FI:SF/IND 55
TECHNICAL REPORT 6

PRE-INVESTMENT SURVEY OF FISHING HARBOURS

INDIA

RATNAGIRI

ENGINEERING

SURVEY
SOIL INVESTIGATIONS
DESIGN

REPORT PREPARED FOR
THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ACTING AS EXECUTING AGENCY FOR THE UNITED NATIONS DEVELOPMENT PROGRAMME
BY
SCANDIACONSULT

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PREFACE

The Pre-Investment Survey of Fishing Harbours is being conducted by the Food and Agriculture Organization of the United Nations in cooperation with the Government of India. The Food and Agriculture Organization of the United Nations, on this Project, is acting as the Executing and Participating Agency for the United Nations Development Programme. The Agency has sub-contracted certain professional and other services to Scandiaconsult Internationl AB, Sweden.

The Project has its Headquarters at Bangalore, India. This Technical Report constitutes one of a number of reports which will be issued during the life of the Project. The contents of this Report are based on the work of Scandiaconsult personnel and of other professional and technical staff provided by the Government of India and the Food and Agriculture Organization of the United Nations.

The conclusions and recommendations given in the Report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the Project.

The designations employed and the presentation of the material in this document (and maps) do not imply the expression of any opinion whatsoever on the part of the United Nations or the Food and Agriculture Organization of the United Nations concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

This report is in two volumes. The first volume contains the text and the second volume the relevant drawings.

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SURVEY

CHAPTER 1

SURVEY REPORT

1.1 SURVEY PERIOD

The survey work was carried out during the period 29 December 1969 to 18 February 1970.

1.2 TRIANGULATION

A grid was established over 16 stations of which Nos, 10, 15 and 16 had been marked and used for an earlier survey in 1954-55 (Ref. Report No. TAA/IND/7 Hydrographic Training and Survey of Minor Ports in the State of Bombay by H.W.R. Krauss). The new stations were marked by steel pipes cast in concrete pillars set in the ground. The coordinates of grid stations from the earlier survey given in feet were converted to metric and in order to ensure that all coordinates within the area should be positive an addition of 18,000 feet (5,485.4 m) was first made to the value of all north coordinates of stations points used in the earlier survey.

For connecting the stations into the already established coordinate system, triangulation survey was made to include the stations: Ratnagiri Lighthouse, Mirya Peak and Nos. 10 and 15.

1.3 DATUM

All levels were referred to the benchmark used by the State Government for the present commercial harbour project. The benchmark on a parapet near the new breakwater was indicated by the Port Engineer to be 9.114 metres (29.90 ft) above datum. This datum is 0.71 m (2.33 ft) below Chart Datum as shown on Hydrographic Chart No. 2028.

1.4 TOPOGRAPHIC SURVEY

The area along the shore was surveyed using plane table with tacheometric alidade. The survey was carried out using the grid stations and also a number of intermediate stations, for which the positions were determined by traverses to the grid points.

1.5 HYDROGRAPHIC SURVEY

Hydrographic Survey was carried out using Kelvin Hughes Echosounder M536MB Mk.1 with outboard rig mounted on a local fishing boat. Position fixing was done mainly using cross fixes to lines on shore.

Echosoundings were carried out in six east-west sections with intervals of approximately 100 metres.

1.6 MAPS

The results from the topographic and hydrographic survey were plotted on maps at a scale of 1:1,000. Details of the built-up area behind and adjoining the surveyed shore were obtained from City Survey maps and reduced for plotting to scale 1:1,000. The position of two traverse stations in the City Survey coordinate system were determined in the coordinate system used for this survey before transferring the details to the Project maps in 1:1,000.

The extent of the surveyed area is shown on the Survey Index Map Drg. No. 05-100, and the survey is represented on Drg. No. 05-102. This map in 1:2,000 was obtained by photographic reduction of the maps in 1:1,000.

1.7 LIST OF CO-ORDINATES

Geographical

Mirya Peak	Lat. 17° 01' 35.92" N
	Long. 73° 15' 39.43" E

Rectangular

Station No.	North	East	Height
Mirya Peak	5486.36	0.00	--
Ratnagiri Lighthouse	1048.20	1287.16	--
1	2349.82	1887.98	+6.047
2	2202.23	1997.16	+5.835
3	2264.90	2289.48	+6.451
4	2452.32	2420.10	+7.069
5	2662.57	2521.69	+6.983
6	2900.40	2576.82	+8.392
7	3183.40	2575.93	+8.234
8	3567.53	2505.96	+7.309
9	3761.15	2445.65	+7.510
10	3992.34	2338.47	--
15	2352.17	1823.25	--
16	2309.89	1782.68	--

1.8 TIDE

A water level recorder was installed near the site of the new breakwater at present under construction and records were obtained during the period 7th February to 7th March, 1970. The records are shown in Drg. No. 05-300.

Using information taken from Hydrographic Chart No. 2028 the following tidal values with respect to datum were obtained:

MHHW	+2.97 m
MLHW	+2.84 m
MLLW	+1.23 m
MHLW	+1.90 m

1.9 WAVES

The report of the Central Water and Power Research Station in Poona on model studies for the commercial port in Ratnagiri contains diagrams of wave heights and wave periods recorded during the years 1949 to 1953. The diagrams have been copied and are reproduced in Drg. No. 05-43 and 05-44.

Maximum wave height recorded outside Mirya Bay for waves from west is about 4 m (14 ft.) with a wave period of 9 to 10 seconds, whereas the maximum wave height from the north-west is between 2.1 to 2.4 m with a period of 7 to 8 seconds.

1.10 WIND

Meterological observations have been made in Ratnagiri over a number of years. A summary of the wind observations together with observations of precipitation, cloud and visibility prepared by Meteorological Department, India are given in the Climatological Table on page 4.

It appears that winds with velocities of more than 61 km. per hour have not been recorded and wind velocities over 20 km. per hour are relatively scarce. The most predominant wind directions are from SW to NW.

1.11 SURVEY REPORT DRAWINGS

Drawing No.	Title	
05-40	Coastline of India with location of proposed harbour	1:10,000,000
05-107	Map showing location of site	1:15,000
05-100	Survey Index Map	1:25,000
05-102	Survey Map	1:2,000
05-300	Tide Recordings February - March, 1970	

CLIMATOLOGICAL TABLE

MONTH		WEATHER PHENOMENA* No. OF DAYS WITH						WIND No. OF DAYS WITH WIND SPEED (Km p.h.)				WIND PERCENTAGE No. OF DAYS OF WIND FROM									CLOUD No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS					CLOUD No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS						VISIBILITY* No. OF DAYS WITH VISIBILITY				
		PRECIPITATION 0-3 mm OR MORE	HAIL	THUNDER	FOG	DUST STORM	SQUALL	62 OR MORE	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	Up to 1 km	1-4 kms	4-10 kms	10-20 kms	OVER 20 kms
JANUARY	I	0.1	0	0	0	0	0		1	29	1	9	17	59	8	1	0	0	3	3	15	11	4	1	0	18	11	2	0	0	0	0	0	4	8	19
	II							0	5	26	0	6	0	0	0	0	6	53	35	0	15	12	3	1	0	19	10	2	0	0	0	0	0	3	13	15
FEBRUARY	I	0.1	0	0	0	0	0	0	1	26	1	14	19	47	6	3	1	1	6	3	14	10	3	1	0	19	8	1	0	0	0	0	0.1	4	7	17
	II							0	6	22	0	6	0	0	0	0	5	54	35	0	14	10	4	0	0	19	7	2	0	0	0	0	0.1	1.1	13	14
MARCH	I	0	0	0	0	0	0	0	1	29	1	15	11	45	10	4	1	2	9	3	14	11	5	1	0	17	12	2	0	0	0	0	0	5	8	18
	II							0	7	24	0	5	0	0	0	1	8	60	26	0	14	10	6	1	0	19	8	4	0	0	0	0	0	1.1	14	16
APRIL	I	1.0	0	0.4	0	0	0	0	1	28	1	17	9	30	8	5	6	8	15	2	7	12	8	3	0	11	12	6	1	0	0	0	0	4	8	18
	II							0	8	22	0	3	1	0	0	0	6	64	26	0	6	12	10	2	0	13	11	6	0	0	0	0	0	1.2	13	16
MAY	I	4	0	0.9	0	0	0	0	1	29	1	14	5	15	4	4	8	19	29	2	3	9	13	5	1	9	10	11	1	0	0	0	0.1	3	9	18
	II							0	8	23	0	2	1	0	0	2	12	55	28	0	3	11	12	4	1	9	12	10	0	0	0	0	0.1	2	13	16
JUNE	I	23	0	1.4	0	0	0	0	4	25	1	3	2	14	10	7	31	22	9	2	0	3	8	11	8	7	5	15	3	0	0	0.1	0.9	6	9	14
	II							0	7	23	0	1	0	1	1	8	43	36	10	0	0	3	7	10	10	7	5	14	3	1	0	0.1	1.0	5	10	13
JULY	I	30	0	0	0	0	0	0	11	20	0	2	1	3	1	2	41	42	7	1	0	0	4	13	14	9	1	16	4	1	0	0.4	3	7	10	11
	II							0	12	19	0	1	0	0	0	2	47	45	5	0	0	1	3	11	16	9	1	14	6	1	0	0.3	2	9	8	12
AUGUST	I	27	0	0	0	0	0	0	6	24	1	2	2	6	2	1	30	45	9	3	2	2	6	13	8	9	2	18	2	0	0	0.1	3	6	8	14
	II							0	9	22	0	1	0	0	0	1	34	54	10	0	2	1	5	12	11	9	1	17	4	0	0	0	1.7	8	8	13
SEPTEMBER	I	22	0	1.2	0	0	0	0	1	28	1	9	8	24	7	4	12	23	10	3	1	5	9	10	5	10	7	12	1	0	0	0	2	3	10	15
	II							0	3	27	0	2	1	1	0	1	15	57	23	0	0	4	10	10	6	10	6	13	1	0	0	0.1	1.5	5	11	13
OCTOBER	I	9	0	2	0	0	0	0	1	29	1	8	13	48	12	5	3	4	5	2	5	8	9	7	2	9	13	9	0	0	0	0	1.4	4	9	16
	II							0	3	28	0	6	2	2	2	3	8	47	30	0	5	7	11	7	3	10	10	10	1	0	0	0	0.5	5	12	13
NOVEMBER	I	3	0	0.6	0.1	0	0	0	2	27	1	3	16	64	11	2	1	1	1	1	10	11	6	2	1	14	13	3	0	0	0	0	0	5	8	17
	II							0	1	29	0	5	1	1	2	1	5	54	31	0	7	11	8	3	1	13	12	5	0	0	0	0	0.2	3	13	13
DECEMBER	I	0.5	0	0	0	0	0	0	2	28	1	4	18	65	8	1	0	0	2	2	12	13	4	2	0	17	11	2	1	0	0	0	0.1	5	9	17
	II							0	1	30	0	5	0	1	0	0	5	60	29	0	11	12	6	1	1	16	12	3	0	0	0	0	0.3	2	15	13
ANNUAL TOTAL OR MEAN	I	120	0	7	0.1	0	0	0	32	322	11	9	10	35	7	3	11	14	9	2	83	95	79	69	39	149	105	97	13	1	0	0.6	11	56	103	194
	II							0	70	295	0	4	1	0	0	2	16	53	24	0	75	94	85	62	49	153	95	100	15	2	0	0.5	7	45	143	167
NUMBER OF YEARS	I			17					22						23								23						15					23		
	II								16						18								18						15					18		

*No. OF DAYS 2 AND ABOVE ARE GIVEN IN WHOLE NUMBERS

SOIL INVESTIGATIONS

CHAPTER 2

SOIL INVESTIGATIONS REPORT

2.1 ASSIGNMENT

The purpose of this investigation was to obtain information for the general planning and design of a fishing harbour.

2.2 METHODS OF WORK

The methods used for carrying out the work were as follows:

A. Penetration Test Borings	B. Sampling
Swedish Motorsounding	Post Hole Auger
Swedish Weightsounding	Side Intake Sampler
Hammersounding	Swedish Piston Sampler

A. Penetration Test Borings

Motorsounding

This drilling method is classed as one of the penetration tests similar to the Standard Penetration Test and Dutch Cone Sounding. The method has been developed in Scandinavia and provides information as to the relative compactness of the various soil layers, and gives a good idea of the granular size of the soil.

The equipment consits of a portable motor unit with a fixture for 22 mm diameter flush jointed steel rods. The rods are in pieces of 1 metre length and at the end there is fitted a 32 mm diam. screwbit 200 mm long.

During the borings the motor is used for rotating the rods, and is held in place by two operators. Special handles are used for holding the motor unit and those handles are connected to a pressure gauge instrument, which indicates the pressure load exercised by the operators on the boring rod.

When starting a boring, the rod with the bit is put into the ground and the distance the rod sinks without any extra load on the handles is measured and recorded. The operators then press the motor unit down using the handles and the load is increased in steps to 10 kg., 25 kg, 50 kg., 75 kg. and 100 kg., measurements of the penetration under each individual load being noted. When the srew-bit does not sink further under a load of 100 kg. the motor is used to rotate the rods and the number of half revolutions for which the bit penetrates a depth of 20 cm. is noted. This is repeated until the required depth is reached. Extra 1 m. long rods are added as needed. The number of half revolutions per 20 cm. penetrated are recorded and drawn up in the form of a diagram of resistance-to-penetraction at each depth.

Weightsounding

This method of sounding is similar to Motorsounding except that

the load is provided by weights and the turning of the bit is carried out manually.

Hammersounding

This method of drilling is also classed as one of the penetration tests. The equipment consists of 3 m long 32 mm diam. flush-jointed steel rods, with a square drill bit 40 x 40 mm the tip of which is turned to a conical point. The rod and bit are put into the ground, cylindrical wedges are locked on to the rod about 1.50 m above the ground. A 65 kg. weight is lifted 60 cm. above the locked wedges and allowed to fall freely onto them, driving the bit and rod into the ground. The number of blows required to drive the bit each step of 20 cm. is noted. The locked wedges are released and lifted up along the rods and re-locked for further driving, additional 1 m or 3 m long rods being added as required.

