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Indian Standard

CODE OF PRACTICE FOR PLANNING AND DESIGN OF PORTS AND HARBOURS

PART I SITE INVESTIGATION

(First Revision)

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Indian Standard

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PART I SITE INVESTIGATION

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part I) (First Revision) was adopted by the Indian Standards Institution on 15 March 1974, after the draft finalized by the Ports and Harbours Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 A great need has been felt for formulating standard recommendations relating to various aspects of waterfront structures. This standard is one of a series of Indian Standards proposed to be formulated on this subject. IS : 4651 (Part III)-1974* relates to loadings. This Part deals with site investigation. This standard was published in 1967 mainly to cover provisions regarding soil investigations and other allied data useful for the design of port and harbour structures. In the first revision the subject has been covered comprehensively to include all aspects related to collection of data needed for the planning and design of such structures.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2 - 1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) deals with site investigation and collection of data necessary for the planning, design and construction of marine structures of ports and harbours after selection of a suitable site for the port.

*Code of practice for planning and design of ports and harbours: Part III Loading (*first revision*).

†Rules for rounding off numerical values (*revised*).

1.2 The information required is grouped under the following headings:

a) Survey (*see* **3**),
b) Meteorological data (*see* **4**),
c) Oceanographic data (*see* **5**),
d) Geological data (*see* **6**),
e) Soil investigation (*see* **7**),
f) Seismic data (*see* **8**), and
g) Local resources (*see* **9**).

2. GENERAL

2.1 A brief description of the site including its latitude, longitude, geographical location, accessibility, etc, should be given. Historical background of the area, purpose of the project, type of hinterland and communications may also be briefly described.

2.2 Available Information — Wherever possible, advantage should be taken of existing local data on tides, storms, wave heights, littoral drifts, mud banks, etc, and records of previous investigations in the vicinity and information compiled. The behaviour of existing structures which may be of similar nature to the ones proposed, and the influence of the soil and water on the materials of construction should be studied and recorded. At such places, site exploration, soil investigation and the examination of the materials of construction may be limited to confirm the site data that may be expected in the neighbourhood of proposed work.

3. SURVEY

3.1 Topographical survey of adequate area covered by the project is the first requirement and should be obtained at the earliest. Survey maps of scale 1 : 50 000 and contour interval of 20 m are required for general planning. The recommended scales for survey maps for detailed planning are 1 : 5 000, 1 : 2 500 and 1 : 1 250 with contour interval of one metre. In no case shall the survey maps for detailed planning be of scale less than 1 : 5 000 with contour interval of one metre, depending however on topography of the area.

3.2 Hydrographic survey charts for the coastal region extending to continental shelf (up to the line at which the depth of water is 200 m) and of scale 1 : 50 000 or 1 : 25 000 (whichever is available) are required for general planning. Hydrographic charts required for detailed planning shall be drawn to a scale as large as possible but in no case shall be less than 1 : 5 000. Recommended scales are 1 : 2 500 and 1 : 1 250.

4. METEOROLOGICAL DATA

4.1 Meteorological data to be collected should cover the following:

a) Winds,
b) Cyclones,
c) Rainfall,
d) Relative humidity,
e) Temperature, and
f) Barometric pressures.

4.2 Winds — For preliminary studies, information may be obtained from the available meteorological records of the area. Recording of velocity and direction of wind at the proposed site shall be obtained by installing continuous and self-recording anemometers. The data shall be collected for at least a period of one year and shall also be correlated with the data available at places nearest to the site. From the data so collected wind roses should be prepared for each month in the form given in Fig. 1 and presented as shown in Fig. 2.

4.3 Cyclones — Information should be compiled regarding track of cyclones. The velocity of maximum winds, radius of maximum wind velocity, duration, pressure drop at the cyclone centre and speed of movement of cyclone centre is required*. From this a design cyclone is adopted and waves that could be incident at a place computed.

4.4 Rainfall — Data on rainfall as available should be collected from India Meteorological Department for a minimum period of 3 years as follows:

a) Annual average rainfall,
b) Months in which the maximum rainfall occurs,
c) Maximum intensity of rainfall and duration, and
d) Average number of wet days in a year.

4.5 Relative Humidity — Data on the maximum, mean and minimum relative humidity for every month shall be obtained for a minimum period of five years.

4.6 Temperature — The normal ambient air temperatures with emphasis on daily and seasonal variation may be noted.

4.7 Barometric Pressures — Data on monthly average barometric pressures should be collected for the nearest site from the India Meteorological Department.

*Information given in 'Handbook of cyclonic storms', 'Tracks of storms and depressions in the Bay of Bengal and Arabian Sea — 1964, and Synoptic charts', issued by the India Meteorological Department.

5. OCEANOGRAPHIC DATA

5.1 Oceanographic data to be collected should cover the following:

a) Tides,
b) Waves (wind waves and swells),
c) Storm surges,
d) Currents,
e) Salinity,
f) Sea water temperature,
g) Suspended load, and
h) Sea bed.

5.2 Tides

5.2.1 Record of the tidal information, over as long a period as possible from Port Authorities or Geodetic and Research Branch, Survey of India or Hydrographic Department of the Indian Navy, including any local information specific to the site of the works should be obtained. Based on this the data as given in Fig. 3 should be compiled and presented.

NOTE 1 — Data over a full metonic cycle of 19 years will be useful.

NOTE 2 — Information on tidal bores, if any, in the area should also be collected and included in the above data.

5.2.2 For most of the ports, the information on tides is available* and may be adopted. For a new place, tide tables could be predicted and furnished by the Survey of India on request. To compile information as indicated in **5.2.1**, at least two years observed records should be studied.

5.2.3 For important structures, tide levels expected at a particular place may be required. For this purpose tides for at least 3 months shall be observed and correlation established between the observed tides and the predicted tides for the harbour in general.

