (M) =10 Nm						VS			1.60		
2.00																					
3.00		3.00	3.40		10 30	10 45	NR									UDS			3.00		
4.00		4.50			11 15	11 30				Torque (M) =10 Nm						VS			4.50		
5.00																					
6.00		6.00	6.40		12 00	12 20	NR									UDS			6.00		Stiff, Light greenish grey, silty CLAY.
		6.40	6.85		12 30	12 40				3	7	8	9	11	35	SPT			6.40		
7.00		7.00	7.45		13 15	13 30				8	6	10	18	25	59	SPT			7.00		Light yellowish grey, fine grained, completely weathered LIMESTONE, decomposed.
8.00		8.50	8.53		15 30	15 50	NR			3/25		REFUSAL			>100	SPT			8.50		
9.00																					
10.00	1	9.80	10.00		16 05	16 30	<8%	NR	NR												
		10.00	10.00		16 40	17 00	NR			0/25		REFUSAL			>100	SPT			10.00		

FS FIELD VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP POCKET PENETROMETER

U TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-8 — Sheet 2of 3

CO ORDINATES	69 09' 51.21" E 22 26'40.24" N	Date: 2nd April 97 to 3rd April 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	2.1M Below chart datum	
DIA. OF BORE HOLE	100MM	Core Dia 55MM

ATTERBERG LIMIT — Plastic Limit ○ | Water Content % □ | Liquid Limit ●; 20 40 60 80 100

UNIT WT. — KN/CuM: Dry, Bulk; 16 20 28

SHEAR STRENGTH — KG/CM²: V L, P P, UC, TU; 200 400 600 800 1000

*All depths are in metres below bed level

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
10.00																			
11.00	2	10.00	11.50		17 20	17 60	NR												
		11.50	11.67		18 30	18 45				26	2.5/25				>100	SPT			11.50
12.00																			
13.00	3	11.50	13.00		21 30	22 05													
		13.00	13.07		22 00	22 30				7/25		REFUSAL			>100	SPT			13.00
14.00																			
	4	13.00	14.50		22 50	23 20	NR												
15.00		14.50	14.78		23 30	23 46				31	18	6.5/25			>100	SPT			14.50
16.00	5	14.50	16.00	3-Apr	23 55	00 20	NR												
		16.00	16.25		00 40	01 00				26	19	2/25			>100	SPT			16.00
17.00																			
	6	16.00	17.50		01 15	01 35	NR												
18.00		17.50	17.75		01 50	02 08				18	26	2/25			>100	SPT			17.50
19.00	7	17.50	19.00		02 15	02 35	NR												
		19.00	19.21		02 50	03 00				21	8/25				>100	SPT			19.00
20.00																			
	8	19.00	20.5		03 15	03 30	NR												

symbol — DESCRIPTION

Dark yellowish to Light brown, fine grained, completely weathered

LIMESTONE

with traces of silt

VS FIELD VANE SHEAR TEST — UC : UNCONFINED COMP.

PP POCKET PENETROMETER — TEST

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-8 Sheet 3of 3

CO ORDINATES 69 09' 51.21" E
22 25'40.24" N
SITE OFF POSITRA
METHOD Rotary
REDUCED LEVEL 2.1M Below chart datum
DIA. OF BORE HOLE 100MM

Date: 2nd April 97 to 3rd April 97
BY JACK-UP BARGE
Core Dia 56MM

	UNIT WT	SHEAR STRENGTH	DEPTH		DEPTH*			TIME		CORING			No of Blows PENETRATION					N - VALUE	TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
	KN/CuM	KG/CM²	SAMPLE	RUN NO.	FROM	TO	DATE	FROM	TO	CR %	SCR %	RQD %	15cm	7.5cm	7.5cm	7.5cm	7.5cm							
	Dry Bulk	VL PP UC TU																						
	15 20 25	200 400 600 800 1000																						
			*All depths are in metres below bed level																					
			21.00		20.60	20.86		03.48	03.55				50					>100	SPT			20.6		Dark yellow, fine grained, completely weathered LIMESTONE.
				9	20.50	22.00		04.10	04.25	NR														
			22.00		22.00	22.22		04.35	04.45				19	7/25				>100	SPT			22.0		
			23.00																					
				10	22.00	23.50		05.00	05.15	NR														
			24.00		23.50	23.65		05.25	05.35				57	REFUSAL				>100	SPT			23.6		
			25.00	11	23.80	25.00		05.50	06.10	NR														
					25.00	25.45		06.20	06.35				10	9	12	13	14	48	SPT			25.0		
			26.00																					Light yellowish brown, fine grained, fractures are closely to medium spaced slightly weathered LIMESTONE.
				12	26.00	26.60		06.50	07.30	61%	56%	47%												
			27.00	13	26.80	26.90		07.30	08.00	NR														Becoming completely weathered from 26.6 m. onwards
			28.00																					END OF BOREHOLE
			29.00																					
			30.00																					

FIELD VANE SHEAR TEST
POCKET PENETROMETER
TRIAXIAL TEST UNDRAINED
UC UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-9 Sheet 1of 2

CO ORDINATES	89 10' 09.93" E 22 25'34.99" N	Date: 3rd Apr 97 to 4th Apr 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	2.5 M below chart datum	
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

*All depths are in metres below bed level

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
0.00		0.00		3-Apr	20 00	20 15										DS			0.00		Very soft, dark grey, marine silty CLAY
1.00																					
		1.50			20 20	20 30				Torque (M)=10 N m.						VS			1.50		
2.00																					
3.00		3.00	3.40		20 35	20 40	NR									UDS	DS		3.00		
4.00																					
		4.50	4.96		21 15	21 30				3	2	4	3	6	14	SPT			4.50		Dark greyish brown, medium grained, clayey SAND
5.00																					grading coarse with traces of coral
6.00		6.00	6.45		21 40	21 55				4	3	3	7	6	19	SPT			6.00		
		6.50	6.60		22 15	22 40				0/25	REFUSAL				>100	SPT			6.50		
7.00																					Light yellowish brown, fine to medium grained, completely
8.00	1	6.60	8.00		23 15	23 45	NR														weathered LIMESTONE.
		8.00	8.45	4-Apr	00 05	00 15				8	4	8	12	11	33	SPT			8.00		
9.00																					
	2	8.00	9.50		00 30	01 00	NR														
10.00		9.50	9.82		01 15	01 30				7	11	9	2/25		>100	SPT			9.50		

UNIT WT: KN/CUM — Dry, Bulk

SHEAR STRENGTH: KG/CM² — VL, PP, UC, TU

'S FIELD VANE SHEAR TEST
P POCKET PENETROMETER
U TRIAXIAL TEST UNDRAINED
UC UNCONFINED COMP. TEST
NR NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-9 — **Sheet 2of 2**

CO ORDINATES 89 10' 09.93" E / 22 26'34.99" N — Date: 3rd Apr 97 to 4th Apr 97
SITE OFF POSITRA
METHOD Rotary — BY JACK-UP BARGE
REDUCED LEVEL 2.5 M below chart datum
DIA. OF BORE HOLE 100 MM — CORE DIA. 55 mm

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH	SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
20 40 60 80 100	KN/CUM Dry / Bulk	KG/CM² V L, P P, UC, TU																				
			11.00	3	9.50	11.00		01 45	02 25	NR												
					11.00	11.37		02 40	03 00				9	8	12	7/25		>100	SPT			11.00
			12.00																			
				4	11.00	12.50		03 15	03 40	NR												
			13.00		12.50	12.85		04 00	04 20				11	8	7	13	18	46	SPT			12.80
			14.00	5	12.50	14.00		04 40	05 10	NR												
					14.00	14.42		05 25	05 40				6	8	12	9	4/25	>100	SPT			14.00
			15.00	6	14.00	14.50		06 00	06 30	NR												
			16.00																			
			17.00																			
			18.00																			
			19.00																			
			20.00																			

*All depths are in metres below bed level

Symbol | DESCRIPTION

Light yellowish brown, fine to medium grained, completely weathered LIMESTONE.

Colour changes to reddish brown from 14 m. onwards.

END OF BOREHOLE

FIELD VANE SHEAR TEST
POCKET PENETROMETER
TRIAXIAL TEST UNDRAINED
UC UNCONFINED COMP TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 10 — Sheet 1of 3

CO ORDINATES	89 10' 46.26" E 22 25' 68.76" N	Date: 28th Mar 97 to 30th Mar 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACKUP BARGE
REDUCED LEVEL	7.1 M Below Chart datum	
DIA. OF BORE HOLE	100 MM	Core dia .55mm

ATTERBERG LIMIT (Plastic Limit / Water Content / Liquid Limit) — 20 40 60 80 100

UNIT WT (KN/CuM: Dry / Bulk) — 15 20 25

SHEAR STRENGTH (KG/CM²: VL / PP / UC / TU) — 200 400 600 800 1000

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					All depths are in metres below bed level
0.00		0.00	0.45	28-Mar	21 00	21 15				Penetration by Weight of Hammer					0	SPT			0.00		Very soft, marine silty CLAY with coral debris and trace of SAND
1.00		1.10	1.11		21 35	21 45				1.6/25					>100	SPT			1.10		Light yellow, fine to medium grained, weathered LIMESTONE
2.00		2.60	2.72		22 05	22 15				9	2	4.5/25			>100	SPT			2.6		Light yellow, fine to medium grained, fractures are extremely closely to very closely spaced, LIMESTONE
3.00	1	2.60	4.00	29-Mar	23 40	00 20	25%	25%	Nil												
4.00		4.00	4.02		00 50	01 00				2/25					>100	SPT			4.00		
5.00																			5.00		
6.00	2	4.10	5.60		04 00	04 45	12%	12%	8%												
		5.60	6.05		05 00	05 15				7	9	12	13	11	45	SPT			5.60		
7.00	3	5.60	7.10		05 45	06 30	NR														Light yellow, fine to medium grained completely weathered LIMESTONE.
8.00		7.10	7.38		06 45	07 05				18	20	3.5/25			>100	SPT			7.10		
	4	7.10	8.60		07 15	08 00	NR														Colour becoming dark yellowish brown with considerable amount of SAND.
9.00		8.60	8.71		08 30	08 45				6	3	3	2	3	11	SPT			8.60		
10.00	5	8.60	10.10		09 00	09 30	NR														

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 10 — Sheet 2of 3

CO ORDINATES	69 10' 45.26" E 22 26' 58.76" N	Date: 28th Mar 97 to 30th Mar 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACKUP BARGE
REDUCED LEVEL	7.1 M Below Chart datum	
DIA. OF BORE HOLE	100 MM	Core dia .55mm

ATTERBERG LIMIT — Plastic Limit | Water Content % | Liquid Limit — 20 40 60 80 100

UNIT WT — KN/CuM — Dry / Bulk — 15 20 25

SHEAR STRENGTH — KG/CM² — V L / P P / UC / TU — 200 400 600 800 1000

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					*All depths are in metres below bed level
10.00		10.10	10.33		09 55	10 10				32	7/50				>100	SPT			10.10		
11.00																					
	6	10.10	11.60		10 20	10 60	NR														
12.00		11.60	11.82		11 05	11 25				38	7/50				>100	SPT			11.60		
13.00	7	11.60	13.10		12 00	13 00	NR														
		13.10	13.22		18 10	18 20				12/50					>100	SPT			13.10		
14.00																					Light yellowish brown to reddish brown, fine grained, completely
	8	13.10	14.60		18 40	18 55	NR														weathered LIMESTONE
15.00		14.60	15.08		19 15	19 25				9	9	9	10	11	38	SPT			14.60		with traces of silt and sand
16.00	9	14.60	16.10		22 30	23 15	NR														
		16.10	16.56		23 30	23 46				12	13	13	12	13	51	SPT			16.10		
17.00																					
	10	16.10	17.60		00 10	00 46	NR														
18.00		17.60	17.77		01 00	01 15				21	2/25				>100	SPT			17.60		
19.00	11	17.60	19.10		01 40	02 30	15%	15%	NIL												Light yellowish brown, fine grained, fractures are extremely
																					closely to very closely spaced, slightly weathered LIMESTONE.
20.00	12	19.10	20.60		02 45	03 30	NR														

B FIELD VANE SHEAR TEST — UC UNCONFINED COMP TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH
Plastic Limit ○ — Water Content % □ — Liquid Limit ●	KN/CuM: Dry Bulk	KG/CM²: VL, PP, UC, TU
20 40 60 80 100	15 20 25	200 400 600 800 1000

DEPTH SAMPLE	RUN NO.	DEPTH' FROM	DEPTH' TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
20.00		20.6	20.85		03 30	03 45				20	22	2.5/26			>100	SPT			20.6
21.00																			
22.00	13	20.6	22.10		04 30	05 10	NR												
		22.10	22.30		05 20	06 30				26	5/25				>100	SPT			22.10
23.00																			
24.00	14	22.10	24.00		06 40	08 00	NR												
		24.00	24.25		08 30	08 40				18	19	2/25			>100	SPT			24.00
25.00																			
26.00																			
27.00																			
28.00																			
29.00																			
30.00																			

"All depths are in metres below bed level

BORE HOLE NO. MB- 10 Sheet 3of 3

CO ORDINATES	69 10' 46.26" E 22 25' 58.76" N	Date: 28th Mar 97 to 30th Mar 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACKUP BARGE
REDUCED LEVEL	7.1 M Below Chart datum	
DIA. OF BORE HOLE	100 MM	Core dia .55mm

Symbol	DESCRIPTION
	Light yellowish brown, fine grained, completely weathered LIMESTONE.
	END OF BOREHOLE

VL FIELD VANE SHEAR TEST — UC : UNCONFINED COMP.

PP POCKET PENETROMETER — TEST

TU TRIAXIAL TEST UNDRAINED — VS = Vane Shear Test

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH	DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
Plastic Limit 20 40 60 80 100	KN/CuM Dry Bulk 15 20 25	VS PP UC TU 25 50 75 100 125																						
			0.00		0.00	0.10	25-Mar	17 15	17 30				19/32					>100	SPT			0.0		Light brownish grey, slightly weathered LIMESTONE, sand & shells.
1.00																								Light to dark yellow, fine grained, fractures are very closely to closely spaced LIMESTONE, ocassionally vesicular.
				1	0.10	1.40		17 45	19 20	35%	25%	Nil												
2.00																								
3.00				2	1.40	2.90	26-Mar	22 30	00 30	26%	26%	17%												
			2.90		2.92			01 00	01 30				2/25					>100	SPT			2.9		
4.00																								
				3	2.90	4.40		02 25	03 15	65%	52%	8%												
5.00																								
6.00				4	4.40	6.00		03 45	04 25	10%	8%	Nil												
			6.00		6.20			04 40	04 50				9	5/30				>100	SPT			6.0		Light yellow to light grey, fine grained completely weathered LIMESTONE.
7.00																								
				5	6.00	7.50		05 10	05 30	NR														
8.00			7.50		7.92			05 45	05 55				9	9	18	18	4/25	>100	SPT			7.5		
9.00				6	7.50	9.00		06 30	06 45	NR														
			9.00		9.45			07 00	07 10				8	8	9	9	10	36	SPT			9.0		
10.00																								
				7	9.00	10.50		07 30	07 50	NR														

BORE HOLE NO. MB- 11 Sheet 1of 3

CO ORDINATES	69 10' 58.00" E 22 26' 00.00" N	Date: 25th Mar. 97 to 27th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	6.2 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

*All depths are in metres below sea level

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-11 — Sheet 2of 3

CO ORDINATES	69 10' 58.00" E 22 26' 00.00" N	Date: 25th Mar. 97 to 27th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	6.2 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT (Plastic Limit, Water Content %, Liquid Limit) — UNIT WT. KN/CuM (Dry Bulk) — SHEAR STRENGTH (VL, PP, UC, TU)

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					*All depths are in metres below bed level
11.00		10.60	10.95		08 15	08 25				9	9	9	10	12	39	SPT			10.6		
12.00	8	10.60	12.00		08 45	09 30	NR												12.0		
		12.00	12.22		09 45	10 00				12	7/25				>100	SPT			13.6		Light to dark yellow, fine grained, completely weathered
13.00																					LIMESTONE
	9	12.00	13.60		10 20	11 00	NR												15.0		with considerable amount of silt
14.00		13.50	13.95		11 15	11 35				8	4	4	6	7	21	SPT					
15.00	10	13.60	15.00		14 15	15 00	NR														
		15.00	15.45		15 10	15 25				3	2	4	2	4	12	SPT			16.5		Light to dark yellow, fine grained, slightly weathered
16.00																					LIMESTONE.
	11	15.00	15.50		15 40	15 55	NR														
17.00		15.50	15.76		16 50	17 15				17	18	4/26			>100	SPT					
	12	15.50	18.00		18 30	19 10	8%	NIL											18.0		
18.00		18.00	18.15		19 25	19 45				50	REFUSAL				>100	SPT					
	13	18.00	19.50		02 00	03 40	35%	35%	NIL												
20.00																					

VL LAB VANE SHEAR TEST — UC UNCONFINED COMP TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH	DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
Plastic Limit 20 40	Water Content % 60 80 100 Liquid Limit	KN/CuM Dry Bulk 15 20 25	V L P P U C T U 25 50 75 100 125																		

*All depths are in metres below bed level

Depth	Run No.	Depth* From	Depth* To	Date	Time From	Time To	Coring CR %	Coring BCR %	Coring RQD %	Penetration No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - Value	Sample Type	Sample No.	Samples	Depths in Meters
20.00																			
21.00	14	18.50	21.00		04 00	04 30	NR												
		21.00	21.45		04 45	05 00				9	4	5	4	9	21	SPT			21.0
22.00																			
23.00	15	21.00	23.00		07 00	08 00	NR												
24.00																			
25.00	16	23.00	25.00		09 00	10 00	NR												
26.00																			
27.00																			
28.00																			
29.00																			
30.00																			

BORE HOLE NO. MB- 11 Sheet 3 of 3

CO ORDINATES	69 10' 58.00" E 22 26' 00.00" N	Date: 25th Mar. 97 to 27th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	6.2 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

Symbol	DESCRIPTION
	Light yellow, fine grained, completely weathered, LIMESTONE with considerable amount of sandy silt.
	END OF BOREHOLE

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-12 Sheet 1of 2

CO ORDINATES	69 11' 06.30" E 22 25' 55.80" N	Date: 22nd Mar. 97 to 24th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	6.9 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT: Plastic Limit ○ | Water Content % □ | Liquid Limit ● — 20 40 60 80 100

UNIT WT. KN/CUM: Dry | Bulk — 15 20 25

SHEAR STRENGTH KG/CM²: V L | P P | UC | TU — 200 400 600 800 1000

*All depths are in metres below bed level

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
0.00		0.00	0.00	22-Mar	18 26	18 46				0/26					>100	SPT			0.00
1.00	1	0.00	0.70		18 30	20 15	91%	91%	47%										
	2	0.70	1.20		21 45	23 00	100%	100%	94%										
2.00																			
	3	1.20	2.40	23-Mar	01 30	03 20	70%	70%	70%										
3.00																			
4.00	4	2.40	3.90		03 45	06 20	67%	67%	54%										
5.00	5	3.90	4.70		06 50	08 20	18%	10%	NIL										
6.00	6	4.70	6.10		08 50	08 10	22%	20%	13%										
		6.10	6.22		08 40	09 00				12/25					>100	SPT			6.10
7.00																			
	7	6.10	7.60		12 45	13 15	21%	16%	8%										
8.00		7.60	7.90		13 45	14 00				15	20	7/30			>100	SPT			7.60
9.00	8	7.60	9.10		14 30	15 15	NR												
		9.10	9.40		15 35	16 45				19	21	7.5/30			>100	SPT			9.10
10.00	9	9.10	10.60		16 15	16 25	NR												

Symbol	DESCRIPTION
	Light yellowish, fine grained, fractures are very closely to closely spaced LIMESTONE.
	Fractures are becoming extremely spaced to highly fractured.

FIELD VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

POCKET PENETROMETER

TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT					UNIT WT.			SHEAR STRENGTH				
		Water Content %		Liquid Limit	KN/CuM Dry Bulk			V L P P UC TU				
20	40	60	80	100	18	20	25	25	50	75	100	125

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00		10.60	10.80		16.45	16.55				20	5/25	REFUSAL			>100	SPT			10.60
12.00	10	10.60	12.10		17.15	17.30	NR												
		12.10	12.55		17.45	18.10				4	4	9	11	12	36	SPT			12.10
13.00																			
14.00																			
15.00	11	12.10	15.10		18.40	19.10	NR												
		15.10	15.55		19.40	19.50				6	6	7	9	9	30	SPT			15.10
16.00																			
	12	15.10	15.60		20.30	21.00	NR												
17.00		16.95	17.05		21.30	21.45				4	8	9	13	19	47	SPT			16.8
18.00	13	16.60	18.10	24-Mar	04.15	04.45	NR												
		18.10	18.55		05.45	06.00				12	11	12	13	13	49	SPT			18.1
19.00																			
20.00																			

*All depths are in metres below bed level

BORE HOLE NO. MB-12 Sheet 2of 2

CO ORDINATES	69 11' 06.30" E 22 25' 55.80" N	Date: 22nd Mar. 97 to 24th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	6.9 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

Symbol	DESCRIPTION
	Light yellowish grey, fine grained, completely weathered
	LIMESTONE
	with trace of fine sandy silt.
	END OF BOREHOLE

LAB VANE SHEAR TEST
POCKET PENETROMETER
TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY.