General

The above methods of sounding are carried out without casing. No allowance is made for the increased weight of drilling rods or the increased friction on the surface of the rods at increasing depths. These methods of sounding provide information for drawing resistance-to-penetration diagrams and indicate the general nature of the soil penetrated.

Samples are taken at points determined from the results of the soundings. The samples are examined and tested to establish the characteristics of the soil, which information is read in conjunction with the sounding diagrams.

B. Sampling

Post Hole Auger

This is used above the water table in cohesionless soils and in all but the hardest cohesive soils, to obtain disturbed samples.

Side Intake Sampler

Where small disturbed samples are required solely for identification purposes, this sampler can be used in soft deposits of cohesive and cohesionless soils with particle sizes not exceeding approximately 2 mm.

Swedish Standard Piston Sampler (designation St II)

This sampler is used for taking 50 mm diam. undisturbed samples. The sampler containing 3 Nos. 170 mm long and 50 mm diam. reinforced plastic sample tubes is forced into the ground without using any casing.

A piston pushes the soil to the side so that it does not enter the sampler. When the desired depth is reached the rods are rotated in an anticlockwise direction thereby forcing out past the picton a thinwalled metal tube with a hard metal cutting shoe containing the sample tubes. The sampler is withdrawn and after removal of the cutting shoe, a clockwise rotation of the

sampling rods extrudes the samples in the tubes each end of which is then covered with a plastic disc and an air-tight rubber cap. The numbers permanently marked on the sides of the tubes are recorded together with the depth from which the sample was taken.

Recording of Borings and Test Results

The symbols indicated on the enclosed pages: Soil Mechanics Symbols Sheet Nos. 1 and 2 are used on all plans, sections and diagrams describing the borings.

2.3 BORINGS EXECUTED

The total number of borings carried out was

1 Motorsounding
27 Hammersoundings
Samples were taken at 3 boreholes

The borings in the sea were carried out from a raft constructed on site from locally obtainable materials. The locations of the borings are shown on the plan, Drg. No. 05.200. The results from the soundings are drawn in diagrammatic form on the Dgr. Nos. 05-210 to 215.

2.4 POSITIONING AND LEVELLING

The positions and levels of boreholes on land were obtained by measurement from survey stations. Sextant angles were used to fix the position of boreholes at sea. Levels were obtained by simultaneous measurements of the water depth and water level, the latter being obtained from the automatic tide level recorder. Small differences in the sea-bed level as measured by the echo-sounder and as recorded during hammersounding are noticeable. These are due to the difficulty in measuring the water depth from the raft because of waves, the height of which reached up tp 0.80 m at times.

2.5 LABORATORY TESTS

Preliminary laboratory tests were carried out on some samples as shown in the Sample Schedule, Laboratory results and diagrams by the geotechnical laboratory of Scandiaconsult International AB, Sweden. The testing of further samples is at present in progress at Mysore Engineering Research Station, Krishnarajasagar.

2.6 DESCRIPTION OF SOIL LAYERS

The sea-bed and shore are covered by a layer of yellow fine medium sand with shells, which material has $\phi = 31^{\circ} - 32^{\circ}$, bulk density 1.79 - 1.94 t/m^3, moisture content 17 - 35 %.

This layer is underlain by a mixed material of brown clay, fine sand and gravel, which resembles a type of boulder clay found in more northerly latitudes, except that it may not have been subject to the same high overburden preasures of similar material found in Europe. One quick undrained triaxial test gave c = 0.4 kg/cm^2 and ϕ = 15°, bulk density 1.77 - 1.83 t/m^3 and moisture content 41 - 53 %.

Test on other samples taken at greater depths showed a moisture content between 14 - 50 %, and bulk density of 1.79 - 2.28 t/m^3, liquid limit 24 - 55 % and plastic limit 18 - 35 %. Due to irregularities in the samples of this material it was not possible to determine the shear strength by triaxial test.

The sounding in Bh. 20 was continued deeper through harder strata until it was stopped on rock or a boulder. The increase in hardness of these layers can be seen from the sounding diagram, and is felt to be due to an increased quantity and size of gravel and sand particles down to -8.6 m. The hard layer below this level down to the borehole stop is felt to be decaying rock.

This general picture is true for the whole site with the exception of the north eastern corner of the investigated area (Bh. 27) where a layer of black organic silt and blac organic clay with bands of non-plastic silt and a layer of black organic silty clay with bands of silt and some fibrous organic material were found. The upper layer had a bulk density 1.83 - 2.05, moisture content 20 - 66 %. The quick undrained triaxial test gave c = 0 and ϕ = 3° - 6°, the fall cone test gave c = 0.29 kg/cm^2. The lower layer had a bulk density 1.65 - 1.83 t/m^3 moisture content 40 - 68 %, quick undrained triaxial test gave c = 0 and ϕ = 4° - 9°, fallcone test gave c = 0.37 kg/cm^2.

The sea-bed slopes down to the north east. The sand layer which covers the site increases in depth to the north and more markedly to the east. The underlying gravelly sandy clayey layer is irregular, though it is thicker towards the eastern part of the site. There is a high point at Bh. 15.

The bottoms of the boreholes are at a hard stop on rock or boulders in most cases, as indicated in the borehole sections but it should be noted that some borings were interrupted before hard stop was reached.

2.7 CONCLUSIONS

The layers of sand and underlying harder materials vary in thickness from one part to another within the investigated area.

Except where the top sand layer is underlain by a weaker layer the permissible work load for foundations of at least 1 m^2 area resting on firm sand is 20 t/m^2 where the foundation is buried over 2 m in the sand. Settlement during the period of construction should be allowed for.

The bearing capacity of the lower strata varies considerably due to changes in the degree of compaction at various locations and to differences in the gravel and block content. At the locations investigated it is expected that strata will be encountered which will provide bearing capacity for a working load of 50 t/m^2 at levels ranging from +2.0 to -7.5 m. In the case of foundations

placed on this layer it is recommended that the actual bearing capacity be determined by a Standard Penetration Test carried out in each case on the actual soil layer prior to construction of permanent work.

Where the depth of material overlying firm rock is limited or for larger concentrated loads it might be advantageous to place the foundations directly on the rock surface. Loads of up to 300 t/m^2 can be placed on the firm rock, the soundness of which in such cases should be proved by drilling to a depth of not less than 3 m.

Where the thickness of the soil layers is sufficient, structures may be founded on piles, which could be either bored or driven.

Precast piles should be driven to a set as calculated using an approved pile formula.

Test loading should be carried out on a number of piles selected from those intended to form part of the permanent structure.

In order to provide more detailed information for the preparation of contract documents it is recommended that further investigations be carried out at the locations proposed for harbour structures.

2.8 BOREHOLE SCHEDULE

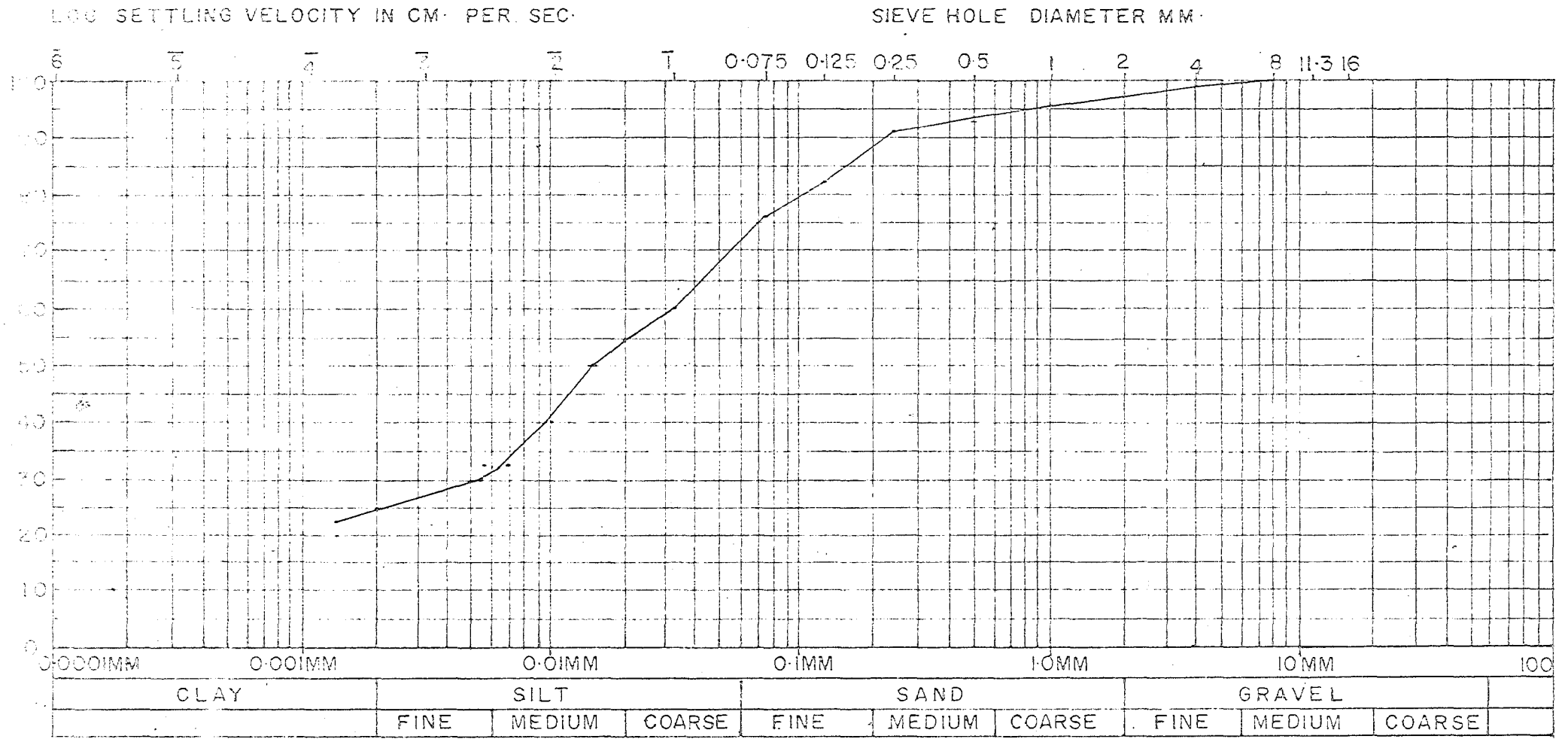
Site Descript.	Borehole Number	Easting	Northing	Level	Depth	Remarks
B1	4	2050	2175	+3.42	7.58	H/S S
C1	18	2298	2238	+6.42	12.60	M/S
C2	19	2264	2315	+3.25	6.49	H/S
C-1	17	2332	2159	+6.58	10.38	H/S
B2	5	2088	2281	+1.25	3.65	H/S
B3	6	2016	2370	-2.08	1.86	H/S
B4	8	2010	2566	-2.84	2.72	H/S
B5	9	2005	2641	-4.09	3.83	H/S
B6	10	1997	2782	-4.54	3.11	M/S
C3	21	2289	2488	+2.49	11.23	H/S
D5	26	2436	2659	+1.43	9.20	H/S
C6	24	2289	3077	-1.71	8.01	H/S
B-C1	12	2156	2400	+0.41	4.25	H/S
A1	1	1876	2444	-2.72	0.32	H/S
A2	2	1894	2592	-5.17	0.37	H/S
C5	23	2289	2872	-0.83	8.34	H/S
B-C4	16	2148	2843	-3.71	5.65	H/S
B7	11	1985	2959	-5.41	5.48	H/S
A3	3	1897	2766	-5.53	3.54	H/S
C4	22	2285	2681	-0.82	8.28	H/S
B-C3	15	2150	2625	-1.57	3.76	H/S
BC2	13	2131	2479	-0.54	7.60	H/S
BC $2^1/2$	14	2104	2588	-1.95	5.86	H/S
D3	20	2332	2418	+2.82	14.60	H/S S
D $3^1/2$	7	2028	2446	-2.10	4.17	H/S
D4	25	2414	2538	+3.37	12.58	H/S
D6	27	2508	2798	+3.87	11.61	M/S S

2.9 SOIL SAMPLE SCHEDULE

Depth below G.L. (M)	Sample Description	M/C %	Density D = Dry B = Bulk t/m^3	LL %	PL %	PI %	C kg/cm^3	Øº	Remarks Tested by
1	2	3	4	5	6	7	8	9	10
Borehole 4									
1.71 - 2.34	Dark grey silty CLAY highly plastic, some organic content	49 to 53	B 1.77 to 1.81	70	37	33	0.4	15º	Quick undrained triaxial Particle size distribution. SCANDIACONSULT
2.79 - 3.34	Grey sandy CLAY highly plastic	41 to 49	B 1.83	73	32	41			Particle size distribution. SCANDIACONSULT
3.66 - 4.34	Grey sandy SILT highly plastic	39 to 50	B 1.79 to 1.87	55	35	20			Particle size distribution. Quick undrained triaxial test dit not give useful result. SCANDIACONSULT
Borehole 20									
2.60 - 2.94	Grayish yellow SAND some gravel and shells	17 to 23	B 1.79 to 1.94				0	31º	Drained shear box test. SCANDIACONSULT
3.52 - 3.89	Grey SAND and GRAVEL with brown CLAY some fibrous organic material and shells	14 to 29	B 1.93	24	18				Particle size distribution. SCANDIACONSULT

1	2	3	4	5	6	7	8	9	10
Borehole 20									
4.61 - 5.24	Mixture of brown CLAY fine SAND and GRAVEL, some fibrous organic material	20 to 26	B 2.27 to 2.28	34	18	16			P.S.D. SCANDIACONSULT
Borehole 27									
1.52 - 1.94	Yellow-grey fine to medium SAND some shells and organic material	28 to 35	B 1.85 to 1.89				0	32°	Particle size distribution. Drained shear box test. SCANDIACONSULT
5.43 - 5.94	Yellow-grey SAND some shells	26 to 34	B 1.82 to 1.93				0	31°	- ditto -
6.43 - 6.94	Black organic SILT and black organic CLAY, bands of non-plastic silt	28 to 66	B 1.83 to 2.05				0	3° to 6°	Quick undrained triaxial test
							0.29	0°	Fallcone test, P.S.D. SCANDIACONSULT
7.86 - 8.54	Dark grey silty fine SAND, some organic material	31 to 43	B 1.95 to 1.96				0.05	24°	Drained shear box test P.S.D. SCANDIACONSULT
8.86 - 9.54	Black organic silty CLAY with bands of silt, some fibrous organic material	40 to 68	B 1.65 to 1.83				0	4° to 9°	Quick undrained triaxial test
							0.37	0°	Fallcone test SCANDIACONSULT

2·10 PARTICLE SIZE DISTRIBUTION ANALYSIS



SIEVE SIZE M.M		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED					2·1	3·1	3·1	6·1	4·1	18·5	12·0	156·0	205·0
% RETAINED					1·0	1·5	1·5	3·0	2·0	9·0	6·0	76·0	100,0
% PASSING				100,0	99·0	97·5	96·0	93·0	91·0	82·0	76·0		

SAMPLE DESCRIPTION ....dark..grey...silty....CLAY....