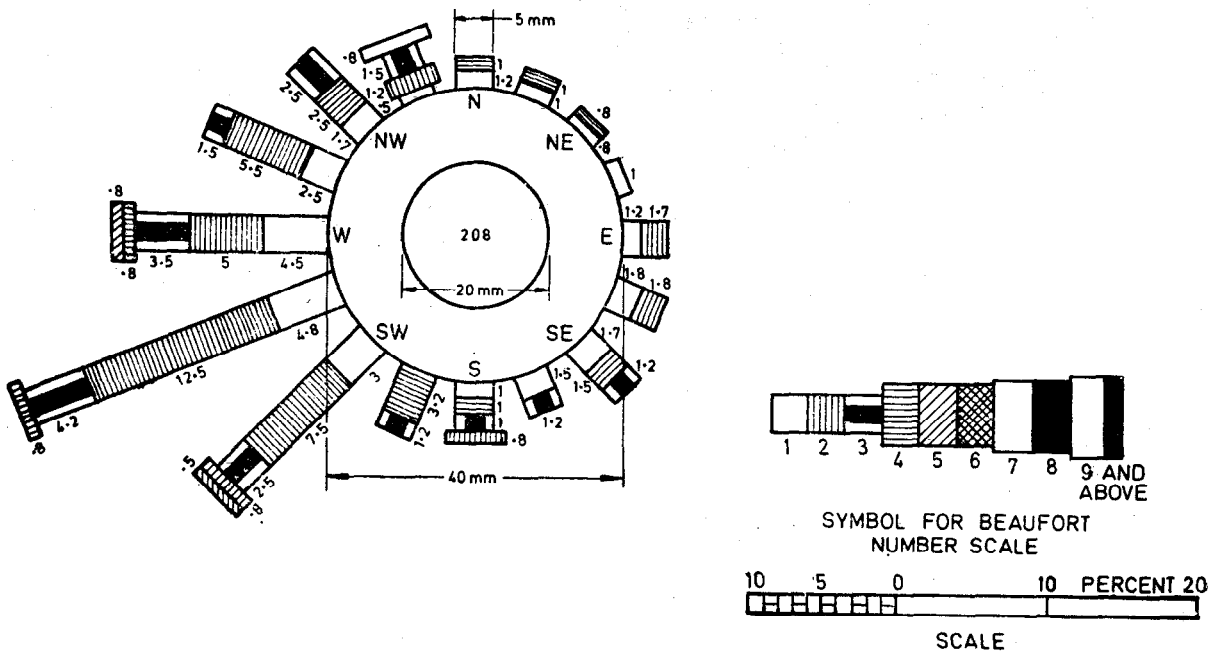
5.3 Waves

5.3.1 For planning and preliminary design purposes, wave data collected by ships plying in the area can be obtained from the India Meteorological Department.

5.3.2 Wave heights can also be computed by hind casting studies using the storm data and synoptic charts from the India Meteorological Department.

5.3.3 For important projects, wave recorders may be installed and information collected on wave height and period for at least 2 years. Separate wave recorders should be installed for long period and short period waves.

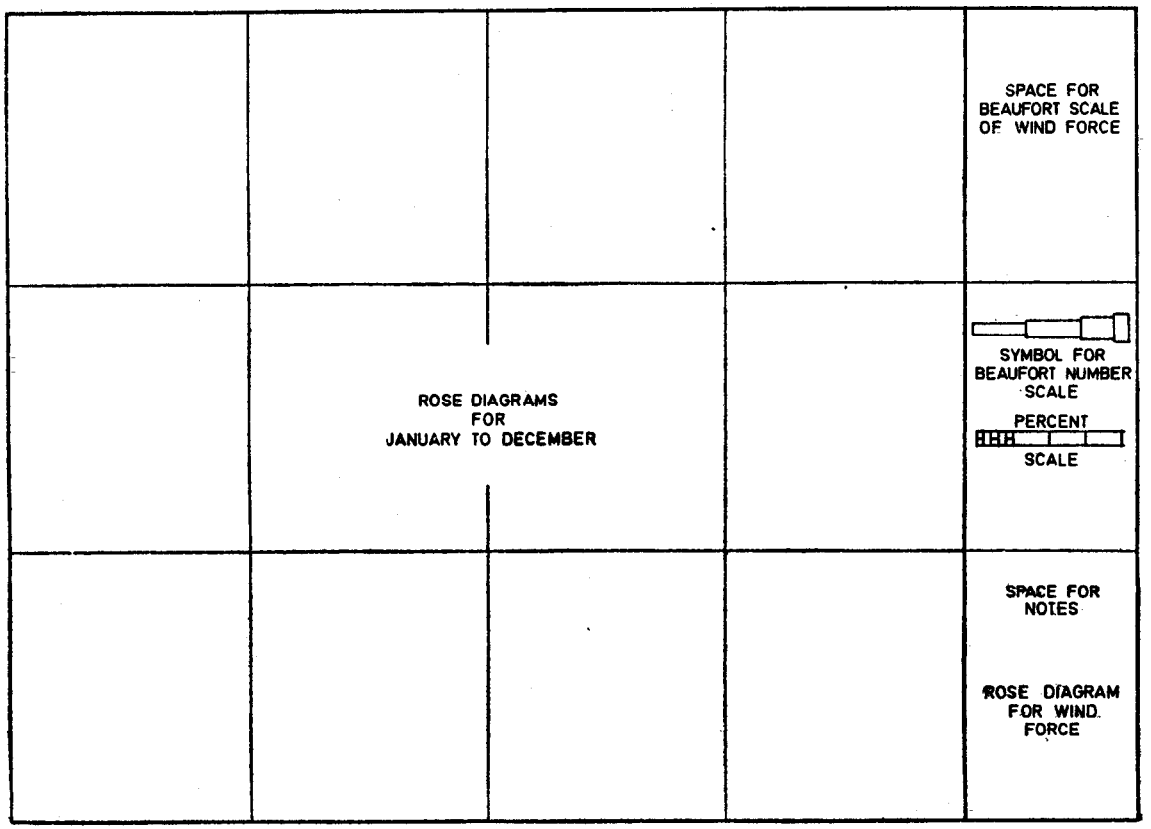
*From the Indian Tide Tables published yearly by the Survey of India, Dehra Dun.



