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 - 1)

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Through

Dr. D. Shanmuganathan

Standing Counsel for Tamil Nadu

National Green Tribunal

Southern Zone, Chennai

Date: 28.09.2024

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

Original Application No.136 of 2024(SZ)

In the matter of:

Thiru.K.Saravanan,
Son of Kasinathan,
Aged about 37 years
No. 30, UrurKuppam,
Besant Nagar, Chennai - 90

...Applicant

Versus

1. The Commissioner,
Fisheries and Fishermen welfare Department,
Government of Tamil Nadu
3rd Floor, Integrated Animal Husbandry and Fisheries Building,
Nandanam, Chennai - 600 035

2. The Tamil Nadu Coastal Zone Management Authority
Rep by its Member Secretary
No.1, Jeenis Road, Panagal Building,
Ground Floor, Saidapet, Chennai-600 015

...Respondent(s)

STATUS REPORT FILED ON BEHALF OF 1st RESPONDENT

1. I, Saravanakumar B.E., S/o N.Kanthasamy aged 55, discharging my duties as Executive Engineer, Fishing Harbor Project

Division, Chennai in the office of the Commissioner/Director, Department of Fisheries and Fishermen Welfare, Chennai-35, file the report as:

2. I am the Executive Engineer, Fishing harbor Project Division, Chennai in the office of Commissioner/Director of Fisheries and Fishermen Welfare, Department of Fisheries and Fishermen Welfare, Chennai-35 and I am well acquainted with the facts and circumstances of the case based on the records available. I am authorized to file this report on behalf of the Commissioner/Director of Fisheries and Fishermen Welfare, Department of Fisheries and Fishermen Welfare, Chennai-35 (1st Respondent). I have perused the affidavit filed by the Petitioner in support of the above Original application and I deny each and every averment and allegations contained therein, save those that are specifically admitted herein.

3. It is respectfully submit that the applicant vide para 1 has stated that the, illegal construction of groynes and dumping of rocks along the shore at Thenpattinam, Vadapattinam, Kadalur, Pudhupattinam, Thiruvidanthai and Muthukaadu villages in Chengalpattu District. I respectfully submit that these fishing villages were severely affected by sea erosion (Photographs enclosed). Sea erosion would start (towards the villages) due to seasonal variation and severe wave action. I respectfully submit that the Engineers and Assistant Director of Fisheries and Fishermen Welfare Department

visit the eroded portion of the sea shore area in presence of the fishermen community and prepare a feasibility report and send it to the Indian Institute of Technology, Madras (IIT, M) for preparation of Detailed Project Report regarding Length, Breadth and Height of the Groynes and Length of Sea wall in order to prevent sea erosion.

The experts at the Indian Institute of Technology will inspect the location of the eroded area of Sea shore line and conducted various investigations and Modelling studies such as Wave modelling and Numeric modelling. Based on the test results, the length and height of the Groynes to be used will be provided by them. After receipt of the report of the Indian Institute of Technology, Madras, the detailed estimates will be prepared and send to the Government to obtain the administrative approval from the Government.

Based on the GO, the technical sanction will be obtained from the Chief Engineer, Fisheries and Fishermen Welfare Department, Chennai. Then only the shore protective works will be executed according to the site requirements and as per existing rules and regulations in force. This methodology is quite useful and technically standard one. The ultimate aim is to protect the livelihood of the fishermen and their coastal stretch from erosion. In order to safeguard the fishermen and to protect their fishing villages from erosion in the above villages, the Government of Tamil Nadu has

accorded Administrative Sanction for Providing Shore Protection works and Development/ Improvement of Fishing Landing Centres under National Bank for Agriculture and Rural Development (NABARD) vide G.O.(D) No. 318, Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department dated 13.12.2021 and G.O.(D) No. 250, Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department dated 05.10.2020 sanction for Rs. 74.80 crore for 6 projects comes under Chengalpattu District.

Sl. No	**Name of Work**	**Project Cost (Rs. in crore)**
1	Providing Shore Protection Works and Construction of Fish Landing Centre at Pudhu Nadukuppam in Chengalpattu District	11.00
2	Providing Shore Protection Works and Construction of Fish Landing Centre at Pazhaya Nadukuppam in Chengalpattu District	11.00
3	Construction of Fish Landing Centre and Shore Protection Works at Kadalore Chinnakuppam in Chengalpattu District.	10.00
4	Construction of Fish Landing Centre and Shore Protection Works at Pudhupattinam & Uyyalikuppamin Chengalpattu District.	16.80

5	Construction of Fish Landing Centre and Shore Protection Works at Chemmencherry kuppam in Chengalpattu District.	10.00
6	Construction of Fish Landing Centre and Shore Protection Works including boat berthing facilities at Karikattukuppam in Chengalpattu District.	16.00
	Total	**74.80**

For all the 6 projects, based on the design reports received from the IIT, Madras, the Environmental Impact Assessment (EIA) study were conducted by the consultancy agency, the Coastal Regulation Zone (CRZ) map were prepared by the Indian Remote Sensing (IRS) under Anna University, Chennai. These three reports namely Environmental Impact Assessment (EIA) study report, Coastal Regulation Zone (CRZ) map and IIT design reports were submitted to the District Coastal Zone Management Authority (DCZMA) through Tamil Nadu Pollution Control Board for District level CRZ clearance. All the reports were scrutinized and the District level CRZ meeting has been conducted. The District level CRZ clearance has been obtained from the District Coastal Zone Management Authority (DCZMA) and recommended to State Coastal Zone Management Authority (SCZMA) for state level CRZ clearance. But, in due course of time, an Application No. 04/2013(SZ) with Appeal No.18/2017(SZ) was filed for which the Honorable NGT, Chennai dated:11.04.2022 has iterated the following 2 points:

i) The Shoreline Management Plan (SMP) should be prepared for all the fishing Villages along the coast of Tamil Nadu mentioning erosion, accretion and stabilized beaches. The consultancy service towards preparation of Shoreline Management plan will be finalized by the Department of Environment, Forest and Climate change, Government of Tamil Nadu.

ii) Further stated that, soft solutions may be adopted for shore protection works and Hard structures like Groynes, RMS wall are not allowed. The identification of site specific solutions whether hard structures/Soft structures should be mentioned in the Shoreline Management Plan (SMP).