SITE ..RATNAGIRI.....

BORE HOLE ...4..... DEPTH UNDER G.L. 2·0 M

WASHING :-

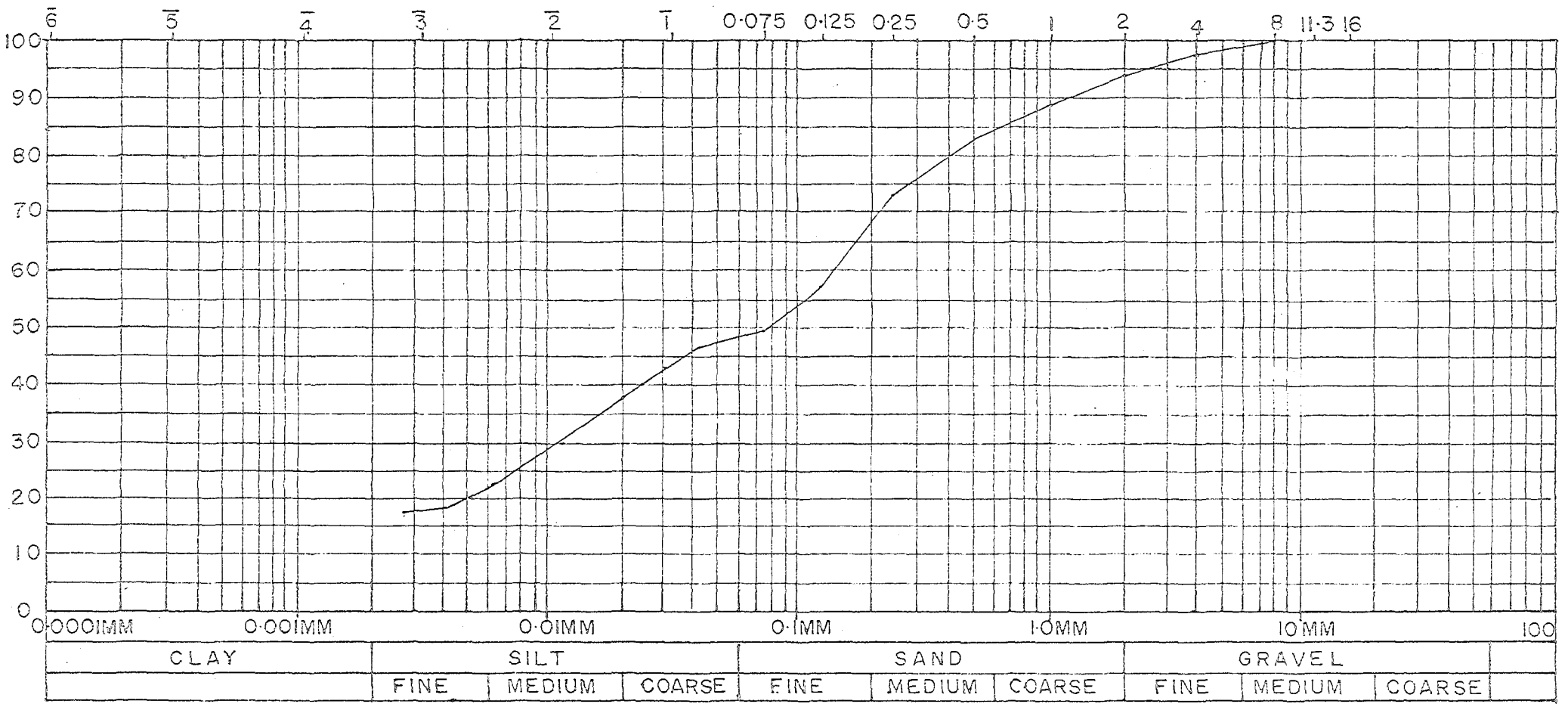
WEIGHT BEFORE ..... 205 ..... g

WEIGHT AFTER ..... 95 ..... g

WASHED AWAY ..... 110 ..... g

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY .... ScandiaConsult International AB .. Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



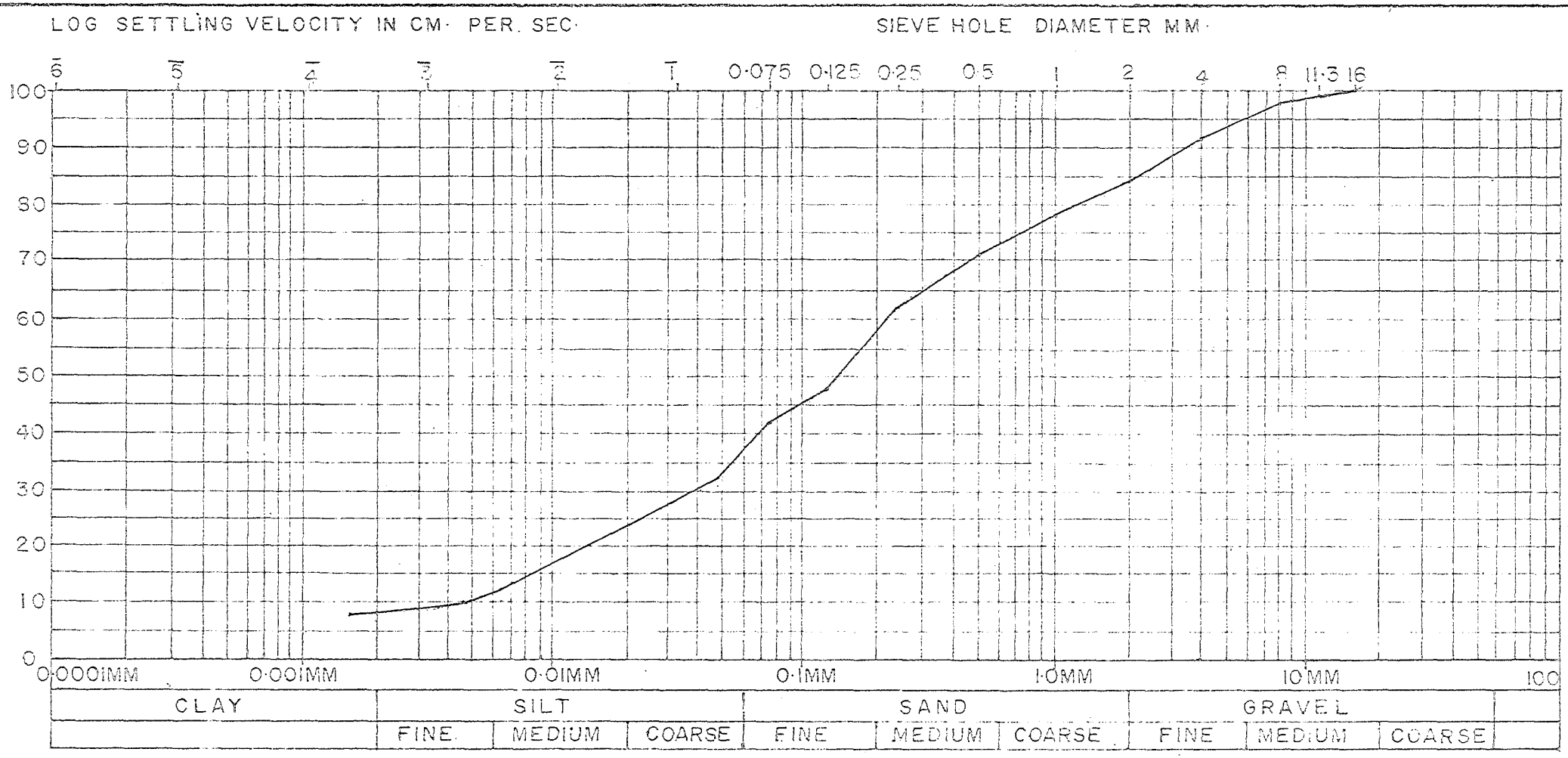
SIEVE SIZE M.M		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED					11	17	22	29	42	71	34	222	448
% RETAINED					2·5	3·8	4·9	6·5	9·4	15·8	7·6	49·5	100
% PASSING				100	97·5	93·7	88·8	82·3	72·9	57·1	49·5		

WASHING :
WEIGHT BEFORE ..... 448 ..... g
WEIGHT AFTER ..... 239 ..... g
WASHED AWAY ..... 209 ..... g

SAMPLE DESCRIPTION ... grey ... sandy CLAY .....
.....
SITE ... RATNAGIRI .....
BORE HOLE ... 4 ..... DEPTH UNDER G.L. 3·0M ..

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY ... ScandiaConsult International AB .. Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



SIEVE SIZE M.M.		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED			4	6	27	32	27	31	40	60	25	181	433
% RETAINED			0·9	1·4	6·2	7·4	6·2	7·2	9·2	14·0	5·8	41·7	100
≦ % PASSING		100	99·1	97·7	91·5	84·1	77·9	70·7	61·5	47·5	41·7		

SAMPLE DESCRIPTION grey sandy SILT

SITE ... R.A.T.N.A.G.I.R.I.

BORE HOLE ... 4 ... DEPTH UNDER G.L. 4·0 M.

WASHING :

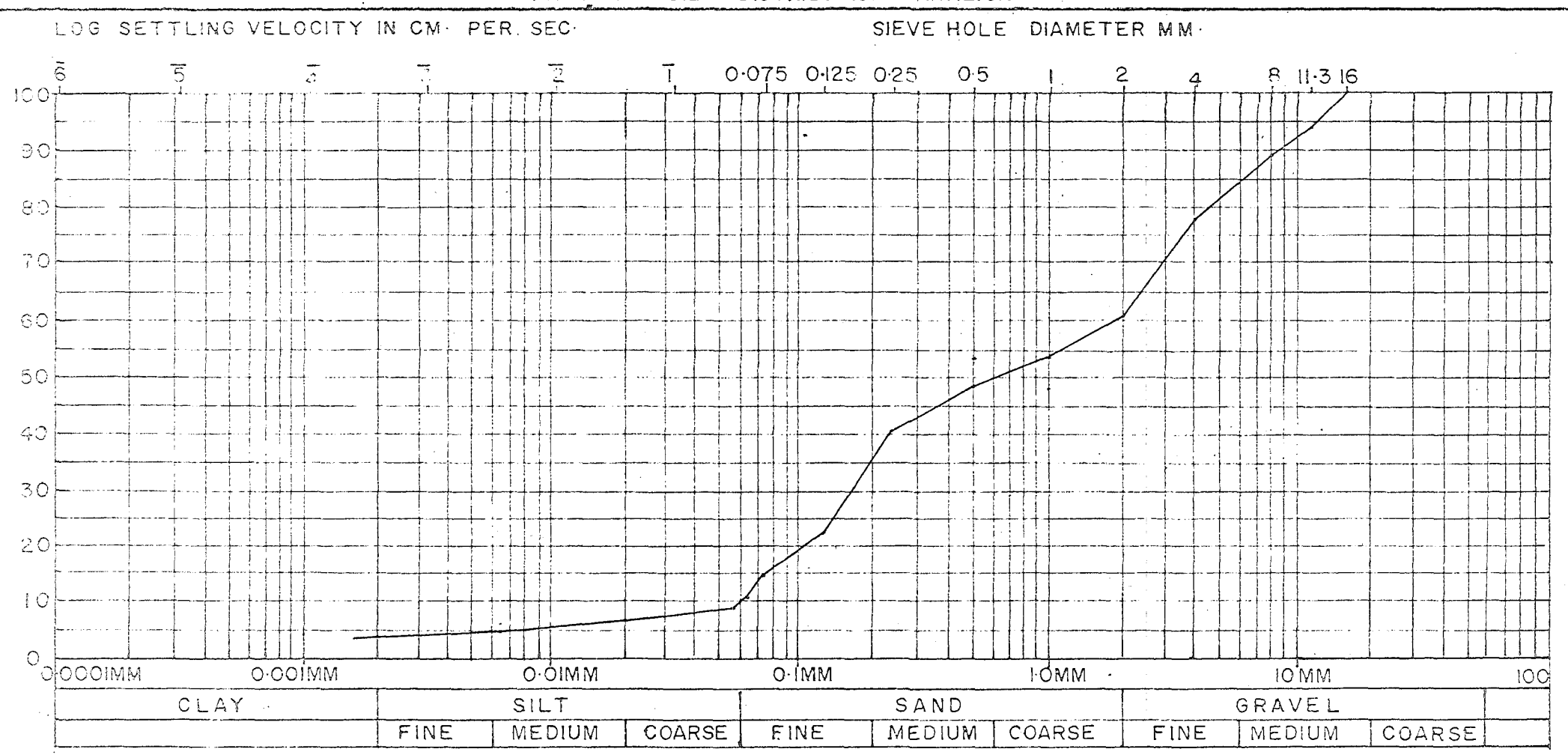
WEIGHT BEFORE ..... 433 ..... g

WEIGHT AFTER ..... 260 ..... g

WASHED AWAY ..... 173 ..... g

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY ..... ScandiaConsult International AB Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



SIEVE SIZE M.M		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED			21	16	40	56	25	17	27	60	26	50	338
% RETAINED			6·2	4·7	11·8	16·7	7·4	5·0	8·0	17·8	7·7	14·8	100
% PASSING		100	93·8	89·1	77·3	60·7	53·3	48·3	40·3	22·5	14·8		

SAMPLE DESCRIPTION SAND and GRAVEL with clay... some fibrous organic material and shells.....

SITE ...RATNAGIRI.....

