BEFORE THE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

Original Application No. 136 of 2024 (SZ)

In the matter of:
Saravanan,
Chennai. …Applicant

Versus

The Commissioner of Fisheries and Fishermen Welfare,
Chennai and Others …Respondent(s)

REPORT FILED BY 1ST RESPONDENT – THE COMMISSIONER OF FISHERIES AND FISHERMEN WELFARE, CHENNAI. (PART - 2)

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Through
Dr. D. Shanmuganathan
Standing Counsel for Tamil Nadu
National Green Tribunal
Southern Zone, Chennai
Date: 28.09.2024

CONSTRUCTION OF GROIN FIELD FOR SHORE PROTECTION WORK IN UYYALIKUPPAM, CHENGALPATTU DISTRICT, TAMILNADU

Client

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1.0 INTRODUCTION

Fisheries Department of Government of Tamilnadu has requested the Department of Ocean Engineering, Indian Institute of Technology Madras to suggest suitable coastal protection measures that could possibly limit the coastal erosion process at the site specified by them in the Uyyalikuppam village. The coastal site is located at Uyyalikuppam village (12°29'9.28"N, 80°09'46.72"E) of Chengalpattu district. The Fisheries Department of Tamilnadu have entrusted the work of establishing the bathymetry and topography survey of the area prior to the commencement of preventive measures. The location of Uyyalikuppam village is shown in **Fig.1**.

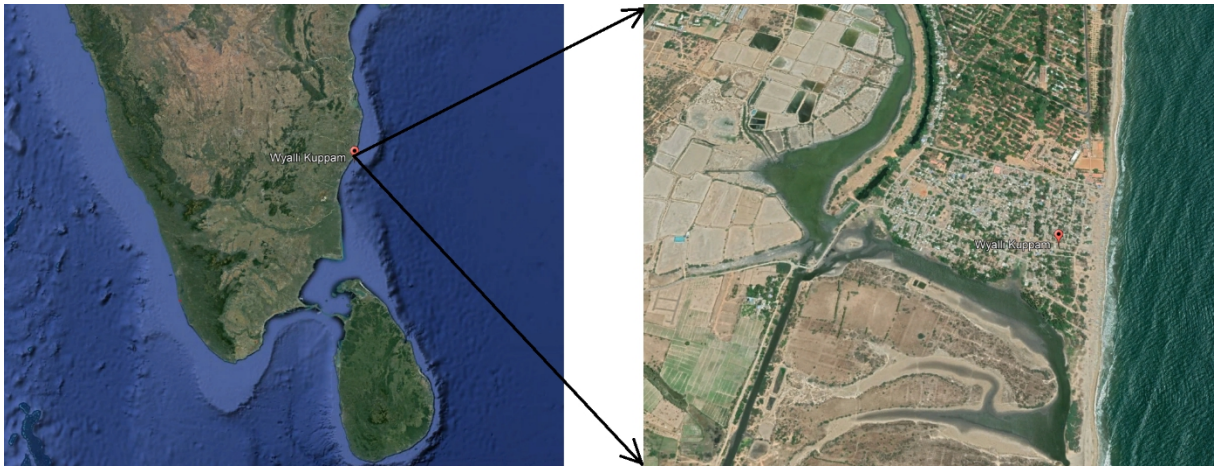


Fig. 1 Location of Uyyalikuppam site

2.0 OBJECTIVE & SCOPE OF WORK

The objectives of the present study includes,

1. Offshore annual wave climate shall be established using the best available data sources.
2. Investigation of shoreline erosion rate along the specified coastal stretch due to waves.
3. The shoreline changes due to the proposed structure i.e., accretion or erosion shall be established.
4. Layout of groin field suitable for Uyyalikuppam coast.
5. Wave tranquility to identify the wave characteristics in the proposed location.
6. Design of groins and cross sections.

3.0 BATHYMETRY

A Bathymetry survey has been conducted on 29th December 2020 and the shore line measurements were taken on 29th December 2020 during the High Tide using ODOM ECHOTRAC MKIII. In addition, the soil samples were also collected near the shore. The detailed bathymetry is given in **Plate 1**.

3.1 Site Condition

The three site photos depict the actual erosion that has occurred at the Uyyalikuppam site and the immediate need to protect the coast from further erosion. The site condition and erosion at Uyyalikuppam village is shown in **Fig. 2**.

Fig. 2 Site Condition and Erosion at Uyyalikuppam village

4.0 OFFSHORE WAVE CHARACTERISTICS

The wave characteristics such as significant wave height, mean wave period and mean wave direction at a deep-water location (12°30'0.00"N, 80°15'0.00"E) off Uyyalikuppam (12° 29'9.28"N, 80° 09'46.72"E) have been extracted at every 6 hours interval from the European Centre for Medium-Range Weather Forecasts (ECMWF).

Table 1 Wave characteristics for the present study

Month	Deep water wave direction (θ_o) w.r.t North	Wave height, H(m)	Wave period, T(sec)
January	73	0.8	5
February	101	0.7	5
March	134	0.8	6
April	149	0.8	5
May	151	0.9	6
June	175	0.9	6
July	192	0.8	6
August	183	0.8	6
September	154	0.9	7
October	146	0.8	6
November	94	0.9	6
December	80	0.9	6

5.0 LITTORAL DRIFT ESTIMATE

Distribution of Sediment Transport

The offshore wave climate provided in the above table is transformed to the near shore location of Uyyalikuppam coast using Snell's law. The average breaking wave characteristics were derived from the available wave data. The monthly distribution of mean breaker wave height for the study area is shown in **Fig. 3.** The results indicate that the mean breaker height varies from about 0.8m to 1.20m. The breaker height is observed to be a maximum during the month of September. The monthly distribution of the mean breaker

wave angle with respect to shore normal is shown in **Fig. 4.** From the results, it is seen that for the study area, the breaker angle with respect to shore normal and longshore current velocity are directed towards North from February to October. The average surf width in which the long shore drift is predominant is further estimated from the breaker wave height for the given bathymetry and is projected in **Fig. 5** for the different months. It shows that the maximum surf width of about 75m occur during the month of September.

Further, the derived wave characteristics were applied to calculate the long shore sediment transport. Three different methods CERC (1984), Komar (1976a), and by integrating the distribution across the surf zone (Komar, 1976b) have been adopted to calculate the alongshore sediment transport rate. The average sediment transport rate for the different months is shown in **Fig. 6.** All the three methods have yielded similar order sediment transport rate. The net drift is found to be about 0.25 million m^3 per annum and directed towards the North.

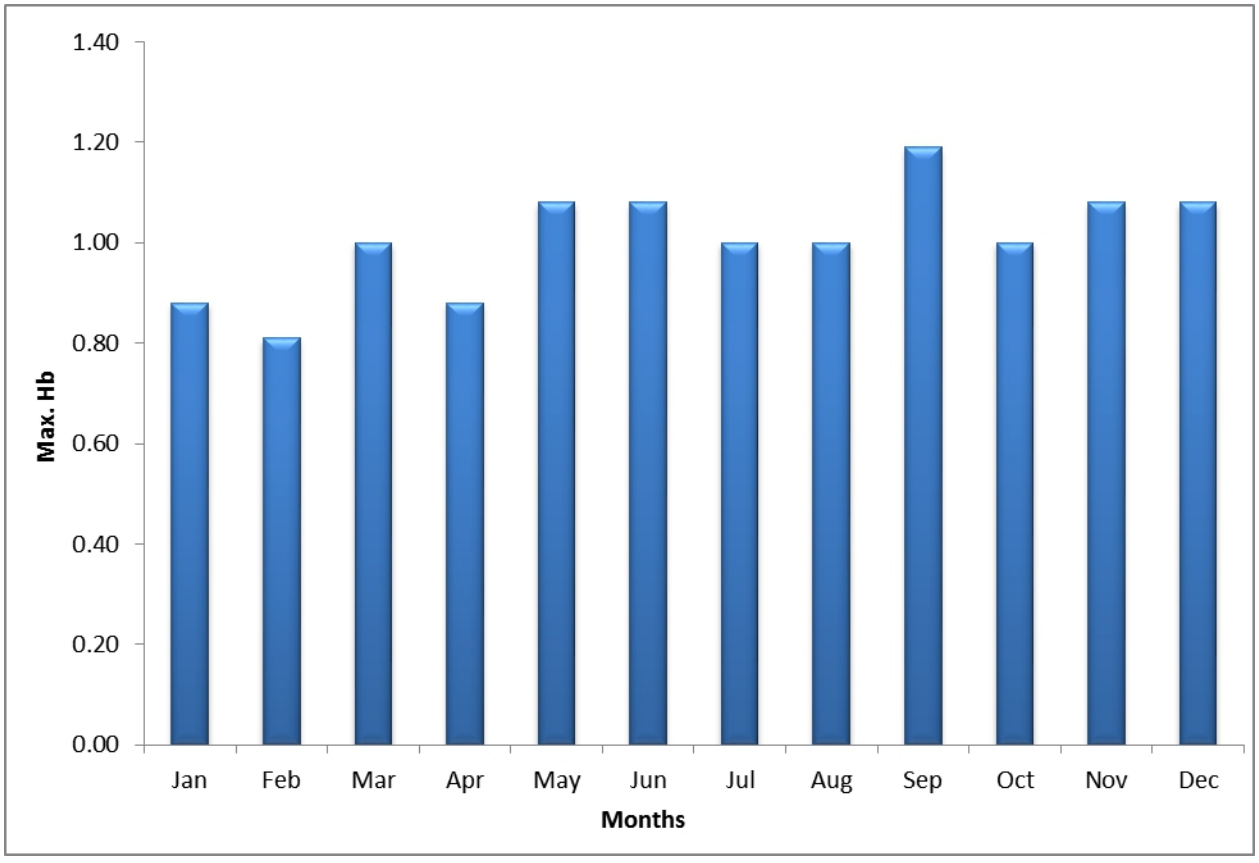


Fig. 3 Breaker wave heights

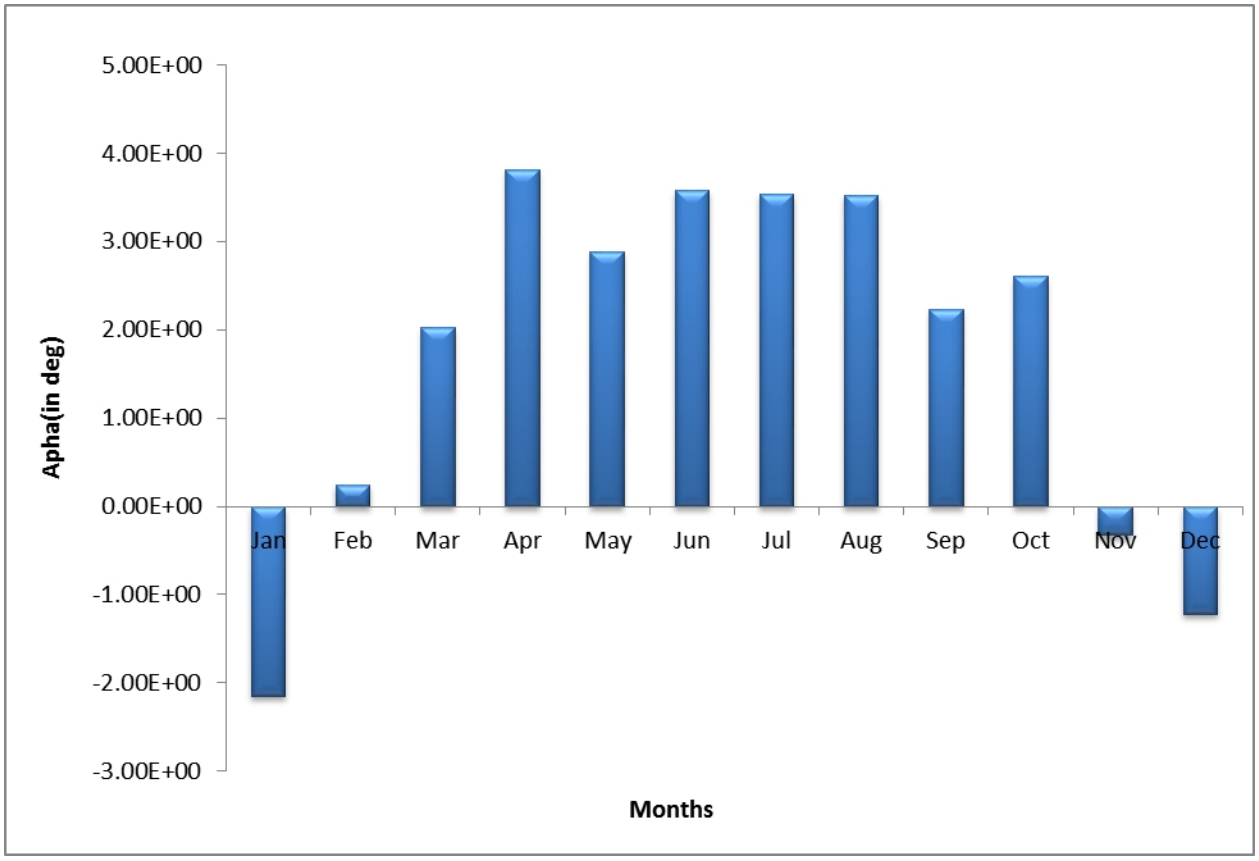


Fig. 4 Wave breaker angle

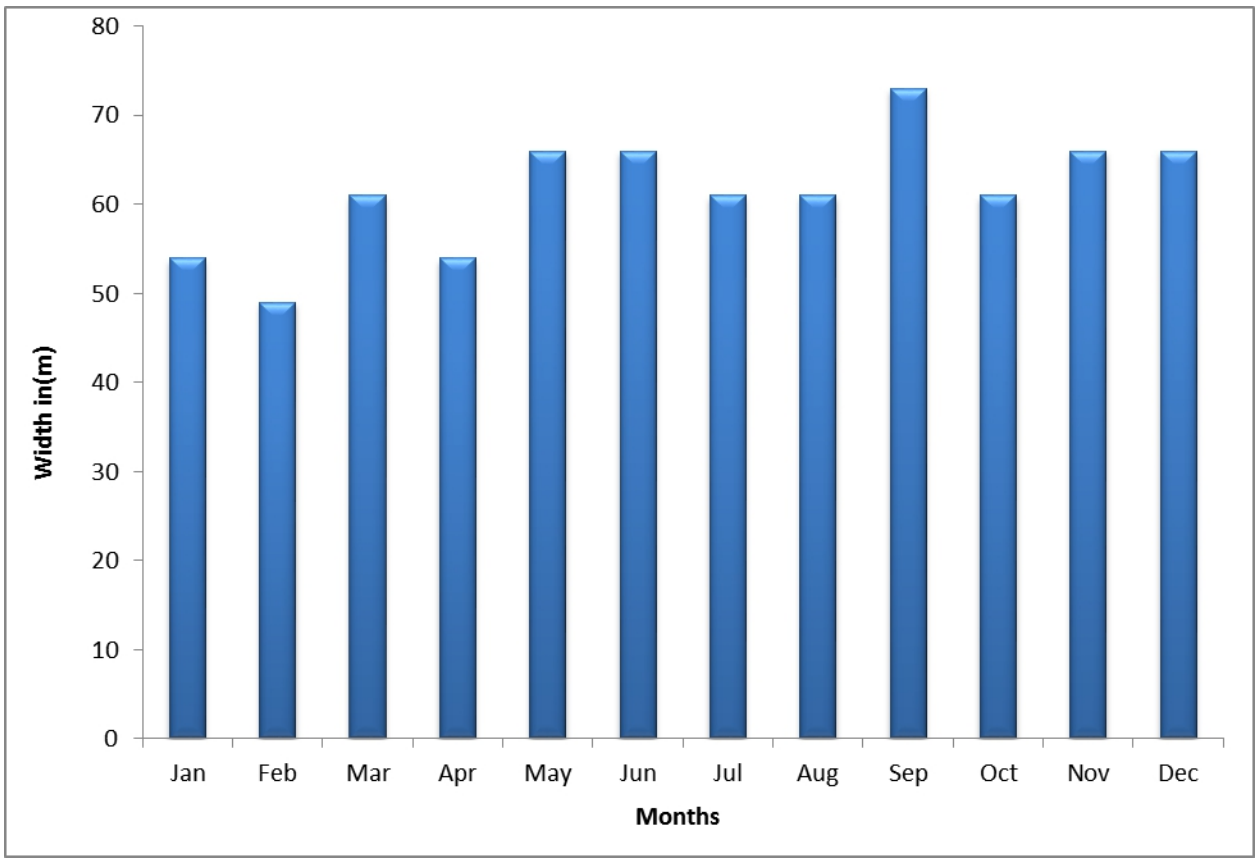


Fig. 5 Surf zone width

Table.2 Sediment transport rate

Methods	Rate (m3/year)
Komar	238251
CERC	248152
Distribution	238623

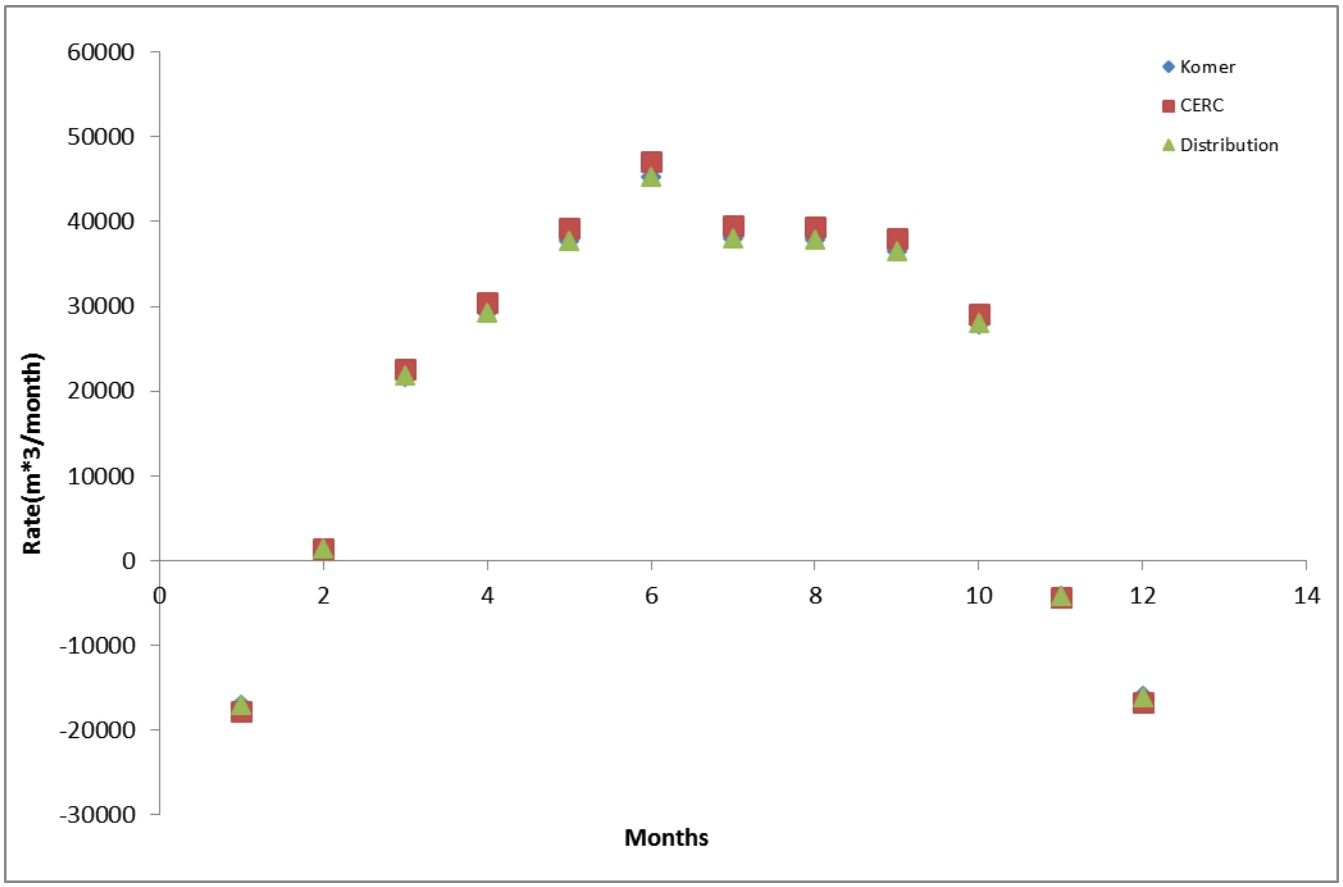


Fig. 6 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROINS

A series of 7 groins have been proposed to protect the coastal stretch of Uyyalikuppam. The stretch of transition groins field will cover a length of 750m of the shoreline. The proposed solution is expected not only to serve as coastal protection measure but also is likely to enhance the rebuilding of the lost beach although it may take a few years,

- Two groins (G1, G7) of length 40m,
- Two groins (G2, G6) of length 60m
- Two groins (G3, G5) of length 80m and
- One groin (G4) of length 90m has been proposed.

Fig. 7 shows the layout of the proposed groin field and **Plate 2** presents the layout in detail. The layout comprises of 40m groins (G1) and (G7) extending upto a water depth of 1.0m and 1.5m respectively, 60m groins (G2) and (G6) extending upto a water depth of 1.5m and 2.0m respectively, similarly 80m groins (G3) and (G5) extending upto a water depth of 3.0m and 2.2m respectively. Further, the groin of length 90m (G4) will extend upto a water depth of 2.8m. All the groins will start from the high tide level of about +1.4m towards the seaside. The layout is as per the bathymetry survey conducted during the finalization of proposal. If the work gets delayed, it is mandatory to conduct atleast one line survey along the alignment of groins to ensure each of the groins reach the design water depth as indicated above. ***Note that the lengths are likely to change prior to installation as it depends on the water depth and hence, IITM must be informed prior to the commencement of the work.***

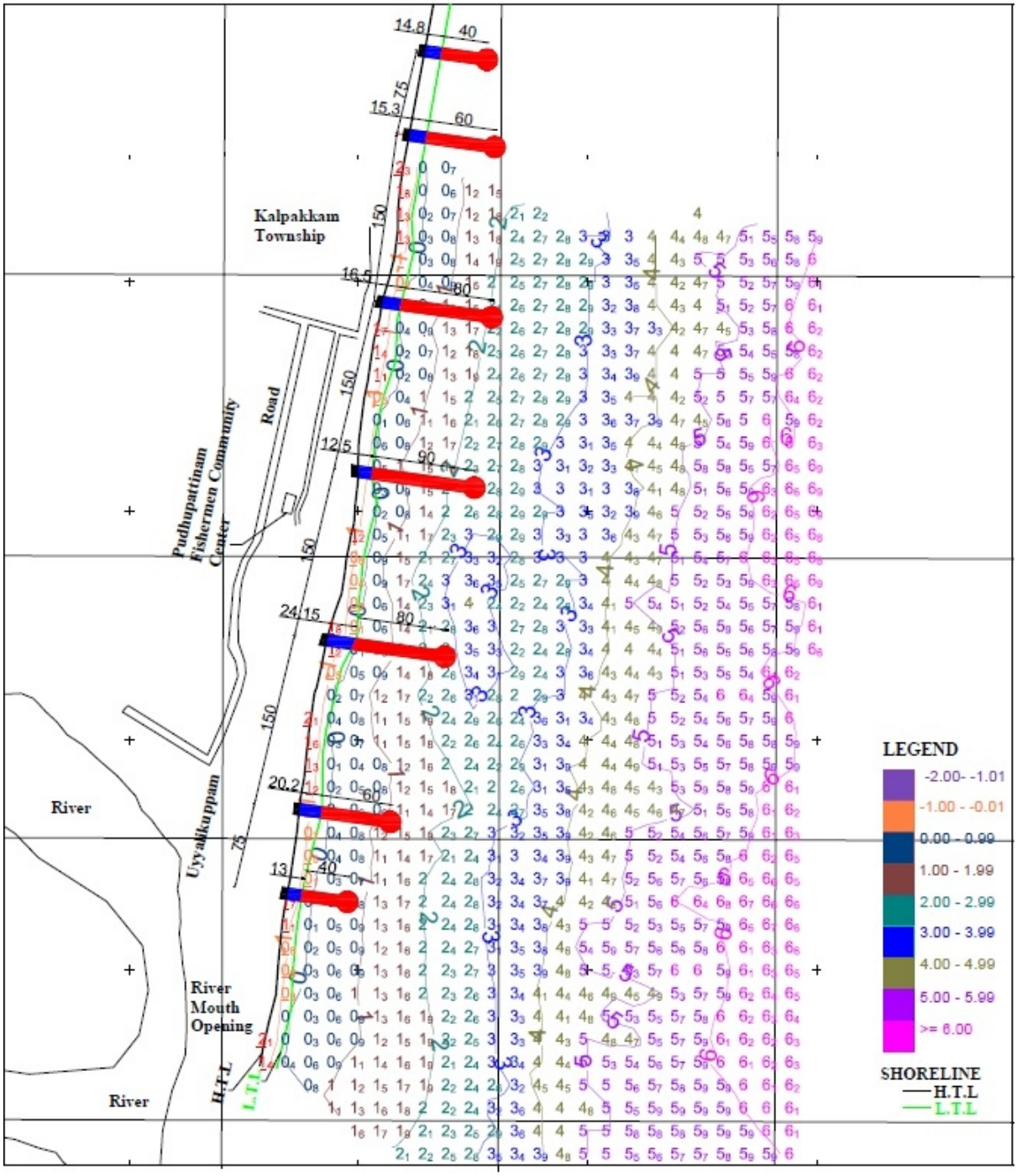


Fig. 7 Layout of groin field

7.0 NUMERICAL MODELLING FOR SHORELINE EVOLUTION

7.1 General

Structures in the near shore environment are built for different purposes, which may be for the formation of artificial harbors, shore protection measures, seawater intake systems, disposal of effluent, etc. There are several configurations of such structures with respect to the shoreline, among which, structures normal to the shore is most common.

The construction of a shore-connected structure often leads to changes in the shoreline. This warrants a study on the shoreline due to presence of the shore-connected structures. Such a study is very much essential in planning stage; so as to assess the impact of shore connected structures on the adjacent shoreline.

Numerical models offer the capability to study the effect of the wave characteristics, structure dimensions and other associated parameters in providing reasonable estimates of the shoreline response. As the ocean waves approaches the near shore it undergoes transformations like shoaling, refraction, diffraction and breaking.

The phenomena of wave breaking throw sediments to the surface due to the turbulence generated. The sediments in suspension are then driven by the wave-induced currents. Since the direction of waves in the near shore is oblique, the currents induced by them have two components.

One along the shore called longshore current mainly responsible for the long shore sediment transport, which plays an important role in the shoreline changes especially due to the shore connected structures. The other component is in the direction normal to the shore, in which case, the mode of sediment transport is called onshore-offshore sediment transport.

When a structure normal to the shoreline is constructed, it will intercept the free passage of longshore sediment transport, which results an imbalance in the quantity of sediment in the near shore especially near the structure. This leads to accretion on the up drift side and erosion on the down drift side of the structure.

7.2 Methodology

Kraus and Harikai (1983) proposed a numerical scheme to solve the one line model using Crank Nicholson implicit finite difference method. The non-dimensional equation of shoreline

$$y^*_{n,t^*+1} = B\left\{Q^*_{n,t^*+1} - Q^*_{n+1,t^*+1}\right\} + C_n$$

$$where\ B = \frac{\delta t^*}{2 \times \delta x^*}\ and\ C_n = B\left\{Q^*_{n,t^*} - Q^*_{n+1,t^*} + 2\delta x^* q^*_{n,t^*}\right\} + y^*_{n,t^*}$$

The non-dimensional shoreline is divided into 'n' grid points at equal non-dimensional interval, δx^*. Then shoreline changes over a non-dimensional time, δt^* is calculated using Crank-Nicholson finite difference scheme. The schematic diagram for finite difference scheme is shown in **Fig. 8.**

In this method, Q^* at the time interval (t^* +1) is expressed in terms of the shoreline co-ordinate of y*, first isolating the term involving α_{sp} (angle of shoreline normal to x-axis) using trigonometric identities. One of the term involving α_{sp} is then expressed as first order quantities in y* at time step (t*+1).

$$Q^* = K_D^2 \cos(\alpha_o) \sin(\alpha_b)$$

Where, $\alpha_o = \alpha - \alpha_{sp}$ and α is wave direction with respect to x-axis. The definition sketch showing the angles is shown in **Fig. 9.**

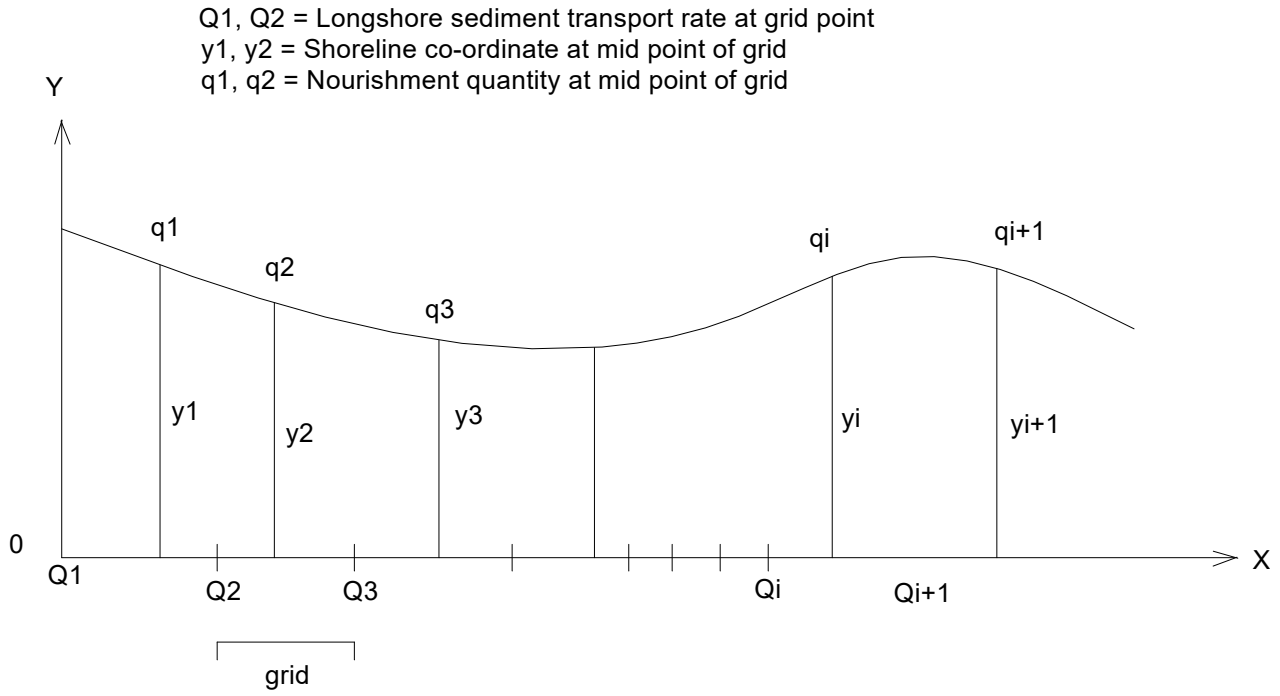


Fig. 8 Schematic diagram for finite difference scheme

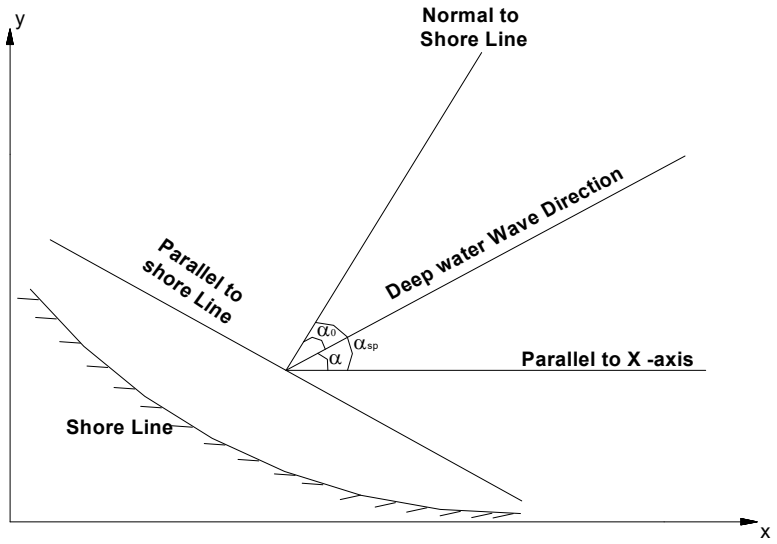


Fig. 9 Definition sketch of angles considered

The elliptical form of mild slope equation, which deals with combined refraction-diffraction,

$$Q^* = K_D^2 \cos\left(\alpha - \alpha_{sp}\right)\sin\left(\alpha_b\right) \quad (1)$$

$$Q^* = K_D^2 \sin\left(\alpha_b\right)\left\{\cos\left(\alpha\right)\sin\left(\alpha_{sp}\right)\cot\left(\alpha_{sp}\right) + \sin\left(\alpha\right)\sin\left(\alpha_{sp}\right)\right\} \quad (2)$$

$$Q^* = E_n \left\{y_{n-1,t^*+1} - y^*_{n,t^*+1}\right\} + F_n \quad (3)$$

Where $E_n = K_D^2 \left\{\cos(\alpha)\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}/\delta x^*$ and $F_n = K_D^2 \left\{\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}$

By substituting above equations, it gives the final equation as given below

$$BE_n\, Q^*_{n-1,t^*+1} - (1+2BE_n)Q^*_{n,t^*+1} + BE_n\, Q^*_{n+1,t^*+1} = E_n\left[C_n - C_{n-1}\right] - F_n$$

The above equations represent a set of (N-1) linear equation for (N-1) unknowns. The end values are specified as boundary conditions, that is, $Q^*_1 = 0$ and $Q^*_{N+1} = Q^*_N$. The above equation results into a tridiagonal form which is solved for Q^*. This process is repeated for the entire duration and non-dimensional quantity is converted into real quantities using the corresponding scale factors. The program has been validated with published results.

7.3 Input and Output

The numerical model to predict the shoreline evolution due to the shore-connected structures has been used to predict the shoreline changes due to the proposed groins. The wave characteristics given as the input to the numerical model is as per given **Table 1.** The length of the groins, water depth at the end of the groins and the present status of the shore are to be given as the input to the numerical model.

The numerical model was executed for the most frequently occurring wave characteristics for the different months as stated earlier**.** The result on the predicted shoreline variations over years are projected in **Fig. 10**. The shoreline prediction has been made at the end of 1 year, 5years, 10years, 15 years, 20 years and 25 years after the construction of the groins and has been presented by superimposing the shoreline patterns.

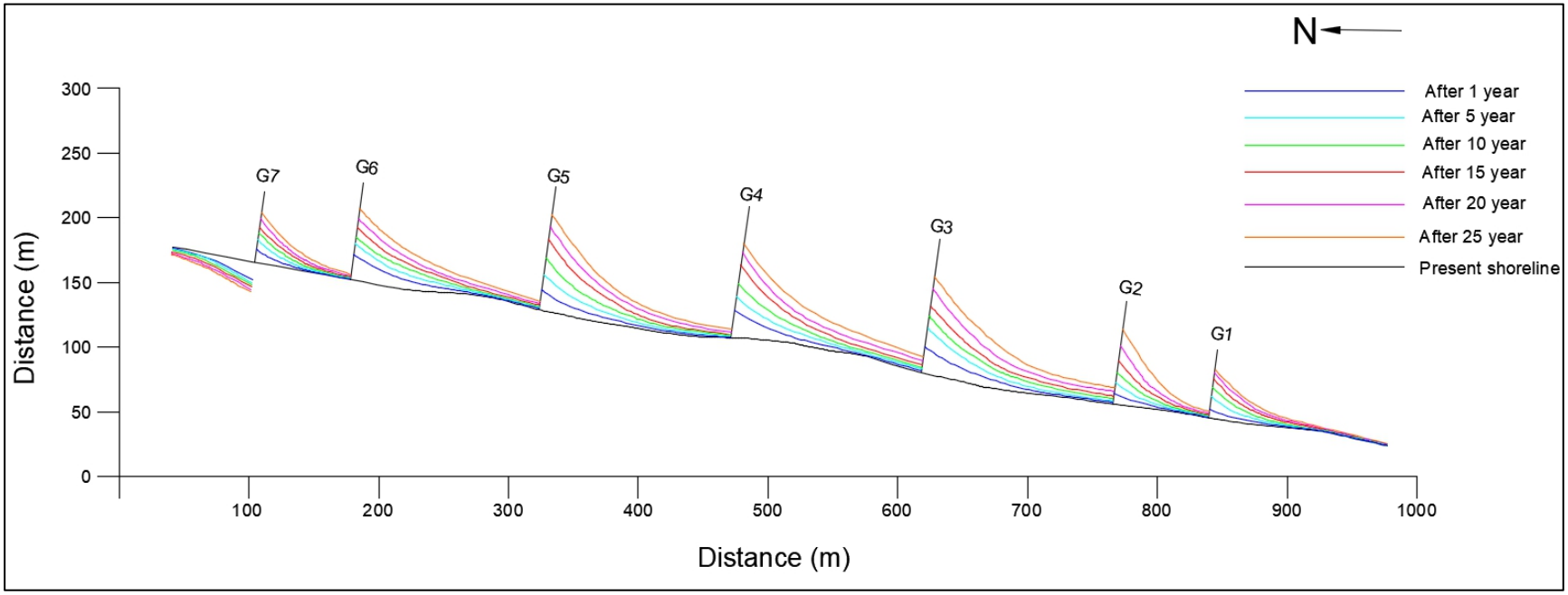


Fig. 10 Shoreline evolution

8.0 WAVE MODELLING

8.1 General

The study aims at providing an in-depth analysis on the wave characteristics of the proposed Groin Layout at Uyyalikuppam Village, Tamilnadu. A suitable numerical model is required in order to carry out this task. For the present simulation, the well-known CGWAVE model has been used.

The nonlinear wave propagation associated with most of the observed phenomenon in offshore region (e.g., wave reflection, refraction and diffraction) is generally represented by the shallow water mild slope equation.

$$\nabla.\left(C_p C_g \nabla \eta\right) + k^2 C_p C_g \eta = 0 \qquad (1)$$

Where,

C_p and C_g are the wave celerity and group celerity respectively.

η is the water surface elevation.

k is the wave number.

For the computation of near shore wave field, this model (Eqn. (1)) is subjected to the proper boundary conditions. This is provided by the bathymetry and the shore line.

8.2 Computational domain

The computational domain roughly approximates a semi-circle of radius 1.5 km. **Fig.11** shows the domain where the computations are actually performed. The direction of the incident monochromatic wave is defined with respect to the geometric northern direction.

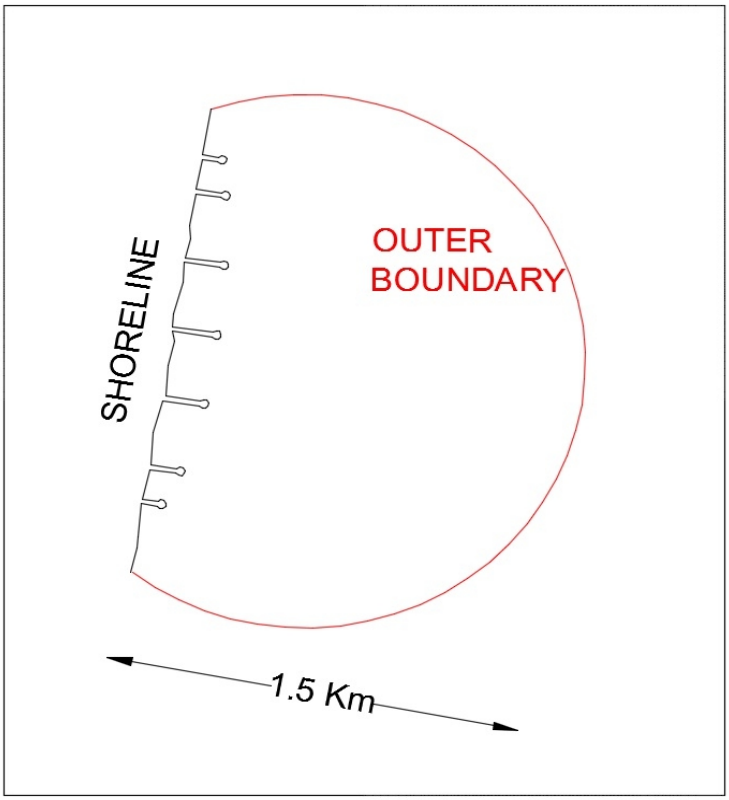


Fig. 11 Computational domain

A numerical method is required to solve the above Eqn. (1) for wave elevation. In this study, Finite Element Method (herein after abbreviated as FEM) is employed. This requires creating a mesh structure in the given computational domain. Upon creation of such a mesh, the domain is represented by nodal points which are connected with each other through the created mesh. The numerical solution of Eqn. (1) is sought in those nodes. This mesh has been generated using the commercial package GAMBIT. The procedure for generation of grid in GAMBIT as follows:

- Based on the region of the sea whose analysis is required add a path in Google earth software.
- Taking the two end nodes of the path draw a semicircle which would represent the domain for which the wave analysis is required.
- Choose the type of elements (tri/quad) and the sizing of mesh.
- Mesh will be generated from which we would be able to know significant wave height and phase at each node.

8.3 Detail of the mesh structure

The CGWAVE model utilizes triangular mesh units in the computational domain. Due to the complexity in the shoreline geometry, an unstructured mesh is desired. Hence a triangular unstructured mesh is generated in GAMBIT, mesh generation software. In such a mesh the nodal spacing is optimized so as to adapt to the nearby portion of the shoreline boundary. The outer semicircular periphery is modeled by 1176 nodes with a spacing of 2 m and the inner shoreline is modeled by nodes with a spacing of 2 m. Then an unstructured mesh is created with an average spacing of 2m inside the domain. This leads to a total number of 226372 nodes with 450556 numbers of triangular elements. The mesh is shown in **Fig. 12.**

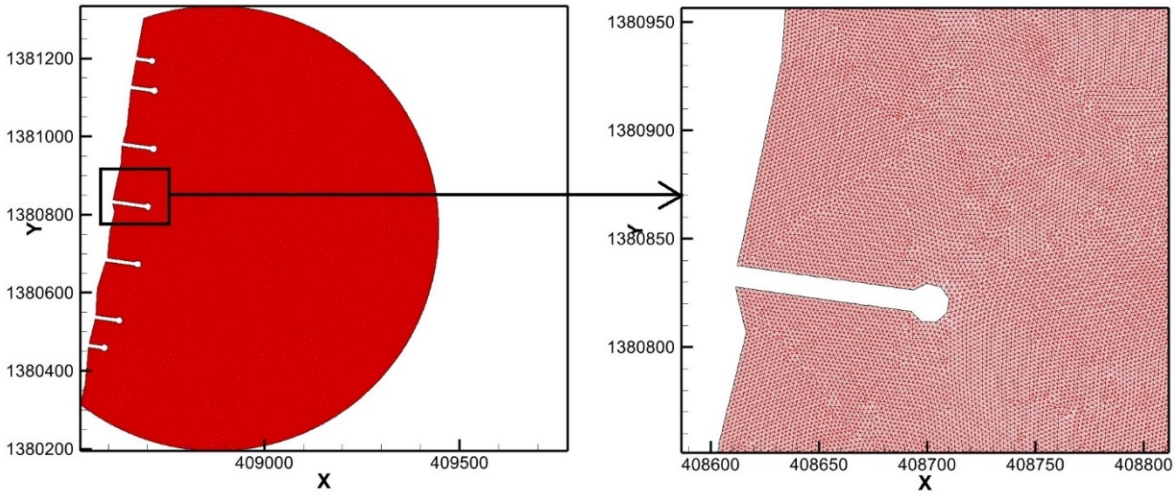


Fig. 12 Mesh Structure adopted for the wave propagation modeling

8.4 Results and discussion

A total number of five wave directions have been simulated in order to investigate the wave tranquility inside the proposed region. The wave directions are chosen such that these represent an annual year. The wave period of the computations is given as 6s-12s to observe the wave climate. The incident wave angle is varied to simulate different wave directional scenarios. The wave climates representing typical wave directions are presented. **Fig. 13** to **Fig. 17** reports the wave phase diagram and the wave height distribution for different wave approach angles of 60^0, 90^0, 115^0, 130^0 and 165^0 respectively.

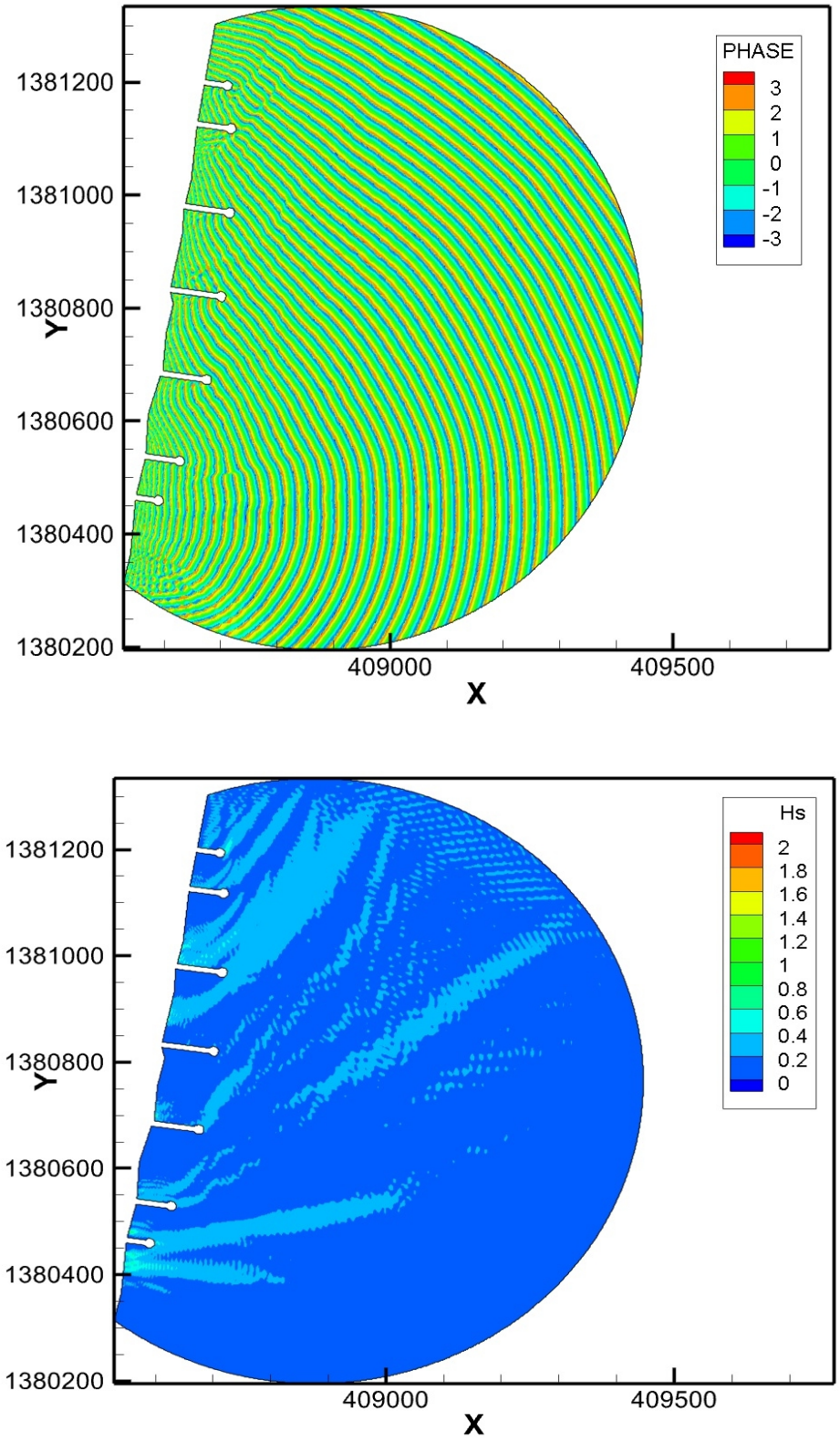


Fig. 13 Phase distributions and Wave height distribution for the wave approach angle from 60^0

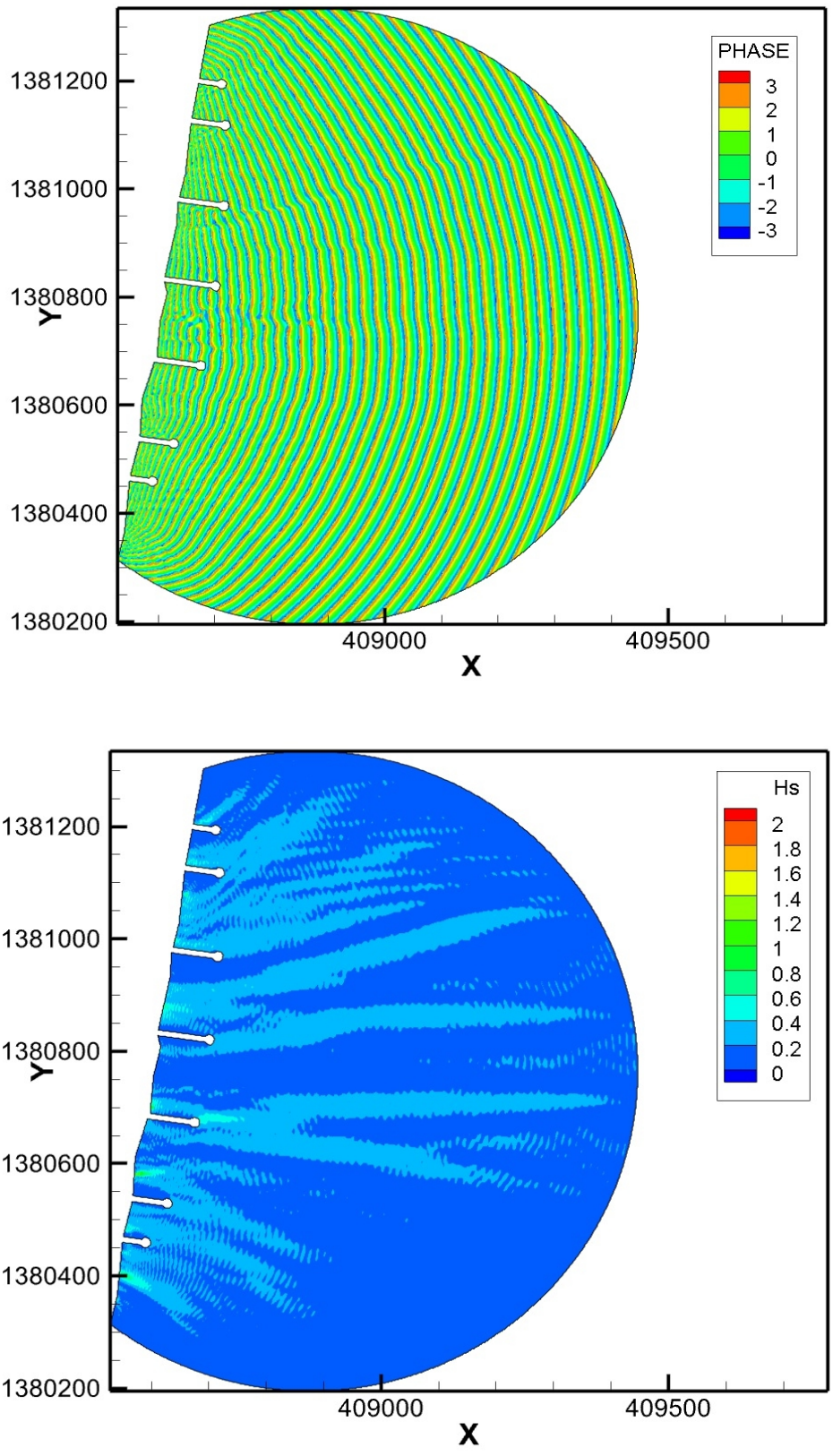


Fig. 14 Phase distributions and Wave height distribution for the wave approach angle from 90^0

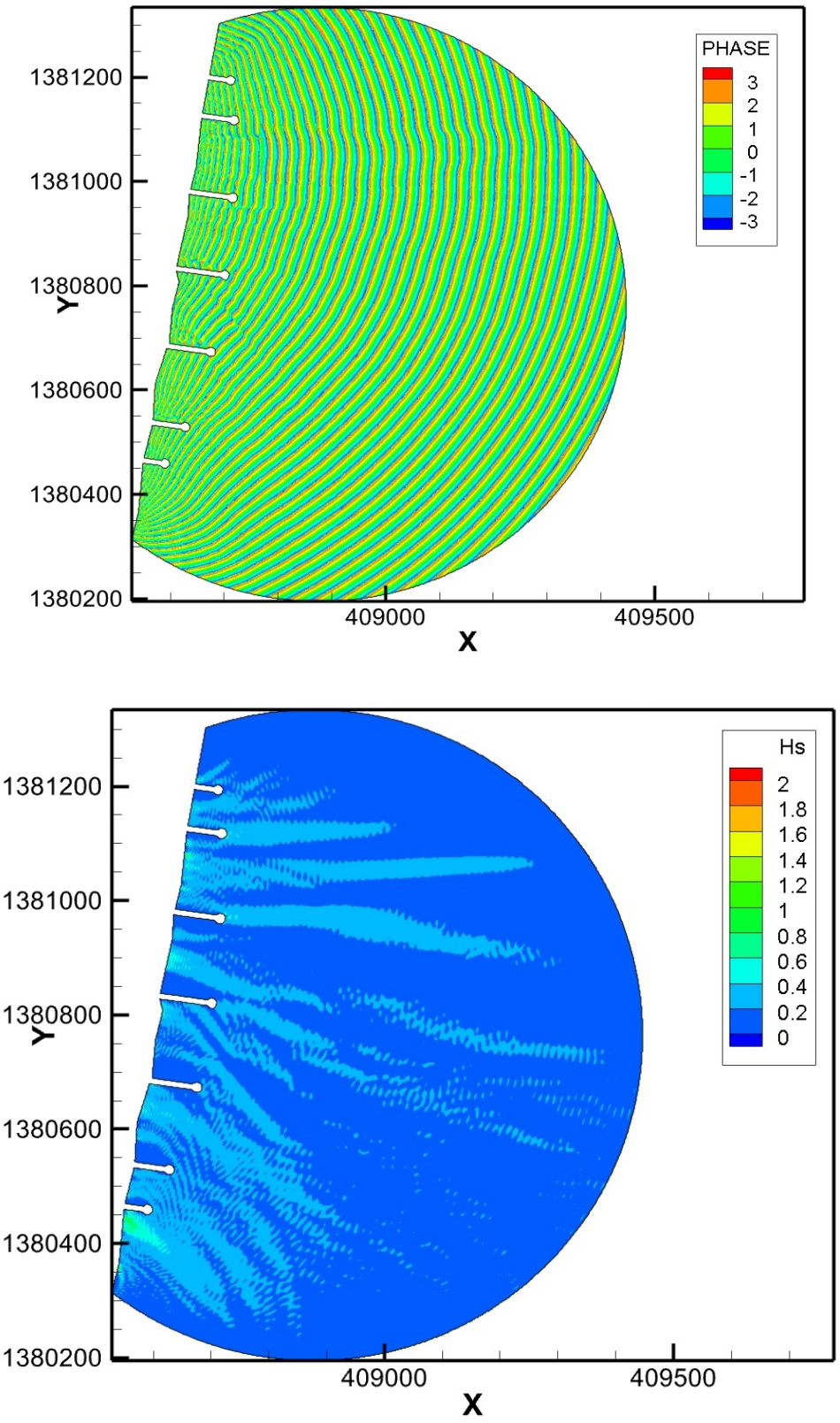


Fig. 15 Phase distributions and Wave height distribution for the wave approach angle from 115^0

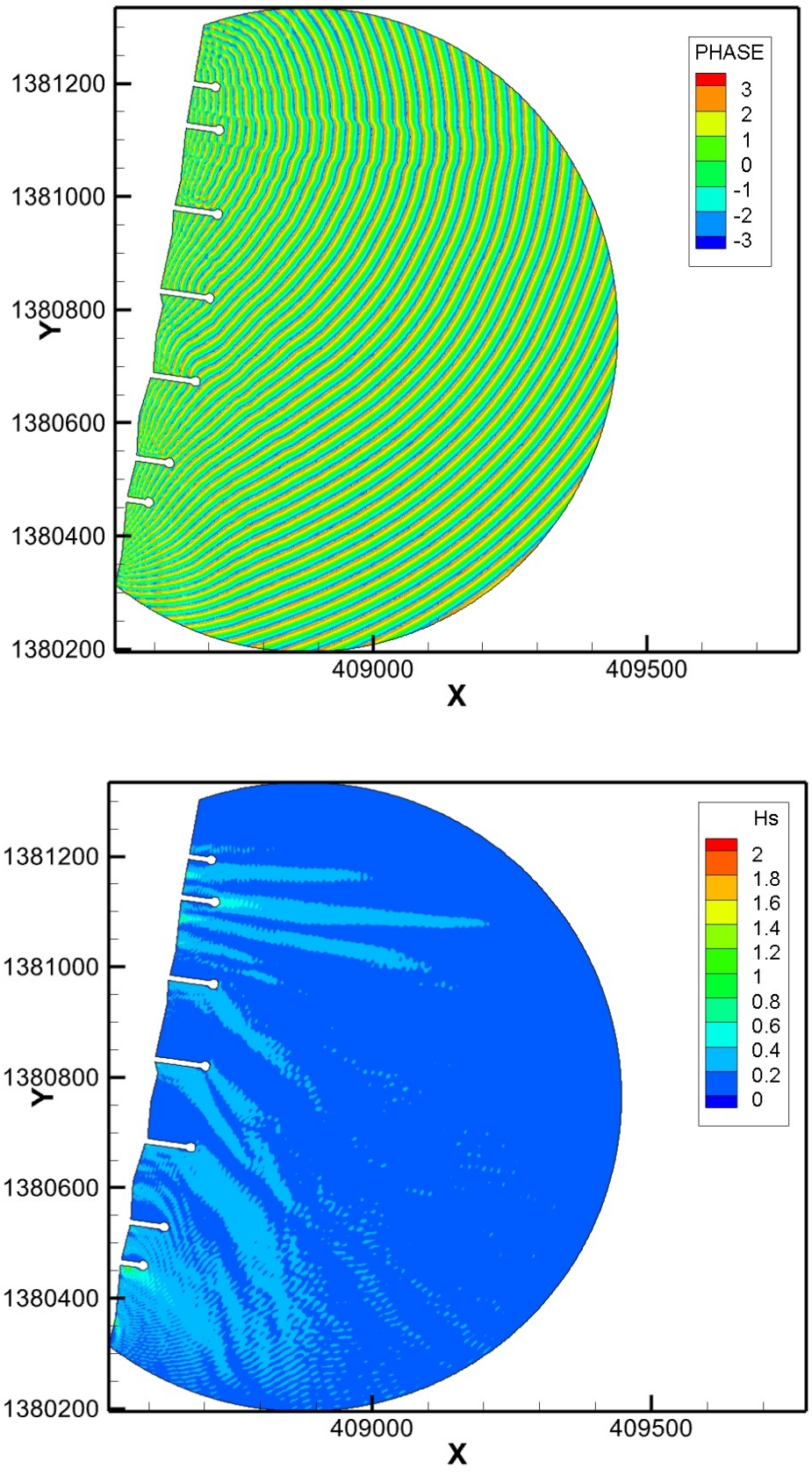


Fig. 16 Phase distributions and Wave height distribution for the wave approach angle from 130^0

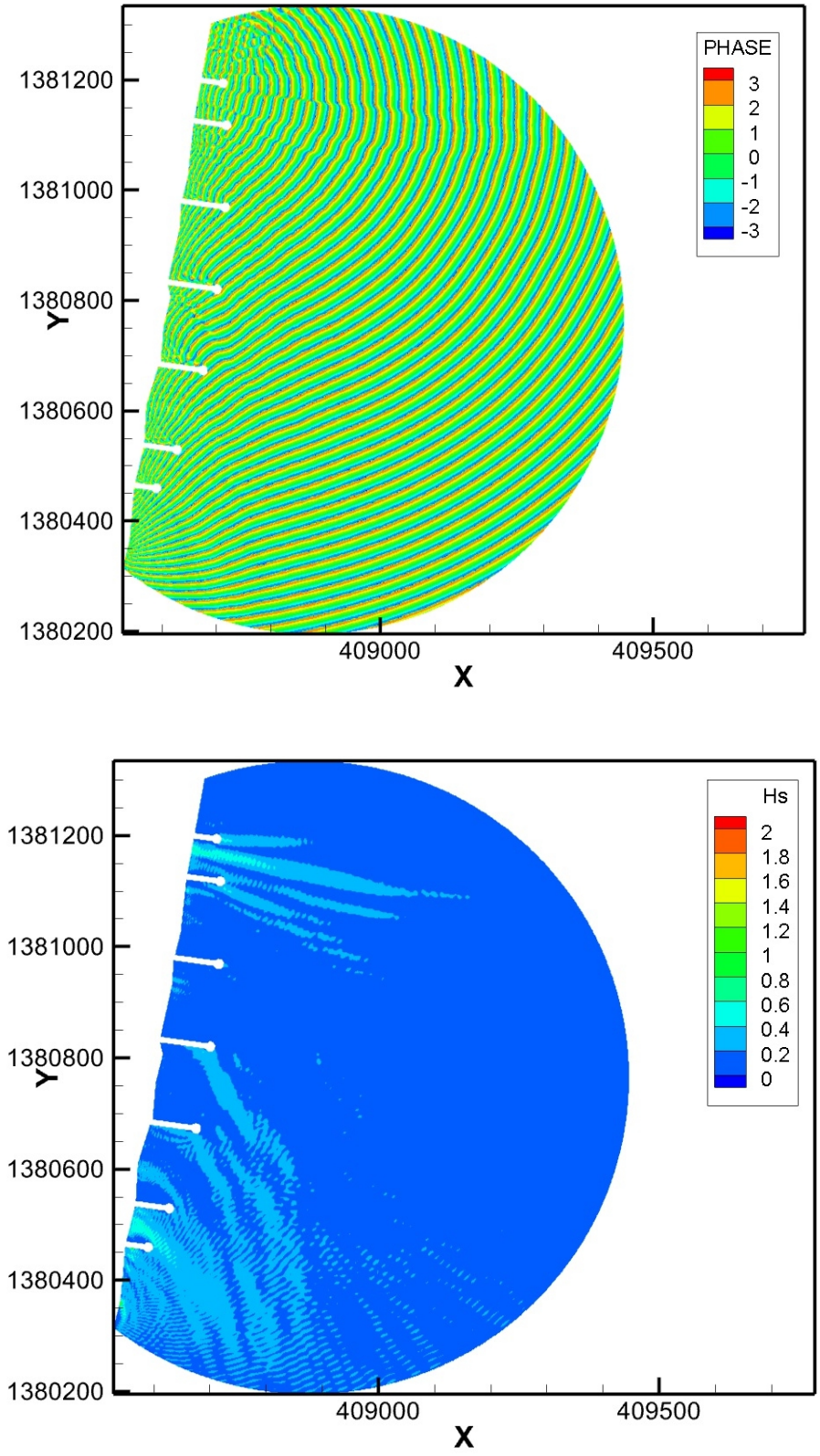


Fig. 17 Phase distributions and Wave height distribution for the wave approach angle from 165^0

9.0 DESIGN OF GROINS

9.1 Design water level

Following design data has been adopted for the design of tetrapod section. The Mean high water level was +1.40m CD. For the design of the section, MHWL is adopted as maximum water level.