BEAUFORT SCALE OF WIND FORCE

Beaufort Number	Description	Velocity	
		In km/h	In Knots
(1)	(2)	(3)	(4)
0	Calm	Less than 1·9	Less than 1
1	Light air	1·9 to 6	1 to 3
2	Light breeze	7 ,, 11	4 ,, 6
3	Gentle breeze	12 ,, 19	7 ,, 10
4	Moderate breeze	20 ,, 29	11 ,, 16
5	Fresh breeze	30 ,, 39	17 ,, 21
6	Strong breeze	40 ,, 50	22 ,, 27
7	Moderate gale	51 ,, 61	28 ,, 33
8	Fresh gale	62 ,, 74	34 ,, 40
9	Strong gale	75 ,, 87	41 ,, 47
10	Whole gale	88 ,, 102	48 ,, 55
11	Storm	103 ,, 117	56 ,, 63
12	Hurricane	118 and above	64 and above

FIG. 1 TYPICAL ROSE DIAGRAM FOR WIND FORCE



NOTE 1 — The centre figure in each rose diagram should indicate the number of observations at.....h of the wind force during the years 19 .....to 19..... (inclusive) except where otherwise noted.

NOTE 2 — The direction of wind is towards the centre of the rose diagram.

NOTE 3 — Size of sheet for rose diagram for wind force is A1 (594 × 841).

FIG. 2 PRESENTATION OF ROSE DIAGRAMS FOR WIND FORCE

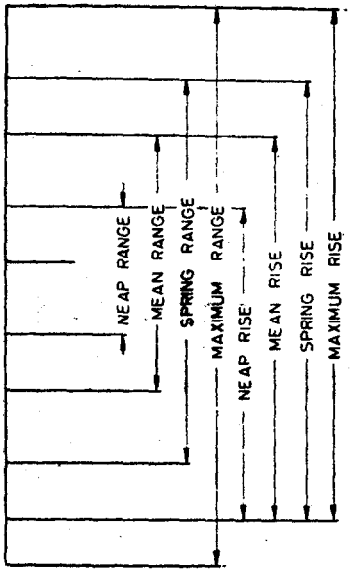


FIG. 3 FORM FOR PRESENTING TIDAL INFORMATION

5.3.4 Wave direction may be obtained by visual observation/aerial photographs and with pairs of wave recorders.

5.3.5 From the data collected as above, design wave parameters should be worked out after drawing refraction/diffraction diagrams for the type of structures.

5.3.6 Rose diagrams of wave heights and periods may be prepared in the form given in Fig. 4 and presented as shown in Fig. 5.

5.3.7 *Long Period Waves* — For the measurement of long period waves, separate long period wave recorders should be installed and at least one year's record obtained. Where such time is not available, wave records during months when cyclones may occur in the fetch area may be taken. For accurate assessment of incidence of long period waves separate wave recorders are required; however, a rough assessment can be made from wind wave/swell recorders or even from tide gauges which plot curves on a graph sheet. From such records the periodic time range of long period waves could be assessed and recorded.

5.4 Storm Surges — Storm surges may be inferred from tidal gauges, if the gauges had functioned through the period of storm. In addition some special instruments can be installed for recording storm surges. They can also be calculated from synoptic charts.