BORE HOLE ...20..... DEPTH UNDER G.L 3·60 M

WASHING :

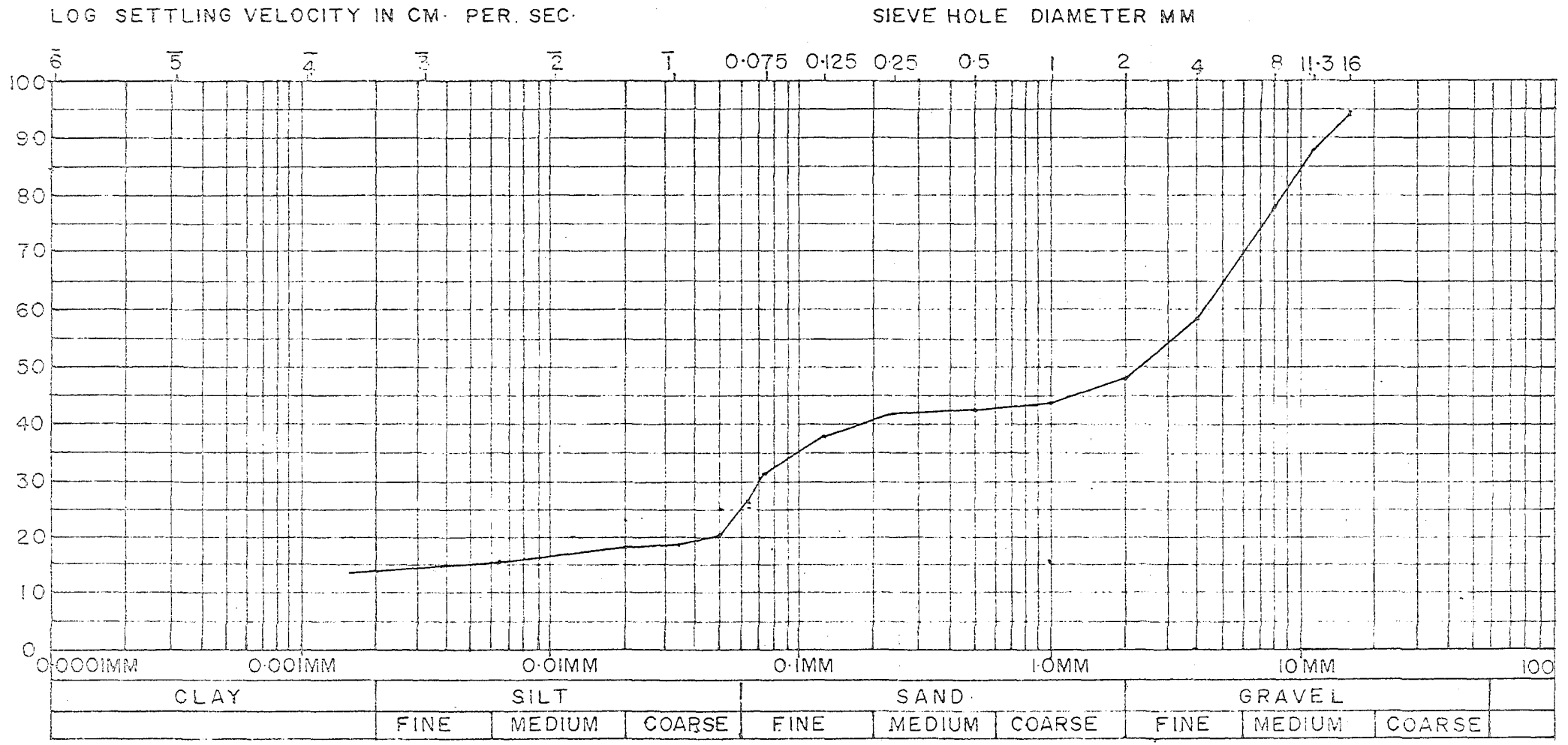
WEIGHT BEFORE ..... 338 ..... g

WEIGHT AFTER ..... 290 ..... g

WASHED AWAY ..... 48 ..... g

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY.... ScandiaConsult International AB Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



SIEVE SIZE M.M		19	16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED		35	7	42	71	133	70	30	10	3	28	45	213	687
%	RETAINED	5·1	1·0	6·1	10·3	19·3	10·2	4·4	1·5	0·4	4·1	6·5	31·1	100
%	PASSING	94·9	93·9	87·8	77·5	58·2	48·0	43·6	42·1	41·7	37·6	31·1		

WASHING :

WEIGHT BEFORE ..... 687 ..... g

WEIGHT AFTER ..... 485 ..... g

WASHED AWAY ..... 202 ..... g

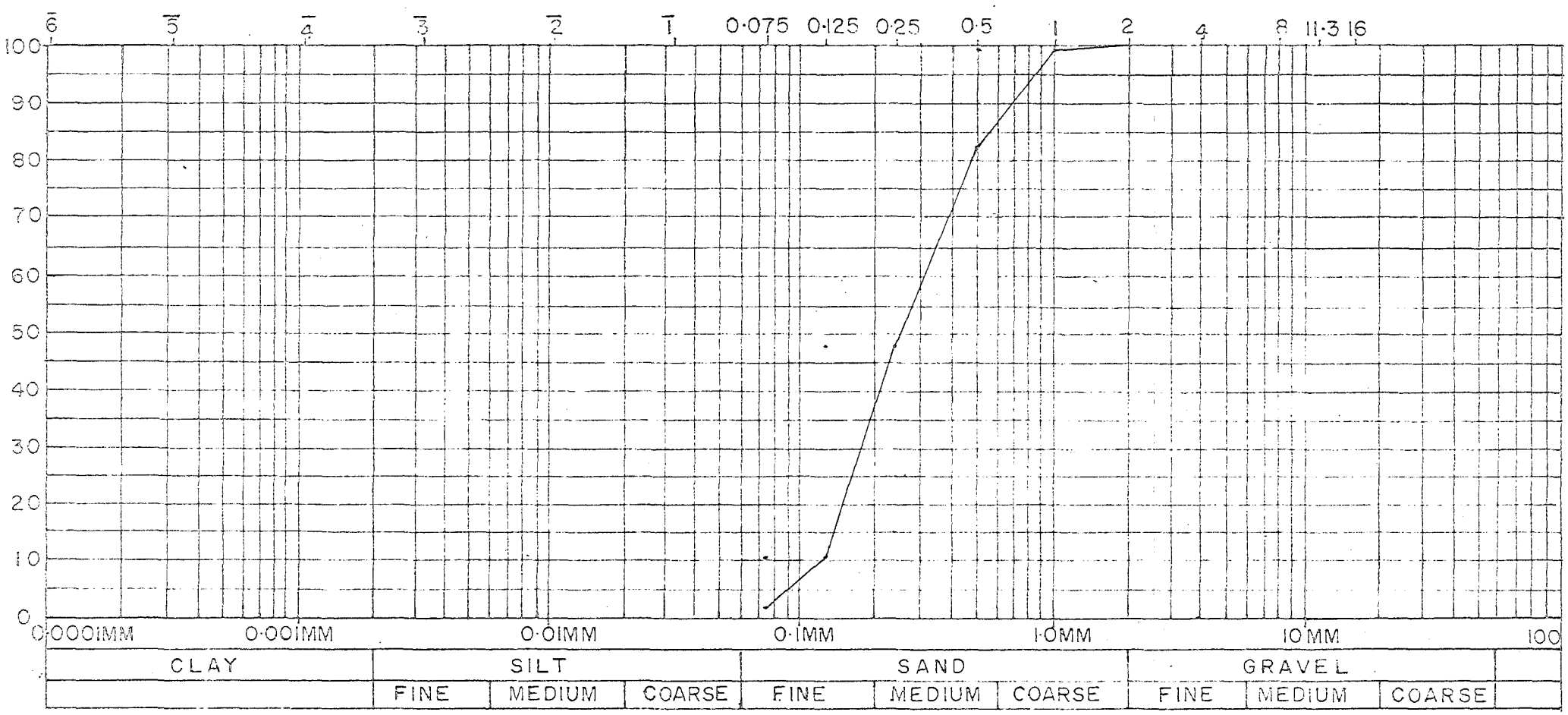
SAMPLE DESCRIPTION ..CLAY, fine SAND and ..... GRAVEL .....

SITE ..RATNAGIRI .....

BORE HOLE ..20 ..... DEPTH UNDER G.L ..4·90 M

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY ..... ScandiaConsult International AB Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



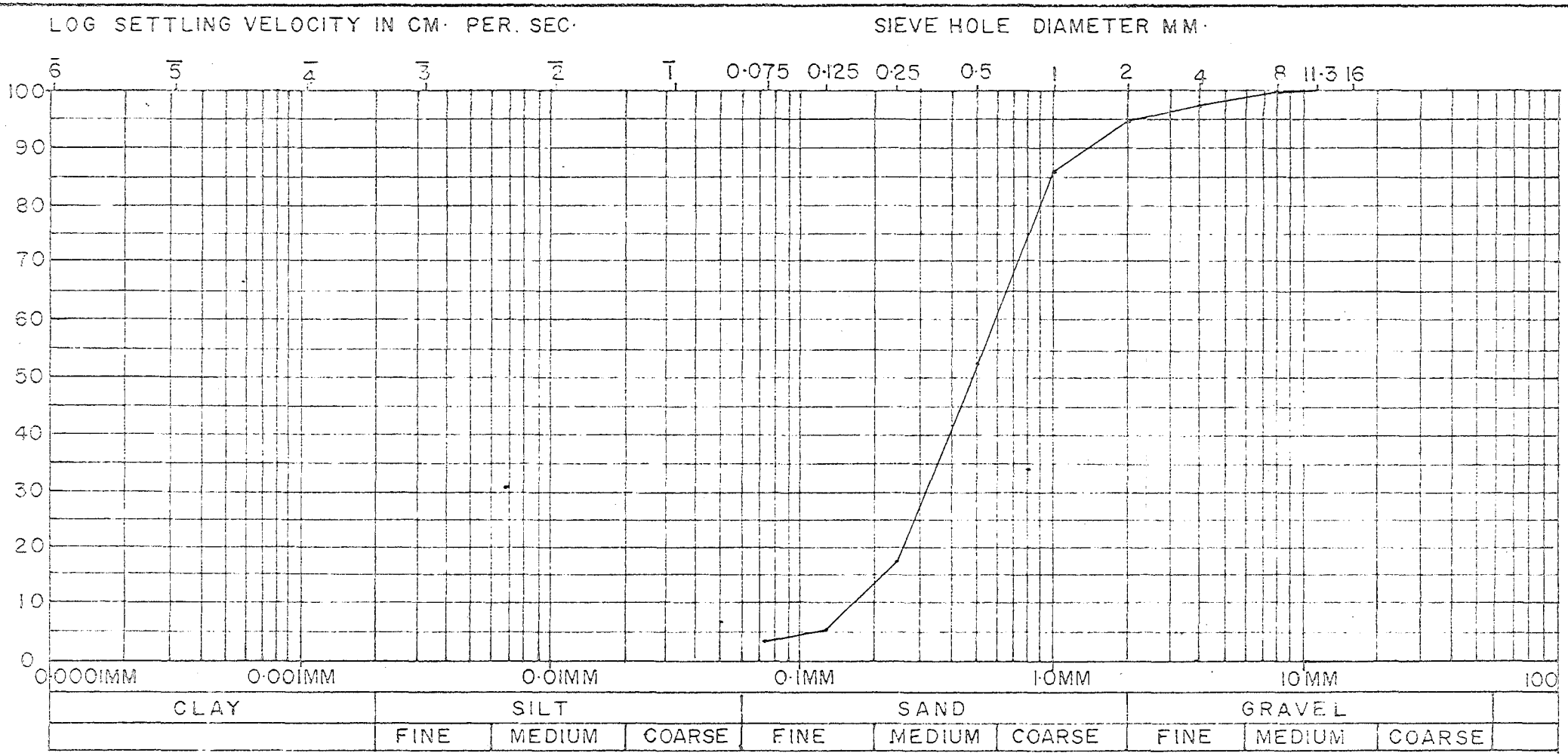
SIEVE SIZE M.M		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED							1·7	33·7	69·3	75·6	17·3	3·4	201·0
% RETAINED							0·8	16·8	34·5	37·6	8·6	1·7	100
% PASSING						100·0	99·2	82·4	47·9	10·3	1·7		

WASHING :
WEIGHT BEFORE ..... 201 ..... g
WEIGHT AFTER ..... 198 ..... g
WASHED AWAY ..... 3 ..... g

SAMPLE DESCRIPTION ..fine..medium..SAND.....
..sume..shells..and..organic..fragments.....
SITE ..RATNAGIRI.....
BORE HOLE ..27.....DEPTH UNDER G.L. 1·68 M.