Based on the NGT order, the State level CRZ authorities have returned the proposal by informing that,

"The approved CZMP shall contain the parameters as listed in the CRZ 2019 Notification including High, Medium and Low erosion stretches for such erosion prone areas. SMP shall be prepared as illustrated by NIOT for such erosion prone areas. We further direct preparation / updation of their SMPs for such identified eroding stretches shown in the CZMPs within six months. Pending preparation/ updation of such SMPs by the Coastal States/UTs, no further hard structures for erosion control be raised or constructed".

But due to severe sea erosion, the fishermen from Kadalore Alikuppam, Kadalore Chinnakuppam, Kadalore Periyakuppam, Angalammankuppam, Pazhaya Nadukuppam and Pudhu Nadukuppam, has protested on Chennai-Pondicherry East Coast Road on 06.02.2023 at Kathankadai busstop by blocking traffic movements, requesting the Government to provide short groynes immediately to protect their villages from erosion.

Inorder to save the fishing villages from severe erosion and to safeguard fishermen and their dwellings, the works were commenced for all the above 6 works.

Inanticipation of CRZ Clearance, only the works were takenup and we have not violated.

4. With regard to the averments made from para 2 & 3 of the affidavit, I respectfully submit that the construction of groynes were properly planned and wisely advised by the reputed institution like Indian Institute of Technology, Madras. Earlier, groynes were laid in perpendicular to sea shore at equal distances. Nowadays, based on the design report of IITM, the advance method is being followed wherein the groyne at central point is longest and other groynes placed on either side of south and north of coastal villages are gradually smaller. By this method, the energy of the wave is

dissipated and hence the velocity of sea erosion is controlled. Therefore, the wave energy cannot be transformed to any other adjoining coastal villages and further erosion is prevented. This helps to conserve the adjoining coastal villages from the effect of sea erosion. This methodology is highly effective.

5. With regard to the averments made from para 4 of the affidavit, I respectfully submit that the Government has issued orders for preparing the Shoreline Management Plan through National Centre for Coastal Research (NCCR), a unit of National Institute of Ocean Technology (NIOT), Chennai vide G.O. (Ms.) No. 69, Environment, Climate Change & Forests Department, dated 29.03.2023. After a period of 1 year of field visits and surveys, NCCR has submitted the inception report and Shoreline Change Assessment Report along Tamil Nadu Coast. The draft report of the Shoreline Management Plan was submitted by NCCR on 28.03.2024 and the same was circulated to Commissioner of Fisheries & Fishermen Welfare, Department of Tourism, Public Works Department, Water Resources Department and Revenue Administration & Disaster Management Department for their comments and suggestions. Final report and the approval from Government of India are still awaited.

Due to the NGT Verdict, the groynes were not provided until the sea shore starts eroded towards the village and the fishermen staged a protest for indefinite strike if Groynes were not constructed. Practically, NCCR team has to conduct so many surveys all along the coast of Tamil Nadu to finalise the Shoreline management plan which will take years to complete. But until that, the sea erosion will not wait and the livelihood and their belongings will be serious threat. Coastline protection is important but protection of fishermen life and livelihood are much more important. Sea erosion poses an imminent threat to Fishermen life.

6. With regard to the averments made from para 6 of the affidavit, I respectfully submit that due to Global warming and climate change, there has been a considerable sea level rise all over the world, which leads to severe sea erosion all over the coastal stretches mainly during the last five years. Further, due to Seasonal variation and severe waves, the shoreline pattern has been changed drastically and the beach portions were fully eroded. The shoreline was forwarded from the sea and progressed towards the fishermen living area so the fishermen were unable to protect their livelihood, dwellings and also to berth their boats safely. In order to protect the lives of fishermen, their properties and also to restore the beach, the sites were inspected and the study was conducted by the Indian

Institute of Technology, Madras. Based on the design report, the groynes were placed along the coastal stretch of fishermen villages. After the placement of groynes, the shore line was restored towards the sea and the ample amount of sandy beaches were formed. After the placement of groynes only the livelihood of fishermen and their properties were saved and their boats were berthed safely during all the seasons. So the placement of groynes were necessary and mandatory to protect the fishermen and the coastal stretch. Otherwise the fishermen lives will be in utmost danger.

7. With regard to the averments made for para 8 of the affidavit, I respectfully submit that the soft solutions like Geotubes were proposed at Bommaiyarpalayam in Villupuram District. But the fishermen has opposed that the geotubes will not control erosion and they staged an indefinite strike at Bommaiyarplayam ECR. Therefore, hybrid solutions comprising groynes (major portion) and geotubes were proposed and implemented. But the geotubes were prone to wear & tear, sunlight and subjected to damage due to movement of boats. Geotubes will not sustain longer and its inclusion will only escalate the project cost which burdens the government.

Hence, hard solutions were recommended by the IIT Madras. For all the 6 projects, by following the rules and regulations, we have placed the proposals before the District level CRZ committee

for CRZ clearance. Based on the records, the District level CRZ committee has recommended to State level CRZ Clearance. Order in OA No. 04/2013(SZ) with Appeal No.18/2017(SZ) was made on 11.04.2022 has insisted that the Shoreline Management Plan (SMP) should be prepared for all the fishing Villages and soft solutions may be adopted for shore protection works. But due to severe sea erosion, the fishermen has protested and requesting the Government to provide groynes immediately to protect their livelihood and their villages from erosion. Inorder to save the fishing villages from severe erosion and to safeguard fishermen and their dwellings, the works were commenced for all the above 6 works.

8. Inanticipation of CRZ Clearance, only the works were takenup due to the urgent need to protect the shore and the fishing villages. Coastline protection is important but protection of fishermen life and livelihood are much more important. The works were commenced by following all the necessary procedures. The Fisheries and Fishermen Welfare Department is taking necessary and required steps in order to protect the fishermen and their belongings as well as to mitigate the sea erosion by adopting suitable advanced methodology.

In view of the reasons and circumstances stated above, I prayed that this Hon'ble Tribunal may be pleased to accept this Status Report and pass such further other orders which it deems fit to the case and thus render justice.

Signature

Executive Engineer
Fishing Harbour Project Division
Chennai.