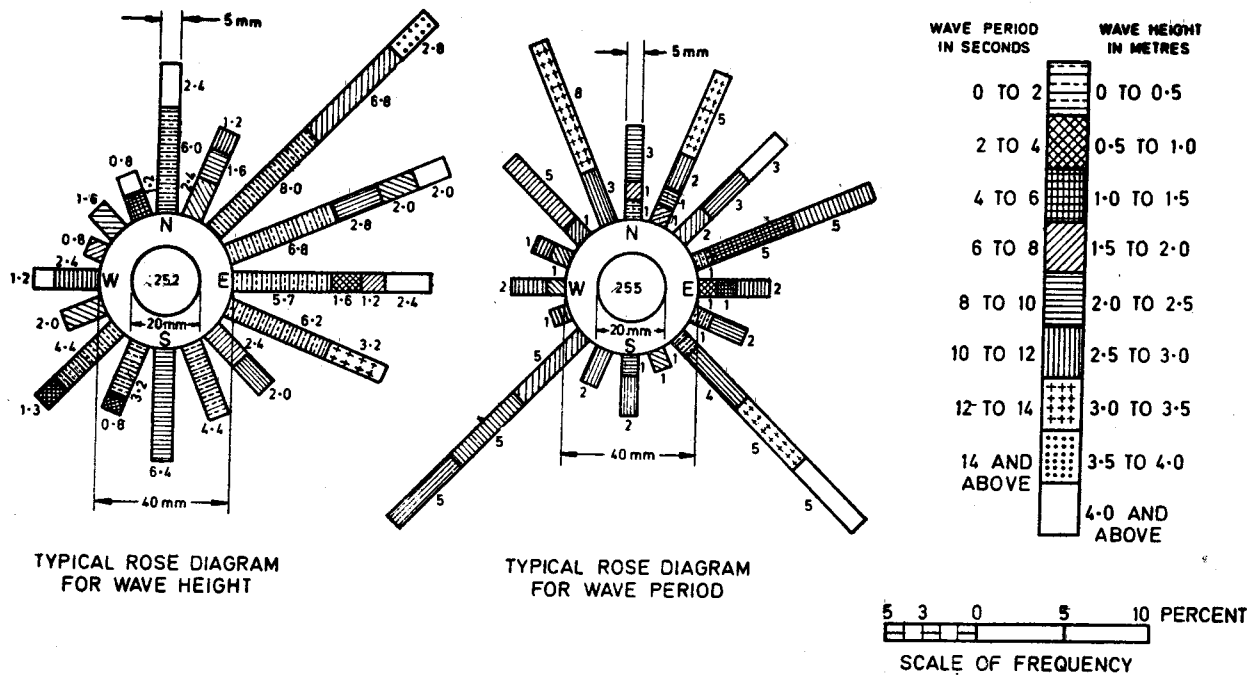
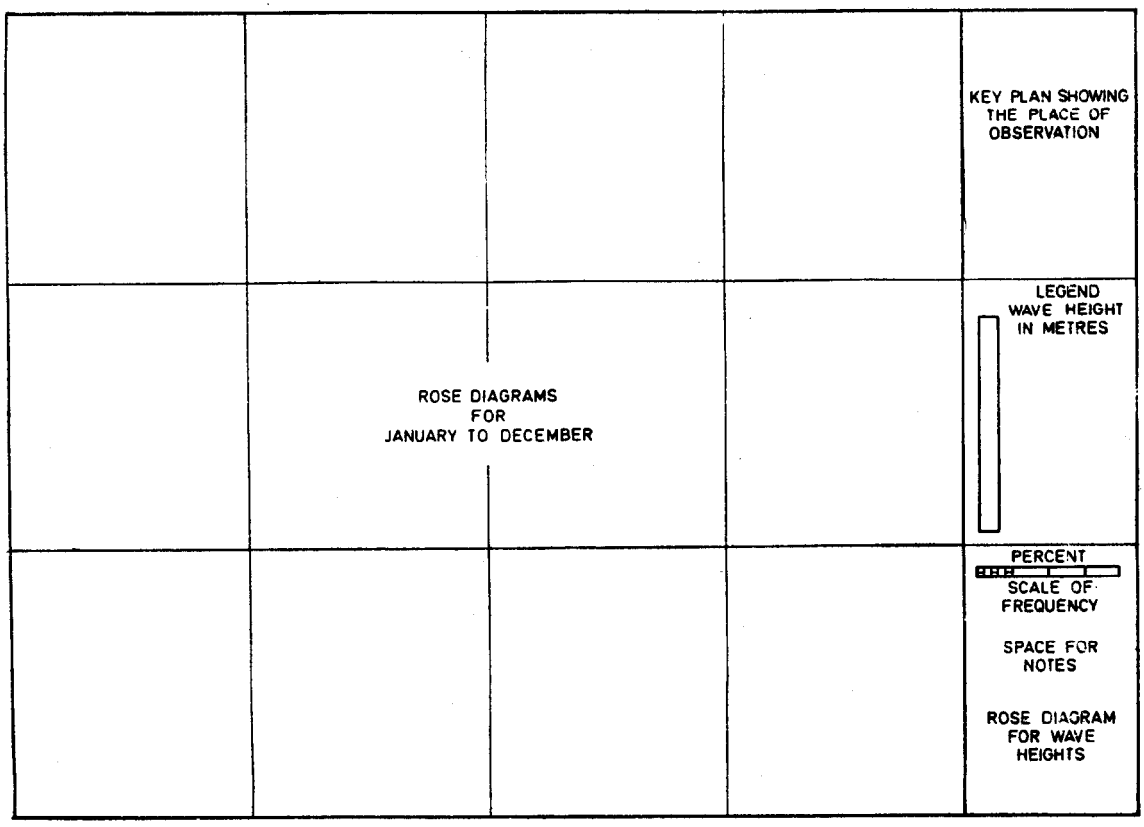


FIG. 4 TYPICAL WAVE ROSE



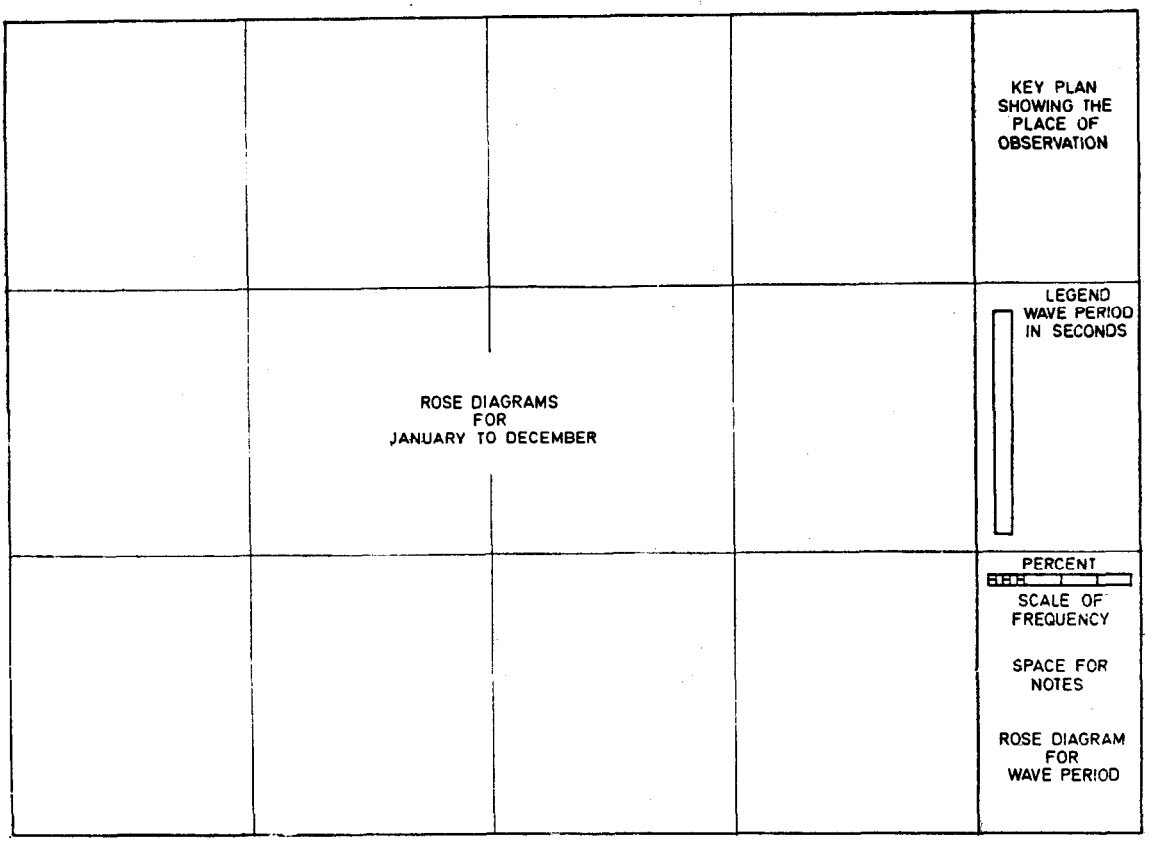
NOTE 1 — The centre figure in each rose diagram should indicate the number of observations of height of waves observed during the years 19.....to 19.....(both inclusive) except where otherwise noted.