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH	DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
Plastic Limit / Water Content % / Liquid Limit	KN/CuM Dry / Bulk	VL PP UC TU																						
20 40 60 80 100	15 20 25	25 50 75 100 125																						
			0.00																					
					0.50	0.54		16 10	16 15				4/25					>100	SPT			0.5		Dark grey, marine CLAY with dead corals
			1.00	1	0.50	0.70		16 15	16 45	NR														Light yellow, fine grained, highly to completely weathered
				2	0.70	0.90		16 55	17 25	NR														LIMESTONE
			2.00	3	0.90	2.00		18 20	19 00	5%														
					2.00	2.16		19 10	19 20				23	1/25				>100	SPT			2.0		
			3.00	4	2.00	2.90		19 40	20 15	15%	15%	Nil												
			4.00																					
				5	2.90	4.50		22 10	22 35	NR														
			5.00		4.50	4.80		23 00	23 10				12	21	7/25			-100	SPT			4.5		
			6.00	6	4.50	6.00		00 50	01 50	5%	5%	Nil												
					6.00	6.26		02 20	02 30				13	18	5/25			>100	SPT			6.0		
			7.00	7	6.00	7.50		03 00	03 40	NR														
			8.00		7.50	7.62		04 00	04 10				20	21	20	2/25		>100	SPT			7.5		
			9.00	8	7.50	9.00		04 30	04 55	10%	10%	Nil												
					9.00	9.37		05 15	05 25				12	22	22	7/25		>100	SPT			9.0		
			10.00																					

*All depths are in metres below bed level

BORE HOLE NO. MB- 13 Sheet 1of 3

CO ORDINATES	69 11' 24.87" E 22 25' 52.28" N	Date: 18th Mar. 97 to 21st Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	7.5 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

S FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
U TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH
Plastic Limit — Water Content % — Liquid Limit	KN/CuM: Dry Bulk	VL / PP / UC / TU
20 40 60 80 100	15 20 25	25 50 75 100 125

BORE HOLE NO. MB-13 — Sheet 2 of 3

CO ORDINATES 89 11' 24.87" E / 22 26' 52.28" N — Date: 18th Mar. 97 to 21st Mar. 97
SITE OFF POSITRA
METHOD Rotary — BY JACK-UP BARGE
REDUCED LEVEL 7.5 M below chart datum
DIA. OF BORE HOLE 100 MM — Core dia. 55 mm

*All depths are in metres below bed level

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
11.00		10.50	10.75		06 50	07 00				15	18	2/25			>100	SPT			10.6		Light yellowish brown, fine grained, completely weathered LIMESTONE with trace of silt.
12.00	10	10.50	12.00		07 30	08 00	NR														
		12.00	12.45		08 30	08 40				10	20	18	19	20	77	SPT			12.0		
13.00																					
	11	12.00	13.50		09 20	10 00	5%														
14.00		13.50	13.92		10 15	10 30				11	10	13	22	5/25	>100	SPT			13.5		
15.00	12	13.50	15.00		14 30	15 30	NR														
		15.00	15.07		15 30	16 00				7/35					>100	SPT			15.0		
16.00																					
	13	15.00	16.50		1630	17 30	NR														
17.00		16.50	16.95		18 30	18 40				7	5	4	7	18	34	SPT			16.5		Light yellow, fine grained, completely weathered LIMESTONE.
18.00	14	16.50	18.00		19 30	20 00	NR														
		18.00	18.19	20-Mar	00 30	01 00				15	4/25				>100	SPT			18.0		
19.00																					
	15	18.00	19.50		06 00	06 30	NR														
20.00		19.50	19.60		07 00	07 10				10/50					>100	SPT			19.5		

VL LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT	UNIT WT	SHEAR STRENGTH
Plastic Limit / Water Content % / Liquid Limit	KN/CuM: Dry, Bulk	VL, PP, UC, TU
20 40 60 80 100	15 20 25	25 50 75 100 125

BORE HOLE NO. MB- 13 Sheet 3 of 3

CO ORDINATES	69 11' 24.87" E 22 25' 52.28" N	Date: 18th Mar. 97 to 21st Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	7.5 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

*All depths are in metres below bed level

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	SAMPLE No.	SAMPLES DEPTHS IN METERS
21.00	16	19.50	21.00		08 00	08 30	15%	8%	Nil									
		21.00	21.45		09 00	09 30				5	2	8	5	10	23	SPT		21.0
22.00																		
23.00	17	21.00	23.00		19 30	20 50	NR											
		23.00	23 15		21 00	21 15				18	0/25				>100	SPT		23.0
24.00																		
	18	23.00	24.50		21 40	22 50	NR											
25.00		24.50	24.80		23 00	23 20				12	21	26			>100	SPT		24.5
26.00																		
	19	24.50	26.50	21-Mar	00 15	01 15	NR											
27.00		26.50	26.95		01 30	01 50				8	12	10	9	22	53	SPT		26.5
28.00	20	26.50	28.00		03 20	04 15	NR											
		28.00	28.07		04 40	05 05				7/25					>100	SPT		28.0
29.00																		
	21	28.00	29.50		05 20	06 10	NR											
30.00		29.50	29.75		06 20	06 45				18	12	3/25			>100	SPT		29.5
31.00	22	29.50	31.00		07 00	07 50	NR											
		31.00	31.35		08 00	08 20				9	15	11	5/25		>100	SPT		31.0

Symbol | DESCRIPTION

Light yellowish brown, fine grained, fractures are extremely closely to very closely spaced. slightly weathered LIMESTONE.

Light yellowish brown, fine grained, completely weathered LIMESTONE

END OF BOREHOLE

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT | UNIT WT. | SHEAR STRENGTH

Plastic Limit | Water Content % | Liquid Limit

20 40 60 80 100

UNIT WT. KN/CuM: Dry, Bulk

SHEAR STRENGTH: VL, PP, UC, TU

15 20 25 25 50 75 100 125

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
0.00		0.00	0.45	17-Mar	10 40	10 50				5	3	2	1	1	7	SPT			0.0
1.00		1.50	1.95		11 20	11 30				4	2	3	3	3	11	SPT			1.50
2.00																			
3.00		3.00	3.45		11 40	11 50				2	1	2	2	2	7	SPT			3.00
4.00																			
		4.50	4.95		12 08	12 18				4	0	0	0	9	9	SPT			4.50
5.00																			
6.00		6.00	6.45		12 45	12 55				2	0	0	0	3	3	SPT			6.00
7.00																			
		7.50	7.95		13 05	13 10				1	0	0	0	1	1	SPT			7.50
8.00																			
9.00		9.00	9.45		13 30	13 40				3	0	0	0	6	6	SPT			9.00
10.00																			

*All depths are in metres below bed level

BORE HOLE NO. MB- 14 Sheet 1of 3

CO ORDINATES 69 12' 57.28" E / 22 23' 33.46" N
Date: 17th Mar. 97 to 18th Mar. 97
SITE OFF POS/TRA
METHOD Rotary — BY JACK-UP BARGE
REDUCED LEVEL 0.6 M above chart datum
DIA. OF BORE HOLE 100 MM — Core dia. 55 mm

Symbol	DESCRIPTION
	Dark to light grey, dead corals with clayey shell fragments.
	Very soft light grey, sandy SILT with corals and shell fragments
	Very soft to soft, dark grey marine silty CLAY

VL LAB VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY.

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG L M T | UNIT WT | SHEAR STRENGTH

Water Content | Plastic Limit | Liquid Limit | KN/CuM Dry / Bulk | VL PP UC TU

20 40 60 80 100 | 15 20 25 | 25 50 75 100 125

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00		10.50	10.90		14.00	14.15										UDS			10.50
12.00		12.00	12.40		15.00	15.13	NR									UDS			12.00
13.00		13.50			15.45	15.55					Torque (M)=20 Nm.					VS			13.50
14.00																			
15.00		15.00			16.15	16.20					Torque (M)=25 Nm.					VS			15.00
16.00																			
17.00		16.50			16.45	16.55					Torque (M)=35 Nm.					VS			16.50
18.00		18.00			17.08	17.10					Torque (M)=30 Nm.					VS			18.00
19.00		18.60	18.91		17.30	17.40				3	0	0	0	12	12	RPT			19.00
20.00																			
21.00																			

*All depths are in metres below bed level

BORE HOLE NO. MB- 14 Sheet 2of 3

CO ORDINATES	89 12' 57.28" E 22 23' 33.46" N	Date: 17th Mar. 97 to 18th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	0.6 M above chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

Symbol | DESCRIPTION

Very soft to soft dark grey, marine silty CLAY

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 14 — **Sheet 3of 3**

CO ORDINATES	69 12' 57.28" E 22 23' 33.46" N	Date: 17th Mar. 97 to 18th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	0.6 M above chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

*"All depths are in metres below bed level

ATTERBERG LIMIT (Water Content %: 20 40 60 80 100)	UNIT WT KN/CuM (Dry / Bulk: 15 20 25)	SHEAR STRENGTH (V L / P P / UC / TU: 25 50 75 100 125)	SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
			21.00		21.00	21.45		18 00	18 10				3	3	7	3	8	18	SPT			21.0		
			22.00																					
					22.60	22.82		18 36	18 50				2	7	13	2/26		>100	SPT			22.6		
			23.00	1	22.80	24.30		21 50	22 20	NR														Light yellowish grey, fine grained, completely weathered,
																								LIMESTONE.
			24.00		24.30	24.60		22 40	22 50				21	13	7/26			>100	SPT			24.3		with trace of sandy silt.
			25.00																					
				2	24.30	25.80		23 15	23 40	NR														
			26.00		26.80	26.25	18-Mar	23 55	00 10				22	7	9	8	9	33	SPT			25.8		
																								END OF BOREHOLE
			27.00																					
			28.00																					
			29.00																					
			30.00																					

LAB VANE SHEAR TEST — UC : UNCONFINED COMP.

POCKET PENETROMETER — TEST

TRIAXIAL TEST UNDRAINED

BORE HOLE NO. MB- 15 — Sheet 1 of 3

CO ORDINATES	69 13' 16.85" E 22 23' 41.22" N	Date: 14th Mar. 97 to 16th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	18.9 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

ATTERBERG LIMIT (Plastic Limit ○ — Water Content % — Liquid Limit ●; 20 40 60 80 100) | UNIT WT. KN/CuM (Dry / Bulk; 15 20 25) | SHEAR STRENGTH (VL / PP / UC / TU; 25 50 75 100 125)

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	No of Blows PENETRATION 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					*All depths are in metres below bed level
0.00		0.00	0.40	14-Mar	23 40	23 50	NR									UDS			0.0		Dark greyish yellow, clayey, silty shell fragments with trace of SAND.
																DS					
1.00																					
		1.50	1.95	15-Mar	00 05	00 15				6	3	5	2	2	12	SPT			1.5		
2.00																					
3.00		3.00	3.45		00 40	01 00				3	2	2	5	8	17	SPT			3.0		
		4.00	4.34		01 30	02 00				12	7	8	4/25		>100	SPT			4.0		
5.00																					
		5.50	5.68		07 00	07 20				25	2.5/20				>100	SPT			5.5		
6.00																					
7.00	1	6.50	7.00		09 45	11 00	NR														Dark yellowish brown, fine grained, completely weathered LIMESTONE. with lithic rock fragments.
		7.00	7.27		11 00	11 30				19	25	4.5/25			>100	SPT			7.0		
8.00																					
	2	7.00	8.50		12 25	13 30	NR														
9.00		8.50	8.57		13 45	14 00				7/25					>100	SPT			8.5		
10.00	3	8.50	10.00		14 20	16 35	NR														
		10.00	10.45		16 10	16 20				13	9	11	12	13	45	SPT			10.0		

VL LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT | UNIT WT | SHEAR STRENGTH

Plastic Limit ○ | Water Content ◪ | Liquid Limit ●

20 40 60 80 100

kN/CuM: Dry / Bulk

15 20 25

VL PP UC TU

25 50 75 100 125

DEPTH SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION/ No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00																			
	4	10.00	11.50		16.50	18.00	NR												
12.00		11.50	11.95		18.40	18.50				12	9	9	12	18	48	SPT			11.5
13.00	5	11.50	13.00		19.30	20.00	NR												
		13.00	13.45		20.45	20.55				7	8	9	12	14	41	SPT			13.0
14.00																			
	6	13.00	14.50		21.30	22.30	NR												
15.00		14.50	14.95		23.30	23.40				15	11	12	13	13	49	SPT			14.5
16.00	7	14.50	16.00		00.30	01.30	NR												
		16.00	16.45		02.10	02.20				12	8	7	8	9	32	SPT			16.0
17.00																			
	8	16.00	17.50		03.00	04.00	NR												
18.00		17.50	17.95		04.30	04.40				11	7	8	9	8	33	SPT			17.5
19.00	9	17.50	19.00		05.10	06.10	NR												
20.00																			
	10	19.00	20.50		08.00	08.30	NR												

BORE HOLE NO. MB- 15 Sheet 2of 3

CO ORDINATES 69 13' 16.85" E / 22 23' 41.22" N
SITE OFF POSITRA
METHOD Rotary
REDUCED LEVEL 18.9 M below chart datum
DIA. OF BORE HOLE 100 MM

Date: 14th Mar. 97 to 16th Mar. 97
BY JACK-UP BARGE
Core dia. 55 mm

*All depths are in metres below bed level

Symbol | DESCRIPTION

Very dense, dark yellowish brown, fine grained completely weathered LIMESTONE.

Dark yellow fine grained, completely weathered LIMESTONE with trace of silty sand

VS FIELD VANE SHEAR TEST
PP POCKET PENETROMETER
TU TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT | UNIT WT. | SHEAR STRENGTH

Water Content % | KN/CuM: Dry, Bulk | VL, PP, UC, TU

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
21.00		20.50	20.65		08 55	09 10				22	3/28				>100	SPT			20.5
22.00	11	20.50	22.00		09 40	11 55	NR												
		20.00	22.45		12 15	12 40				21	19	16	16	14	65	SPT			20.0
23.00																			
	12	22.00	23.50		13 30	15 00	NR												
24.00		23.50	23.80		15 30	15 45				29	23	7.5/31			>100	SPT			23.5
25.00	13	23.50	25.00		16 35	18 00	NR												
		25.00	25.27		18 30	18 00				32	30	4.5/20			>100	SPT			25.0
26.00																			
27.00																			
28.00																			
29.00																			
30.00																			

*All depths are in metres below bed level

BORE HOLE NO. MB- 15 Sheet 3of 3

CO ORDINATES	69 13' 16.85" E 22 23' 41.22" N	Date: 14th Mar. 97 to 16th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	18.9 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

Symbol | DESCRIPTION

Dark to light greyish yellow, fine grained, completely weathered LIMESTONE.

END OF BOREHOLE

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
UU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST
NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB- 16 — **Sheet 1of 3**

CO ORDINATES	69 13' 11.15" E 22 23' 21.29" N	Date: 12th Mar. 97 to 14th Mar. 97
SITE	OFF POSITRA	
METHOD	Rotary	BY JACK-UP BARGE
REDUCED LEVEL	21.7 M below chart datum	
DIA. OF BORE HOLE	100 MM	Core dia. 55 mm

**All depths are in metres below bed level*

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH	SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
			0.00		0.00	0.40		16.40	17.00	NR									UDS			0.0		Very soft, dark grey marine silty CLAY
																			DS			0.6		
			1.00																					
			2.00		2.00	2.45		17.20	18.10	NR			2	1	2	1	2	6	SPT			2.0		
			3.00																					
					3.50	3.95		18.30	19.00				6	4	4	6	14	27	SPT			3.5		Medium dense, dark grey, very clayey SAND
			4.00																					with broken shells
			5.00		5.00	5.45		20.30	20.56	NR			5	4	6	4	4	17	SPT			5.0		
			6.00		6.00	6.43		22.00	22.30				6	8	4	17	6/50	>100	SPT			6.0		
																								Very dense, light greyish yellow, completely weathered
			7.00																					LIMESTONE.
				1	8.30	7.80	13-Mar	01 00	01 26	NR														
			8.00		7.80	8.05		02 40	03 00				8	7	2/25			>100	SPT			7.8		Light to dark yellow, fine grained, completely to highly weathered
																								LIMESTONE.
			9.00	2	7.80	8.30		03 30	05 10	NR														
					8.30	8.41		06 00	06 30				11/50					>100	SPT			8.3		
			10.00																					
				3	8.30	10.80		07 30	10 00	20%														

LAB VANE SHEAR TEST — UC : UNCONFINED COMP.

POCKET PENETROMETER — TEST

TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ATTERBERG LIMIT | UNIT WT | SHEAR STRENGTH

Plastic Limit | Water Content % | Liquid Limit | 20 40 60 80 100

UNIT WT: KN/CuM — Dry — Bulk | 15 20 25

SHEAR STRENGTH: VL, PP, UC, TU | 25 50 75 100 125

BORE HOLE NO. MB- 16 — Sheet 2of 3

CO ORDINATES 69 13' 11.15" E / 22 23' 21.29" N — Date: 12th Mar. 97 to 14th Mar. 97

SITE OFF POSITRA

METHOD Rotary — BY JACK-UP BARGE

REDUCED LEVEL 21.7 M below chart datum

DIA. OF BORE HOLE 100 MM — Core dia. 56 mm

SAMPLE DEPTH	RUN NO.	DEPTH" FROM	DEPTH" TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					All depths are in metres below bed level
11.00		10.80	10.87		11.15	11.35				7/50					>100	SPT			10.8		Dark yellow to light reddish brown, fine medium grained, completely weathered LIMESTONE.
12.00	4	10.80	12.30		12.15	13.30	NR														
13.00	5	12.30	13.80		14.00	15.30	NR														
14.00		13.80	14.05		15.30	15.45				12	18	3/26			>100	SPT			13.8		Colour changes to bluish grey with some silty fine sand.
15.00	6	13.80	15.30		16.00	17.00	NR														
16.00		15.30	15.52		17.20	17.45				19	7/50				>100	SPT			15.3		
17.00	7	15.30	17.30		18.15	18.45	NR														
18.00		17.30	17.58		20.50	21.15				21	29		REFUSAL		>100	SPT			17.3		
19.00	8	17.30	18.80	14-Mar	22.00	23.30	NR														
		18.80	19.08		00.35	01.00				18	22	5.5/28			>100	SPT			18.8		
20.00	9	18.80	20.30		01.30	03.00	NR														

VS FIELD VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED — NR : NO RECOVERY

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

BORE HOLE NO. MB-16 'Sheet 3 of 3

CO ORDINATES 69 13' 11.16" E / 22 23' 21.29" N
SITE OFF POSITRA
METHOD Rotary
REDUCED LEVEL 21.7 M below chart datum
DIA. OF BORE HOLE 100 MM

Date: 12th Mar. 97 to 14th Mar. 97
BY JACK-UP BARGE
Core dia. 55 mm

*All depths are in metres below bed level

ATTERBERG LIMIT (Plastic Limit / Water Content % / Liquid Limit)	UNIT WT KN/CuM (Dry Bulk)	SHEAR STRENGTH VL PP UC TU	SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
			20.00																					
					20.30	20.32		03.30	04.00				7/25					>100	SPT			20.83		Very dense, dark grey, fine grained, completely weathered
			21.00																					LIMESTONE.
				10	20.30	21.80		06 00	07 00	NR														with traces of silty SAND.
			22.00		21.80	21.97		07 10	07 30				22	2/25				>100	SPT			21.8		
			23.00																					
				11	21.80	23.30		09 00	10 00	20%														
			24.00		23 30	23.65		10 30	10 46				11	28	3/25			>100	SPT			23.3		
			25.00	12	23 30	25 00		11 30	12 46	NR														
					25 00	25 21		13 06	13 13				22	6/25				>100	SPT			25.0		
			26.00																					END OF BOREHOLE
			27.00																					
			28.00																					
			29.00																					
			30.00																					

VL LAB VANE SHEAR TEST
PP POCKET PENETROMETER TEST
TU TRIAXIAL TEST UNDRAINED
UC UNCONFINED COMP
NR NO RECOVERY

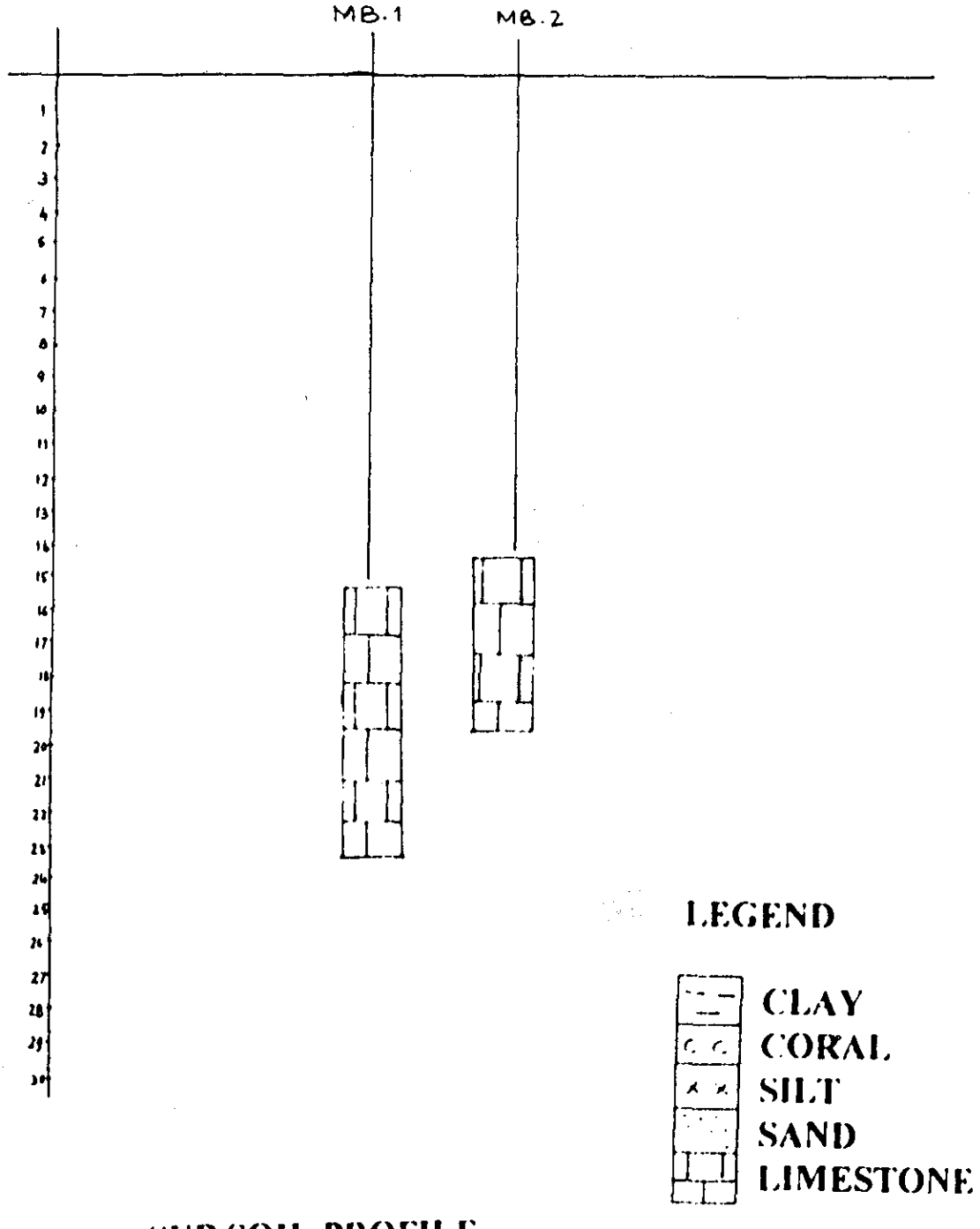
PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ANNEXURE - 4

GEOTECHNICAL INVESTIGATION OFF POSITRA
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