Date: 07.08.2024

VERIFICATION

I, Saravanakumar B.E., S/o N.Kanthasamy aged 55, presently discharging my duties as the Executive Engineer, Fishing Harbor Project Division, Chennai in the office of the Commissioner/Director, Department of Fisheries and Fishermen Welfare, Chennai-35, Solemnly affirm that the contents of this Report are true to the best of my knowledge based on the records and I have not suppressed any facts.

Signature

Executive Engineer
Fishing Harbour Project Division
Chennai.

Date: 07.08.2024

ABSTRACT

Fisheries and Fishermen Welfare – Announcements 2021-22 - Construction of Fish Landing Centres and Development / improvements to Fish Landing Centres at various fishing villages in 7 Districts of Tamil Nadu with the financial assistance from National Bank for Agriculture and Rural Development under RIDF-XXVII – Administrative Approval – Orders - Issued.

Animal Husbandry, Dairying, Fisheries and Fishermen Welfare
(FS-1) Department

G.O.(D).No.318 Dated 13.12.2021

பிலவ வருடம், கார்த்திகை – 27

திருவள்ளுவர் ஆண்டு – 2052

Read:

1. Announcements made by the Hon'ble Minister (Fisheries-Fishermen Welfare and Animal Husbandry) dated 28.08.2021.
2. From the Commissioner of Fisheries letter Rc. No.17588/C3/2019, dated 06.07.2021.
3. Government letter No.30854/Fin(Res.II)/2021-1, Finance Department, dated 29.07.2021.
4. From the Deputy General Manager, National Bank for Agriculture and Rural Development, Chennai, Letter No.NB.TN.SPD/572/RIDF-6/RIDF-XXVII/2021-22, dated 02.11.2021.

ORDER:

While moving the Demand for Fisheries and Fishermen Welfare and Animal Husbandry Department held during the Budget Session 2021-2022 on 28.08.2021 in the Tamil Nadu Legislative Assembly, the Hon'ble Minister for Fisheries-Fishermen Welfare and Animal Husbandry has made the following Announcements:-

வ. எண்.	அறிவிப்பு எண்.	அறிவிப்பு
1.	(7)	செங்கல்பட்டு மாவட்டம் கொக்கிலமேடு, கடலூர் பெரியகுப்பம், கடலூர் சின்னக்குப்பம் மற்றும் கடலூர் ஆளிக்குப்பம் ஆகிய இடங்களில் மொத்தம் 39 கோடி ரூபாய் செலவில் மீன் இறங்குதளங்கள் அமைக்கப்படும்.
2.	(8)	தூத்துக்குடி மாவட்டம் மணப்பாடு கிராமத்தில் 45 கோடி ரூபாய் மதிப்பீட்டில் முகத்துவாரத்தினை நிலைப்படுத்தி மீன் இறங்குதளம் அமைக்கப்படும்.
3.	(9)	தஞ்சாவூர் மாவட்டம், சேதுபாவாசத்திரத்தில் உள்ள மீன் இறங்குதளம் 10 கோடி ரூபாய் மதிப்பீட்டில் மேம்படுத்தப்படும்.
4.	(10)	விழுப்புரம் மாவட்டம் எக்கியார்குப்பம் மீன் இறங்குதளம் மேம்பாட்டு பணிகள் மற்றும் அனுமந்தை கிராமத்தில் புதிய மீன் இறங்குதளம் அமைக்கும் பணிகள் 10 கோடி ரூபாய் மதிப்பீட்டில் மேற்கொள்ளப்படும்.
5.	(11)	தூத்துக்குடி மாவட்டம் அமலி நகர், ஜீவா நகர், ஆலந்தலை, மீனவர் காலனி மற்றும் குலசேகரபட்டிணம் ஆகிய கடலோர கிராமங்களில் மொத்தம் 12 கோடி ரூபாய் மதிப்பீட்டில் புதிய மீன் இறங்குதளங்கள் அமைக்கப்படும்.
6.	(12)	செங்கல்பட்டு மாவட்டம், பழைய நடுக்குப்பம், புது நடுக்குப்பம், அங்காளம்மன்குப்பம், செம்மஞ்சேரிக்குப்பம் மற்றும் கரிகாட்டுக் குப்பம் ஆகிய மீனவ கிராமங்களில் மொத்தம் 57 கோடி ரூபாய் செலவில் மீன் இறங்கு தளங்கள் அமைக்கப்படும்.
7.	(13)	கன்னியாகுமரி மாவட்டம், கேசவன்புத்தன்துறை, கீழமணக்குடி மற்றும் மேலமணக்குடி ஆகிய கடலோர கிராமங்களில் 79 கோடி ரூபாய் மதிப்பீட்டில் நேர்கல் சுவர்களுடன் கூடிய மீன் இறங்குதளங்கள் அமைக்கப்படும்.
8.	(14)	மயிலாடுதுறை மாவட்டம், திருமுல்லைவாசல் மற்றும் புதுகுப்பம் மீனவ கிராமத்தில் மீன் இறங்கு தளம் மேம்படுத்துதல் மற்றும் நேர்கல் சுவர் அமைக்கும் பணிகள் 27 கோடி ரூபாய் செலவில் மேற்கொள்ளப்படும்.
9.	(15)	தூத்துக்குடி மாவட்டம் பெரியதாழை மற்றும் வீரபாண்டியபட்டிணம் ஆகிய கடலோர கிராமங்களில் 14 கோடி ரூபாய் மதிப்பீட்டில் மீன் இறங்குதளங்கள் அமைக்கப்படும்.
10.	(16)	கடலூர் மாவட்டத்தில் வெள்ளார் முகத்துவாரம் நிலைப்படுத்தும் பணி 30 கோடி ரூபாய் மதிப்பீட்டில் மேற்கொள்ளப்படும்.
11.	(17)	கடலூர் மாவட்டம், பெரியகுப்பம், புதுக்குப்பம் மற்றும் சி.புதுப்பேட்டை ஆகிய கடலோர கிராமங்களில் கடல் அரிப்பு தடுப்பு சுவர்களுடன் கூடிய புதிய மீன் இறங்குதளங்கள் 25 கோடி ரூபாய் மதிப்பீட்டில் அமைக்கப்படும்.