NOTE 2 — Direction of the waves is towards the centre of rose diagram.

NOTE 3 — Size of sheet for rose diagram for wave height is A1 (594 × 841).

5A Rose Diagrams for Wave Heights

FIG. 5 TYPICAL PRESENTATION OF ROSE DIAGRAM FOR WAVE HEIGHTS AND WAVE PERIODS — *Contd*



NOTE 1 — The centre figure in each rose diagram should indicate the number of observations of wave periods observed during the years 19.....to 19.....(both inclusive) except where otherwise noted.

NOTE 2 — Direction of wave is towards the centre of the rose diagram.

NOTE 3 — Size of sheet for rose diagram for wave period is A1 (594 × 841).

5B Rose Diagrams for Wave Period

FIG. 5 TYPICAL PRESENTATION OF ROSE DIAGRAM FOR WAVE HEIGHTS AND WAVE PERIODS

5.5 Currents

5.5.1 The direction, strength and duration of current during complete tidal cycles at maximum spring and neap tide over a year should be recorded. In riverine ports where there is fresh water discharge, current pattern at highest expected flood should be assessed and recorded. Current pattern at the specific location of structures, should also be assessed for a period of at least one year for purposes of alignment of berth, dock entrances, moorings, etc.

5.5.2 Current readings should be taken at a minimum of three points preferably at depths of 0·1 *d*, 0·5 *d* and 0·9 *d* where *d* is the depth of water, and recorded.

5.6 Sea Bed — Classification of sea bed material in the vicinity of structures and approaches and up to an area in the sea where depth of water is 6 m more than the maximum depth for which the harbour is being designed, should be ascertained and recorded. Sea bed slope which is also a design parameter may be ascertained from hydrographic survey charts.

5.7 Suspended Load, Salinity and Temperature

5.7.1 These observations shall be carried out both during the dry and wet seasons at different locations in the harbour and channels over the full tidal cycle during neap and spring tides. The suspended load and salinity shall be measured at depths of 0·1 *d*, 0·5 *d* and 0·9 *d* below the water level (where *d* is the depth of water) at every hour during the tide cycle. Salinity and suspended load should be assessed from the water samples collected at these depths. Salinity may also be measured at the site by using direct meters which are available for this purpose. Sea water temperature shall also be measured during these observations.

5.7.2 The quantum of littoral drifts may be estimated from observations at nearby harbour sites over a period of at least one year. The direction of drifts at the site may be ascertained from radio flourescent tracer studies and other observations of the coast line in the vicinity of the structure, such as dredging records, shore line changes, accretion errosion, wave data and the orientation of river mouths. These studies may be conducted up to a location where the depth of water is 12 m more than the design depth.

6. GEOLOGICAL DATA

6.1 Any detailed published information on the geological condition of the area of the project, if available, should be carefully studied.

6.2 Geophysical Survey — The geophysical survey method of locating base rock aims at giving a continuous record of strata. Geophysical survey by seismic refraction method may also be resorted to find out more reliable information about the strata.

6.2.1 *Stratification Survey by High Resolution Seismic Profiling (Known Commonly as Sparker Survey)* — This may be suitably used to determine the thickness of the various sediment layers and disposition of underlying bedrock. It may also be used to map the top of the first compacted layer and to check the water depths.

6.2.1.1 A first interpretation can be made on the spot from the onboard cross sections. Consequently, the survey programme can be modified, while operating. Finally, a geophysical interpretation is made by preparing a location map and a cross-section showing the stratification of various layers and pointing out the main geological features. During or after the survey it is common practice to select some locations for shallow and deep corings. A correlation is obtained between the findings of the seismic survey and the actual soils encountered during coring.

6.3 Compilation of Geological Data — The following data about the geology of the area should be compiled:

a) Type of bedrock including information on its origin and method of formation;

b) Any faults, fissures, folds and other unconformities in the area of the project; and

c) Crushing strength and other properties of the rock in the project area and its suitability for use in marine works.

7. SOIL INVESTIGATION

7.1 Earlier Uses of the Site — In a site which has been partially developed enquiries should be made regarding the past structures layout of pipes and obstructions likely to be met in the area for new works. Enquiries should also be made regarding old creeklets, excavated pits, etc, which might have either silted up or reclaimed. This information will be particularly useful in deciding the number and location of trial pits and borings; and assessing in general, the likely soil strata that may be met with.

7.2 Subsurface Exploration

7.2.1 It is not practicable to standardize the disposition and spacing of borings required for subsurface investigation as these depend upon the type of structure and the nature of the site. Broadly speaking the number of bore holes should be sufficient to give a picture of the probable variation in the subsurface strata over the site and their depth should be such as to include all strata likely to affect the stability of the structure. Any soft strata encountered below foundation level should receive special study.

7.2.2 A few subsurface soundings like the standard penetration test and the cone penetration test may be conducted. The cone penetration test should

be conducted in conjunction with at least one bore hole with sampling for correlation of soil type with the penetration resistance obtained from soundings.

7.2.3 The subsoil investigation should be carried out generally according to IS : 1892-1962*.

7.2.4 Initially the main borings may be along the top edge of the shore. These borings may be spaced 50 m apart and taken to a depth of 3 m into hard strata or a depth equal to twice the difference in the elevation of the ground surface on either side of the structure (*see* Fig. 6). In a few cases, the borings may be taken deeper to investigate the nature of the underlying strata. It is desirable to use large diameter bores in reclaimed areas and where embedded boulder layers are encountered, depending on the size of the project.