The design water level for the groin can thus be set as the sum of MHWS and the design water depth is,

d = 3+1.4+1.25= 5.65m

where +1.25m surge is considered.

Hmax = 0.78 x 5.65

= 4.4 m

Significant wave Height = Hmax /1.6 = 2.75m

Take Design wave height as 2.75m.

9.2 Design of layers

A typical design of groin is detailed below.

Armour Layer

The size of the armour stones for the groin section is calculated by using the Hudson formula, which is recommended by CERC (1984). Quarry stones are used as armour stones.

$$W = \frac{W_r H_D^3}{K_D (S_r - 1)^3 \cot\theta}$$

Where,

W=Weight of an individual armour unit in the primary cover layer.

W_r =Unit weight of Quarry stones, 2.65 T/m^3.

H_D =Design wave height at the structure site in meters,

S_r =Specific weight of armour unit relating to water at the structure

$S_r = (W_r / W_w)$

W_w =Unit weight of seawater = 1025 kg/m^3

θ =Angle of structure slope measured with the horizontal in degrees =1:2 (Chosen) for Head section, 1:1.5 (Chosen) for trunk sections

K_D =Stability coefficient is 2 for rough quarry stones in breaking condition.

From Hudson's formula, the weight of Stone is worked out to be 2.0T to 3.0T in two layer to withstand the design wave height of 2.75m at the maximum water depth.

The thickness of the armour layer is calculated by following,

$$t = nK\delta\left[\frac{w}{w_r}\right]^{\frac{1}{3}} = 1.82$$

1.96m thickness was adopted for armour layer.

Under layer

Rough angular quarry stones of weight 500 Kg to 800 Kg are suggested for toe layer for which W_r =2650 kg/m^3 with 1.25m thickness for the trunk and head portion.

Core layer

The size of stone in core layer is 100 kg to 300 kg rough angular quarry stones are suggested for core layer for which W_r =2650 kg / m^3.

Toe Mound

The size of stone in toe mound is taken as W /10 to W /15 (as per CERC, 1984).

Rough angular quarry stones of weight 500 Kg to 800 Kg are suggested for toe layer for which W_r =2650 kg/m^3 with 1.25m thickness for the trunk and head portion.

Crest width

Crest width, r is arrived from the formula

$$r = nK_\delta\left[\frac{W}{W_r}\right]^{\frac{1}{3}}$$

Where,

n= number of tetrapods or stones on the crest

K_δ =Layer coefficient

Hence, Crest Width = 4m

Crest elevation

The crest elevation of the groin is given by,

Crest elevation = MHWS + Design Water Level + free board

Free board may be adopted in calculating the design elevation to give free height for exceptional cases of storms and cyclone waves that hit the toe of the structure to avoid dangers. For groins, (+) 4.0m crest elevation is maintained up to (+) 1.5m cross sections.

Filter layer

The size of stone in filter layer is taken as 1 kg to 10 kg Rough angular quarry stones are for which W_r =2650 kg / m^3. The thickness of filter layer is 0.3m.

Geotextile layer

1.5mm to 10mm thick geotextile layer can be laid under the filter layer throughout the structure to retain the soil particles.

The detailed plan, longitudinal sections and cross sections of the groin are given in **Plates 3 to 16.**

10.0 BILL OF QUANTITY

10.1 Quantity of material for 40m length Groin (G1)

Trunk Sections

Uyyalikuppam -G1-40m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)0.5m to (-)1.0m	19.62	24.13	19.66	21.90	429.64	300.75	796.98
0.0m to (-)0.5m	10.37	19.66	16.38	18.02	186.90	130.83	346.70
0.0m	10.00	16.38	16.38	16.38	163.83	114.68	303.90
0.0m to (+)0.5m	5.20	16.38	24.59	20.48	106.52	74.56	197.59
(+)0.5m to (+)1.0m	4.38	24.59	24.59	24.59	107.68	75.38	199.75
(+)1.0m to (+)1.5m	3.43	24.59	24.59	24.59	84.33	59.03	156.43
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**2616.50**

Uyyalikuppam -G1-40m Groin Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)0.5m to (-)1.0m	19.62	12.58	12.58	12.58	246.73	172.71	457.69
						Total	**457.69**

Uyyalikuppam -G1-40m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)0.5m to (-)1.0m	19.62	6.39	15.39	10.89	213.74	149.61	396.48
0.0m to (-)0.5m	10.37	15.39	10.75	13.07	135.55	94.89	251.45
0.0m	10.00	10.75	10.75	10.75	107.50	75.25	199.41
0.0m to (+)0.5m	5.20	10.75	10.75	10.75	55.90	39.13	103.69
(+)0.5m to (+)1.0m	4.38	10.75	10.75	10.75	47.08	32.96	87.34
(+)1.0m to (+)1.5m	3.43	10.75	10.75	10.75	36.87	25.81	68.40
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**1304.25**

Uyyalikuppam -G1-40m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)0.5m to (-)1.0m	19.62	16.33	15.70	16.02	314.28	219.99	582.98
0.0m to (-)0.5m	10.37	15.70	15.70	15.70	162.84	113.99	302.06
0.0m	10.00	15.70	15.70	15.70	157.03	109.92	291.28
						Total	**1176.32**

Uyyalikuppam -G1-40m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)0.5m to (-)1.0m	19.62	7.97	7.52	7.74	151.86	106.30	281.70
0.0m to (-)0.5m	10.37	7.52	7.07	7.29	75.60	52.92	140.23
0.0m	10.00	7.07	7.07	7.07	70.65	49.46	131.06
0.0m to (+)0.5m	5.20	7.07	5.27	6.17	32.06	22.44	59.47
(+)0.5m to (+)1.0m	4.38	5.27	5.27	5.27	23.06	16.14	42.78
(+)1.0m to (+)1.5m	3.43	5.27	5.27	5.27	18.06	12.64	33.50
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**825.85**

Uyyalikuppam -G1-40m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average Base length**	**Geo textile layer Area(m^2)**
(-)0.5m to (-)1.0m	19.62	26.25	515.03
0.0m to (-)0.5m	10.37	24.75	256.66
0.0m	10.00	21	210.00
0.0m to (+)0.5m	5.20	18	93.60
(+)0.5m to (+)1.0m	4.38	18	78.84
(+)1.0m to (+)1.5m	3.43	18	61.74
Shore anchor	16.00	18	288.00
		Total	**1503.86**

Round Head Section

Head portion (-1.00 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	3.45	9.90	3.00	493.66		
Armour Layer	1.49	5.52	2.54	79.45		
Total Armour layer					**217.46**	**576.27**
Under layer						
Under layer	2.74	8.02	2.54	261.39		
Under layer	1.49	5.22	2.24	68.56		
Total Under layer					**101.24**	**268.27**
Toe mound layer						
Toe mound	1.25	15.40	12.90	787.92		
Toe mound	1.25	8.02	5.52	181.94		
Total Toe mound layer					**318.14**	**843.07**
Core Material	1.49	5.22	2.24	68.56	**35.99**	**95.38**
Filter Layer	0.30	17.00	16.40	262.74	**137.94**	**365.54**
						Quantity in (m^2)
Geotextile layer						**681**

Total quantity of materials for 40m Groin (G1)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
40m	**3193**	**726**	**1400**	**2019**	**1191**	**2185**

10.2 Quantity of material for 60m length Groin (G2)

Trunk Sections

Uyyalikuppam -G2-50m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	11.33	27.67	24.13	25.90	293.43	205.40	544.32
(-)0.5m to (-)1.0m	24.33	24.13	19.66	21.90	532.78	372.94	988.30
0.0m to (-)0.5m	14.00	19.66	16.38	18.02	252.33	176.63	468.06
0.0m	10.34	16.38	16.38	16.38	169.40	118.58	314.23
0.0m to (+)0.5m	6.57	16.38	24.59	20.48	134.58	94.21	249.65
(+)0.5m to (+)1.0m	4.79	24.59	24.59	24.59	117.76	82.43	218.45
(+)1.0m to (+)1.5m	8.84	24.59	24.59	24.59	217.33	152.13	403.16
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**3801.32**

Uyyalikuppam -G2-50m Groin Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	11.33	14.83	12.58	13.70	155.25	108.67	287.98
(-)0.5m to (-)1.0m	24.33	12.58	12.58	12.58	305.96	214.17	567.56
						Total	**855.54**

Uyyalikuppam -G2-50m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	11.33	10.03	6.39	8.21	93.05	65.14	172.61
(-)0.5m to (-)1.0m	24.33	6.39	15.39	10.89	265.04	185.53	491.66
0.0m to (-)0.5m	14.00	15.39	10.75	13.07	183.00	128.10	339.47
0.0m	10.34	10.75	10.75	10.75	111.15	77.81	206.18
0.0m to (+)0.5m	6.57	10.75	10.75	10.75	70.62	49.44	131.01
(+)0.5m to (+)1.0m	4.79	10.75	10.75	10.75	51.49	36.04	95.52
(+)1.0m to (+)1.5m	8.84	10.75	10.75	10.75	95.03	66.52	176.27
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**1810.21**

Uyyalikuppam -G2-50m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	11.33	16.33	16.33	16.33	185.06	129.54	206.18
(-)0.5m to (-)1.0m	24.33	16.33	15.70	16.02	389.72	272.80	131.01
0.0m to (-)0.5m	14.00	15.70	15.70	15.70	219.84	153.89	95.52
0.0m	10.34	15.70	15.70	15.70	162.36	113.66	301.19
						Total	**733.90**

Uyyalikuppam -G2-50m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	11.33	8.42	7.97	8.19	92.79	64.95	172.13
(-)0.5m to (-)1.0m	24.33	7.97	7.52	7.74	188.31	131.82	349.32
0.0m to (-)0.5m	14.00	7.52	7.07	7.29	102.06	71.44	189.32
0.0m	10.34	7.07	7.07	7.07	73.05	51.14	135.51
0.0m to (+)0.5m	6.57	7.07	5.27	6.17	40.50	28.35	75.14
(+)0.5m to (+)1.0m	4.79	5.27	5.27	5.27	25.22	17.65	46.78
(+)1.0m to (+)1.5m	8.84	5.27	5.27	5.27	46.54	32.58	86.34
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**1191.66**

Uyyalikuppam -G2-50m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)1.0m to (-)1.5m	11.33	27.75	314.41
(-)0.5m to (-)1.0m	24.33	26.25	638.66
0.0m to (-)0.5m	14.00	24.75	346.50
0.0m	10.34	21.00	217.14
0.0m to (+)0.5m	6.57	18.00	118.26
(+)0.5m to (+)1.0m	4.79	18.00	86.22
(+)1.0m to (+)1.5m	8.84	18.00	159.12
Shore anchor	16.00	18.00	288.00
		Total	**2168.31**

Round Head Section

Head portion (-1.5 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	3.95	10.90	3.00	663.60		
Armour Layer	1.99	6.52	2.54	136.39		
Total Armour layer					**276.79**	**733.49**
Under layer						
Under layer	3.24	9.02	2.54	375.48		
Under layer	1.99	6.22	2.24	120.05		
Total Under layer					**134.10**	**355.37**
Toe mound layer						
Toe mound	1.25	16.40	13.90	902.92		
Toe mound	1.25	9.02	6.52	239.01		
Total Toe mound layer					**348.55**	**923.67**
Core Material	1.99	6.22	2.24	120.05	**63.03**	**167.03**
Filter Layer	0.30	18.00	17.40	295.15	**154.95**	**410.62**
						Quantity in (m^2)
Geotextile layer						**763.41**

Total quantity of materials for 60m Groin (G2)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
60m	**4535**	**1211**	**1977**	**1658**	**1602**	**2932**

10.3 Quantity of material for 80m length Groin (G3)

Trunk Sections

Uyyalikuppam -G3-80m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5m to (-)3.0m	13.21	38.27	34.73	36.50	482.27	337.59	894.62
(-)2.0m to (-)2.5m	5.72	34.73	31.20	32.97	188.56	131.99	349.79
(-)1.5m to (-)2.0m	12.56	31.20	27.67	29.43	369.67	258.77	685.73
(-)1.0m to (-)1.5m	15.84	27.67	24.13	25.90	410.24	287.17	760.99
(-)0.5m to (-)1.0m	13.94	24.13	19.66	21.90	305.26	213.68	566.25
0.0m to (-)0.5m	10.55	19.66	16.38	18.02	190.15	133.10	352.72
0.0m	8.17	16.38	16.38	16.38	133.80	93.66	248.19
0.0m to (+)0.5m	8.40	16.38	24.59	20.48	172.07	120.45	319.18
(+)0.5m to (+)1.0m	4.00	24.59	24.59	24.59	98.34	68.84	182.42
(+)1.0m to (+)1.5m	11.75	24.59	24.59	24.59	288.88	202.21	535.87
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**5510.92**

Uyyalikuppam -G3-80m Groin Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5m to (-)3.0m	13.21	21.59	19.34	20.46	270.37	189.26	501.54
(-)2.0m to (-)2.5m	5.72	19.34	17.08	18.21	104.16	72.91	193.21
(-)1.5m to (-)2.0m	12.56	17.08	14.83	15.96	200.40	140.28	371.75
(-)1.0m to (-)1.5m	15.84	14.83	12.58	13.70	217.04	151.93	402.62
(-)0.5m to (-)1.0m	13.94	12.58	12.58	12.58	175.30	122.71	325.19
						Total	**1794.30**

Uyyalikuppam -G3-80m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5m to (-)3.0m	13.21	25.45	19.56	22.50	297.32	208.12	551.53
(-)2.0m to (-)2.5m	5.72	19.56	14.42	16.99	97.18	68.02	180.26
(-)1.5m to (-)2.0m	12.56	14.42	10.03	12.23	153.56	107.49	284.85
(-)1.0m to (-)1.5m	15.84	10.03	6.39	8.21	130.09	91.06	241.32
(-)0.5m to (-)1.0m	13.94	6.39	15.39	10.89	151.86	106.30	281.70
0.0m to (-)0.5m	10.55	15.39	10.75	13.07	137.91	96.53	255.81
0.0m	8.17	10.75	10.75	10.75	87.79	61.45	162.85
0.0m to (+)0.5m	8.40	10.75	10.75	10.75	90.30	63.21	167.50
(+)0.5m to (+)1.0m	4.00	10.75	10.75	10.75	43.00	30.10	79.76
(+)1.0m to (+)1.5m	11.75	10.75	10.75	10.75	126.31	88.42	234.30
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**2637.38**

Uyyalikuppam -G3-80m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5m to (-)3.0m	13.21	16.33	16.33	16.33	215.82	151.07	400.34
(-)2.0m to (-)2.5m	5.72	16.33	16.33	16.33	93.43	65.40	173.31
(-)1.5m to (-)2.0m	12.56	16.33	16.33	16.33	205.15	143.61	380.55
(-)1.0m to (-)1.5m	15.84	16.33	16.33	16.33	258.72	181.11	479.93
(-)0.5m to (-)1.0m	13.94	16.33	15.70	16.02	223.29	156.30	414.21
0.0m to (-)0.5m	10.55	15.70	15.70	15.70	165.66	115.96	307.30
0.0m	8.17	15.70	15.70	15.70	128.24	89.77	237.89
						Total	**2393.54**

Uyyalikuppam -G3-80m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5m to (-)3.0m	13.21	9.77	9.32	9.54	126.05	88.24	233.83
(-)2.0m to (-)2.5m	5.72	9.32	8.87	9.09	51.99	36.40	96.45
(-)1.5m to (-)2.0m	12.56	8.87	8.42	8.64	108.52	75.96	201.30
(-)1.0m to (-)1.5m	15.84	8.42	7.97	8.19	129.73	90.81	240.65
(-)0.5m to (-)1.0m	13.94	7.97	7.52	7.74	107.90	75.53	200.15
0.0m to (-)0.5m	10.55	7.52	7.07	7.29	76.91	53.84	142.67
0.0m	8.17	7.07	7.07	7.07	57.70	40.39	107.03
0.0m to (+)0.5m	8.40	7.07	5.27	6.17	51.79	36.25	96.06
(+)0.5m to (+)1.0m	4.00	5.27	5.27	5.27	21.06	14.74	39.07
(+)1.0m to (+)1.5m	11.75	5.27	5.27	5.27	61.86	43.30	114.76
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**1609.08**

Uyyalikuppam -G3-80m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)2.5m to (-)3.0m	13.21	32.25	426.12
(-)2.0m to (-)2.5m	5.72	30.75	175.89
(-)1.5m to (-)2.0m	12.56	29.25	367.38
(-)1.0m to (-)1.5m	15.84	27.75	439.56
(-)0.5m to (-)1.0m	13.94	26.25	365.93
0.0m to (-)0.5m	10.55	24.75	261.11
0.0m	8.17	21.00	171.51
0.0m to (+)0.5m	8.40	18.00	151.20
(+)0.5m to (+)1.0m	4.00	18.00	72.00
(+)1.0m to (+)1.5m	11.75	18.00	211.50
Shore anchor	16.00	18.00	288.00
		Total	**2930.19**

Round Head Section

Head portion (-3.0 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	5.45	13.90	3.00	1391.34		
Armour Layer	3.49	9.52	2.54	442.96		
Total Armour layer					**497.90**	**1319.44**
Under layer						
Under layer	4.74	12.02	2.54	900.27		
Under layer	3.49	9.22	2.24	404.29		
Total Under layer					**260.39**	**690.03**
Toe mound layer						
Toe mound	1.25	19.40	16.90	1295.03		
Toe mound	1.25	12.02	9.52	457.32		
Total Toe mound layer					**439.80**	**1165.47**
Core Material	3.49	9.22	2.24	404.29	**212.25**	**562.48**
Filter Layer	0.30	21.00	20.40	403.67	**211.92**	**561.60**
						Quantity in (m^2)
Geotextile layer						**1039**

Total quantity of materials for 80m Groin (G3)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
80m	**6830**	**2484**	**3200**	**3559**	**2171**	**3969**

10.4 Quantity of material for 90m length Groin (G4)

Trunk Sections

Uyyalikuppam -G4-90m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5 m to (-)2.8m	13.07	36.85	34.73	35.79	467.81	327.46	867.78
(-)2.0 m to (-)2.5m	11.04	34.73	31.20	32.97	363.94	254.76	675.11
(-)1.5m to (-)2.0m	18.40	31.20	27.67	29.43	541.55	379.09	1004.58
(-)1.0m to (-)1.5m	18.56	27.67	24.13	25.90	480.68	336.48	891.66
(-)0.5m to (-)1.0m	14.03	24.13	19.66	21.90	307.23	215.06	569.91
0.0 m to (-)0.5m	8.00	19.66	16.38	18.02	144.19	100.93	267.47
0m	6.90	16.38	16.38	16.38	113.04	79.13	209.69
0.0m to (+)0.5m	4.00	16.38	24.59	20.48	81.94	57.36	151.99
(+)0.5m to (+)1.0m	4.19	24.59	24.59	24.59	103.01	72.11	191.09
(+)1.0m to (+)1.5m	4.31	24.59	24.59	24.59	105.96	74.17	196.56
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**5640.99**

Uyyalikuppam -G4-90m Groin Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5 m to (-)2.8m	13.07	20.69	19.34	20.01	261.56	183.09	485.19
(-)2.0 m to (-)2.5m	11.04	19.34	17.08	18.21	201.03	140.72	372.91
(-)1.5m to (-)2.0m	18.40	17.08	14.83	15.96	293.58	205.51	544.60
(-)1.0m to (-)1.5m	18.56	14.83	12.58	13.70	254.31	178.02	471.75
(-)0.5m to (-)1.0m	14.03	12.58	12.58	12.58	176.43	123.50	327.29
						Total	**2201.73**

Uyyalikuppam -G4-90m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5 m to (-)2.8m	13.07	23.00	19.56	21.28	278.12	194.69	515.92
(-)2.0 m to (-)2.5m	11.04	19.56	14.42	16.99	187.56	131.29	347.92
(-)1.5m to (-)2.0m	18.40	14.42	10.03	12.23	224.96	157.47	417.30
(-)1.0m to (-)1.5m	18.56	10.03	6.39	8.21	152.43	106.70	282.76
(-)0.5m to (-)1.0m	14.03	6.39	15.39	10.89	152.84	106.99	283.52
0.0 m to (-)0.5m	8.00	15.39	10.75	13.07	104.57	73.20	193.98
0m	6.90	10.75	10.75	10.75	74.17	51.92	137.59
0.0m to (+)0.5m	4.00	10.75	10.75	10.75	43.00	30.10	79.76
(+)0.5m to (+)1.0m	4.19	10.75	10.75	10.75	45.04	31.53	83.55
(+)1.0m to (+)1.5m	4.31	10.75	10.75	10.75	46.33	32.43	85.94
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**2625.73**

Uyyalikuppam -G4-90m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5 m to (-)2.8m	13.07	16.33	16.33	16.33	213.48	149.44	396.01
(-)2.0 m to (-)2.5m	11.04	16.33	16.33	16.33	180.32	126.23	334.50
(-)1.5m to (-)2.0m	18.40	16.33	16.33	16.33	300.54	210.38	557.50
(-)1.0m to (-)1.5m	18.56	16.33	16.33	16.33	303.15	212.21	562.35
(-)0.5m to (-)1.0m	14.03	16.33	15.70	16.02	224.73	157.31	416.88
0.0 m to (-)0.5m	8.00	15.70	15.70	15.70	125.62	87.93	233.03
0m	6.90	15.70	15.70	15.70	108.35	75.84	200.99
						Total	**2701.24**

Uyyalikuppam -G4-90m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.5 m to (-)2.8m	13.07	9.59	9.32	9.45	123.51	86.46	229.11
(-)2.0 m to (-)2.5m	11.04	9.32	8.87	9.09	100.35	70.25	186.16
(-)1.5m to (-)2.0m	18.40	8.87	8.42	8.64	158.98	111.28	294.90
(-)1.0m to (-)1.5m	18.56	8.42	7.97	8.19	152.01	106.40	281.97
(-)0.5m to (-)1.0m	14.03	7.97	7.52	7.74	108.59	76.01	201.44
0.0 m to (-)0.5m	8.00	7.52	7.07	7.29	58.32	40.82	108.18
0m	6.90	7.07	7.07	7.07	48.75	34.12	90.43
0.0m to (+)0.5m	4.00	7.07	5.27	6.17	24.66	17.26	45.74
(+)0.5m to (+)1.0m	4.19	5.27	5.27	5.27	22.06	15.44	40.92
(+)1.0m to (+)1.5m	4.31	5.27	5.27	5.27	22.69	15.88	42.09
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**1658.07**

Uyyalikuppam -G4-90m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)2.5 m to (-)2.8m	13.07	31.95	417.59
(-)2.0 m to (-)2.5m	11.04	30.75	339.48
(-)1.5m to (-)2.0m	18.40	29.25	538.20
(-)1.0m to (-)1.5m	18.56	27.75	515.04
(-)0.5m to (-)1.0m	14.03	26.25	368.29
0.0 m to (-)0.5m	8.00	24.75	198.00
0m	6.90	21.00	144.90
0.0m to (+)0.5m	4.00	18.00	72.00
(+)0.5m to (+)1.0m	4.19	18.00	75.42
(+)1.0m to (+)1.5m	4.31	18.00	77.58
Shore anchor	16.00	18.00	288.00
		Total	**3034.49**

Round Head Section

Head portion (-2.8 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	5.25	13.50	3.00	1273.47		
Armour Layer	3.29	9.12	2.54	388.40		
Total Armour layer					**464.66**	**1231.35**
Under layer						
Under layer	4.54	11.62	2.54	812.53		
Under layer	3.29	8.82	2.24	353.19		
Total Under layer					**241.15**	**639.05**
Toe mound layer						
Toe mound	1.25	19.00	16.50	1238.66		
Toe mound	1.25	11.62	9.12	424.13		
Total Toe mound layer					**427.63**	**1133.23**
Core Material	3.29	8.82	2.24	353.19	**185.43**	**491.38**
Filter Layer	0.30	20.60	20.00	388.22	**203.81**	**540.11**
						Quantity in (m^2)
Geotextile layer						**999.874725**

Total quantity of materials for 90m Groin (G4)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
90m	**6872**	**2841**	**3117**	**3834**	**2198**	**4034**

10.5 Quantity of material for 80m length Groin (G5)

Trunk Sections

Uyyalikuppam -G5-80m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.0 m to (-)2.2m	12.18	32.61	31.20	31.91	388.74	272.12	721.11
(-)1.5m to (-)2.0m	17.74	31.20	27.67	29.43	522.13	365.49	968.55
(-)1.0m to (-)1.5m	15.56	27.67	24.13	25.90	402.99	282.09	747.54
(-)0.5m to (-)1.0m	17.79	24.13	19.66	21.90	389.56	272.70	722.64
0.0 m to (-)0.5m	8.94	19.66	16.38	18.02	161.13	112.79	298.89
0m	7.76	16.38	16.38	16.38	127.13	88.99	235.83
0.0m to (+)0.5m	7.57	16.38	24.59	20.48	155.06	108.54	287.64
(+)0.5m to (+)1.0m	4.55	24.59	24.59	24.59	111.86	78.30	207.51
(+)1.0m to (+)1.5m	4.38	24.59	24.59	24.59	107.68	75.38	199.75
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**5004.61**

Uyyalikuppam -G5-80m Groin Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.0 m to (-)2.2m	12.18	17.98	17.08	17.53	213.62	149.54	396.27
(-)1.5m to (-)2.0m	17.74	17.08	14.83	15.96	283.05	198.14	525.07
(-)1.0m to (-)1.5m	15.56	14.83	12.58	13.70	213.21	149.24	395.50
(-)0.5m to (-)1.0m	17.79	12.58	12.58	12.58	223.72	156.60	415.00
						Total	**1731.83**

Uyyalikuppam -G5-80m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.0 m to (-)2.2m	12.18	16.39	14.42	15.40	187.67	131.37	348.12
(-)1.5m to (-)2.0m	17.74	14.42	10.03	12.23	216.89	151.82	402.33
(-)1.0m to (-)1.5m	15.56	10.03	6.39	8.21	127.79	89.45	237.06
(-)0.5m to (-)1.0m	17.79	6.39	15.39	10.89	193.80	135.66	359.50
0.0 m to (-)0.5m	8.94	15.39	10.75	13.07	116.86	81.80	216.78
0m	7.76	10.75	10.75	10.75	83.42	58.39	154.74
0.0m to (+)0.5m	7.57	10.75	10.75	10.75	81.37	56.96	150.95
(+)0.5m to (+)1.0m	4.55	10.75	10.75	10.75	48.91	34.24	90.73
(+)1.0m to (+)1.5m	4.38	10.75	10.75	10.75	47.08	32.96	86.57
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	44.44
						Total	**2091.20**

Uyyalikuppam -G5-80m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.0 m to (-)2.2m	12.18	16.34	16.33	16.34	199.05	139.33	369.23
(-)1.5m to (-)2.0m	17.74	16.33	16.33	16.33	289.76	202.83	537.50
(-)1.0m to (-)1.5m	15.56	16.33	16.33	16.33	254.15	177.91	471.45
(-)0.5m to (-)1.0m	17.79	16.33	15.70	16.02	284.96	199.47	528.60
0.0 m to (-)0.5m	8.94	15.70	15.70	15.70	140.38	98.27	260.41
0m	7.76	15.70	15.70	15.70	121.85	85.30	226.04
						Total	**2393.23**

Uyyalikuppam -G5-80m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)2.0 m to (-)2.2m	12.18	9.05	8.87	8.96	109.13	76.39	202.43
(-)1.5m to (-)2.0m	17.74	8.87	8.42	8.64	153.27	107.29	284.32
(-)1.0m to (-)1.5m	15.56	8.42	7.97	8.19	127.44	89.21	236.39
(-)0.5m to (-)1.0m	17.79	7.97	7.52	7.74	137.69	96.39	255.42
0.0 m to (-)0.5m	8.94	7.52	7.07	7.29	65.17	45.62	120.90
0m	7.76	7.07	7.07	7.07	54.82	38.38	101.70
0.0m to (+)0.5m	7.57	7.07	5.27	6.17	46.67	32.67	86.57
(+)0.5m to (+)1.0m	4.55	5.27	5.27	5.27	23.96	16.77	44.44
(+)1.0m to (+)1.5m	4.38	5.27	5.27	5.27	23.06	16.14	42.78
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**1512.07**

Uyyalikuppam -G5-80m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)2.0 m to (-)2.2m	12.18	30.31	369.24
(-)1.5m to (-)2.0m	17.74	29.25	518.90
(-)1.0m to (-)1.5m	15.56	27.75	431.79
(-)0.5m to (-)1.0m	17.79	26.25	466.99
0.0 m to (-)0.5m	8.94	24.75	221.27
0m	7.76	21.00	162.96
0.0m to (+)0.5m	7.57	18.00	136.26
(+)0.5m to (+)1.0m	4.55	18.00	81.90
(+)1.0m to (+)1.5m	4.38	18.00	78.84
Shore anchor	16.00	18.00	288.00
		Total	**2756.13**

Round Head Section

Head portion (-2.2 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.65	12.30	3.00	959.72		
Armour Layer	2.69	7.92	2.54	251.41		
Total Armour layer					**371.86**	**985.44**
Under layer						
Under layer	2.69	7.92	2.54	251.41		
Under layer	1.44	5.12	2.24	64.36		
Total Under layer					**98.20**	**260.24**
Toe mound layer						
Toe mound	1.25	17.80	15.30	1077.11		
Toe mound	1.25	10.42	7.92	332.09		
Total Toe mound layer					**391.13**	**1036.51**
Core Material	2.69	7.62	2.24	225.67	**118.48**	**313.96**
Filter Layer	0.30	19.40	18.80	343.68	**180.43**	**478.14**
						Quantity in (m^2)
Geotextile layer						**886.78**

Total quantity of materials for 80m Groin (G5)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
80m	**5990**	**1992**	**2405**	**3430**	**1990**	**3643**

10.6 Quantity of material for 60m length Groin (G6)

Trunk Sections

Uyyalikuppam -G6-60m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.5m to (-)2.0m	11.89	31.20	27.67	29.43	349.95	244.96	649.16
(-)1.0m to (-)1.5m	18.44	27.67	24.13	25.90	477.57	334.30	885.90
(-)0.5m to (-)1.0m	14.44	24.13	19.66	21.90	316.21	221.34	586.56
0.0 m to (-)0.5m	8.94	19.66	16.38	18.02	161.13	112.79	298.89
0m	6.29	16.38	16.38	16.38	102.97	72.08	191.01
0.0m to (+)0.5m	6.46	16.38	24.59	20.48	132.33	92.63	245.47
(+)0.5m to (+)1.0m	4.19	24.59	24.59	24.59	103.01	72.11	191.09
(+)1.0m to (+)1.5m	4.65	24.59	24.59	24.59	114.32	80.03	212.07
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**3875.29**

Uyyalikuppam -G6-60m Groin under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.5m to (-)2.0m	11.89	17.08	14.83	15.96	189.71	132.80	351.92
(-)1.0m to (-)1.5m	18.44	14.83	12.58	13.70	252.67	176.87	468.70
(-)0.5m to (-)1.0m	14.44	12.58	12.58	12.58	181.59	127.11	336.85
						Total	**1157.47**

Uyyalikuppam -G6-60m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.5m to (-)2.0m	11.89	14.42	10.03	12.23	145.37	101.76	269.65
(-)1.0m to (-)1.5m	18.44	10.03	6.39	8.21	151.45	106.01	280.93
(-)0.5m to (-)1.0m	14.44	6.39	15.39	10.89	157.31	110.11	291.80
0.0 m to (-)0.5m	8.94	15.39	10.75	13.07	116.86	81.80	216.78
0m	6.29	10.75	10.75	10.75	67.56	47.29	125.33
0.0m to (+)0.5m	6.46	10.75	10.75	10.75	69.44	48.61	128.82
(+)0.5m to (+)1.0m	4.19	10.75	10.75	10.75	45.04	31.53	83.55
(+)1.0m to (+)1.5m	4.65	10.75	10.75	10.75	49.99	34.99	92.72
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**1687.07**

Uyyalikuppam -G6-60m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.5m to (-)2.0m	11.89	16.33	16.33	16.33	194.21	135.94	360.25
(-)1.0m to (-)1.5m	18.44	16.33	16.33	16.33	301.19	210.83	558.71
(-)0.5m to (-)1.0m	14.44	16.33	15.70	16.02	231.30	161.91	429.06
0.0 m to (-)0.5m	8.94	15.70	15.70	15.70	140.38	98.27	260.41
0m	6.29	15.70	15.70	15.70	98.69	69.09	183.08
						Total	**1791.51**

Uyyalikuppam -G6-60m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.5m to (-)2.0m	11.89	8.87	8.42	8.64	102.73	71.91	190.56
(-)1.0m to (-)1.5m	18.44	8.42	7.97	8.19	151.02	105.72	280.15
(-)0.5m to (-)1.0m	14.44	7.97	7.52	7.74	111.77	78.24	207.33
0.0 m to (-)0.5m	8.94	7.52	7.07	7.29	65.17	45.62	120.90
0m	6.29	7.07	7.07	7.07	44.40	31.08	82.37
0.0m to (+)0.5m	6.46	7.07	5.27	6.17	39.83	27.88	73.88
(+)0.5m to (+)1.0m	4.19	5.27	5.27	5.27	22.06	15.44	40.92
(+)1.0m to (+)1.5m	4.65	5.27	5.27	5.27	24.48	17.14	45.41
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**1178.64**

Uyyalikuppam -G6-60m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)1.5m to (-)2.0m	11.89	29.25	347.78
(-)1.0m to (-)1.5m	18.44	27.75	511.71
(-)0.5m to (-)1.0m	14.44	26.25	379.05
0.0 m to (-)0.5m	8.94	24.75	221.27
0m	6.29	21.00	131.99
0.0m to (+)0.5m	6.46	18.00	116.28
(+)0.5m to (+)1.0m	4.19	18.00	75.42
(+)1.0m to (+)1.5m	4.65	18.00	83.70
Shore anchor	16.00	18.00	288.00
		Total	**2155.20**

Round Head Section

Head portion (-2.00 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer	-	-	-	-	-	-
Armour Layer	4.45	11.90	3.00	867.77		
Armour Layer	2.49	7.52	2.54	213.98		
Total Armour layer					**343.24**	**909.59**
Under layer	-					
Under layer	3.74	10.02	2.54	517.90		
Under layer	2.49	7.22	2.24	191.08		
Total Under layer					**171.58**	**454.69**
-						
Toe mound layer	-	-	-	-	-	-
Toe mound	1.25	17.40	14.90	1025.77		
Toe mound	1.25	10.02	7.52	303.93		
Total Toe mound layer					**378.97**	**1004.27**
Core Material	2.49	7..22	2.24	191.08	**100.32**	**265.84**
Filter Layer	0.30	19.00	18.40	329.44	**172.95**	**458.33**
						Quantity in (m^2)
Geotextile layer						**850.586175**

Total quantity of materials for 60m Groin (G6)

LENGTH OF GROIN	**QUANTITY IN TONNES**					**QUANTITY IN m^2**
	ARMOUR LAYER (Stones)	**UNDER LAYER**	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**	**GEOTEXTILE LAYER**
60m	**4785**	**1612**	**1953**	**2796**	**1637**	**3006**

10.7 Quantity of material for 40m length Groin (G7)

Trunk Sections

Uyyalikuppam -G7-40m Groin Armour layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	15.07	27.67	24.13	25.90	390.29	273.21	724.00
(-)0.5m to (-)1.0m	12.57	24.13	19.66	21.90	275.26	192.68	510.60
0.0 m to (-)0.5m	7.52	19.66	16.38	18.02	135.53	94.87	251.42
0m	3.02	16.38	16.38	16.38	49.48	34.63	91.78
0.0m to (+)0.5m	3.05	16.38	24.59	20.48	62.48	43.73	115.89
(+)0.5m to (+)1.0m	5.32	24.59	24.59	24.59	130.79	91.56	242.62
(+)1.0m to (+)1.5m	8.25	24.59	24.59	24.59	202.83	141.98	376.25
Shore anchor	16.00	20.73	20.73	20.73	331.62	232.13	615.15
						Total	**2927.71**

Uyyalikuppam -G1-40m Groin under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Under layer (Stones) Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	15.07	14.83	12.58	13.70	206.49	144.55	383.04
(-)0.5m to (-)1.0m	12.57	12.58	12.58	12.58	158.07	110.65	293.23
						Total	**676.27**

Uyyalikuppam -G7-40m Groin Core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	15.07	10.03	6.39	8.21	123.77	86.64	229.59
(-)0.5m to (-)1.0m	12.57	6.39	15.39	10.89	136.93	95.85	254.01
0.0 m to (-)0.5m	7.52	15.39	10.75	13.07	98.30	68.81	182.34
0m	3.02	10.75	10.75	10.75	32.46	22.72	60.22
0.0m to (+)0.5m	3.05	10.75	10.75	10.75	32.79	22.95	60.82
(+)0.5m to (+)1.0m	5.32	10.75	10.75	10.75	57.19	40.03	106.08
(+)1.0m to (+)1.5m	8.25	10.75	10.75	10.75	88.68	62.08	164.51
Shore anchor	16.00	6.65	6.65	6.65	106.46	74.52	197.49
						Total	**1255.07**

Uyyalikuppam -G7-40m Groin Toe mound layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	15.07	16.33	16.33	16.33	246.15	172.30	456.60
(-)0.5m to (-)1.0m	12.57	16.33	15.70	16.02	201.35	140.94	373.50
0.0 m to (-)0.5m	7.52	15.70	15.70	15.70	118.08	82.66	219.04
0m	3.02	15.70	15.70	15.70	47.42	33.20	87.97
						Total	**1137.12**

Uyyalikuppam -G7-40m Groin Filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-)1.0m to (-)1.5m	15.07	8.42	7.97	8.19	123.42	86.40	228.95
(-)0.5m to (-)1.0m	12.57	7.97	7.52	7.74	97.29	68.10	180.48
0.0 m to (-)0.5m	7.52	7.52	7.07	7.29	54.82	38.37	101.69
0m	3.02	7.07	7.07	7.07	21.34	14.94	39.58
0.0m to (+)0.5m	3.05	7.07	5.27	6.17	18.80	13.16	34.88
(+)0.5m to (+)1.0m	5.32	5.27	5.27	5.27	28.01	19.61	51.96
(+)1.0m to (+)1.5m	8.25	5.27	5.27	5.27	43.44	30.41	80.57
Shore anchor	16.00	4.62	4.62	4.62	73.92	51.74	137.12
						Total	**855.23**

Uyyalikuppam -G7-40m Groin - Geotextile layer			
Water depth(m)	**Length (m)**	**Average**	**Geo textile layer Area(m^2)**
(-)1.0m to (-)1.5m	15.07	27.75	418.19
(-)0.5m to (-)1.0m	12.57	26.25	329.96
0.0 m to (-)0.5m	7.52	24.75	186.12
0m	3.02	21.00	63.42
0.0m to (+)0.5m	3.05	18.00	54.90
(+)0.5m to (+)1.0m	5.32	18.00	95.76
(+)1.0m to (+)1.5m	8.25	18.00	148.50
Shore anchor	16.00	18.00	288.00
		Total	**1584.86**

Round Head Section

Head portion (-1.5 m water depth)						
SPECIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer	-	-	-	-	-	-
Armour Layer	3.95	10.90	3.00	663.60		
Armour Layer	1.99	6.52	2.54	136.39		
Total Armour layer					**276.79**	**733.49**
Under layer	-					
Under layer	3.24	9.02	2.54	375.48		
Under layer	1.99	6.22	2.24	120.05		
Total Under layer					**134.10**	**355.37**
-						
Toe mound layer	-	-	-	-	-	-
Toe mound	1.25	16.40	13.90	902.92		
Toe mound	1.25	9.02	6.52	239.01		
Total Toe mound layer					**348.55**	**923.67**
Core Material	1.99	6.22	2.24	120.05	**63.03**	**167.03**
Filter Layer	0.30	18.00	17.40	295.15	**154.95**	**410.62**
						Quantity in (m^2)
Geotextile layer						**763.407**

Total quantity of materials for 40m Groin (G7)

LENGTH OF GROIN	QUANTITY IN TONNES					QUANTITY IN m^2
	ARMOUR LAYER (Stones)	UNDER LAYER	CORE LAYER	TOE MOUND LAYER	FILTER LAYER	GEOTEXTILE LAYER
40m	3661	1032	1422	2061	1266	2348

10.8 Overall Quantity of all Groins (G1 to G7)

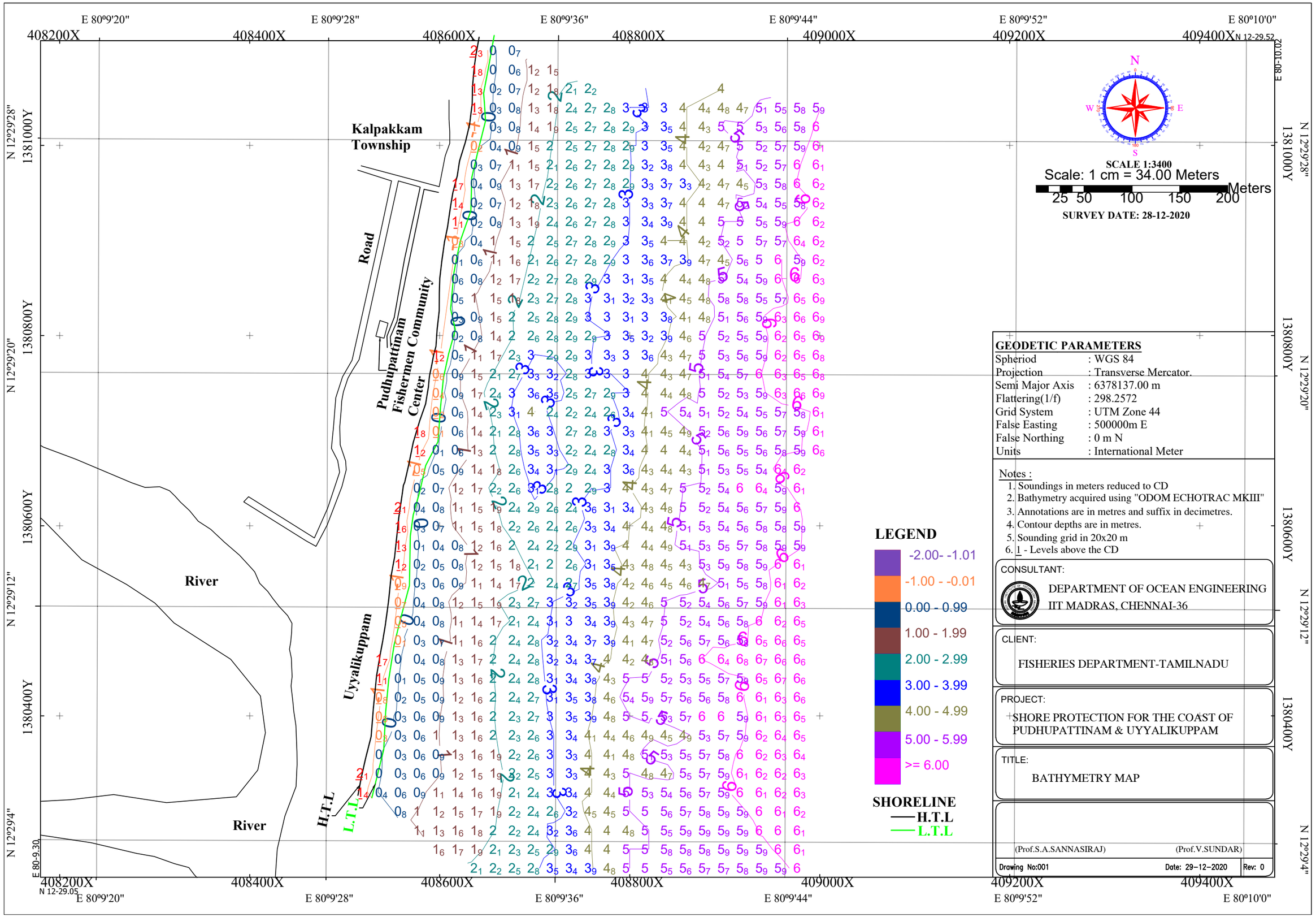
UYYALIKUPPAM						
GROINS	QUANTITY IN TONNES					QUANTITY IN m^2
	ARMOUR LAYER (stones)	UNDER LAYER (stones)	CORE LAYER	TOE MOUND LAYER	FILTER LAYER	GEOTEXTILE LAYER
(G1-G7)	35867	11898	15474	19357	12056	22117

Dredging Quantity	
Groin number	Volume (m^3)
G1 (40m)	621.00
G2 (60m)	884.00
G3 (80m)	953.00
G4 (90m)	512.00
G5 (50m)	662.00
G6 (50m)	577.00
G7 (20m)	519.00
Total	4728

11.0 FINAL RECOMMENDATION

To combat the existing coastal erosion problem along the Tamilnadu coast at Uyyalikuppam, the necessary Oceanographic data dictating the direction of magnitude of the littoral that is responsible for the above stated perennial problem was collected. A rigorous and comprehensive data analysis was employed to derive the average wave characteristics, like breaker wave height and breaker angle, which in turn were employed in the assessment of the monthly variation of the long shore drift. In addition, an in-house developed wave model was used to study the penetration of waves from offshore to the near shore. The environmental aspects, the pros and cons of the proposed groin field of transition groin field was carefully planned and designed. The wave model as well as the shoreline evolution models were used to assess the shoreline evolution, the results of which prove to be a positive solution, in the sense, that coastal protection will not only solve the erosion problem but will also promote the formation of beach and retrieve the lost beach within a few years after the implementation of the solution. ***Note that the lengths are likely to change prior to installation as it depends on the water depth and hence, IITM must be informed prior to the commencement of the work.*** Further, IITM need to be consulted for the construction sequence before the starting the construction as it depends on the direction of littoral drift which is essential.