CHANNEL BOREHOLE

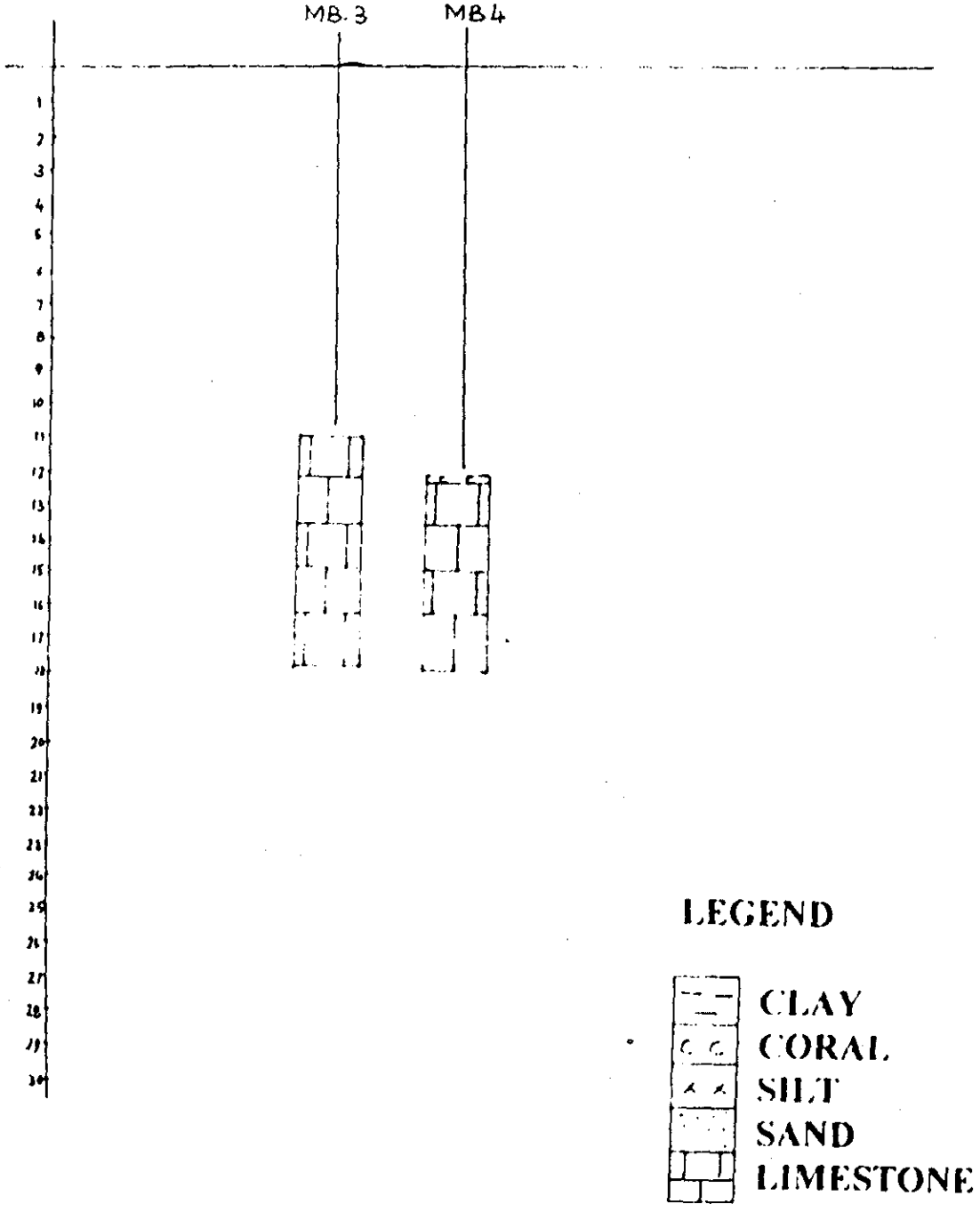


SUB SOIL PROFILE

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

GEOTECHNICAL INVESTIGATION OFF POSITRA
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

CHANNEL BOREHOLE



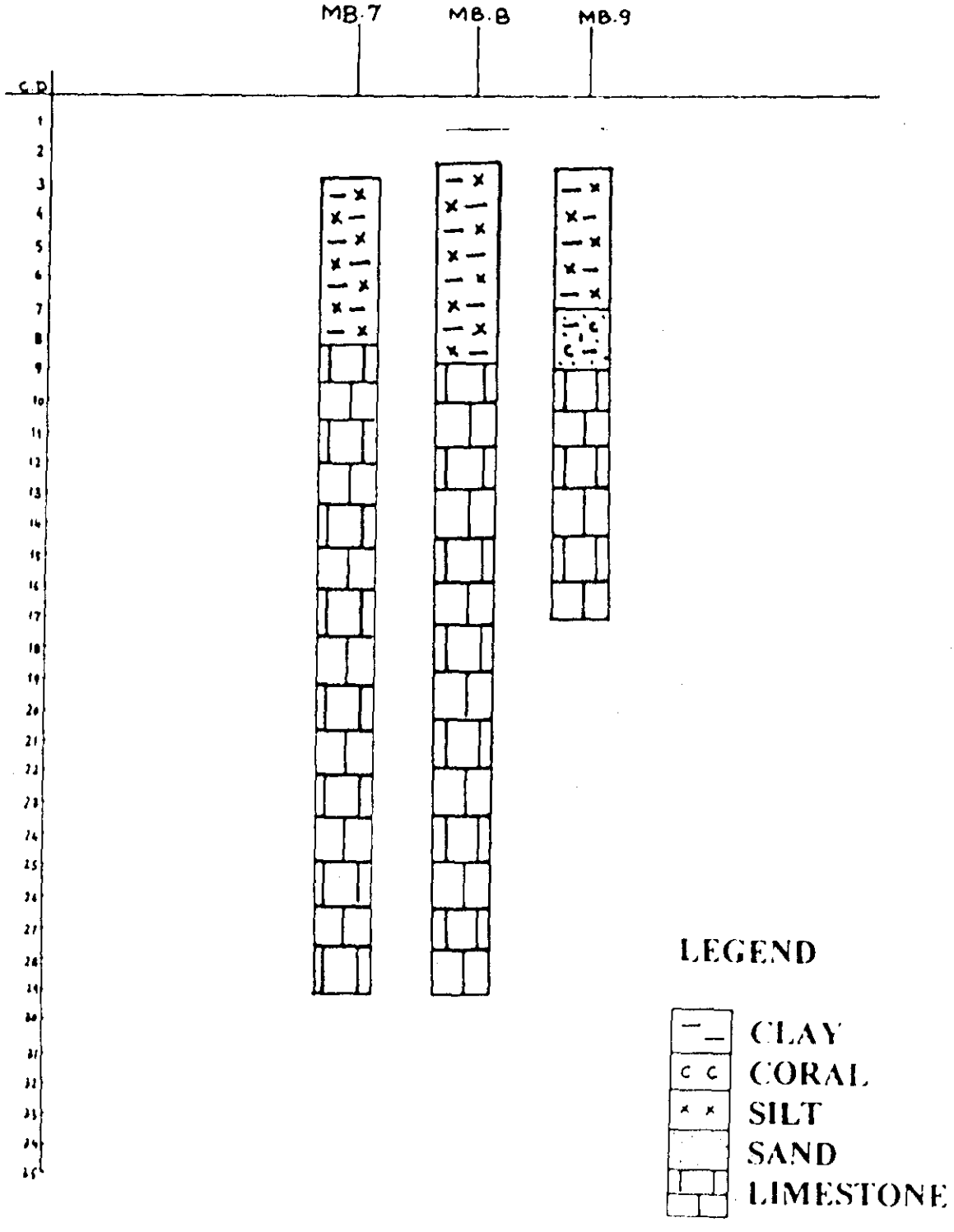
SUB SOIL PROFILE

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

GEOTECHNICAL INVESTIGATION OFF POSITRA
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

SUB SOIL PROFILE

LOCATION - POSITRA II

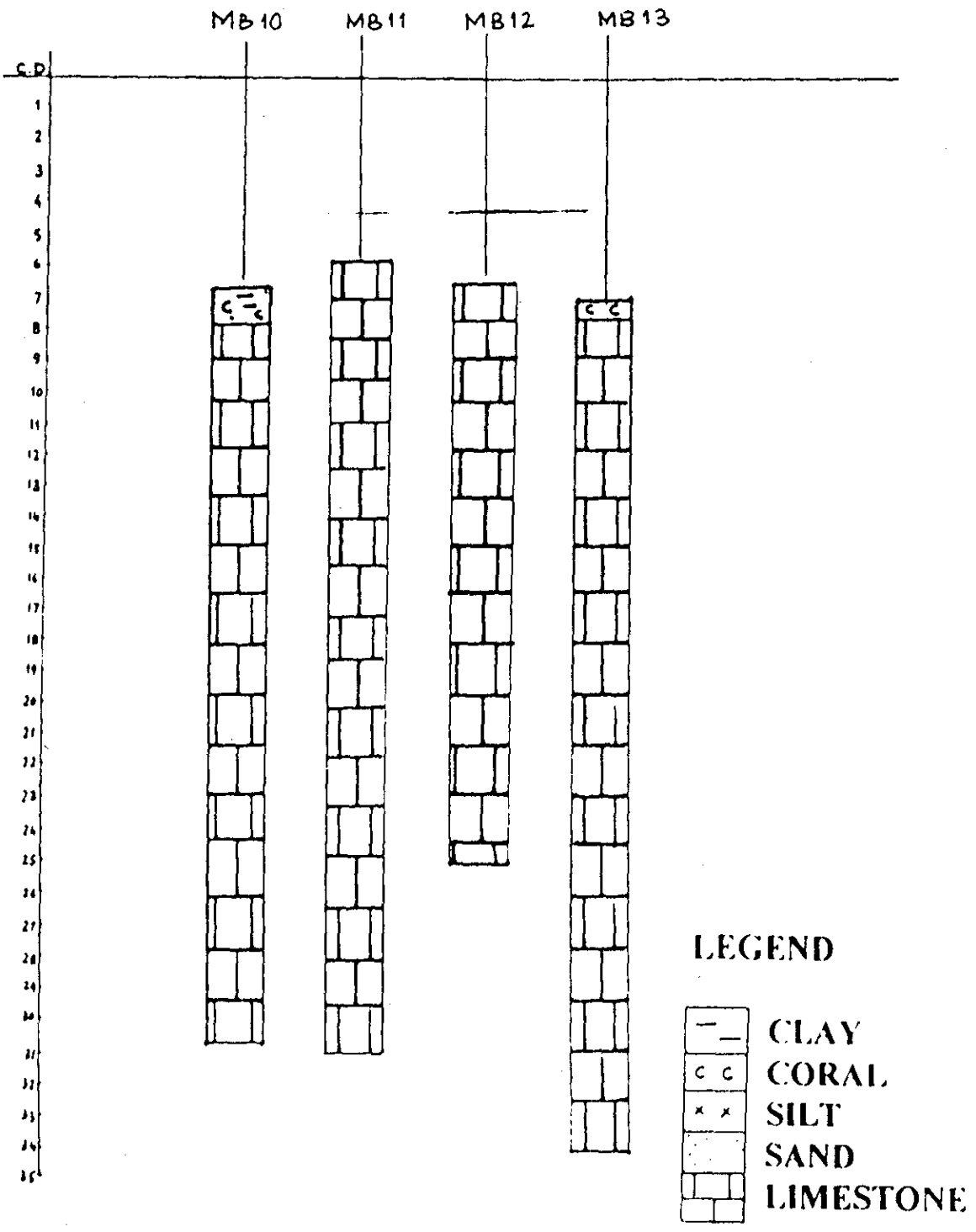


PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

GEOTECHNICAL INVESTIGATION OFF POSITRA
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

SUB SOIL PROFILE

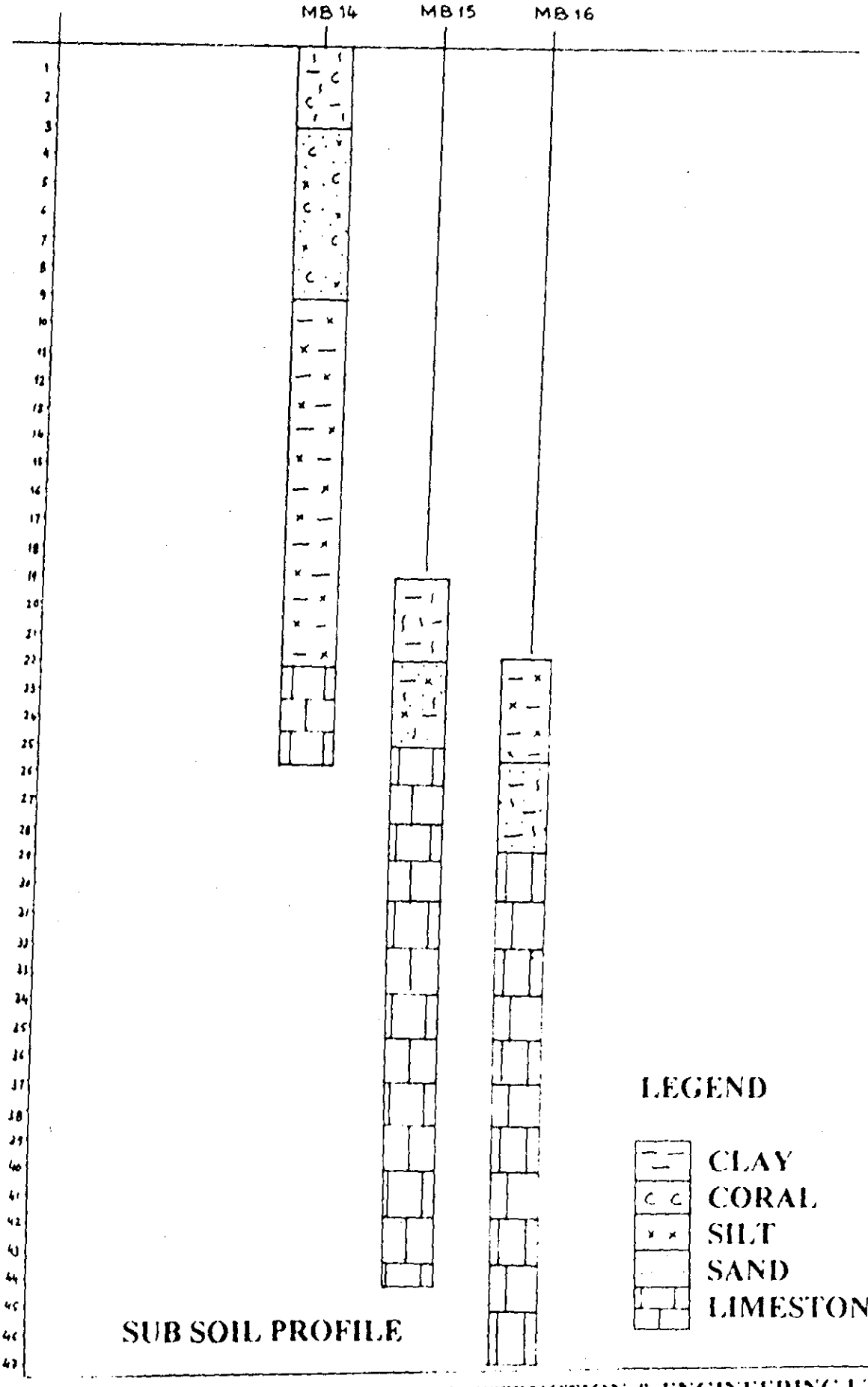
LOCATION - POSITRA II



PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

GEOTECHNICAL INVESTIGATION OFF POSITRA
CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

LOCATION - POSITRA III



SUB SOIL PROFILE

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

ANNEXURE - 5

TE: POSITRA

SOIL TEST DATA SHEET

E/	DEPTH	SAMPLE TYPE UD/D	DENSITY		NATURAL MOISTURE CONTENT	MECHANICAL ANALYSIS				CONSISTENCY LIMITS			SOIL CLASSI-FICATION (BS)	SHEAR STRENGTH TEST			CONSOLIDATION TEST		SPECIFIC GRAVITY	OTHER TESTS (SEE LEGEND)	REMARKS
			WET	DRY		GRAVEL	SAND	SILT	CLAY	LIQUID	PLASTIC	PLAS-TICITY INDEX		TYPE	COHE-SION (KPa)	φ	COMP. INDEX (Lab.)	INITIAL VOIDS RATIO e0			
	m		gm/cc	gm/cc	%	%	%	%	%	%	%	%				Deg.					
3	5.50	D	-	-	-	20	20	← 60 →		41	16	25	CIS	-	-	-	-	-	-	-	
4	3.50	D	-	-	-	1	6	← 93 →		57	20	37	CH	-	-	-	-	-	-	-	
7	0.00	D	-	-	-	-	22	← 78 →		71	23	48	CV	-	-	-	-	-	-	-	
	14.00	D	-	-	-	-	6	← 94 →		81	26	55	CV	-	-	-	-	-	-	-	
	23.00	D	-	-	-	3	57	← 40 →		28	17	11	CLS	-	-	-	-	-	-	-	
8	0.00	D	-	-	-	-	42	← 58 →		45	18	27	CIS	-	-	-	-	-	-	-	
	14.50	D	-	-	-	7	32	← 61 →		34	17	17	CLS	-	-	-	-	-	-	-	
	23.50	D	-	-	-	3	14	← 83 →		38	15	23	CI	-	-	-	-	-	-	-	
9	3.00	D	-	-	-	6	42	← 52 →		39	21	18	CIS	-	-	-	-	-	-	-	
	12.50	D	-	-	-	34	51	← 15 →		-	-	-	SWM	-	-	-	-	-	-	-	
10	0.00	D	-	-	-	46	42	← 12 →		-	-	-	SWM	-	-	-	-	-	-	-	
	14.60	D	-	-	-	1	79	← 20 →		-	-	-	SML	-	-	-	-	-	-	-	
	22.10	D	-	-	-	6	53	← 41 →		32	14	18	CLS	-	-	-	-	-	-	-	
12	9.10	D	-	-	-	1	19	← 80 →		34	15	19	CL	-	-	-	-	-	-	-	

HEM : CHEMICAL ANALYSIS TEST
OMP : COMPACTION TEST
S : DIRECT SHEAR TEST
: PERMEABILITY TEST
S : FREE SWELL TEST

Tuu : TRIAXIAL TEST UNCONSOLIDATED UNDRAINED
Tcu : TRIAXIAL TEST CONSOLIDATED UNDRAINED
Tcd : TRIAXIAL TEST CONSOLIDATED DRAINED
NP : NON PLASTIC
SL : SHRINKAGE LIMIT TEST

SP : SWELLING PRESSURE OR SWELLING POTENTIAL TEST
RM : ON REMOULDED SOIL
VL : LABORATORY VANE SHEAR TEST
UC : UNCONFINED COMPRESSION TEST

DRG. NO.: 8522/74

AFCONS

TE: POSITRA

SOIL TEST DATA SHEET

	DEPTH m	SAMPLE TYPE UD/D	DENSITY WET gm/cc	DENSITY DRY gm/cc	NATURAL MOISTURE CONTENT %	MECHANICAL ANALYSIS GRAVEL %	SAND %	SILT %	CLAY %	CONSISTENCY LIMITS LIQUID %	PLASTIC %	PLASTICITY INDEX %	SOIL CLASSIFICATION (BS)	SHEAR STRENGTH TEST TYPE	COHESION (KPa)	ϕ Deg.	CONSOLIDATION TEST COMP. INDEX (Lab.)	INITIAL VOIDS RATIO e₀	SPECIFIC GRAVITY	OTHER TESTS (SEE LEGEND)	REMARKS
2	16.60	D	-	-	-	8	79	← 13 →		-	-	-	SPM	-	-	-	-	-	-	-	
4	1.50	D	-	-	-	46	42	← 12 →		-	-	-	SWM	-	-	-	-	-	-	-	
	6.00	D	-	-	-	40	41	← 19 →		-	-	-	SML	-	-	-	-	-	-	-	
	9.00	D	-	-	-	1	28	← 71 →		64	28	36	CH	-	-	-	-	-	-	-	
	10.50/ 10.90	UD	1.57	0.95	66	-	17	39	44	76	29	47	CV	TUU	21	0	0.90	1.778	2.64	K = 2.39×10^{-9}	
														UC	16	-					
	19.50	D	-	-	-	1	24	← 75 →		48	18	30	CI	-	-	-	-	-	-	-	
15	3.00	D	-	-	-	13	37	← 50 →		-	-	-	-	-	-	-	-	-	-	-	
6	0.00	D	-	-	-	1	12	← 87 →		70	27	43	CH	-	-	-	-	-	-	-	

EM : CHEMICAL ANALYSIS TEST
MP : COMPACTION TEST
: DIRECT SHEAR TEST
: PERMEABILITY TEST
: FREE SWELL TEST

Tuu : TRIAXIAL TEST UNCONSOLIDATED UNDRAINED
Tcu : TRIAXIAL TEST CONSOLIDATED UNDRAINED
Tcd : TRIAXIAL TEST CONSOLIDATED DRAINED
NP : NON PLASTIC
SL : SHRINKAGE LIMIT TEST

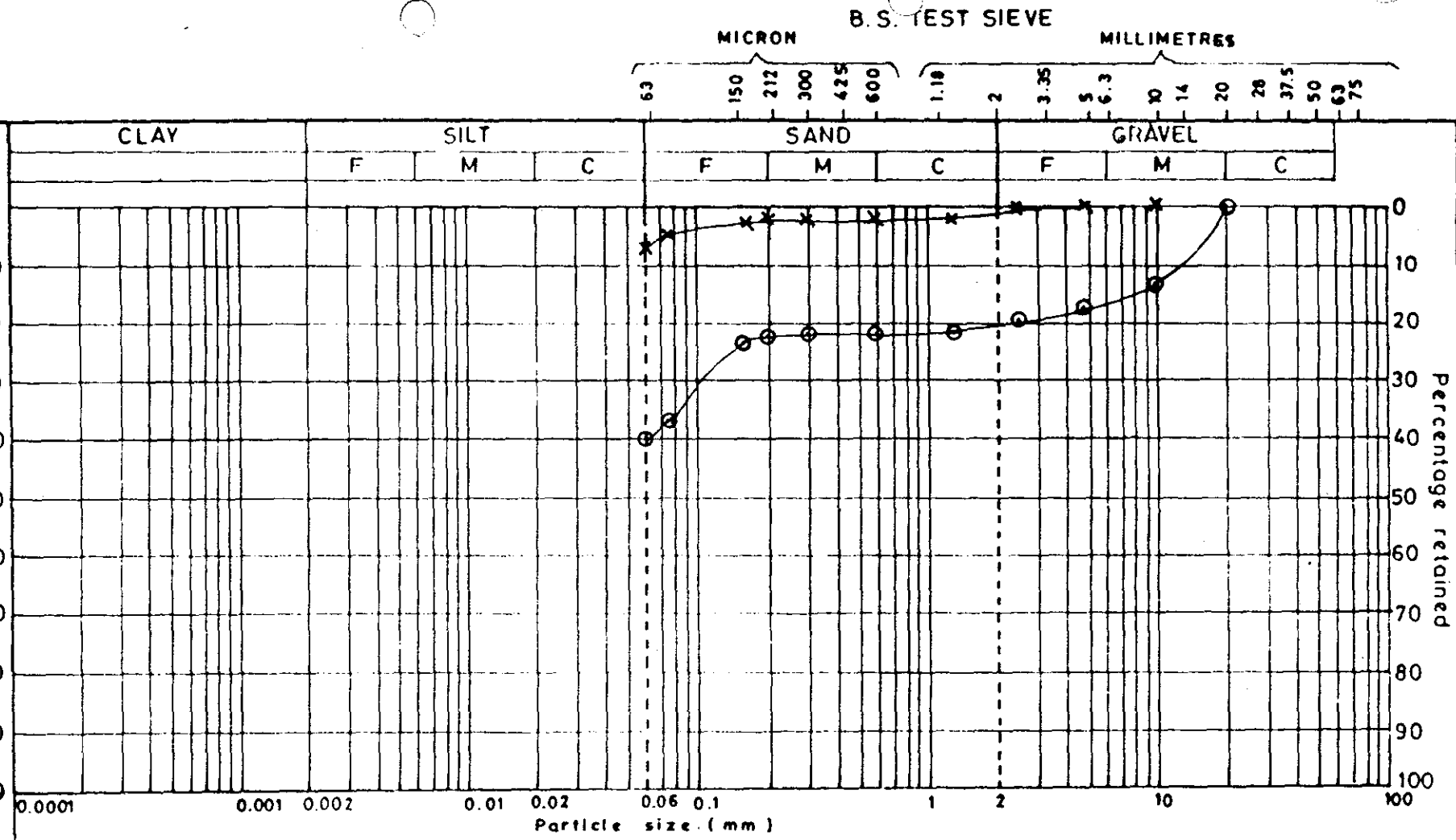
SP : SWELLING PRESSURE OR SWELLING POTENTIAL TEST
RM : ON REMOULDED SOIL
VL : LABORATORY VANE SHEAR TEST
UC : UNCONFINED COMPRESSION TEST