7.2.5 The intermediate borings of the first order may be further drilled after the findings of the principal borings are known, to a depth at which the known uniform soil layer, identified by the principal borings, is encountered, here also the spacing of the borings may be 50 m.

7.2.6 The intermediate borings of the second order may be drilled only when there is a considerable change in the upper layers. Normally, they are also located at 50 m spacing but off the areas as shown in Fig. 5. The spacing could be reduced if the subsoil conditions so require it. The boring depth depends on the result of the preceding borings and should extend at least to twice the design depth.

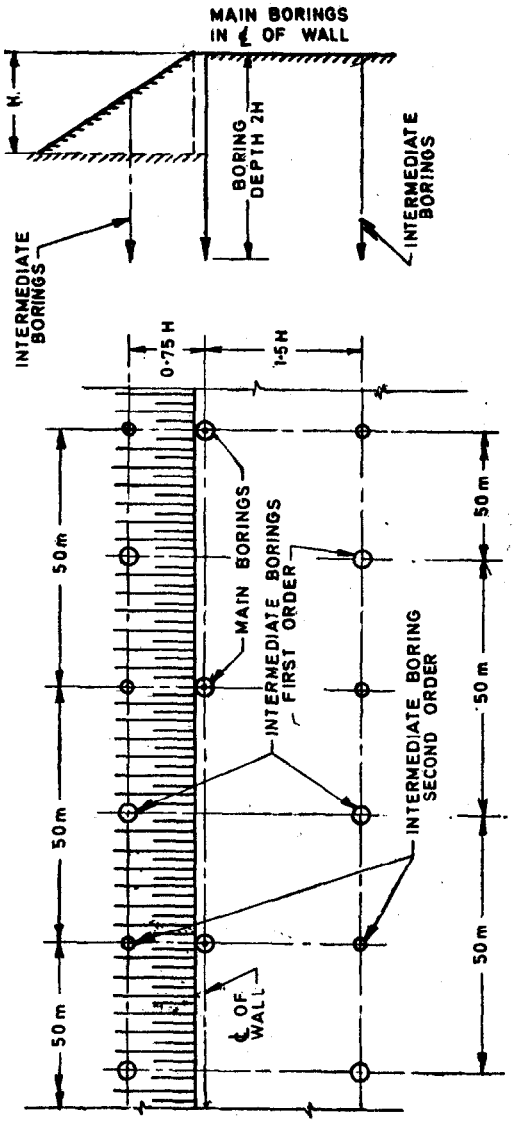
7.2.7 *Depth of Exploration for Channels and Dredging* — For this purpose the bore holes should be extended to a known geological formation below the dredged depth or the minimum of five metres beyond the design dredged depth whichever is less.

7.2.8 Bore hole data should be presented in the form of bore hole logs along with important longitudinal and cross-sectional soil profiles and bore holes location plan. A recommended *pro forma* for bore hole logs is given in Appendix A.

7.3 Mean Ground Water Level in Tidal Areas — This should be ascertained over a yearly cycle on the entire site under reference or may be assumed to lie at about 0·30 m above the mean tides water level. With a stronger ground water influx from the shore, the mean water level may lie higher as in rainy season and in areas with poor drainage characteristics.

7.4 The results of field tests and those obtained from laboratory investigations should be compiled and properties of identified strata tabulated for use in design work.

*Code of practice for site investigation for foundations.



H = Difference in elevation of ground surfaces.

FIG. 6 LAYOUT OF BORINGS FOR WATER FRONT STRUCTURES IN DOCKS AND HARBOURS

8. SEISMIC DATA

8.1 Past data regarding seismic activity in the particular site may be collected for use in design (*see* IS : 1893-1970*).

9. LOCAL RESOURCES

9.1 This section deals with construction resources only. Local resources may be men, materials and machine.

9.2 Materials — A comprehensive assessment of the availability of the local construction materials and their costs should be made as regards to the following:

a) Types of material like bricks, stones, timber, etc;

b) Existing and proposed quarries; and

c) Facilities for transport of materials by rail, road or other modes of transport.

9.3 Manpower Resources — The availability of the following should be judged and prevailing rates of daily wages recorded:

a) Skilled labour, trade-wise;

b) Unskilled labour; and

c) Availability of local construction agencies with their resources.

9.4 Plant and Equipment — Availability of earth-moving and other machinery and workshop facilities with the local bodies like Public Works Department, etc, should be assessed so that advantage could be taken of these facilities in the initial stages of the project till the project machinery arrives and workshop facilities are set up.

9.5 Water and Power — The availability of water and power for the proposed facility and construction purpose should be ascertained and recorded.

9.6 Local Rates — For costing purposes, local schedule of rates of material, labour, transportation, hiring of plant, etc, should also be collected.

10. OTHER INFORMATION

10.1 Before deciding the preliminary design of the proposed work, information on the following aspects should also be collected:

a) Availability and ownership of land for acquisition in the entire area of the port.

*Criteria for earthquake resistant design of structures (*second revision*).

b) Map indicating areas of inundation during highest high tide.

c) Pollution and environmental effects:

i) Measurement of existing pollution level, and

ii) Pollution limit standards laid down by local bodies and other authorities.

d) Any existing/proposed master plan for the development of the area including hinter-land development.

e) Other information useful in the general planning of the port area, such as investigations of any river/stream which has outlet in the harbour, investigations regarding the river requiring diversion, etc.