Prof. V. Sundar **Prof. S.A.Sannasiraj**



GEODETIC PARAMETERS

Spheriod	: WGS 84
Projection	: Transverse Mercator.
Semi Major Axis	: 6378137.00 m
Flattering(1/f)	: 298.2572
Grid System	: UTM Zone 44
False Easting	: 500000m E
False Northing	: 0 m N
Units	: International Meter

Notes :

1. Soundings in meters reduced to CD
2. Bathymetry acquired using "ODOM ECHOTRAC MKIII"
3. Annotations are in metres and suffix in decimetres.
4. Contour depths are in metres.
5. Sounding grid in 20x20 m
6. 1 - Levels above the CD

CONSULTANT:

DEPARTMENT OF OCEAN ENGINEERING
IIT MADRAS, CHENNAI-36

CLIENT:

FISHERIES DEPARTMENT-TAMILNADU

PROJECT:

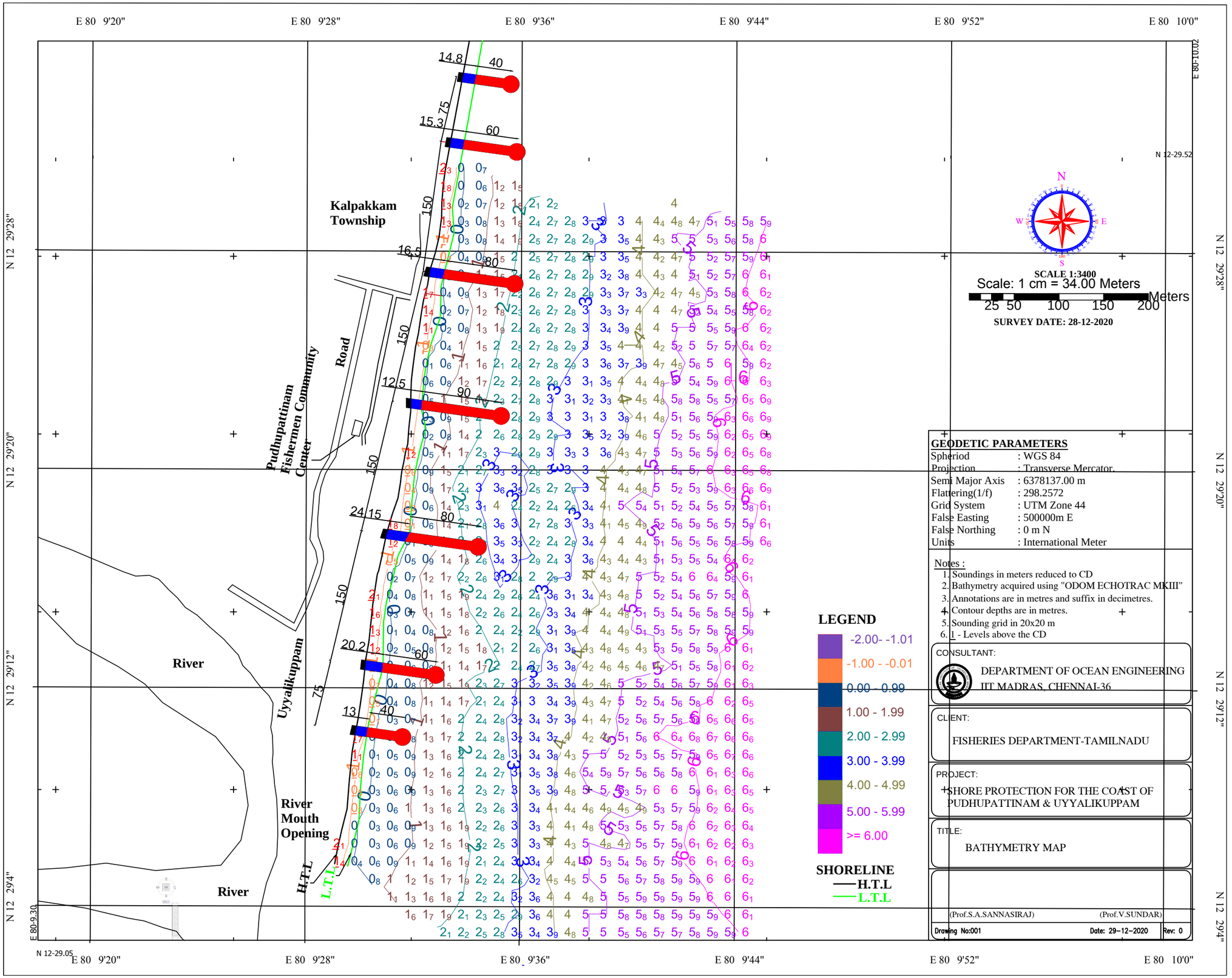
SHORE PROTECTION FOR THE COAST OF PUDHUPATTINAM & UYYALIKUPPAM

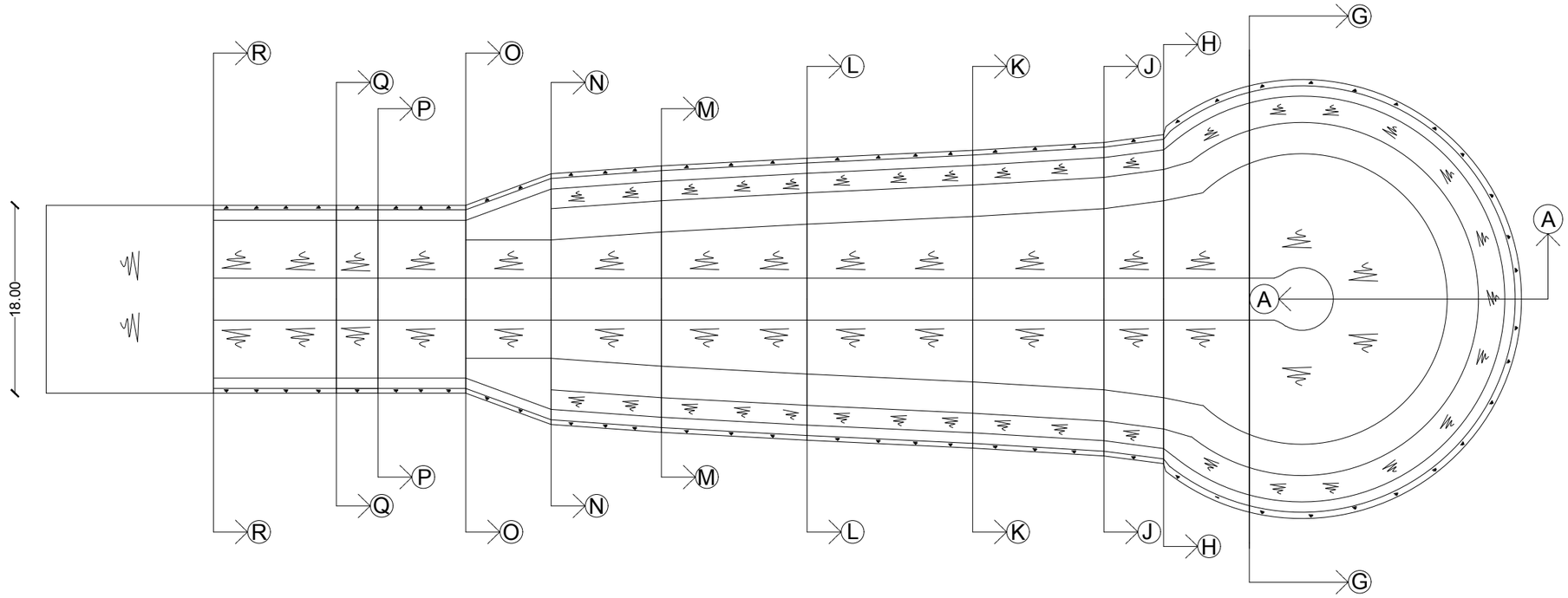
TITLE:

BATHYMETRY MAP

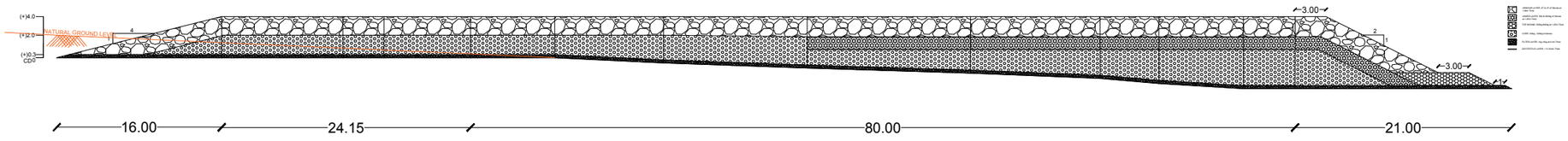
(Prof.S.A.SANNASIRAJ) (Prof.V.SUNDAR)

Drawing No:001 | Date: 29-12-2020 | Rev: 0


E 80 9'20"
E 80 9'28"
E 80 9'36"
E 80 9'44"
E 80 9'52"
E 80 10'0"
N 12 29'28"
N 12 29'20"
N 12 29'12"
N 12 29'4"
N 12-29.52
N 12-29.05
E 80-9.30
E 80-10.02
Kalpakkam Township
Pudhupattinam Fishermen Community Center
Road
River
Uyyalikuppam
River Mouth Opening
River
H.T.L
L.T.L
14.8
40
75
15.3
60
150
16.5
80
150
12.5
90
150
24.15
80
150
20.2
60
75
13
40
N
S
W
E
SCALE 1:3400
Scale: 1 cm = 34.00 Meters
25 50 100 150 200 Meters
SURVEY DATE: 28-12-2020
LEGEND
-2.00- -1.01
-1.00 - -0.01
0.00 - 0.99
1.00 - 1.99
2.00 - 2.99
3.00 - 3.99
4.00 - 4.99
5.00 - 5.99
>= 6.00
SHORELINE
H.T.L
L.T.L
GEODETIC PARAMETERS
Spheriod : WGS 84
Projection : Transverse Mercator.
Semi Major Axis : 6378137.00 m
Flattering(1/f) : 298.2572
Grid System : UTM Zone 44
False Easting : 500000m E
False Northing : 0 m N
Units : International Meter
Notes :
1. Soundings in meters reduced to CD
2. Bathymetry acquired using "ODOM ECHOTRAC MKIII"
3. Annotations are in metres and suffix in decimetres.
4. Contour depths are in metres.
5. Sounding grid in 20x20 m
6. 1 - Levels above the CD
CONSULTANT:
DEPARTMENT OF OCEAN ENGINEERING
IIT MADRAS, CHENNAI-36
CLIENT:
FISHERIES DEPARTMENT-TAMILNADU
PROJECT:
SHORE PROTECTION FOR THE COAST OF PUDHUPATTINAM & UYYALIKUPPAM
TITLE:
BATHYMETRY MAP
(Prof.S.A.SANNASIRAJ)
(Prof.V.SUNDAR)
Drawing No:001
Date: 29-12-2020
Rev: 0



PLAN VIEW OF 80M GROYNE



TYPICAL LONGITUDINAL SECTION OF 80M GROYNE

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

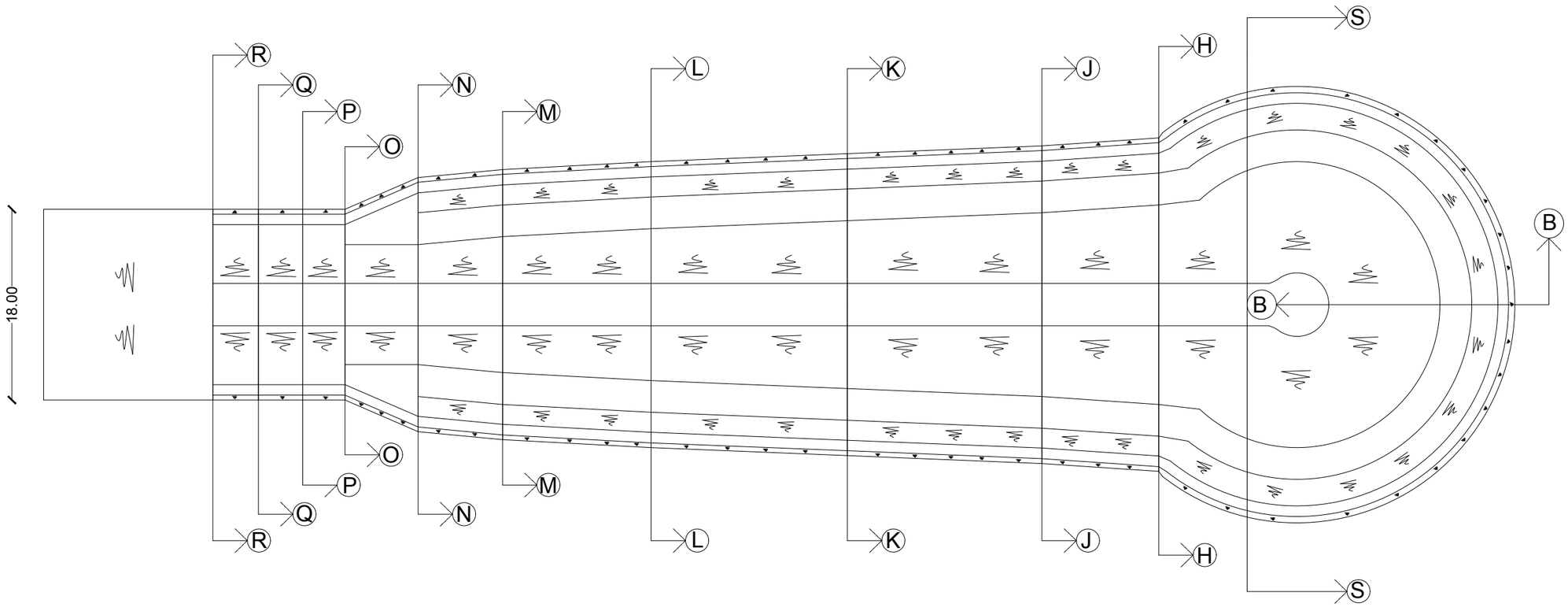
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

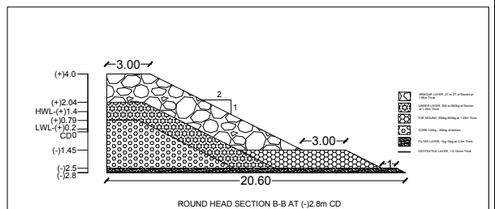
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TYPICAL PLAN AND LONGITUDINAL SECTION OF 80M GROYNE
DRAWING NO:	1
DATE:	03.02.2021

ENGINEERING FIRM:

Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



PLAN VIEW OF 90M GROYNE WITH ROUND SECTION (-)2.8



ROUND HEAD SECTION B-B AT (-)2.8m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

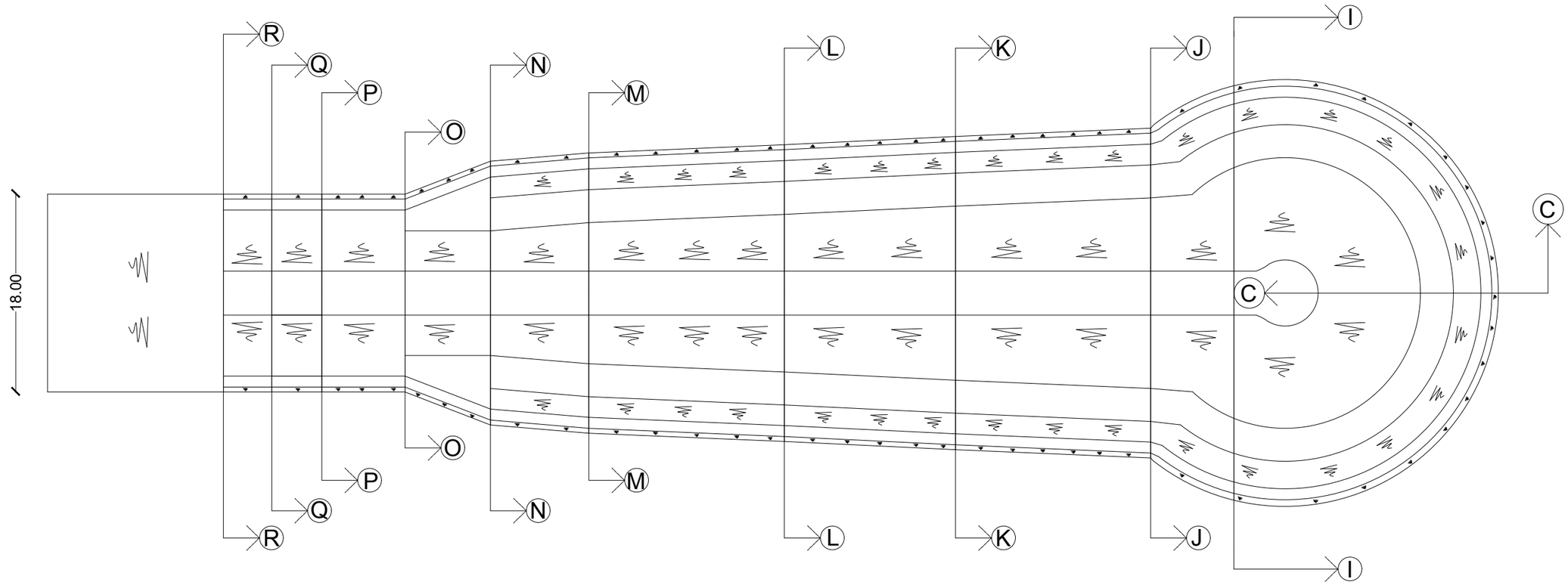
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

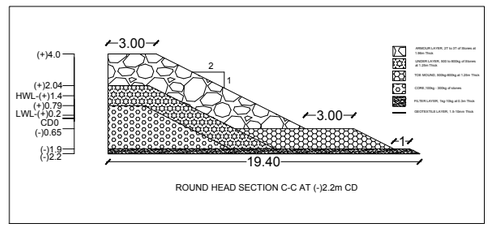
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	PLAN VIEW OF 90M GROYNE WITH ROUND SECTION (-)2.8
DRAWING NO:	2
ENGINEERING FIRM:	

DATE: 03.02.2021

Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



PLAN VIEW OF 80M GROYNE WITH ROUND SECTION (-)2.2



ROUND HEAD SECTION C-C AT (-)2.2m CD

NOTES :-

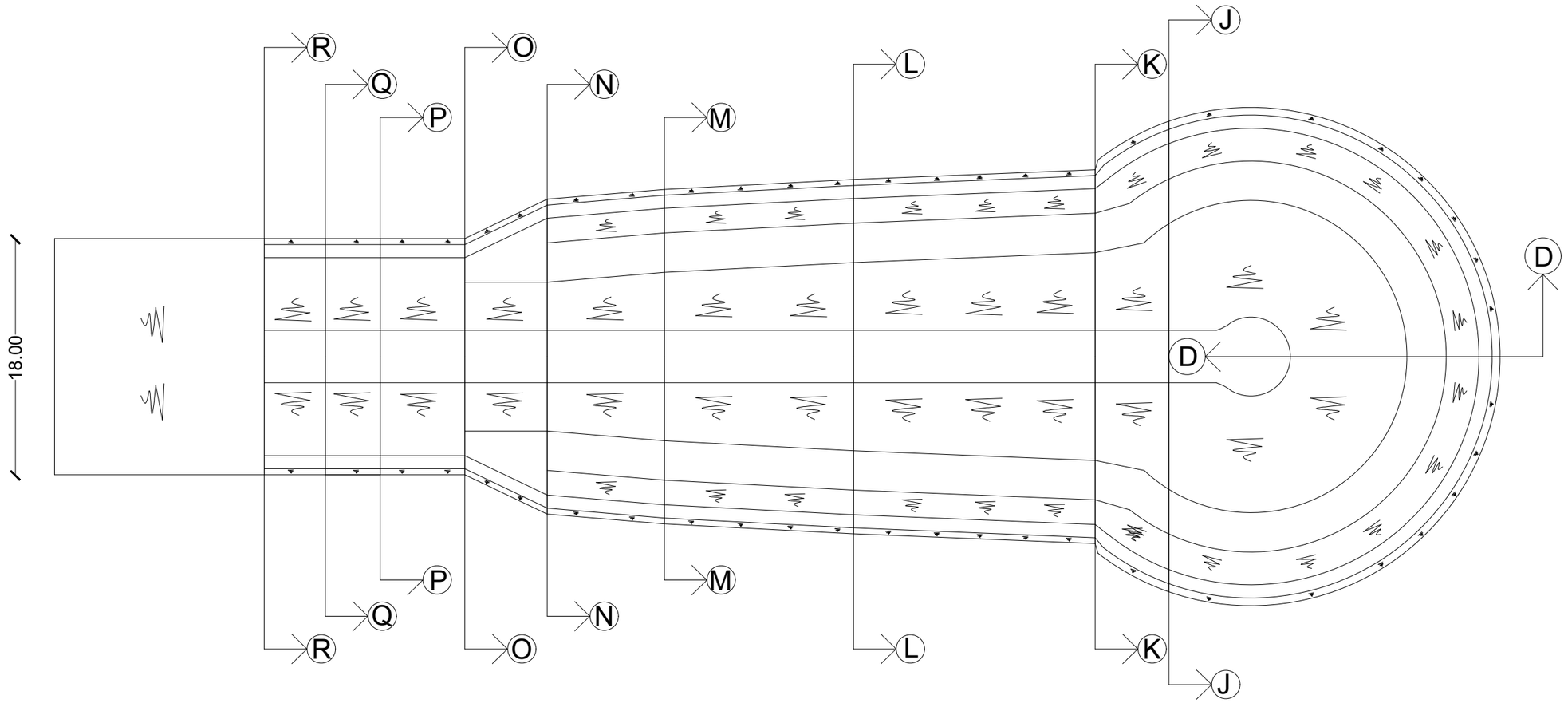
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

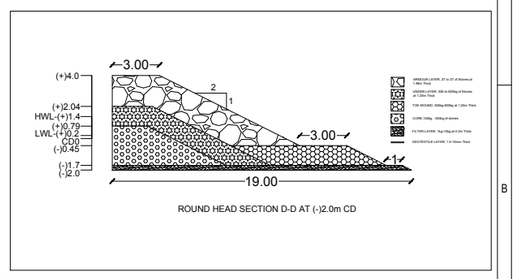
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE: A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	PLAN VIEW OF 80M GROYNE WITH ROUND SECTION (-)2.2
DRAWING NO:	3
DATE:	03.02.2021
ENGINEERING FIRM:	Prof. V. SUNDAR, Prof. S. A. SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



PLAN VIEW OF 60M GROYNE WITH ROUND SECTION (-)2.0



ROUND HEAD SECTION D-D AT (-)2.0m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

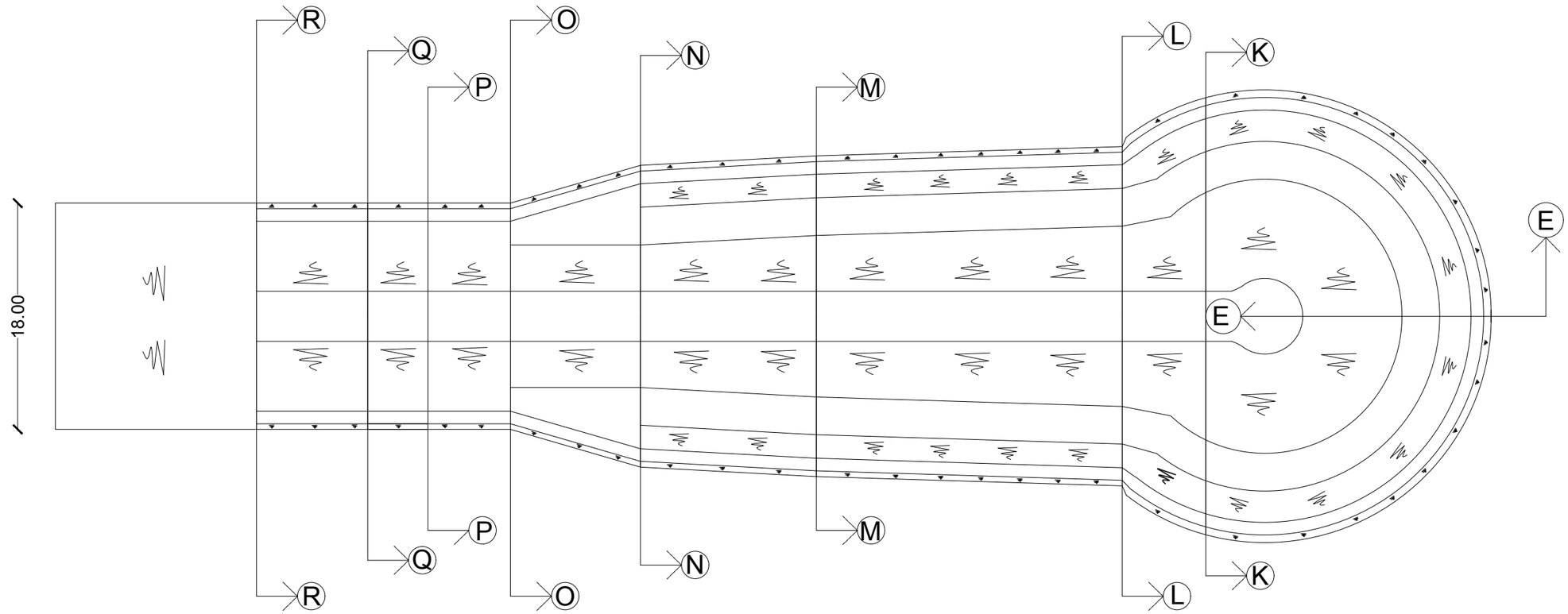
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

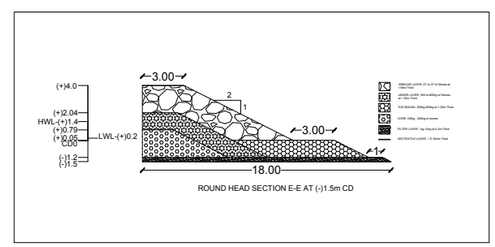
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	PLAN VIEW OF 60M GROYNE WITH ROUND SECTION (-)2.0
DRAWING NO:	4
DATE:	03.02.2021

ENGINEERING FIRM:

Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



PLAN VIEW OF 60M GROYNE WITH ROUND SECTION (-)1.5



ROUND HEAD SECTION E-E AT (-)1.5m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

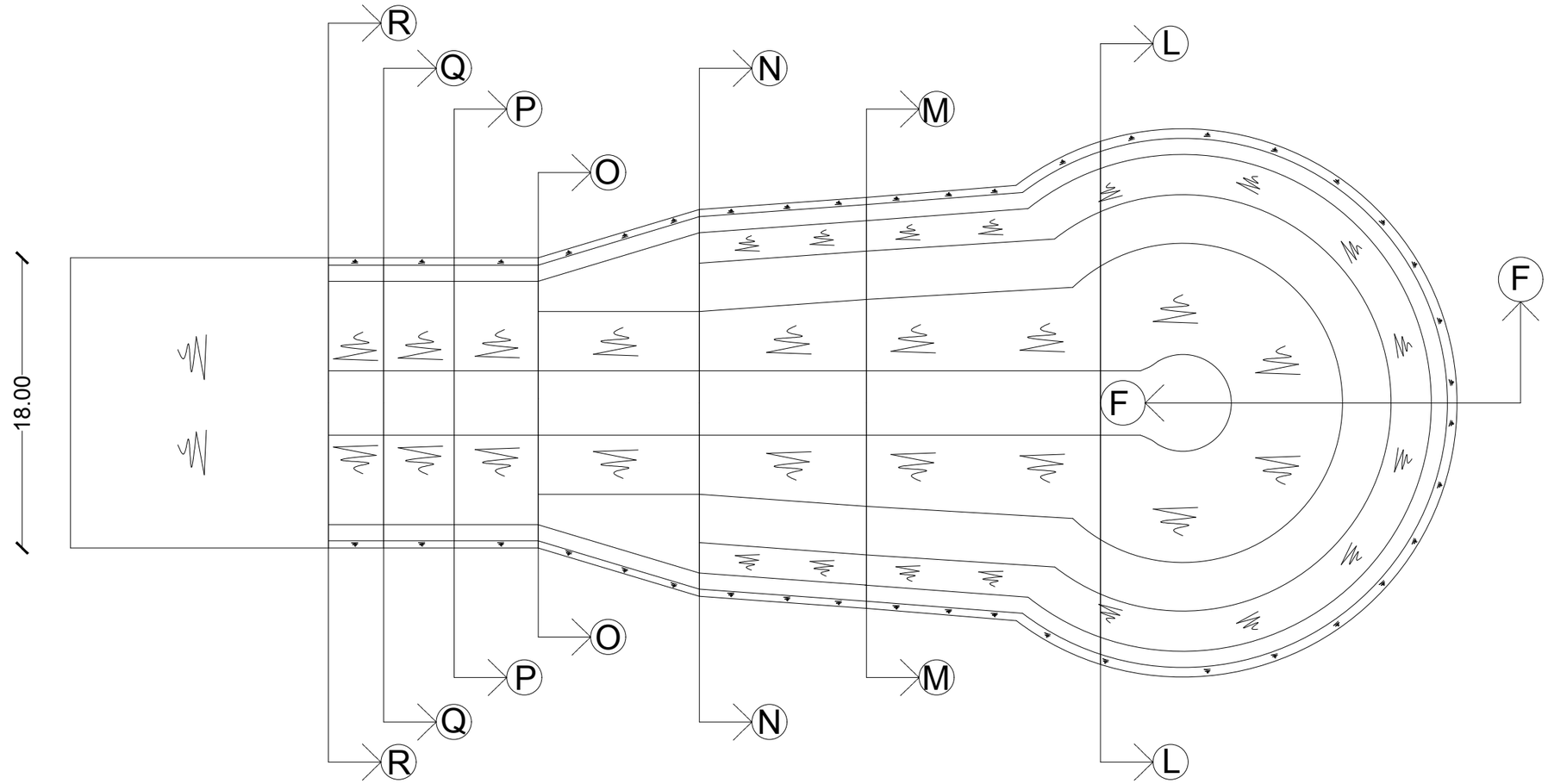
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

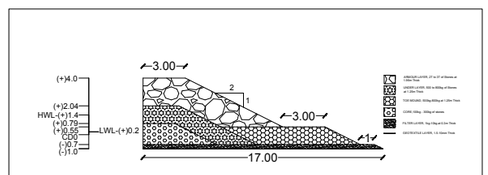
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	PLAN VIEW OF 60M GROYNE WITH ROUND SECTION (-)1.5
DRAWING NO:	5
DATE:	03.02.2021

ENGINEERING FIRM:

Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



PLAN VIEW OF 40M GROYNE WITH ROUND SECTION (-)1.0



ROUND HEAD SECTION F-F AT (-)1.0m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

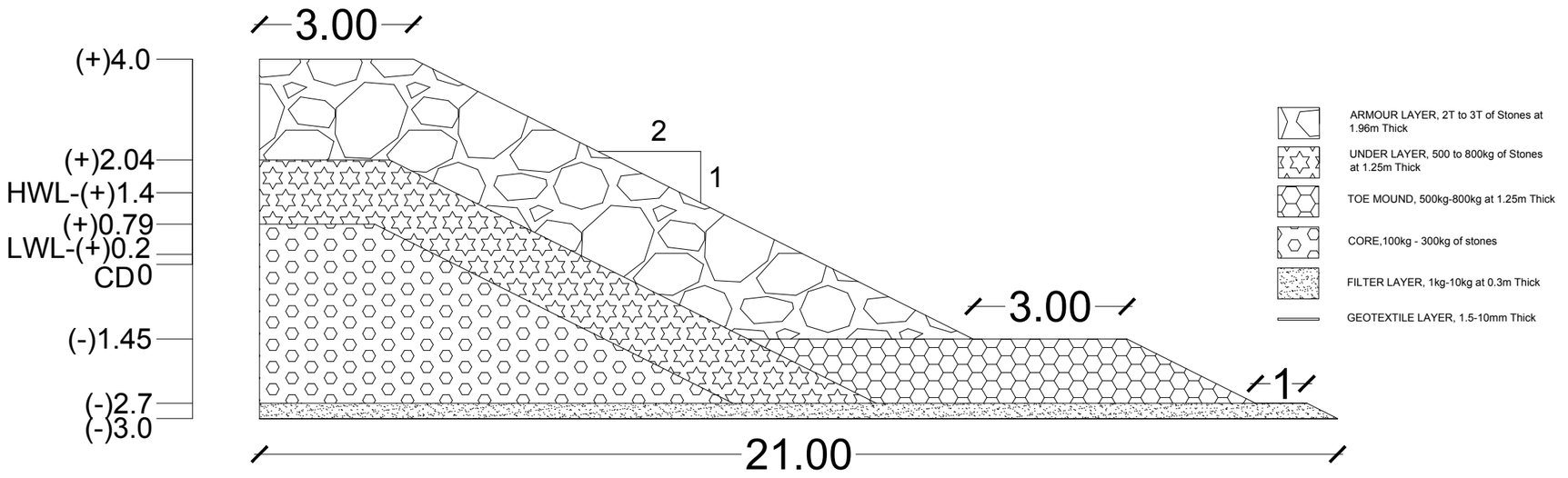
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

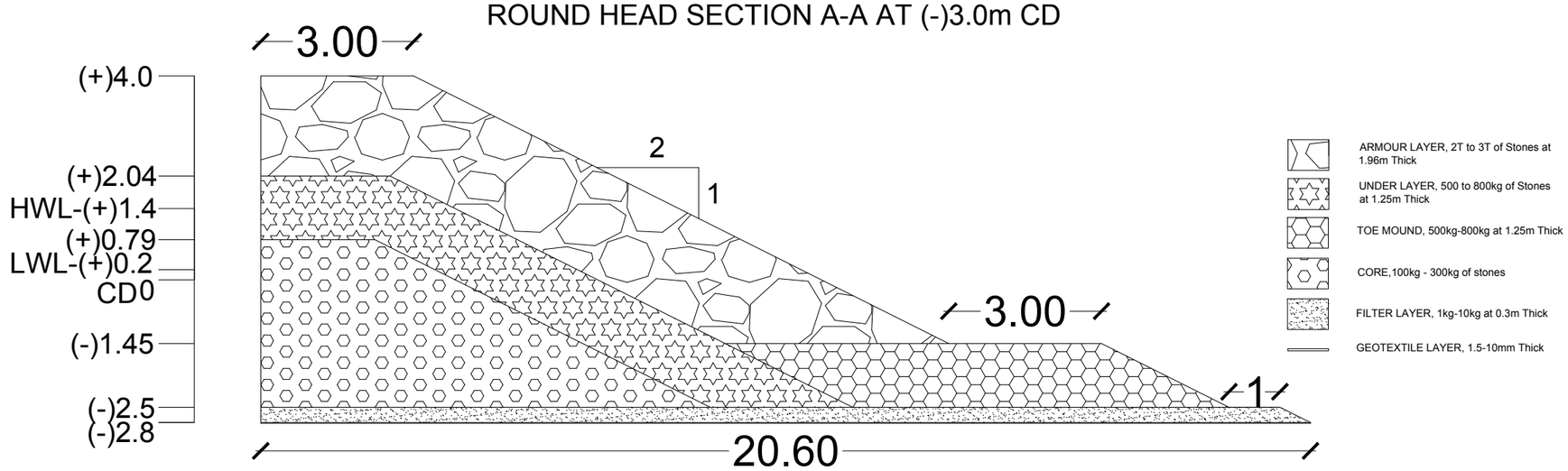
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	PLAN VIEW OF 40M GROYNE WITH ROUND SECTION (-)1.0
DRAWING NO:	6
ENGINEERING FIRM:	

DATE: 03.02.2021

Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



ROUND HEAD SECTION A-A AT (-)3.0m CD



ROUND HEAD SECTION B-B AT (-)2.8m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

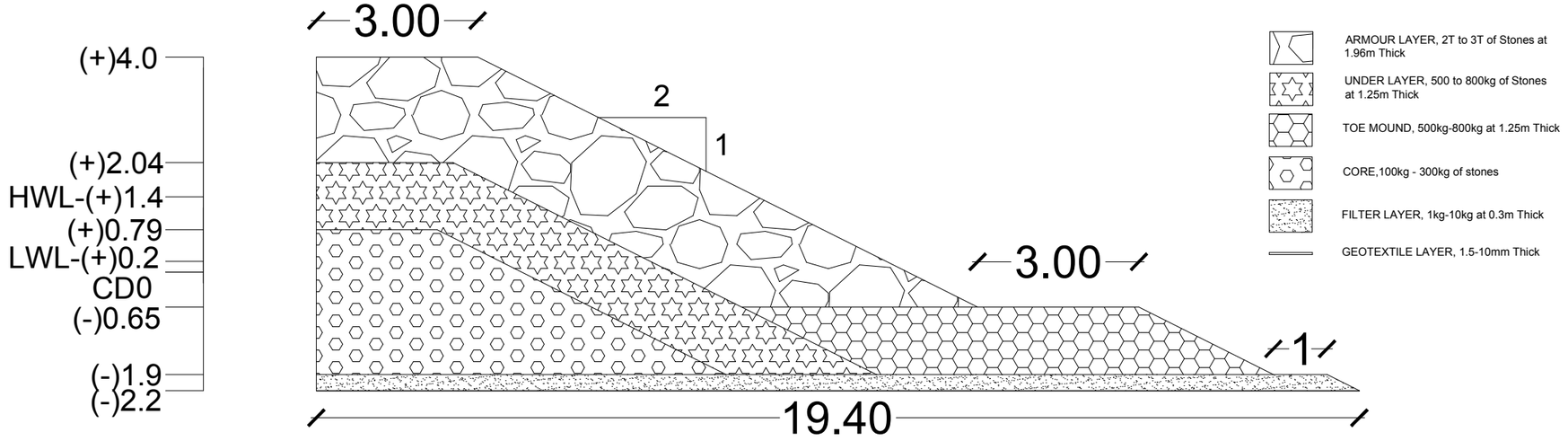
LEGEND :-

HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

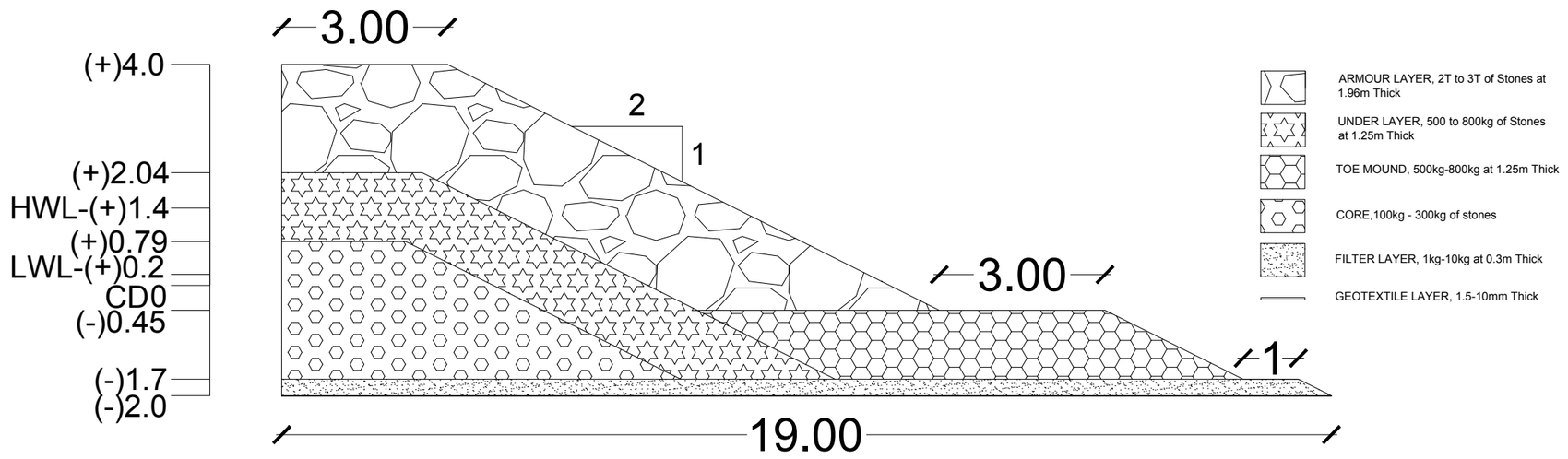
ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	ROUND HEAD SECTION AT (-)3.0m CD AND (-)2.8m CD
DRAWING NO:	7
DATE:	03.02.2021

ENGINEERING FIRM:
Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



ROUND HEAD SECTION C-C AT (-)2.2m CD



ROUND HEAD SECTION D-D AT (-)2.0m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

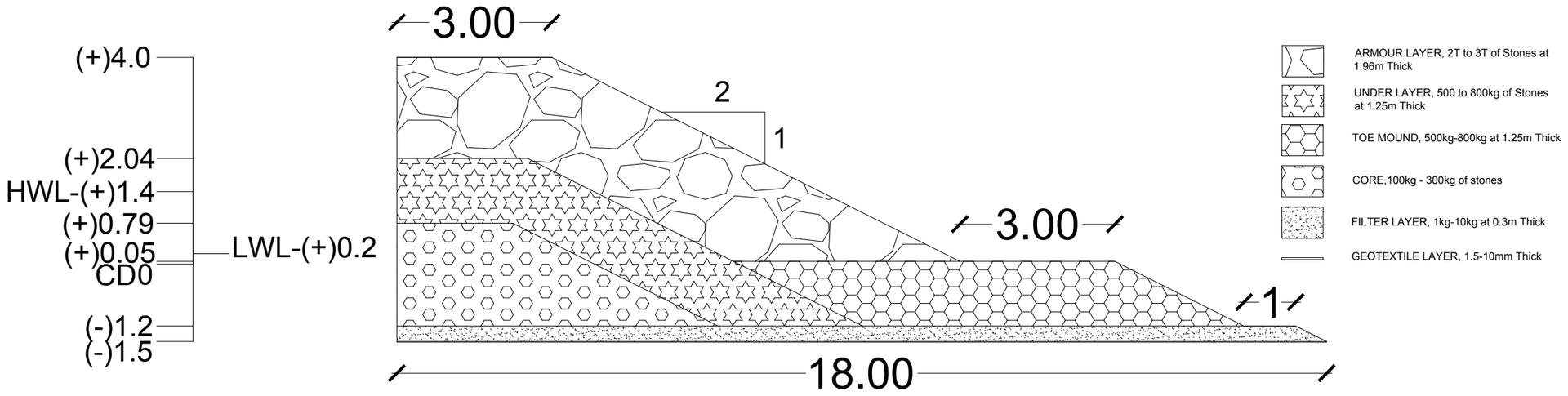
LEGEND :-

HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

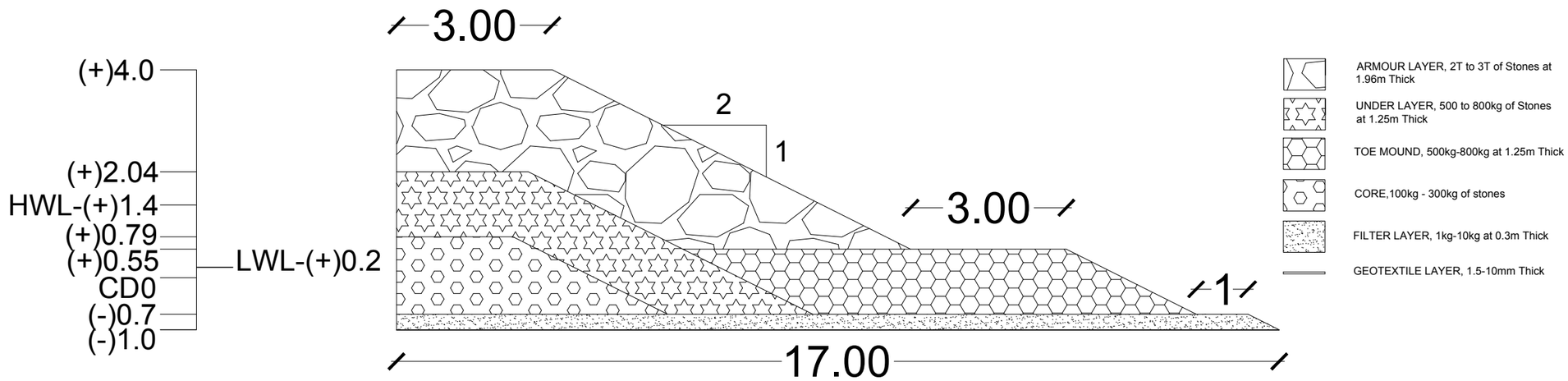
ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	ROUND HEAD SECTION AT (-)2.2m CD AND (-)2.0m CD
DRAWING NO:	8
DATE:	03.02.2021

ENGINEERING FIRM:
Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



ROUND HEAD SECTION E-E AT (-)1.5m CD



ROUND HEAD SECTION F-F AT (-)1.0m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

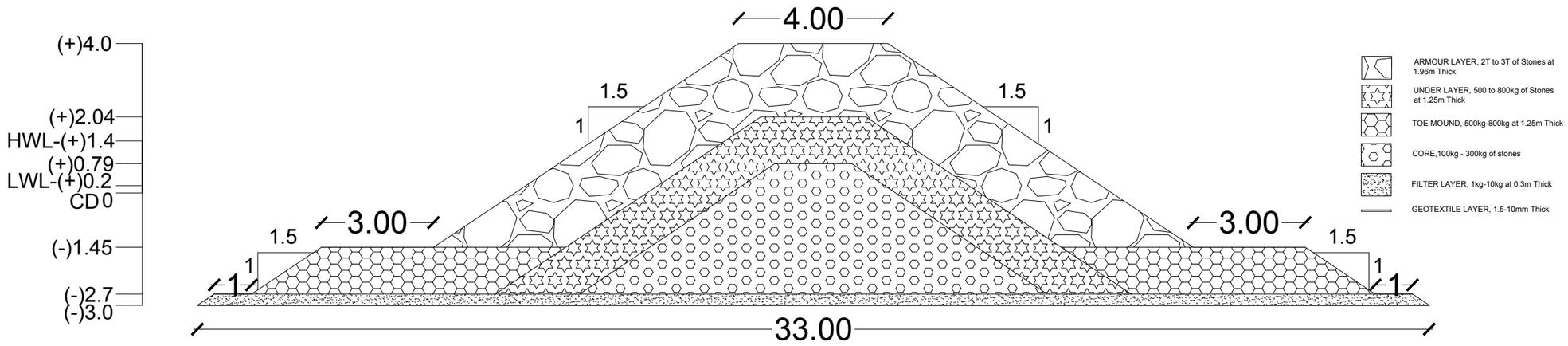
LEGEND :-

HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

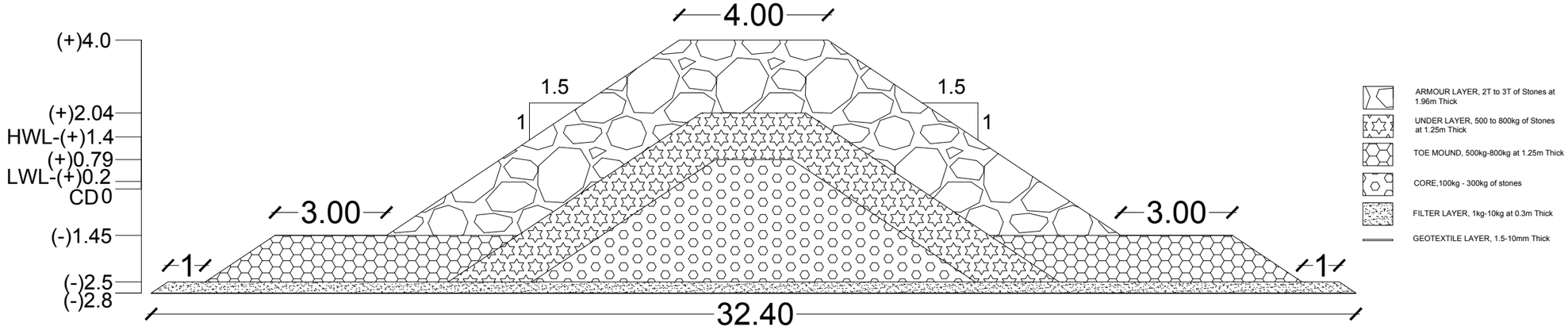
ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	ROUND HEAD SECTION AT (-)1.5m CD AND (-)1.0m CD
DRAWING NO:	9
DATE:	03.02.2021

ENGINEERING FIRM:
Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



TRUNK SECTION G-G AT(-)2.5m to (-)3.0m



TRUNK SECTION AT (-)2.5m to (-)2.8m CD

NOTES :-

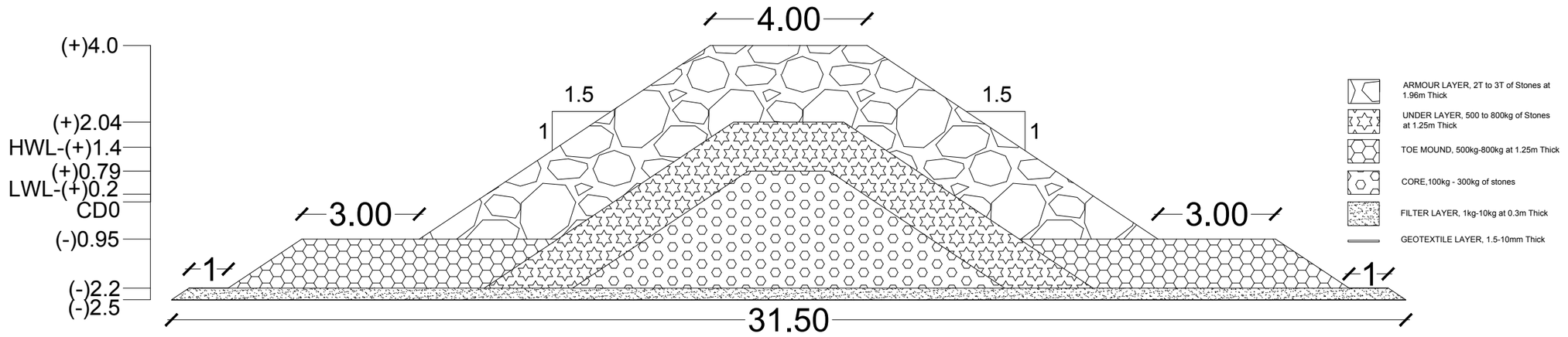
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

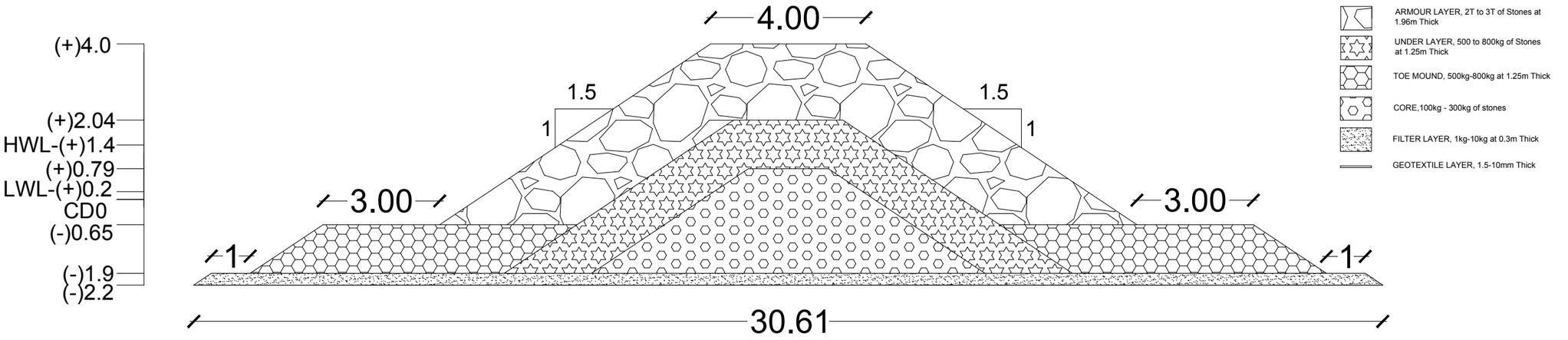
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TRUNK SECTION AT (-)2.5m to (-)3.0m CD , (-)2.5m to (-)2.8m AND
DRAWING NO:	10
DATE:	03.02.2021
ENGINEERING FIRM:	Prof. V. SUNDAR Prof. S. A. SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



TRUNK SECTION H-H AT (-)2.0m to (-)2.5m CD



TRUNK SECTION I-I AT (-)2.0m to (-)2.2m CD

NOTES :-

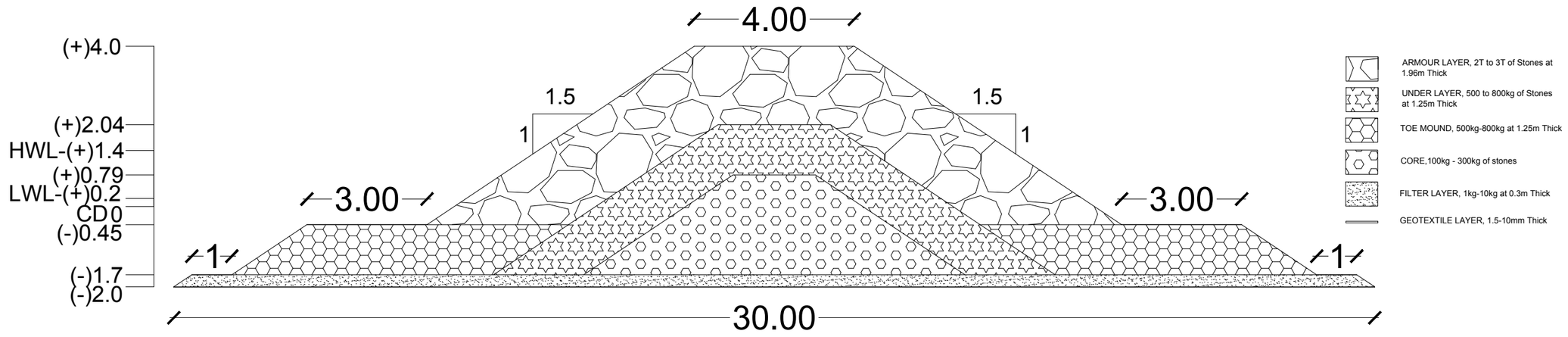
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. BED LEVEL SHOULD BE DREDGED UPTO THE 0.0m IN THE LAND SIDE BEFORE PLACING THE SECTION
4. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

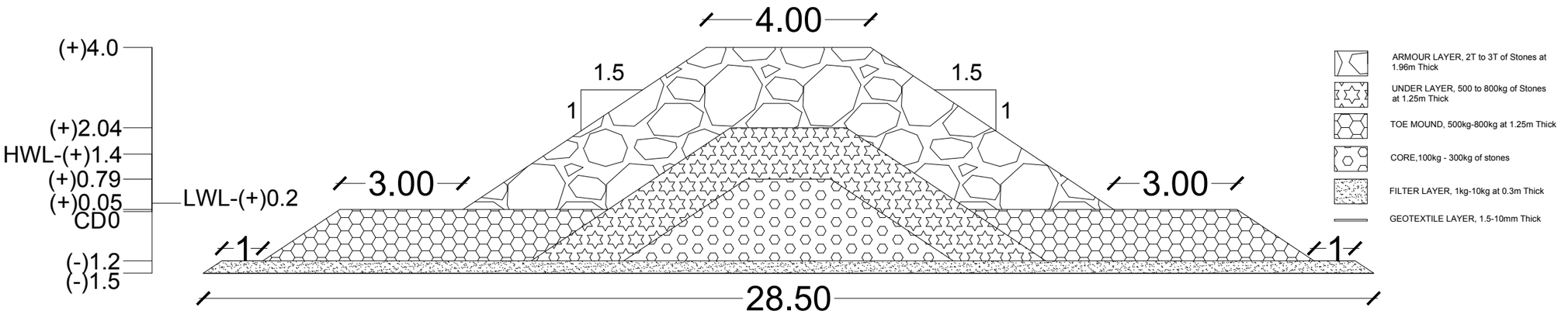
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TRUNK SECTION AT (-)2.0m to (-)2.5m CD AND (-)2.0m to (-)2.2m CD
DRAWING NO:	11
DATE:	03.02.2021
ENGINEERING FIRM:	Prof. V. SUNDAR, Prof. S. A. SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



TRUNK SECTION J-J AT (-)1.5m to (-)2.0m CD



TRUNK SECTION K-K AT (-)1.0m to (-)1.5m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. BED LEVEL SHOULD BE DREDGED UPTO THE 0.0m IN THE LAND SIDE BEFORE PLACING THE SECTION
4. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

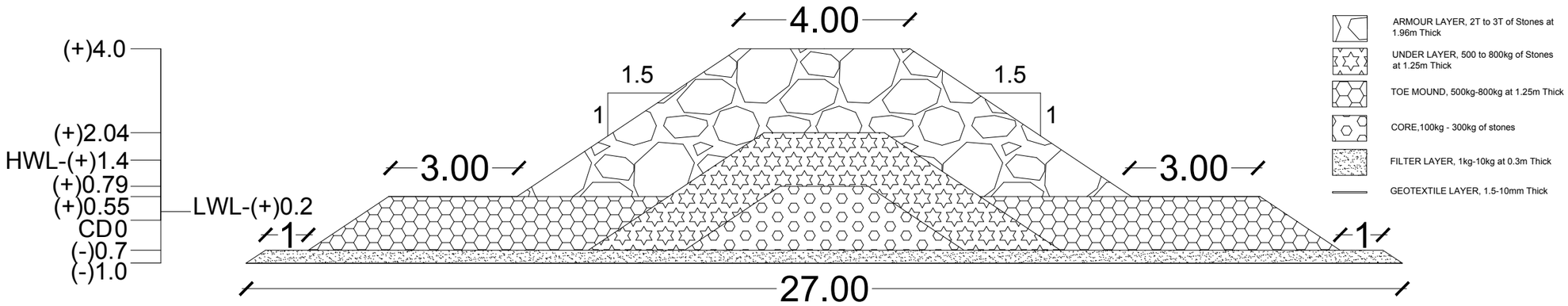
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE-A3

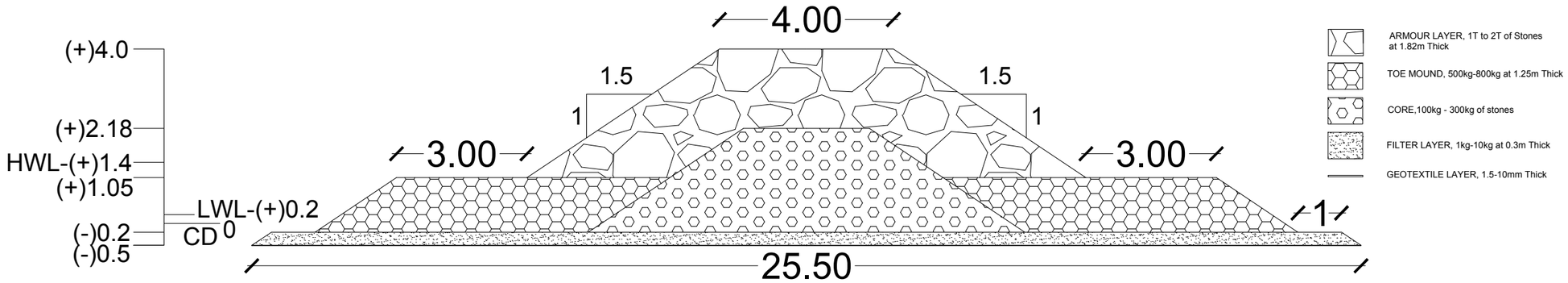
CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TRUNK SECTION AT (-)1.5m to (-)2.0m CD, (-)1.0m to (-)1.5m CD
DRAWING NO:	12
ENGINEERING FIRM:	

DATE: 03.03.2021

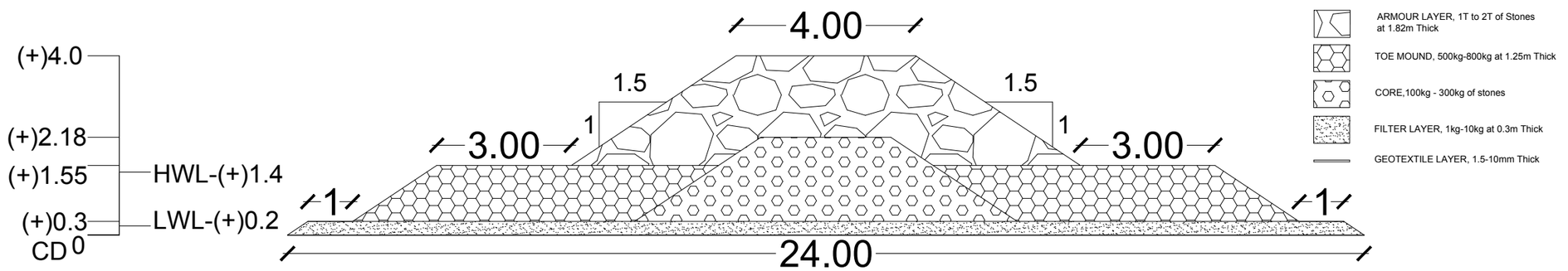
Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



TRUNK SECTION L-L AT (-)0.5m to (-)1.0m CD



TRUNK SECTION M-M AT 0 m to 0.5m CD



TRUNK SECTION N-N AT to (-)0.5 to 0m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. BED LEVEL SHOULD BE DREDGED UPTO THE 0.0m IN THE LAND SIDE BEFORE PLACING THE SECTION
4. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