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY.... ScandiaConsult International AB Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



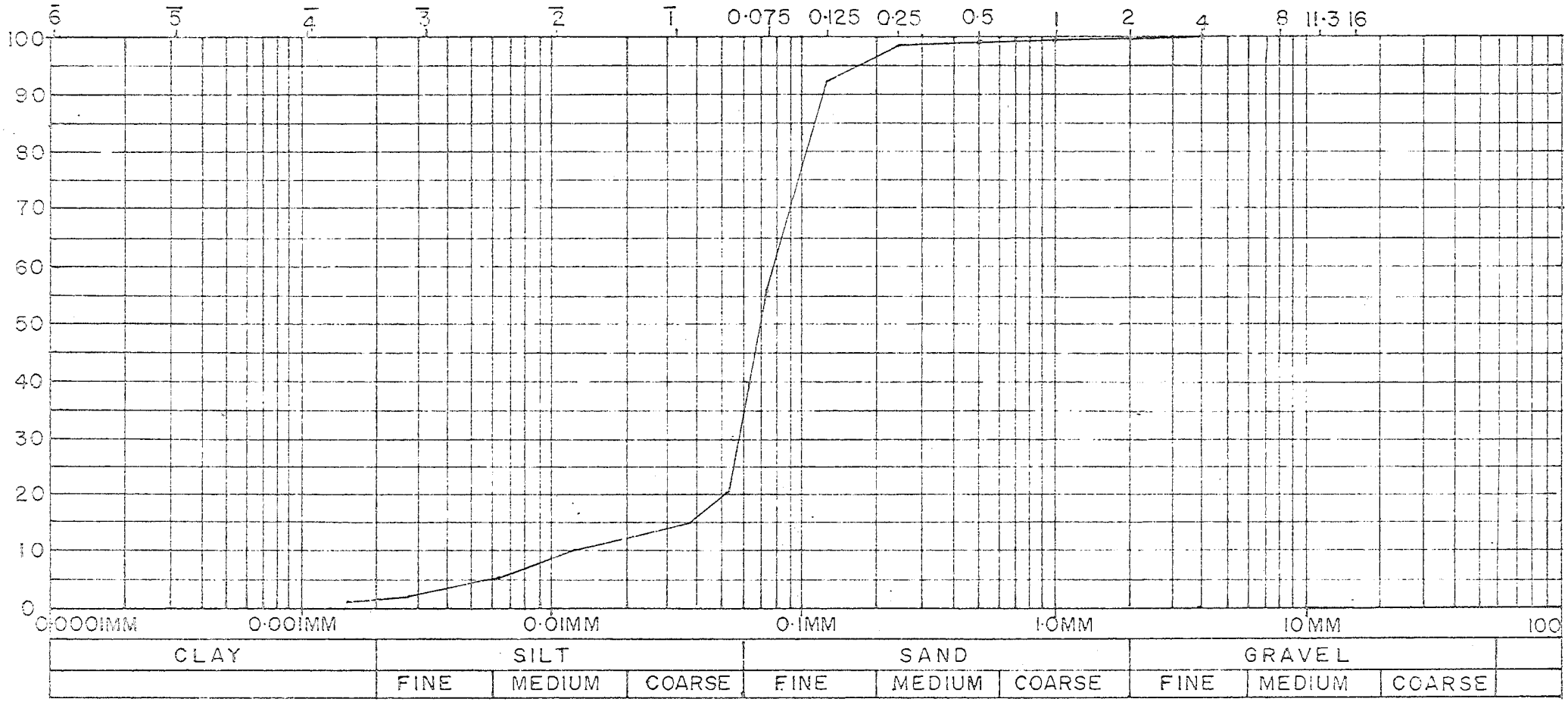
SIEVE SIZE M.M		16	11·3	8	4	2	1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED				0·2	4·9	3·8	16·0	58·9	61·0	21·8	3·8	5·6	176·0
% RETAINED				0·1	2·8	2·2	9·0	33·5	34·7	12·4	2·1	3·2	100·0
≷ % PASSING			100·0	99·9	97·1	94·9	85·9	52·4	17·7	5·3	3·2		

WASHING :
WEIGHT BEFORE ..... 176 ..... g
WEIGHT AFTER ..... 171 ..... g
WASHED AWAY ..... 5 ..... g

SAMPLE DESCRIPTION ... yellow-grey ... SAND, ... some shells .....
SITE .. RATNAGIRI .....
BORE HOLE . 27 ..... DEPTH UNDER G.L. 5·68 M.

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY .... ScandiaConsult International AB Sweden

PARTICLE SIZE DISTRIBUTION ANALYSIS



SIEVE SIZE M.M		16	11·3	8	4	2	.1	0·5	0·25	0·125	0·075	<0·075	
GRAMS RETAINED						0·6	1·0	0·7	1·0	10·0	63·4	97·3	1740
% RETAINED						0·3	0·6	0·4	0·6	5·8	36·5	55·8	100
% PASSING					100	99·7	99·1	98·7	98·1	92·3	55·8		

WASHING :
WEIGHT BEFORE 174 g
WEIGHT AFTER 80 g
WASHED AWAY 94 g

SAMPLE DESCRIPTION dark grey silty fine SAND

SITE RATNAGIRI

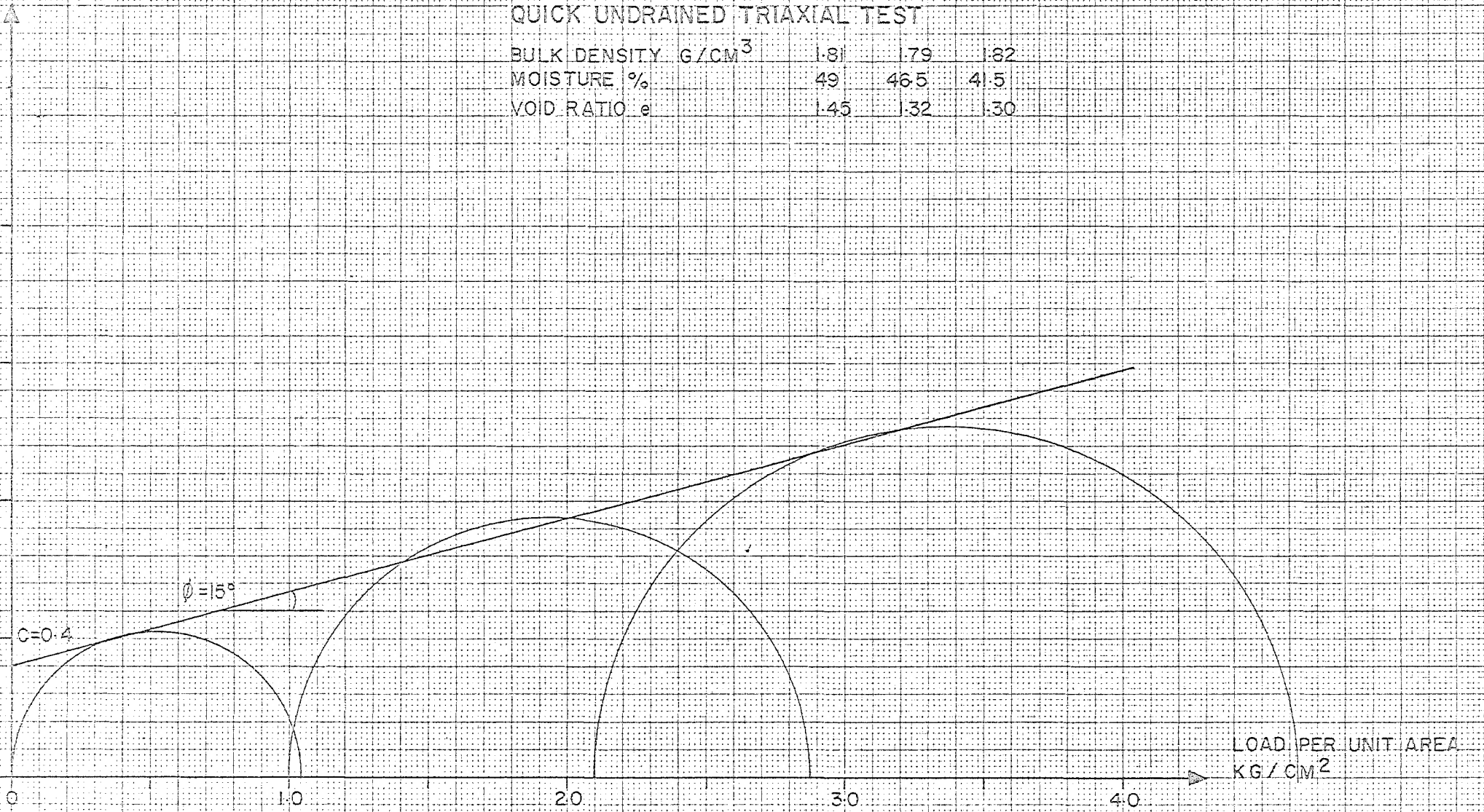
BORE HOLE 27 DEPTH UNDER G.L. 8·12M.

PARTICLE SIZE DISTRIBUTION ANALYSIS CARRIED OUT BY ... ScandiaConsult International AB Sweden