DRG. NO.: 8522/74

AFCONS

SITE : POSITRA

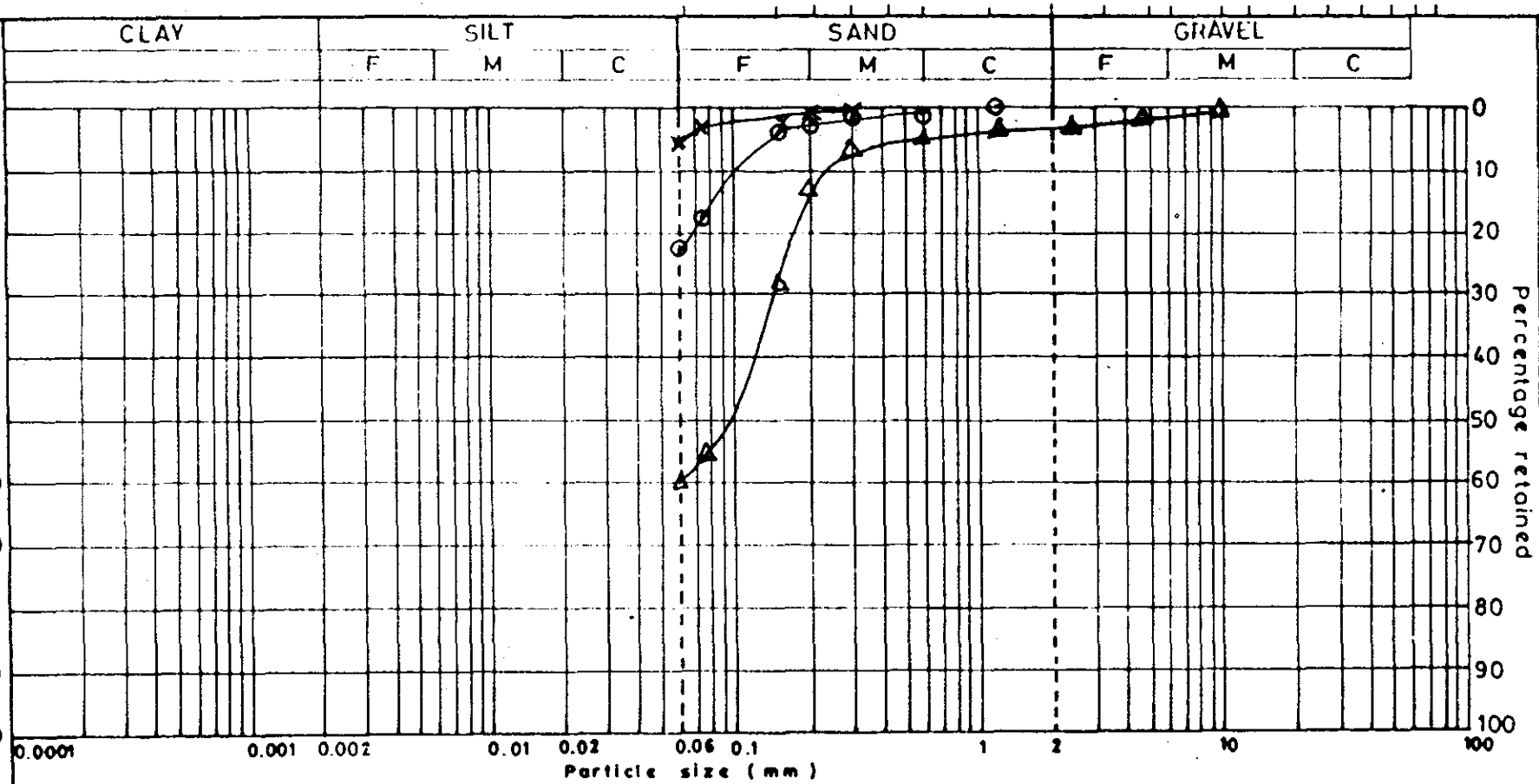
GRAIN SIZE DISTRIBUTION



Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ø 10 % mm	ø 30 % mm	ø 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-3	5.50	CIS	20	20	← 60 →		-	-	-	-	-	D
×—×	MB-4	3.50	CH	1	6	← 93 →		-	-	-	-	-	D

GRAIN SIZE DISTRIBUTION

SITE : POSITRA

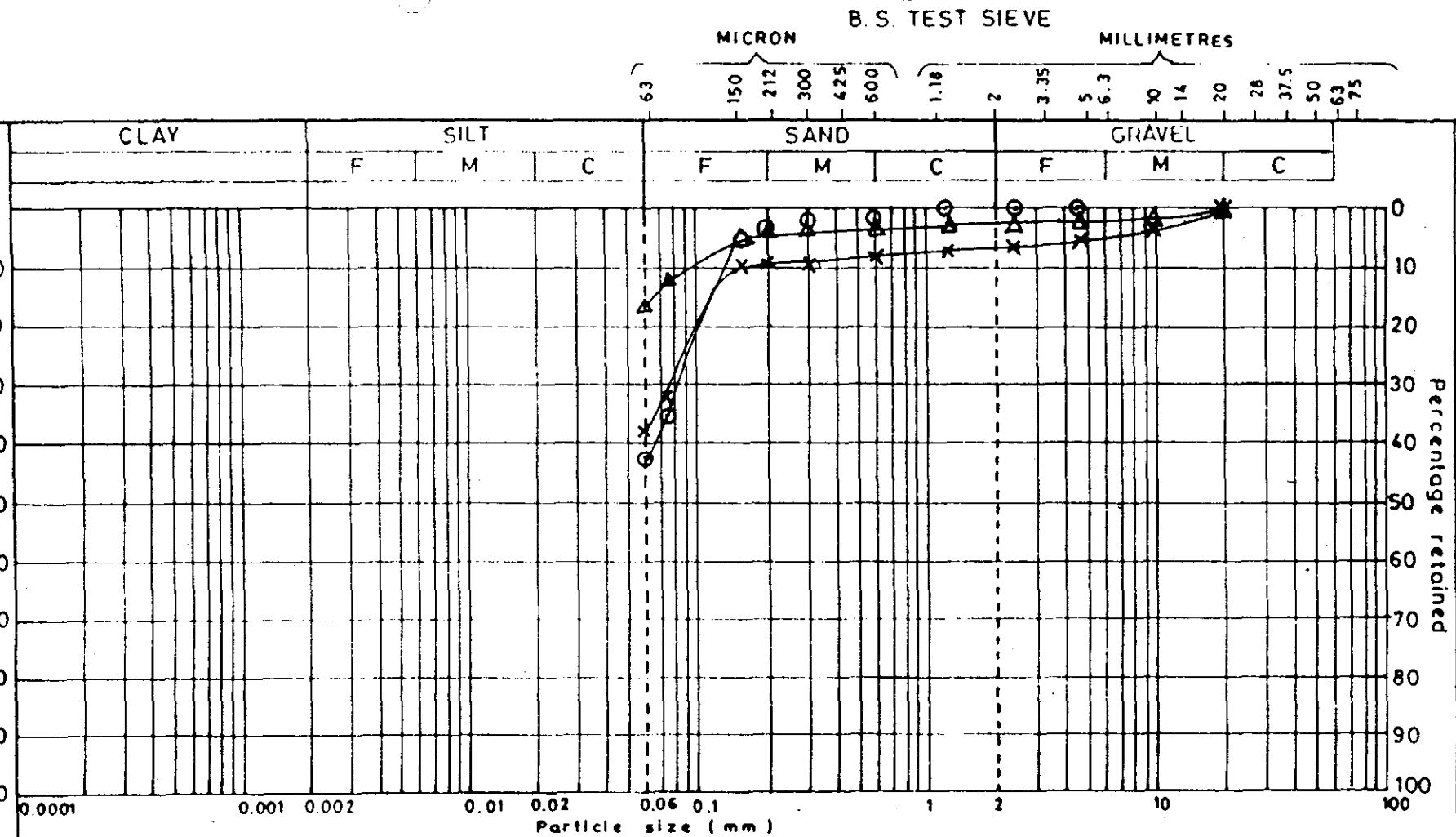


Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ϕ 10 % mm	ϕ 30 % mm	ϕ 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-7	0.00	CV	-	22	← 78 →		-	-	-	-	-	D
×—×		14.00	CV	-	6	← 94 →		-	-	-	-	-	D
△—△		23.00	CLS	3	57	← 40 →		-	-	-	-	-	D

AECONS BOMBAY : DATE : 15/4/97 DRG. NO. 8522/74

GRAIN SIZE DISTRIBUTION

SITE: POSITRA

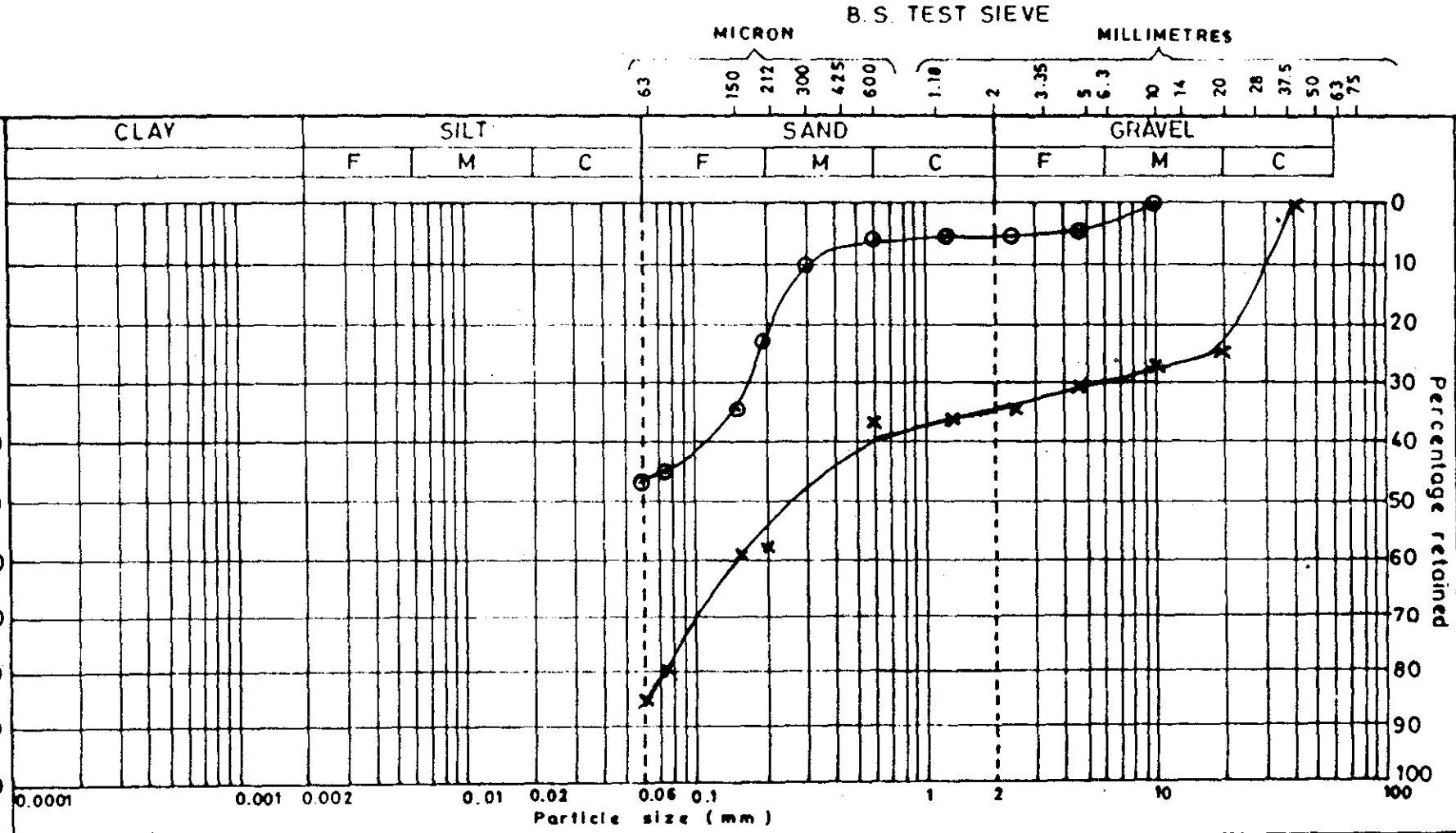


Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ϕ 10 % mm	ϕ 30 % mm	ϕ 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-8	0.00	CIS	-	42	← 58 →		-	-	-	-	-	D
×—×		14.50	CLS	7	32	← 61 →		-	-	-	-	-	D
△—△		23.50	CI	3	14	← 83 →		-	-	-	-	-	D

DRG NO 8522/74

GRAIN SIZE DISTRIBUTION

SITE: POSITRA



Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ϕ 10 % mm	ϕ 30 % mm	ϕ 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-9	3.00	CIS	6	42	← 52 →		-	-	-	-	-	D
×—×		12.50	SWM	34	51	← 15 →		-	-	-	-	-	D

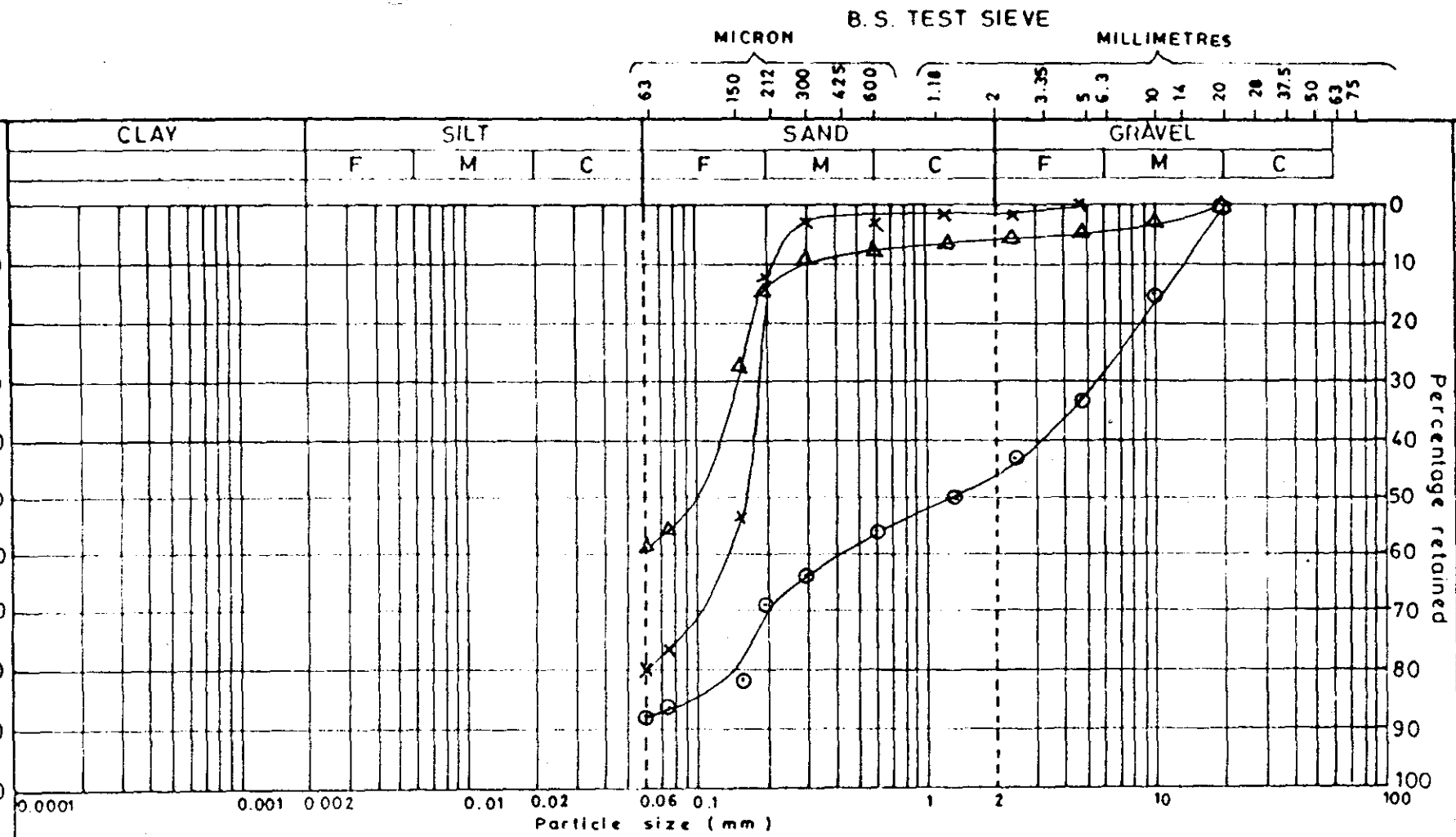
GRAIN SIZE DISTRIBUTION

AFCONS BOMBAY.

SITE : POSITRA

DATE : 15/4/97

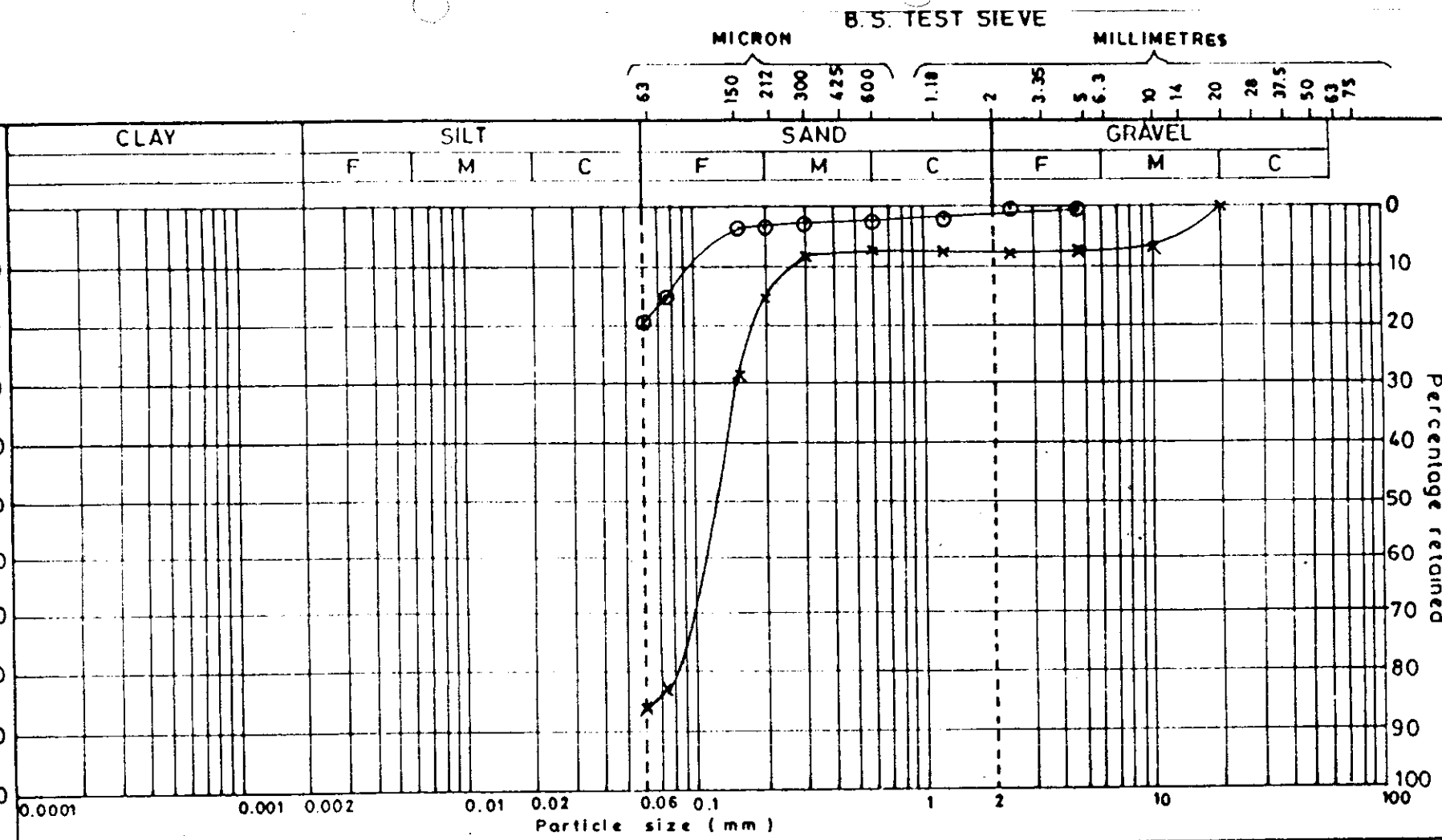
DRG. NO. 8522/74



Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ø 10 % mm	ø 30 % mm	ø 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-10	0.00	SWM	46	42	← 12 →		-	-	-	-	-	D
×—×		14.60	SML	1	79	← 20 →		-	-	-	-	-	D
△—△		22.10	CLS	6	53	← 41 →		-	-	-	-	-	D