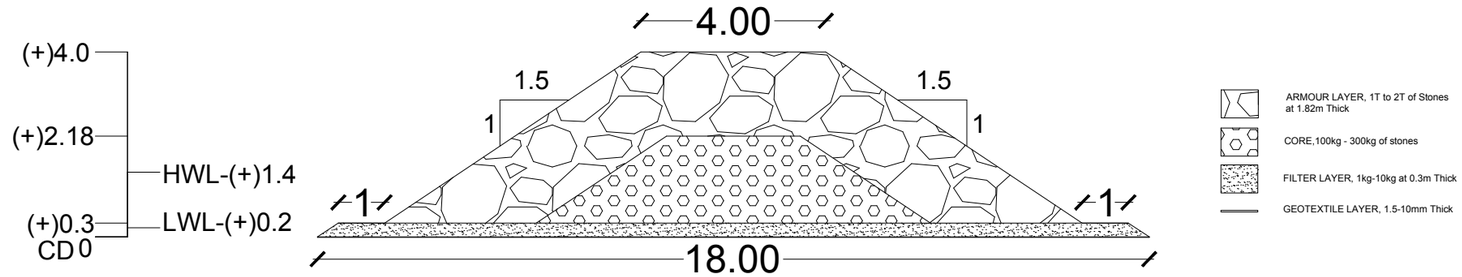
LEGEND :-

HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

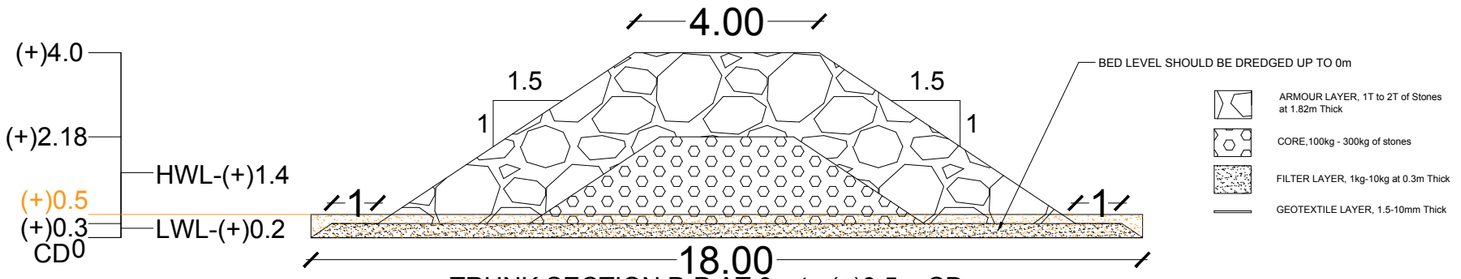
ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TRUNK SECTION AT (-)0.5m to (-)1.0m CD, 0.0m to (-)0.5m CD AND (-)0.5 to 0m CD
DRAWING NO:	13
DATE:	03.03.2021

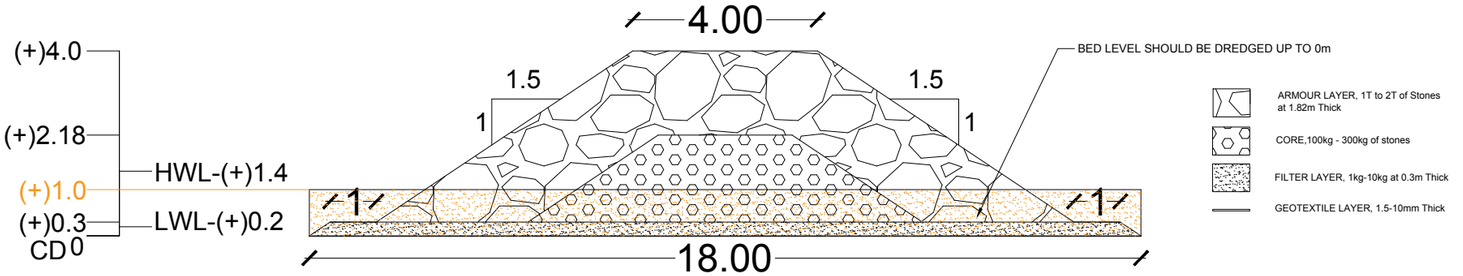
ENGINEERING FIRM:
Prof. V. SUNDAR Prof. S. A. SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36



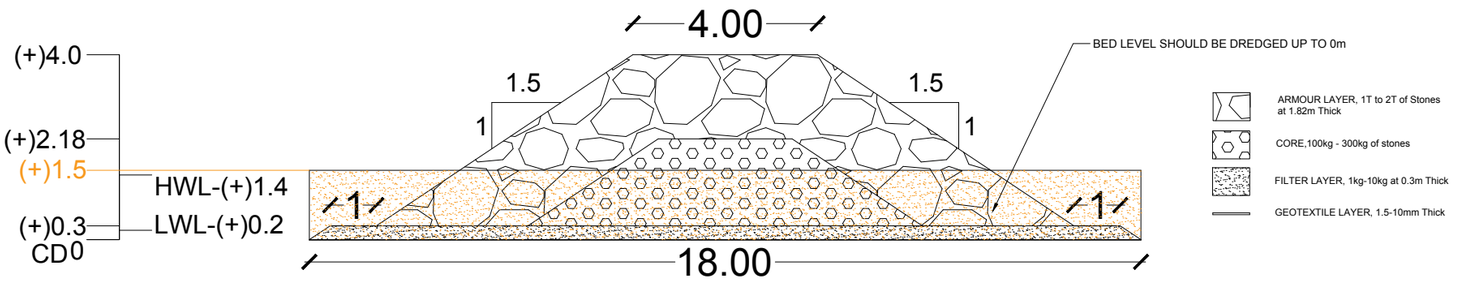
TRUNK SECTION O-O AT 0m CD



TRUNK SECTION P-P AT 0m to (+)0.5m CD



TRUNK SECTION Q-Q AT (+)0.5m to (+)1.0m CD



TRUNK SECTION R-R AT (+)1.0m to (+)1.5m CD

NOTES :-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
2. ALL LEVELS INDICATED ARE IN METERS
3. BED LEVEL SHOULD BE DREDGED UPTO THE 0.0m IN THE LAND SIDE BEFORE PLACING THE SECTION
4. SLOPE - 1 IN 2 FOR HEAD SECTION, 1 IN 1.5 FOR TRUNK SECTION

LEGEND :-

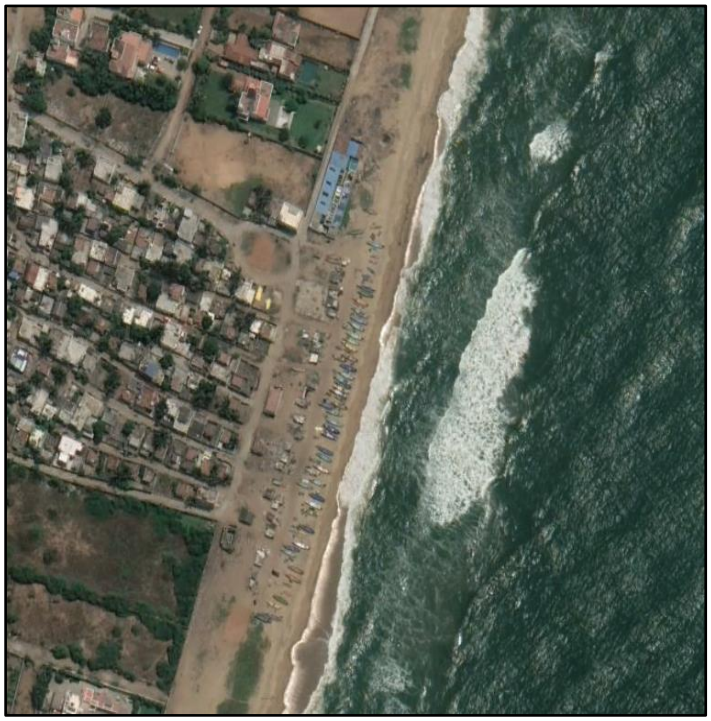
HWL - HIGH WATER LEVEL
LWL - LOW WATER LEVEL
CD - CHART DATUM

ORIGINAL SIZE:A3

CLIENT:	DEPARTMENT OF FISHERIES, TAMILNADU
PROJECT:	DESIGN OF GROINS AT UYYALIKUPPAM
DRAWING TITLE:	TRUNK SECTION AT 0m CD, (+)0.0m to (+)0.5m CD, (+)0.5m to (+)1.0m CD AND (+)1.0m to (+)1.5m CD
DRAWING NO:	14
ENGINEERING FIRM:	Prof. V. SUNDAR, Prof. S. A. SANNASIRAJ, DEPARTMENT OF OCEAN ENGINEERING, IIT MADRAS, CHENNAI - 36

DATE: 03.03.2021

CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS AT CHEMMENCHERRY IN CHENGALPATTU DISTRICT



Client

Fisheries Department, Tamilnadu

Consultants

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Prof. S. A. Sannasiraj

Department of Ocean Engineering
Indian Institute of Technology Madras
Chennai 600 036, India

October 2022

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1.0 INTRODUCTION

The Department of Fisheries, Tamilnadu has requested the Department of Ocean Engineering, Indian Institute of Technology Madras to suggest suitable coastal protection measures that could possibly limit the coastal erosion process in the site vicinity of Chemmencherry. The coastal site of the Chemmencherry is located at latitude 12°46'28.33"N and longitude 80°15'9.71"E, in Chengalpattu district. Prior to the implementation of preventative measures, the Department of Fisheries, Tamilnadu conducted a bathymetry and topographical study of the area. The location of Chemmencherry is shown in **Fig.1.**

Fig.1 Location of Chemmencherry site

2.0 OBJECTIVE & SCOPE OF WORK

The objectives of the present study include,

1. Offshore annual wave climate shall be established using the best available data sources.
2. Layout of groynes field suitable for Chemmencherry coast.
3. Wave tranquility to identify the wave characteristics in the proposed location.
4. The shoreline changes due to the proposed structure i.e., accretion or erosion shall be established.
5. Design of groynes, cross sections and bill of quantity.

3.0 BATHYMETRY

A bathymetry survey for a stretch of about 650 m off the coast of Chemmencherry has been provided by the Department of Fisheries, Tamilnadu on 9th May 2022 (Surveyed on 15th march 2022) which is shown in **Fig.2** and **Plate *(IITM - CMC - GY – 001).***

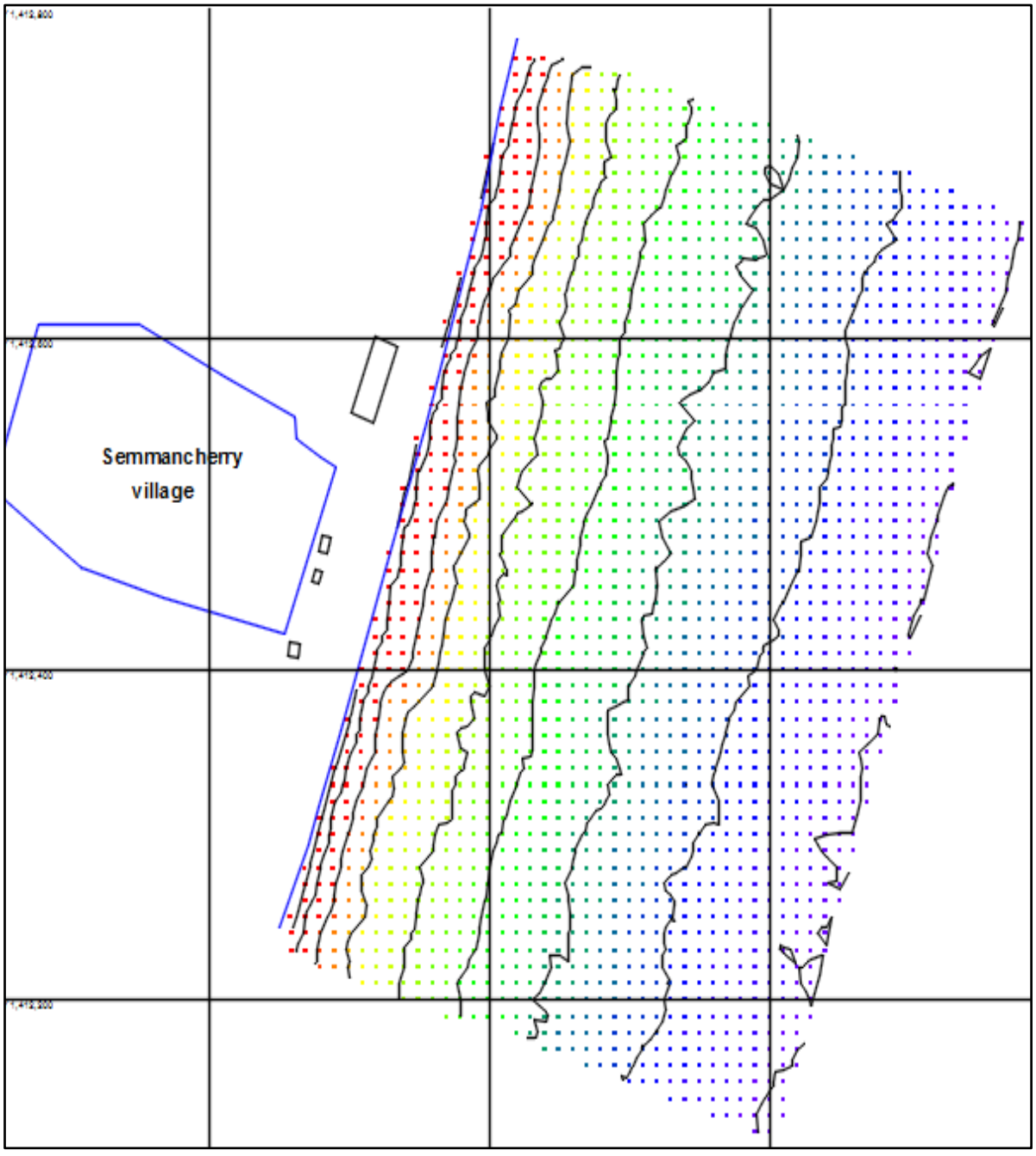


Fig.2 Bathymetry off Chemmencherry stretch provided by the Department of Fisheries, Tamilnadu

4.0 OFFSHORE WAVE CHARACTERISTICS

The wave characteristics such as significant wave height, mean wave period and mean wave direction at a deep-water location (12°75'00.00"N, 80°05'0.00"E) off Chengalpattu have been extracted at every 6 hours interval from the European Centre for Medium-Range Weather Forecasts (ECMWF). Basically, the wave field follows the wind pattern. It is noted that the spatial variability is closely related, the maximum H_s are associated with maximum wind speeds. The annual percentage of occurrence of significant wave height is presented in **Fig.3.** . It is observed that the offshore wave climate of Chengalpattu is predominantly from east and south east.

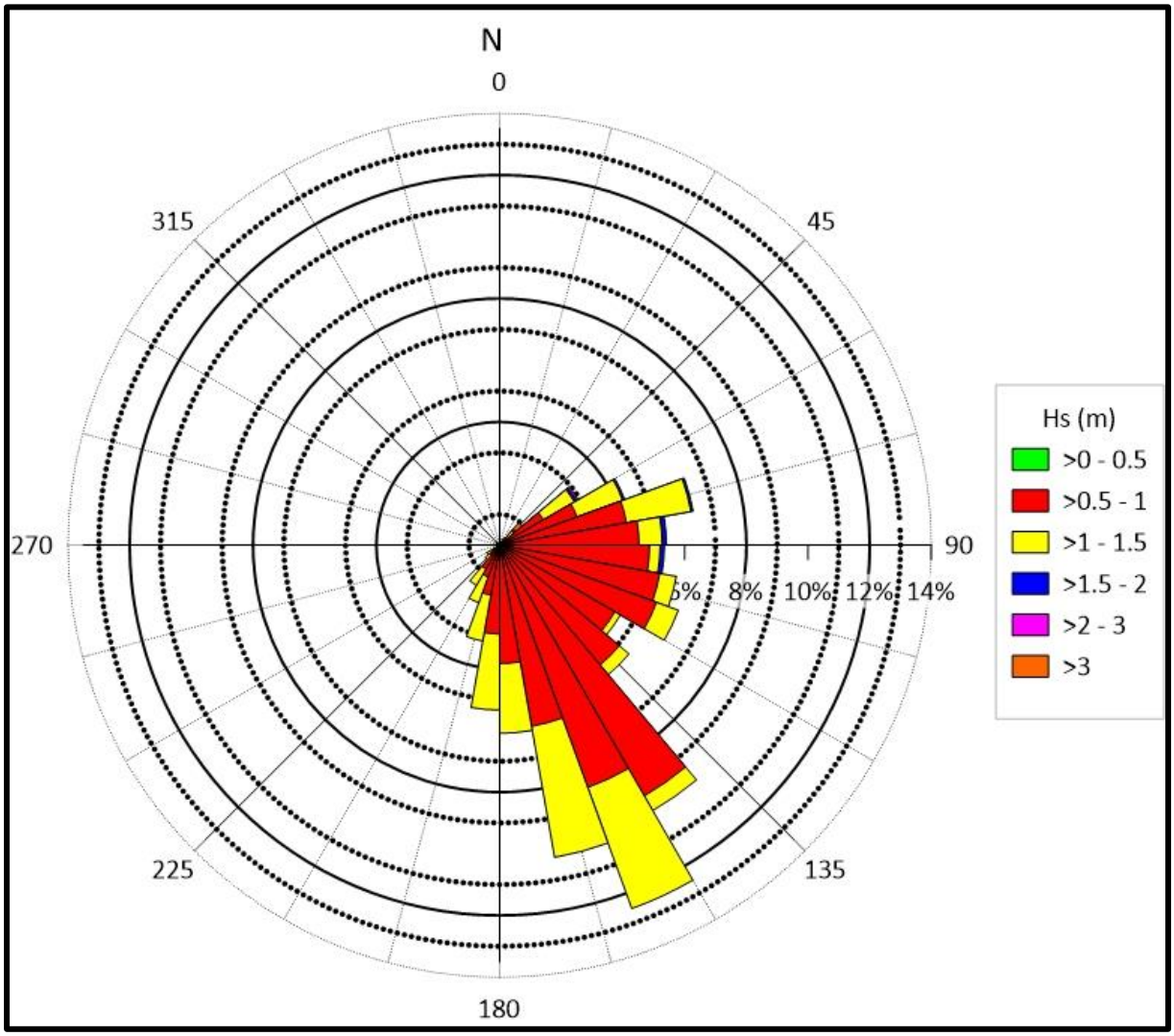


Fig.3 Wave Rose diagram representing the significant wave height (m) along the direction for an annual year

5.0 LITTORAL DRIFT ESTIMATE

5.1 Distribution of Sediment Transport

The wave characteristics such as significant wave height, mean wave period and mean wave direction at a deep-water location (12°75'0.00"N, 80°05'0.00"E), Chengalpattu have been extracted at every 6 hours interval from the European Centre for Medium-Range Weather Forecasts (ECMWF). **Table 1** shows the Wave characteristics for the present study. These are offshore wave climate and are transformed to the near shore location of Chemmencherry coast using Snell's law. The average breaking wave characteristics were derived from the available wave data. The monthly distribution of mean breaker wave height for the study area is shown in **Fig. 4.** The results indicate that the mean breaker height varies from about 0.85 m to 1.40 m. The breaker height is observed to be a maximum during the month of September. The monthly distribution of the mean breaker wave angle with respect to shore normal is shown in **Fig. 5**. From the results, it is seen that for the study area, the breaker angle with respect to shore normal and longshore current velocity are directed towards North during the months, March to October, and towards the South in January, February, November and December. The average surf width within which the long shore drift is predominant is further estimated from the breaker wave height for the given bathymetry and is projected in **Fig.6** for the different months. It shows that the maximum surf width of about 90 m during the month of September.

Further, the derived wave characteristics were used to calculate the long shore sediment transport. Three different methods CERC (1984), Komar (1976 a), and by integrating the distribution across the surf zone (Komar, 1976 b) have been adopted to calculate the alongshore sediment transport rate. The average sediment transport rate for the different months is shown in **Fig.7.** All the three methods have yielded similar order sediment transport rate. The net drift is found to be about 154900 m^3 per annum and directed towards the north.

Table 1 Wave characteristics for the present study

	Month	Deep water wave direction w.r.t North	Wave height, H_s(m)	Wave period, T(sec)
1	January	67	0.9	5.3
2	February	102	0.7	5.3
3	March	138	0.8	5.8
4	April	145	0.9	5.5
5	May	148	1.0	5.5
6	June	183	1.1	5.4
7	July	164	0.9	5.8
8	August	184	1.0	5.5
9	September	160	1.1	7.3
10	October	140	0.9	5.8
11	November	113	1.0	6.2
12	December	83	0.9	5.8

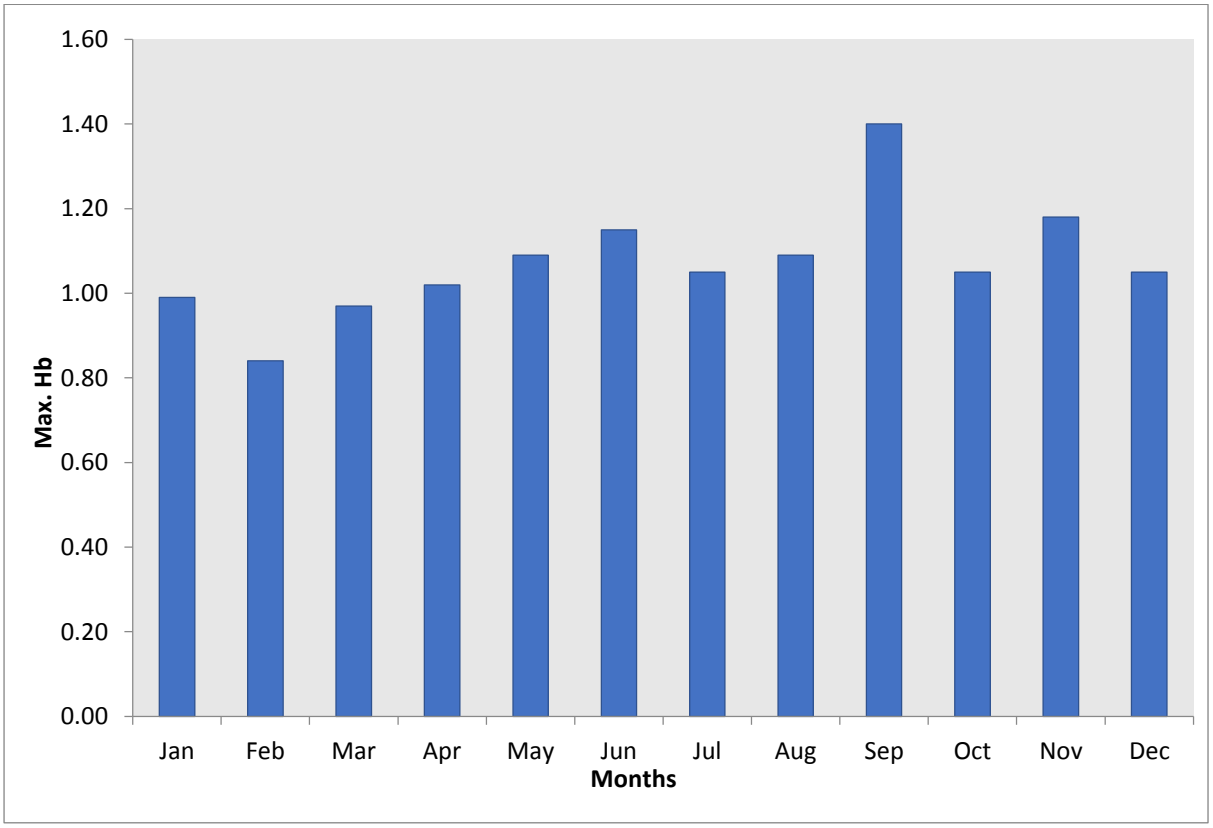


Fig.4 Breaker wave heights in meter

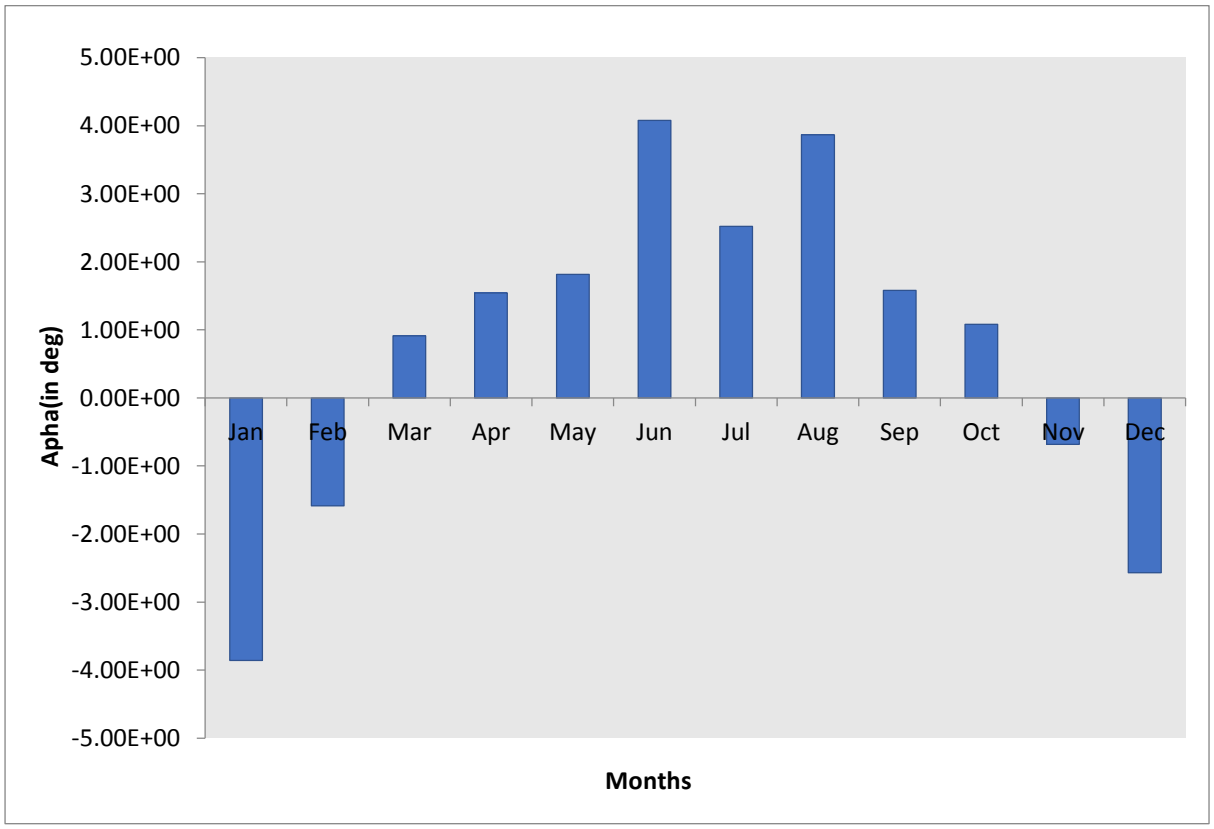


Fig.5 Wave breaker angle

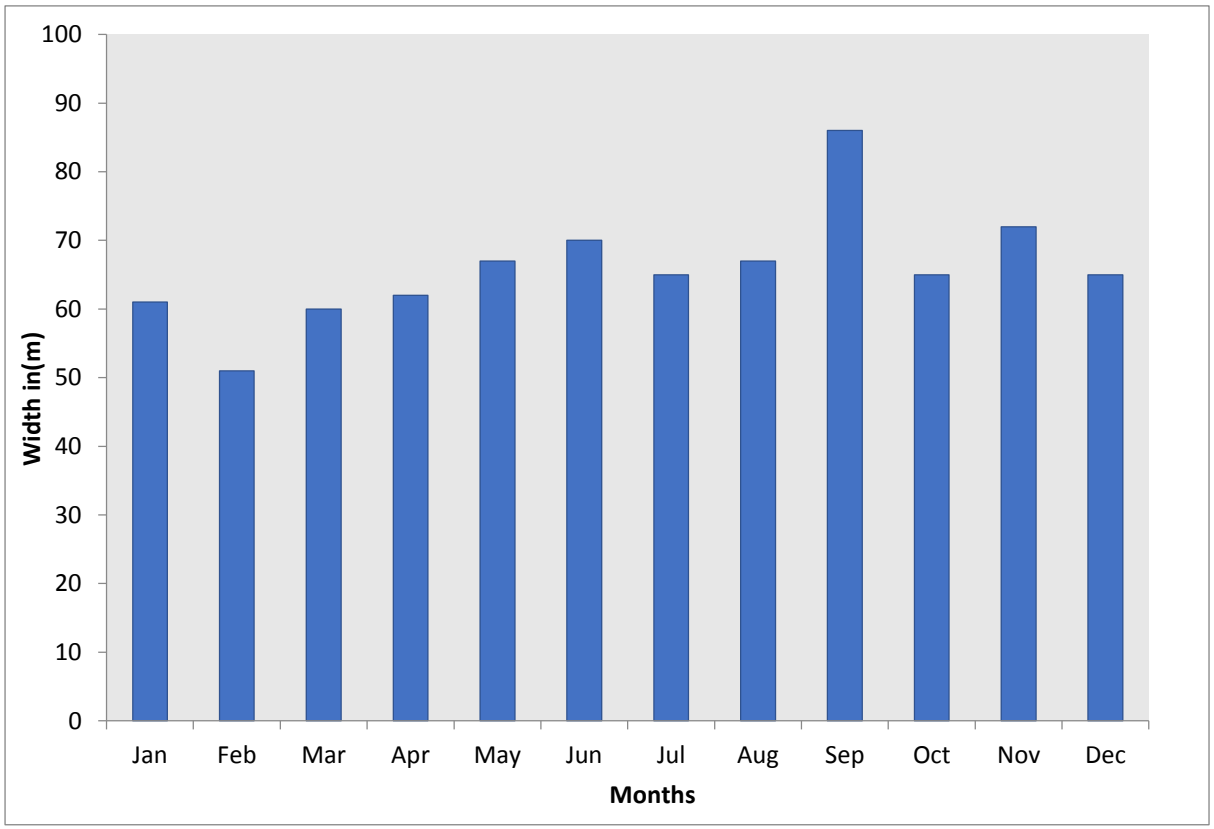


Fig.6 Surf zone width

Table.2 Sediment transport rate (Net Northerly)

Methods	Rate (m^3/year)
Komar	152700
CERC	159000
Distribution	153000

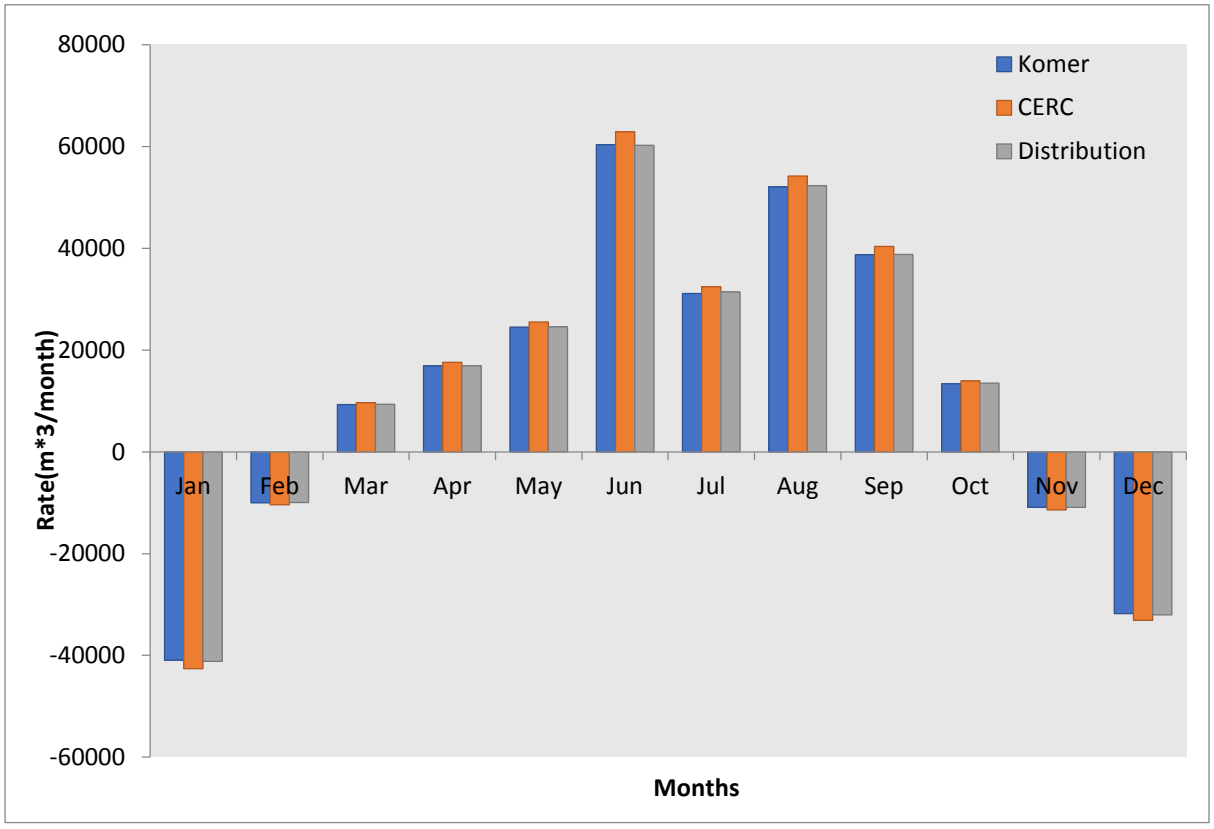


Fig.7 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROYNES

A series of 6 transitional groynes have been proposed to protect the coastal stretch (620m) of Chemmencherry. **Fig.8** depicts an overview of the proposed groynes superposed over bathymetry provided by the Fisheries Department, Tamilnadu on 09/05/22, the details of which are projected in **Plate *(IITM - CMC - GY - 101 - 01).*** The groynes, G1 and G6, each of which measure 20 m in length reaching a maximum water depth of about -1.1 m and -1.5 m respectively. Each of the G2 and G4 measures 50 metres in length and extends to about -2.1 m and -2.3 m of water depth respectively. The groyne G3, 30 m long will extend to water depths of -1.7 m. Groyne G3, which is 60 m long will extend to a water depth of -2.7 m.

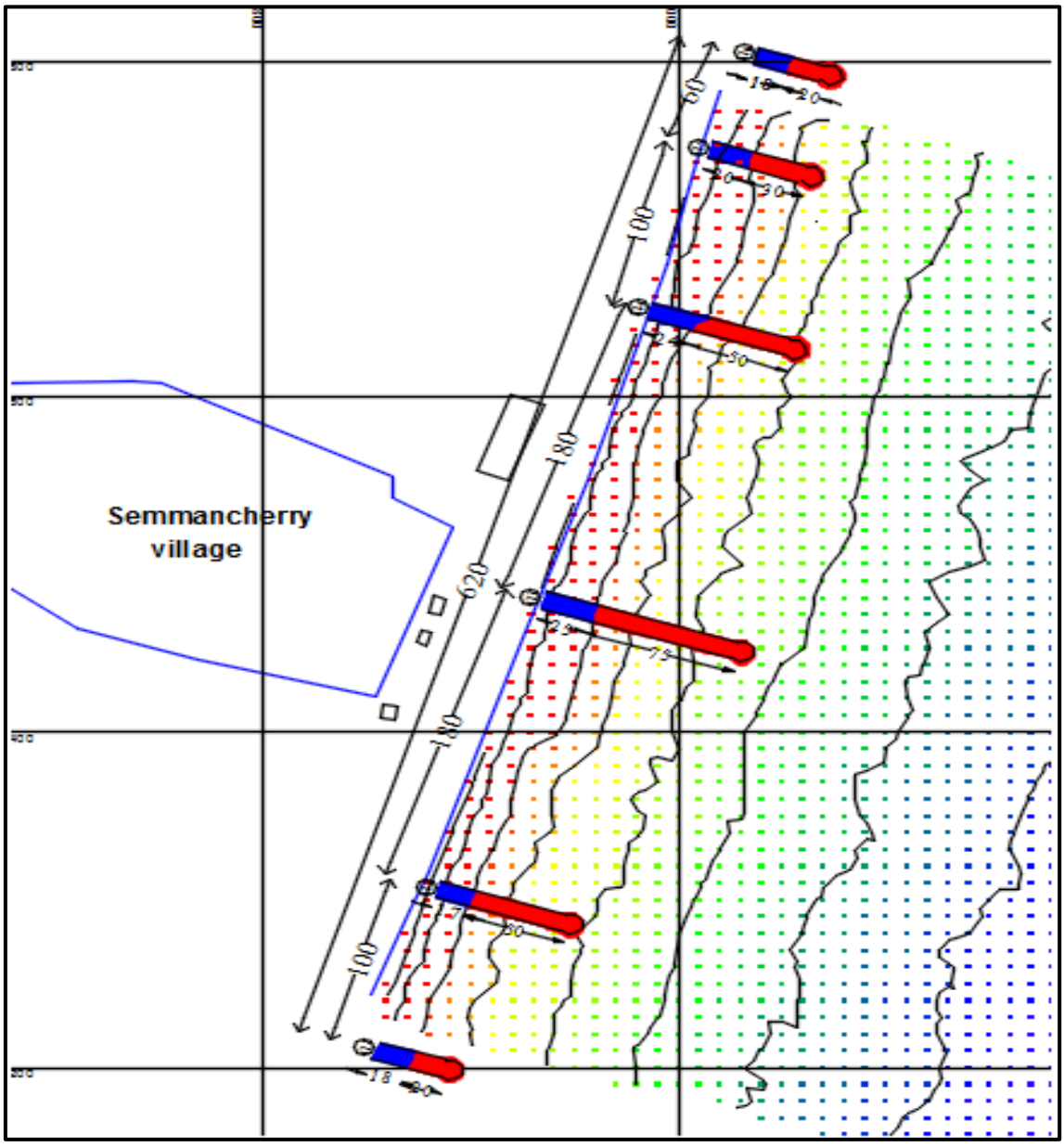


Fig.8 Layout of groynes field

7.0 NUMERICAL MODELLING FOR SHORELINE EVOLUTION

Structures in the near shore environment are built for different purposes, which may be for the formation of artificial harbors, shore protection measures, seawater intake systems, disposal of effluent, etc. There are several configurations of such structures with respect to the shoreline, among which, structures normal to the shore is most common. The construction of a shore-connected structure often leads to changes in the shoreline. This warrants a study on the shoreline due to presence of the shore-connected structures. Such a study is very much essential in planning stage; so as to assess the impact of shore connected structures on the adjacent shoreline.

Numerical models offer the capability to study the effect of the wave characteristics, structure dimensions and other associated parameters in providing reasonable estimates of the shoreline response. As the ocean waves approaches the near shore it undergoes transformations like shoaling, refraction, diffraction and breaking. The phenomena of wave breaking throw sediments to the surface due to the turbulence generated. The sediments in suspension are then driven by the wave-induced currents. Since the direction of waves in the near shore is oblique, the currents induced by them have two components. One along the shore called longshore current mainly responsible for the long shore sediment transport, which plays an important role in the shoreline changes especially due to the shore connected structures. The other component is in the direction normal to the shore, in which case, the mode of sediment transport is called onshore-offshore sediment transport. When a structure normal to the shoreline is constructed, it will intercept the free passage of longshore sediment transport, which results an imbalance in the quantity of sediment in the near shore especially near the structure. This leads to accretion on the up-drift side and erosion on the down drift side of the structure.

Methodology

Kraus and Harikai (1983) proposed a numerical scheme to solve the one line model using Crank Nicholson implicit finite difference method. The non-dimensional equation of shoreline

$$y^*_{n,t^*+1} = B\left\{Q^*_{n,t^*+1} - Q^*_{n+1,t^*+1}\right\} + C_n$$

$$where\, B = \frac{\delta t^*}{2\times\delta x^*}\, and\, C_n = B\left\{Q^*_{n,t^*} - Q^*_{n+1,t^*} + 2\delta x^* q^*_{n,t^*}\right\} + y^*_{n,t^*}$$

The non-dimensional shoreline is divided into 'n' grid points at equal non-dimensional interval, δx^*. Then shoreline changes over a non-dimensional time, δt^* is calculated using Crank-Nicholson finite difference scheme. The schematic diagram for finite difference scheme is shown in **Fig. 9**

In this method, Q^* at the time interval (t^* +1) is expressed in terms of the shoreline co-ordinate of y*, first isolating the term involving α_{sp} (angle of shoreline normal to x-axis) using trigonometric identities. One of the terms involving α_{sp} is then expressed as first order quantities in y* at time step (t*+1).

$$Q^* = K_D^2 \cos(\alpha_o)\sin(\alpha_b)$$

Where, $\alpha_o = \alpha - \alpha_{sp}$ and α is wave direction with respect to x-axis. The definition sketch showing the angles is shown in **Fig. 10.**

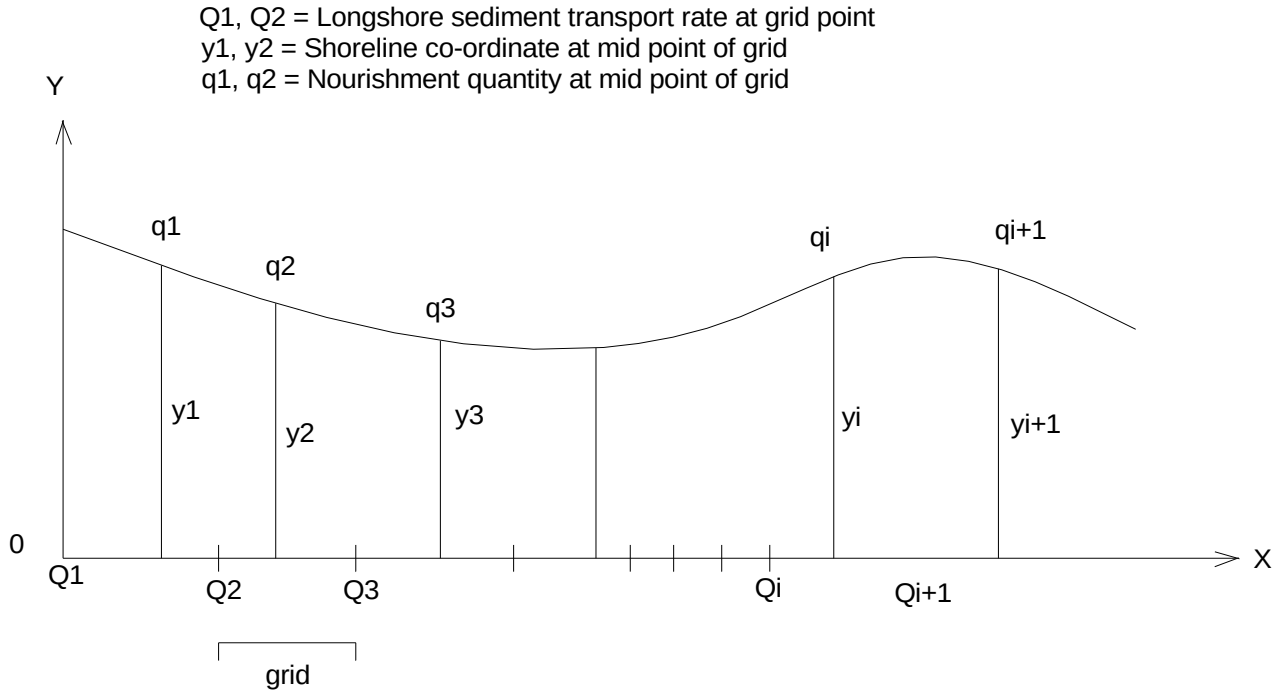


Fig 9. Schematic diagram for finite difference scheme

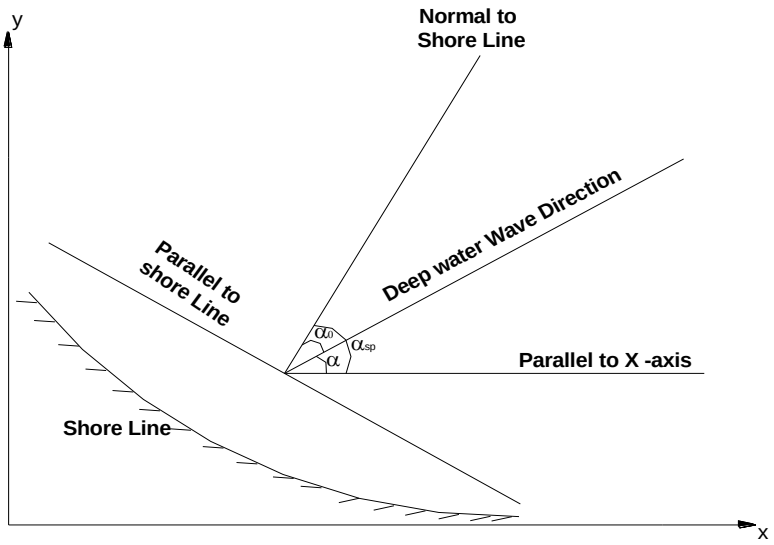


Fig 10. Definition sketch of angles considered

The elliptical form of mild slope equation, which deals with combined refraction-diffraction,

$$Q^* = K_D^2 \cos\left(\alpha - \alpha_{sp}\right)\sin\left(\alpha_b\right) \quad (1)$$

$$Q^* = K_D^2 \sin\left(\alpha_b\right)\left\{\cos\left(\alpha\right)\sin\left(\alpha_{sp}\right)\cot\left(\alpha_{sp}\right) + \sin\left(\alpha\right)\sin\left(\alpha_{sp}\right)\right\} \quad (2)$$

$$Q^* = E_n \left\{y_{n-1,t^*+1} - y^*_{n,t^*+1}\right\} + F_n \quad (3)$$

$$\text{Where } E_n = K_D^2 \left\{\cos(\alpha)\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}/\delta x^* \text{ and } F_n = K_D^2 \left\{\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}$$

By substituting above equations, give the final equation as given below

$$BE_n\, Q^*_{n-1,t^*+1} - (1+2BE_n)Q^*_{n,t^*+1} + BE_n\, Q^*_{n+1,t^*+1} = E_n\left[C_n - C_{n-1}\right] - F_n$$

The above equations represent a set of (N-1) linear equation for (N-1) unknowns. The end values are specified as boundary conditions, that is, $Q^*_1 = 0$ and $Q^*_{N+1} = Q^*_N$. The above equation results into a tri diagonal form which is solved for Q^*. This process is repeated for the entire duration and non-dimensional quantity is converted into real quantities using the corresponding scale factors. The program has been validated with published results.

7.1 Input and Output

The numerical model to predict the shoreline evolution due to the shore-connected structures has been used to predict the shoreline changes due to the proposed groynes over the bathymetry the fisheries department, Tamilnadu the on 9th May 2022. The wave characteristics given as the input to the numerical model is as per given **Table 1**. The length of the groynes, water depth at the end of the groynes and the present status of the shore are to be given as the input to the numerical model.

The numerical model was executed for the most frequently occurring wave characteristics for the different months as stated earlier. The result on the predicted shoreline variations over years are projected in **Fig. 11**. The shoreline prediction has been made at the end of 1 year, 5 years, 10 years, 15 years, 20 years, and 25 years after the construction of the groynes and has been presented by superimposing the shoreline patterns.

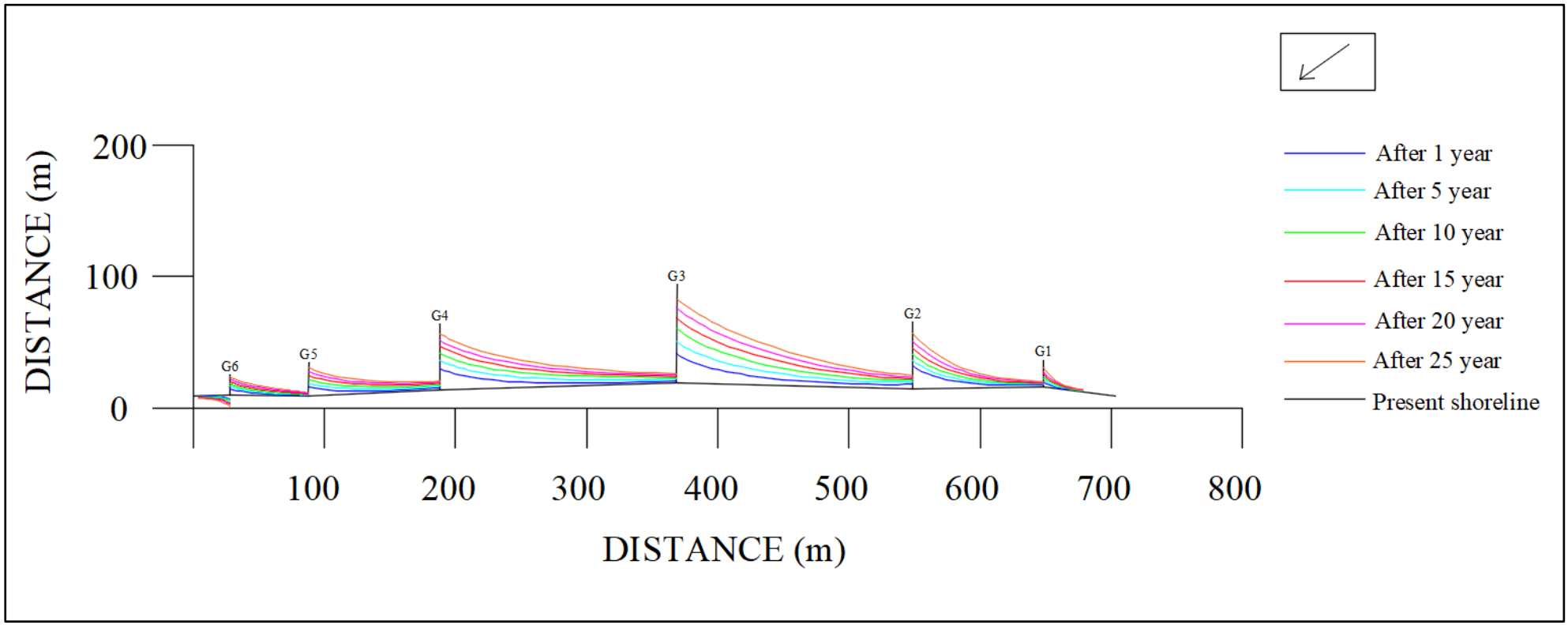


Fig.11 Shoreline evolution

8.0 WAVE MODELLING

8.1 General

The study aims at providing an in-depth analysis on the wave characteristics along the series of groynes at Chemmencherry. A suitable numerical model is required in order to carry out this task. For the present simulation, the well-known CGWAVE model has been used.

The nonlinear wave propagation associated with most of the observed phenomenon in offshore region (e.g., wave reflection, refraction and diffraction) is generally represented by the shallow water mild slope equation.

$$\nabla.\left(C_p C_g \nabla\eta\right) + k^2 C_p C_g \eta = 0 \qquad (4)$$

Where,

C_p and C_g are the wave celerity and group celerity respectively.

η is the water surface elevation.

k is the wave number.

For the computation of near shore wave field, this model (Eqn. (4)) is subjected to the proper boundary conditions. This is provided by the bathymetry and the shore line.

8.2 Computational domain

The computational domain roughly approximates a semi-circle of radius 1km. **Fig.12** shows the domain where the computations are performed. The direction of the incident monochromatic wave is defined with respect to the geometric northern direction.

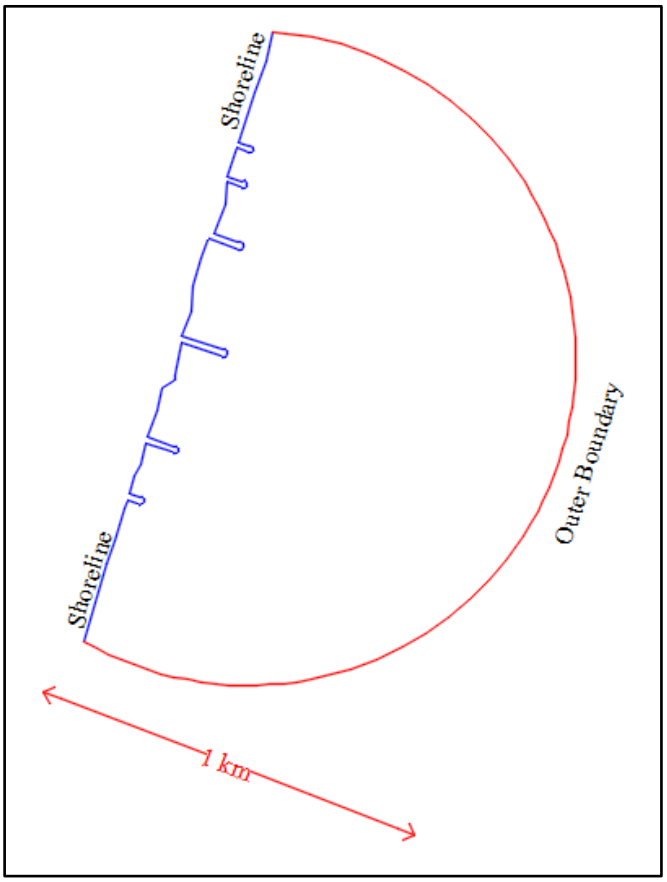


Fig. 12 Computational domain

A numerical method is required to solve the above Eqn. (4) for wave elevation. In this study, Finite Element Method (herein after abbreviated as FEM) is employed. This requires creating a mesh structure in the given computational domain. Upon creation of such a mesh, the domain is represented by nodal points which are connected with each other through the created mesh. The numerical solution of Eqn. (4) is sought in those nodes. This mesh has been generated using the commercial package GAMBIT. The procedure for generation of grid in GAMBIT as follows:

- Based on the region of the sea whose analysis is required add a path in Google earth software.
- Taking the two end nodes of the path draw a semicircle which would represent the domain for which the wave analysis is required.
- Choose the type of elements (tri/quad) and the sizing of mesh.
- Mesh will be generated from which we would be able to know significant wave height and phase at each node.

8.3 Detail of the mesh structure

The CGWAVE model utilizes triangular mesh units in the computational domain. Due to the complexity in the shoreline geometry, an unstructured mesh is desired. Hence a triangular unstructured mesh is generated in GAMBIT, mesh generation software. In such a mesh the nodal spacing is optimized so as to adapt to the nearby portion of the shoreline boundary. The outer semicircular periphery is modeled by 395 nodes with a spacing of 5 m and the inner shoreline is modeled by nodes with a spacing of 5 m. Then an unstructured mesh is created with an average spacing of 5 m inside the domain. This leads to a total number of 28336 nodes with 55948 numbers of triangular elements. The mesh is shown in **Fig. 13.**

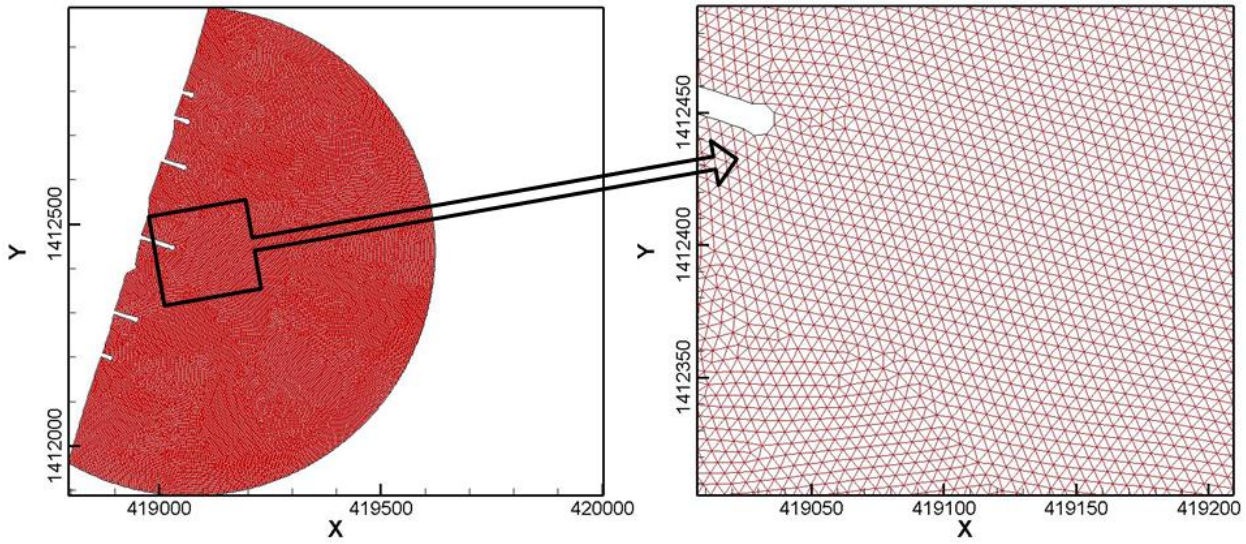


Fig.13 Mesh Structure adopted for the wave propagation modeling

8.4 Results and discussion

A total number of five wave directions have been simulated in order to investigate the wave tranquility inside the proposed port region. The wave directions are chosen such that these represent an annual year. The wave period of the computations is given as 6s-12s to observe the wave climate. The incident wave angle is varied to simulate different wave directional scenarios. The wave climates representing typical wave directions are presented. **Fig.14** to **Fig.19** reports the wave phase diagram and the wave height distribution for different wave approach angles of $45^{\mathbf{0}}$, $90^{\mathbf{0}}$, 135^{0}, $155^{\mathbf{0}}$, $180^{\mathbf{0}}$ and $200^{\mathbf{0}}$ respectively.