12.	(18)	தூத்துக்குடி மாவட்டம், திரேஸ்புரம், சிப்பிகுளம் மற்றும் கீழவைப்பார் ஆகிய கிராமங்களில் உள்ள மீன் இறங்குதளங்கள் 38 கோடி ரூபாய் மதிப்பீட்டில் மேம்படுத்தப்படும்.
13.	(19)	செங்கல்பட்டு மாவட்டம், கோவளம் கிராமத்தில் கிழக்கு பகுதியில் 3 கோடி ரூபாய் மதிப்பீட்டில் மீன் இறங்குதளம் அமைக்கப்படும்.
14.	(20)	கன்னியாகுமரி மாவட்டம், புத்தன்துறை கிராமத்தில் கடல் அரிப்பு தடுப்பு பணிக்காக கூடுதல் நேர்கல் சுவர் 22 கோடி ரூபாய் மதிப்பீட்டில் அமைக்கப்படும்.

2. In order to execute the Announcements made by the Hon'ble Minister for Fisheries-Fishermen Welfare and Animal Husbandry, in the letter second read above, the Commissioner of Fisheries has furnished proposals for 33 works towards construction of Fish Landing Centres and Development / improvements to Fish Landing Centres at various fishing villages in 7 Districts of Tamil Nadu along with the Detailed Project Reports and has requested the Government to accord Administrative sanction at an estimated cost of Rs.411.00 crore under National Bank for Agriculture and Rural Development RIDF-XXVII loan assistance for the year 2021-22.

3. In the letter third read above, the proposals of the 33 works in respect of construction of Fish Landing Centres and Development / improvements to Fish Landing Centres at various fishing villages in 7 Districts of Tamil Nadu at an estimated cost of Rs.411.00 crore have been forwarded to National Bank for Agriculture and Rural Development, for obtaining loan assistance under RIDF-XXVII for the year 2021-22.

4. In the letter fourth read above, the Deputy General Manager, National Bank for Agriculture and Rural Development, Chennai has stated that Project Sanctioning Committee of National Bank for Agriculture and Rural Development in its 195th meeting held on 26.10.2021, had sanctioned an amount of Rs.39045.00 lakh (95% of the total project cost) for the 33 works in respect of construction of Fish Landing Centres and Development / improvements to Fish Landing Centres at various fishing villages in 7 Districts of Tamil Nadu as RIDF loan to Government of Tamil Nadu with the total financial outlay of Rs.41100.00 lakh under RIDF-XXVII for the year 2021-22.

5. The Government, after careful examination, hereby accord Administrative Sanction for Rs.411,00,00,000/- (Rupees four hundred and eleven crore only) (Rs.390.45 crore [95%] NABARD loan + Rs.20.55 crore [5%] State Fund) for 33 works towards construction of Fish Landing Centres and Development / improvements to Fish Landing Centres at

various fishing villages in 7 Districts of Tamil Nadu as annexed to this order under National Bank for Agriculture and Rural Development RIDF-XXVII during the year 2021-22.

6. This order issues with concurrence of the Finance Department vide its U.O.No.233/JS(GKT)/Finance(AHDF&FW)/2021, dated 13.12.2021.

(By Order of the Governor)

T.S. Jawahar
Additional Chief Secretary to Government

To
The Commissioner of Fisheries, Chennai-35.
The Chief Engineer, Fishing Harbour Project Circle, Chennai-35.
The Deputy General Manager,
National Bank for Agriculture and Rural Development, Chennai-34.
The Principal Accountant General (E&RSA), Chennai-18 / By Name.
The Pay and Accounts Officer (South), Chennai-35.
The Resident Audit Officer,
Office of the Principal Accountant General (Audit-I), Chennai-9.

Copy to:
The Finance (AHDF&FW/Res-II) Department, Chennai-9.
The Office of the Hon'ble Chief Minister, Chennai-9.
The Special Personal Assistant to Hon'ble Minister (Finance and Human Resources Management), Chennai-9.
The Special Personal Assistant to Hon'ble Minister (Fisheries-Fishermen Welfare and Animal Husbandry), Chennai-9.
The Private Secretary to the Additional Chief Secretary to Government, Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department, Chennai-9.
Stock file/spare copies.

//Forwarded By Order//

Section Officer 13/12/21

13/12/21

ANNEXURE TO G.O.(D).No.318, Animal Husbandry, Dairying, Fisheries and Fishermen Welfare (FS-1) Department, Dated 13.12.2021

Sl. No.	Announce-ment No.	Name Of the work	Estimate Cost (Rs. in Crore)
1.	(7)	Construction of Fish Landing Centre and Shore Protection Works at Kokilamedu in Chengalpattu District.	10.00
2.		Providing Shore Protection Works and Improvements to Fish Landing Centre at Kadalore Periyakuppam in Chengalpattu District.	9.00
3.		Construction of Fish Landing Centre and Shore Protection Works at Kadalore ChinnaKuppam in Chengalpattu District.	10.00
4.		Construction of Fish Landing Centre and Shore Protection Works at Alikuppam in Chengalpattu District.	10.00
5.	(8)	Providing Permanent Stability of Bar Mouth and Development of Fish Landing Centre at Manapad in Thoothukudi District.	45.00
6.	(9)	Development of Existing Fish Landing Centre at Sethubavachatram in Thanjavur District.	10.00
7.	(10)	Construction of Fish Landing Centre at Ekkiyarkuppam and Anumanthai in Villupuram District	10.00
8.	(11)	Construction of Fish Landing Centre at Jeeva Nagar (Tiruchendur) in Thoothukudi District.	3.00
9.		Construction of Fish Landing Centre at Amali Nagar in Thoothukudi District.	3.00
10.		Construction of Fish Landing Centre at Alanthalai in Thoothukudi District.	2.00
11.		Construction of Fish Landing Centre at Fishermen Colony (Near Thermal - II) in Thoothukudi District.	2.00
12.		Construction of Fish Landing Centre at Kulasekaranpattinam in Thoothukudi District.	2.00