2·11 SHEAR TEST DIAGRAM

RATNAGIRI
BH4 CYL 5677, 5672, 5685
DEPTH 1·71 - 2·34M AND 2·79 - 3·34M
QUICK UNDRAINED TRIAXIAL TEST

BULK DENSITY G/CM^3	1·81	1·79	1·82
MOISTURE %	49	46·5	41·5
VOID RATIO e	1·45	1·32	1·30

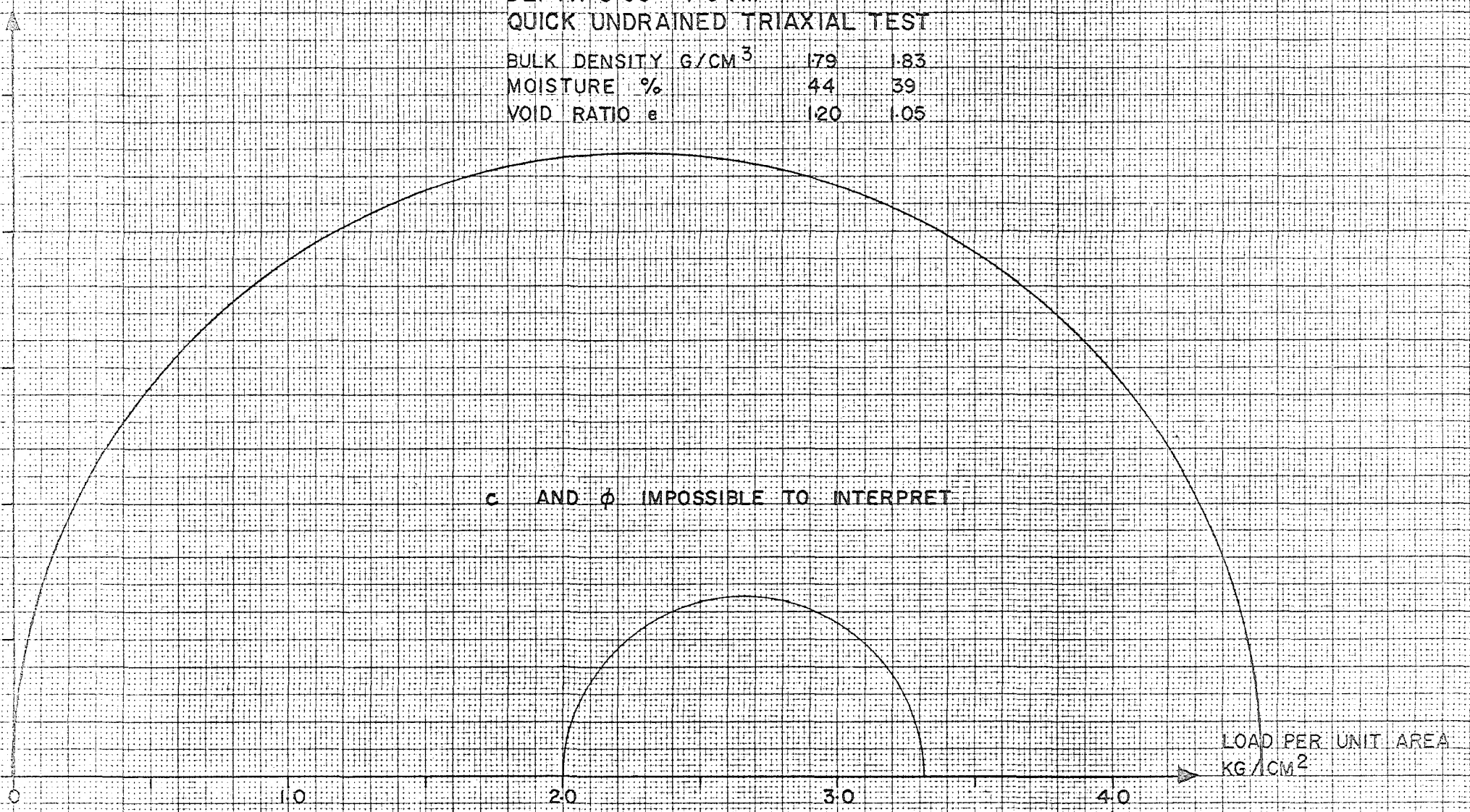


Tested by Scandia Consult International AB Sweden

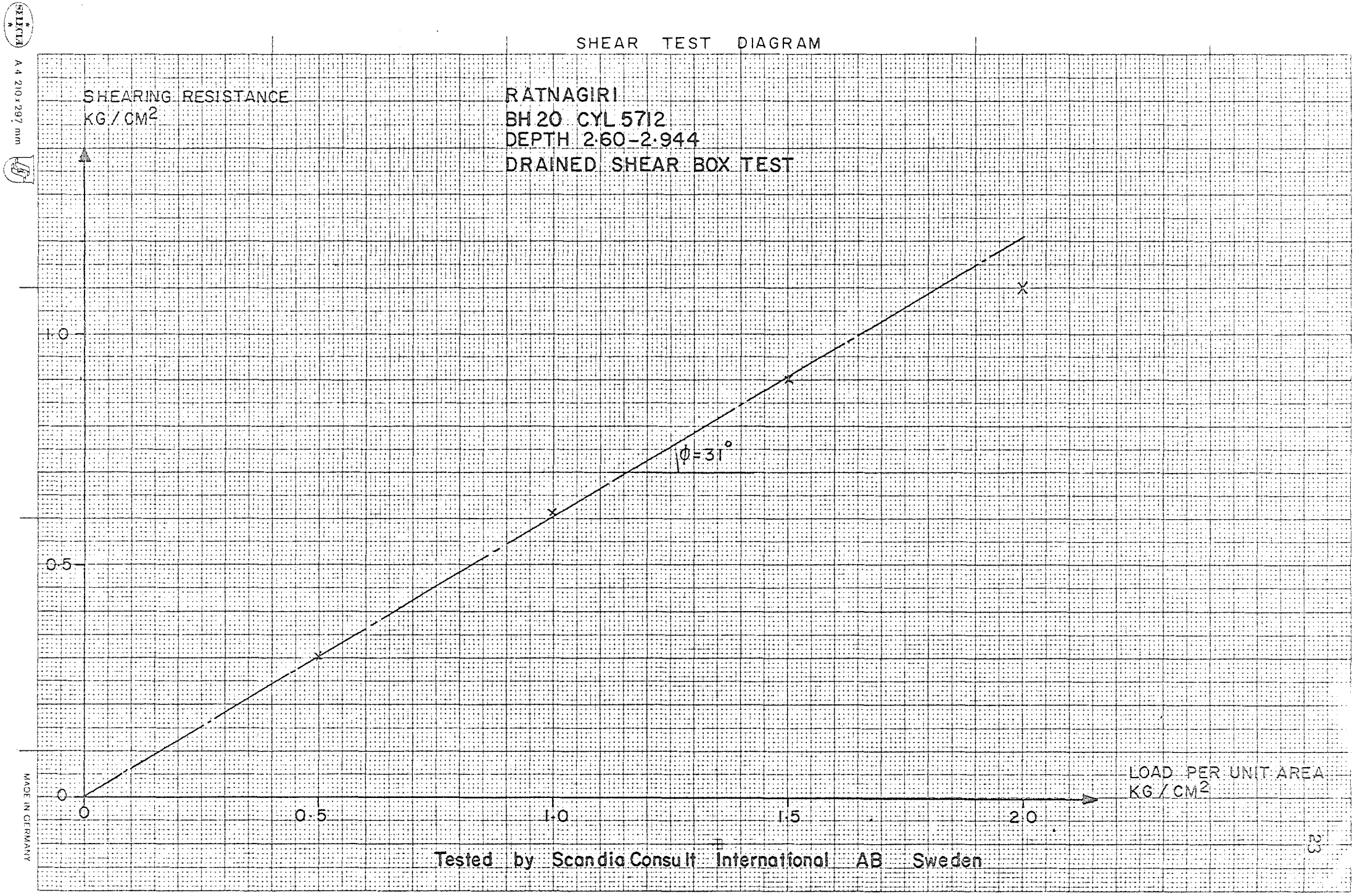
SHEAR TEST DIAGRAM

RATNAGIRI
BH 4 CYL 5667, 5668
DEPTH 3·66 – 4·34 M
QUICK UNDRAINED TRIAXIAL TEST

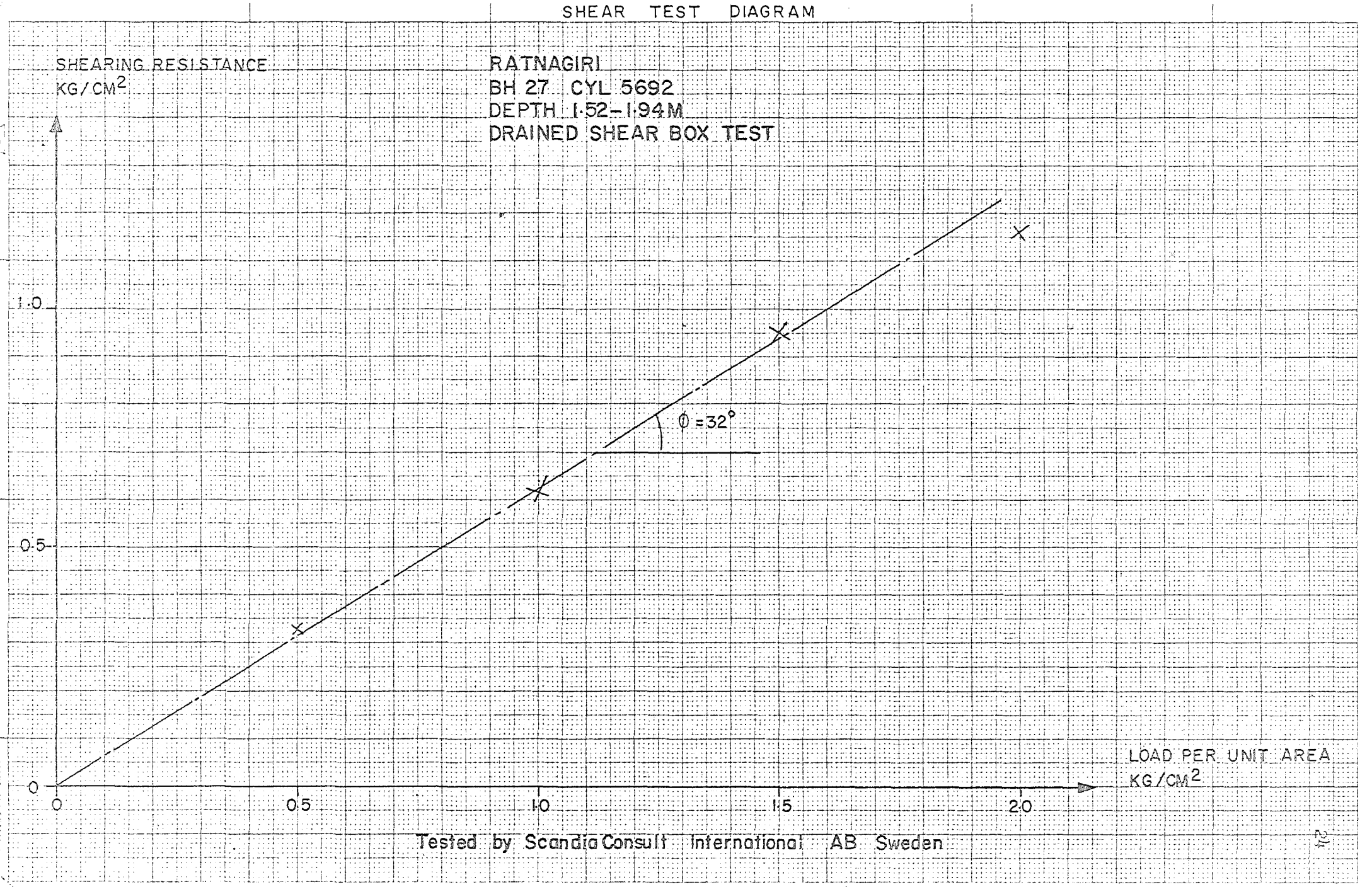
BULK DENSITY G/CM^3	1·79	1·83
MOISTURE %	44	39
VOID RATIO e	1·20	1·05



Tested by ScandiaConsult International AB Sweden

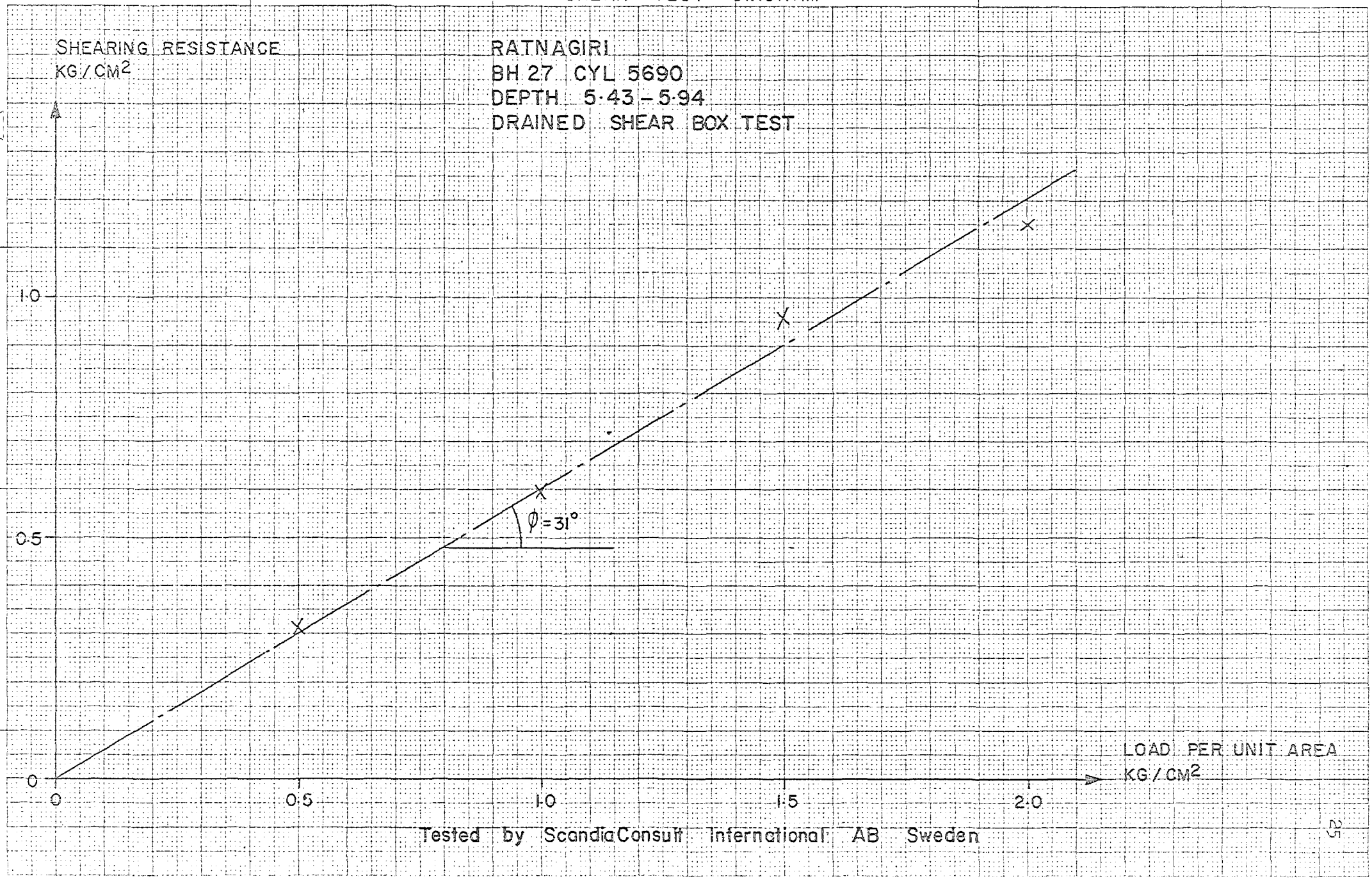

SHEAR TEST DIAGRAM
SHEARING RESISTANCE
KG / CM2
RATNAGIRI
BH 20 CYL 5712
DEPTH 2·60-2·944
DRAINED SHEAR BOX TEST
1·0
0·5
0
φ=31°
0
0·5
1·0
1·5
2·0
LOAD PER UNIT AREA
KG / CM2
Tested by Scandia Consult International AB Sweden
23
A 4 210 x 297 mm
MADE IN GERMANY