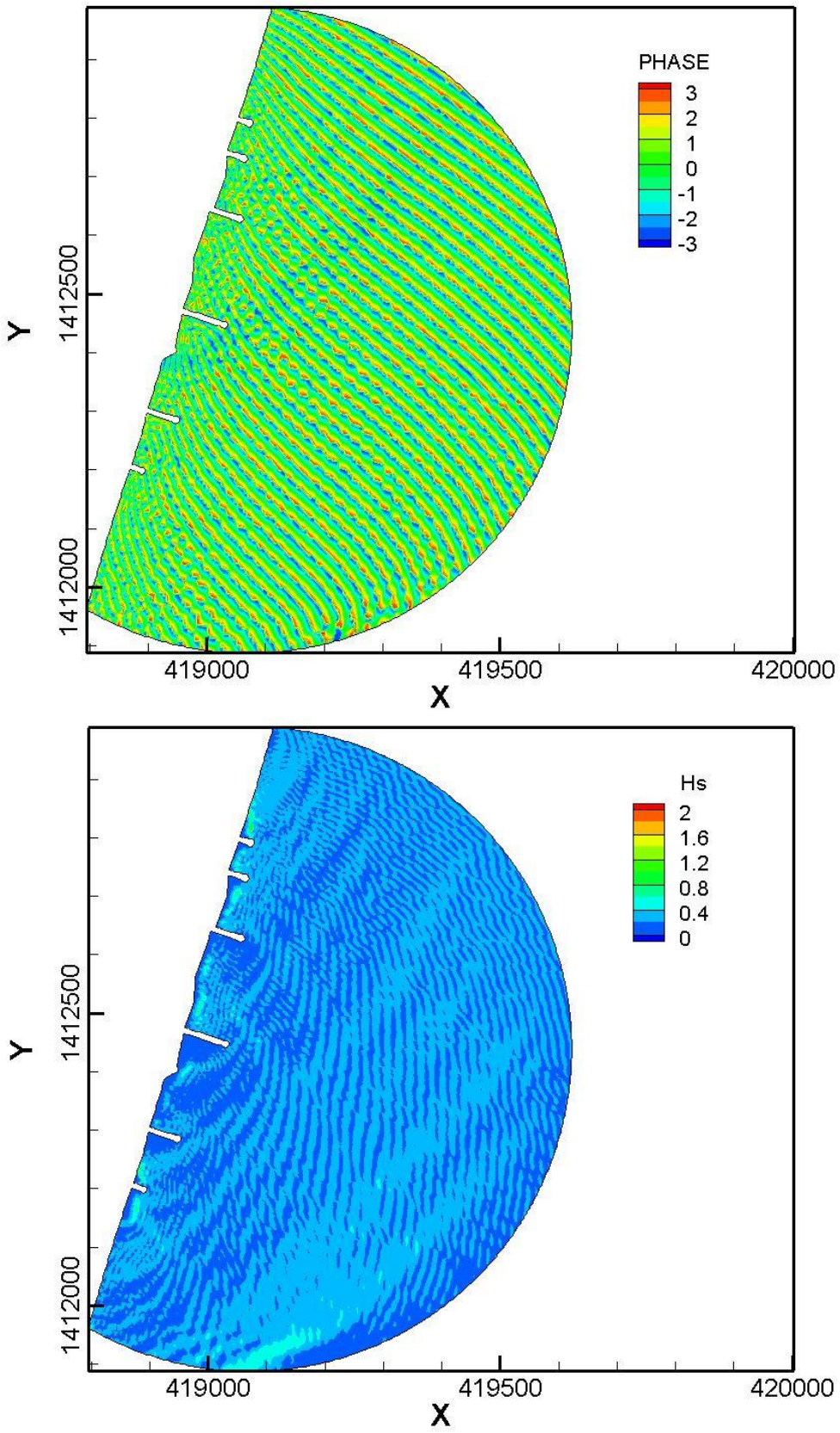


Fig.14 Phase distributions and Wave height distribution for the wave approach angle from 45^0

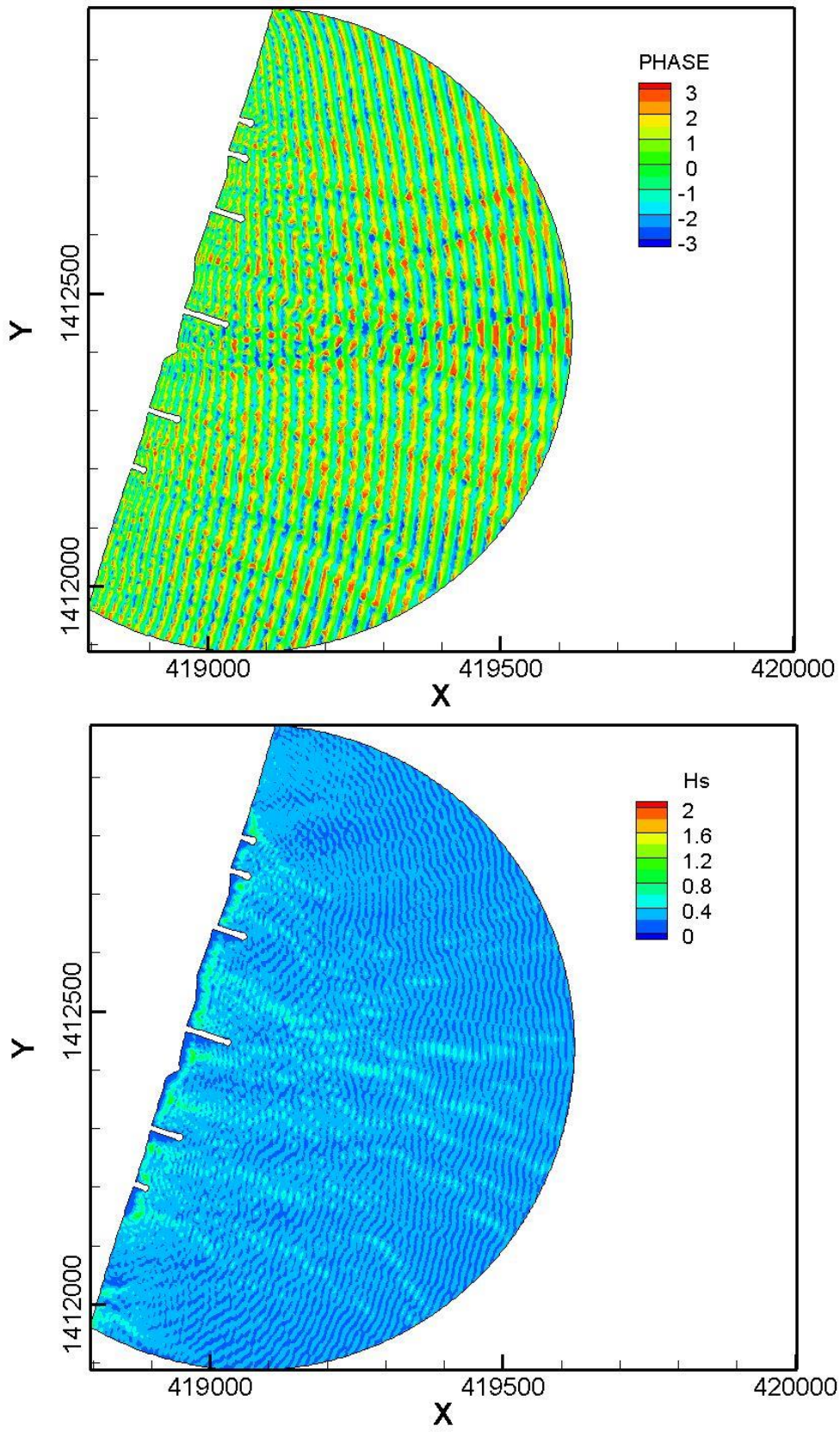


Fig.15 Phase distributions and Wave height distribution for the wave approach angle from 90^0

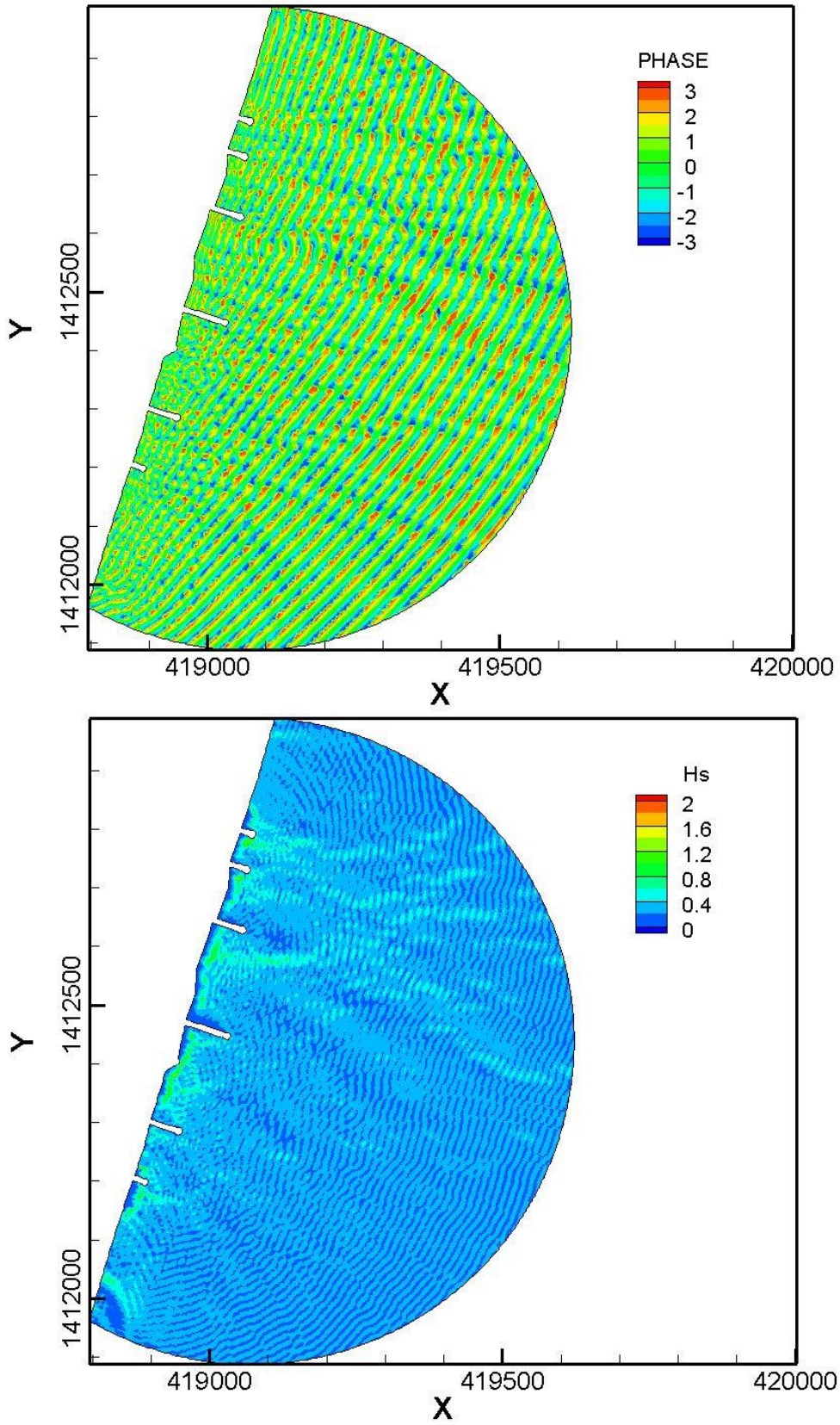


Fig.16 Phase distributions and Wave height distribution for the wave approach angle from 135^0

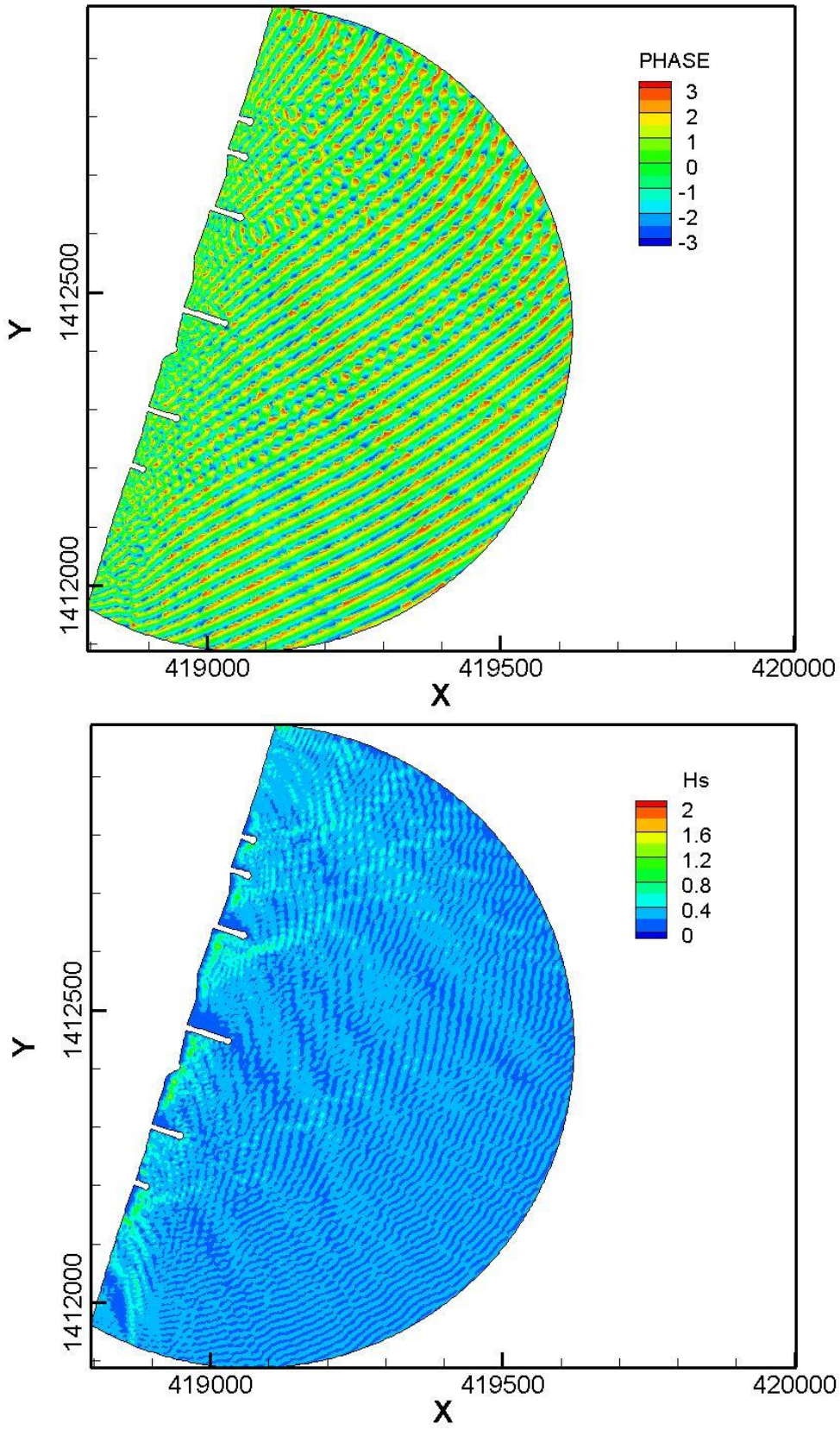


Fig.17 Phase distributions and Wave height distribution for the wave approach angle from 155^0

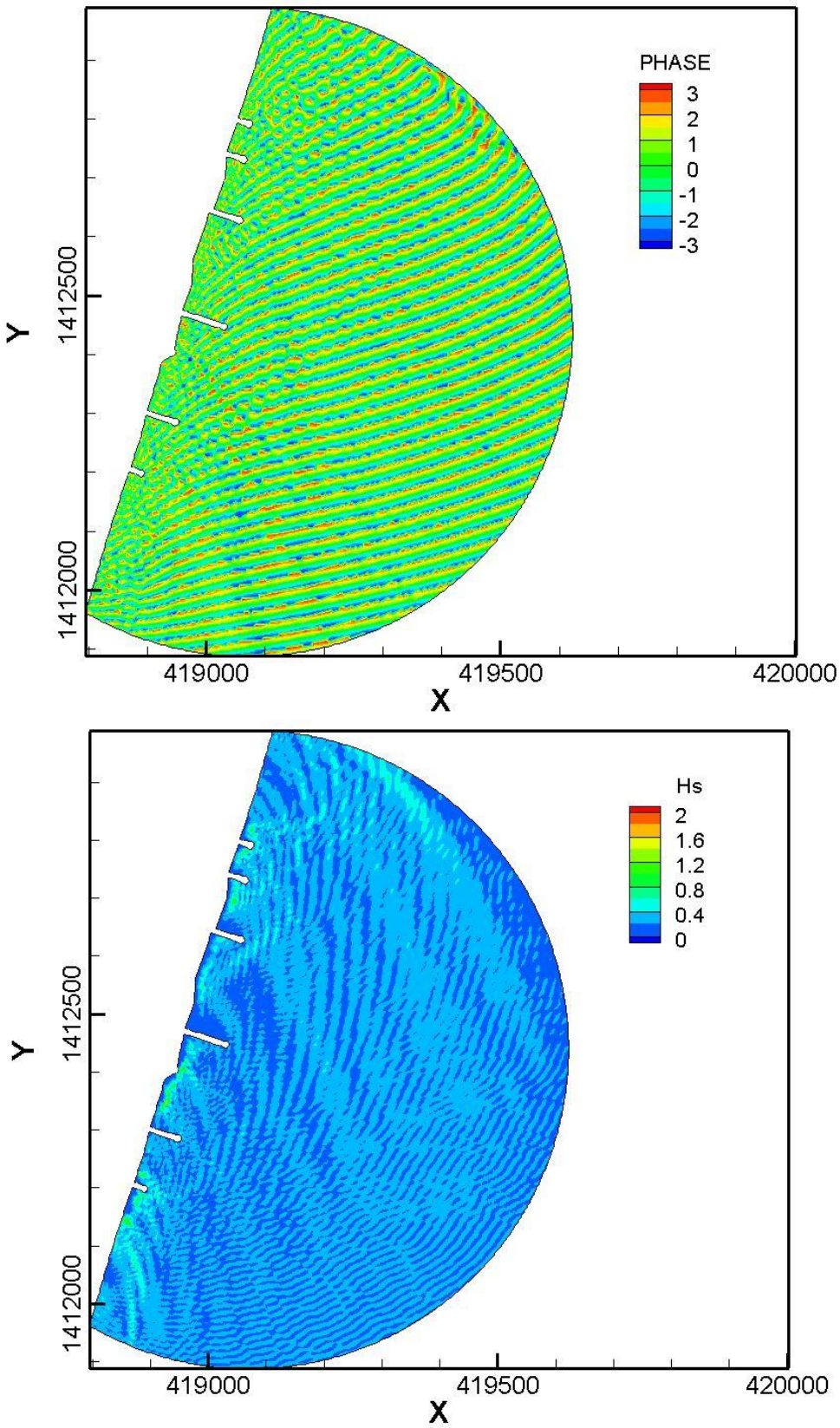


Fig.18 Phase distributions and Wave height distribution for the wave approach angle from 180^0

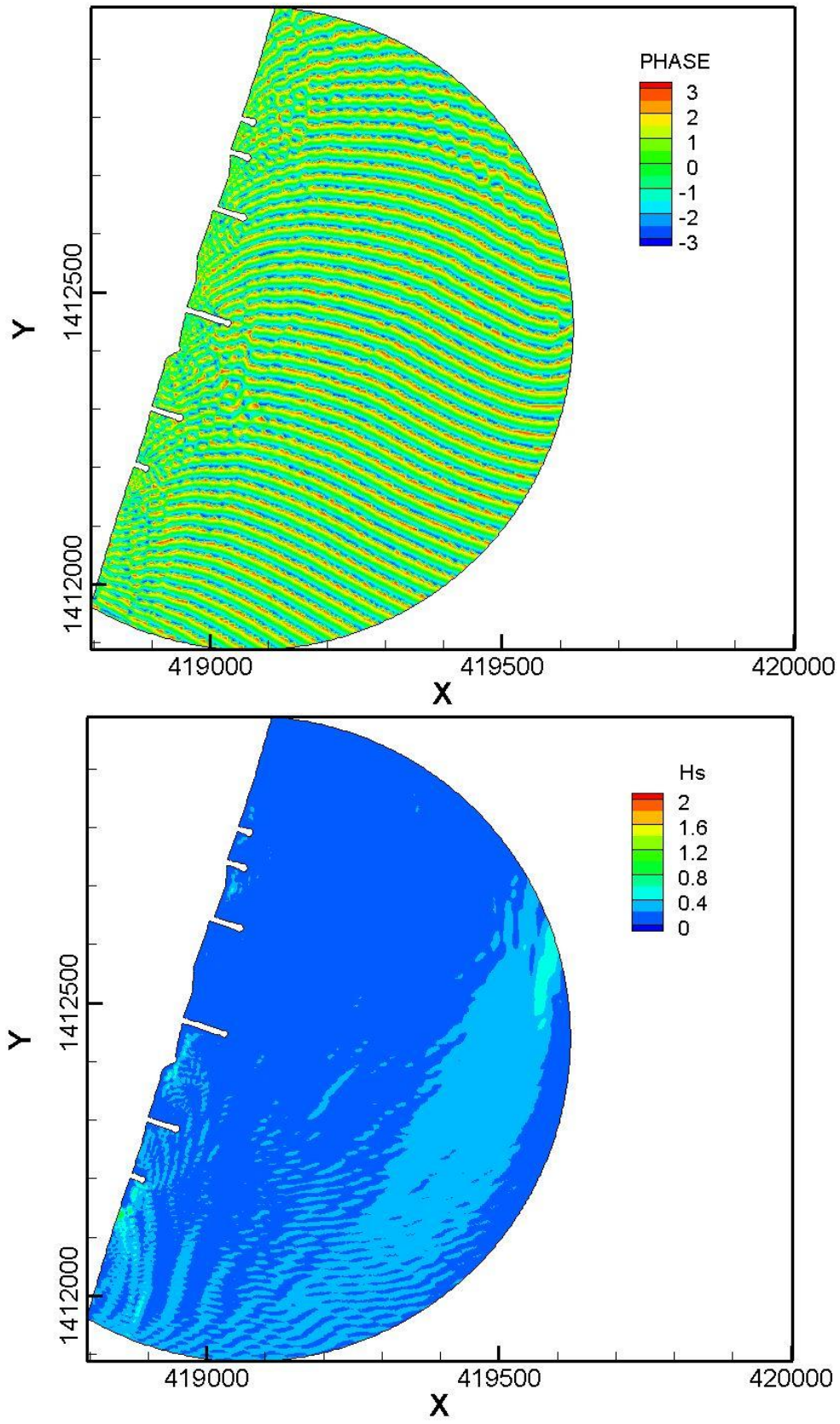


Fig.19 Phase distributions and Wave height distribution for the wave approach angle from 200^0

9.0 DESIGN OF GROYNES

9.1 Design water level

Following design data has been adopted for the design of stone section. The Mean high-water level was +1.2m CD. For the design of the section, MHWL is adopted as maximum water level.

The design water level for the groyne can thus be set as the sum of MHWS and the design water depth is,

d = 2.7+1.2+0.8= 4.7 m

Hmax = 0.78 x 4.7

= 3.70 m

Significant wave Height = Hmax /1.6 = 2.40 m

Take Design wave height as 2.40 m.

9.2 Design of layers

The following describes a typical groyne design.

Armour Layer

The size of the armour stones for the groyne section is calculated by using the Hudson formula, which is recommended by CERC (1984). Stones are used as armour unit.

$$W = \frac{W_r H_D^3}{K_D (S_r - 1)^3 \cot\theta}$$

Where,

W=Weight of an individual armour unit in the primary cover layer.

W_r =Unit weight of stones, 2.65 T/m^3.

H_D =Design wave height at the structure site in meters,

S_r =Specific weight of armour unit relating to water at the structure

$S_r = (W_r / W_w)$

W_w =Unit weight of seawater = 1025 kg/m^3

θ =Angle of structure slope measured with the horizontal in degrees =1:1.5 (Chosen) for trunk section and 1:2 for head section.

K_D =for rough quarry stones in breaking condition, the stability coefficient is 2, and it is 1.6 for the head and trunk, respectively.

From Hudson's formula, the weight of Stone is worked out to be 2.5 T to 4 T in two layers to withstand the design wave height of 2.40 m at the maximum water depth (-) 2.7 m water depth.

The thickness of the armour layer is calculated by following,

$$t = nK\delta\left[\frac{w}{w_r}\right]^{\frac{1}{3}} = 2.15 \text{ m}$$

2.15 m thickness was adopted for armour layer.

Core layer

The size of stone in core layer is 100 kg to 300 kg rough angular quarry stones are suggested for core layer for which W_r =2650 kg / m^3.

Toe Mound

The size of stone in toe mound is taken as $W/10$ to $W/15$ (as per CERC, 1984).

Rough angular quarry stones of weight 500 Kg to 800 Kg are suggested for toe layer for which W_r =2650 kg/m^3 with 1.25m thickness for the trunk and head portion.

Crest width

Crest width, r is arrived from the formula

$$r = nK_\delta\left[\frac{W}{W_r}\right]^{\frac{1}{3}}$$

Where,

n= number of tetrapod's or stones on the crest

K_δ =Layer coefficient

Hence, Crest Width = 4 m

Crest elevation

The crest elevation of the groyne is given by,

Crest elevation = MHWS + Design Water Level + free board

Free board may be adopted in calculating the design elevation to give free height for exceptional cases of storms and cyclone waves that hit the toe of the structure to avoid dangers. For groynes, (+) 4.5 m crest elevation is maintained up to +1.2 m cross sections.

Filter layer

The size of stone in filter layer is taken as 1 kg to 10 kg Rough angular quarry stones are for which W_r =2650 kg / m^3. The thickness of filter layer is 0.3m.

The detailed plan, longitudinal sections and cross sections of the groyne are given in **Plates *(IITM - CMC - GY - 101 – 02)* to *(IITM - CMC - GY - 101 – 08).***

10.0 BILL OF QUANTITIES

Chemmencherry - G1 (20m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.20	21.40	23.80	238.00	166.60	441.49
0.0 m to (-) 0.5 m	5.00	21.40	18.40	19.90	99.50	69.65	184.57
at 0.0 m	5.00	18.40	25.90	22.15	110.75	77.53	205.44
0 to (+) 0.5 m	10.00	25.90	25.90	25.90	259.00	181.30	480.45
(+) 0.5 m to (+) 1.2	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**2723.05**

Chemmencherry - G1 (20m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.90	23.10	25.00	250.00	175.00	463.75
0.0 m to (-) 0.5 m	5.00	23.10	17.40	20.25	101.25	70.88	187.82
at 0.0 m	5.00	17.40	17.40	17.40	87.00	60.90	161.39
0 to (+) 0.5 m	10.00	17.40	17.40	17.40	174.00	121.80	322.77
(+) 0.5 m to (+) 1.2	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**1907.31**

Chemmencherry - G1 (20m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	15.70	14.90	15.30	153.00	107.10	283.82
0.0 m to (-) 0.5 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
at 0.0 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
						Total	**560.21**

Chemmencherry - G1 (20m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	8.70	8.30	8.50	85.00	59.50	157.68
0.0 m to (-) 0.5 m	5.00	8.30	7.80	8.05	40.25	28.18	74.66
at 0.0 m	5.00	7.80	6.00	6.90	34.50	24.15	64.00
0 to (+) 0.5 m	10.00	6.00	6.00	6.00	60.00	42.00	111.30
(+) 0.5 m to (+) 1.2	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**800.90**

Head Portion (-1.1 m Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.10	10.80	3.00	678.20		
Armour Layer	2.20	6.90	2.60	166.51		
			Total Armour layer		268.64	**711.90**
Toe mound layer						
Toe mound	1.30	16.30	13.80	926.71		
	1.30	9.30	6.90	269.78		
			Total Toe mound layer		344.89	**913.95**
Core Material	3.50	9.30	2.60	430.19	225.85	**598.50**
Filter Layer	0.30	18.30	17.80	306.93	161.14	**427.01**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3434.94**	**2506**	**1474**	**1228**

Chemmencherry - G2 (50m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	17.00	35.30	29.50	32.40	550.80	385.56	1021.73
(-) 1.0 m to (-) 1.5 m	14.00	29.50	26.20	27.85	389.90	272.93	723.26
(-) 0.5 m to (-) 1.0 m	8.00	26.20	21.40	23.80	190.40	133.28	353.19
0.0 m to (-) 0.5 m	6.00	21.40	18.40	19.90	119.40	83.58	221.49
at 0.0 m	5.00	18.40	25.90	22.15	110.75	77.53	205.44
0 to (+) 0.5 m	9.00	25.90	25.90	25.90	233.10	163.17	432.40
(+) 0.5 m to (+) 1.2	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**4368.62**

Chemmencherry - G2 (50m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	17.00	38.20	33.80	36.00	612.00	428.40	1135.26
(-) 1.0 m to (-) 1.5 m	14.00	33.80	26.90	30.35	424.90	297.43	788.19
(-) 0.5 m to (-) 1.0 m	8.00	26.90	23.10	25.00	200.00	140.00	371.00
0.0 m to (-) 0.5 m	6.00	23.10	17.40	20.25	121.50	85.05	225.38
at 0.0 m	5.00	17.40	17.40	17.40	87.00	60.90	161.39
0 to (+) 0.5 m	9.00	17.40	17.40	17.40	156.60	109.62	290.49
(+) 0.5 m to (+) 1.2	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**3743.30**

Chemmencherry - G2 (50m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	17.00	16.50	16.50	16.50	280.50	196.35	520.33
(-) 1.0 m to (-) 1.5 m	14.00	16.50	15.70	16.10	225.40	157.78	418.12
(-) 0.5 m to (-) 1.0 m	8.00	15.70	14.90	15.30	122.40	85.68	227.05
0.0 m to (-) 0.5 m	6.00	14.90	14.90	14.90	89.40	62.58	165.84
at 0.0 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
						Total	**1469.53**

Chemmencherry - G2 (50m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	17.00	9.60	9.20	9.40	159.80	111.86	296.43
(-) 1.0 m to (-) 1.5 m	14.00	9.20	8.70	8.95	125.30	87.71	232.43
(-) 0.5 m to (-) 1.0 m	8.00	8.70	8.30	8.50	68.00	47.60	126.14
0.0 m to (-) 0.5 m	6.00	8.30	7.80	8.05	48.30	33.81	89.60
at 0.0 m	5.00	7.80	6.00	6.90	34.50	24.15	64.00
0 to (+) 0.5 m	9.00	6.00	6.00	6.00	54.00	37.80	100.17
(+) 0.5 m to (+) 1.2	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1302.02**

Head Portion (-2.1 m Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	5.10	12.80	3.00	1127.60		
Armour Layer	3.10	8.41	2.51	318.42		
			Total Armour layer		424.82	**1125.77**
Toe mound layer						
Toe mound	1.30	18.20	15.80	1181.66		
	1.30	10.83	8.41	379.76		
			Total Toe mound layer		421.00	**1115.64**
Core Material	4.31	10.83	2.51	680.15	357.08	**946.26**
Filter Layer	0.30	20.30	19.70	376.83	197.83	**524.26**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
50 m	**5494.38**	**4690**	**2585**	**1826**

Chemmencherry - G3 (75m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.0 m to (-) 2.5 m	26.00	38.90	35.30	37.10	964.60	675.22	1789.33
(-) 1.5 m to (-) 2.0 m	15.00	35.30	29.50	32.40	486.00	340.20	901.53
(-) 1.0 m to (-) 1.5 m	15.00	29.50	26.20	27.85	417.75	292.43	774.93
(-) 0.5 m to (-) 1.0 m	9.00	26.20	21.40	23.80	214.20	149.94	397.34
0.0 m to (-) 0.5 m	5.00	21.40	18.40	19.90	99.50	69.65	184.57
at 0.0 m	5.00	18.40	25.90	22.15	110.75	77.53	205.44
0 to (+) 0.5 m	12.50	25.90	25.90	25.90	323.75	226.63	600.56
(+) 0.5 m to (+) 1.2	12.50	25.90	25.90	25.90	323.75	226.63	600.56
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**6481.00**

Chemmencherry - G3 (75m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.0 m to (-) 2.5 m	26.00	46.20	38.20	42.20	1097.20	768.04	2035.31
(-) 1.5 m to (-) 2.0 m	15.00	38.20	33.80	36.00	540.00	378.00	1001.70
(-) 1.0 m to (-) 1.5 m	15.00	33.80	26.90	30.35	455.25	318.68	844.49
(-) 0.5 m to (-) 1.0 m	9.00	26.90	23.10	25.00	225.00	157.50	417.38
0.0 m to (-) 0.5 m	5.00	23.10	17.40	20.25	101.25	70.88	187.82
at 0.0 m	5.00	17.40	17.40	17.40	87.00	60.90	161.39
0 to (+) 0.5 m	12.50	17.40	17.40	17.40	217.50	152.25	403.46
(+) 0.5 m to (+) 1.2	12.50	17.40	17.40	17.40	217.50	152.25	403.46
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**5968.37**

Chemmencherry - G3 (75m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.0 m to (-) 2.5 m	26.00	16.50	16.50	16.50	429.00	300.30	795.80
(-) 1.5 m to (-) 2.0 m	15.00	16.50	16.50	16.50	247.50	173.25	459.11
(-) 1.0 m to (-) 1.5 m	15.00	16.50	15.70	16.10	241.50	169.05	447.98
(-) 0.5 m to (-) 1.0 m	9.00	15.70	14.90	15.30	137.70	96.39	255.43
0.0 m to (-) 0.5 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
at 0.0 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
						Total	**2234.72**

Chemmencherry - G3 (75m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.0 m to (-) 2.5 m	26.00	10.10	9.60	9.85	256.10	179.27	475.07
(-) 1.5 m to (-) 2.0 m	15.00	9.60	9.20	9.40	141.00	98.70	261.56
(-) 1.0 m to (-) 1.5 m	15.00	9.20	8.70	8.95	134.25	93.98	249.03
(-) 0.5 m to (-) 1.0 m	9.00	8.70	8.30	8.50	76.50	53.55	141.91
0.0 m to (-) 0.5 m	5.00	8.30	7.80	8.05	40.25	28.18	74.66
at 0.0 m	5.00	7.80	6.00	6.90	34.50	24.15	64.00
0 to (+) 0.5 m	12.50	6.00	6.00	6.00	75.00	52.50	139.13
(+) 0.5 m to (+) 1.2	12.50	6.00	6.00	6.00	75.00	52.50	139.13
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1848.69**

Head Portion (-2.7 m Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	5.70	13.90	3.00	1455.17		
Armour Layer	3.50	9.20	2.50	417.22		
			Total Armour layer		544.92	**1444.05**
Toe mound layer						
Toe mound	1.30	19.30	16.90	1339.26		
	1.30	11.70	9.20	447.89		
			Total Toe mound layer		467.97	**1240.12**
Core Material	4.80	11.70	2.50	866.09	454.70	**1204.94**
Filter Layer	0.30	21.40	20.80	419.42	220.19	**583.51**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
75 m	**7925.05**	**7173**	**3475**	**2432**

Chemmencherry - G4 (50m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	19.00	35.30	29.50	32.40	615.60	430.92	1141.94
(-) 1.0 m to (-) 1.5 m	10.00	29.50	26.20	27.85	278.50	194.95	516.62
(-) 0.5 m to (-) 1.0 m	8.00	26.20	21.40	23.80	190.40	133.28	353.19
0.0 m to (-) 0.5 m	7.00	21.40	18.40	19.90	139.30	97.51	258.40
at 0.0 m	6.00	18.40	25.90	22.15	132.90	93.03	246.53
0 to (+) 0.5 m	14.00	25.90	25.90	25.90	362.60	253.82	672.62
(+) 0.5 m to (+) 1.2	10.00	25.90	25.90	25.90	259.00	181.30	480.45
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**4696.49**

Chemmencherry - G4 (50m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	19.00	38.20	33.80	36.00	684.00	478.80	1268.82
(-) 1.0 m to (-) 1.5 m	10.00	33.80	26.90	30.35	303.50	212.45	562.99
(-) 0.5 m to (-) 1.0 m	8.00	26.90	23.10	25.00	200.00	140.00	371.00
0.0 m to (-) 0.5 m	7.00	23.10	17.40	20.25	141.75	99.23	262.95
at 0.0 m	6.00	17.40	17.40	17.40	104.40	73.08	193.66
0 to (+) 0.5 m	14.00	17.40	17.40	17.40	243.60	170.52	451.88
(+) 0.5 m to (+) 1.2	10.00	17.40	17.40	17.40	174.00	121.80	322.77
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**3947.44**

Chemmencherry - G4 (50m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	19.00	16.50	16.50	16.50	313.50	219.45	581.54
(-) 1.0 m to (-) 1.5 m	10.00	16.50	15.70	16.10	161.00	112.70	298.66
(-) 0.5 m to (-) 1.0 m	8.00	15.70	14.90	15.30	122.40	85.68	227.05
0.0 m to (-) 0.5 m	7.00	14.90	14.90	14.90	104.30	73.01	193.48
at 0.0 m	6.00	14.90	14.90	14.90	89.40	62.58	165.84
						Total	**1466.56**

Chemmencherry - G4 (50m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.5 m to (-) 2.0 m	19.00	9.60	9.20	9.40	178.60	125.02	331.30
(-) 1.0 m to (-) 1.5 m	10.00	9.20	8.70	8.95	89.50	62.65	166.02
(-) 0.5 m to (-) 1.0 m	8.00	8.70	8.30	8.50	68.00	47.60	126.14
0.0 m to (-) 0.5 m	7.00	8.30	7.80	8.05	56.35	39.45	104.53
at 0.0 m	6.00	7.80	6.00	6.90	41.40	28.98	76.80
0 to (+) 0.5 m	14.00	6.00	6.00	6.00	84.00	58.80	155.82
(+) 0.5 m to (+) 1.2	10.00	6.00	6.00	6.00	60.00	42.00	111.30
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1376.13**

Head Portion (-2.3 m Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	5.30	13.20	3.00	1236.17		
Armour Layer	3.30	8.80	2.51	365.53		
			Total Armour layer		457.08	**1211.27**
Toe mound layer						
Toe mound	1.30	18.60	16.20	1237.83		
	1.30	11.22	8.80	411.01		
			Total Toe mound layer		434.08	**1150.31**
Core Material	4.50	11.22	2.51	755.25	396.51	**1050.74**
Filter Layer	0.30	20.70	20.10	392.05	205.83	**545.44**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
50 m	**5907.76**	**4998**	**2617**	**1922**

Chemmencherry - G5 (30m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.20	21.40	23.80	238.00	166.60	441.49
0.0 m to (-) 0.5 m	10.00	21.40	18.40	19.90	199.00	139.30	369.15
at 0.0 m	10.00	18.40	25.90	22.15	221.50	155.05	410.88
0 to (+) 0.5 m	10.00	25.90	25.90	25.90	259.00	181.30	480.45
(+) 0.5 m to (+) 1.2	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3113.06**

Chemmencherry - G5 (30m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.90	23.10	25.00	250.00	175.00	463.75
0.0 m to (-) 0.5 m	10.00	23.10	17.40	20.25	202.50	141.75	375.64
at 0.0 m	10.00	17.40	17.40	17.40	174.00	121.80	322.77
0 to (+) 0.5 m	10.00	17.40	17.40	17.40	174.00	121.80	322.77
(+) 0.5 m to (+) 1.2	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**2256.51**

Chemmencherry - G5 (30m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	15.70	14.90	15.30	153.00	107.10	283.82
0.0 m to (-) 0.5 m	10.00	14.90	14.90	14.90	149.00	104.30	276.40
at 0.0 m	10.00	14.90	14.90	14.90	149.00	104.30	276.40
						Total	**836.61**

Chemmencherry - G5 (30m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	8.70	8.30	8.50	85.00	59.50	157.68
0.0 m to (-) 0.5 m	10.00	8.30	7.80	8.05	80.50	56.35	149.33
at 0.0 m	10.00	7.80	6.00	6.90	69.00	48.30	128.00
0 to (+) 0.5 m	10.00	6.00	6.00	6.00	60.00	42.00	111.30
(+) 0.5 m to (+) 1.2	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**939.56**

Head Portion (-1.7 m Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.70	12.00	3.00	929.75		
Armour Layer	2.70	7.64	2.51	236.95		
			Total Armour layer		363.72	**963.86**
Toe mound layer						
Toe mound	1.30	17.41	15.00	1073.92		
	1.30	10.10	7.64	323.22		
			Total Toe mound layer		394.12	**1044.41**
Core Material	3.90	10.10	2.51	545.60	286.44	**759.07**
Filter Layer	0.30	19.50	18.90	347.29	182.33	**483.16**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
30 m	**4076.93**	**3016**	**1881**	**1423**

Chemmencherry - G6 (20m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.20	21.40	23.80	238.00	166.60	441.49
0.0 m to (-) 0.5 m	5.00	21.40	18.40	19.90	99.50	69.65	184.57
at 0.0 m	5.00	18.40	25.90	22.15	110.75	77.53	205.44
0 to (+) 0.5 m	10.00	25.90	25.90	25.90	259.00	181.30	480.45
(+) 0.5 m to (+) 1.2	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**2723.05**

Chemmencherry - G6 (20m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.90	23.10	25.00	250.00	175.00	0.00
0.0 m to (-) 0.5 m	5.00	23.10	17.40	20.25	101.25	70.88	0.00
at 0.0 m	5.00	17.40	17.40	17.40	87.00	60.90	0.00
0 to (+) 0.5 m	10.00	17.40	17.40	17.40	174.00	121.80	322.77
(+) 0.5 m to (+) 1.2	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**1094.36**

Chemmencherry - G6 (20m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	15.70	14.90	15.30	153.00	107.10	283.82
0.0 m to (-) 0.5 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
at 0.0 m	5.00	14.90	14.90	14.90	74.50	52.15	138.20
						Total	**560.21**

Chemmencherry - G6 (20m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	8.70	8.30	8.50	85.00	59.50	157.68
0.0 m to (-) 0.5 m	5.00	8.30	7.80	8.05	40.25	28.18	74.66
at 0.0 m	5.00	7.80	6.00	6.90	34.50	24.15	64.00
0 to (+) 0.5 m	10.00	6.00	6.00	6.00	60.00	42.00	111.30
(+) 0.5 m to (+) 1.2	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**800.90**

Head portion (-1.5 m water depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME (m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.45	11.61	3.00	831.96		
Armour Layer	2.45	7.25	2.51	197.61		
			Total Armour layer		333.04	**882.55**
Toe mound layer						
Toe mound	1.30	17.03	14.61	1023.60		
	1.30	9.67	7.25	294.15		
			Total Toe mound layer		382.96	**1014.86**
Core Material	3.70	9.67	2.51	480.52	252.27	**668.53**
Filter Layer	0.30	19.11	18.53	333.68	175.18	**464.23**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3605.59**	**1763**	**1575**	**1265**

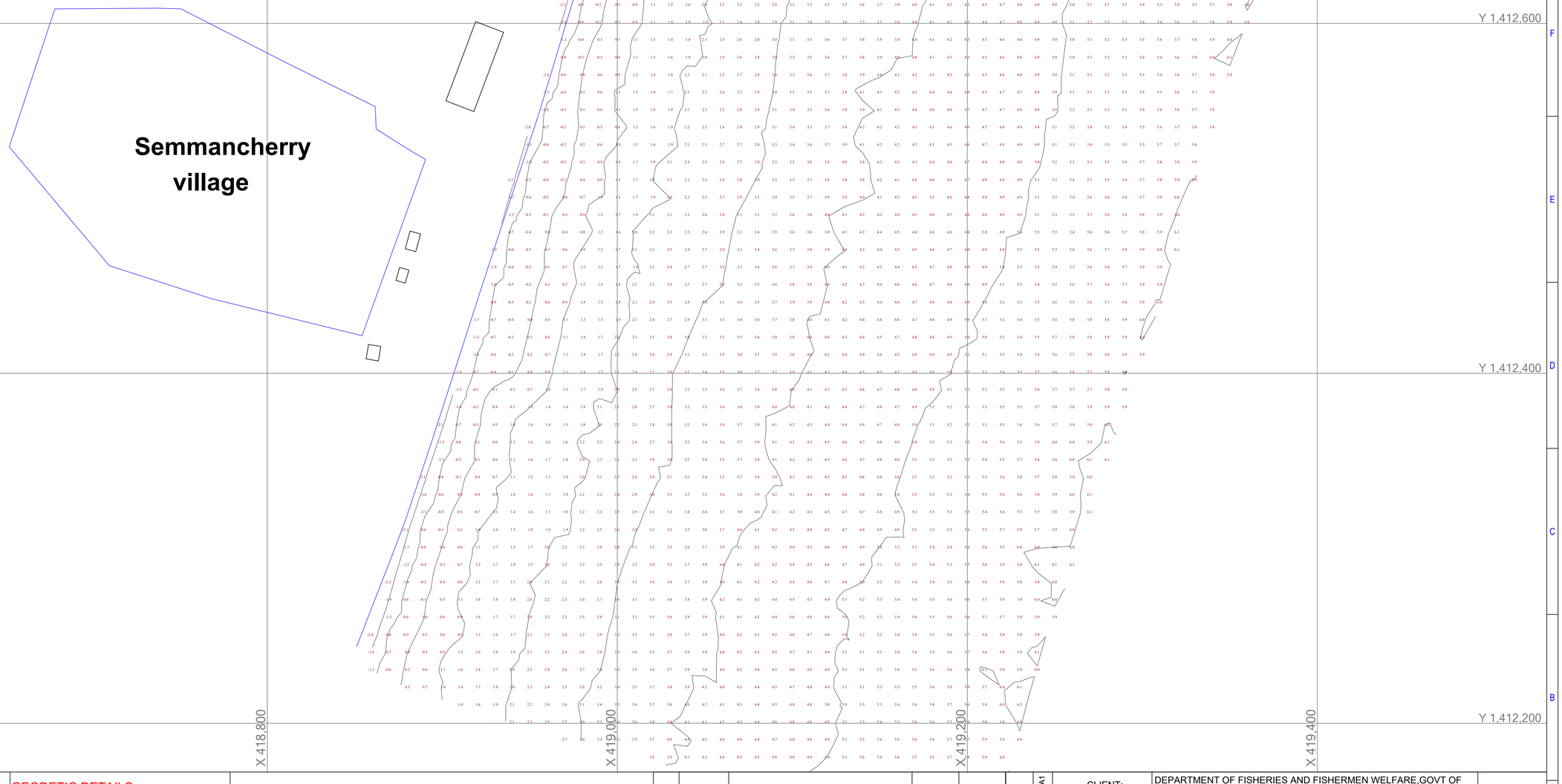
10.1 Total Quantity of Groynes

QUANTITY IN TONNES CHEMMENCHERRY	
GROYNES G1 TO G6	
ARMOUR LAYER (Rubble mound)	30445
CORE LAYER	24146
TOE MOUND LAYER	13608
FILTER LAYER	10096
Total Quantity of Groynes	**78295**

11.0 RECOMMENDATION

A comprehensive study was carried out on arriving at the coastal protection measure for a stretch of 620 m along the coast of Chemmencherry (12°46'28.33"N and longitude 80°15'9.71"E), as per the request of the Department of Fisheries, Tamilnadu. After deriving the offshore wave climate from the wind climate, the driving forces, breaker wave characteristics were obtained, which were then adopted to estimate the longshore sediment characteristics, both its magnitude and direction**.** The net sediment transport of the study area is estimated to be about 1.5 Lakhs per annum directed towards the North. To combat erosion, a transitional groyne field of 6 groynes is proposed which was subjected to shoreline evolution computation study to assess its behavior in trapping the longshore drift which is found effective. Prior to the commencement of the work as proposed, borehole investigation needs to perform to ascertain the soil conditions and the one-line bathymetry along the proposed alignment of the groynes as there could be a possibility of the changes in the bathymetry. IIT Madras should be informed prior to the commencement of the construction.

Prof. S.A.Sannasiraj **Prof. V. Sundar**



SURVEYED BY
LA MER
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NOTES :

1. ALL DIMENSIONS ARE IN METERS.
2. WATER DEPTHS ARE WITH REFERENCE TO CHART DATUM (CD).
3. WATER DEPTH IS IN METERS BELOW CD
4. THE BATHYMETRY CHART SHOWN ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY LAMER SURVEYS INDIA PVT LTD ON 15TH MARCH 2022.

GEODETIC DETAILS:-

Ellipsoid	WGS 84
Semi major axis (a)	6378137.00 m
Flattening (1/f)	298.2572
Grid Projection	U.T.M. Zone 44
Latitude of origin	0° equator
Longitude of origin (CM)	81° East
Scale factor on CM	0.9996
False easting	500000m E
False northing	0m N
Unit	International Meter

306

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION		

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY BATHYMETRY MAP
DRAWING NO:	IITM - CMC - GY - 001
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022

Scale as shown
REV 0

X 418,600
X 418,800
X 419,000
X 419,200
X 419,400
Y 1,412,800
Y 1,412,600
Y 1,412,400
Y 1,412,200

Semmancherry village

G5
18
20
60
G3
20
30
100
G4
24
50
180
G3
25
75
620
G2
17
50
100
G1
18
20

N

NOTES :

1. ALL DIMENSIONS ARE IN METERS.
2. WATER DEPTHS ARE WITH REFERENCE TO CHART DATUM (CD).
3. WATER DEPTH ARE METERS & DECIMETERS BELOW CD
4. THE BATHYMETRY CHART SHOWN ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY LAMER SURVEYS INDIA PVT LTD ON MARCH 2022.