SITE : POSITRA

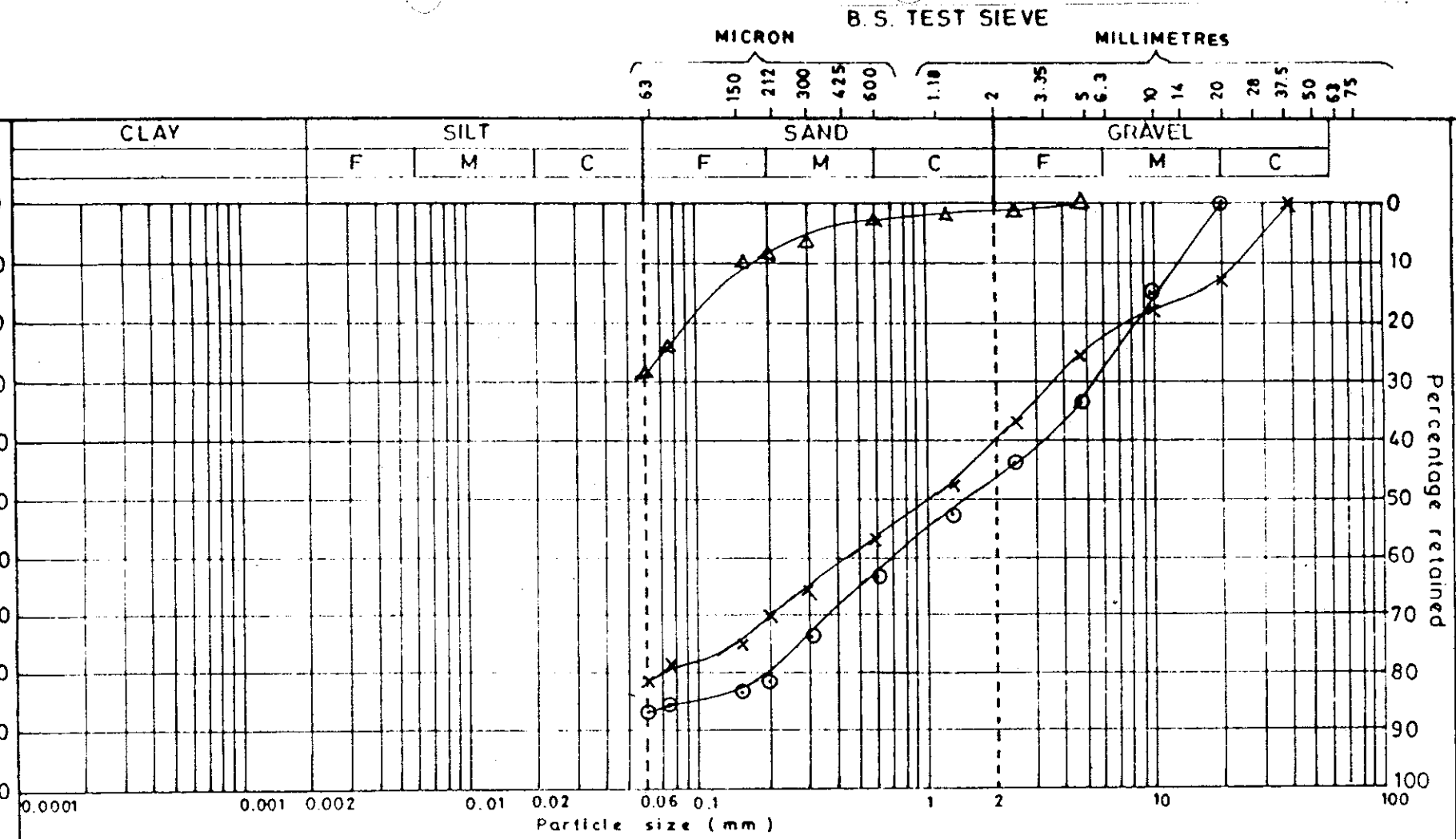
GRAIN SIZE DISTRIBUTION



Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ϕ 10 % mm	ϕ 30 % mm	ϕ 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-12	9.10	CL	1	19	← 80 →		-	-	-	-	-	D
x—x		16.60	SPM	8	79	← 13 →		-	-	-	-	-	D

SITE: POSITRA

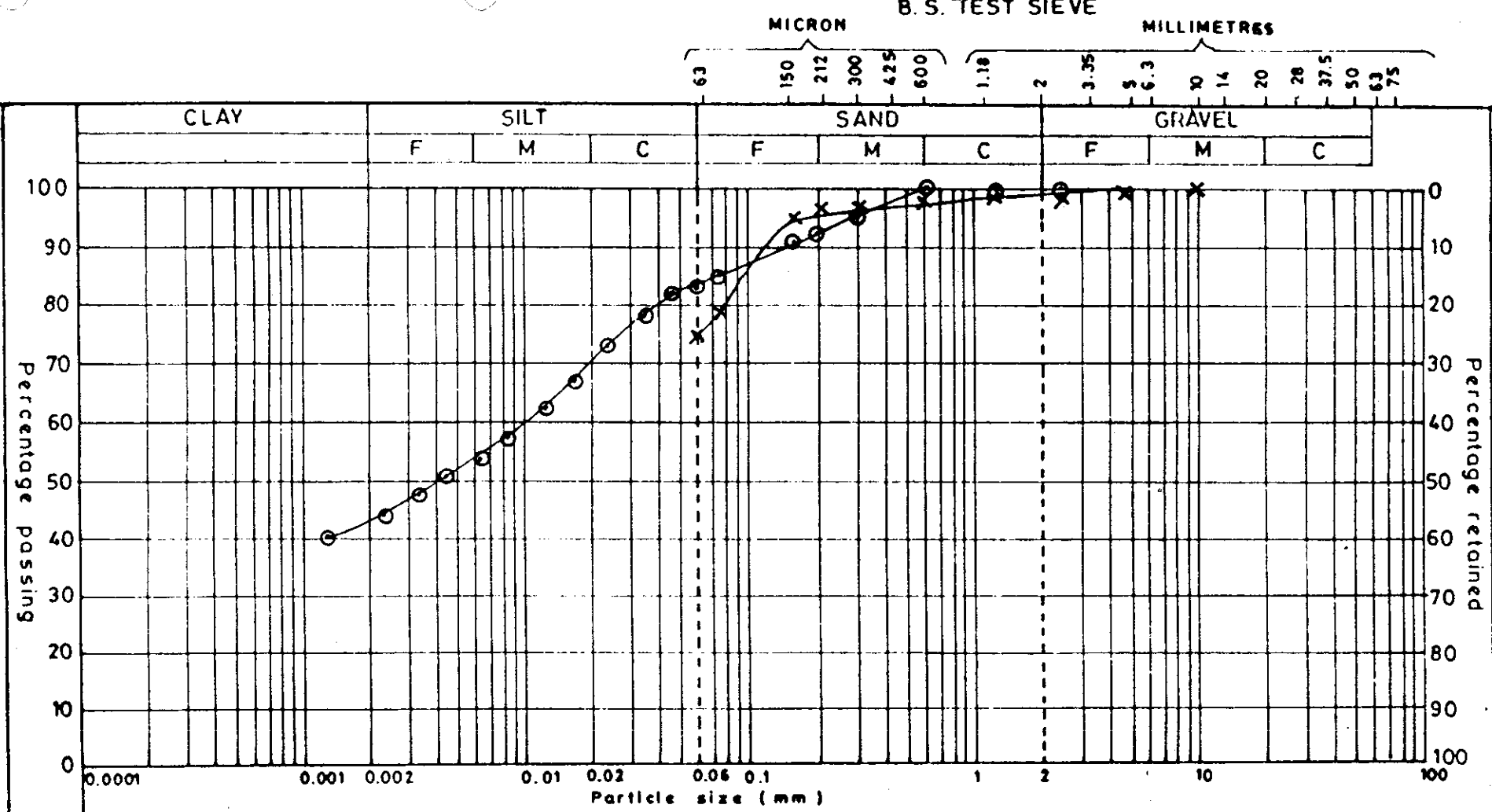
GRAIN SIZE DISTRIBUTION



Symbol	BOREHOLE No	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ø 10 % mm	ø 30 % mm	ø 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-14	1.50	SWM	46	42	← 12 →		-	-	-	-	-	D
×—×		6.00	SML	40	41	← 19 →		-	-	-	-	-	D
△—△		9.00	CH	1	28	← 71 →		-	-	-	-	-	D

SITE: POSITRA

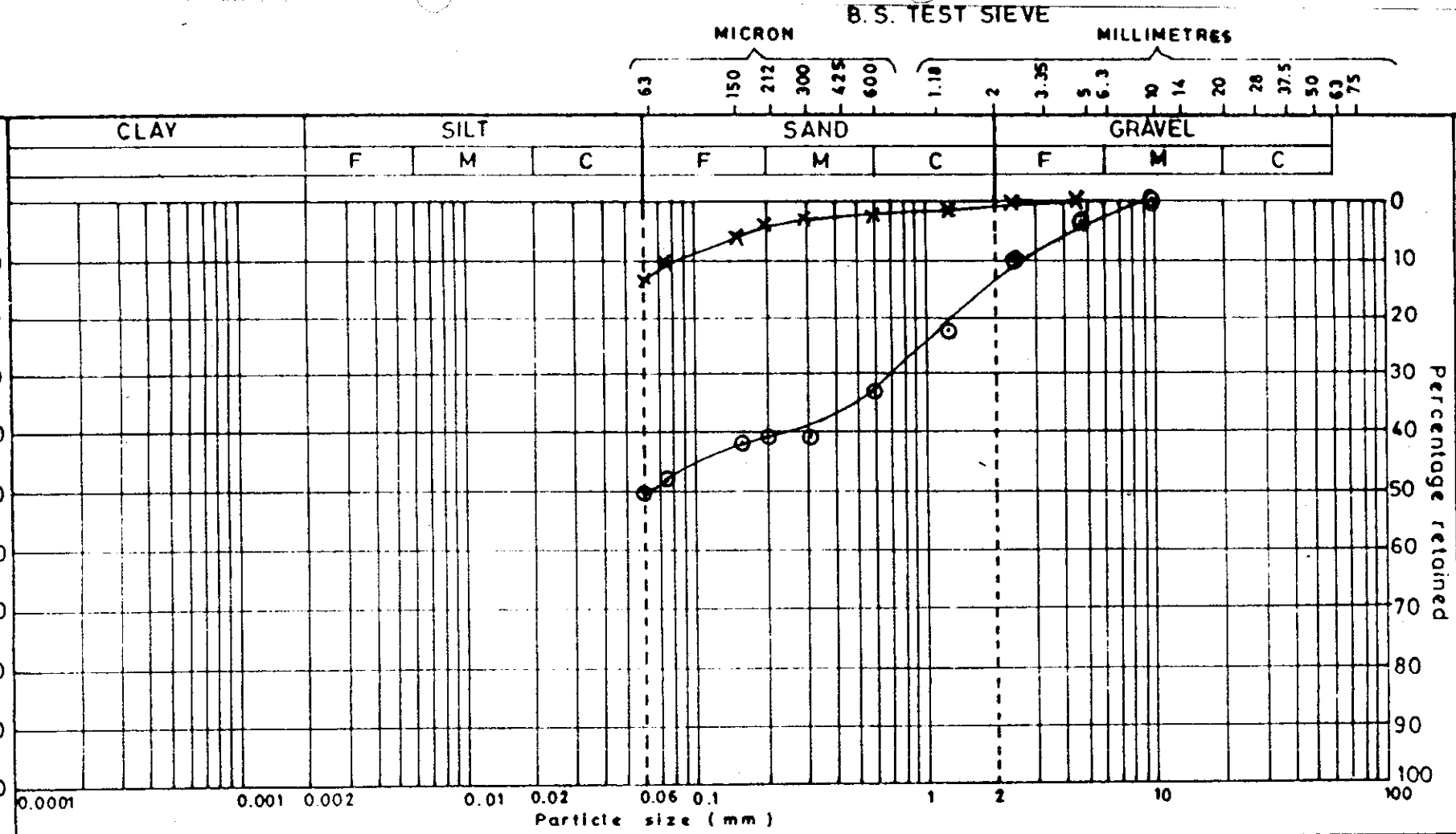
GRAIN SIZE DISTRIBUTION



Symbol	BOREHOLE no.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ϕ 10 % mm	ϕ 30 % mm	ϕ 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-14	10.50/10.90	CV	-	17	39	44	-	-	-	-	-	UD
×—×		19.50	CI	1	24	← 75 →		-	-	-	-	-	D

SITE : POSITRA

GRAIN SIZE DISTRIBUTION



Symbol	BOREHOLE No.	Depth m	Classification (B.S.)	Grav. %	Sand %	Silt %	Clay %	ø 10 % mm	ø 30 % mm	ø 60 % mm	Cu	Cc	Remarks
⊙—⊙	MB-15	3.00	–	13	37	← 50 →		–	–	–	–	–	D
x—x	MB-16	0.00	CH	1	12	← 87 →		–	–	–	–	–	D

TRIAXIAL COMPRESSION TEST

SITE POSITRA

TYPE OF TEST UU

RATE OF STRAIN 1.25 mm / min.

SPECIMEN MEASUREMENTS ϕ = 38 mm
L = 76 mm

DATE 17-4-97

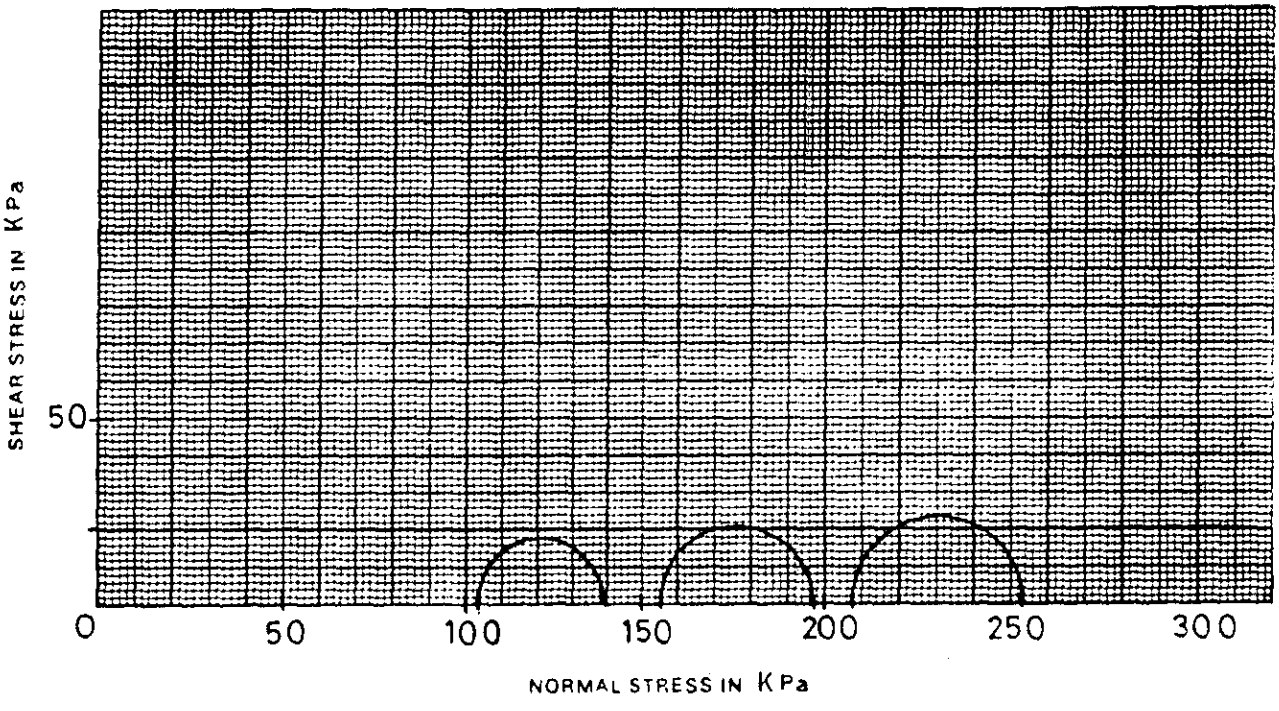
BORE HOLE NO MB-14

SAMPLE DEPTH 10.50 / 10.90 m

VISUAL DESCRIPTION
Soft grey CLAY.

BULK DENSITY 1.57 gm/cc
MOISTURE CONTENT 66 % } AVERAGE OF 3 SPECIMEN

SR. NO.	CELL PRESSURE IN KPa	DEVIATOR STRESS AT FAILURE IN KPa	PORE PRESSURE AT FAILURE IN KPa	STRAIN AT FAILURE IN %
1	104	37.4	-	7
2	156	41.6	-	11
3	208	46.8	-	12



COHESION INTERCEPT C = 21 KPa

ANGLE OF SHEARING RESISTANCE ϕ = 0

AFCONS

DRG. NO. 8522/7

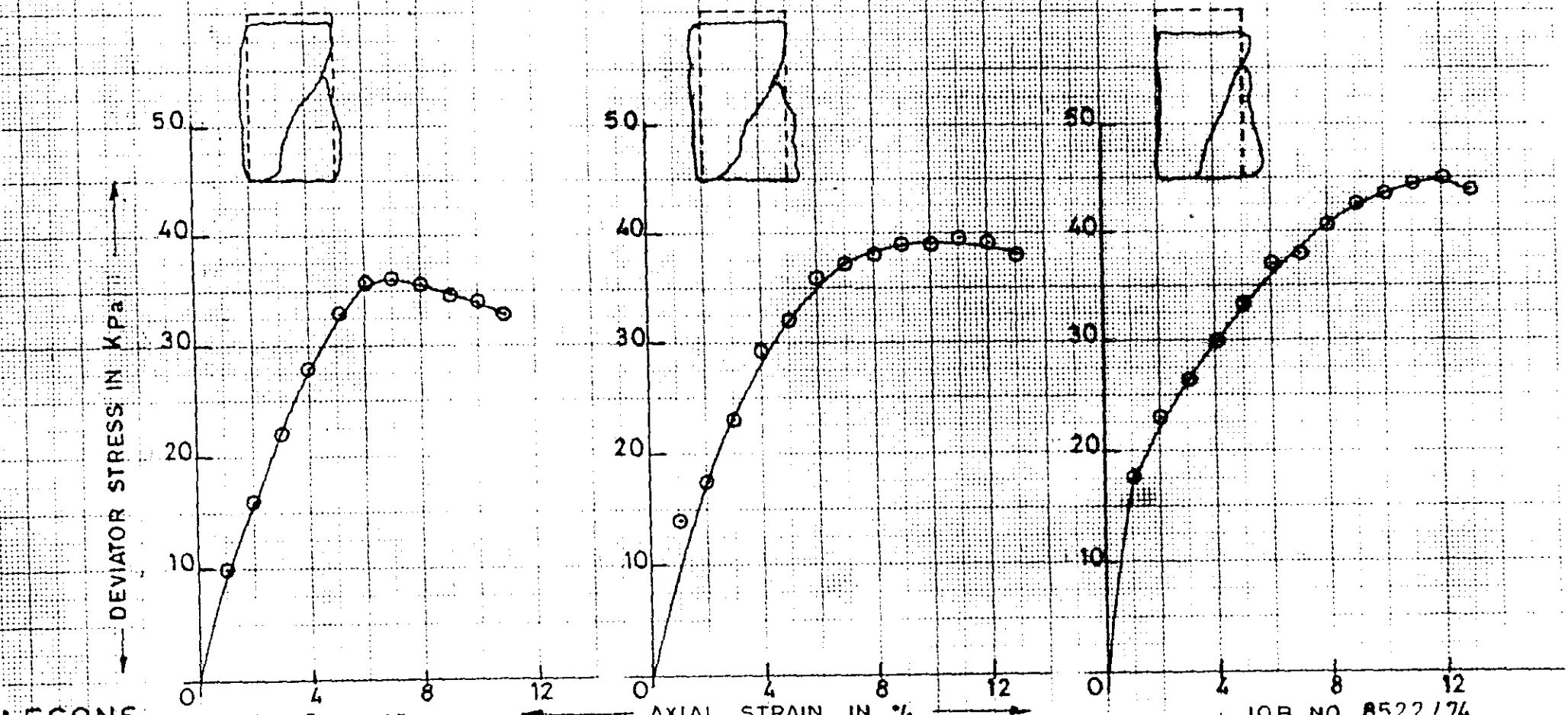
UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

ITE : POSITRA

BOREHOLE NO. MB-14 DEPTH : 10.50 / 10.90 m

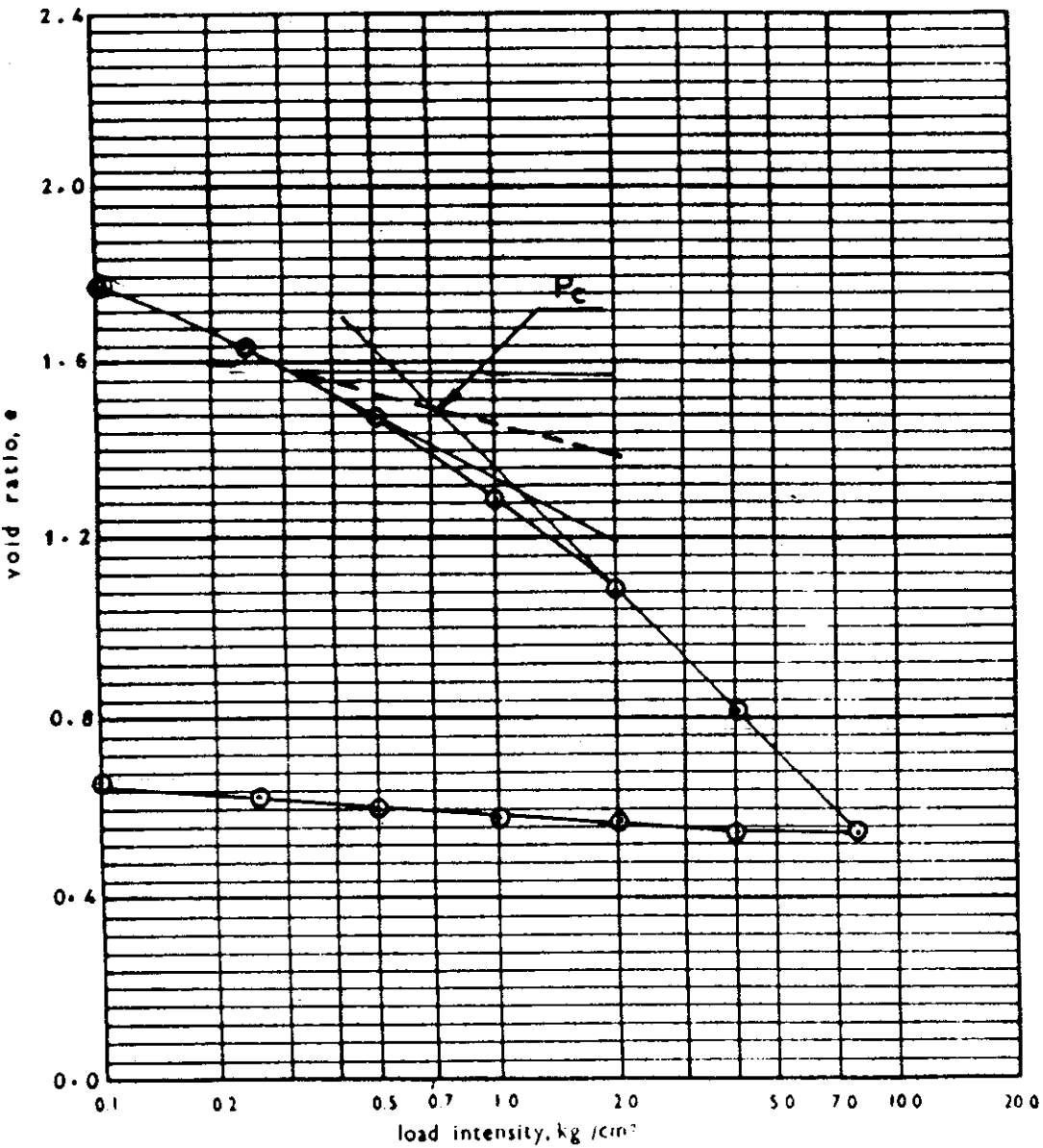
SPECIMEN NO. :	1	2	3
ELL PRESSURE (KPa) :	(104)	(356)	(208)

SKETCH OF SPECIMEN AFTER FAILURE :



JOB NO. 8522 / 74

SITE:- POSITRA



CONSOLIDATION TEST DATA

BORE HOLE No.MB 14 DEPTH: 10.50 m. TO 10.90 m.