11. REPORTING OF SITE DATA

11.1 A summary of site data may be reported on a form as suggested and given at Appendix B for easy assimilation.

APPENDIX A

(*Clause* 7.2.8)

PRO FORMA FOR BORE HOLE LOG

i) Client's name:

ii) Name of the job:

iii) Name of the agency doing investigation:

Ground surface level: Location:

Type of boring: Boring No.:

Diameter of boring: Soil sampler used:

Inclination: Date started:

Date completed:

Sl No.	Description of Strata	Soil Classification	Symbol	Depth from Ground Surface m	Thickness of Stratum m	Percentage of Core Recovery 20	40	60	80	100	Depth of Core m	Sampling Type	Sample No.	Depth and Thickness of Sample	Standard Penetration Test No. of Blows-N	Ground Water Observation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)

Legends for different types of samples:

i) *U* — Undisturbed sample

ii) *D* — Disturbed sample

iii) *C* — Core

iv) *W* — Water sample

v) *P* — Penetrometer test

vi) *DL* — Large disturbed sample

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APPENDIX B

(*Clause* 11.1)

PRECISE DATA FORM FOR PREPARATION OF A DOCK AND HARBOUR ENGINEERING PROJECT

NOTE — This form is designed to serve as a check list. Many items may be inapplicable for a particular project.

B-1. TERMS OF REFERENCE

a) Administrative authority/client.

b) Purpose of the scheme/project.

c) Design ships required to be catered for with all relevant parameters.

d) Number of ships likely to use Dock/Harbour facility at one time.

e) Duration of use during calendar year, whether all weather or fair weather only.

f) Permanently/Estimated life of structures required.

g) Summary of requirements:

1) Proposed approach channel/Entrance channel bearings, widths and dredged depths and turning circles;

2) Wharfage/Berthage in linear metres and special requirements, if any;

3) Dock harbour facilities like cranes, capstans and services, such as water (fresh/salt), electricity (ac/dc), compressed air, fuel oil, bunkering and so on;

4) Shore facilities like workshops, administrative blocks, passenger transit lounges, warehouses, transit sheds and open storage area, etc; and

5) Any special requirements, such as anchorages, navigational aids, pollution control.

h) Time of completion allowed.

B-2. SITE DATA

B-2.1 Location

a) Designation of site;

b) Latitude and longitude (Survey of India, Map sheet No. or Mercantile Marine Department Map with coordinates);

c) Altitude; and

d) Hinter-land characteristics including neighbouring towns or villages, and prominent local features.

B-2.2 Communications

a) Existing highways with particular reference to state and national highways;

b) Railway gauge (sidings and other facilities);

c) Inland waterways (quantum of barge and lighterage traffic); and

d) Air routes.

B-2.3 Survey-Topographical Maps and Hydrographic Charts

B-2.3.1 *Topographical*

a) Plan showing GTS bench marks, cardinal points with coordinates for triangulation (scale 1 : 50 000);

b) Contour plan with contour interval 1 metre (scale not less than 1 : 5 000; 1 : 2 500 or 1 : 1 250 preferable);

c) Auxiliary plan showing relative heights of important landmarks; and

d) Relief maps.

B-2.3.2 *Hydrographic*

a) Sounding chart of coastal region (scale 1 : 50 000 or 1 : 25 000);

b) Sounding chart of shore region (scale not less than 1 : 5 000; 1 : 2 500 or 1 : 1 250 preferable) showing sounding at two metre intervals; and

c) General plan showing location and description of shore fixes and other defined areas, such as dumping places.

B-2.4 Meteorological Data

B-2.4.1 *Winds*

a) Wind roses — direction/frequency,

b) Combind direction and frequency with roses with velocity superimposed; and

c) Velocity data with frequency and intensity represented on Beaufort scale.

B-2.4.2 *Cyclones*

a) Tracks of severe cyclones — (traces).

b) Characteristics of design cyclone of frequency:

1) Maximum wind velocities in km/h,
2) Radii of maximum winds in km,
3) Pressure drop at eye of cyclone in mm of mercury,
4) Speed of movement of eye of cyclone in km/h, and
5) Height of wave generated by the design cyclone at deep sea.

B-2.4.3 *Rainfall*

a) Annual total rainfall (average)
b) Months of maximum rainfall
c) Maximum intensity (mm per hour)
d) Average number of wet days per year

} To be given in statement form for at least 3 past years

B-2.4.4 *Relative Humidity*

a) Maximum for every month,
b) Mean for every month, and
c) Minimum for every month.

B-2.4.5 *Temperatures* — Daily and seasonal variation.

B-2.4.6 *Barometric Pressures*

a) Mean for every month year-wise, and
b) Annual mean year-wise.

B-2.5 Oceanographic Data

B-2.5.1 *General Tidal Data for the Place*

a) Lowest low water recorded,
b) Mean lower low water spring,
c) Mean low water spring,
d) Mean low water neaps,
e) Mean sea level,
f) Mean high water neap,
g) Mean high water springs,
h) Mean higher high water springs, and
j) Highest high water level recorded.

B-2.5.2 *Tide-table (predicted levels) for the area/place*

B-2.5.3 *Observed tidal record of preceding 2 years in the area*

B-2.5.4 *Tide Data for a Specific Site*

a) Observed tidal records for a 3 month period for specific structures,
b) Bore tides for estuarine harbours — over a 12 month period, and
c) Any abnormal tidal phenomena.

B-2.5.5 *Waves*

a) Frequency of occurrence for design storm;
b) Fetch;
c) Maximum wave heights and direction: wind waves and swell;
d) Significant wave height, period and length for each type;
e) Location of wave recorders and output;
f) Wave roses of observed waves;
g) Local storm surge and harbour resonance data if available; and
h) Long-period wave data.

B-2.5.6 *Local Currents*

a) Charts showing tidal current direction and velocity at springs and neaps for the general area;
b) Modification in current pattern due to flood discharges for riverine ports;
c) Current metre observations at depths of 0·1 *d*, 0·5 *d* and 0·9 *d* from surface for a particular location/site under reference; and
d) Radio active-tracer studies for circulation pattern over the area.

B-2.5.7 *Suspended Load, Salinity and Temperature*

a) Wet and dry season observations for silt charge at depths of 0·1 *d*, 0·5 *d* and 0·9 *d* below water level for area in general;
b) Littoral drift — yearly cyclic observations;
c) Hourly observations of percentage content of silt and salinity (graphic) for the site; and
d) Seasonal observation (monthly) for variation of silt and salinity content (ppm and sp gr observations respectively) (graph) (for the site).

B-2.5.8 *Sea-Bed Characteristics*

a) Sea-bed composition, and
b) General characteristics of bed-slope.