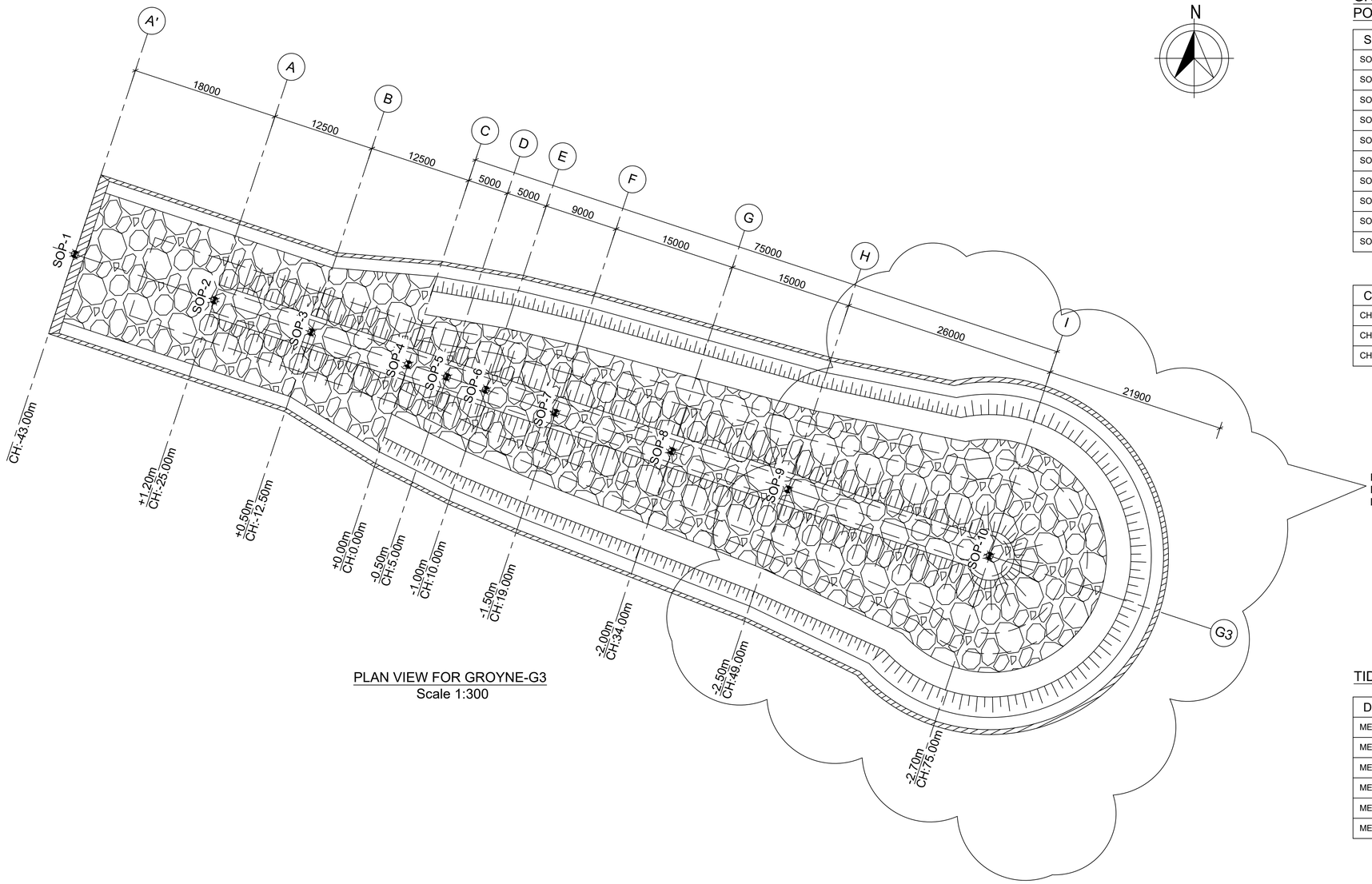
- HIGH TIDE TO LOW TIDE
- LOW TIDE TO ROUND HEAD

1. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	CS

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.	DATE: 14.10.2022
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.	
DRAWING TITLE:	CHEMMANCHERRY OVERALL GROYNE LAYOUT	
DRAWING NO:	IITM - CMC - GY - 101 - 01	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



PLAN VIEW FOR GROYNE-G3
Scale 1:300

ROUND HEAD PLAN
DETAIL REFER DWG NO:
IITM-CMC-GY-101-03

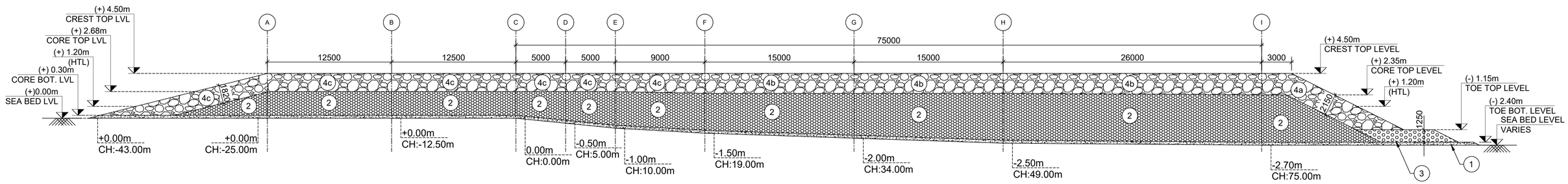
GROYNE SETTING OUT POINTS:-

SOP	EASTINGS (m)	NORTHINGS (m)
SOP 01	418917.874	1412484.303
SOP 02	418934.968	1412478.666
SOP 03	418946.840	1412474.752
SOP 04	418958.711	1412470.838
SOP 05	418963.460	1412469.272
SOP 06	418968.208	1412467.706
SOP 07	418976.756	1412464.888
SOP 08	418991.001	1412460.191
SOP 09	419005.247	1412455.494
SOP 10	419029.939	1412447.352

CHAINAGE, (m)	PRIMARY ARMOUR
CH. -43.00 TO +19.00	1.5T TO 2.5T STONES
CH. +19.00 TO +75.00	2.5T TO 3.5T STONES
CH. +75.00 TO HEAD	2.5T TO 4.0T STONES

TIDE DATA:-

DESCRIPTION	CD(m)
MEAN HIGH WATER SPRING (MHWS)	(+) 1.15
MEAN HIGH WATER NEAP (MHWN)	(+) 0.84
MEAN SEA LEVEL (MSL)	(+) 0.65
MEAN LOW WATER NEAP (MLWN)	(+) 0.43
MEAN LOW WATER SPRING (MLWS)	(+) 0.14
MEAN LOWER LOW WATER SPRING (MLLWS)	(+) 0.09



LONGITUDINAL SECTIONAL VIEW FOR GROYNE-G3
Scale 1:200

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- ① - FILTER LAYER 1kg TO 10kg
- ② - CORE 100kg TO 300kg
- ③ - TOE MOUND 500kg TO 800kg 1.25m Thick
- 4a - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- 4b - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- ⑤ - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-CMC-GY-101-01
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001

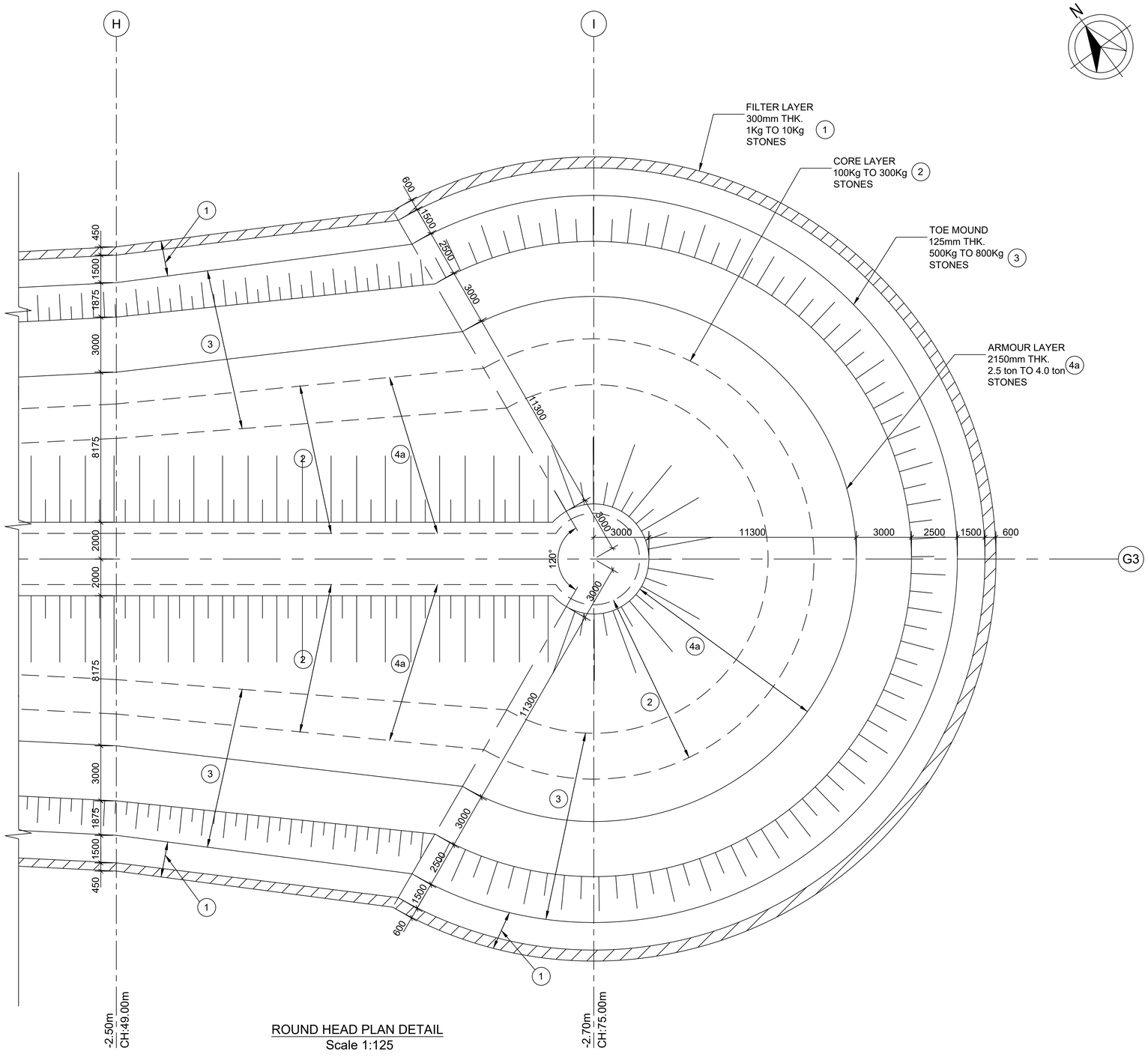
308

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (2 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 02
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022
Scale as shown
REV 0



ROUND HEAD PLAN DETAIL
Scale 1:125

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- (1) - FILTER LAYER 1kg TO 10kg
- (2) - CORE 100kg TO 300kg
- (3) - TOE MOUND 500kg TO 800kg 1.25m Thick
- (4a) - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- (4b) - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- (4c) - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- (5) - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-CMC-GY-101-01
   b) IITM-CMC-GY-101-02
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (3 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 03
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022
Scale as shown
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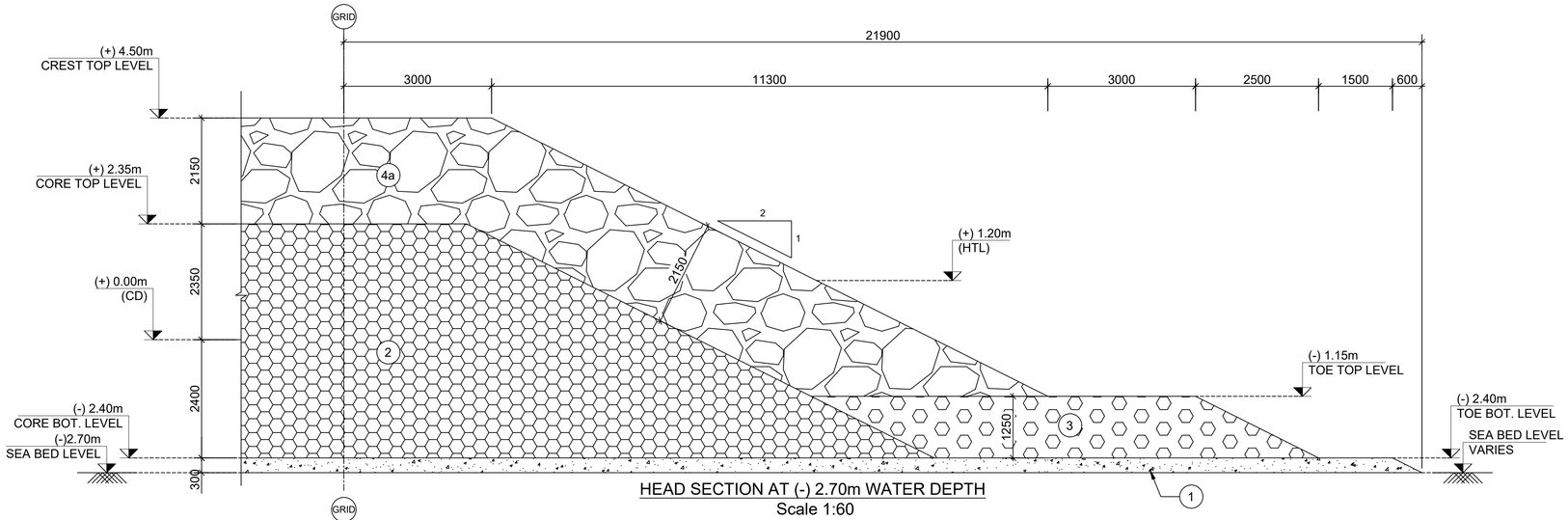
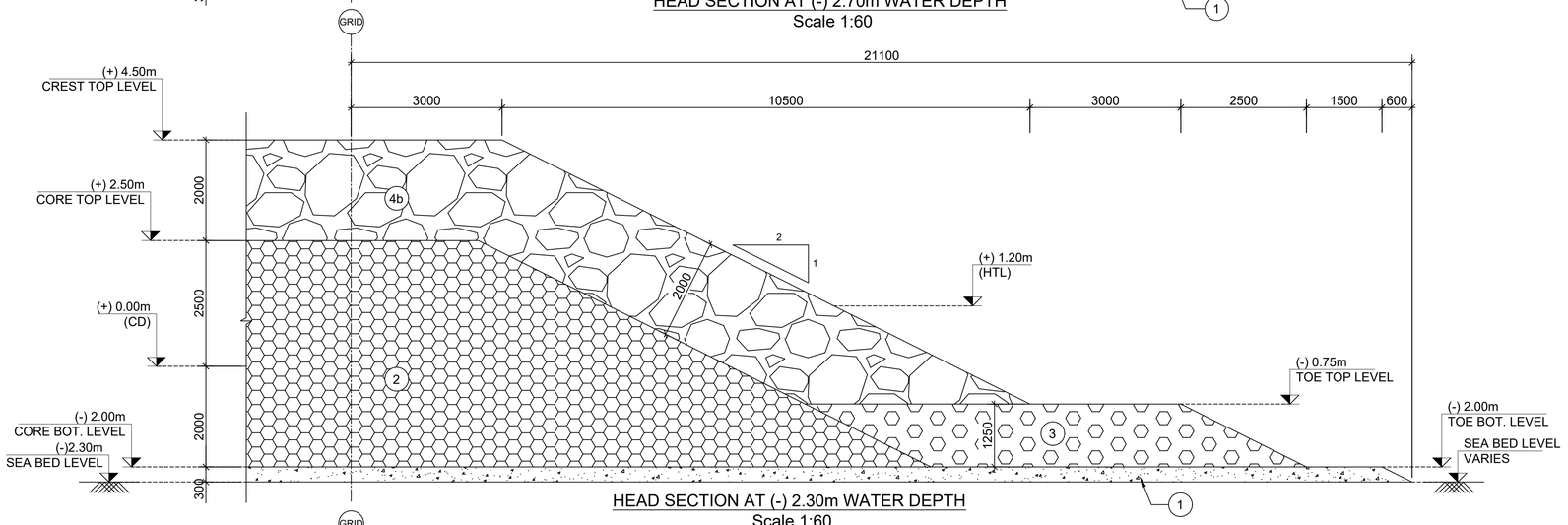
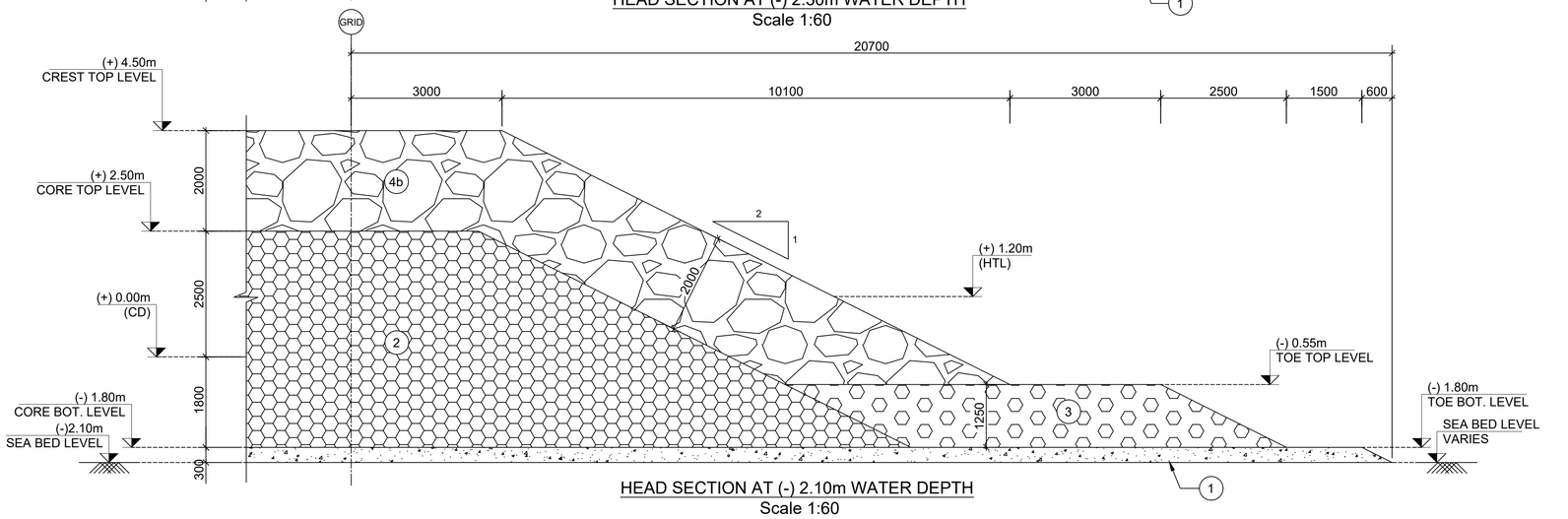


HEAD SECTION AT (-) 2.70m WATER DEPTH
Scale 1:60



HEAD SECTION AT (-) 2.30m WATER DEPTH
Scale 1:60



HEAD SECTION AT (-) 2.10m WATER DEPTH
Scale 1:60

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- (1) - FILTER LAYER 1kg TO 10kg
- (2) - CORE 100kg TO 300kg
- (3) - TOE MOUND 500kg TO 800kg 1.25m Thick
- (4a) - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- (4b) - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- (4c) - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- (5) - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-CMC-GY-101-01
   b) IITM-CMC-GY-101-02
   c) IITM-CMC-GY-101-03

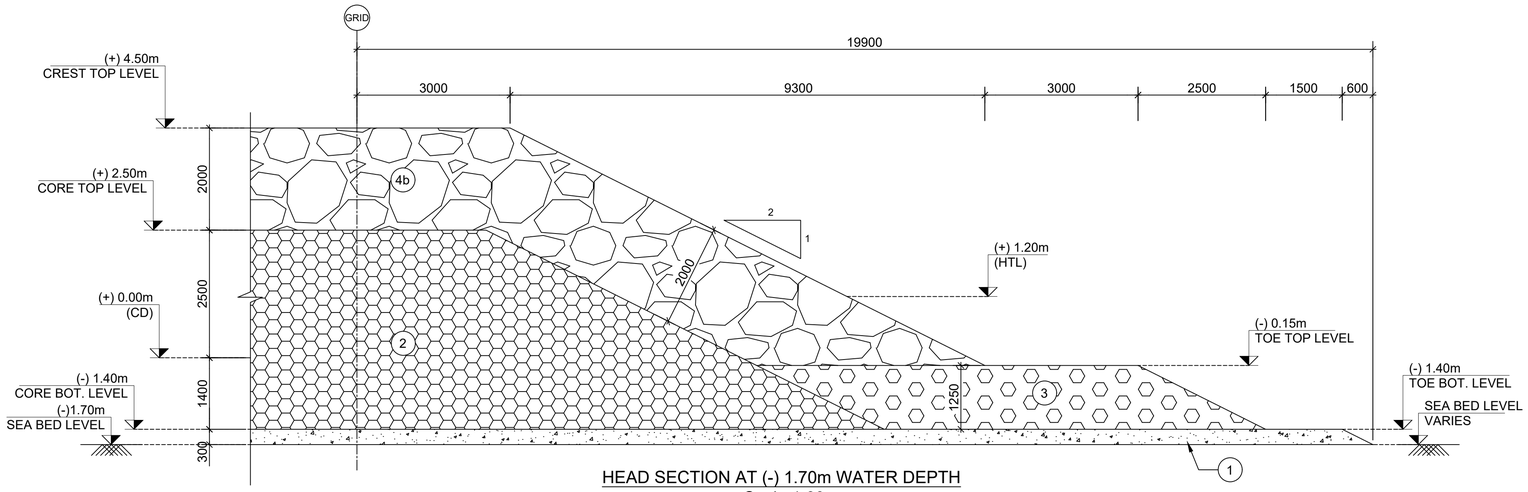
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001 310

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

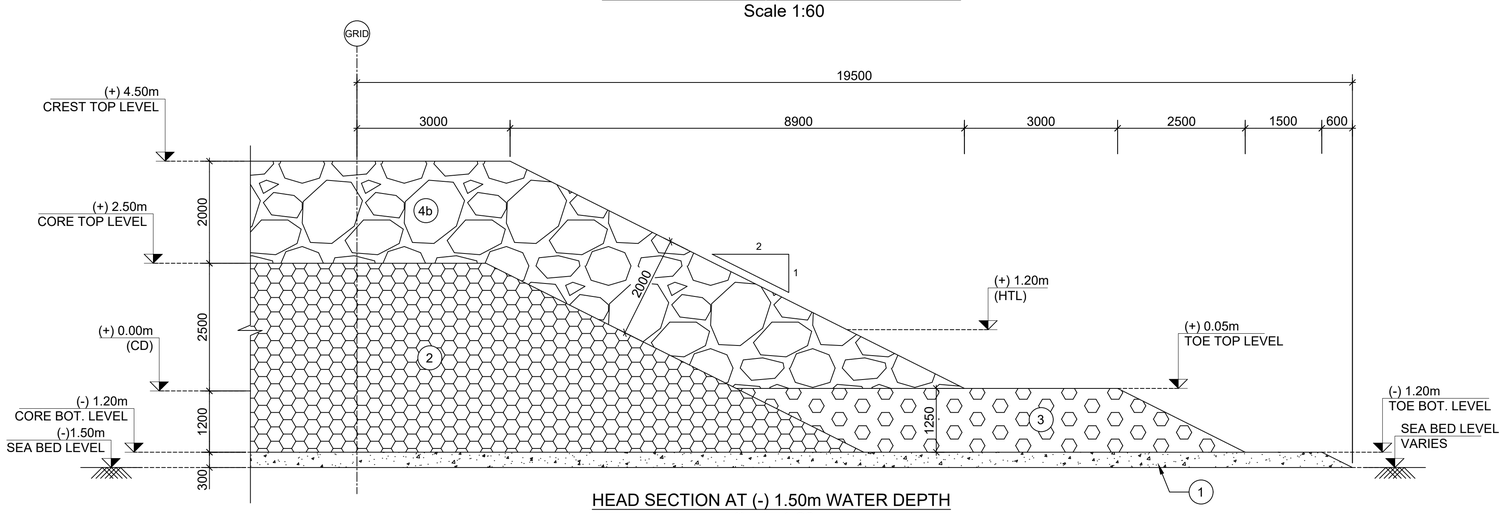
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (4 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 04
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

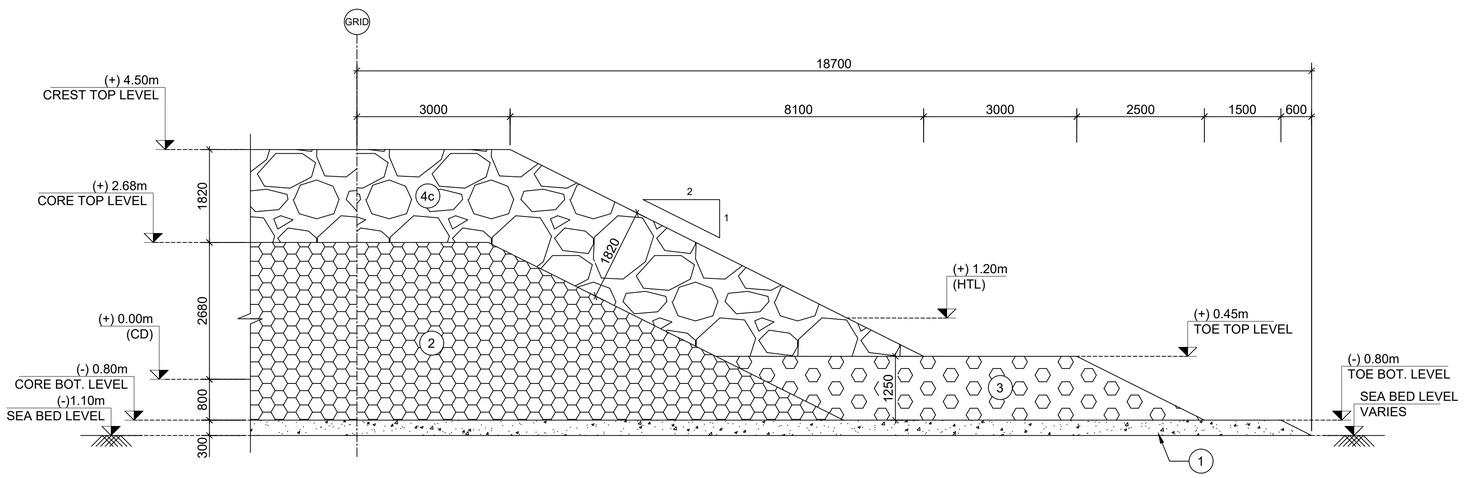
DATE: 14.10.2022
Scale as shown
REV 0



HEAD SECTION AT (-) 1.70m WATER DEPTH
Scale 1:60



HEAD SECTION AT (-) 1.50m WATER DEPTH
Scale 1:60



HEAD SECTION AT (-) 1.10m WATER DEPTH
Scale 1:60

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- ① - FILTER LAYER 1kg TO 10kg
- ② - CORE 100kg TO 300kg
- ③ - TOE MOUND 500kg TO 800kg 1.25m Thick
- 4a - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- 4b - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- ⑤ - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-CMC-GY-101-01
   b) IITM-CMC-GY-101-02
   c) IITM-CMC-GY-101-03
   d) IITM-CMC-GY-101-04
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001 311

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (5 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 05
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022
Scale as shown
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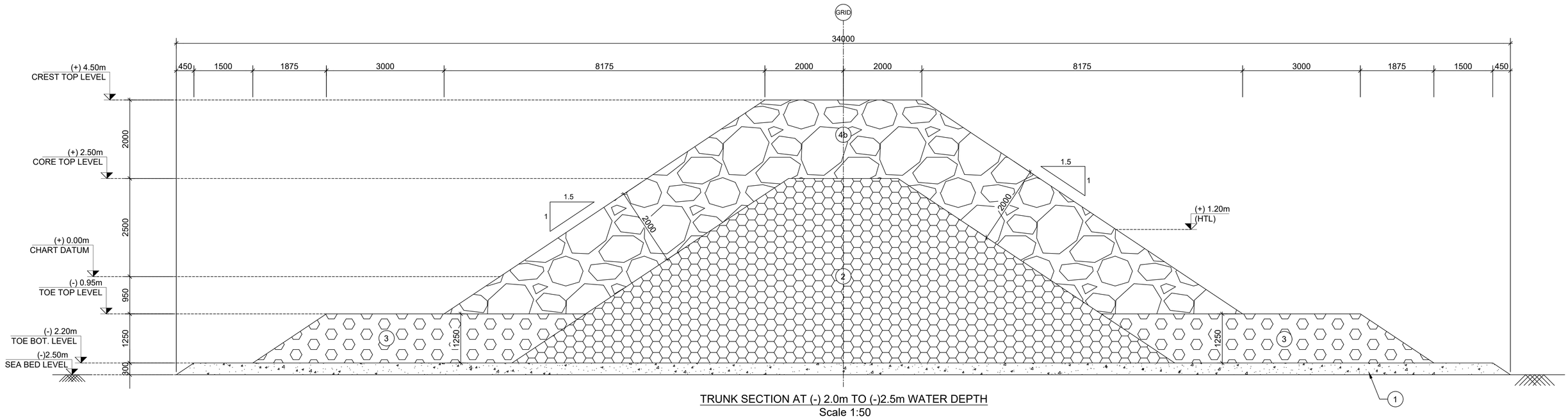

TRUNK SECTION AT (-) 2.0m TO (-)2.5m WATER DEPTH
Scale 1:50

TRUNK SECTION AT (-) 1.5m TO (-)2.0m WATER DEPTH
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- ① - FILTER LAYER 1kg TO 10kg
- ② - CORE 100kg TO 300kg
- ③ - TOE MOUND 500kg TO 800kg 1.25m Thick
- 4a - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- 4b - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- ⑤ - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
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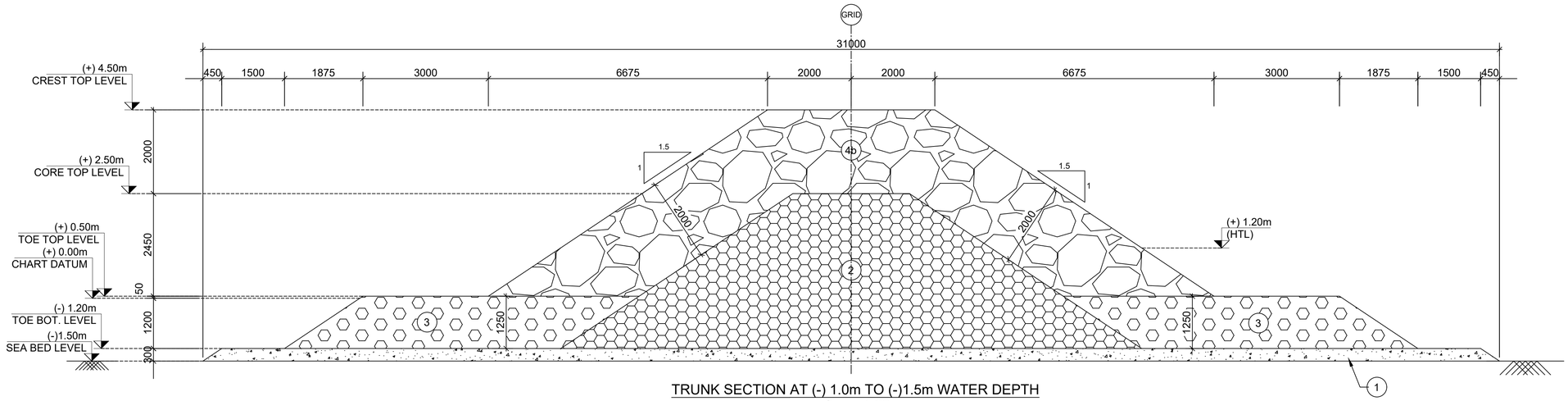
   b) IITM-CMC-GY-101-02
   c) IITM-CMC-GY-101-03
   d) IITM-CMC-GY-101-04
   e) IITM-CMC-GY-101-05
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001 312

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE-A1

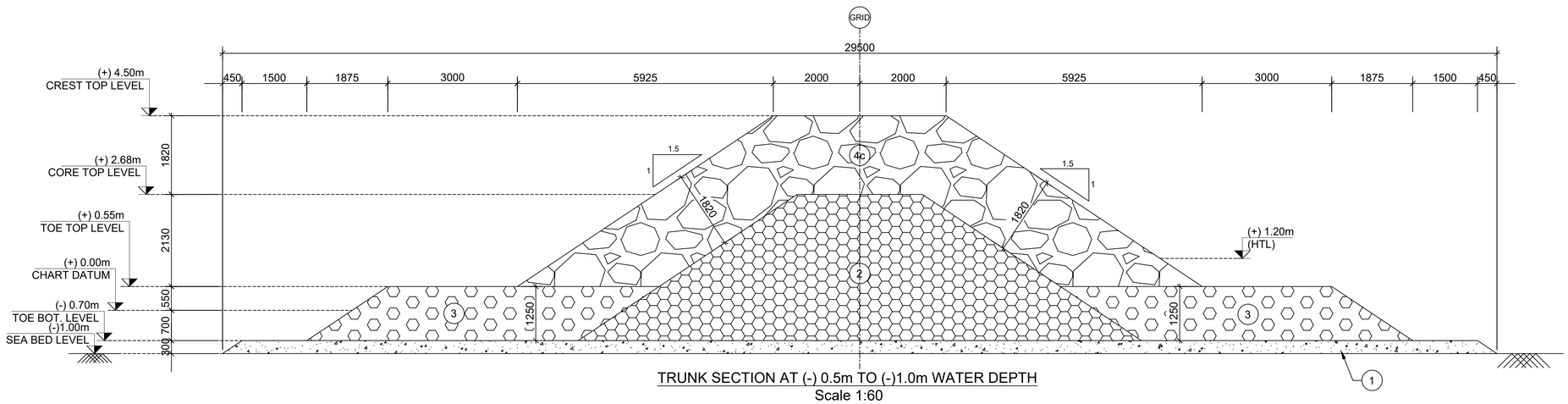
CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (6 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022
Scale as shown
REV 0



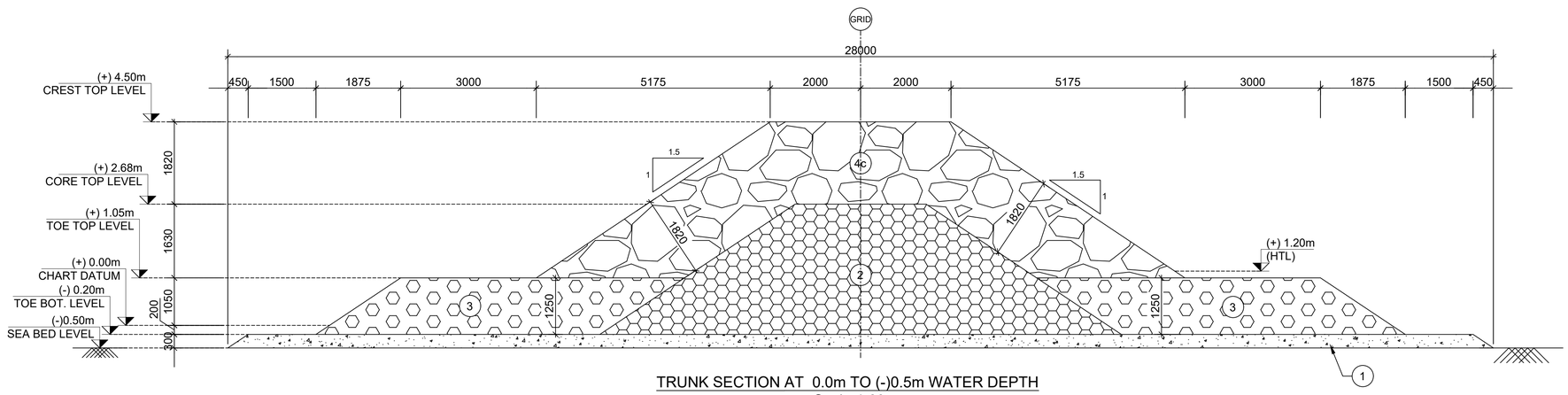
TRUNK SECTION AT (-) 1.0m TO (-)1.5m WATER DEPTH

Scale 1:60



TRUNK SECTION AT (-) 0.5m TO (-)1.0m WATER DEPTH

Scale 1:60



TRUNK SECTION AT 0.0m TO (-)0.5m WATER DEPTH

Scale 1:60

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- (1) - FILTER LAYER 1kg TO 10kg
- (2) - CORE 100kg TO 300kg
- (3) - TOE MOUND 500kg TO 800kg 1.25m Thick
- (4a) - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- (4b) - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- (4c) - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- (5) - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-CMC-GY-101-01 e) IITM-CMC-GY-101-05
   b) IITM-CMC-GY-101-02 f) IITM-CMC-GY-101-06
   c) IITM-CMC-GY-101-03
   d) IITM-CMC-GY-101-04
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-CMC-GY-001

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

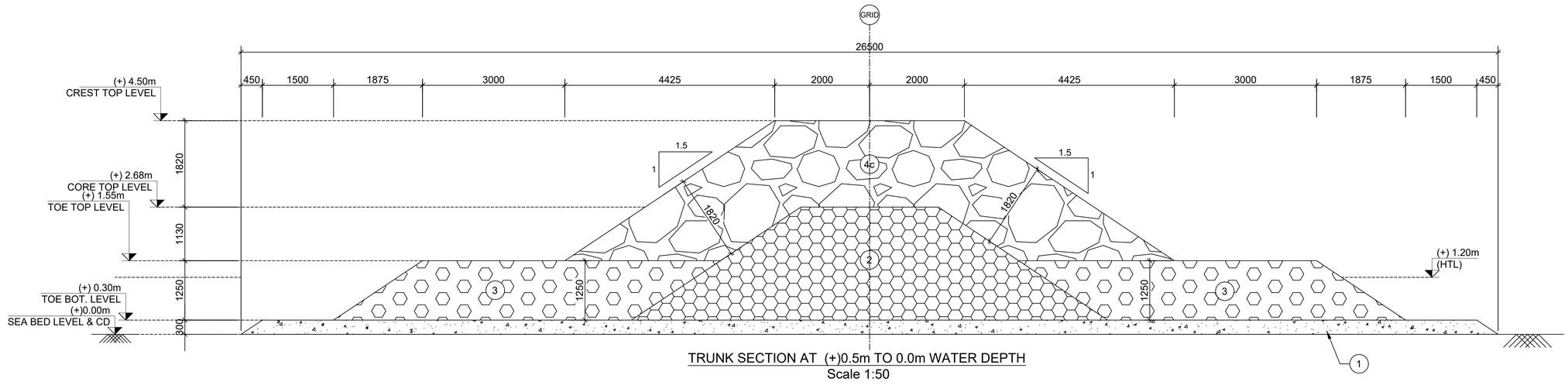
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (7 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 07
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 14.10.2022

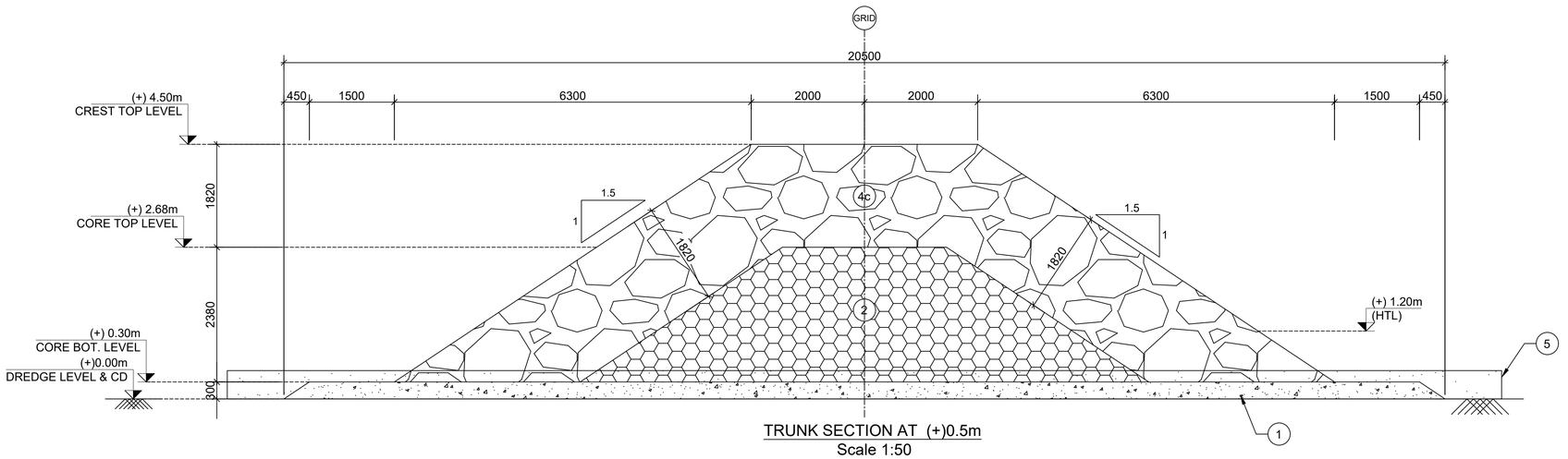
Scale as shown

REV 0



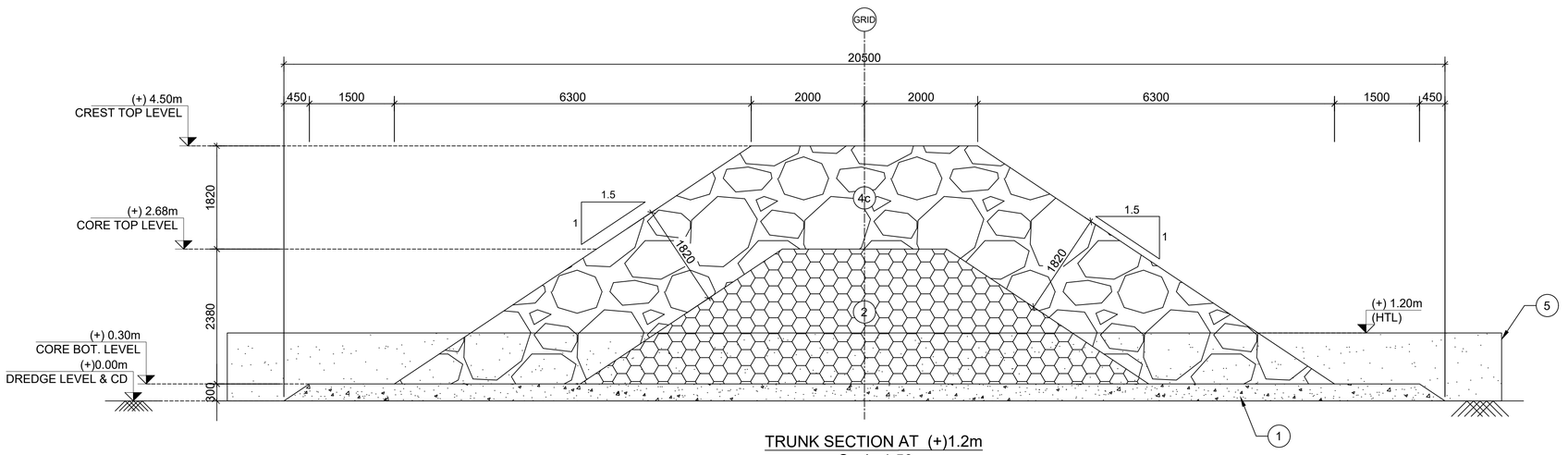
TRUNK SECTION AT (+)0.5m TO 0.0m WATER DEPTH

Scale 1:50



TRUNK SECTION AT (+)0.5m

Scale 1:50



TRUNK SECTION AT (+)1.2m

Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- (1) - FILTER LAYER 1kg TO 10kg
- (2) - CORE 100kg TO 300kg
- (3) - TOE MOUND 500kg TO 800kg 1.25m Thick
- (4a) - ARMOUR LAYER, 2.5T- 4.0 T Stones 2 layer at 2.15m Thick
- (4b) - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick

LEGEND:-

- (4c) - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- (5) - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   - a) IITM-CMC-GY-101-01
   - b) IITM-CMC-GY-101-02
   - c) IITM-CMC-GY-101-03
   - d) IITM-CMC-GY-101-04
   - e) IITM-CMC-GY-101-05
   - f) IITM-CMC-GY-101-06
   - g) IITM-CMC-GY-101-07
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   - a) IITM-CMC-GY-001

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	14.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT CHEMMANCHERRY IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	CHEMMANCHERRY GROYNE GENERAL ARRANGMENT SHEET (8 OF 8)
DRAWING NO:	IITM - CMC - GY - 101 - 08
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 14.10.2022

Scale as shown

REV 0

CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BOAT BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT

Client

Fisheries Department, Tamilnadu

Consultants

Prof. S. A. Sannasiraj

Prof. V.Sundar

Department of Ocean Engineering
Indian Institute of Technology Madras
Chennai 600 036, India

October 2022

Table of Contents

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List of Figures

1.0 INTRODUCTION

The Department of Fisheries, Tamilnadu has requested the Department of Ocean Engineering, Indian Institute of Technology Madras to suggest suitable coastal protection measures that could possibly limit the coastal erosion process in the site vicinity of Karikattukuppam. The coastal site of the Karikattukuppam is located at latitude 12°49'15.67"N and longitude 80°14'51.04"E, in Chengalpattu district. Prior to the implementation of preventative measures, the Department of Fisheries, Tamilnadu conducted a bathymetry and topographical study of the area. The location of Karikattukuppam is shown in **Fig.1.**

Fig.1 Location of Karikattukuppam site

2.0 OBJECTIVE & SCOPE OF WORK

The objectives of the present study include,

1. Offshore annual wave climate shall be established using the best available data sources.
2. Layout of groynes field suitable for Karikattukuppam coast.
3. Wave tranquility to identify the wave characteristics in the proposed location.
4. The shoreline changes due to the proposed structure i.e., accretion or erosion shall be established.
5. Design of groynes, cross sections and bill of quantity.

3.0 BATHYMETRY

A bathymetry survey for a stretch of about 750 m off the coast of Karikattukuppam has been provided by the Department of Fisheries, Tamilnadu on 9th May 2022 (Surveyed on 15th March 2022) which is shown in **Fig.2** and **Plate *(IITM - KKK - BG – 001).***

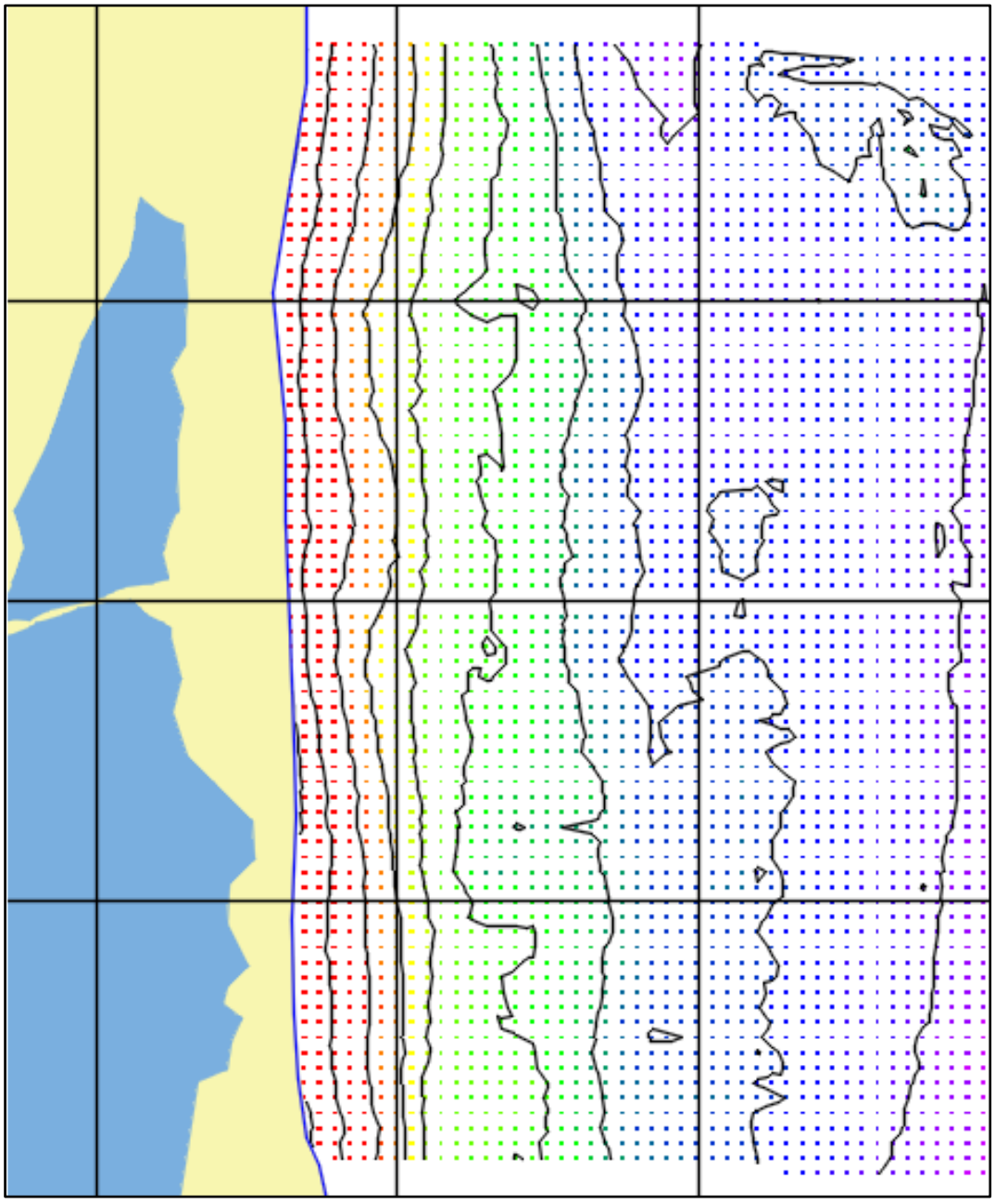


Fig.2 Bathymetry off Karikattukuppam stretch provided by the Department of Fisheries, Tamilnadu

4.0 OFFSHORE WAVE CHARACTERISTICS

The wave characteristics such as significant wave height, mean wave period and mean wave direction at a deep-water location (12°75'00.00"N, 80°05'0.00"E) off Chengalpattu have been extracted at every 6 hours interval from the European Centre for Medium-Range Weather Forecasts (ECMWF). Basically, the wave field follows the wind pattern. It is noted that the spatial variability is closely related, the maximum H_s are associated with maximum wind speeds. The annual percentage of occurrence of significant wave height is presented in **Fig.3.** It is observed that the offshore wave climate of Chengalpattu is predominantly from east and south east.

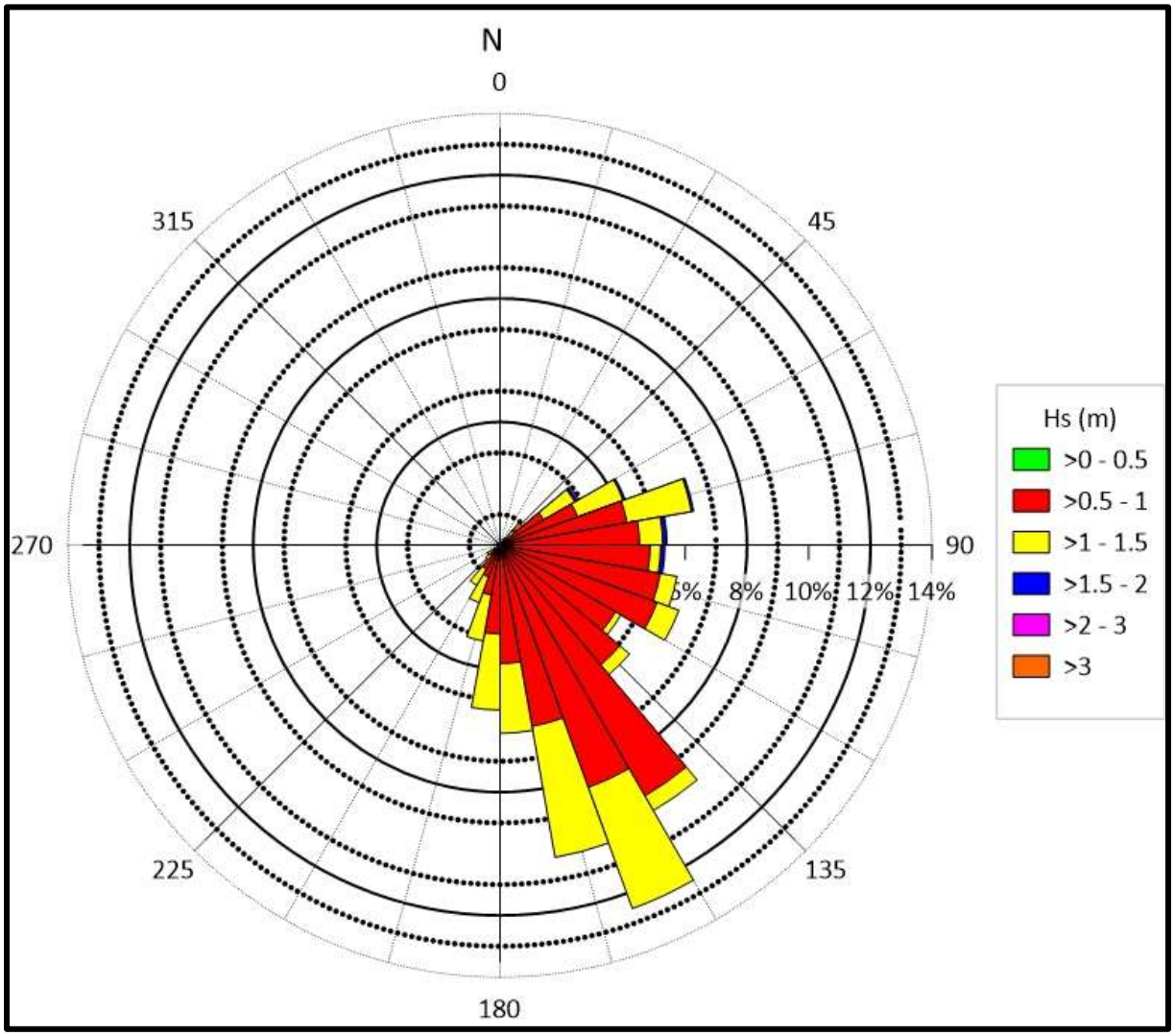


Fig.3 Wave Rose diagram representing the significant wave height (m) along the direction for an annual year

5.0 LITTORAL DRIFT ESTIMATE

5.1 Distribution of Sediment Transport

The wave characteristics such as significant wave height, mean wave period and mean wave direction at a deep-water location (12°75'00.00"N, 80°05'0.00"E), Chengalpattu have been extracted at every 6 hours interval from the European Centre for Medium-Range Weather Forecasts (ECMWF). **Table 1** shows the Wave characteristics for the present study. These are offshore wave climate and are transformed to the near shore location of Karikattukuppam coast using Snell's law. The average breaking wave characteristics were derived from the available wave data. The monthly distribution of mean breaker wave height for the study area is shown in **Fig. 4.** The results indicate that the mean breaker height varies from about 0.80 m to 1.40 m. The breaker height is observed to be a maximum during the month of September. The monthly distribution of the mean breaker wave angle with respect to shore normal is shown in **Fig. 5**. From the results, it is seen that for the study area, the breaker angle with respect to shore normal and longshore current velocity are directed towards North during the months, March to November, and towards the South in January, February and December. The average surf width within which the long shore drift is predominant is further estimated from the breaker wave height for the given bathymetry and is projected in **Fig.6** for the different months. It shows that the maximum surf width of about 90 m during the month of September.

Further, the derived wave characteristics were used to calculate the long shore sediment transport. Three different methods CERC (1984), Komar (1976a), and by integrating the distribution across the surf zone (Komar, 1976b) have been adopted to calculate the alongshore sediment transport rate. The average sediment transport rate for the different months is shown in **Fig.7.** All the three methods have yielded similar order sediment transport rate. The net drift is found to be about 111600 m^3 per annum and directed towards the north.

Table 1 Wave characteristics for the present study

	Month	Deep water wave direction w.r.t North	Wave height, H_s(m)	Wave period, T(sec)
1	January	67	0.9	5.3
2	February	102	0.7	5.3
3	March	138	0.8	5.8
4	April	145	0.9	5.5
5	May	148	1.0	5.5
6	June	183	1.1	5.4
7	July	164	0.9	5.8
8	August	184	1.0	5.5
9	September	160	1.1	7.3
10	October	140	0.9	5.8
11	November	113	1.0	6.2
12	December	83	0.9	5.8

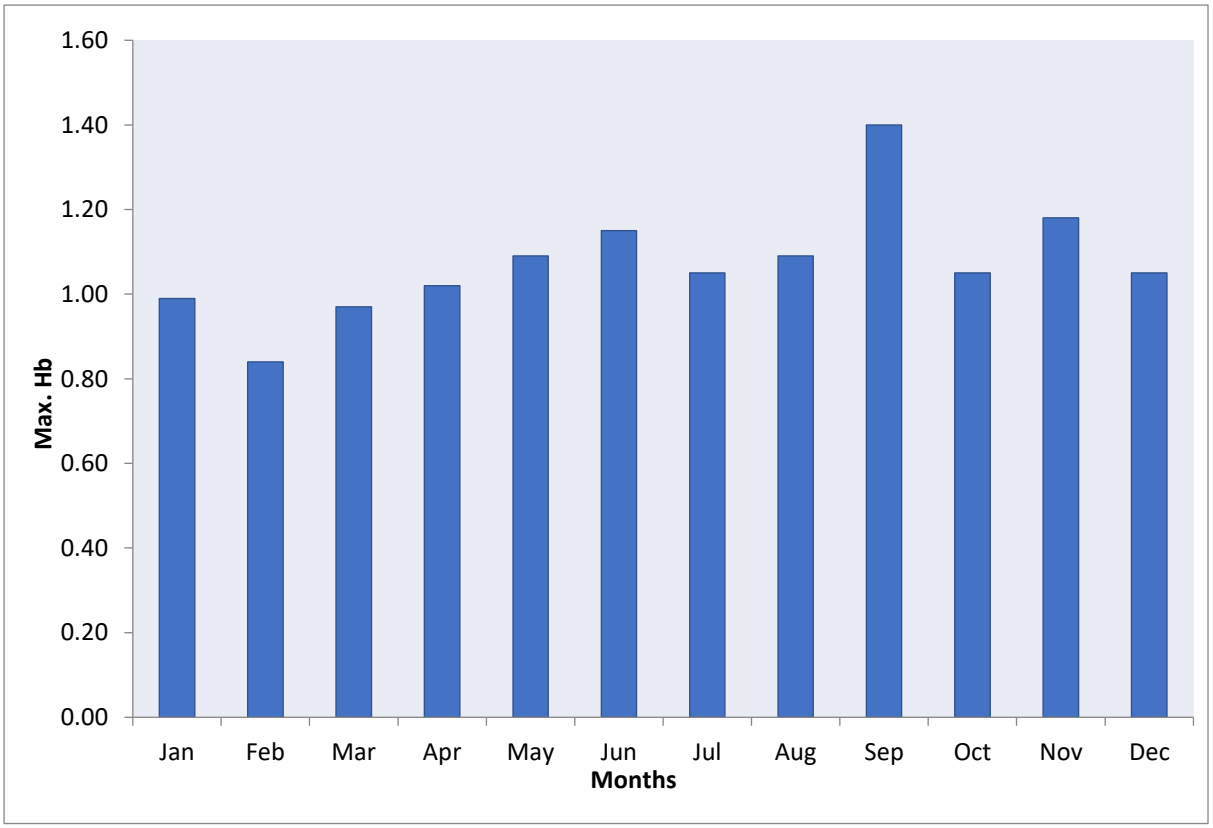


Fig.4 Breaker wave heights in meter

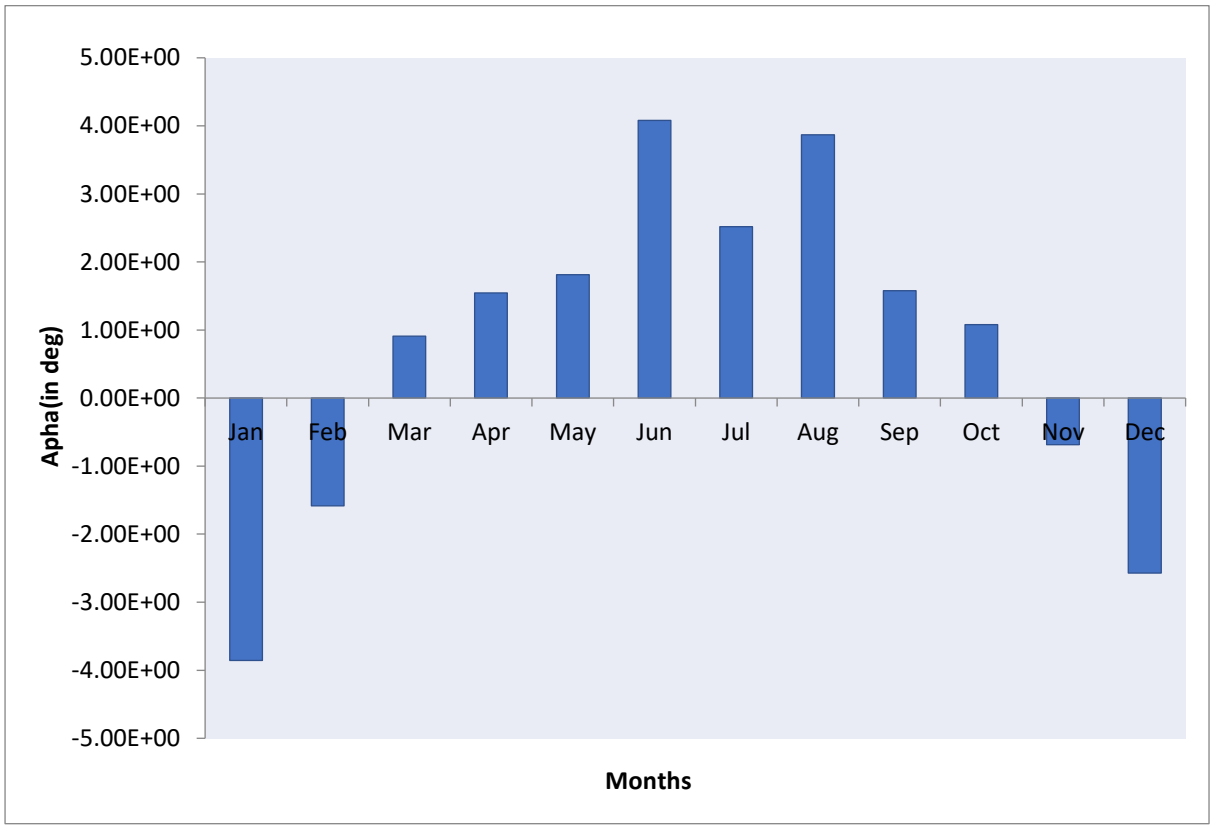


Fig.5 Wave breaker angle

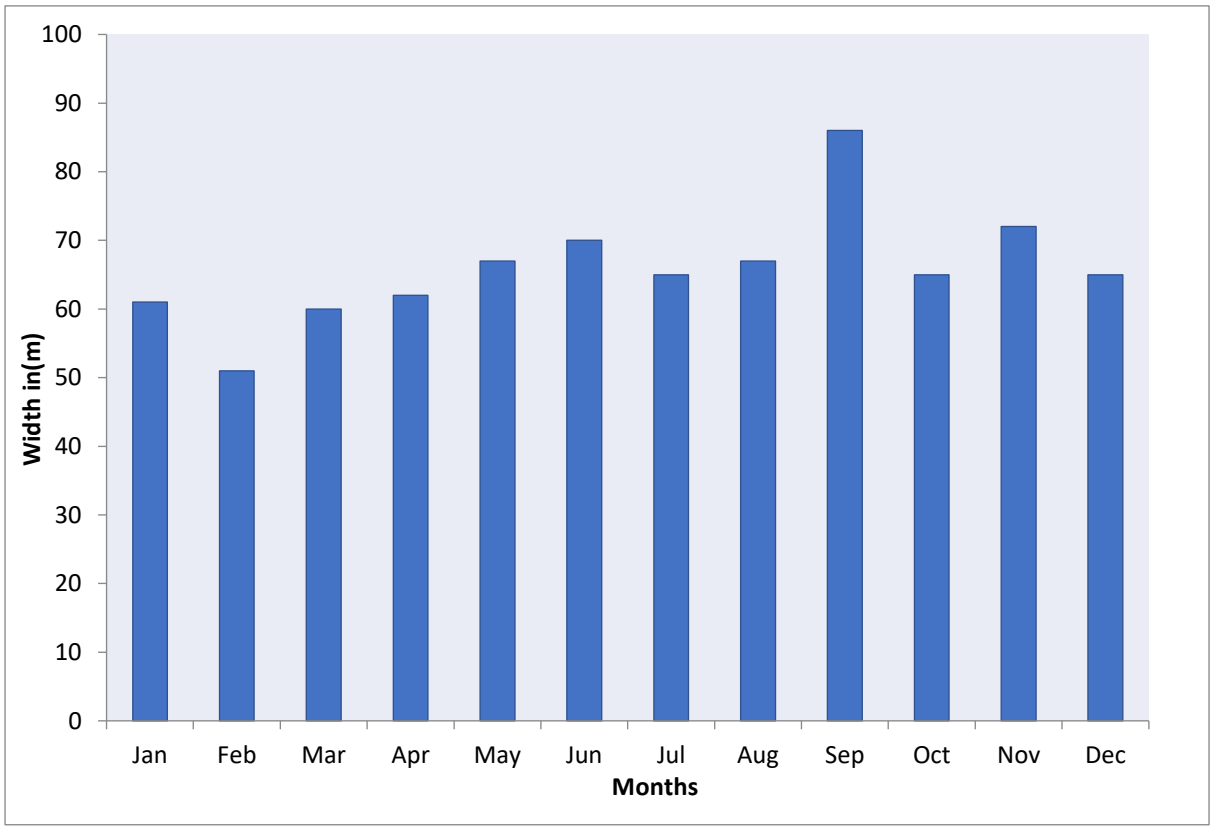


Fig.6 Surf zone width

Table.2 Sediment transport rate (Net Northerly)

Methods	Rate (m^3/year)
Komar	101000
CERC	114500
Distribution	110110

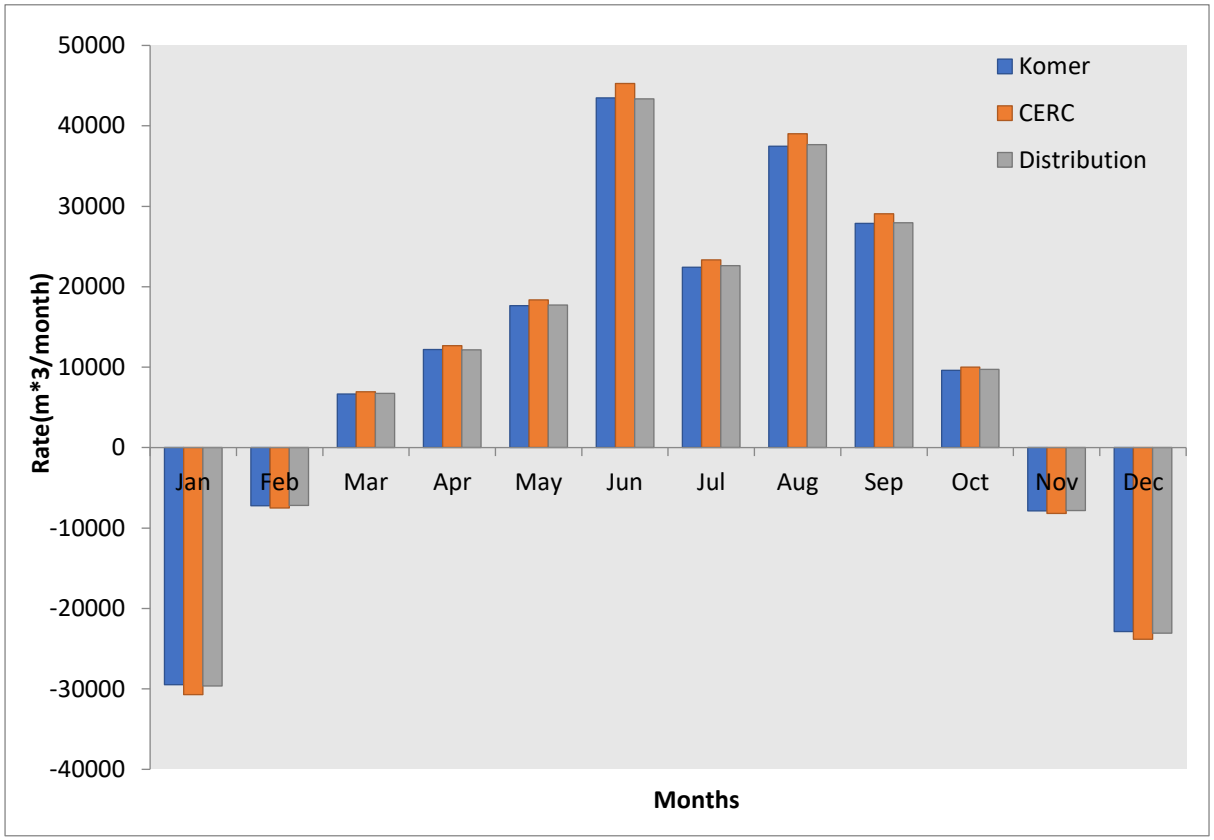


Fig.7 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROYNES

A pair of breakwater and a pair of groynes have been proposed to protect the coastal stretch (400m) of Karikattukuppam. **Fig.8** depicts an overview of the proposed breakwater and groynes superposed over bathymetry provided by the Tamilnadu fisheries department on 09/05/22. The details of which are projected in **Plate *(IITM - KKK - BG - 101 – 01).*** The Southern breakwater and northern breakwater, each of which measuring 160 m and 80 m in length, would reach a maximum water depth of about (-) 4.0 m and (-) 3.0 m respectively. Each of the groynes, G1 and G2 should measure 40 metres and 20 metres in length and extend to about (-) 1.5 m and (-) 1.0 m of water depth respectively.