Sl. No.	Announce-ment No.	Name Of the work	Estimate Cost (Rs. in Crore)
13.	(12)	Providing Shore Protection Works and Construction of Fish Landing Centre at PazhayaNadukuppam in Chengalpattu District.	11.00
14.		Providing Shore Protection Works and Construction of Fish Landing Centre at PudhuNadukuppam in Chengalpattu District.	11.00
15.		Construction of Fish Landing Centre and Shore Protection Works at Angalammankuppam in Chengalpattu District.	9.00
16.		Construction of Fish Landing Centre and Shore Protection Works at Chemmencherry kuppam in Chengalpattu District.	10.00
17.		Construction of Fish Landing Centre and Shore Protection Works including boat berthing facilities at Karikattukuppam in Chengalpattu District.	16.00
18.	(13)	Construction of Additional Groynes for Shore protection at Kesavanputhenthurai village in Kanniyakumari District.	20.00
19.		Construction of Fish Landing Centre at Keelamanakudy village in Kanniyakumari District.	29.50
20.		Construction of Fish Landing Centre at Melamanakudy village in Kanniyakumari District.	29.50
21.	(14)	Upgradation of Existing Fish Landing Centre at Thirumullaivasal in Mayiladuthurai District.	18.00
22.		Construction of Short Groynes in Northern side of Poompuhar Fishing Harbour at Puthukuppam village in Mayiladthurai District.	9.00

Sl. No.	Announce-ment No.	Name Of the work	Estimate Cost (Rs. in Crore)
23.	(15)	Providing Infrastructure Facilities at Periyathalai Fish Landing Centre in Thoothukudi District.	9.00
24.		Construction of Fish Landing Centre at Veerapandyanpattinam in Thoothukudi District.	5.00
25.	(16)	Providing Permanent Stability of Vellar Barmouth in Cuddalore District.	30.00
26.	(17)	Construction of Fish Landing Centre and Shore Protection Works at Periyakuppam in Cuddalore District.	12.00
27.		Construction of Fish Landing Centre and Dredging of Approach Channel in Pudhukuppam in Cuddalore District	8.00
28.		Construction of Fish Landing Centre at C.Pudhupettai in Cuddalore District	5.00
29.	(18)	Development of Fish Landing Centre at Sippikulam in Thoothukudi District.	7.00
30.		Development of Fish Landing Centre at Threspuram in Thoothukudi District.	21.00
31.		Development of Fish Landing Centre at Keelavaipar in Thoothukudi District.	10.00
32.	(19)	Improvements to Fish Landing Centre at Kovalam Muslim Village in Chengalpattu District.	3.00
33.	(20)	Construction of Additional Groynes for Shore protection at Puthenthurai village in Kanniyakumari District.	22.00
		TOTAL	**411.00**

T.S. Jawahar
Additional Chief Secretary to Government

//True Copy//

Section Officer 13/12/21

13/12/21

ABSTRACT

Fisheries - Announcement 2020-21 - Construction of Fish Landing Centres and shore protection works, Providing landside facilities and Permanent stability of barmouth under National Bank for Agriculture and Rural Development – RIDF XXVI at a total estimated cost of Rs.133.5858 crore - Administrative Approval - Accorded - Orders – Issued.

Animal Husbandry, Dairying and Fisheries (FS-1) Department

G.O.(D).No.250 Dated 05.10.2020
சார்வரி, புரட்டாசி – 19
திருவள்ளுவர் ஆண்டு – 2051

Read:

1 From the Director of Fisheries Letter Rc.No.9100/ C3/2020, dated 19.05.2020.

2 Government Letter No.17133/Fin(Res.II)/2020-1, Finance Department, Dated 06.08.2020.

3 Government letter No.10053/Fs1/2020-1, Animal Husbandry, Dairying and Fisheries (FS1) Department, dated 18.09.2020.

ORDER:

In the letter first read above, the Director of Fisheries has furnished eleven project proposals at a total estimate cost of Rs.137.90 crore for forwarding to National Bank for Agriculture and Rural Development for funding assistance under RIDF XXVI for the financial year 2020-21.

2. In the letter second read above, the total estimate cost of the eleven proposals restricted to Rs.133.5858 crore and forwarded the proposals to National Bank for Agriculture and Rural Development for funding assistance under RIDF XXVI for the financial year 2020-21 as tabulated below:-

Sl. No	Name of the work	District	Estimate cost (Rs in crore)
1	Construction of Fish Landing Centre at Helen Nagar	Kanniyakumari	14.4813
2	Construction of Fish Landing Centre at Rajakkamangalam		14.3382
3	Construction of Fish Landing Centre at Kottilpadu		9.7280

4	Permanent Stability of Barmouth at Pulicat	Thiruvallur	26.8500
5	Construction of Fish Landing Centre and Shore Protection Works at Pudupattinam and Uyyalikuppam	Kancheepuram	16.8044
6	Construction of Fish Landing Centre and Shore Protection works at Roachma Nagar	Ramanathapuram	9.9115
7	Construction of Fish Landing Centre and Shore Protection Works at Thangachimadam	Thoothukudi	8.9512
8	Construction of Fish Landing Centre and Shore Protection Works at Chinnamedu	Nagapattinam	9.7800
9	Construction of Fish Landing Centre and Shore Protection Works at Koozhaiyar		6.8300
10	Providing landside Facilities at Kodiyampalayam		2.8500
11	Construction of Fish Landing Centre at Thazhankuda	Cuddalore	13.0612
	TOTAL		**133.5858**

3. In the letter third read above, the Revised Estimates worked out to Rs.133.5858 crore for the above eleven projects have been sent to National Bank for Agriculture and Rural Development to be placed before the Project Steering and Sanctioning Committee.

4. The Government, after careful examination, accord administrative approval for Rs.133,58,58,000/- (Rupees one hundred thirty three crore fifty eight lakh and fifty eight thousand only) for the eleven projects tabulated in paragraph 2 above under National Bank for Agriculture and Rural Development RIDF XXVI for the Financial year 2020-21, in order to avoid delay in Tender Process, commencement and implementation of the projects subject to condition that the financial sanction for the above projects shall be given after obtaining approval from National Bank for Agriculture and Rural Development.

5. This order issues with the concurrence of the Finance Department vide its U.O.No.35269/Fin(AHD&F)/2020, dated 05.10.2020.

(By Order of the Governor)

K.GOPAL
Principal Secretary to Government

To
The Director of Fisheries, Chennai-35.
The Chief Engineer, Fishing Harbour Project Circle, Chennai-35.
The Chief General Manager, NABARD, Chennai-34.
The Principal Accountant General (E&RSA), Chennai-18.