$(C_c)_{lab} = 0.90$, $\bar{P}_c = 0.73$ kg/cm², $G_s = 2.64$

Prior To Test			At The End of Test		
γ =	1.57	g/cm³	γ_w =	1.99	%
γ_d =	0.95	g/cm³	γ_d =	1.59	
w =	65	%	W =	25	
e_o =	1.778		e_o =	0.662	
Sr =	97	%	S_r =	100	%

TIME RATE SETTLEMENT DATA

LOAD INCREMENT IN Kg/cm²	COEFFICIENT OF CONSOLIDATION C_v m²/year	COEFFICIENT OF VOLUME COMPRESSIBILITY m_v cm²/kg
0.10/0.25	1.50	33.80×10^{-2}
0.25/0.50	1.20	24.60×10^{-2}
0.50/1.00	0.80	15.00×10^{-2}
1.00/2.00	0.60	8.70×10^{-2}
2.00/4.00	0.50	6.40×10^{-2}
4.00/8.00	0.30	3.70×10^{-2}

AFCONS BOMBAY

DATE: 28-4-97

PLAN NO. 8522/74

TE : POSITRA

ROCK TEST DATA SHEET

RE LE O.	CORE PIECE NO.	DEPTH m	DENSITY BULK gm/cc	DENSITY DRY gm/cc	WATER CONTENT %	POROSITY %	WATER ABSOR-PTION %	SPECIFIC GRAVITY	UNIAXIAL COMPRESSIVE STRENGTH DIA-METER cm	HEIGHT cm	D : H	UNIAXIAL COMPRESSIVE STRENGTH MPa	MODULUS OF ELASTICITY Kg/cm²	POISSON'S RATIO	CONDITION OF TEST	POINT LOAD STRENGTH DIA-METER mm	LENGTH mm	CORRECTED STRENGTH INDEX IS (50) MPa	CONDITION OF TEST	OTHER TESTS SEE ADDL. SHEET
B-1	3	0.5	-	2.25	-	-	-	-	-	-	-	-	-	-	-	53	78	2.99	U	-
	6	1.0	-	2.13	-	-	-	-	5.3	6.9	1:1.30	6.4	-		U	-	-	-	-	-
B-2	1	0.0	-	2.40	-	-	-	-	5.4	6.3	1:1.17	30.2	-	-	U	-	-	-	-	-
	7	2.3	-	2.30	-	-	-	-	-	-	-	-	-	-	-	52	75	2.31	U	-
	11	3.6	-	2.50	-	-	-	-	-	-	-	-	-	-	-	54	75	3.27	U	-
B-7	-	5.60/ 5.75	-	2.10	-	-	-	-	5.4	10.6	1:1.96	21.8	-	-	U	-	-	-	-	-
	-	8.55/ 8.60	-	2.19	-	-	-	-	-	-	-	-	-	-	-	52	40	1.54	U	-
	-	18.45/ 18.50	-	2.19	-	-	-	-	-	-	-	-	-	-	-	53	60	1.12	U	-
B-8	-	25.00/ 25.07	-	2.09	-	-	-	-	-	-	-	-	-	-	-	53	90	0.75	U	-
	-	26.00/ 26.15	-	2.25	-	-	-	-	5.3	10.4	1:1.96	6.8	-	-	U	-	-	-	-	-
B-9	-	15.45	-	2.70	-	-	-	-	-	-	-	-	-	-	-	53	77	3.36	U	-

NOTES : 1. UNIAXIAL COMPRESSIVE STRENGTH CORRECTED FOR D : H = 1 : 2 (As per ASTM : D 2938)

2. ✱ INDICATES THE SAMPLE FAILED ALONG JOINTS.

3. Δ " " " " WHILE PREPARATION.

4. ▲ " " " CRUMBLED IN WATER.

S = SOAKED (FOR 24 Hrs. in water)

U = UNSOAKED

D = OVEN DRY

RLL = POINT LOAD LUMP STRENGTH

TSB = TENSILE STRENGTH (BRAZILIAN)

DTS = DIRECT TENSILE STRENGTH

TXL = TRIAXIAL COMPRESSION TEST

PET = PETRO GRAPHIC EXAMINATION

AFCONS

DATE : 17-4-97

DRG. NO. 8522 / 74

E : POSITRA

ROCK TEST DATA SHEET

CORE PIECE NO.	DEPTH m	DENSITY BULK gm/cc	DENSITY DRY gm/cc	WATER CONTENT %	POROSITY %	WATER ABSOR-PTION %	SPECIFIC GRAVITY	UNIAXIAL COMPRESSIVE STRENGTH DIA-METER cm	HEIGHT cm	D : H	UNIAXIAL COMPRESSIVE STRENGTH MP_a	MODULUS OF ELASTICITY Kg/cm²	POISSON'S RATIO	CONDITION OF TEST	POINT LOAD STRENGTH DIA-METER mm	LENGTH mm	CORRECTED STRENGTH INDEX IS (50) MP_a	CONDITION OF TEST	OTHER TESTS SEE ADDL. SHEET
-	2.65 / 2.70	-	2.23	-	-	-	-	-	-	-	-	-	-	-	53	50	1.48	U	-
-	5.40 / 5.55	-	2.40	-	-	-	-	5.4	9.9	1:1.83	30.0	-	-	U	-	-	-	-	-
1	1.0	-	2.22	-	-	-	-	-	-	-	-	-	-	-	54	64	1.09	U	-
7	2.8	-	2.15	-	-	-	-	5.2	9.6	1:1.85	20.8	-	-	U	-	-	-	-	-
13	3.5	-	2.08	-	-	-	-	5.4	10.1	1:1.87	19.4	-	-	U	-	-	-	-	-
18	5.8	-	2.20	-	-	-	-	-	-	-	-	-	-	-	54	67	2.18	U	-
23	18.5	-	2.18	-	-	-	-	5.3	7.4	1:1.40	12.7	-	-	U	-	-	-	-	-

TES: 1 UNIAXIAL COMPRESSIVE STRENGTH CORRECTED FOR D : H = 1 2

2. ● INDICATES THE SAMPLE FAILED ALONG JOINTS.

3. Δ " " " " WHILE PREPARATION.

4. ▲ " " " CRUMBLED IN WATER.

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DTS = DIRECT TENSILE STRENGTH

TXL = TRIAXIAL COMPRESSION TEST

PET = PETRO GRAPHIC EXAMINATION

FCONS

DATE: 15-4-97

DRG. NO. 8522 / 74

SITE : POSITRA

ROCK TEST DATA SHEET

BORE HOLE NO.	CORE PIECE NO.	DEPTH m	DENSITY BULK gm/cc	DENSITY DRY gm/cc	WATER* CONTENT %	POROSITY %	WATER ABSORPTION %	SPECIFIC GRAVITY	UNIAXIAL COMPRESSIVE STRENGTH DIAMETER cm	HEIGHT cm	D:H	UNIAXIAL COMPRESSIVE STRENGTH MPa	MODULUS OF ELASTICITY Kg/cm²	POISSON'S RATIO	CONDITION OF TEST	POINT LOAD STRENGTH DIAMETER mm	LENGTH mm	CORRECTED STRENGTH INDEX IS(50) MPa	CONDITION OF TEST	OTHER TESTS SEE ADDL. SHEET
MB-12	-	0.30/ 0.35	-	2.48	-	-	-	-	-	-	-	-	-	-	-	53	53	3.75	U	-
	4	0.40	-	2.21	-	-	-	-	5.4	9.0	1:1.67	40.5	-	-	U	-	-	-	-	-
	7	0.90/ 1.20	-	2.28	-	-	-		5.4	10.7	1:1.98	43.6	-	-	U	-	-	-	-	-
	11	3.0	-	1.96	-	-	-	-	5.4	11.5	1:2.13	19.8	-	-	U	-	-	-	-	-
	13	3.40/ 3.55	-	1.99	-	-	-	-	5.4	10.8	1:2.00	26.2	-	-	U	-	-	-	-	-
	16	5.2	-	2.33	-	-	-	-	5.4	10.8	1:2.00	26.2	-	-	U	-	-	-	-	-
	20	7.6	-	2.30	-	-	-	-	5.4	9.7	1:1.80	15.1	-	-	U	-	-	-	-	-
MB13	1	2.5	-	2.27	-	-	-	-	-	-	-	-	-	-	-	53	100	1.87	U	-
	4	8.5	-	2.33	-	-	-	-	-	-	-	-	-	-	-	54	79	3.27	U	-
	8	21.00	-	2.70	-	-	-	-	-	-	-	-	-	-	-	54	72	3.64	U	-

NOTES: 1. UNIAXIAL COMPRESSIVE STRENGTH CORRECTED FOR D:H = 1:2 (As per ASTM : D 2938)

2. ✱ INDICATES THE SAMPLE FAILED ALONG JOINTS.

3. Δ - - - - WHILE PREPARATION.

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PET = PETRO GRAPHIC EXAMINATION

AFCONS

DATE: 17-4-97

DRG. NO. 8522/74

TE : POSITRA

ROCK TEST DATA SHEET

	CORE PIECE NO.	DEPTH m	DENSITY BULK gm/cc	DENSITY DRY gm/cc	WATER CONTENT %	POROSITY %	WATER ABSORPTION %	SPECIFIC GRAVITY	UNIAXIAL COMPRESSIVE STRENGTH DIAMETER cm	HEIGHT cm	D:H	UNIAXIAL COMPRESSIVE STRENGTH MPa	MODULUS OF ELASTICITY Kg/cm²	POISSON'S RATIO	CONDITION OF TEST	POINT LOAD STRENGTH DIAMETER mm	LENGTH mm	CORRECTED STRENGTH INDEX IS(50) MPa	CONDITION OF TEST	OTHER TESTS SEE ADDL. SHEET
5	1	8.0	-	2.14	-	-	-	-	-	-	-	-	-	-	-	49	48	0.42	U	-
6	1	13.6	-	1.97	-	-	-	-	-	-	-	-	-	-	-	55	71	0.35	U	-
	2	22.0	-	2.12	-	-	-	-	-	-	-	-	-	-	-	49	55	0.42	U	-
	3	22.7	-	2.08	-	-	-	-	-	-	-	-	-	-	-	49	35	0.42	U	-

TES : 1. UNIAXIAL COMPRESSIVE STRENGTH CORRECTED FOR D:H = 1:2 (As per ASTM : D 2938)

2. ● INDICATES THE SAMPLE FAILED ALONG JOINTS.

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PET = PETRO GRAPHIC EXAMINATION

FCONS

DATE : 17-4-97

DRG. NO. 8522/74

APPENDIX F

REPORT ON ONSHORE GEOTECHNICAL INVESTIGATION AT POSITRA

BY

COASTAL MARINE CONSTRUCTION AND ENGG. LTD., MUMBAI.

Coastal Marine Construction
& Engineering Ltd
COMACOE

Final Report

on

Onshore Geotechnical Investigation

for

Frederic R Harris (India) Pvt. Ltd

HARRIS

at Positra II and Positra III
Gulf Of Kutch
Gujarat

COM/CM-9606/GI/Ver 01 of Sept 1997

CONTENTS ...

ON-SHORE GEOTECHNICAL INVESTIGATION AT POSITRA

1.0 INTRODUCTION

Gujarat Maritime Board, Under the port policy of Government of Gujarat, put forward a white paper on the frame work for developing various ports around the coast of Gujarat. M/s Frederic R. Harris (India) Pvt. Ltd. awarded the assignment for preparing a detailed project report for development of port facility at Positra.

At Positra, the Geotechnical investigations are required to be carried out to provide engineering properties, nature and performance of subsurface strata for deciding the load carrying capacities for movement of crane and large stock piles.

In this regard, M/s Frederic R. Harris (India) Pvt. Ltd. placed their Letter of Intent dated June 10th 1996 on Coastal Marine Construction & Engineering Limited, for the work of Geotechnical Investigation at Positra.

1.1 LOCATION AND GENERAL INFORMATION

Positra is located on the western side of the Gulf of Kutch on its southern bank. The existing OKHA port lies around 5 Knautical miles to its west.

The area in general has various small islands which cover to varied extents during different stages of high tides.

Presence of these islands cause predictable cross currents in the early flooding period which are quite strong and do not follow a precise pattern.

2.0 OBJECTIVE AND SCOPE OF THE WORK:

2.1 OBJECTIVE

The purpose of the sub soil investigation is to provide information of the extent, depth and thickness of the various soil strata underlying the project sites to establish the engineering properties of soils by insitu test as also laboratory analysis of samples collected during the course of the investigations.

2.2 SCOPE OF WORK

The scope of work includes :-

To conduct geotechnical investigation at 11 borehole locations from T-6 to T-10 are in POSITRA II and borehole T-4 and LB7 to LB11 in POSITRA III to a depth specified by FRH based on the termination criteria defined. Boreholes are located in the approach area.

Positra II locations : T-6 , T-7 , T-8 , T-9, T-10
Positra III locations : T-4 , LB7, LB8 , LB9, LB10, LB11
Bulk samples collected at T-1 to T-10 locations.

2.2.1 Mobilisation of Geotechnical Spread

- Mobilisation of suitable rotary drilling rig , drilling and sampling accessories and personnel to undertake investigation in all kind of soil and rock formation.

- Mobilisation of suitable positioning equipment and personnel for positioning the rig at above released boreholes location.

- Drilling of 100 mm diameter boreholes in all kinds of overburden soil , drilling and collection of 'NX' size rock samples in rocky strata.

- Collection of undisturbed & disturbed samples, conducting Standard penetration test in overburden soils at regular intervals .

- Conducting classification strength in the laboratory on the Soil & Rock samples.

- Submission of factual Geotechnical Report.

3.0 FIELD INVESTIGATIONS

3.1 MOBILISATION TO SITE

The rotary drilling rig was mobilised at positra to undertake the investigations at the proposed borehole locations . All requisite permissions from port / custom authorities were obtained in advance by the Base Manager.

3.2 EQUIPMENTS

The key Geotechnical Euipments mobilised to the site were as follows.

GEOTECHNICAL EQUIPMENTS

Drilling Rig with rock coring arrangement
Mud pump for water circulation
Drilling accessories
API drill string
N - Rods
NWM singie and double tube core barrel
Thin walled shellby tubes (UDS)
SPT rods, Trip hammer
SPT - split spoon sampler
T.C & Diamond Drilling Bits
All other tools and tackles as required.

SURVEY EQUIPMENTS

DGPS TRIMBLE 4000 RS (Sub meter accuracy units)
CSI Modulator
CSI DTM Demodulator with active antenna
Base Texas Transmitting Tower
UHF Data link
ECHO Sounder
VHF radio with Walky talky .

3.3 POSITIONING

The positioning of the drilling rig to the borehole location was carried out using a TRIMBLE 4000 RS DGPS system. The base station (Reference station) for DGPS was installed near the light house at Okha towards the right of the approach to the existing Jetty (Okha port) at a station with known Geodetic values.

3.4 DRILLING , BORING AND SAMPLING

Borehole of 100 mm diameter was advanced using rotary drilling with sea water circulation in all kinds of overburden soils. Casings were driven up to hard rock strata to prevent collapse of Boreholes. When advancing the Boreholes in overburden soils , Standard Penetration Test & Undisturbed sampling were conducted at regular intervals in appropriate soil condition.

Rock coring of NX size was carried out using Tungsten Carbide bits and Diamond Bit. The drill string was coupled with Reamer Shell and NWM Double Tube core barrel fitted with a core catcher attached to the lower end for facilitating good recovery and retention of the core samples. Controlled water circulation, bit pressure and RPM were maintained during coring operations to ensure washing out of the core cuttings from the annular space between the outer drill string and hole and thus preventing the jamming of the drill string.

Rock coring was terminated after arriving desired depths as per the termination criterion provided by FRH which varied from location to location.

Standard penetration test (SPT) using split spoon sampler were conducted in over burden soils and in weathered rock where RQD was less than 25%, using 65.5 kgs hammer having free fall of 750mm on to anvil on top of the drill rod. The number of blows required to penetrate every successive 15cm and 7.5cm in to the strata up to maximum total depth of 45cm were recorded . The number of blows required for penetration between 15cm to 45cm were recorded as N-value for the particular stratum. The soil sample collected in the split spoon sampler were visually classified by experienced geotechnical engineer / engineering geologist on board and sent onshore for laboratory testing as disturbed samples (DS) after proper marking, sealing and logging.

3.5 DETAILS OF INVESTIGATION

POSITRA II BOREHOLES

Borehole T-6 : Borehole was extended upto 4.5m below ground level. Brownish silty fine sand with clay was observed upto 0.5 m. Limestone with 40% core recovery was encountered up to 2.0m depth. At 2.0m SPT was carried out which shows refusal and at the end of hole i.e at 4.5m SPT value 33 was observed. The ground water level was found at 3.65m..

Borehole T-7 : Borehole was extended upto 13.95 m below ground level. The overburden soil extended up 1.0m comprises of Brownish fine silty clay with sand was observed. After 1.0m highly weathered Limestone with low core recoveries was observed which is extended

up to 5.50m. From 5.5m to end of the hole, completely weathered Limestone with considerable amount of silty sand and stiff clays was observed.In this zone SPT values were in the range of 30 to 41. In this borehole ground water was found at 2.90m depth.

Borehole T-8 : The borehole was drilled upto 15.0m below ground level. Overburden soil comprises of Reddish brown to greyish brown silty sand with stiff clay was extended upto 10.5 m.The SPT values observed in the range of 30 to 45. After 10.5 m Limestone deposits were observed upto the end of the hole. Intermittent seams of stiff clay with considerable amount of silty sand were encountered during the course of drilling.The highest value of CR & RQD have been observed at 13.5 - 15.0 m run. Ground water was found at 3.50m depth.

Borehole T-9 : The borehole was drilled upto 13.85m. below G.L. A thin layer of approximately 0.5 m. of overburden soil comprising of Dark brownish silty sands were encountered . The overburden soil is followed by Limestone stratification upto end of the hole. The highest CR & RQDs were observed in 12.3 to 13.8m run. Ground water was found at 3.19m depth.

Borehole T-10 : This borehole was drilled upto 13.50m below G.L. Overburden soils comprises of Dark brownish silty sands with Clays extends upto 9.0m depth. SPThammer rebound was observed at 9.00 m. confirming the Limestone formation with good CR & RQDs up to end of the hole. Ground water was found at 3.11m depth.

POSITRA III BOREHOLES

BoreholeT-4 : This borehole was drilled upto 14.00m below G.L. The overburden soils comprising of dark reddish brown silty sand with clays were observed up to 2.0m depth. SPT value at 2.00 shows refusal confirming the Limestone formation afterwards. The highest value of CR & RQDs were observed in the 7.5 to 9.5 m run.

Borehole LB-7 : This borehole was drilled upto 20.33 m depth below G.L. The overburden soils comprising of dark reddish silty sands with clay extended up to 3.0 m .Below the top layer of overburden highly fractured limestone followed by completely weathered limestone was observed up to end of the borehole.The completely weathered Limestone is decomposed in nature occasionally showing seams of clay with considerable amount of silty sand. Ground was found at 5.13m depth.

Borehole LB-8 : This borehole was drilled upto 25.45m below G.L. The overburden comprises of Light brownish yellow to greyish yellow fine silty sands with clay extended up to 4.70 m where SPT value showing refusal.The overburden is followed by Limestone strata ,hard with good CR was extended upto 6.5 m. The hard Limestone becomes completely

weathered, decomposed in nature from 6.5 m onwards. SPT values ranging between 17 to 42 have been observed till the end of the hole. Ground water was found at 5.98m depth.

Borehole LB-9: This borehole was drilled upto 12.40 m below G.L. A thin layer of about 0.5m overburden was observed with sandy soil. Dark brown to dark yellowish grey, with very closely to closely spaced fractures Limestone was observed below the existing overburden soil. Intermittent seams of clay with some amount of silty sand are encountered alternating with completely weathered Limestone. The highest value of 96% CR & 50% RQD was observed in 5.70-6.50m run. Ground water was found at 4.79m depth.

Borehole LB-10 : This borehole was drilled upto 18.45m depth below G.L. A thin layer of 0.6m overburden was observed, comprising of Brownish coarse to fine grained sand with clay. From 0.6 to 6.0 m hard Limestone was observed with highest CR of 91% and RQD of 57% at 0.6 to 1.60m run. From 6.0m to end of the hole completely weathered Limestone with SPT values ranging from 18 to 35 was observed. SPT refusal values were encountered and 14.0 and 14.5 m depth. Ground water was found at 5.17m depth.

Borehole LB-11: This borehole was drilled up to 19.29m below G.L. A thin layer of 0.22m overburden was observed comprising of silty sands. From 0.22m to end of the hole completely weathered Limestone was observed. The completely weathered Limestone is decomposed in nature with occasionally showing alternate seams of clay or silty sand. SPT values are ranging from 17 to 43. At the end of the hole SPT refusal was observed. Ground water was found at 4.27m depth.

Collection of Bulk samples : Bulk samples (10 kg each) were collected from **T-1** to **T-10** locations and sent to the laboratory for Compaction and C.B.R testing.

CO-ORDINATES OF REFERENCE STATION

CLIENT : M/s Frederic R. Harris (India) Pvt. Ltd.

LOCATION : POSITRA

NAME OF STATION	LATITUDE (N)	LONGITUDE (E)
OKHA	22° 28' 39.19"	69° 04' 29.94"

4.0 GENERAL GEOLOGY

Geologically, all along the coastal tract between Positra, Dwarka & Okha Tertiary rocks are exposed with sand , clay , silt and Limestone.

4.1 HISTORY

The Tertiary era is most important in the physical history of the whole Indian region, the Himalayas as well as peninsula. It was during these ages that the most important surface features of the area were acquired and the present configuration of the country was outlined in the middle of the Eocene era and of earth movements set in which materially altered the whole geography of the Indian region. Two great events of Geodynamics and stand out prominently in these readjustments are one the final breaking up of the old Gondwana continent by the submergence of large segments of it underneath the sea, other the uplift of the Tethyen geocinclinal track of sea deposit to the north in to the lofty chain of the Himalayas.

4.2 GENERAL GEOLOGY

At the extreme East and West point of Saurashtra peninsula, tertiary era start range from Oligocene to pliocene is found overlying the Deccan trap. A trougn fault was found in the Cambay area in early Eocene. This trough is known to extend beyond N.Latitude 24° north of Cambay and along the Bombay coast to the south. The traps are overlain by a fully Tertiary succession in these area.

4.3 STRATIGRAPHY

The western out crops is known as Dwarka beds of Pliocene age. Which mainly consists Gypsoferous clay , silt , Limestone. Dwarka beds cover in large area between Positra and Okha. A narrow strip of these rocks is also exposed east of the Okha Rann. The contact with the Limestone is usually marked in a thin layer of gypsiferous clays. The maximum thickness of Dwarka beds is found near the Khatumba village where the exposed cliff is about 125 feet high.