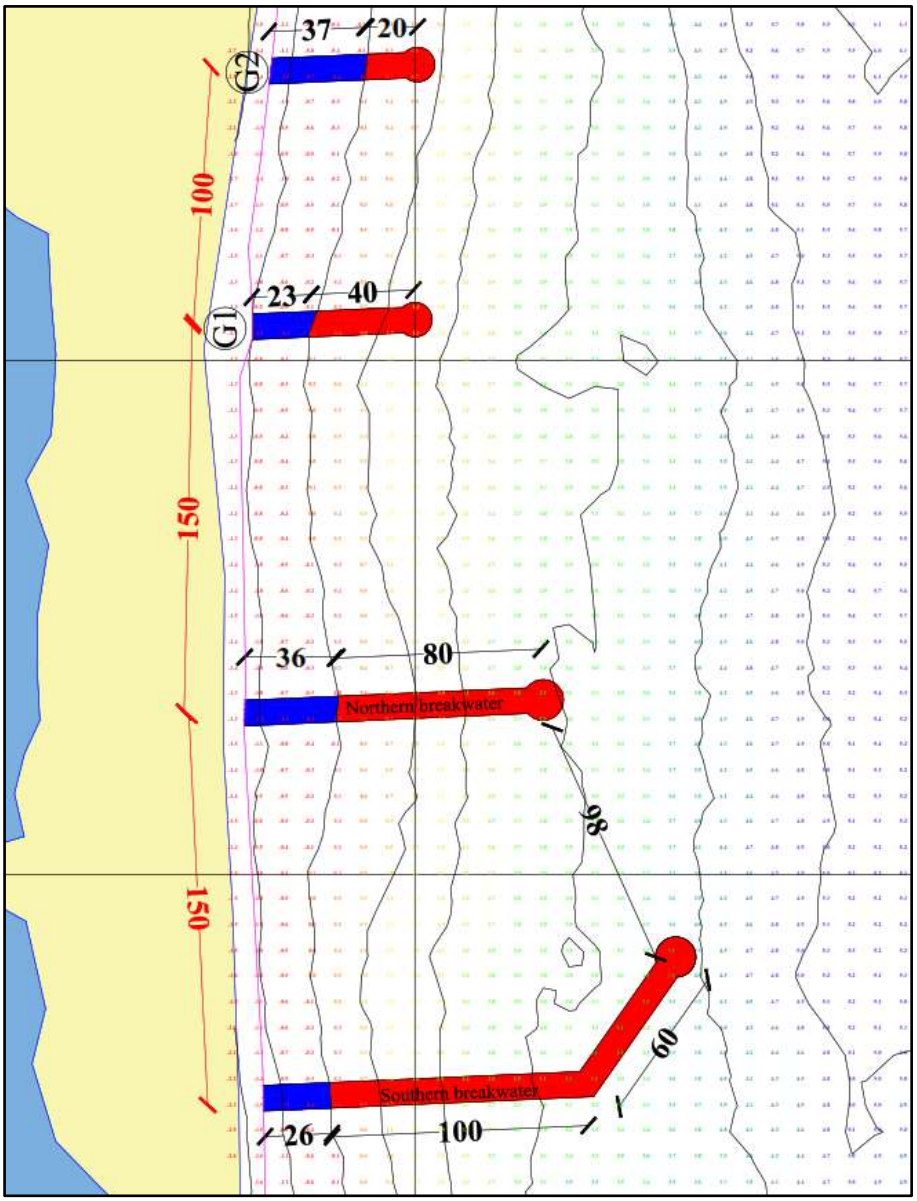


Fig.8 Layout of groynes field

7.0 NUMERICAL MODELLING FOR SHORELINE EVOLUTION

Structures in the near shore environment are built for different purposes, which may be for the formation of artificial harbors, shore protection measures, seawater intake systems, disposal of effluent, etc. There are several configurations of such structures with respect to the shoreline, among which, structures normal to the shore is most common. The construction of a shore-connected structure often leads to changes in the shoreline. This warrants a study on the shoreline due to presence of the shore-connected structures. Such a study is very much essential in planning stage; so as to assess the impact of shore connected structures on the adjacent shoreline.

Numerical models offer the capability to study the effect of the wave characteristics, structure dimensions and other associated parameters in providing reasonable estimates of the shoreline response. As the ocean waves approaches the near shore it undergoes transformations like shoaling, refraction, diffraction and breaking. The phenomena of wave breaking throw sediments to the surface due to the turbulence generated. The sediments in suspension are then driven by the wave-induced currents. Since the direction of waves in the near shore is oblique, the currents induced by them have two components. One along the shore called longshore current mainly responsible for the long shore sediment transport, which plays an important role in the shoreline changes especially due to the shore connected structures. The other component is in the direction normal to the shore, in which case, the mode of sediment transport is called onshore-offshore sediment transport. When a structure normal to the shoreline is constructed, it will intercept the free passage of longshore sediment transport, which results an imbalance in the quantity of sediment in the near shore especially near the structure. This leads to accretion on the up-drift side and erosion on the down drift side of the structure.

Methodology

Kraus and Harikai (1983) proposed a numerical scheme to solve the one line model using Crank Nicholson implicit finite difference method. The non-dimensional equation of shoreline

$$y^*_{n,t^*+1} = B\left\{Q^*_{n,t^*+1} - Q^*_{n+1,t^*+1}\right\} + C_n$$

$$where\, B = \frac{\delta t^*}{2\times\delta x^*}\, and\, C_n = B\left\{Q^*_{n,t^*} - Q^*_{n+1,t^*} + 2\delta x^* q^*_{n,t^*}\right\} + y^*_{n,t^*}$$

The non-dimensional shoreline is divided into 'n' grid points at equal non-dimensional interval, δx^*. Then shoreline changes over a non-dimensional time, δt^* is calculated using Crank-Nicholson finite difference scheme. The schematic diagram for finite difference scheme is shown in **Fig. 9**

In this method, Q^* at the time interval (t^* +1) is expressed in terms of the shoreline co-ordinate of y*, first isolating the term involving α_{sp} (angle of shoreline normal to x-axis) using trigonometric identities. One of the terms involving α_{sp} is then expressed as first order quantities in y* at time step (t*+1).

$$Q^* = K_D^2 \cos(\alpha_o)\sin(\alpha_b)$$

Where, $\alpha_o = \alpha - \alpha_{sp}$ and α is wave direction with respect to x-axis. The definition sketch showing the angles is shown in **Fig. 10.**

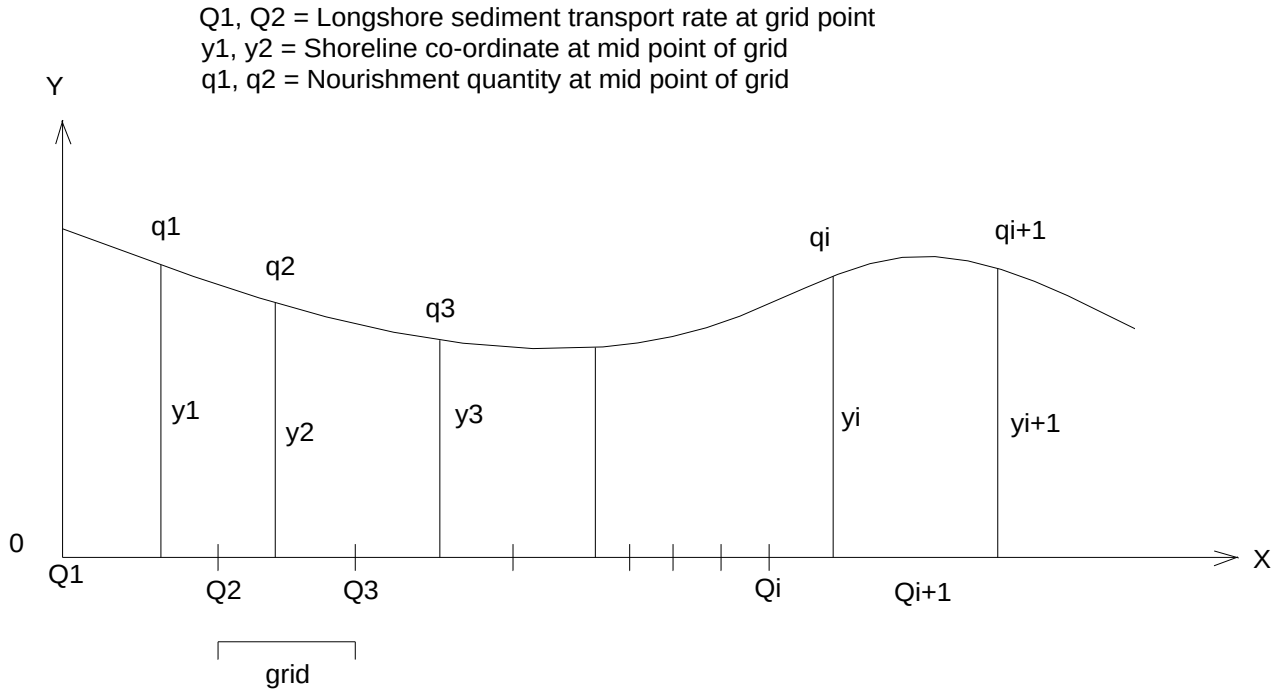


Fig 9. Schematic diagram for finite difference scheme

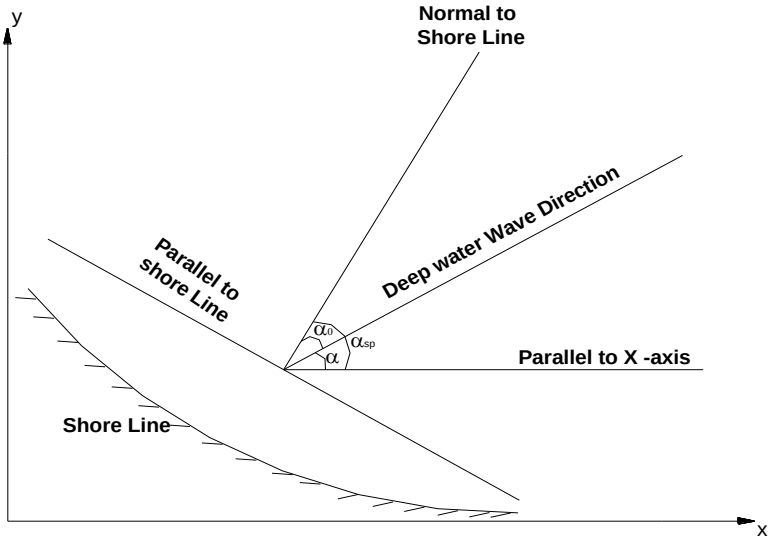


Fig 10. Definition sketch of angles considered

The elliptical form of mild slope equation, which deals with combined refraction-diffraction,

$$Q^* = K_D^2 \cos\left(\alpha - \alpha_{sp}\right)\sin\left(\alpha_b\right) \quad (1)$$

$$Q^* = K_D^2 \sin\left(\alpha_b\right)\left\{\cos\left(\alpha\right)\sin\left(\alpha_{sp}\right)\cot\left(\alpha_{sp}\right) + \sin\left(\alpha\right)\sin\left(\alpha_{sp}\right)\right\} \quad (2)$$

$$Q^* = E_n \left\{y_{n-1,t^*+1} - y^*_{n,t^*+1}\right\} + F_n \quad (3)$$

Where $E_n = K_D^2 \left\{\cos(\alpha)\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}/\delta x^*$ and $F_n = K_D^2 \left\{\sin\left(\alpha_{sp,t^*}\right)\sin\left(\alpha_{b,t^*}\right)\right\}$

By substituting above equations, give the final equation as given below

$$BE_n\, Q^*_{n-1,t^*+1} - (1+2BE_n)Q^*_{n,t^*+1} + BE_n\, Q^*_{n+1,t^*+1} = E_n\left[C_n - C_{n-1}\right] - F_n$$

The above equations represent a set of (N-1) linear equation for (N-1) unknowns. The end values are specified as boundary conditions, that is, $Q^*_1 = 0$ and $Q^*_{N+1} = Q^*_N$. The above equation results into a tri diagonal form which is solved for Q^*. This process is repeated for the entire duration and non-dimensional quantity is converted into real quantities using the corresponding scale factors. The program has been validated with published results.

7.1 Input and Output

The numerical model to predict the shoreline evolution due to the shore-connected structures has been used to predict the shoreline changes due to the proposed groynes over the bathymetry the Department of Fisheries, Tamilnadu the on 9th May 2022. The wave characteristics given as the input to the numerical model is as per given **Table 1**. The length of the groynes, water depth at the end of the groynes and the present status of the shore are to be given as the input to the numerical model.

The numerical model was executed for the most frequently occurring wave characteristics for the different months as stated earlier. The result on the predicted shoreline variations over years are projected in **Fig. 11**. The shoreline prediction has been made at the end of 1 year, 5years, 10years, 15 years, 20 years and 25 years after the construction of the groynes and has been presented by superimposing the shoreline patterns.

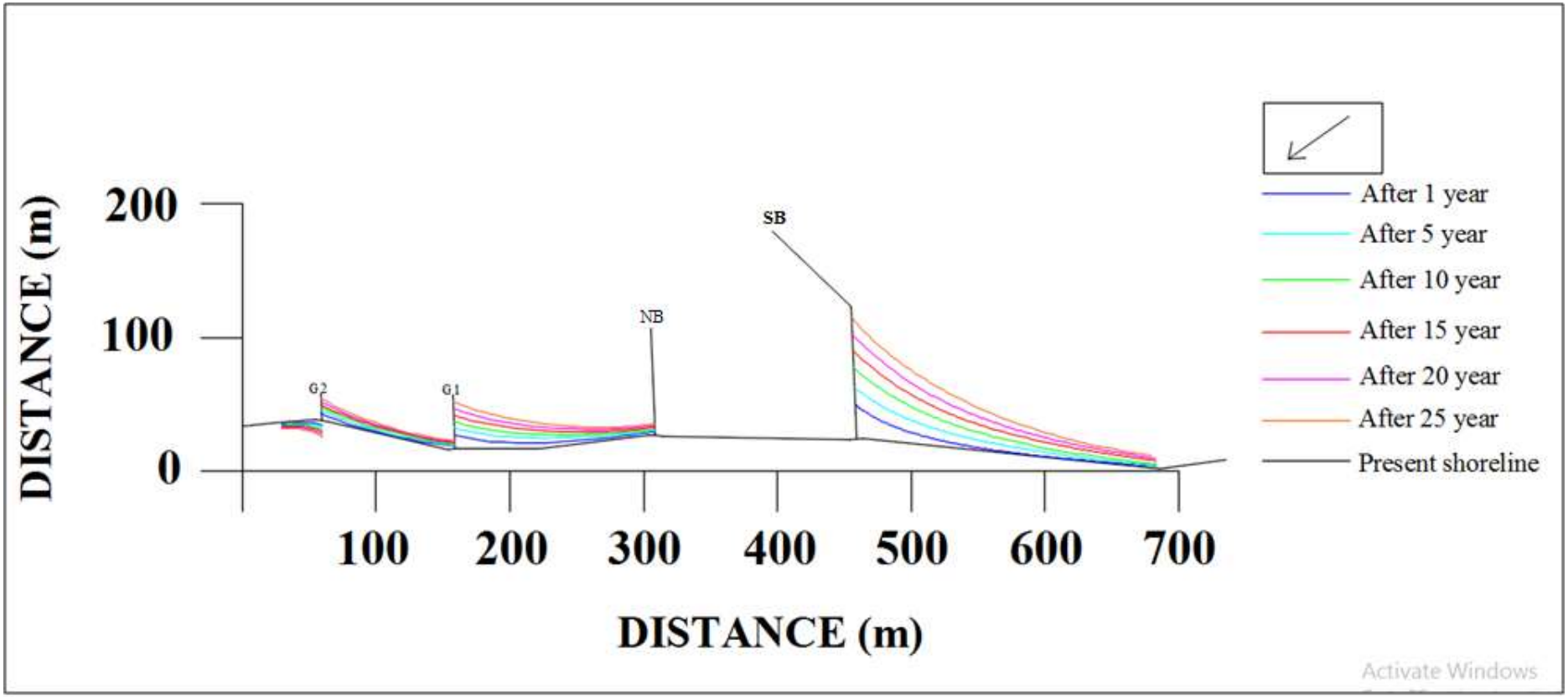


Fig.11 Shoreline evolution

8.0 WAVE MODELLING

8.1 General

The study aims at providing an in-depth analysis on the wave characteristics along the series of groynes at Karikattukuppam. A suitable numerical model is required in order to carry out this task. For the present simulation, the well-known CGWAVE model has been used.

The nonlinear wave propagation associated with most of the observed phenomenon in offshore region (e.g., wave reflection, refraction and diffraction) is generally represented by the shallow water mild slope equation.

$$\nabla.\left(C_p C_g \nabla \eta\right) + k^2 C_p C_g \eta = 0 \qquad (4)$$

Where,

C_p and C_g are the wave celerity and group celerity respectively.

η is the water surface elevation.

k is the wave number.

For the computation of near shore wave field, this model (Eqn. (4)) is subjected to the proper boundary conditions. This is provided by the bathymetry and the shore line.

8.2 Computational domain

The computational domain roughly approximates a semi-circle of radius 1km. **Fig.12** shows the domain where the computations are actually performed. The direction of the incident monochromatic wave is defined with respect to the geometric northern direction.

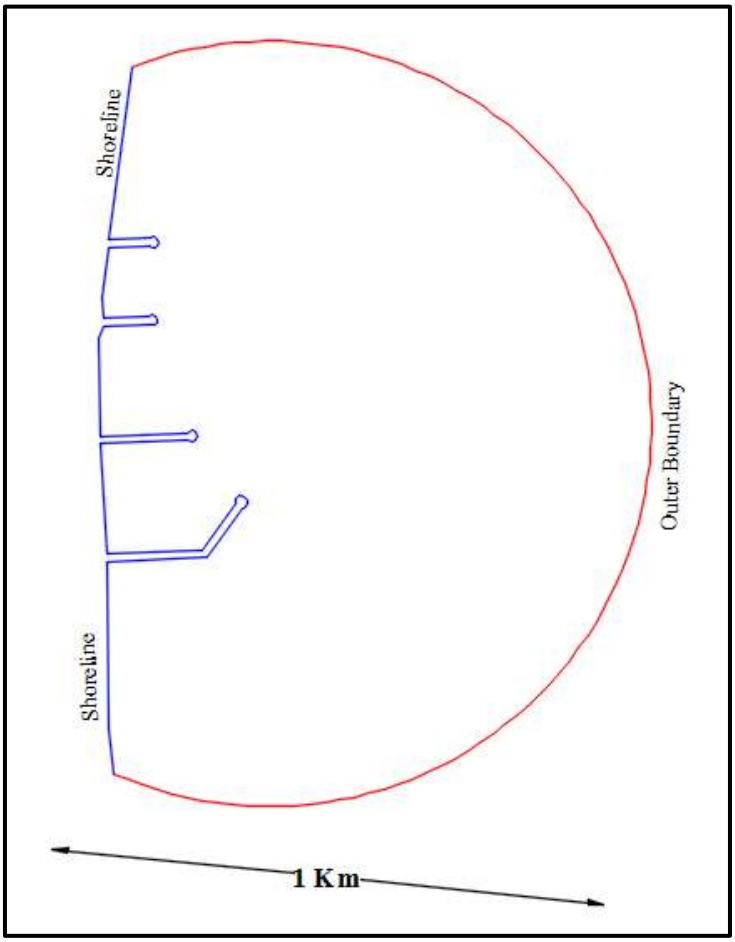


Fig. 12 Computational domain

A numerical method is required to solve the above Eqn. (4) for wave elevation. In this study, Finite Element Method (herein after abbreviated as FEM) is employed. This requires creating a mesh structure in the given computational domain. Upon creation of such a mesh, the domain is represented by nodal points which are connected with each other through the created mesh. The numerical solution of Eqn. (4) is sought in those nodes. This mesh has been generated using the commercial package GAMBIT. The procedure for generation of grid in GAMBIT as follows:

- Based on the region of the sea whose analysis is required add a path in Google earth software.
- Taking the two end nodes of the path draw a semicircle which would represent the domain for which the wave analysis is required.
- Choose the type of elements (tri/quad) and the sizing of mesh.
- Mesh will be generated from which we would be able to know significant wave height and phase at each node.

8.3 Detail of the mesh structure

The CGWAVE model utilizes triangular mesh units in the computational domain. Due to the complexity in the shoreline geometry, an unstructured mesh is desired. Hence a triangular unstructured mesh is generated in GAMBIT, mesh generation software. In such a mesh the nodal spacing is optimized so as to adapt to the nearby portion of the shoreline boundary. The outer semicircular periphery is modeled by 382 nodes with a spacing of 5 m and the inner shoreline is modeled by nodes with a spacing of 5 m. Then an unstructured mesh is created with an average spacing of 5 m inside the domain. This leads to a total number of 26531 nodes with 52308 numbers of triangular elements. The mesh is shown in **Fig. 13.**

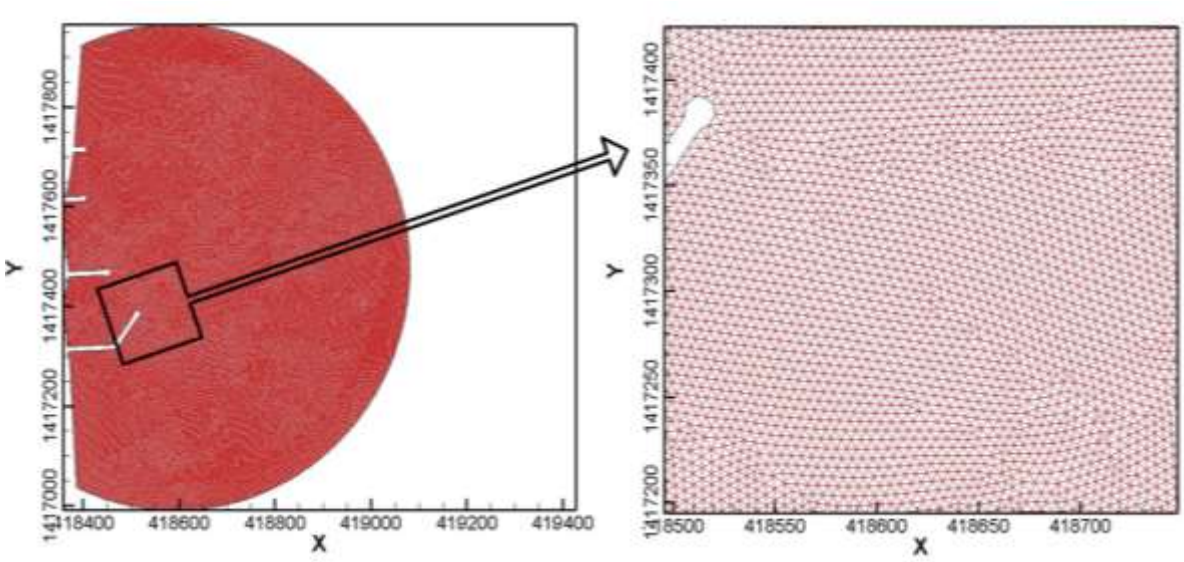


Fig.13 Mesh Structure adopted for the wave propagation modeling

8.4 Results and discussion

A total number of five wave directions have been simulated in order to investigate the wave tranquility inside the proposed port region. The wave directions are chosen such that these represent an annual year. The wave period of the computations is given as 6s-12s to observe the wave climate. The incident wave angle is varied to simulate different wave directional scenarios. The wave climates representing typical wave directions are presented. **Fig.14** to **Fig.18** reports the wave phase diagram and the wave height distribution for different wave approach angles of 45^{0}, 90^{0}, 135^{0}, 155^{0} and 180^{0} respectively.

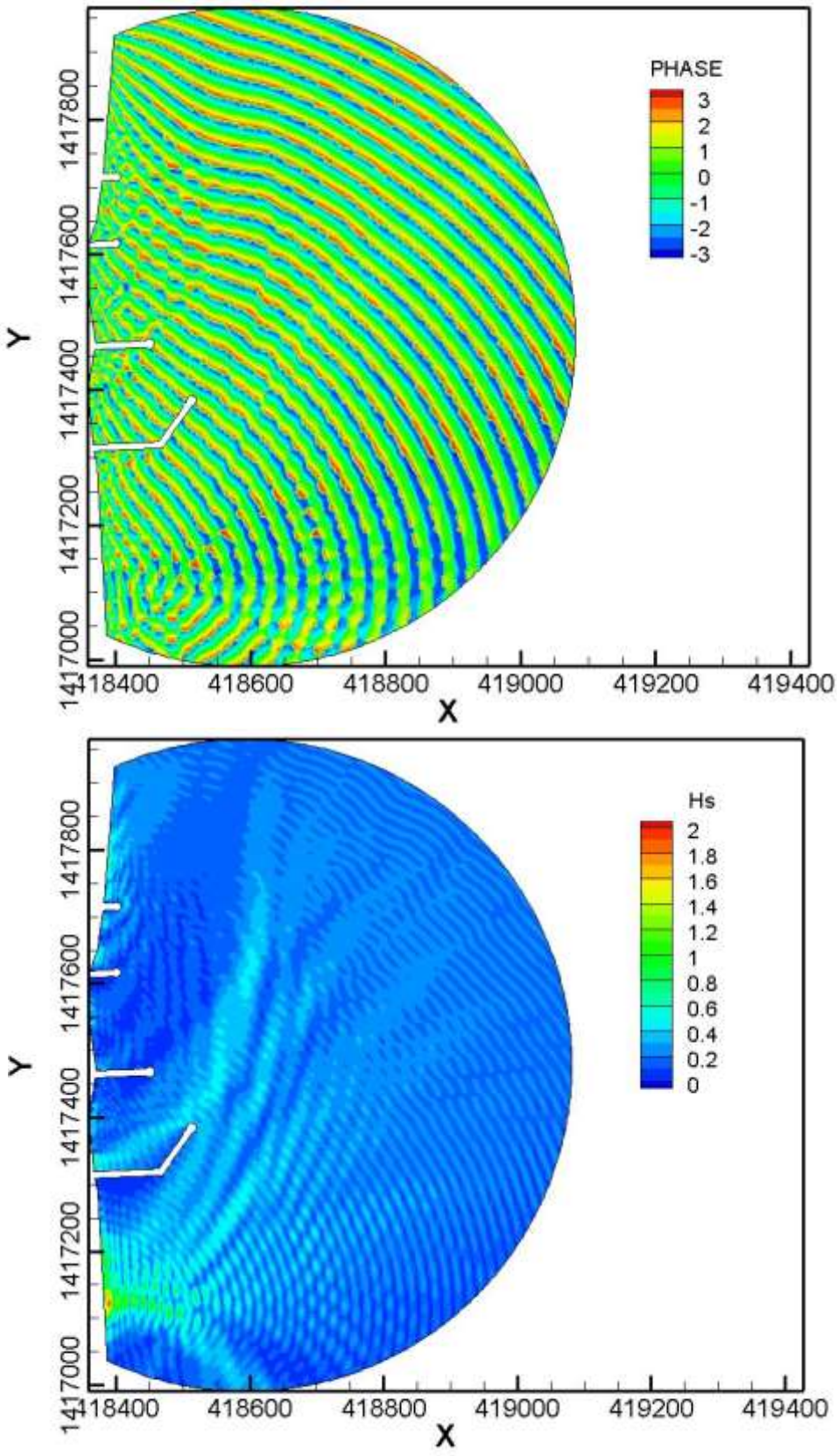


Fig.14 Phase distributions and Wave height distribution for the wave approach angle from 45^0

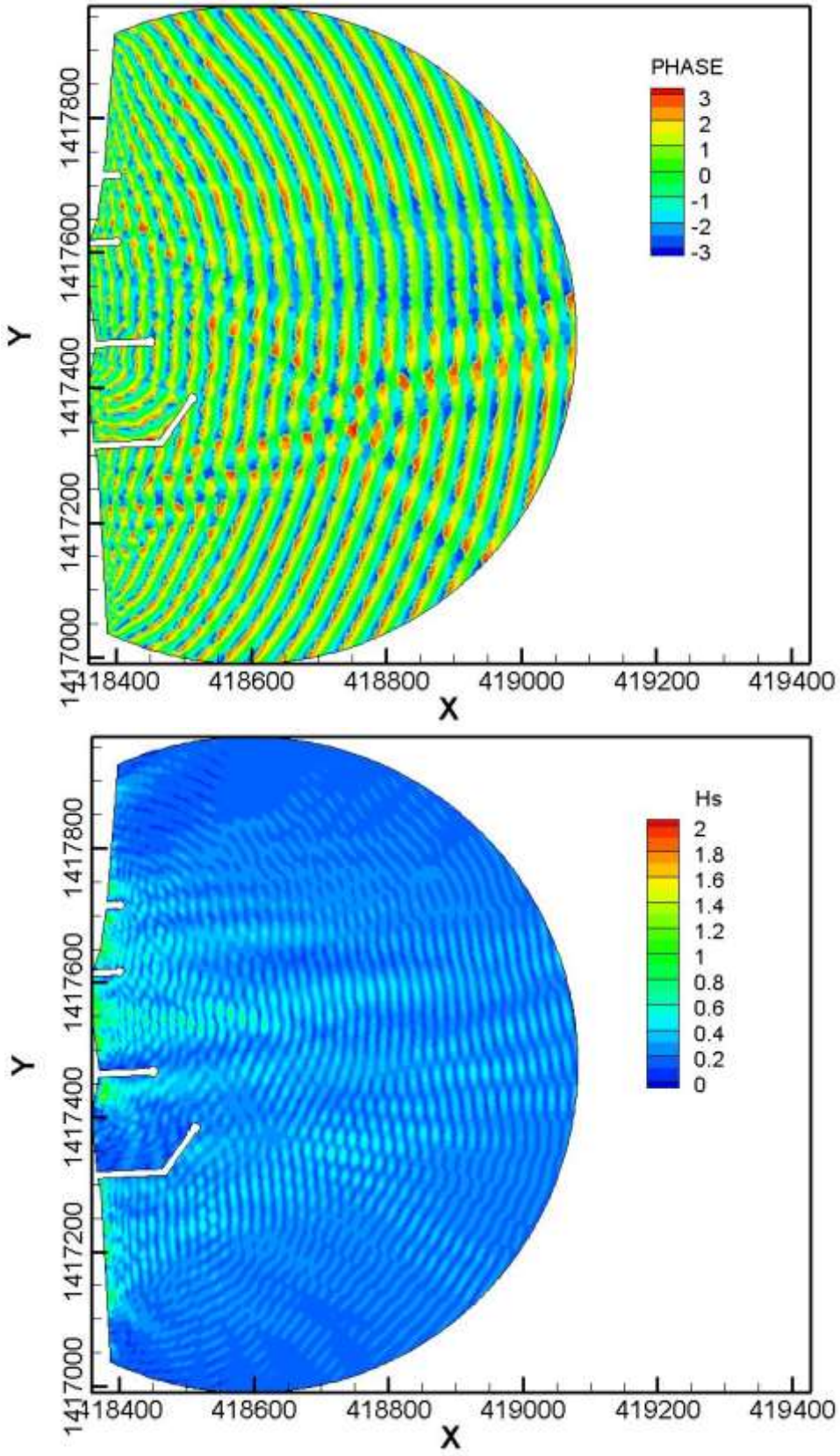


Fig.15 Phase distributions and Wave height distribution for the wave approach angle from 90^0

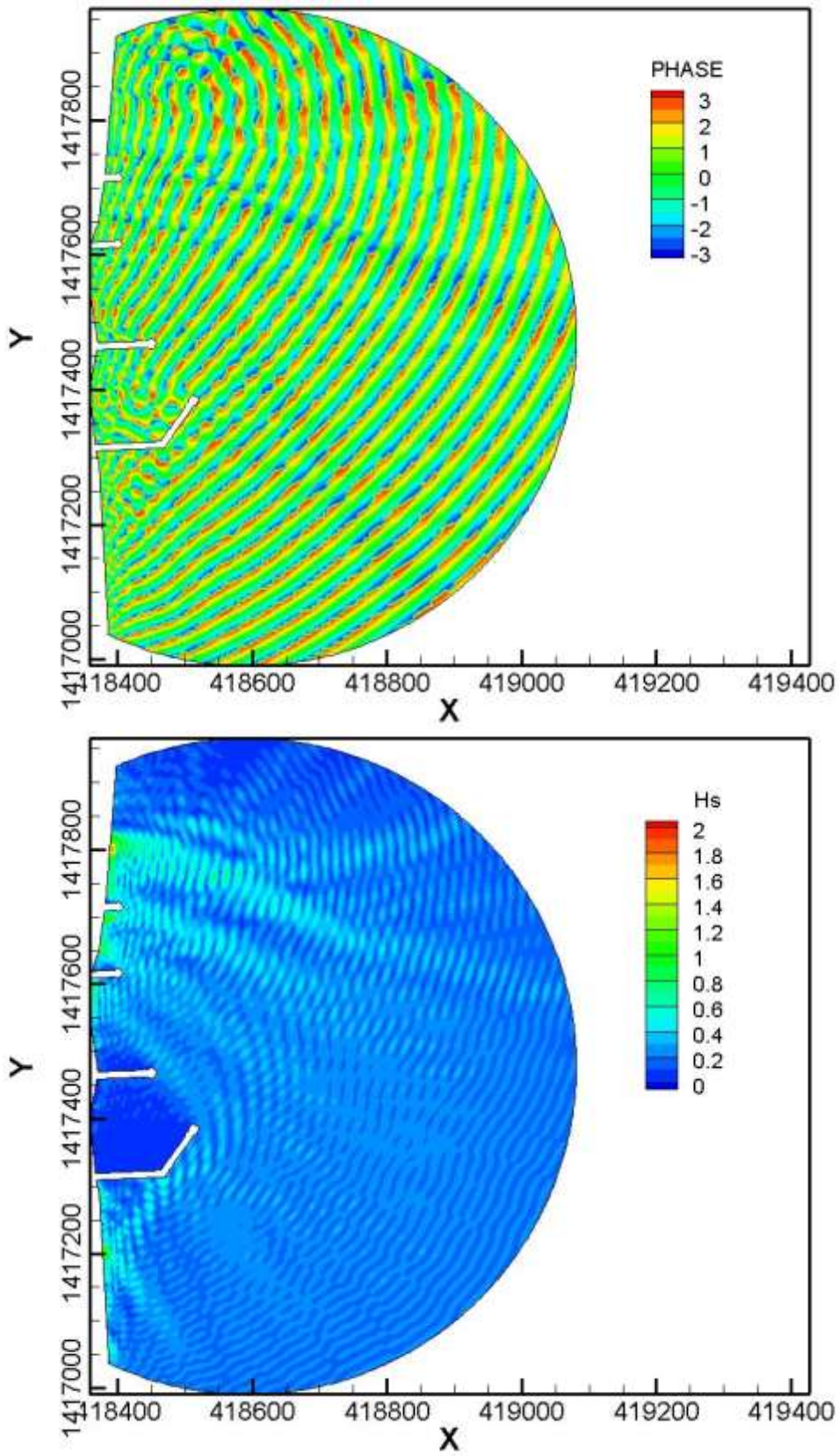


Fig.16 Phase distributions and Wave height distribution for the wave approach angle from 135^0

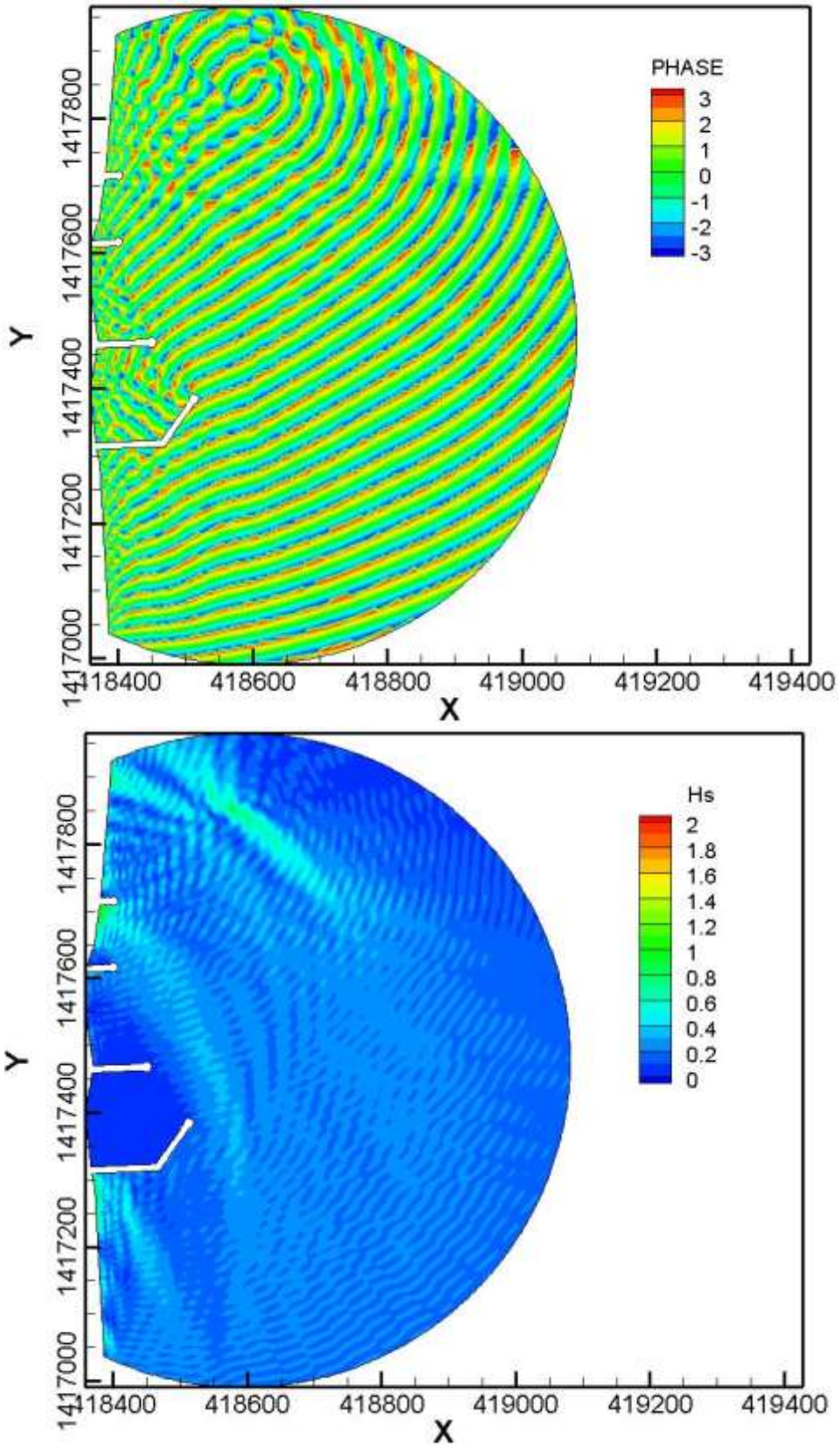


Fig.17 Phase distributions and Wave height distribution for the wave approach angle from 155^0

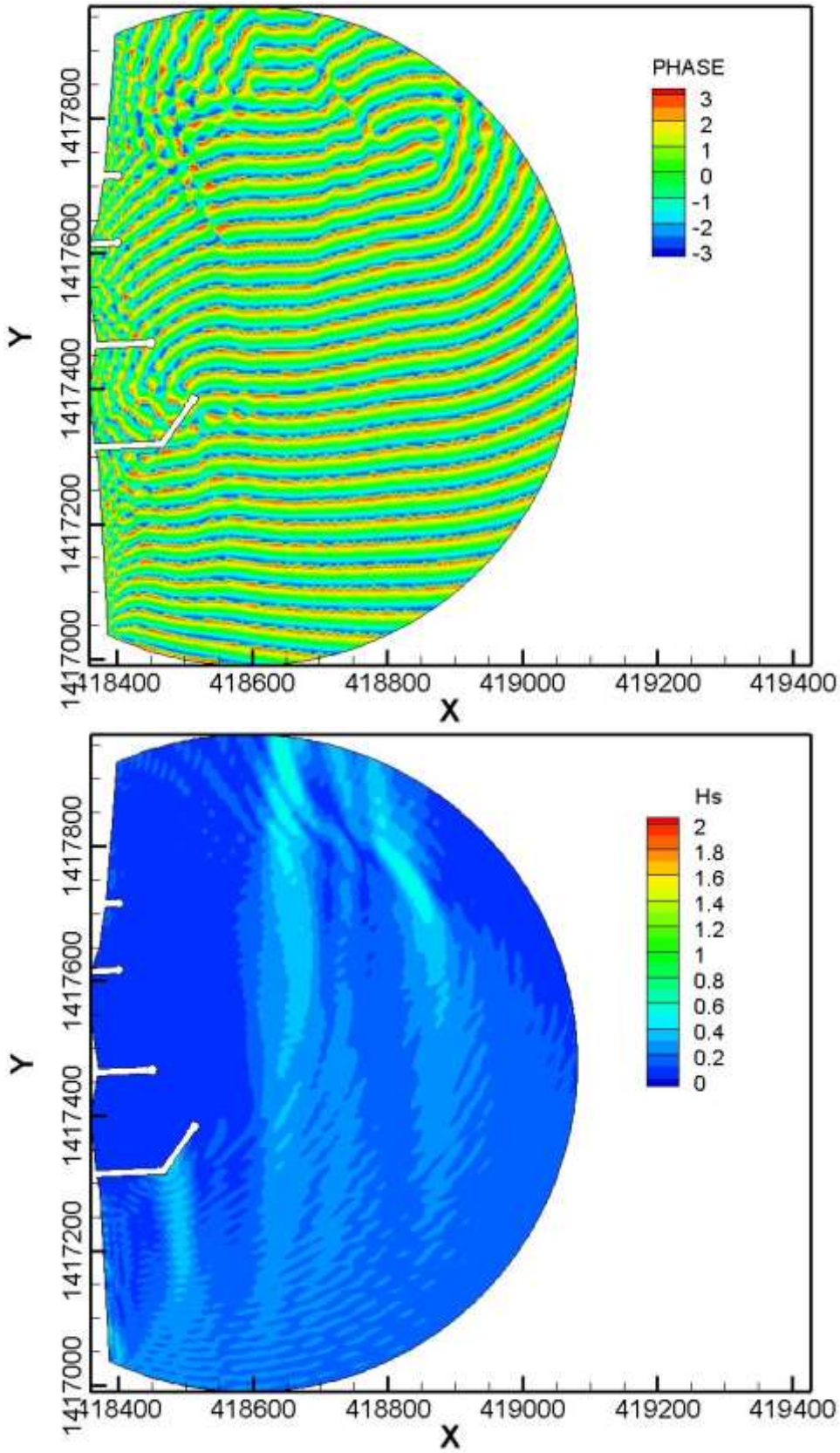


Fig.18 Phase distributions and Wave height distribution for the wave approach angle from 180^0

9.0 DESIGN OF BREAKWATER

9.1 Design water level

Following design data has been adopted for the design of tetrapod's section. The Mean high-water level was +1.2 m CD. For the design of the section, MHWL is adopted as maximum water level.

The design water level for the breakwater can thus be set as the sum of MHWS and the design water depth is,

d = 4.0 +1.2+0.8= 6.0 m

Hmax = 0.78 x 6.0

= 4.68 m

Significant wave Height = Hmax /1.6 =2.92 m

Take Design wave height as 2.92 m.

9.2 Design of layers

The following describes a typical breakwater design.

Armour Layer

The size of the armour stones for the breakwater section is calculated by using the Hudson formula, which is recommended by CERC (1984). Stones are used as armour unit.

$$W = \frac{W_r H_D^3}{K_D (S_r - 1)^3 \cot\theta}$$

Where,

W=Weight of an individual armour unit in the primary cover layer.

W_r =Unit weight of tetrapod's, 2.40 T/m^3.

H_D =Design wave height at the structure site in meters,

S_r =Specific weight of armour unit relating to water at the structure

$S_r = (W_r / W_w)$

W_w =Unit weight of seawater = 1025 kg/m^3

θ =Angle of structure slope measured with the horizontal in degrees =1:1.5 (Chosen) for trunk section and 1:2 for head section.

K_D =for rough quarry stones in breaking condition, the stability coefficient is 7, and it is 4.5 for the head and trunk, respectively.

From Hudson's formula, the weight of tetrapod's is worked out to be 4 T in two layers to withstand the design wave height of 2.92 m at the maximum water depth (-) 4.0 m water depth.

The thickness of the armour layer is calculated by following,

$$t = nK\delta\left[\frac{w}{w_r}\right]^{\frac{1}{3}} = 2.50 \text{ m}$$

2.50 m thickness was adopted for armour layer.

Core layer

The size of stone in core layer is 100 kg to 300 kg rough angular quarry stones are suggested for core layer for which W_r =2650 kg / m^3.

Toe Mound

The size of stone in toe mound is taken as $W/10$ to $W/15$ (as per CERC, 1984).

Rough angular quarry stones of weight 500 Kg to 800 Kg are suggested for toe layer for which W_r =2650 kg / m^3 with 1.25 m thickness for the trunk and head portion.

Crest width

Crest width, r is arrived from the formula

$$r = nK_\delta\left[\frac{W}{W_r}\right]^{\frac{1}{3}}$$

Where,

n= number of tetrapod's or stones on the crest

K_δ =Layer coefficient

Hence, Crest Width = 4 m

Crest elevation

The crest elevation of the breakwater is given by,

Crest elevation = MHWS + Design Water Level + free board

Free board may be adopted in calculating the design elevation to give free height for exceptional cases of storms and cyclone waves that hit the toe of the structure to avoid dangers. For breakwater and groynes, (+) 4.5 m crest elevation is maintained for breakwater and for groynes up to +1.2 m cross sections.

Filter layer

The size of stone in filter layer is taken as 1 kg to 10 kg Rough angular quarry stones are for which W_r =2650 kg / m^3. The thickness of filter layer is 0.3 m.