The Pay and Accounts Officer (South), Chennai-35.
The Resident Audit Officer,
Office of the Principal Accountant General (G&SSA), Chennai-9.

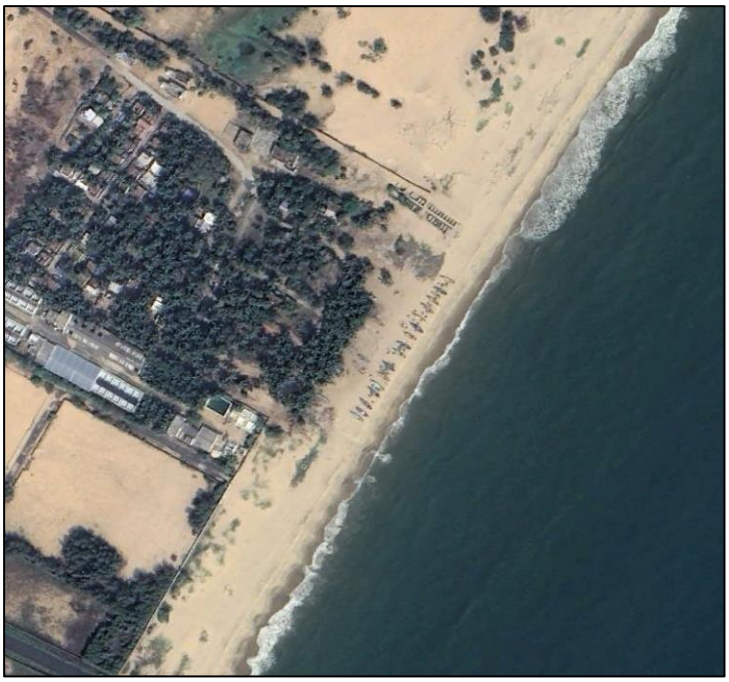
Copy to:
The Office of the Hon'ble Chief Minister, Chennai-9.
The Office of the Hon'ble Deputy Chief Minister, Chennai-9.
The Special Personal Assistant to the Hon'ble Minister (Fisheries, P&AR), Chennai-9.
The Finance (AHD&F/Res.II) Department, Chennai-9.
The Animal Husbandry, Dairying and Fisheries (FSIV) Department, Chennai-9.
The Private Secretary to the Principal Secretary to Government, Animal Husbandry, Dairying and Fisheries Department, Chennai-9.
Stock file / spare copies.

//Forwarded By Order//

05/10/2020
Section Officer

5/10/2020

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



Client

Fisheries Department, Tamilnadu

Consultants

Prof. V.Sundar

Prof. S. A. Sannasiraj

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

August 2022

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1.0 INTRODUCTION

The Fisheries Department, 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 Pudhunadukuppam. The coastal site of the Pudhunadukuppam is located at latitude 12°24'54.57"N and longitude 80°7'19.11"E, Chengalpattu district. Prior to the implementation of preventative measures, the Tamilnadu Fisheries Department conducted a bathymetry and topographical study of the area. The location of Pudhunadukuppam is shown in **Fig.1.**

Fig.1 Location of Pudhunadukuppam 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 groin field suitable for Pudhunadukuppam 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 600 m off the coast of Pudhunadukuppam has been provided by the fisheries department, Tamilnadu the on 9th May 2022 (Surveyed on 15th march 2022) which is shown in **Fig.2**. **Plate *(IITM - PNK - GY – 001)***