4.3.1 STRATIGRAPHY SUCCESSION

Porbandar	- Oolitic milliolite list	Pleistocene
Dwarka Beds	**- Clays, silts , Limestone**	**Pliocene**
Piram beds	- Conglomerates , grits and clays with mammalian fossils	Pliocene
Gogha Beds	- The bedded grits and sandstone exposed in the east coast.	Miocene to Plocene

Gaj Beds	- Variegated clays, marls , impure Limestone	Lower Miocene

4.3.2 AGE

A large number of determination of absolute age by radiometric method and Palaentological data are now available. As a result of the symposium held by the Geological Society of London on the Phenerozic time scale (Q.J.G.S London , Vol:120 1964) The limits are assigned to the different system in the tertiary era.

Pliocene	- 7 million years
Miocene	- 26 million years
Oligocene	- 38 million years

The Dwarka beds come under the Pliocene age.

4.4 INVESTIGATION AREA

The Geology of the area under study and from the investigation carried out which covered by silty clay and somewhere small hillocks (Limestone) are present in this area. The Limestone strata shows various degrees of weathering. The present investigations carried out in this region, it was observed that the strata shows alternate layers of weathered to completely weathered , fine grained hard Limestone with characteristic sign of Tertiary era.

The average water level around the area varies from 3 to 6m depth, it was observed during investigation from the boreholes and local sources from April 1997 to May 1997.

5.0 LABORATORY ANALYSIS

The soil and rock samples collected in the course of field investigation were visually classified and logged by Geotechnical engineer / Engineering Geologist. The samples were thereafter sealed prior to dispatch to the laboratory for carrying out tests for the various physical properties of the samples as prescribed by M/s Frederic R. Harris (India) Pvt. Ltd.
The various types of tests carried out on different kinds of sample are as enumerated below.

A) Clay / Silty samples

a) Natural moisture content,
b) Atterberg limits,
c) Sieve and hydrometer analysis,
d) Wet and dry density
e) Triaxial shear test , consolidated undrained shear test with pore pressure (CUPP) .
f) Unconfined compression test,
g) Consolidation test.

B) Sandy samples

a) Natural moisture content,
b) Unit weight ,
c) Sieve analysis,
d) Drained direct shear.

C) Rock samples

a) Natural Moisture content
b) Bulk and dry density
c) Specific gravity
d) Uniaxial compression strength
e) Point load test

D) Bulk samples

a) Atterburg Limits
b) Grain size analysis
c) Proctor compaction test
d) Lab. C.B.R test

The results of laboratory analysis are given in ***Annexure 5***

6.0 ENGINEERING ANALYSIS:

From the laboratory testing some of the engineering properties of the overburden soils , Limestone and Bulk samples are given below for design purpose.

OVERBURDEN SOILS

Liquid limit range	:	22 % to 70 %
Plastic limit range	:	14 % to 28 %
Wet density range	:	1.98 to 2.09 gm/cc
Dry density range	:	1.65 to 1.85 gm/cc
Natural moisture content variation	:	13 to 20 %
Triaxial unconfined undrained		
Cohesion	:	147 to 194 Kpa
Angle of internal friction	:	0^0
Unconfined compression test		
Cohesion	:	128 to 175 Kpa
Coefficient of permeability (K)	:	1.7×10^{-7} to 3.6×10^{-4} cm/sec

LIMESTONE

Liquid limit range	:	24 % to 83 %
Plastic limit range	:	15 % to 37 %
Wet density range	:	1.75 to 1.95 gm/cc
Dry density range	:	1.37 to 1.65 gm/cc
Natural moisture content variation	:	18 to 34 %
Triaxial unconfined undrained		
Cohesion	:	35 to 134 Kpa
Angle of internal friction	:	0^0
Unconfined compression test		
Cohesion	:	31 to 103 Kpa
Coefficient of permeability (K)	:	1.6×10^{-7} to 2.8×10^{-4} cm/sec
Unconfined compressive strength	:	7.5 to 50.4 Mpa
Point load strength	:	0.67 to 7.84 Mpa

BULK SAMPLES

Liquid limit range	:	21 to 25 %
Plastic limit range	:	13 to 15 %

Compaction

Maximum dry density	:	1.81 to 1.98 gm/cc
Optimum moisture content	:	9.8 to 14.8 gm/cc

California bearing ratio value

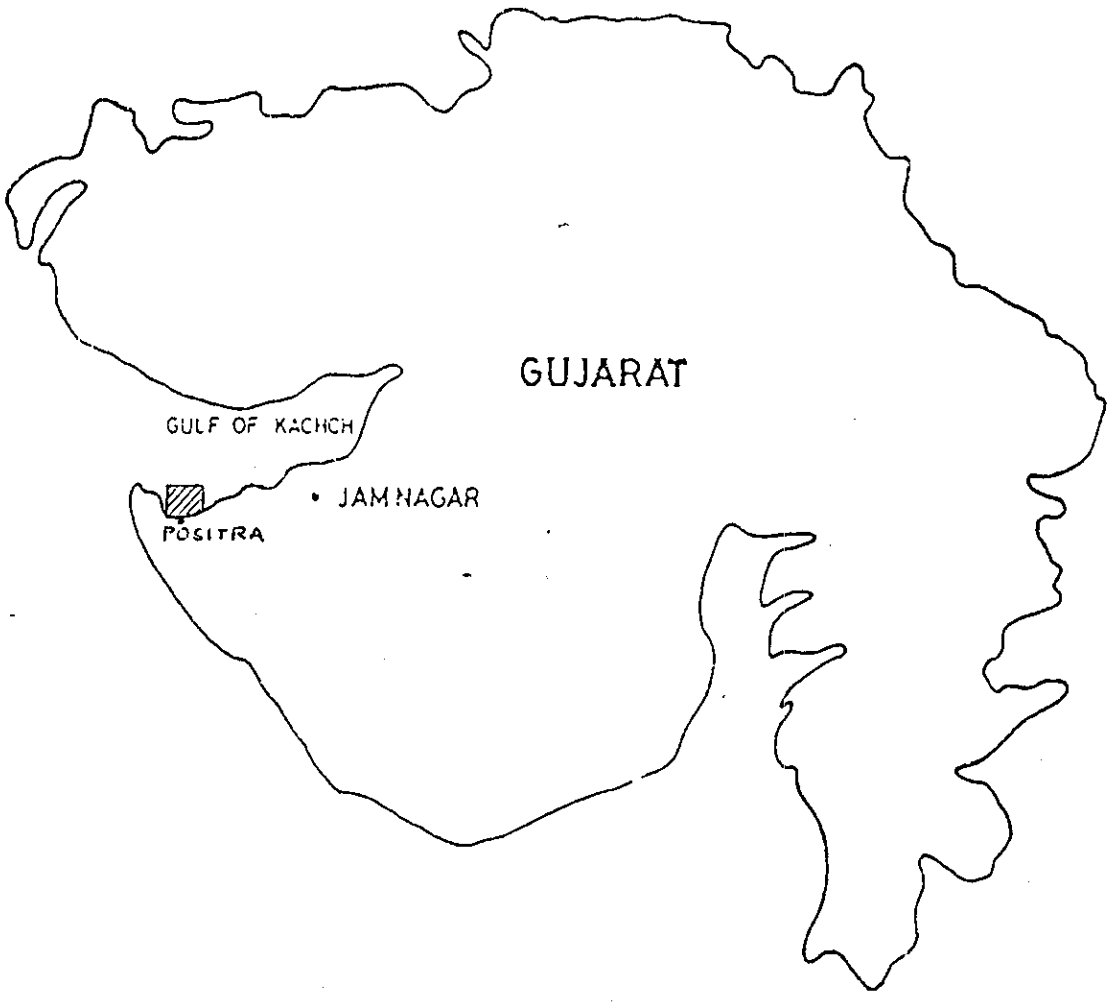
for 2.5 mm	:	9.4 to 15.9 %
for 5.0 mm	:	7.6 to 14.2 %

ANNEXURE 1

PROJECT : SOIL INVESTIGATION GULF OF KACHCH

LOCATION : **POSITRA**

FIG-1

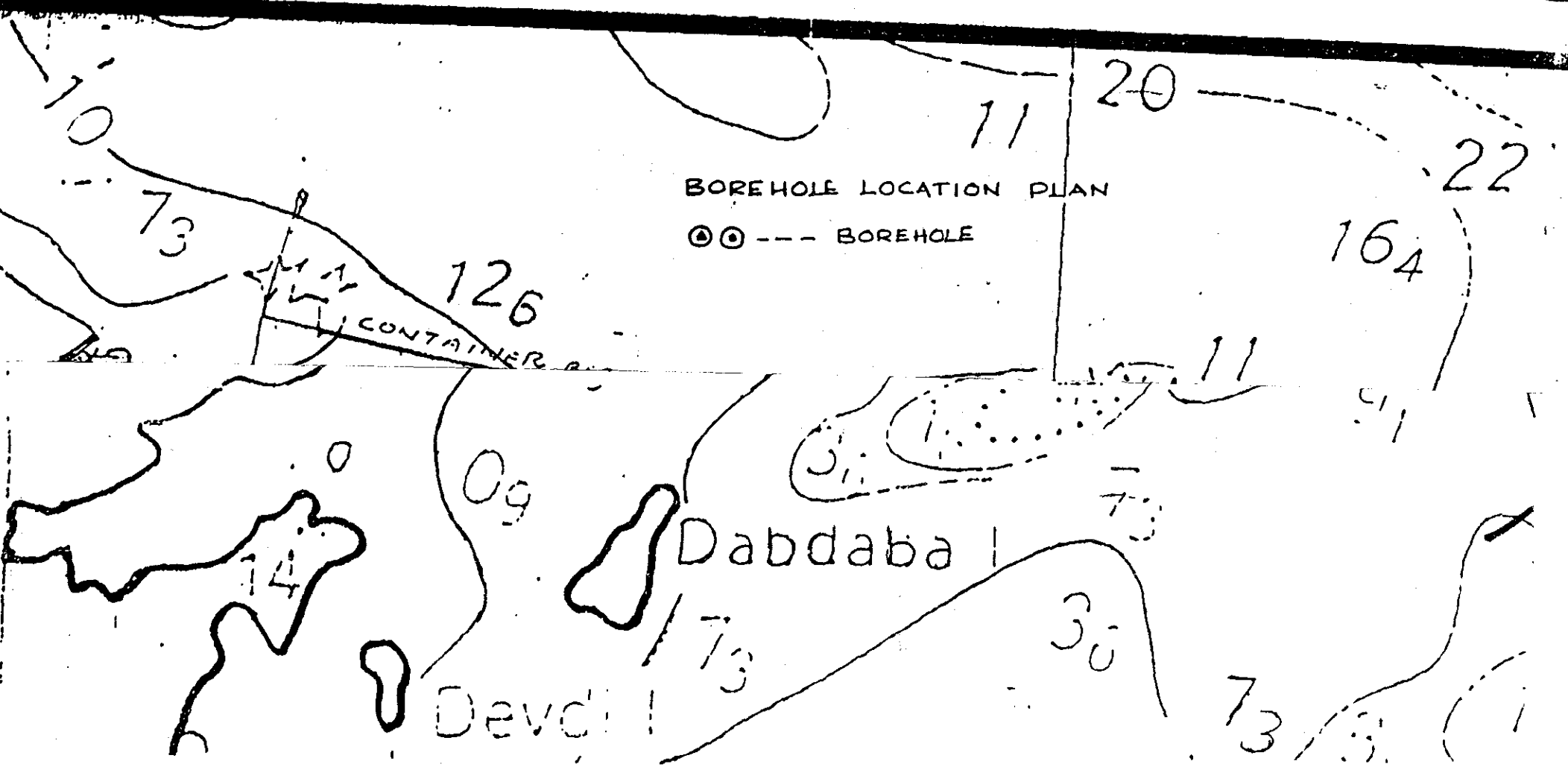


GENERAL LOCATION

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R. HARRIS (INDIA) PVT. LTD.

ANNEXURE 2



Legend

Locations of onshore boreholes (LB I to LB 10) shown thus : •

PROPOSED LOCATIONS OF ONSHORE BOREHOLE:

FIGURE NO. D-1

Scale : 1:25,000

BOREHOLE CO-ORDINATES , REDUCED AND GROUND WATER LEVELS

PROJECT : ON-SHORE POSITRA

BORE HOLE NO.	CO-ORDINATES GEOGRAPHICAL		REDUCED LEVEL ABOVE C.D	GROUND WATER LEVEL
	LONGITUDE	*LATTITUDE*	M	M
T-10	69°11'16.00"	22°25'03.00"	4.943	3.11
T-9	69°10'59.00"	22°25'03.00"	6.719	3.19
T-8	69°10'41.00"	22°24'43.00"	5.412	3.50
T-7	69°10'29.00"	22°24'34.00"	7.197	2.90
T-6	69°11'10.00"	22°24'38.00"	5.443	3.65
T-4	69°10'35.00"	22°23'53.00"	18.685	
LB-11	69°10'56.00"	22°24'14.00"	6.648	4.27
LB-10	69°11'40.58"	22°23'53.00"	6.205	5.17
LB-8	69°11'29.28"	22°23'36.35"	8.50	5.98
LB-7	69°11'21.80"	22°23'37.00"	9.275	5.13
LB-9	69°11'30.69"	22°23'49.22"	5.650	4.76

ANNEXURE 3

BORE HOLE NO. T- 10 — **Sheet 1 of 2**

CO ORDINATES	69 11 16.00 E 22 25 30.00 N	Date: 26 Apr.97 to 28 Apr.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	4.943 M above chart datum	G.W.L.—3.11 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit ○ — Water Content % □ — Liquid Limit ◆ — 20 40 60 80 100

UNIT WT. KN/CuM — ○ Dry ▢ Bulk — 15 20 25

SHEAR STRENGTH KG/CM² — ○ VL ▢ PP ○ UC ▢ TU — 200 400 600 800 1000

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
0.00		0.00	0.50	26-Apr	1600	1610										DS			0.0
		0.50	0.70		1610	1620										DS			0.5
1.00		0.70	1.50		1620	1700	NIL												
		1.50	1.95		1700	1720				6	10		13		23	SPT			1.5
2.00																			
		1.50	3.00	27-Apr	08 00	08 30													
3.00		3.00	3.45		08 30	08 35				9	16		23		39	SPT			3.0
4.00		3.00	4.50		08 35	08 45	NIL												
		4.50	4.95		08 45	1030				7	15		25		40	SPT			4.5
6.00																			
		4.50	6.00		1100	1200	NIL												
6.00		6.00	6.45		1200	1300				9	13		25		38	SPT			6.0
7.00		6.00	7.50		1400	1600	NIL												
		7.50	7.95		1600	1645				10	19		20		39	SPT			7.5
8.00																			
9.00		7.50	9.00		1645	1830	NIL												
		9.00	9.10	28-Apr	08 00	08 30					10CM/60BLOES				N>100	SPT			9.0
10.00																			

*All depths are in metres below bed level

Symbol	DESCRIPTION
	Dark brown, fine to coarse grained, SAND.
	Light greyish brown to greyish red, medium stiff to stiff CLAY. traces of sands observed occasionally.
	Light reddish brown to yellowish brown , fractures are very closely to closely spaced, wethered LIMESTONE.

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T- 10 **Sheet 2of 2**

CO ORDINATES 69 11 16.00 E / 22 25 30.00 N — Date: 26 Apr.97 to 28 Apr.97
SITE POSITRA
METHOD Rotary
REDUCED LEVEL 4.943 M above chart datum — G.W.L.--3.11 m
DIA. OF BORE HOLE 100 MM — CORE DIA. 55 mm

ATTERBERG LIMIT: Plastic Limit 0 | Water Content % | Liquid Limit # (20 40 60 80 100)
UNIT WT. KN/CuM: Dry, Bulk (15 20 25)
SHEAR STRENGTH KG/CM²: VL, PP, UC, TU (200 400 600 800 1000)

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
	1.0	9.00	10.50		09 30	1100	35	26	18										
11.00																			
12.00	2	10.50	12.00		1120	1240	60	60	56										
13.00	3	12.00	13.50		1300	1416	70	70	54										
		13.50	13.62		1500	1545				2CM/32BLOWS					N>100	SPT			13.5
14.00																			
15.00																			
16.00																			
17.00																			
18.00																			
19.00																			
20.00																			
21.00																			

*All depths are in metres below bed level

Symbol | DESCRIPTION

Borehole terminated at 13.5 m

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T-9 — Sheet 1of 2

CO ORDINATES	69 10 59.00 E 22 25 30.00 N	Date: 29 Apr.97 to 30 Apr.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.719 M above chart datum	G.W.L.—3.19 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit ○ / Water Content % □ / Liquid Limit ● (20 40 60 80 100)

UNIT WT. — KN/CuM — Dry ○ / Bulk □ (15 20 25)

SHEAR STRENGTH — KG/CM² — VL ○ / PP □ / UC ○ / TU □ (200 400 600 800 1000)

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	NO. SAMPLE	SAMPLES	METERS DEPTHS IN	Symbol	DESCRIPTION
																					All depths are in metres below bed level
0.00		0.00	0.20	29-Apr	08 00	08 11										DS			0.0		Dark brownish , silty SAND with clay.
		0.50	0.70		08 11	08 30										DS			0.5		
1.00		0.70	1.00		08 30	08 00	Nil														Brownish yellow,fine grained fractures are extremely closely to
		1.00	1.10		08 00	08 20				10CM/50BLOWS					N>100	SPT			1.0		very closely spaced, weathered LIMESTONE.
2.00																					
	1	1.00	2.00		08 20	1100	23	18	Nil												
3.00																					
4.00	2	3.80	4.10		1100	1300	36	26	20										4.1		
		4.10	4.60		1300	1430	Nil														
4.60		4.60	4.95		1430	1600				7	11		17		28	SPT			4.5		Reddish brown to greyish brown, completely wethered LIMESTONE.
																					with seams of silty sand and clay observed occasionally.
6.00		4.95	6.00		1600	1700	Nil														
		6.00	6.40		1700	1730				8	15		20		35	SPT			6.0		
7.00		6.00	7.80		1730	1845	Nil														
		7.80	7.95		1845	1920				11	19		23		42	SPT			7.5		
8.00		7.80	8.00	30-Apr	08 00	08 00	Nil														
		8.00	8.35		08 00	08 20	REC.									UDS			8.0		
9.00		8.00	8.00		08 20	1045	Nil														
		9.00	9.45		1045	1115				7	11		25		36	SPT			9.0		
10.00		9.00	10.00		1115	1300													10.5		

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T- 9 — Sheet 2of 2

CO ORDINATES	69 10 50.00 E 22 25 30.00 N	Date:	29 Apr.97 to 30 Apr.97
SITE	POSITRA		
METHOD	Rotary		
REDUCED LEVEL	6.719 M above chart datum	G.W.L.	—3.19 m
DIA. OF BORE HOLE	100 MM	CORE DIA.	55 mm

ATTERBERG LIMIT — Plastic Limit ○ | Water Content % □ | Liquid Limit ●
UNIT WT. — KN/CuM — Dry ⋯ Bulk ⋯
SHEAR STRENGTH — KG/CM² — VL ▽ PP □ UC ◇ TU □

20	40	60	80	100	15	20	25	200	400	600	800	1000

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CCRING CR %	CCRING SCR %	CCRING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	No. SAMPLE	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					All depths are in metres below bed level
11.00		10.50	10.80		1300	1400				13	16		21		39	SPT			10.5		Brownish grey to yellow , fractures are very closely to closely spaced, wethered LIMESTONE.
12.00	3	10.50	12.30		1400	1600	43	43	27												Coclderable amount of silty Sand with some Clay was observed.
13.00																					
	4	12.30	13.80		1600	1800	50	50	43												
14.00		13.80	13.95		1800	1830				5CM/40BLOWS					N>100	SPT			13.8		Borehole terminated at 13.65 m.
15.00																					
16.00																					
17.00																					
18.00																					
19.00																					
20.00																					
21.00																					

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

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BORE HOLE NO. T-8 — **Sheet 1of 2**

CO ORDINATES	89 10 41.00 E 22 24 43.00 N	Date: 1 May.97 to 2 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	5.412 m above C.D	G.W.L. —3.60 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH	SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO. OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
Plastic Limit ○ / Water Content % □ / Liquid Limit ●	KN/CuM: Dry ○ / Bulk □	KG/CM²: VL ○ / PP □ / UC ○ / TU □																						
20 40 60 80 100	15 20 25	200 400 600 800 1000																						
			"All depths are in metres below bed level																					
					0.00	0.00	0.20	1-May	1000	1010									DS			0.0		Light brownish grey to brownish grey, fine to medium grained, silty SAND, with traces of greyish brown clay.
						0.50	0.70		1010	1020									DS			0.5		
					1.00	0.50	1.50		1020	1100	NR													
						1.50	1.95		1100	1120				10	12		18	30	SPT			1.5		
					2.00																			
					3.00	1.50	3.00		1120	1245	NR													
						3.00	3.45		1245	1310				7	13		16	29	SPT			3.0		
					4.00	3.00	4.50		1310	1420	NR													
						4.50	4.75		1420	1440	REC.			13	19		20	39	SPT			4.5		
					5.00																			
					6.00	4.50	6.00		1500	1630	NR													
						6.00	6.45		1630	1700				11	20		22	42	SPT			6.0		
					7.00	6.00	7.50		1700	1830	NR													
						7.50	7.95		1830	1900				15	20		22	42	SPT			7.5		
					8.00																			
						7.50	8.95	2-May	08 00	08 30	NR													
					9.00	8.95	9.40		08 30	1000				14	20		28	48	SPT			8.95		
					10.00	8.95	10.50		1500	1145	NR													

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC: UNCONFINED COMP TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T- 8 — **Sheet 2of 2**

CO ORDINATES	89 10 41.00 E 22 24 43.00 N	Date: 1 May.97 to 2 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.412 m above C.D	G.W.L. –3.60 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit / Water Content % / Liquid Limit): 20 40 60 80 100

UNIT WT. KN/CuM (Dry / Bulk): 16 28 28

SHEAR STRENGTH KG/CM² (VL, PP, UC, TU): 200 400 600 800 1000

*All depths are in metres below bed level

DEPTH SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
11.00		10.50	10.80		1145	1220				10CM/50BLOWS					N>100	SPT			10.8		Yellowish brown to Greyish yellow ,fine grained, completely weathered LIMESTONE.
12.00	1	10.50	12.00		1240	1360	NR														
		12.00	12.06		1360	1415				5CM/ 35 BLOWS					N>100	SPT			12.0		Light yellowish brown, fine to medium grained , fractures are very closely to closely spaced, slightly weathered LIMESTONE.
13.00	2	12.00	13.60		1415	1530	28	23	23												
14.00																					
15.00	3	13.60	15.00		1530	1640	60	60	36												
16.00																					Borehole terminated at 15.00 m
17.00																					
18.00																					
19.00																					
20.00																					
21.00																					

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T-7

Sheet 1 of 2

CO ORDINATES	69 10 29.008 E 22 24 34.00 N	Date: 3 May.97 to 4 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	7.197 M above chart datum	G.W.T. —2.90 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit | Water Content % | Liquid Limit) | UNIT WT. (KN/CuM: Dry / Bulk) | SHEAR STRENGTH (KG/CM²: VL, PP, UC, TU)