The detailed plan, longitudinal sections, and cross sections of the breakwater and groynes are given in **Plates *(IITM - KKK - BG - 101 – 02 to IITM - KKK - BG - 101 – 10).***

10.0 BILL OF QUANTITIES

Karikattkuppam - Southern Breakwater (160m)_ Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 3.5 m to (-) 4.0 m	15.00	70.40	61.40	65.90	988.50	494.25	1186.20
(-) 3.0 m to (-) 3.5 m	30.00	61.40	56.80	59.10	1773.00	886.50	2127.60
at (-) 3.0 m	30.00	56.80	56.80	56.80	1704.00	852.00	2044.80
					Total	**Tetrapod**	**5358.60**
(-) 2.5 m to (-) 3.0 m	*22.00*	*42.48*	*38.90*	*40.69*	*895.18*	*626.63*	*1660.56*
(-) 2.0 m to (-) 2.5 m	14.00	38.90	35.30	37.10	519.40	363.58	963.49
(-) 1.5 m to (-) 2.0 m	11.00	35.30	29.50	32.40	356.40	249.48	661.12
(-) 1.0 m to (-) 1.5 m	13.00	29.50	26.20	27.85	362.05	253.44	671.60
(-) 0.5 m to (-) 1.0 m	13.00	26.20	21.40	23.80	309.40	216.58	573.94
0.0 m to (-) 0.5 m	6.00	21.40	18.40	19.90	119.40	83.58	221.49
at 0.0 m	6.00	18.40	25.90	22.15	132.90	93.03	246.53
0 to (+) 0.5 m	15.00	25.90	25.90	25.90	388.50	271.95	720.67
(+) 0.5 m to (+) 1.2	11.00	25.90	25.90	25.90	284.90	199.43	528.49
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**7274.62**
					Total	**Armour layer**	**12633.22**

Karikattkuppam - Southern breakwater (160m) _ core layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 3.5 m to (-) 4.0 m	15.00	45.31	30.23	37.77	566.55	396.59	1050.95
(-) 3.0 m to (-) 3.5 m	30.00	30.23	23.81	27.02	810.60	567.42	1503.66
at (-) 3.0 m	30.00	23.81	23.81	23.81	714.30	500.01	1325.03
(-) 2.5 m to (-) 3.0 m	*22.00*	*55.00*	*46.24*	*50.62*	*1113.64*	*779.55*	*2065.80*
(-) 1.5 m to (-) 2.0 m	14.00	46.24	30.90	38.57	539.98	377.99	1001.66
(-) 1.0 m to (-) 1.5 m	11.00	30.90	26.93	28.92	318.07	222.65	590.01
(-) 0.5 m to (-) 1.0 m	13.00	26.93	20.80	23.87	310.25	217.17	575.50
0.0 m to (-) 0.5 m	13.00	20.80	15.40	18.10	235.30	164.71	436.48
at 0.0 m	6.00	15.40	15.40	15.40	92.40	64.68	171.40
0 to (+) 0.5 m	6.00	15.40	13.40	14.40	86.40	60.48	160.27
(+) 0.5 m to (+) 1.2	11.00	13.40	13.40	13.40	147.40	103.18	273.43

shore anchore	20.50	13.50	13.50	276.75	193.73	513.37
					Total	**9667.57**

Karikattkuppam - Northern breakwater (160m)_ Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 3.5 m to (-) 4.0 m	15.00	22.00	17.62	19.81	297.15	208.01	551.21
(-) 3.0 m to (-) 3.5 m	30.00	17.62	15.36	16.49	494.70	346.29	917.67
(-) 2.5 m to (-) 3.0 m	30.00	15.36	15.36	15.36	460.80	322.56	854.78
						Total	**2323.67**

Karikattkuppam - Southern breakwater (160m)_toe layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 3.5 m to (-) 4.0 m	15.00	22.90	22.90	22.90	343.50	240.45	637.19
(-) 3.0 m to (-) 3.5 m	30.00	22.90	22.90	22.90	687.00	480.90	1274.39
at 3.0 m	30.00	22.90	22.90	22.90	687.00	480.90	1274.39
(-) 2.5 m to (-) 3.0 m	*22.00*	*16.51*	*16.51*	*16.51*	*363.22*	*254.25*	*673.77*
(-) 2.0 m to (-) 2.5 m	14.00	22.90	16.51	19.71	275.87	193.11	511.74
(-) 1.5 m to (-) 2.0 m	11.00	16.51	16.51	16.51	181.61	127.13	336.89
(-) 1.0 m to (-) 1.5 m	13.00	16.51	15.70	16.11	209.37	146.56	388.37
(-) 0.5 m to (-) 1.0 m	13.00	15.70	15.70	15.70	204.10	142.87	378.61
0.0 m to (-) 0.5 m	6.00	15.70	15.70	15.70	94.20	65.94	174.74
at 0.0 m	6.00	15.70	15.70	15.70	94.20	65.94	174.74
						Total	**5824.82**

Karikattkuppam - Southern breakwater (160m)_ filter layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 3.5 m to (-) 4.0 m	15.00	11.50	10.60	11.05	165.75	116.03	307.47
(-) 3.0 m to (-) 3.5 m	30.00	10.60	10.15	10.38	311.25	217.88	577.37
at (-) 3.0 m	30.00	10.15	10.15	10.15	304.50	213.15	564.85
(-) 2.5 m to (-) 3.0 m	*22.00*	*10.21*	*10.06*	*10.14*	*222.97*	*156.08*	*413.61*
(-) 2.0 m to (-) 2.5 m	14.00	10.06	9.61	9.84	137.69	96.38	255.41

(-) 1.5 m to (-) 2.0 m	11.00	9.61	9.16	9.39	103.24	72.26	191.50
(-) 1.0 m to (-) 1.5 m	13.00	9.16	8.71	8.94	116.16	81.31	215.47
(-) 0.5 m to (-) 1.0 m	13.00	8.71	8.26	8.49	110.31	77.21	204.62
0.0 m to (-) 0.5 m	6.00	8.26	7.81	8.04	48.21	33.75	89.43
at 0.0 m	6.00	7.81	6.01	6.91	41.46	29.02	76.91
0 to (+) 0.5 m	6.00	6.01	6.01	6.01	36.06	25.24	66.89
(+) 0.5 m to (+) 1.2	11.00	6.01	6.01	6.01	66.11	46.28	122.63
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**3390.37**

Head Portion (-4.0 M Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.5	12.9	3	1008.46		
Armour Layer	2	7.31	2.41	160.90		
Armour Layer	2.5	8.74	3.74	322.01		
			Total Armour layer		614.03	**1473.67**
Toe mound layer						
Toe mound	1.25	21.55	19.05	1619.50		
Toe mound	1.25	12.02	9.54	458.13		
			Total Toe mound layer		609.72	**1615.75**
under layer	4.96	14.97	2.41	1380.86		
under layer	3.71	9.55	2.12	450.22		
			Total under layer		488.59	**1294.75**
Core Material	4.95	12.02	2.12	903.86	474.53	**1257.50**
Filter Layer	0.3	23.65	23.05	513.63	269.65	**714.58**

GROYNE	**QUANTITY IN TONNES**					
	ARMOUR LAYER 4 T TETRAPOD	**ARMOUR LAYER (STONES)**	**CORE LAYER**	**UNDER LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
SOUTHERN BREAKWATER _ 160M	**6832.27**	**7275**	**10925**	**3618**	**7441**	**4104.96**

Karikattkuppam - Northern Breakwater _ 80m Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.5 m to (-) 3.0 m	15.00	56.80	52.30	54.55	818.25	409.13	981.90
					Total	**tetrapod**	**981.90**
(-) 2.0 m to (-) 2.5 m	13.00	38.90	35.30	37.10	482.30	337.61	894.67
(-) 1.5 m to (-) 2.0 m	9.00	35.30	31.66	33.48	301.32	210.92	558.95
(-) 1.0 m to (-) 1.5 m	10.00	31.66	26.20	28.93	289.30	202.51	536.65
(-) 0.5 m to (-) 1.0 m	14.00	26.20	22.94	24.57	343.98	240.79	638.08
0.0 m to (-) 0.5 m	10.00	22.94	19.60	21.27	212.70	148.89	394.56
at 0.0 m	9.00	19.60	26.50	23.05	207.45	145.22	384.82
0 to (+) 0.5 m	17.00	26.50	26.50	26.50	450.50	315.35	835.68
(+) 0.5 m to (+) 1.2	18.00	26.50	26.50	26.50	477.00	333.90	884.84
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**6154.98**
					Total	**Armour layer**	**7136.88**

Karikattkuppam - Northern Breakwater _ 80m Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.5 m to (-) 3.0 m	15.00	23.81	27.70	25.76	386.33	270.43	716.63
(-) 2.0 m to (-) 2.5 m	13.00	46.24	38.20	42.22	548.86	384.20	1018.14
(-) 1.5 m to (-) 2.0 m	9.00	38.20	30.90	34.55	310.95	217.67	576.81
(-) 1.0 m to (-) 1.5 m	10.00	30.90	26.93	28.92	289.15	202.41	536.37
(-) 0.5 m to (-) 1.0 m	14.00	26.93	20.80	23.87	334.11	233.88	619.77
0.0 m to (-) 0.5 m	10.00	20.80	15.40	18.10	181.00	126.70	335.76
at 0.0 m	9.00	15.40	15.40	15.40	138.60	97.02	257.10
0 to (+) 0.5 m	17.00	13.40	13.40	13.40	227.80	159.46	422.57
(+) 0.5 m to (+) 1.2	18.00	13.40	13.40	13.40	241.20	168.84	447.43
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**5443.95**

Karikattkuppam - Northern breakwater (180m)_ Under layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.5 m to (-) 3.0 m	15.00	15.36	15.36	15.36	230.40	161.28	427.39
						Total	**427.39**

Karikattkuppam - Northern Breakwater _ 80m Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.5 m to (-) 3.0 m	15.00	22.90	16.51	19.71	295.58	206.90	548.29
(-) 2.0 m to (-) 2.5 m	13.00	16.51	16.51	16.51	214.63	150.24	398.14
(-) 1.5 m to (-) 2.0 m	9.00	16.51	16.51	16.51	148.59	104.01	275.63
(-) 1.0 m to (-) 1.5 m	10.00	16.51	15.70	16.11	161.05	112.74	298.75
(-) 0.5 m to (-) 1.0 m	14.00	15.70	15.70	15.70	219.80	153.86	407.73
0.0 m to (-) 0.5 m	10.00	15.70	15.70	15.70	157.00	109.90	291.24
at 0.0 m	9.00	15.70	15.70	15.70	141.30	98.91	262.11
						Total	**2481.89**

Karikattkuppam - Northern Breakwater _ 80m Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 2.5 m to (-) 3.0 m	15.00	10.15	10.06	10.11	151.58	106.10	281.17
(-) 2.0 m to (-) 2.5 m	13.00	10.06	9.61	9.84	127.86	89.50	237.17
(-) 1.5 m to (-) 2.0 m	9.00	9.61	9.16	9.39	84.47	59.13	156.68
(-) 1.0 m to (-) 1.5 m	10.00	9.16	8.71	8.94	89.35	62.55	165.74
(-) 0.5 m to (-) 1.0 m	14.00	8.71	8.26	8.49	118.79	83.15	220.36
0.0 m to (-) 0.5 m	10.00	8.26	7.81	8.04	80.35	56.25	149.05
at 0.0 m	9.00	7.81	6.01	6.91	62.19	43.53	115.36
0 to (+) 0.5 m	17.00	6.01	6.01	6.01	102.17	71.52	189.53
(+) 0.5 m to (+) 1.2	18.00	6.01	6.01	6.01	108.18	75.73	200.67
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**2019.96**

Head portion (-3.0 m water depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	3.45	9.99	3.00	501.10		
Armour Layer	0.95	4.31	2.41	34.57		
Armour Layer	2.50	8.74	3.74	322.01		
			Total Armour Layer		295.70	**709.69**
Toe Mound Layer						
Toe Mound	1.25	18.55	16.05	1176.76		
Toe Mound	1.25	9.05	6.51	239.68		
			Total Toe Mound Layer		491.96	**1303.70**
Under Layer	3.45	9.31	2.41	414.98		
Under Layer	2.20	6.51	2.11	139.47		
			Total Under Layer		636.61	**1687.01**
Core Material	3.45	9.01	2.11	377.87	198.38	**525.71**
Filter Layer	0.30	20.65	20.12	391.47	205.52	**544.63**

GROYNE	**QUANTITY IN TONNES**					
	ARMOUR LAYER 4 T TETRAPOD	**ARMOUR LAYER (STONES)**	**CORE LAYER**	**UNDER LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
Northern breakwater _ 80m	**1691.59**	**6155**	**5970**	**2114**	**3786**	**2564.59**

Karikattkuppam - G1 (40m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.0 m to (-) 1.5 m	13.00	31.66	26.20	28.93	376.09	263.26	697.65
(-) 0.5 m to (-) 1.0 m	12.00	26.20	22.94	24.57	294.84	206.39	546.93
0.0 m to (-) 0.5 m	8.00	22.94	19.60	21.27	170.16	119.11	315.65
at 0.0 m	7.00	19.60	26.50	23.05	161.35	112.95	299.30
0 to (+) 0.5 m	12.00	26.50	26.50	26.50	318.00	222.60	589.89
(+) 0.5 m to (+) 1.2	11.00	26.50	26.50	26.50	291.50	204.05	540.73
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**4016.89**

Karikattkuppam - G1 (40m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.0 m to (-) 1.5 m	13.00	30.90	26.93	28.92	375.90	263.13	697.29
(-) 0.5 m to (-) 1.0 m	12.00	26.93	20.80	23.87	286.38	200.47	531.23
0.0 m to (-) 0.5 m	8.00	20.80	15.40	18.10	144.80	101.36	268.60
at 0.0 m	7.00	15.40	15.40	15.40	107.80	75.46	199.97
0 to (+) 0.5 m	12.00	13.40	13.40	13.40	160.80	112.56	298.28
(+) 0.5 m to (+) 1.2	11.00	13.40	13.40	13.40	147.40	103.18	273.43
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**2782.18**

Karikattkuppam - G1 (40m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.0 m to (-) 1.5 m	13.00	16.51	15.70	16.11	209.37	146.56	388.37
(-) 0.5 m to (-) 1.0 m	12.00	15.70	15.70	15.70	188.40	131.88	349.48
0.0 m to (-) 0.5 m	8.00	15.70	15.70	15.70	125.60	87.92	232.99
at 0.0 m	7.00	15.70	15.70	15.70	109.90	76.93	203.86
						Total	**1174.71**

Karikattkuppam - G1 (40m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 1.0 m to (-) 1.5 m	13.00	9.16	8.71	8.94	116.16	81.31	215.47
(-) 0.5 m to (-) 1.0 m	12.00	8.71	8.26	8.49	101.82	71.27	188.88
0.0 m to (-) 0.5 m	8.00	8.26	7.81	8.04	64.28	45.00	119.24
at 0.0 m	7.00	7.81	6.01	6.91	48.37	33.86	89.73
0 to (+) 0.5 m	12.00	6.01	6.01	6.01	72.12	50.48	133.78
(+) 0.5 m to (+) 1.2	11.00	6.01	6.01	6.01	66.11	46.28	122.63
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1173.95**

Head Portion (-1.5 M Water Depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.45	11.61	3.00	831.96		
Armour Layer	2.63	7.65	2.56	233.05		
			Total Armour layer		314.43	**833.24**
Toe mound layer						
Toe mound	1.25	17.03	14.61	984.23		
Toe mound	1.25	7.65	10.06	309.66		
			Total Toe mound layer		354.15	**938.50**
Core Material	3.88	10.06	2.56	542.20	284.65	**754.33**
Filter Layer	0.30	19.11	18.53	333.68	175.18	**464.23**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
G1_40m	**4850.13**	**3537**	**2113**	**1638**

Karikattkuppam - G2 (20m) Armour Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Armour layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.20	22.94	24.57	245.70	171.99	455.77
0.0 m to (-) 0.5 m	5.00	22.94	19.60	21.27	106.35	74.45	197.28
at 0.0 m	5.00	19.60	26.50	23.05	115.25	80.68	213.79
0 to (+) 0.5 m	18.00	26.50	26.50	26.50	477.00	333.90	884.84
(+) 0.5 m to (+) 1.2	18.00	26.50	26.50	26.50	477.00	333.90	884.84
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3663.25**

Karikattkuppam - G2 (20m) Core Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Core layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	26.93	20.80	23.87	238.65	167.06	442.70
0.0 m to (-) 0.5 m	5.00	20.80	15.40	18.10	90.50	63.35	167.88
at 0.0 m	5.00	15.40	15.40	15.40	77.00	53.90	142.84
0 to (+) 0.5 m	18.00	13.40	13.40	13.40	241.20	168.84	447.43
(+) 0.5 m to (+) 1.2	18.00	13.40	13.40	13.40	241.20	168.84	447.43
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**2161.63**

Karikattkuppam - G2 (20m) Toe Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Toe mound layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	15.70	15.70	15.70	157.00	109.90	291.24
0.0 m to (-) 0.5 m	5.00	15.70	15.70	15.70	78.50	54.95	145.62
at 0.0 m	5.00	15.70	15.70	15.70	78.50	54.95	145.62
						Total	**582.47**

Karikattkuppam - G2 (20m) Filter Layer							
Water depth(m)	**Length (m)**	**Start chainage Area(m^2)**	**End chainage Area(m^2)**	**Filter layer Average(m^2)**	**Volume (m^3)**	**Volume including porosity (m^3)**	**Quantity in Tonnes**
(-) 0.5 m to (-) 1.0 m	10.00	8.71	8.26	8.49	84.85	59.40	157.40
0.0 m to (-) 0.5 m	5.00	8.26	7.81	8.04	40.18	28.12	74.52
at 0.0 m	5.00	7.81	6.01	6.91	34.55	24.19	64.09
0 to (+) 0.5 m	18.00	6.01	6.01	6.01	108.18	75.73	200.67
(+) 0.5 m to (+) 1.2	18.00	6.01	6.01	6.01	108.18	75.73	200.67
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1001.58**

Head portion (-1.0 m water depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	4.45	11.61	3.00	831.96		
Armour Layer	2.45	7.25	2.51	197.61		
			Total Armour layer		333.04	**882.55**
Toe mound layer						
Toe mound	1.30	17.03	14.61	1023.60		
Toe mound	1.30	9.67	7.25	294.15		
			Total Toe mound layer		382.96	**1014.86**
Core Material	3.70	9.67	2.51	480.52	252.27	**668.53**
Filter Layer	0.30	19.11	18.53	333.68	175.18	**464.23**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
G2_20m	**4545.80**	**2830**	**1597**	**1466**

Calculation of Number of Tetrapod's

Southern breakwater _ 180m					
Water depth(m)	**Length (m)**	**Start chainage length(m)**	**End chainage length(m)**	**Armour layer length (Tetrapods) Average(m)**	**Surface Area (m^2)**
(-) 3.5 m to (-) 4.0 m	15.00	28.12	24.44	26.28	394
(-) 3.0 m to (-) 3.5 m	30.00	24.44	22.68	23.56	707
(-) 2.5 m to (-) 3.0 m	30.00	22.68	22.68	22.68	680
4T-Tetrapods - Surface area					**1781**
Head Portion (-)4.0 m - 4T - Tetrapods - Surface area					**722**
					2503

Northern breakwater _ 80m					
Water depth(m)	**Length (m)**	**Start chainage length(m)**	**End chainage length(m)**	**Armour layer length (Tetrapods) Average(m)**	**Surface Area (m^2)**
(-) 2.5 m to (-) 3.0 m	15.00	22.68	21.70	22.19	333
4T-Tetrapods - Surface area					**333**
Head Portion (-)3.0m - 4T - Tetrapods - Surface area					452
					785

Total	**3273**

Calculation of Number of Tetrapods			
N=Na/A	**($1/m^2$)**		
N=nkt(1-nv)/(Dn50)^2			
N	=	0.740	/m2
Na - No of 4T - Tetrapods	=	**2433**	**Nos**

10.2 Total Quantity of Groynes

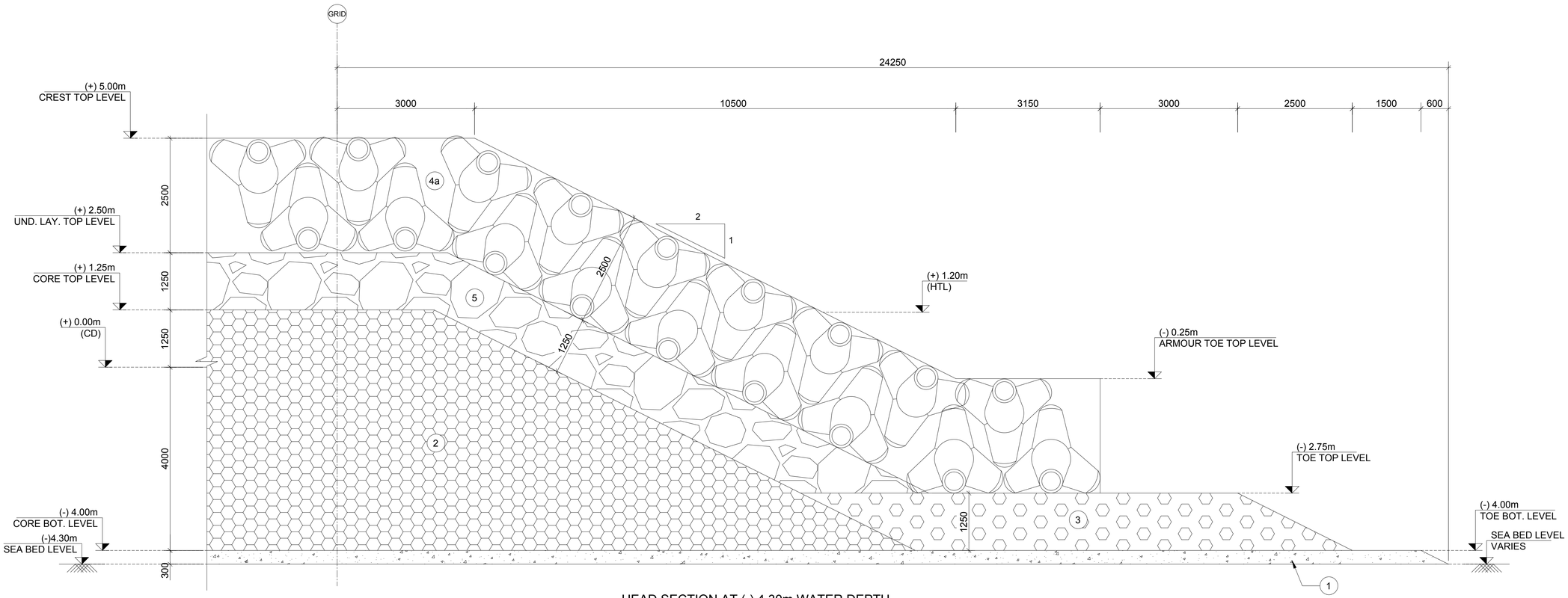
KARIKATTKUPPAM	
NORTHERN BREAKWATER _ 80M , SOUTHERN BREAKWATER _ 160M , GROYNES G1 AND G2	**QUANTITY IN TONNES**
ARMOUR LAYER 4 T - Tetrapod	**8524**
ARMOUR LAYER (Stones)	**22826**
CORE LAYER	**23261**
TOE MOUND LAYER	**14937**
UNDER LAYER	**5733**
FILTER LAYER	**9774**
TOTAL	***85055.00***

11.0 RECOMMENDATION

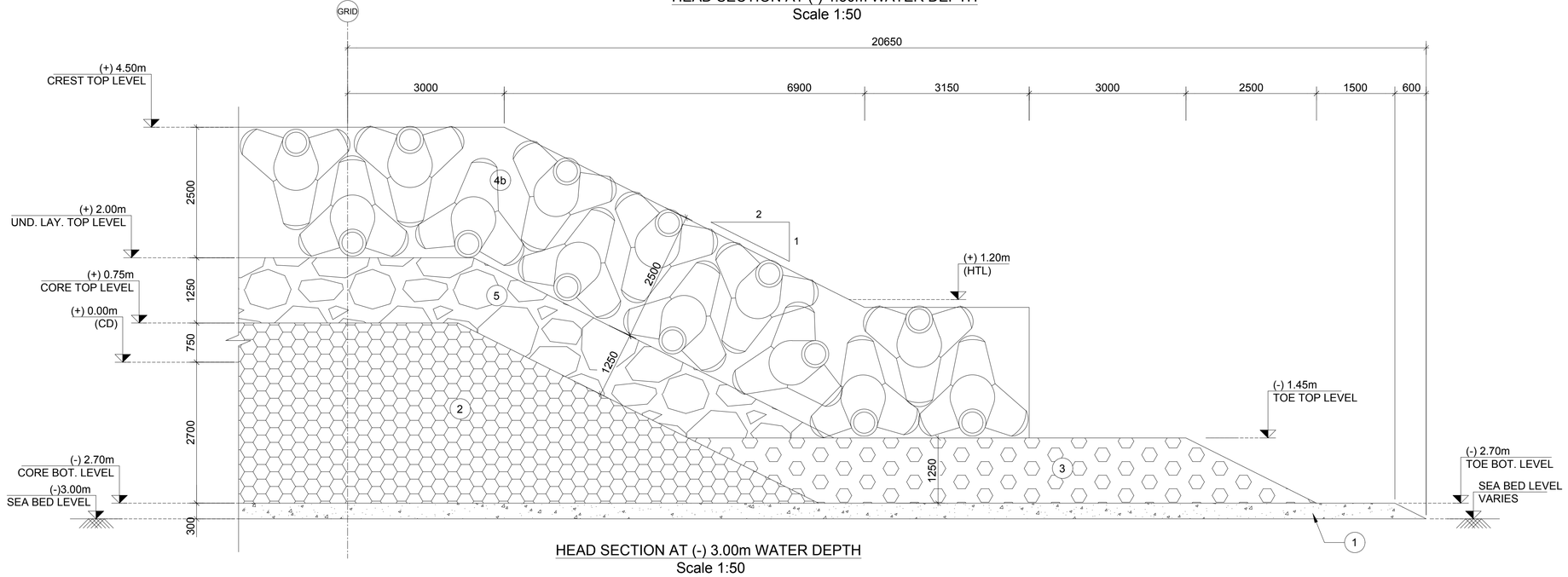
A comprehensive study was carried out on arriving at the coastal protection measure for a stretch of 400 m along the coast of Karikattukuppam (latitude 12°49'15.67"N and longitude 80°14'51.04"E) as per the request of the Department of Fisheries, Tamilnadu. After deriving the offshore wave climate from the wind climate, the driving forces, breaker wave characteristics were obtained, which were then adopted to estimate the longshore sediment characteristics, both its magnitude and direction**.** The net sediment transport of the study area is estimated to be about 1.5 Lakhs per annum directed towards the North. For the welfare of the fisherman community and combat erosion, a pair of groynes and pair of breakwater field has been proposed which was subjected as fish landing center for small fishing boats.

Prior to the commencement of the work as proposed, borehole investigation needs to be performed to ascertain the soil conditions and the one-line bathymetry along the proposed alignment of the groynes as there could be a possibility of the changes in the bathymetry. IIT Madras should be informed prior to the commencement of the construction.

Prof. S.A.Sannasiraj



HEAD SECTION AT (-) 4.30m WATER DEPTH
Scale 1:50



HEAD SECTION AT (-) 3.00m WATER DEPTH
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- (1) - FILTER LAYER 1kg TO 10kg
- (2) - CORE 100kg TO 300kg
- (3) - TOE MOUND 500kg TO 800kg 1.25m Thick
- (4a) - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick
- (4b) - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick

LEGEND:-

- (4c) - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- (4d) - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- (5) - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- (6) - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KKK-BG-101-01
   b) IITM-KKK-BG-101-02
   c) IITM-KKK-BG-101-03
   d) IITM-KKK-BG-101-04
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KKK-BG-001

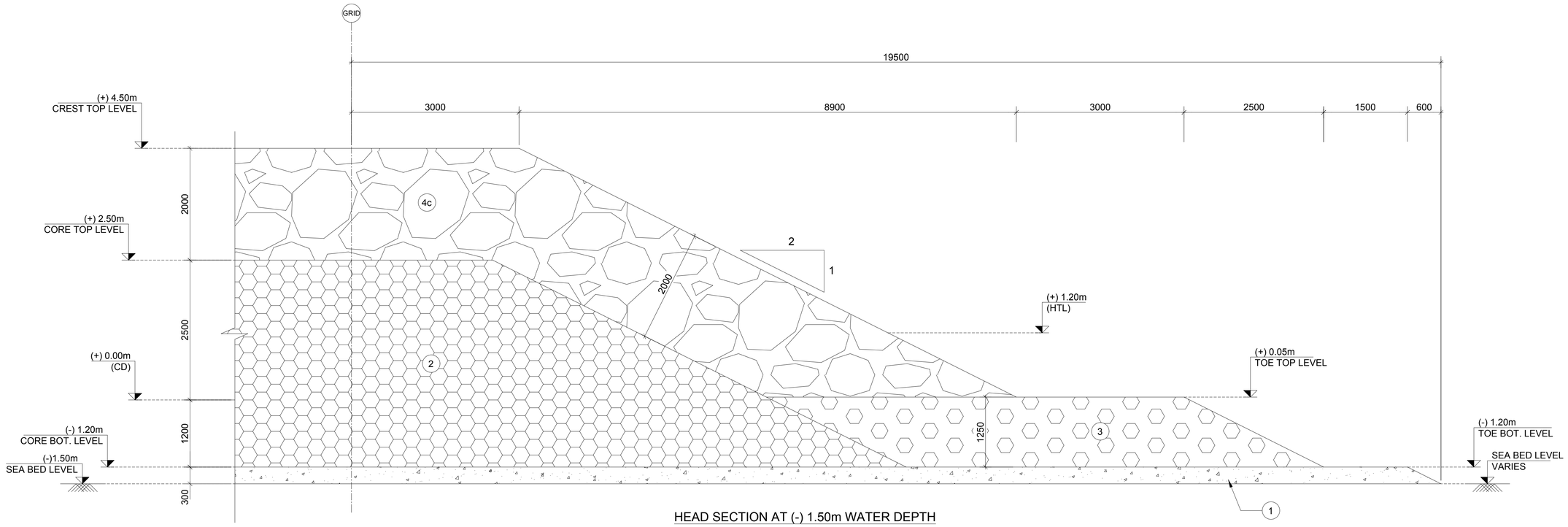
355

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	STR

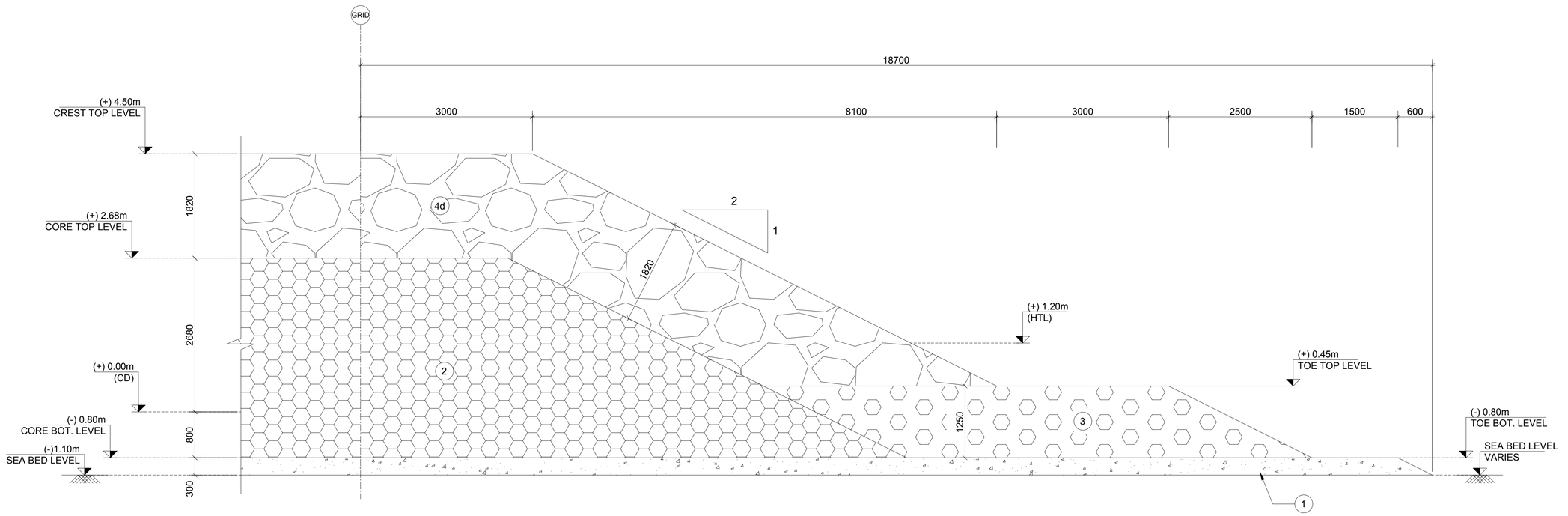
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (5 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 05
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023
Scale as shown
REV 0



HEAD SECTION AT (-) 1.50m WATER DEPTH
Scale 1:40



HEAD SECTION AT (-) 1.10m WATER DEPTH
Scale 1:40

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

1. FILTER LAYER 1kg TO 10kg
2. CORE 100kg TO 300kg
3. TOE MOUND 500kg TO 800kg 1.25m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- 4d - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- 5 - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- 6 - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KKK-BG-101-01
   b) IITM-KKK-BG-101-02
   c) IITM-KKK-BG-101-03
   d) IITM-KKK-BG-101-04
   e) IITM-KKK-BG-101-05
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KKK-BG-001

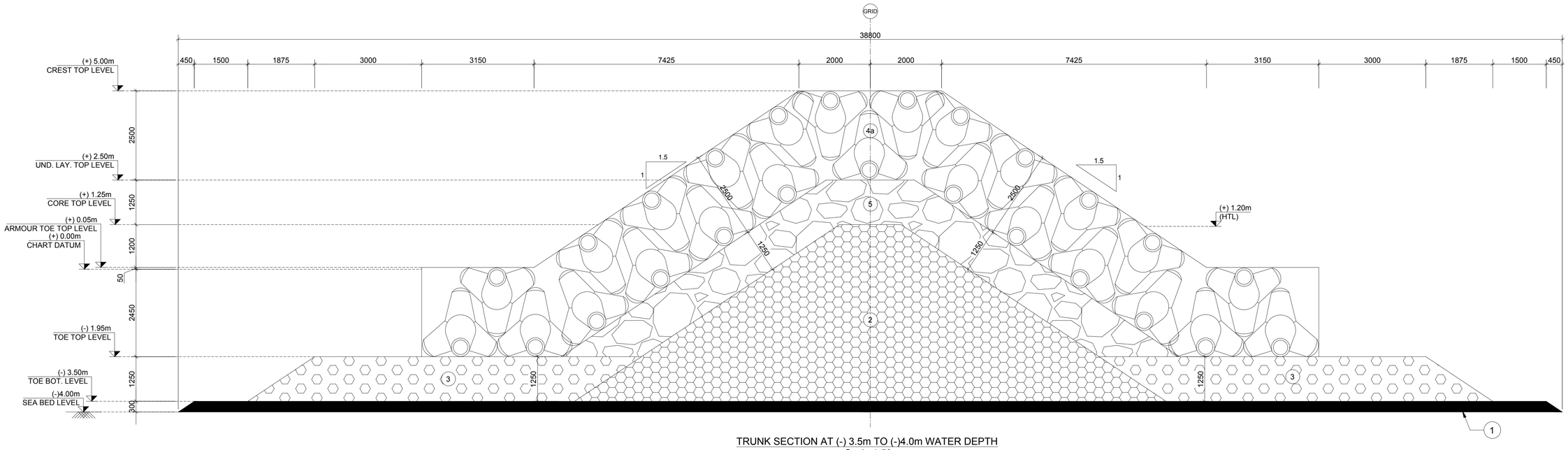
356

REV.	DDMMYY	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	AKE

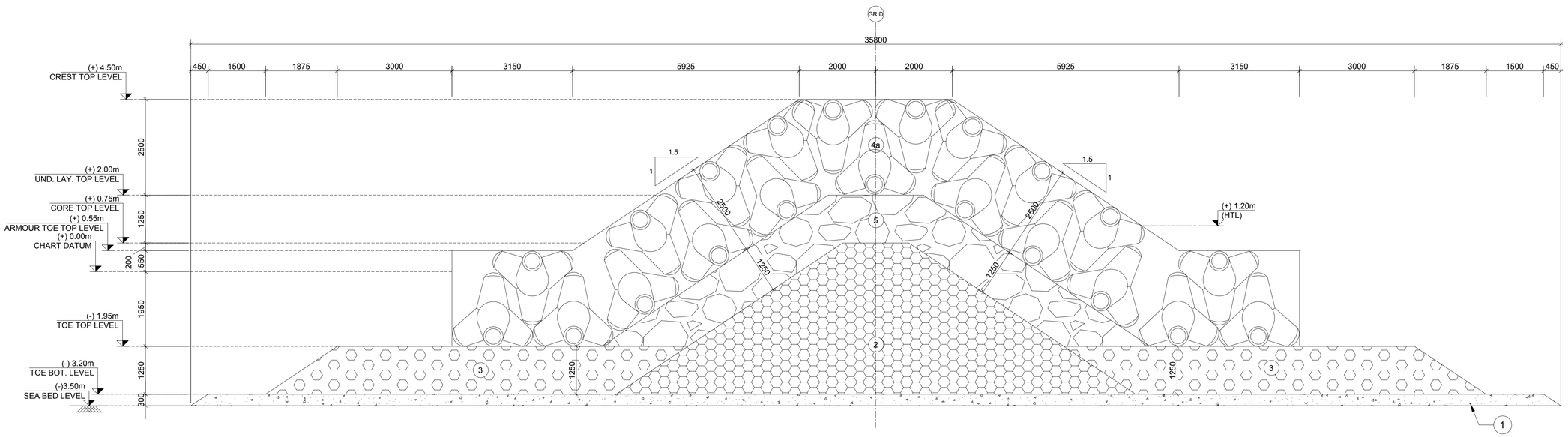
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (6 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023
Scale as shown
REV 0



TRUNK SECTION AT (-) 3.5m TO (-)4.0m WATER DEPTH
Scale 1:50



TRUNK SECTION AT (-) 3.0m TO (-)3.5m WATER DEPTH
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- 1 - FILTER LAYER 1kg TO 10kg
- 2 - CORE 100kg TO 300kg
- 3 - TOE MOUND 500kg TO 800kg 1.25m Thick
- 4a - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick
- 4b - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- 4d - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- 5 - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- 6 - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KKK-BG-101-01
   b) IITM-KKK-BG-101-02
   c) IITM-KKK-BG-101-03
   d) IITM-KKK-BG-101-04
   e) IITM-KKK-BG-101-05
   f) IITM-KKK-BG-101-06
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KKK-BG-001

357

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (7 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 07
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023

Scale as shown
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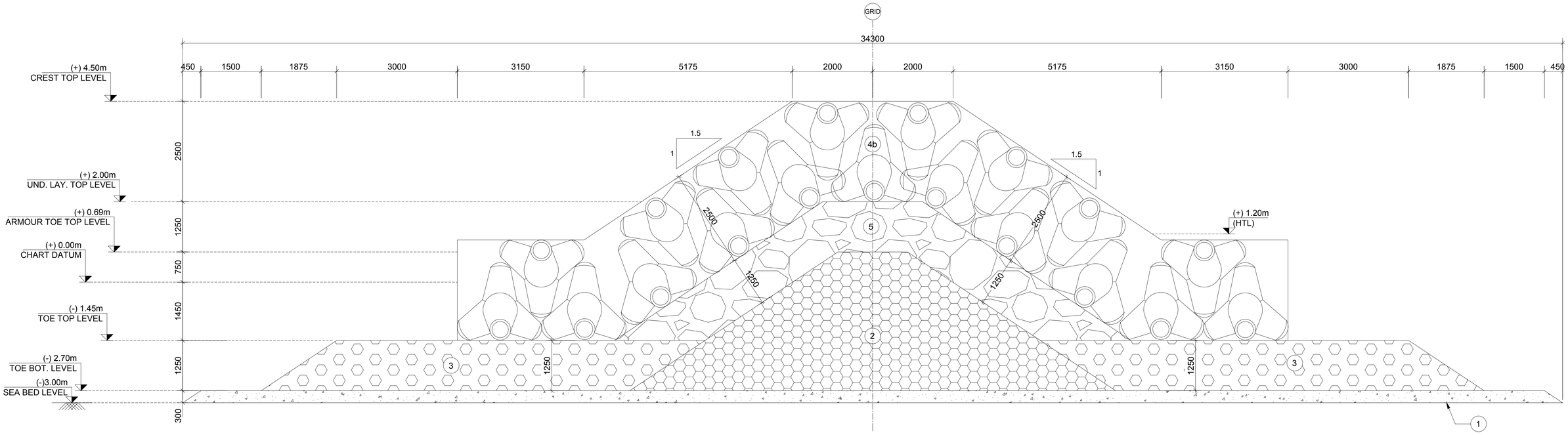
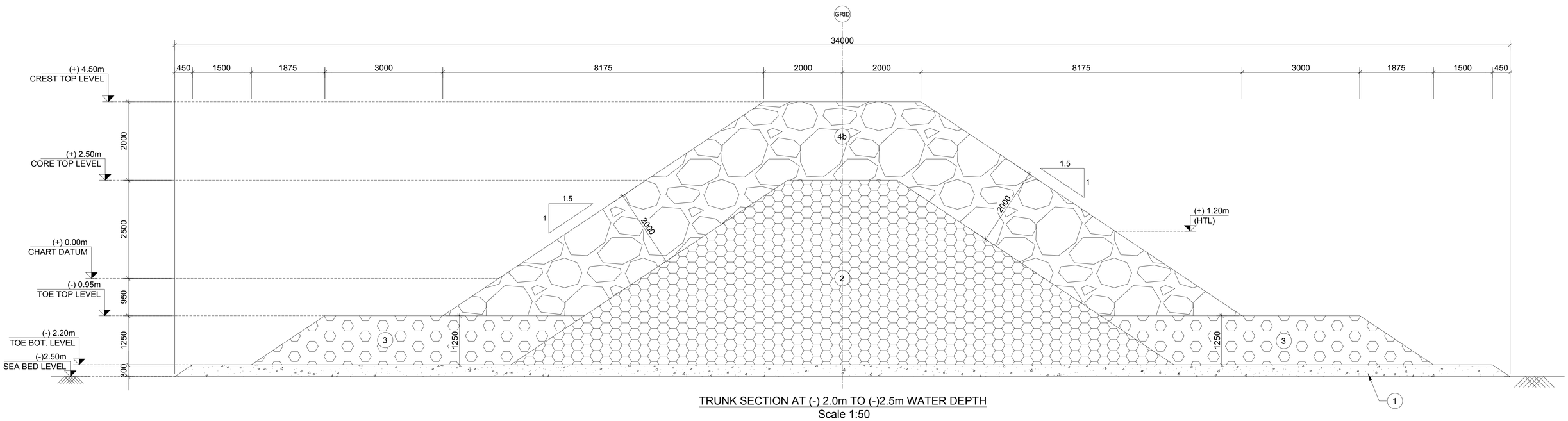


TRUNK SECTION AT (-) 2.5m TO (-)3.0m WATER DEPTH
Scale 1:50



TRUNK SECTION AT (-) 2.0m TO (-)2.5m WATER DEPTH
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- 1 - FILTER LAYER 1kg TO 10kg
- 2 - CORE 100kg TO 300kg
- 3 - TOE MOUND 500kg TO 800kg 1.25m Thick
- 4a - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick
- 4b - ARMOUR LAYER, 4.0 Ton Tetrapods 2 layer at 2.50m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- 4d - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- 5 - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- 6 - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KKK-BG-101-01
   b) IITM-KKK-BG-101-02
   c) IITM-KKK-BG-101-03
   d) IITM-KKK-BG-101-04
   e) IITM-KKK-BG-101-05
   f) IITM-KKK-BG-101-06
   g) IITM-KKK-BG-101-07
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KKK-BG-001

358

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (8 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 08
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023
Scale as shown
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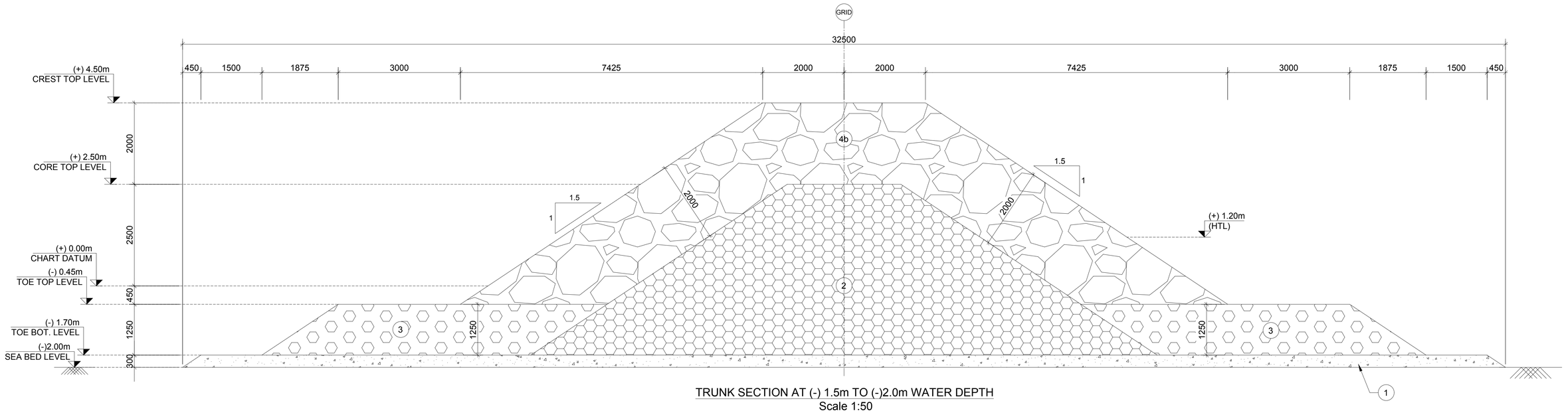
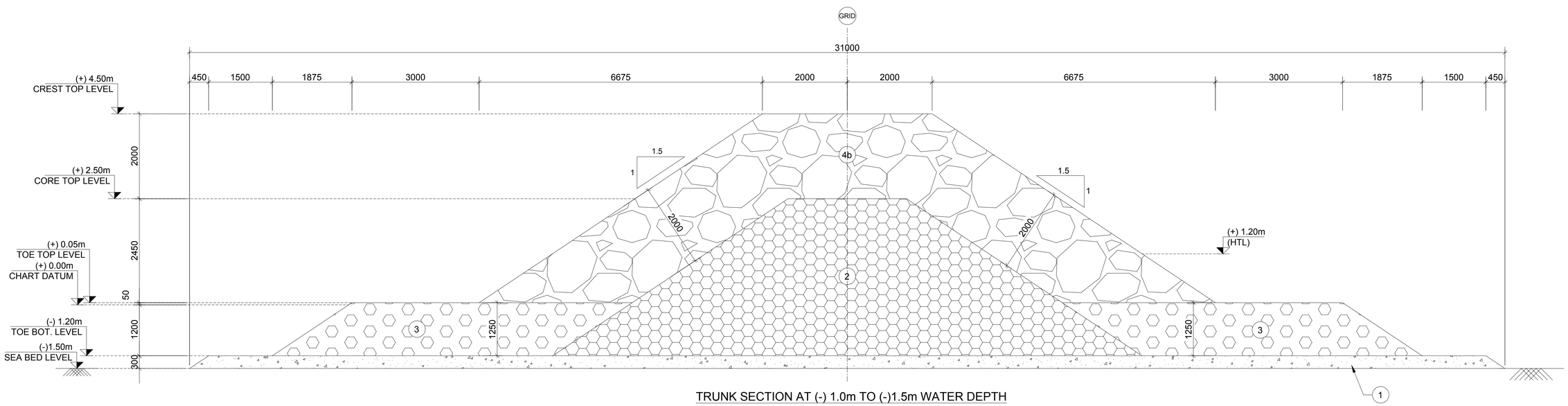


TRUNK SECTION AT (-) 1.5m TO (-)2.0m WATER DEPTH
Scale 1:50



TRUNK SECTION AT (-) 1.0m TO (-)1.5m WATER DEPTH
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- ① - FILTER LAYER 1kg TO 10kg
- ② - CORE 100kg TO 300kg
- ③ - TOE MOUND 500kg TO 800kg 1.25m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- 4d - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- ⑤ - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- ⑥ - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KKK-BG-101-01
   b) IITM-KKK-BG-101-02
   c) IITM-KKK-BG-101-03
   d) IITM-KKK-BG-101-04
   e) IITM-KKK-BG-101-05
   f) IITM-KKK-BG-101-06
   g) IITM-KKK-BG-101-07
   h) IITM-KKK-BG-101-08
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KKK-BG-001

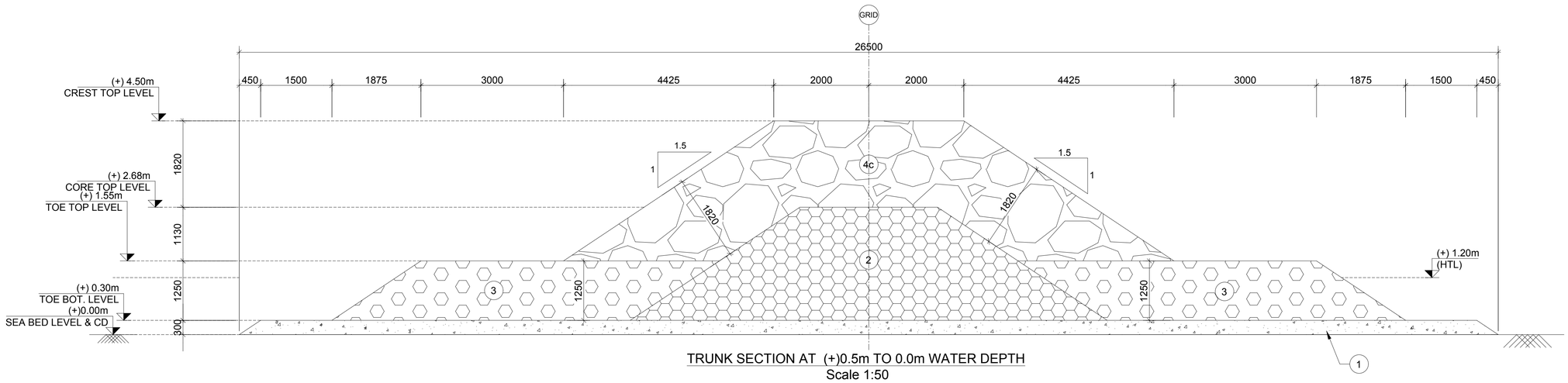
359

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

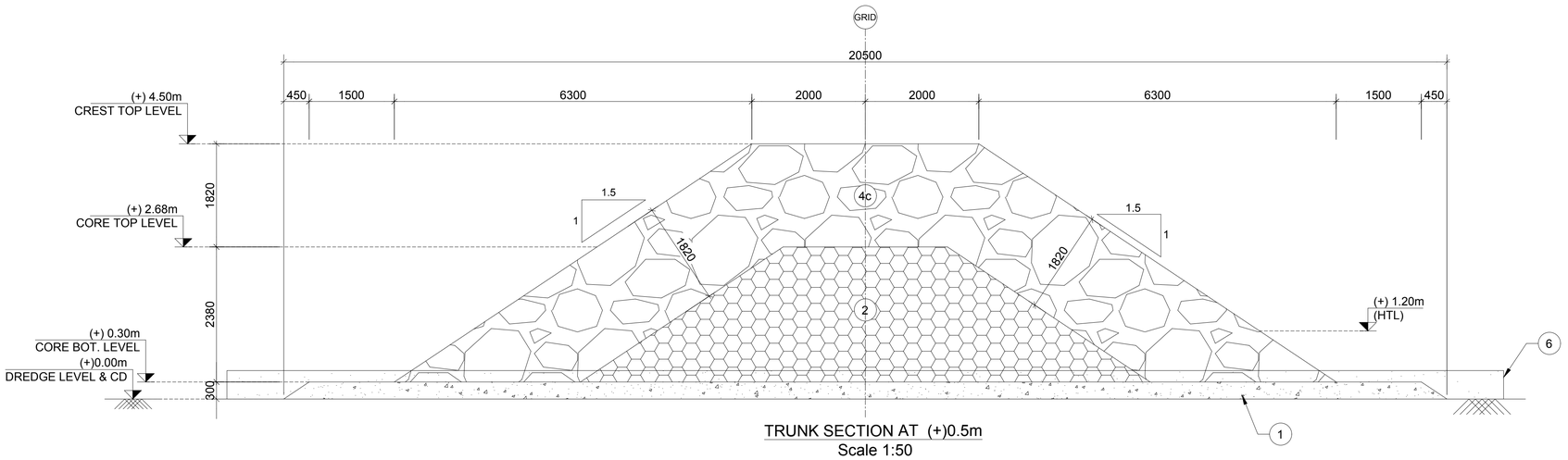
CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (9 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 09
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023
Scale as shown
REV 0



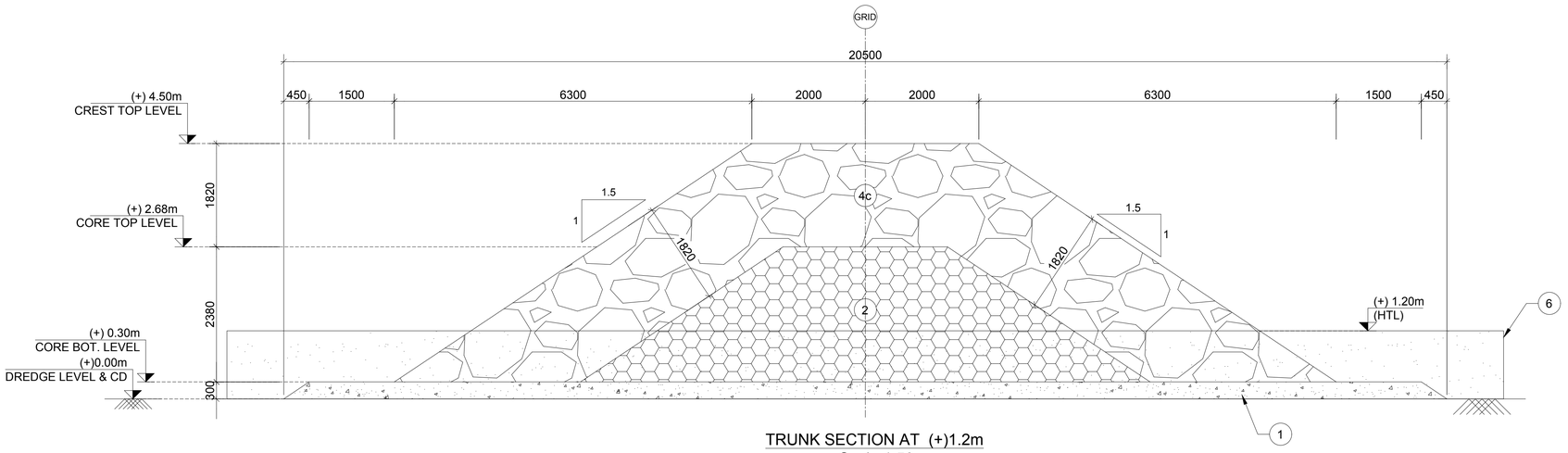
TRUNK SECTION AT (+)0.5m TO 0.0m WATER DEPTH

Scale 1:50



TRUNK SECTION AT (+)0.5m

Scale 1:50



TRUNK SECTION AT (+)1.2m

Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVELS INDICATED ARE IN METERS WITH RESPECT TO CHART DATUM (CD).
3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

- ① - FILTER LAYER 1kg TO 10kg
- ② - CORE 100kg TO 300kg
- ③ - TOE MOUND 500kg TO 800kg 1.25m Thick

LEGEND:-

- 4c - ARMOUR LAYER, 2.5T- 3.5 T Stones 2 layer at 2.00m Thick
- 4d - ARMOUR LAYER, 1.5 T- 2.5 T Stones 2 layer at 1.82m Thick
- ⑤ - UNDER LAYER, 500kg - 800kg Stones 1.25m Thick
- ⑥ - DREDGE AREA

REFERENCE DRAWINGS :-

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-KKK-BG-101-01
b) IITM-KKK-BG-101-02
c) IITM-KKK-BG-101-03
d) IITM-KKK-BG-101-04
e) IITM-KKK-BG-101-05
f) IITM-KKK-BG-101-06
g) IITM-KKK-BG-101-07
h) IITM-KKK-BG-101-08
i) IITM-KKK-BG-101-09

2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:

a) IITM-KKK-BG-001

360

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	09.02.2023	ISSUED FOR CONSTRUCTION	CS	AKE

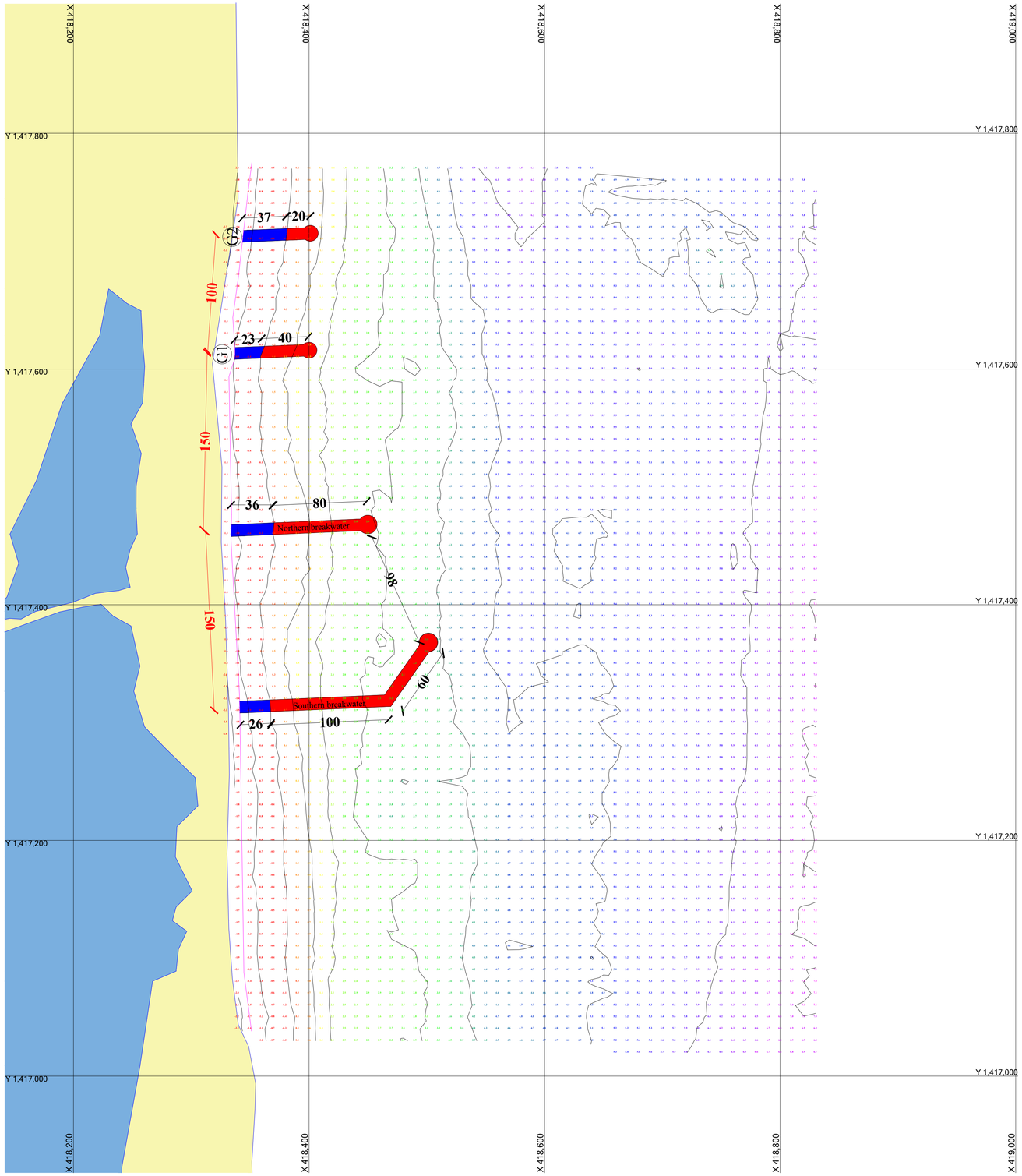
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	CONSTRUCTION OF FISH LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KARIKATTUKUPPAM BREAKWATER AND GROYNE GENERAL ARRANGMENT SHEET (10 OF 10)
DRAWING NO:	IITM - KKK - BG - 101 - 10
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 09.02.2023

Scale as shown

REV 0



NOTES :

BATHYMETRY CHART BY:

LEGEND :

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	09.07.2022	ISSUED FOR CONSTRUCTION	XXX	XXX

361

ORIGINAL SIZE A1

CLIENT:	FISHING HARBOUR PROJECT DIVISION, TAMILNADU
PROJECT:	CONSTRUCTION OF FISHING LANDING CENTRE AND SHORE PROTECTION WORKS INCLUDING BOAT BERTHING FACILITIES AT KARIKATTUKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	BREAKWATER LAYOUT FOR KARIKATTUKUPPAM
DRAWING NO:	1

DATE: 03.07.2022

Scale as shown
REV 0

ENGINEERING FIRM:

Prof.S.A.SANNASIRAJ Prof.V.SUNDAR
DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36