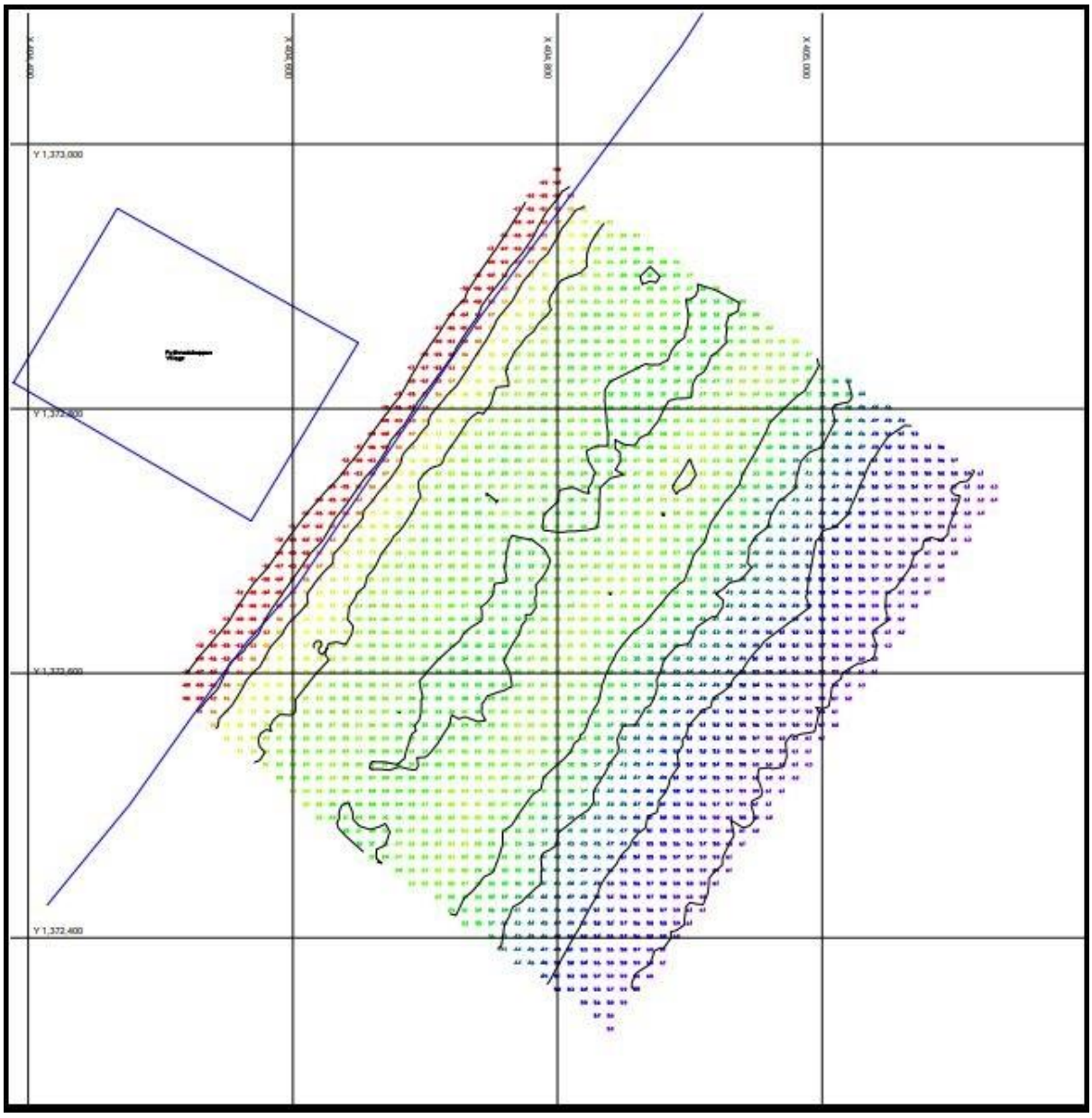


Fig.2 Bathymetry off Pudhunadukuppam stretch provided by fisheries department, Tamilnadu

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°22'30.00"N, 80°15'0.00"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. **Fig.3** represents the annual occurrence of wave climate. It is noticed that the offshore wave climate of Chengalpattu is predominantly from east and south east.

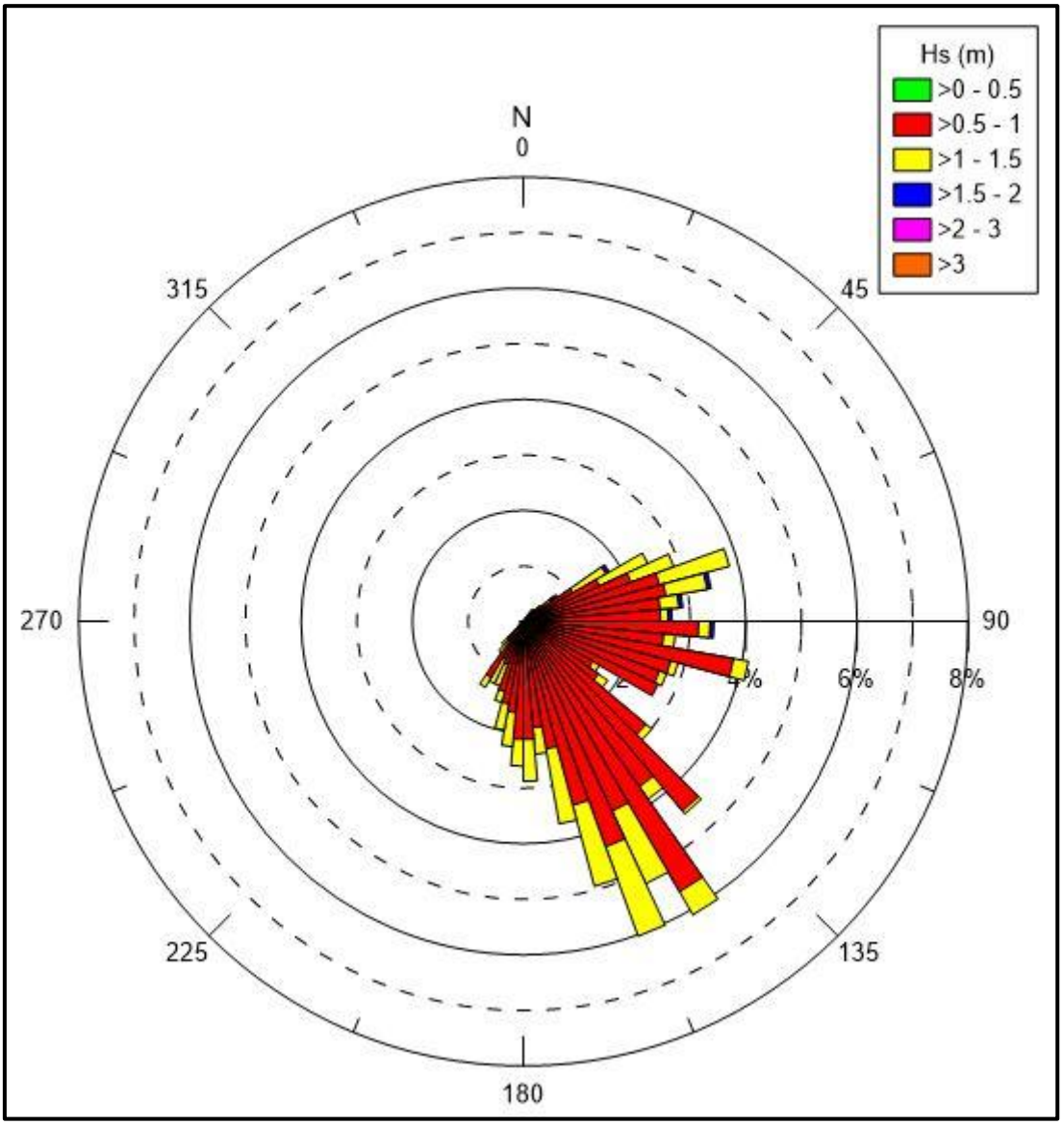


Fig.3 Wave rose diagram representing the significant wave height (m) along the direction for an annual year

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°0'0.00"N, 80°15'0.00"E) and (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 Pudhunadukuppam 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 0.83 m to 1.29 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 march to October, and towards South in January, February, November and December. 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.6** for the different months. It shows that the maximum surf width of about 79 m occurs 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 116267.98m^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(m)	Wave period, T(sec)
1	January	66	0.9	5.3
2	February	93	0.7	5.2
3	March	133	0.8	5.6
4	April	150	0.9	5.2
5	May	149	1.0	5.3
6	June	176	1.1	5.3
7	July	185	0.9	5.3
8	August	168	0.8	6.2
9	September	157	1.0	7.1
10	October	148	1.0	5.6
11	November	104	1.0	6.2
12	December	75	0.9	5.6