SHEAR TEST DIAGRAM



Tested by Scandia Consult International AB Sweden

SHEAR TEST DIAGRAM

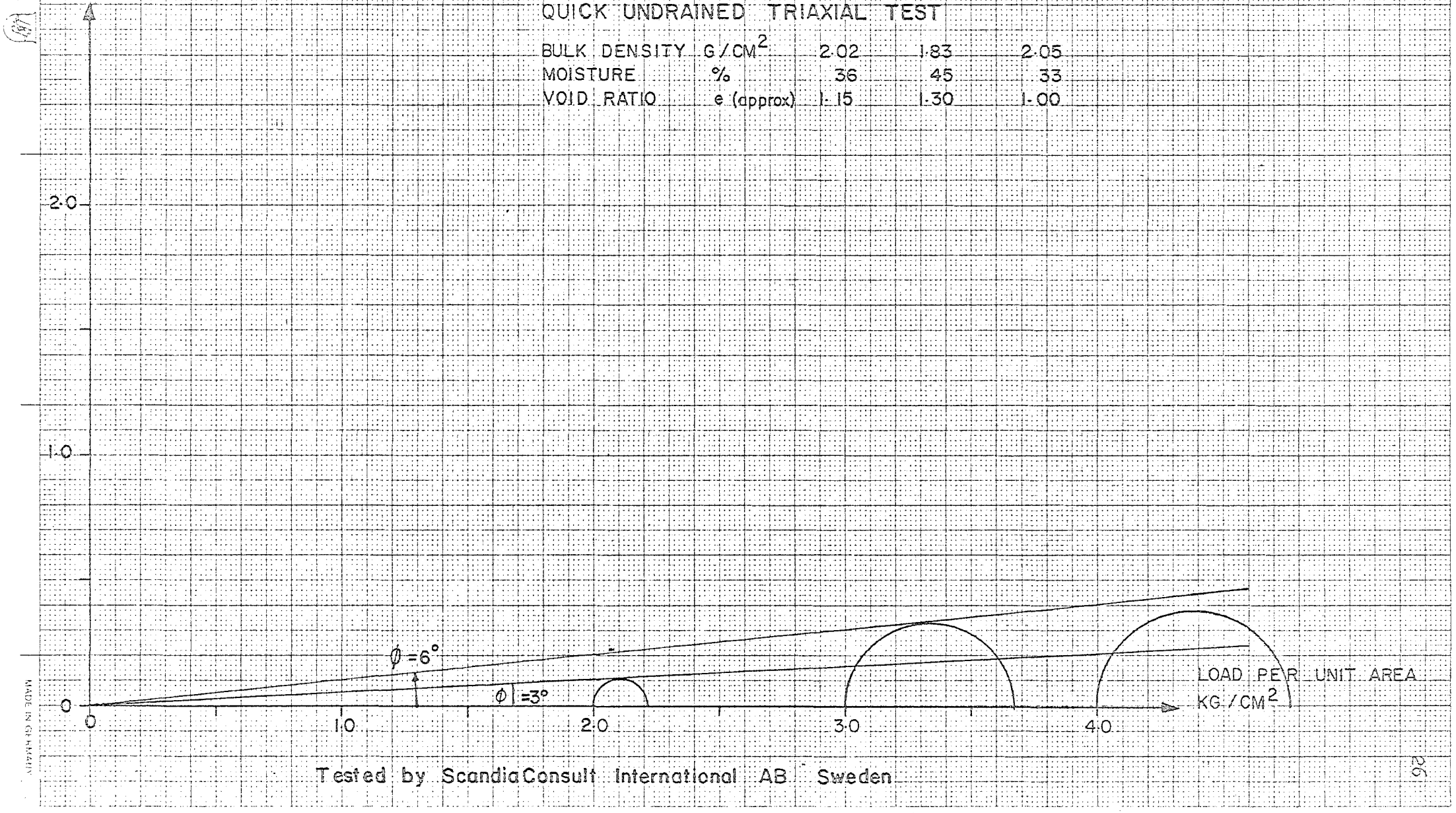


Tested by ScandiaConsult International AB Sweden

SHEAR TEST DIAGRAM

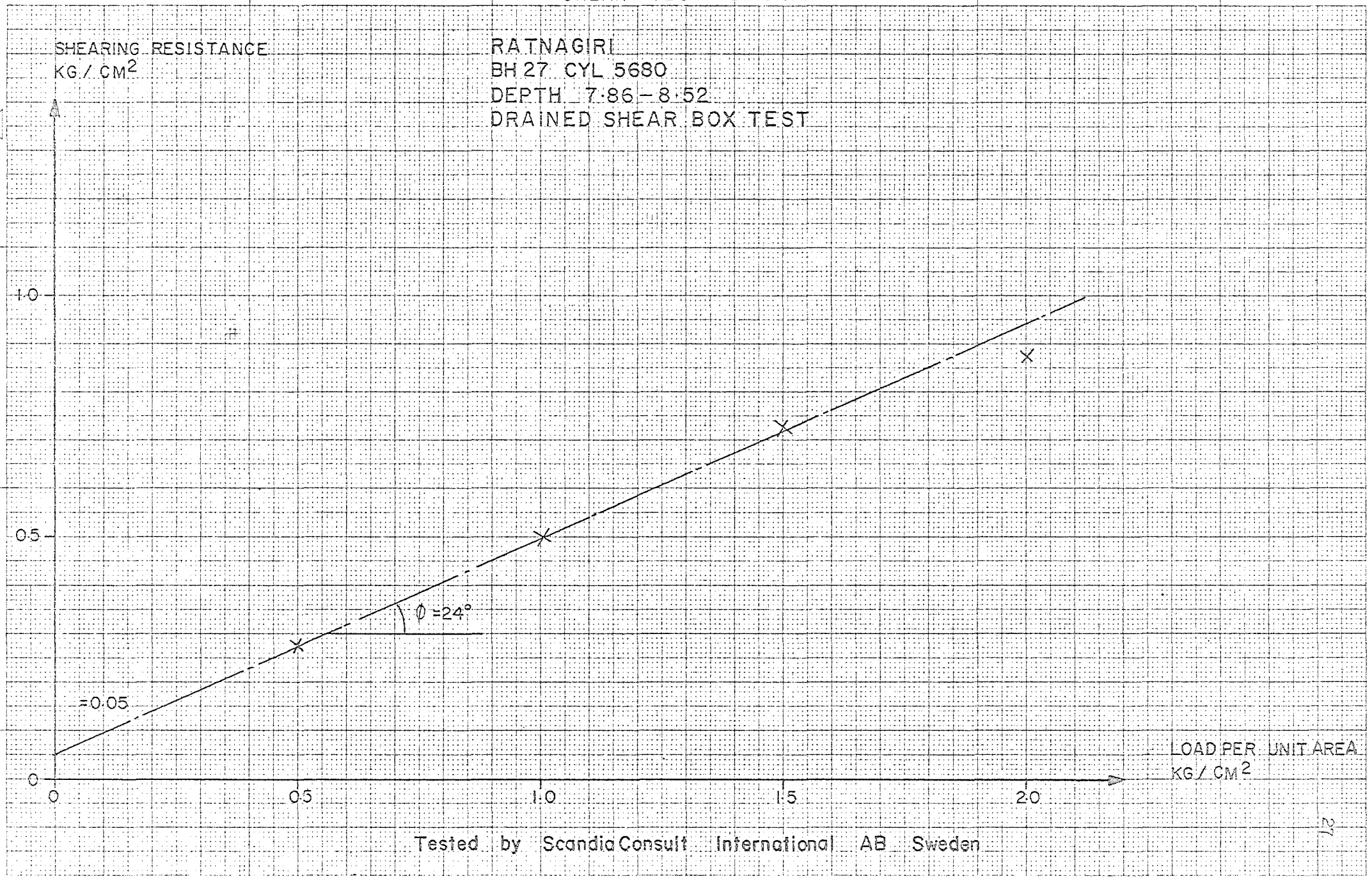
RATNAGIRI
BH 27 CYL 5691, 5704, 5694
DEPTH 6·43 – 6·94 M
QUICK UNDRAINED TRIAXIAL TEST

BULK DENSITY	G/CM^2	2·02	1·83	2·05
MOISTURE	%	36	45	33
VOID RATIO	e (approx)	1·15	1·30	1·00



Tested by Scandia Consult International AB Sweden

SHEAR TEST DIAGRAM



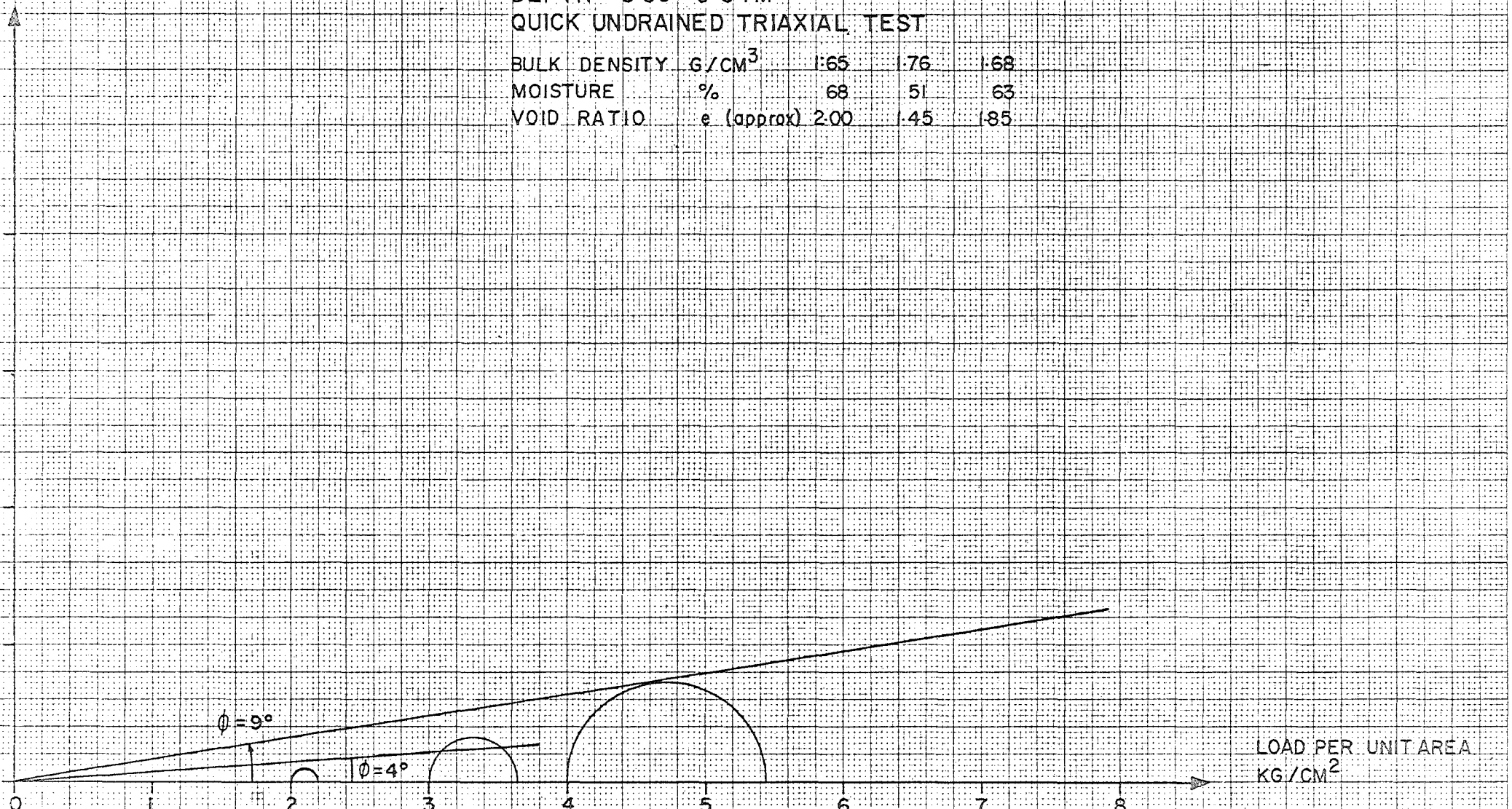
Tested by Scandia Consult International AB Sweden

12

SHEAR TEST DIAGRAM

RATNAGIRI
BH 27CYL 5689, 5688, 5683
DEPTH 8·86 – 9·54M
QUICK UNDRAINED TRIAXIAL TEST

BULK DENSITY	G/CM^3	1·65	1·76	1·68
MOISTURE	%	68	51	63
VOID RATIO	e (approx)	2·00	1·45	1·85



Tested by Scandia Consult International AB Sweden

Detailed Plan Symbol

81
+4.10 20.09.69
+3.15 22.09.69

A
+6.86

Cl +5.20
Sa +3.60
Si +3.10
Sa +1.60
Cl -2.10
Gr -4.45

Simple Plan Symbol

81

A Indicates Chemical or Special analysis carried out

SOUNDING

- Sticksounding
- Weightsounding, Press-sounding Motorsounding
- Hammersounding

SAMPLING

- Disturbed Sample
- Undisturbed Sample

IN-SITU TESTS

- Vane Test
- Sounding to hard stop
- Sounding to presumed Rock
- Rock boring at least 3 m. under presumed Rock surface
- - Ditto - with examination of the dust
- Rock coring at least 3 m.

HYDROLOGICAL MEASURMENTS

- Ground Water Level measured
- Ground Water Level recorded over long period
- - Ditto - short period
- Pump or Infiltration Test
- Pore Pressure Measurement
- Deformation Measurement
- Trial Pit or other test point e.g. Test Loading

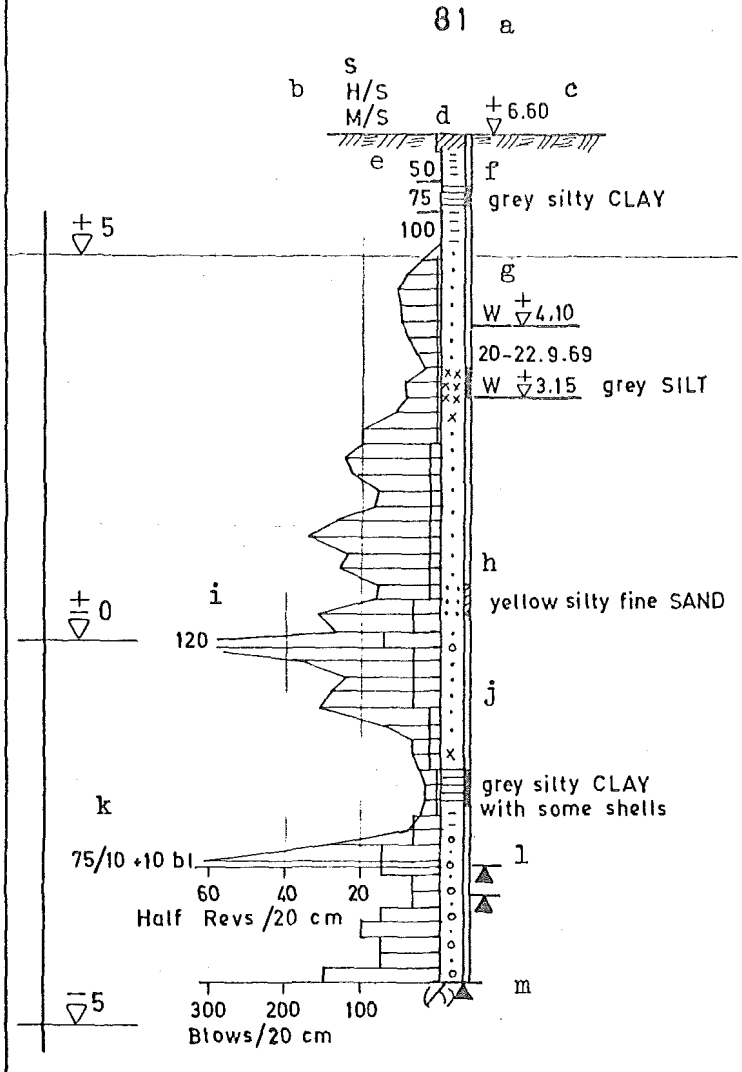
SECTIONS

- Filling
- Topsoil
- Peat
- Shells
- Clay (Cl)
- Silt (Si)
- Sand (Sa)
- Gravel (Gr)

BOREHOLE STOPS

Section	Plan	
		Probably Rock
		Probably Stone or Rock
		Stone, Block or Rock
		Non-Rock, Stone or Block stop
		Boring discontinued, can be driven deeper without hammering
		- Ditto - but only with hammering
		Rock Drilling

SOIL MECHANICS SYMBOLS SHEET No. 1



a Borehole number 81

b S Sampling carried out
H/S Hammersounding carried out
M/S Motorsounding carried out

c Ground level in metres above or below Datum

d Hole made in ground with auger or crow-bar. 20 cm deep

e 50, 75, 100, pressures in Kg. applied for Motorsounding. The rods were not turned.

f Fully shaded area indicates undisturbed sampling. The adjectives describing the sample are in small letters. Nouns are in capital letters. Borehole legend across the whole section indicates that the material has been sampled and seen. Legend in the centre of the section only indicates the material present, in the opinion of the engineer.

g W +4.10 Highest water level measured over the period shown.
20-22.9.69
W +3.15 Lowest water level measured over same period.

h Position of disturbed sample shown cross-hatched.

i 120 Motorsounding, half revs./20 cm., redorded in numbers when the figure is very high.

j Hammersounding, number of hammer-blows/20 cm.

k 75/10+10 bl 75 half turns. Motorsounding penetrated only 10 cm. 10 blows of a sledge hammer were applied.

l Previous boring attempt discontinued at a hard stop.

m Boring stopped on Stone, Block or Rock.

Hammersounding results are represented as follows:

Free sinking is drawn	as 0 blows/20 cm.
1 - 10 blows	as 5 blows/20 cm.
11- 20 blows	as 15 blows/20 cm.
21- 50 blows	as 35 blows/20 cm.
51-100 blows	as 75 blows/20 cm.

2.13 DRAWINGS

Drawing No.	Title
05-200	Borehole Plan
05-210	Section of Boreholes Nos. 1, 2, 3
05-211	" " " " 4, 5, 6, 7, 8, 9, 10, 11
05-212	" " " " 12, 13, 14, 15, 16
05-213	" " " " 17, 18, 19, 20, 21
05-214	" " " " 22, 23, 24
05-215	" " " " 20, 25, 26, 27

DESIGN

CHAPTER 3

DESIGN OF THE HARBOUR

3.1 INTRODUCTION

Ratnagiri town is the District Headquarters of Ratnagiri District of Maharashtra State. It is situated on the west coast of India about 240 km. soth of Bombay and has a population of about 40,000.