20 40 60 80 100 | 15 20 25 | 200 400 600 800 1000

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	METERS DEPTHS IN	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.20	3-May	08 00	08 10										DS			0.0		Brownish, fine silty SAND with traces of clay.
		0.50	0.70		08 10	08 20										DS			0.5		
1.00																					Yellow to yellowish grey, medium to fine grained, fractures are extremely closely to very closely spaced, wethered LIMESTONE.
2.00	1	1.00	2.50		08 60	1100	NR														
3.00																					
4.00	2	2.50	4.00		1100	1300	41	38	24												
5.00	3	4.00	5.50		1300	1500	18	16	NR												
		5.50	5.95		1500	1530				10	13		17		30	SPT			5.5		Light grey to brownish grey, completely weathered LIMESTONE, with considerable amount of stiff clay and silty sand.
6.00																					
7.00		5.50	7.50		1530	1700	NR														
		7.50	7.90		1700	1740	REC.									UDS			7.5		
8.00																					
9.00		7.90	9.00		1740	1930	NR														
		9.00	9.45		1930	1900				12	17		18		35	SPT			9.0		
10.00																					

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH
Plastic Limit ○ / Water Content % ▭ / Liquid Limit ●	KN/CuM — Dry / Bulk	KG/CM² — VL / PP / UC / TU
20 40 60 80 100	16 20 26	200 400 600 800 1000

BORE HOLE NO. T-7 Sheet 2of 2

CO ORDINATES	69 10 29.008 E 22 24 34.00 N		Date: 3 May.97 to 4 May.97
SITE	POSITRA		
METHOD	Rotary		
REDUCED LEVEL	7.197 M above chart datum		G.W.T. —2.90m
DIA. OF BORE HOLE	100 MM		CORE DIA. 55 mm

*All depths are in metres below bed level

Sample Depth	Run No.	Depth* From	Depth* To	Date	Time From	Time To	Coring CR %	Coring SCR %	Coring RQD %	Penetration / No of Blows 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - Value	Sample Type	Sample No.	Samples	Depths in Meters	Description
		9.00	10.50	4-May	09 00	1000	NH													
11.00		10.50	10.95		1000	1040				15	18		18		20	SPT			10.5	
12.00		10.50	12.00		1040	1200	NH													
		12.00	12.45		1200	1240				14	18		22		40	SPT			12.0	a seam of soft clay was encountered with traces of silt and clay.
13.00		12.00	13.50		1240	1400	NH													
		13.50	13.95		1400	1420				11	21		20		41	SPT			13.5	
14.00																				Borehole terminated at 13.95 m.
15.00																				
16.00																				
17.00																				
18.00																				
19.00																				
20.00																				
21.00																				

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

ATTERBERG LIMIT	UNIT WT.	SHEAR STRENGTH
Plastic Limit ○ — Water Content % □ — Liquid Limit ●	KN/CuM — Dry Bulk	KG/CM² — V L, P P, UC, TU
20 40 60 80 100	15 20 25	200 400 600 800 1000

BORE HOLE NO. T- 6 — Sheet 1of 1

CO ORDINATES	69 11 10.00 E 22 24 38.00 N	Date: 4 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.443 M above chart datum	G.W.T. — 3.65 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

"All depths are in metres below bed level

SAMPLE	RUN NO.	DEPTH" FROM	DEPTH" TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
0.00		0.00	0.20	4-May	1630	1640										DS			0.0		Light brown , fine silty SAND with traces of clay.
		0.60	0.68		1640	1650										DS			0.6		
1.00																					Yellow, fine grained , completely weathered , LIMESTONE,with traces of fine silty sands and Clay observed.
2.00	1	0.80	2.08		1650	1730	40	24	NIL												
		2.00	2.10		1730	1745				8	2CM/25BLOWS				N>100	SPT			2.0		
3.00	2	2.00	3.88		1745	1845	48	46	37												
4.00		3.80	4.68		1845	1915	NIL			7											
		4.60	4.66		1915	1940				9	16		17		33	SPT			4.6		Concilderable amount of silty fine sand with clay is observed.
5.00																					Borehole terminated at 4.50 m
6.00																					
7.00																					
8.00																					
9.00																					
10.00																					

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. T-4

Sheet 1of 2

CO ORDINATES 69 10 35.00 E, 22 23 53.00 N
Date: 6 May.97 to 7 May.97
SITE POSITRA
METHOD Rotary
REDUCED LEVEL 18.686 M above chart datum
DIA. OF BORE HOLE 100 MM
CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit / Water Content % / Liquid Limit) — UNIT WT. KN/CuM (Dry / Bulk) — SHEAR STRENGTH KG/CM² (VL / PP / UC / TU)

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
																			0.0
0.00		0.00	0.50	6-May	08 00	08 20										DS			0.5
		0.50	0.70		08 20	08 40										DS			
1.00																			
2.00		0.70	2.00		08 40	1030	NR												
		2.00	2.10		1030	1120				10CM/40BLOWS					N>100	SPT			2.0
3.00	1	2.00	3.50		1100	1300	36	26	NR										
		3.50	3.95		1300	1340				9	13	9CM/25BL			N>100	SPT			3.5
4.00																			
6.00	2	3.50	6.00		1340	1500	28	16	NR										
		6.00	6.45		1500	1520				9	9	13			22	SPT			5.0
6.00		6.00	6.50		1520	1600	NR												
		6.50	6.68		1600	1620				22	3CM/25BLOWS				N>100	SPT			6.5
7.00		6.50	7.50		1620	1845	30	17	NR										
		7.50	7.62		1845	1900					2CM/2SBLOWS				N>100	SPT			7.6
8.00																			
9.00																			
		7.50	9.50	7-May	08 00	1220	60	64	82										
10.00																			

*All depths are in metres below bed level

Symbol | DESCRIPTION

0.0 – 2.0: Dark reddish brown , fine silty SAND with trace of clay.

2.0 – 7.6: Light yellowish grey to greyish brown, fractures are extremely closely to very closely spaced, weathered LIMESTONE.
traces of stiff clay and silty sands observed occasionally.

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP. TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

ATTERBERG LIMIT | UNIT WT. | SHEAR STRENGTH

Plastic Limit ○ | Water Content % □ | Liquid Limit ●

KN/CuM | Dry Bulk

KG/CM² | V L | P P | UC | TU

20 40 60 80 100 | 16 20 26 | 200 400 600 800 1000

BORE HOLE NO. T-4

Sheet 2of 2

CO ORDINATES 69 10 35.00 E, 22 23 53.00 N

Date: 6 May.97 to 7 May.97

SITE POSITRA

METHOD Rotary

REDUCED LEVEL 18.686 M above chart datum

DIA. OF BORE HOLE 100 MM | CORE DIA. 55 mm

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
																					All depths are in metres below bed level
11.00		9.60	11.00		1220	1400	Nil														
		11.60	11.48		1400	1430				9	20		22		42	SPT			11.0		Concilderable amount of silty Sand with some clay was observed
12.00		11.60	11.80		1430	1520	Nil														embedded with Limestone.
		11.80	12.26		1520	1600				10	21		23		44	SPT			11.8		
13.00																					
		11.60	13.56		1600	1816	Nil														
14.00		13.66	14.00		1816	1845				14	15		26		40	SPT			13.95		
																					Borehole terminated at 14.00 m
16.00																					
18.00																					
17.00																					
18.00																					
19.00																					
20.00																					
21.00																					

VL: LAB VANE SHEAR TEST

PP: POCKET PENETROMETER TEST

TU: TRIAXIAL TEST UNDRAINED

UC: UNCONFINED COMP

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB-11

Sheet 1of 2

CO ORDINATES	89 10 56.00 E 22 24 14.00 N	Date: 11 May.97 to 14 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.648M above chart datum	G.W.L.—4.27 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit ○ / Water Content % □ / Liquid Limit ●
20 40 60 80 100

UNIT WT. — KN/CuM — Dry ▽ / Bulk ▽
15 20 25

SHEAR STRENGTH — KG/CM² — VL ▽ / P P ▽ / UC ▽ / TU ▽
200 400 600 800 1000

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	No. SAMPLE	SAMPLES	METERS DEPTHS IN	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.22	11-May	1010	1030										DS			0.0		Reddish brown , fine silty SAND.
1.00		0.22	1.50		1030	1300	20	20	18												Brownish yellow,fine grained, fractures are extremely closely to very closely spaced, weathered LIMESTONE.
2.00		1.50	1.95		1300	1330				5	6	11			17	SPT			1.5		
3.00		1.50	3.30		1400	1600	NR														Brownish yellow to greyish yellow, completely weathered LIMESTONE.
4.00		3.30	3.75		1600	1630				6	8	13			21	SPT			3.3		traces of stiff clay and silty sands observed regularly.
		3.30	4.80		1630	1825	NR														
5.00		4.80	5.25		1825	1900				6	12	18			30	SPT			4.8		
6.00																					
		4.80	6.95	12-May	07 30	08 30	NR														
7.00		6.95	7.10		08 30	1000				6	7	13			20	SPT			6.95		
		6.95	7.95		1000	1200	NR														
8.00		7.95	8.10		1200	1300				6	9	15			24	SPT			7.95		
9.00		7.95	8.10		1300	1515	NR														
		8.10	9.95		1515	1605				13	16	18			34	SPT			8.10		
10.00																					

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB-11 — **Sheet 2of 2**

CO ORDINATES	89 10 56.00 E 22 24 14.00 N	Date: 11 May.97 to 14 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.648M above chart datum	G.W.L.---4.27 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit ○ — Water Content % □ — Liquid Limit ●) | UNIT WT. KN/CuM (Dry □ Bulk ○) | SHEAR STRENGTH KG/CM² (VL ○ PP □ UC ○ TU □)

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTH IN METERS	Symbol	DESCRIPTION
		"All depths are in metres below bed level																			
		9.15	10.71		1550	1730	NR														
11.00		10.71	11.16		1730	1900				11	14		19		33	SPT			10.71		Yellowish grey to Greyish brown, completely weathered
																					LIMESTONE.
12.00		10.71	12.00		1900	1910	NR														traces of stiff clays and fine silty sand observed regularly.
		12.00	12.46		1910	1940				11	16		25		41	SPT			12.0		
13.00		12.00	13.50	13-May	08 30	1230	NR														
		13.50	13.96		1230	1300				6	8		13		21	SPT			13.5		
14.00																					
		13.50	15.00		1530	1630	NR														
15.00		15.00	15.46		1630	1900				8	12		21		43	SPT			15.0		
16.00		15.00	16.00	14-May	08 00	1010	NR														
		16.00	16.46		1610	1640				7	16		25		40	SPT			16.0		
17.00		16.00	17.26		1640	1300	NR														
		17.26	17.79		1300	1340				5	11		16		27	SPT			17.26		completely weathered Limestone with some sand and stiff Clay.
18.00																					
19.00		17.26	19.00		1340	1600	NR														
		19.00	19.29		1600	1650				17	14CM/02BLOWS				N>100	SPT			19.0		considerable amount of sand and clay was observed.
20.00																					Borehole terminated at 19.29 m
21.00																					

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB-10

Sheet 1of 2

CO ORDINATES	69 11 40.58 E 22 23 39.53 N	Date: 19 May.97 to 22 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.205 M above chart datum	G.W.L—5.17m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT: Plastic Limit ○ | Water Content % □ | Liquid Limit ●; 20 40 60 80 100

UNIT WT. KN/CuM: Dry Bulb; 15 20 25

SHEAR STRENGTH KG/CM²: V L, P P, UC, TU; 200 400 600 800 1000

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
0.00		0.00	0.60	18-May	1300	1310															Dark brownish to brownish , coarse to medium grained sand, with CLAY
		0.60	0.76		1400	1425				19CM/75BLS HAMMER REBOUND					>100	SPT			0.6		
1.00	1	0.60	1.60		1425	1600	91	89	87												Reddish yellow to light grey, fine grained ,fractures are very closely closely spaced LIMESTONE.
2.00																					
3.00	2	1.60	3.33		1600	1800	28	20	16												
4.00																					
	3	3.33	4.83		1800	1920	44	40	21												
6.00																					
6.00	4	4.83	6.00		1920	2120	92	86	36												
		6.00	6.46	20-May	06 00	09 00				6	9		10		19	SPT			6.0		Yellowish brown to Greyish brown, completely weathered LIMESTONE, with considerable amount of silty sand, intermittent seams of brownish, stiff silty clay are also observed.
7.00		6.00	7.60		09 00	1100	NR														
		7.60	7.96		1100	1136				6	9		15		24	SPT			7.5		
8.00																					
8.00		7.60	8.00		1136	1315	NR														
		8.00	8.46		1315	1400				5	7		11		18	SPT			8.0		
10.00		8.00	10.80		1400	1630	NR														

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

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CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB-10 — **Sheet 2of 2**

CO ORDINATES	69 11 40.68 E 22 23 39.53 N	Date: 19 May.97 to 22 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	6.205 M above chart datum	G.W.L.—5.17M
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit 0 — Water Content % — Liquid Limit

UNIT WT. — KN/CuM — Dry Bulk

SHEAR STRENGTH — KG/CM² — VL, PP, UC, TU

SAMPLE DEPTH	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00		10.50	10.95		1530	1600				8	12		20		32	SPT			10.5
12.00		10.50	12.50		1600	1820	NIL												
13.00		12.50	12.95	21-May	09 30	1015				8	15		20		35	SPT			12.5
14.00		12.50	14.00		1500	1730	NIL												
		14.00	14.31		1730	1810				5	22	10CM/3 REBOUND			N>100	SPT			14.0
15.00		14.00	14.50	22-May	09 00	09 00	NIL												
		14.50	14.68		09 00	09 40					7CM/30BL'S REBOUND				N>100	SPT			14.5
16.00	8	14.50	16.71		09 25	1130	NIL												
		16.71	16.16		1130	1210				6	14		17		31	SPT			16.71
17.00		16.16	17.50		1210	1415	NIL												
18.00		17.50	18.05		1415	1520				4	7		15		22	SPT			17.8
		17.50	18.00		1520	1835	NIL												
19.00		18.50	18.46		1835	1915				7	11		16		27	SPT			18.0
20.00																			
21.00																			

*All depths are in metres below bed level

Symbol | DESCRIPTION

Dark brown to light yellow , medium to fine grained , completely weathered LIMESTONE. Decomposed.

traces of fine sands and med.stiff clays observed occasionally.

Borehole terminated at 18.46m

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB- 8 — **Sheet 1of 3**

CO ORDINATES	69 11 29.26 E 22 23 36.35 N	Date: 23 May.97 to 26 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	8.50 M above chart datum	G.W.T.— 5.98 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit, Water Content %, Liquid Limit (20 40 60 80 100)

UNIT WT. — KN/CuM — Dry Bulk (15 20 25)

SHEAR STRENGTH — KG/CM² — VL, PP, UC, TU (200 400 600 800 1000)

*All depths are in metres below bed level

DEPTH SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
0.00		0.00	0.50	23-May	07 00	07 20	Nil									DS			0.0		Light brownish yellow to greyish yellow, fine silty sand and CLAY
		0.50	0.70		07 20	08 00	Nil									DS			0.5		
1.00		0.70	1.50		08 00	09 30	Nil														
		1.50	1.95		09 30	1000				5	7		9		16	SPT			1.5		
2.00																					
		1.50	3.00		1000	1100	Nil														
3.00		3.00	3.45		1100	1130				5	7		9		16	SPT			3.0		
4.00		3.00	4.30		1130	1215	Nil														
		4.30	4.66		1215	1260	REC									UDS			4.3		
5.00		4.30	4.70		1260	1315	Nil														
		4.70	4.71		1315	1400				10CM/20BLOWS			REBOUND		N>100	SPT			4.7		Light greyish yellow, fine to medium grained ,fractures are
6.00																					extremely closely to very closely spaced, weathered LIMESTONE.
	1	4.70	6.50		1400	1950	30	30	25												
7.00		6.50	6.95		1950	1915				7	10		12		22	SPT			6.5		Brownish grey to yellowish brown , fine grained , completely
																					weathered LIMESTONE , with some silty sand and clay.
8.00		6.50	8.00	24-May	06 00	08 00	Nil														
		8.00	8.45		08 00	08 30				5	7		15		22	SPT			8.0		
9.00		8.00	8.96		08 30	1000	Nil														
10.00		8.5	8.96		1000	1040				8	17		25		42	SPT			9.5		

VL LAB VANE SHEAR TEST — UC : UNCONFINED COMP TEST

PP POCKET PENETROMETER

TU TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB- 8 — **Sheet 2of 3**

CO ORDINATES	69 11 29.28 E 22 23 36.36 N	Date: 23 May.97 to 26 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	8.50 M above chart datum	G.W.T. — 5.98 m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT — Plastic Limit % | Water Content % | Liquid Limit %; UNIT WT. — KN/CuM (Dry, Bulk); SHEAR STRENGTH — KG/CM² (VL, PP, UC, TU)

SAMPLE	RUN NO.	DEPTH FROM	DEPTH TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS
11.00		9.96	11.00		1040	1200	NH												
		11.00	11.45		1200	1230				6	12		18		30	SPT			11.0
12.00		11.00	12.70		1300	1415	NH												
13.00		12.70	13.15		1415	1450				6	10		13		23	SPT			12.7
14.00		12.70	14.15		1450	1650	NH												
		14.15	14.60		1650	1730				4	6		11		17	SPT			14.2
15.00		14.15	15.65		1730	1930	NH												
		15.90	15.95		1930	2020				6	13		17		30	SPT			15.6
16.00																			
17.00		15.90	17.60	25-May	07 00	08 30	NH												
		17.60	17.95		08 30	1030				6	16		22		37	SPT			17.5
18.00																			
		17.60	18.75		1030	1245	NH												
19.00		18.75	18.20		1245	1330				7	14		19		33	SPT			18.75
20.00		18.75	20.00		1330	1615	NH												
		20.00	20.46		1615	1700				5	13		21		34	SPT			20.0

*All depths are in metres below bed level

Symbol	DESCRIPTION
	Light yellowish brown to dark greyish black, fine grained completely weathered LIMESTONE, with considerable amount of stiff clay and silty sand.

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB- 8 — **Sheet 3 of 3**

CO ORDINATES	89 11 29.28 E 22 23 36.35 N	Date: 23 May.97 to 26 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	8.50 M above chart datum	G.W.T— 5.98m
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit O — Water Content % — Liquid Limit ●) | UNIT WT. (KN/CUM: Dry Bulk) | SHEAR STRENGTH (KG/CM²: VL, PP, UC, TU)

SAMPLE DEPTH	RUN NO	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.6cm	7.6cm	7.6cm	7.6cm	N - VALUE	SAMPLE TYPE	SAMPLE No.	SAMPLES	DEPTHS IN METERS	Symbol	DESCRIPTION
		*All depths are in metres below bed level																			
21.00		20.90	21.50	26-May	07.00	09.40	NR														
		21.50	22.00		09.40	10.30	REC.									UDS			21.0		Intermittent seam of soft silty Clay was observed at 21.0 M.
22.00																					
23.00		21.50	23.50		10.30	13.00	NR														
		23.50	23.95		13.00	13.45				7	19		19		38	SPT			23.5		
24.00																					
25.00		23.50	25.00		13.45	17.20	NR														
			25.00		17.20	17.40	REC.									DS			25.0		
26.00		25.00	25.45		17.40	19.10				8	12		16		28	SPT			25.0		concilderable amount of silty/sandy Clay.
27.00																					Borehole terminated at 26.45 m
28.00																					
29.00																					
30.00																					
31.00																					

VL: LAB VANE SHEAR TEST
PP: POCKET PENETROMETER
TU: TRIAXIAL TEST UNDRAINED
UC : UNCONFINED COMP TEST

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

BORE HOLE NO. LB- 7 — **Sheet 1of 2**

CO ORDINATES	69 11 21.80 E 22 23 37.00 N	Date: 27 May to 30 May.97
SITE	POSITRA	
METHOD	Rotary	
REDUCED LEVEL	9.275 M above chart datum	G.W.L.–6.13M
DIA. OF BORE HOLE	100 MM	CORE DIA. 55 mm

ATTERBERG LIMIT (Plastic Limit ○ — Water Content % □ — Liquid Limit ●; 20 40 60 80 100) | UNIT WT. KN/CuM (/ Dry / Bulk; 16 20 26) | SHEAR STRENGTH KG/CM² (V L / P P / UC / TU; 200 400 600 800 1000)

SAMPLE	RUN NO.	DEPTH* FROM	DEPTH* TO	DATE	TIME FROM	TIME TO	CORING CR %	CORING SCR %	CORING RQD %	PENETRATION / NO.OF BLOWS 15cm	7.5cm	7.5cm	7.5cm	7.5cm	N - VALUE	TYPE SAMPLE	NO. SAMPLES	METERS DEPTHS IN	Symbol	DESCRIPTION
																				All depths are in metres below bed level
0.60		0.00	0.60	27-May	07 00	07 20										DS		0.0		Dark reddish brown to yellowish brown, medium to fine sandy CLAY.
1.00		0.60	1.60		07 20	09 10	Nil													
		1.60	1.95		09 10	09 30				6	10		15		25	SPT		1.6		
2.00																				
3.00		1.60	3.00		09 30	1115	NH													
		3.00	3.45		1115	1135				5	11		17		28	SPT		3.0		
4.00																				Light yellowish grey to dark yelow , fine grained , fractures are
	1	3.00	4.50		1135	1400	NH													extremely closely to very closely spaced, fossilliferous
5.00		4.50	4.95		1400	1420				9CM/25BLOWS					N>100	SPT		4.5		LIMESTONE.
6.00	2	4.50	6.00		1420	1740	26	26	7											
7.00																				
	3	6.00	7.50	28-May	07 00	09 45	33	23	6											
8.00																				
	4	7.50	8.50		09 45	1500	20	16	Nil											
9.00		8.00	8.00		1620	1540	REC.									UDS		8.5		Light greyish brown to yellowish brown , fine grained, completely
		8.00	8.50	29-May	08 00	1000	Nil													weathered LIMESTONE.
10.00		8.50	8.95		1230	1300				5	16		15		30	SPT		8.5		conciderable amount of Clay and silty sands observed.

VL: LAB VANE SHEAR TEST — UC : UNCONFINED COMP. TEST

PP: POCKET PENETROMETER

TU: TRIAXIAL TEST UNDRAINED

PREPARED BY : COASTAL MARINE CONSTRUCTION & ENGINEERING LTD.

CLIENT : FREDERIC R.HARRIS(INDIA)PVT.LTD.

8	3	8831	0
8	12	8431	0
9	3	8830	0
9	12	8430	0
10	3	8131	0
10	12	7431	0
11	3	6030	0
11	12	5730	0
12	3	7531	0
12	12	7031	0

YEAR - 1976

1	3	8231	0
1	12	7431	0
2	3	7429	0
2	12	6729	0
3	3	8131	0
3	12	7631	0
4	3	8329	0
4	12	7830	0
5	3	8331	0
5	12	8231	0
6	3	8530	0
6	12	8130	0
7	3	8231	0
7	12	7931	0
8	3	8931	0
8	12	8631	0
9	3	9230	0
9	12	8930	0
10	3	8631	0
10	12	8431	0
11	3	7230	0
11	12	7230	0
12	3	6131	0
12	12	6131	0

YEAR - 1977

1	3	6331	0
1	12	6131	0
2	3	7828	0
2	12	7428	0
3	3	8631	0
3	12	8230	0
4	3	8330	0
4	12	7730	0