B-2.6 Geological Data

a) Published information about site geology, geomorphology (Reference of pamphlets/periodicals/publications).

b) Geophysical survey of site:
   1) Location and category of base rocks;
   2) Bed rock characteristics; and
   3) Geological features like faults, folds, unconformities, dip, strike, etc, observed at site.

c) Quarry sites:
   1) Location of quarries,
   2) Distances from site of work,
   3) Type of rock and its crushing strength, and
   4) Type of rock formations.

B-2.7 Subsurface Data

a) Plan showing location and distribution of main borings and intermediate boring of first and second order,
b) Bore hole logs,
c) Longitudinal and cross-sectional profiles,
d) Table of properties of soil strata found at site,
e) Summary of test results for soil characteristics,
f) Ground water level data over entire site with yearly variation, and
g) Record of artesian head of water in pervious layers and pumping out test results.

B-2.8 Seismic Data

a) Design horizontal acceleration coefficient, and
b) Design vertical acceleration coefficient.

B-2.9 Location of Resources

B-2.9.1 *Materials*

a) Existing and proposed quarries with yields;
b) Construction materials; and
c) Facilities for transportation of materials like steel, cement by rail, road and by other means of transportation.

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TO

IS : 4651 (Part I)-1974 CODE OF PRACTICE FOR PLANNING AND DESIGN OF PORTS AND HARBOURS

PART I SITE INVESTIGATION

(First Revision)

Corrigendum

(*Page* 9, *Fig.* 3) — Substitute the figure on page 2 of this amendment for the existing figure.

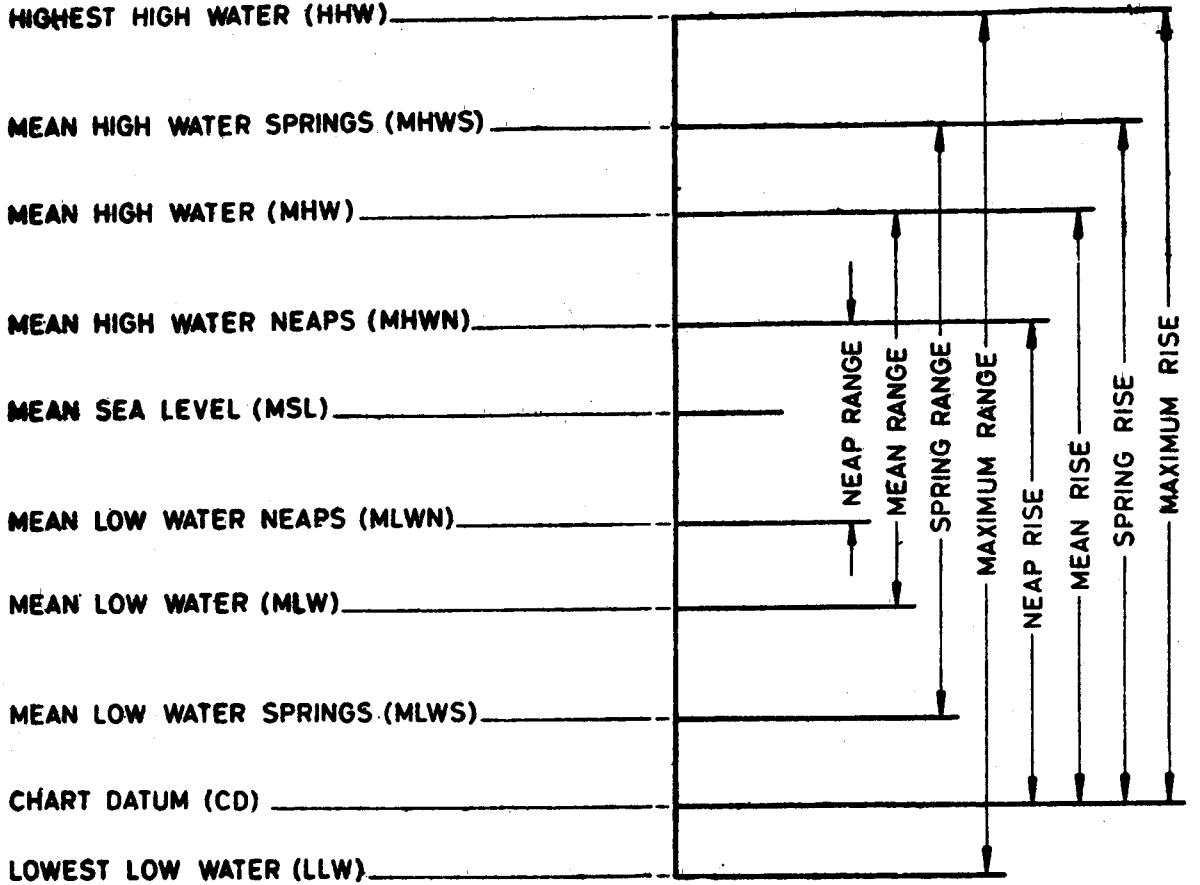

FIG. 3 FORM FOR PRESENTING TIDAL INFORMATION

Seema Offset Press, Delhi, India

AMENDMENT NO. 2 MARCH 1980

TO

IS:4651(Part I)-1974 CODE OF PRACTICE FOR PLANNING AND DESIGN OF PORTS AND HARBOURS

PART I SITE INVESTIGATION

(First Revision)

Alterations

(*Page 15, clause 7.2.3, line 2*) - Substitute 'IS:1892-1979*' *for* 'IS:1892-1962*'.

(*Page 15, foot-note with* '*' *mark*) - Substitute the following for the existing foot-note:

'*Code of practice for sub-surface investigation for foundations (*first revision*).'

(*Page 17, clause 8.1, line 2*) - Substitute 'IS:1893-1975*' *for* 'IS:1893-1970*'.

(*Page 17, foot-note with* '*' *mark*) - Substitute the following for the existing foot-note:

'*Criteria for earthquake resistant design of structures (*third revision*).'

(BDC 66)

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