Besides being the location of an established fishing industry Ratnagiri has a coastal trade of passenger and commercial traffic availing of ship to shore connections using ferry boats and lighters. Just northwest of Ratnagiri in Mirya Bay, works on a breakwater are at present in progress. The construction will, on completion of the final stage, provide all weather landing facilities catering for vessels requiring depths of up to 8 metres.

An R.C.C. jetty for passenger traffic, 143 m long and 2.66 m wide, was constructed during 1962/65. However, the jetty is mainly used by fishing boats as a landing place with restricted tidal access. The present proposal does not make use of this existing jetty which will be covered up by proposed reclamation works.

3.2 LOCATION OF THE HARBOUR

The site proposed for the location of the fishing harbour is situated in the south east part of Mirya Bay close to the existing fishermen's habitations. The advantages of this location from a technical point of view are:

a) The site is well protected against waves from southwest from which direction the highest waves come during the monsoon period. A breakwater is under construction for the commercial harbour and the first stage of that construction provides such shelter that the height of the waves coming from west will be reduced by about 60 % when reaching the site of the fishing harbour.

b) There is no river with outlet into the bay.

c) A comparison between soundings made in 1878 and 1955 indicates that there is limited sand movement in the bay (Drg. No. 05-42).

d) The depth in the bay is quite satisfactory and extensive and frequent maintenance dredging in the approach channel is not foreseen.

e) Soil investigations have indicated that firm bottom in the area of the proposed site is encountered at levels between +1.0 and -9.0 metres and that the formation would provide good support for foundation structures.

3.3 PLANNING AND DESIGN OF HARBOUR

3.3.1 Number and Size of Vessels

The harbour should be designed for the following number and size of boats according to forecast for 1981:

No. of boats	Landing length overall (m)	Draft (m)	No. of days for one trip	Average landing per boat in a peak-month	Time of arrival to the harbour
150	12	1.20	1	0.675	1600-2000
40	15	1.80	2	5.700	0800-2200

3.3.2 Layout

The layout of the proposed harbour as shown on Drg. No. P-05-51 has been designed to cater for the fleet of fishing vessels expected in 1981 as indicated above. The position and the shape of the harbour basin has been determined with regard to the location of firm bottom contours which were indicated during the Soil Mechanics investigation.

The proposal includes a harbour basin with a total area of about 50,000 m^2 protected on the west side by a rockfill breakwater (West Breakwater) and on the north side by a jetty with sheet piled face (North Breakwater). On the east and south side are quays behind which an area will be reclaimed thereby creating space for administrative buildings and fishery related industries. This area extends to the planned main road leading to the commercial harbour.

3.3.3 Depth of the Harbour

The following information about tide conditions has been obtained from the Hydrographic Chart No. 2028. The levels have been reduced to the datum indicated by the Port Authorities. This datum is 0.71 m below the Chart Datum as shown on the Hydrographic Chart.

MHHW +2.97

MLHW +2.84

MHLW +1.90

MLLW +1.23

For the design it has been assumed that the highest water occuring would reach +4.00 and the lowest water +0.60.

The maximum draft of vessels catered for in the design is 1.80 m. In order, however, to assist in providing fill material for the reclamation areas with the added advantage of catering for the draft of larger vessels the basin has been designed for a dredged level of -3.3 m giving a depth of 3.9 m at LLW. This depth will allow boats of up to about 27 m length to enter the harbour.

3.3.4 Wave Protection

A rockfill breakwater, the West Breakwater, has been proposed to provide shelter for the harbour basin, where landing and berthing will take place. It has been designed for the conditions existing when only the first stage of the Main Breakwater for the Commercial Harbour will have been constructed.

Refraction and diffraction studies of the wave conditions have been carried out and results are shown on Drgs. Nos. 05-45 to 05-50. The initial deep water wave-heights and corresponding periods used in the studies (Drgs. Nos. 05-43 and 05-44) are taken from the report by the Central Water and Power Research Station, Poona: "Hydraulic Model Studies for the development of an all-weather port at Mirya Bay - Ratnagiri, 1964".

It has been found that the West Breakwater should be designed for waves with a height of 3.0 metres and a period of 8 seconds. Within a long period, say for instance 10 years or more, extreme storm waves higher than the above may occur. It is, however, expected that if the final stage of the Main Breakwater of the commercial harbour be constructed in the next few years, the probability of extreme storm waves attacking the West Breakwater would then be comparatively small. The risk of damage to the proposed West Breakwater would therefore be apparent only during the interim period between the completion of the first and the final stages of the Main Breakwater for the Commercial Harbour. When the final stage of the Main Breakwater has been completed it will reduce the height of the extreme storm waves attacking the West Breakwater to a height equal to the design wave height used for the proposal.

The designed breakwater shown on Drg. No. P-05-53 is calculated to withstand waves with a height of 3.4 m with 5 % displacement of armour units and waves with a height of 3.8 m with a displacement of 15 %.

The top of the proposed breakwater has been brought up to such a level that there will be no overtopping with waves of 3.0 m height.

The North Breakwater has been oriented in such a direction so as not to be exposed to frontal attack of larger waves. It is therefore proposed that it will be constructed as a jetty with a concrete sheet pile wall on the sea side Drg. No. P-05-58.

Before the final design of the breakwaters for the fishing harbour is undertaken an assessment of the likely completion date for the commercial harbour should be obtained.

3.3.5 Landing Area

The length of the landing quay is calculated for the following number of boats as per forcast for year 1981:

150 boats 12 m length
40 " 15 " "

It has been assumed that at any one time 10 % of the total number of boats are not fishing due to maintenance or other reasons.

The number of boats to be considered for design of landing area are thus:

135 boats 12 m length
36 " 15 " "

Average daily landing per trip in a peakmonth:

12 m boats 0.675T 1 day fishing trip (rest each 7th day)
15 " " 5.700T 2 days " " (" " 3rd ")

That means that:

The 12 m boats will bring 78.0 T fish average per day in a peakmonth
and " 15 " " " " 68.5 T " " " " " " "

For a peak day an additional 50 % has to be added. This larger catch is estimated to arrive only on a few days per season and it has therefore been decided to design for the average daily landing in a peakmonth.

The length of the landing quay has been calculated from the following formula:

$$L = \frac{Q}{r \times h} (a + s) \times f$$

L = Length of the quay

Q = Total average landing per day in a peakmonth (tonnes)

r = Unloading rate 4T/hour

h = Period of the day in hours during which the boats are landing fish. In this case assumed to be 4 hours for 12 m boats and 9 hours for 15 m boats.

a = Length overall (m)

s = Space between the boats when landing (here 0,5 m)

f = Factor for non-uniform utilization of the landing quay (Varies from 1 to 2. Here assumed to be 1.5)

12 m boats will according to this require L = 92 metres

15 " " " " " " " L = 44 "

Total required quay L = 136 metres

The provided length is 140 metres.

3.3.6 Berthing Jetties

The total length of jetties required for berthing is calculated using the following formulae:

$$N_b = N_n \left(\frac{d_r}{C} + \frac{d_l}{C}\right)$$

N_b = Number of boats expected to be berthed during the same night

N_n = Total number of boats -10 %

C = Number of days in a full fishing operation cycle

d_r = Number of rest days in a full fishing operation cycle

d_l = Number of days landing in a full fishing operation cycle

12 metre boats: $N_b = 135 \left(\frac{1}{7} + \frac{6}{7}\right) = 135$

15 " " : $N_b = 36 \left(\frac{1}{3} + \frac{1}{3}\right) = 24$

Total $N_b = 159$

$$L_b = \frac{1}{R_b} \times N_b \times l_b$$

L_b = Required berthing length per boat type

R_b = Number of rows when berthing

l_b = Length overall including space between the boats (here 1.5 metres)

12 metre boats: $L_b = \frac{1}{3} \times 135 \times 13.5 = 607$

15 " " : $L_b = \frac{1}{2} \times 24 \times 16.5 = 198$

Total $L_b = 805$

Provided total berthing length = 805 metres

3.4 DETAILS OF THE PROPSED HARBOUR

3.4.1 Breakwaters

The breakwater along the west side of the basin is a rubble mound construction, faced with armourstones of minimum 2.5 tonnes weight.

In lee of the breakwater an area 60 m wide and 150 m long will be reclaimed to be used mainly as a landing and auction area.

The wave protection on the northern side of the basin consists of a jetty of reinforced concrete on a foundation of concrete piles. The seaward side of the jetty is faced with a concrete sheet pile wall.

3.4.2 Landing Quay

The landing quay is shown on Drg. No. P-05-54. It is a reinforced concrete structure with a foundation of concrete columns supported on rock. The quay has a total length of 180 m including the quay reserved for vessels taking supply of ice from the ice factory. The length of quay available for ships landing their catch is thus 140 m.

The face of the quay is fitted with wooden fenders and along the quay cast iron bollards are provided at 10 m centres.

3.4.3 Berthing Jetties and Quays

The proposal includes two 150 m long finger jetties which will provide an effective length for berthing of 4 x 140 m. The quay along the eastside of the harbour basin will provide berthing along 125 m of its length.

Berthing is also provided along 120 m of the inside of the north-east breakwater jetty.

Cross sections of the quays and the jetties are shown on the Drgs. Nos. P-05-56, 57 and 58.

The two finger jetties and the quay along eastside of the harbour basin are reinforced concrets structures supported by columns resing on rock. The quay and the jetties are provided with wooden fenders and cast iron bollards.

3.4.4 Supplying Area

Fuel and water services are provided at the northern jetty. Ice can be supplied to boats at the north end of the landing quay where a 30 metre long quay has been proposed.

3.4.5 Boatyard

A boatyard with a slipway for up to 200 T boats and a transverse system with side tracks will be constructed. The boatyard can accommodate seventeen 15 m long boats. On a quay close to the boatyard a 10 tonnes crane will be provided for lifting engines etc.

3.4.6 Power and Lighting

A transformer station will be required for distribution of power within the harbour area.

Electricity will be provided for the auction and packing halls, the ice plants and cold stores, the workshops, etc. Distribution is also required for the lighting of quays, jetties, roads, boat-yard and areas for landing and handling of fish.

A standby diesel generating station may be provided to ensure uninterrupted supply of electricity to ice plants and cold stores.

3.4.7 Water Supply

Fresh water should be provided by extension of the water supply system of the town of Ratnagiri. An elevated water tank will be provided and water distributed to the various tap-stations in the auction hall, the ice plants, the packing hall, the offices, etc.

3.4.8 Sewage and Drainage

The drainage of the harbour site till be by the partially separate system. The drainage water from the area in fornt of the auction hall, the packing hall and from the landing quay, which water my be polluted with organic debris, fish offal etc., will be disposed of through the sewage disposal system. The sewage will be conducted to septic tanks from which the effluent will be pumped out to sea.

The drainage from areas other than the above mentioned will be conducted directly into the sea preferably outside the basin.

3.4.9 Roads and Surfaced Areas

A typical section of road construction with bituminous toppning is shown on Drg. No. P-05-55.

3.4.10 Fencing

It is proposed to enclose the land area of the harbour by a steelnet fence. The boatyard will be fenced in separately.

3.4.11 Navigation Aids

Navigation aids for the fishing harbour should be of such character so as not to conflict with the system proposed for the commercial harbour. Sectered lights at the ends of the breakwater and north-east jetty are provided.

3.5 DRAWINGS

Drawing No.	Titel	
P-05-400	Proposed Fishing Harbour, Perspective	
05-41	Map showing location of proposed fishing harbour	1:15,000
05-42	Comparison between soudings 1878 and 1955	1:12,000
05-43	Wave height observations 1949-1953	
05-44	Wave period observations 1949-1953	
05-45	Diffraction Study	1:10,000
05-46	" "	1:10,000
05-47	" "	1:10,000
05-48	Refraction Study	1:15,000
05-49	" "	1:15,000
05-50	" "	1:15,000
P-05-51	General Layout	1:2,000
P-05-53	Breakwater cross sections	1:200
P-05-54	Landing Area cross sections	1:200
P-05-55	Reclamation Bund cross section	1:100
P-05-56	Landing Quay cross section	1:50
P-05-57	Berthing Jetty cross section	1:50 and 1:20
P-05-58	Jetty with sheet-piled face cross section	1:50
P-05-52	General Layout - Phase I	

3.6 COST ESTIMATE

Description	Unit	Quantity	Cost per Unit Rs.		Estimated Cost Rs.
1. Dredging incl. reclamation	m^3	166,000	7		1,162,000
2. Borrow material for reclamation	m	92,000	2		184,000
3. Breakwater and reclamation bunds					
Rock 2.5 to 3.5 tonnes	m^3	23,000	75	1,725,000	
Rock 250 to 350 kgs.	"	12,900	35	451,500	
Rock 50 to 100 kgs.	"	2,200	30	66,000	
Quarry waste in Breakwater	"	30,000	25	752,500	
Quarry waste in bunds	"	14,400	15	216,000	3,211,000
4. Quays and Jetties					
Quay section A56	m	353	6,200	2,188,600	
Jetty section A57	"	300	5,100	1,530,000	
Quay section A58	"	200	4,600	920,000	4,638,600
5. Slipway and repair facilities	L.S.				2,000,000
6. Roads and bitumen pavement	m^2	18,000	20		360,000
7. Water supply	L.S.				550,000
8. Drainage & Sewage	L.S.				300,000
9. Electricity Sub-station	L.S.				350,000
10. Harbour Office	L.S.				250,000
11. Auction Hall	L.S.				1,200,000
12. Fuel Station	L.S.				50,000
13. Toilets	L.S.				60,000
14. Lighting	L.S.				170,000
15. Navigation Lights and Marks	L.S.				60,000
					14,545,600
Add contingencies at 10 %					1,454,400
					16,000,000
Add Supervision charges at about					2,000,000
GRAND TOTAL					18,000,000

PHASING OF WORKS

If considered desirable the harbour basin and facilities can be provided in phases.

A suitable Phase I providing minimum facilities and services is shown on Drg. No. P-05-52. Berthing space has been provided for about 60 boats berthing in 3 rows abreast. Other boats could obtain sheltered anchorage in bad weather at places presently used by the fishing fleet such as Ratnagiri Bay.

Temporary water and fuel services can be provided at the north end of the landing quay.

The cost of this first phase is estimated to be Rs. 8,400,000 leaving a phase, which could be completed later at a cost of approximately Rs. 11,000,000 based on present day prices.