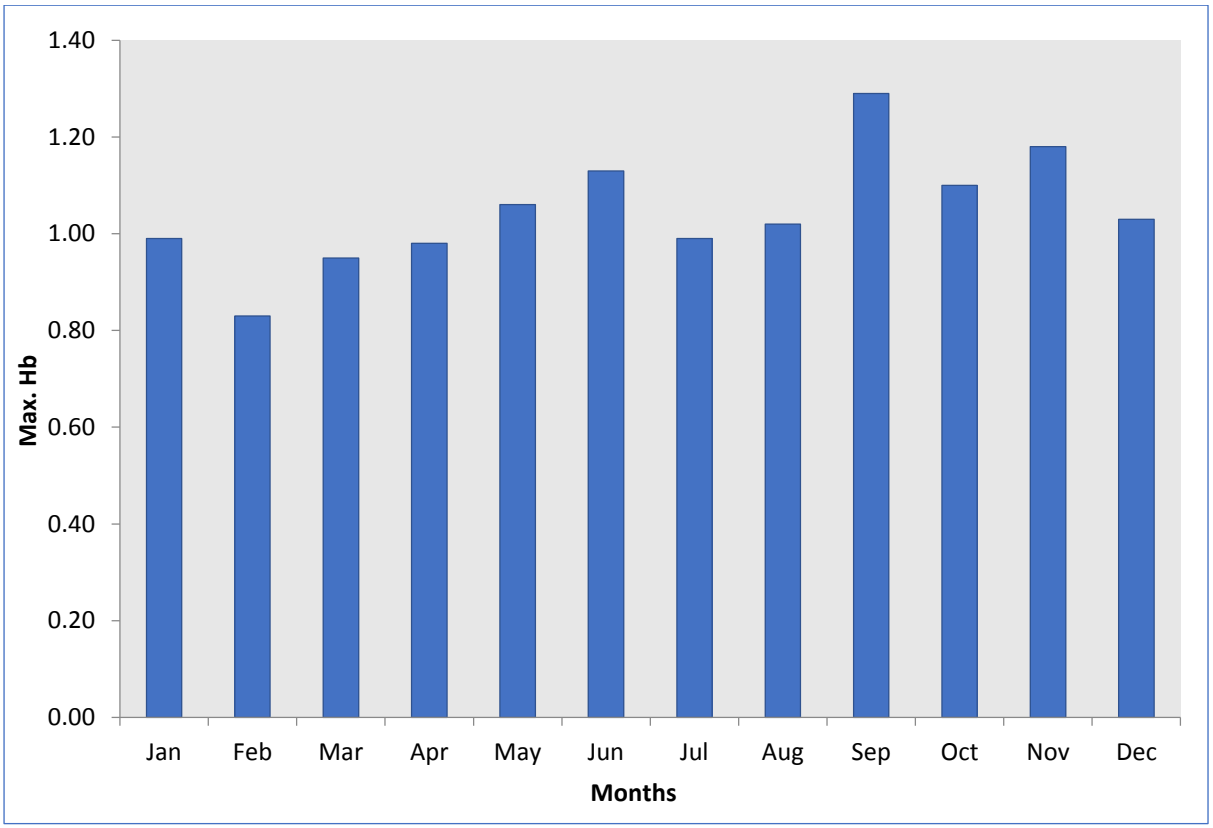


Fig.4 Breaker wave heights in m

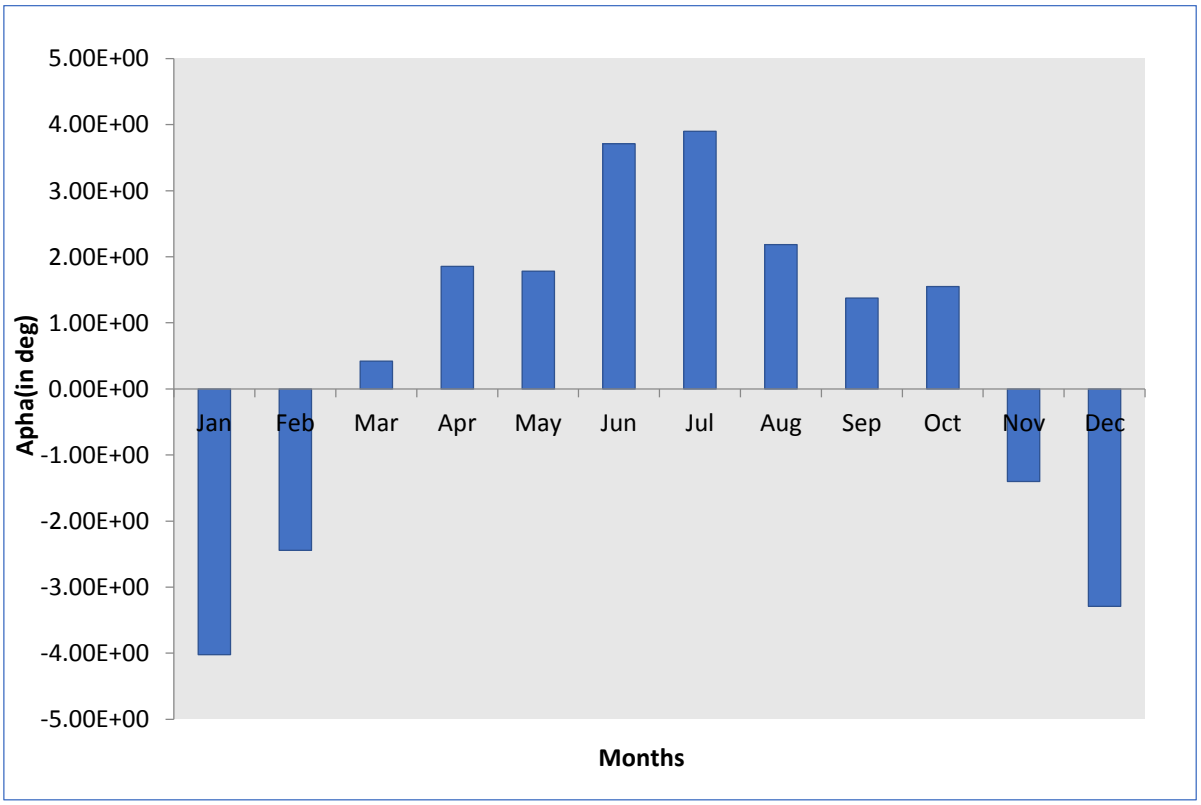


Fig.5 Wave breaker angle

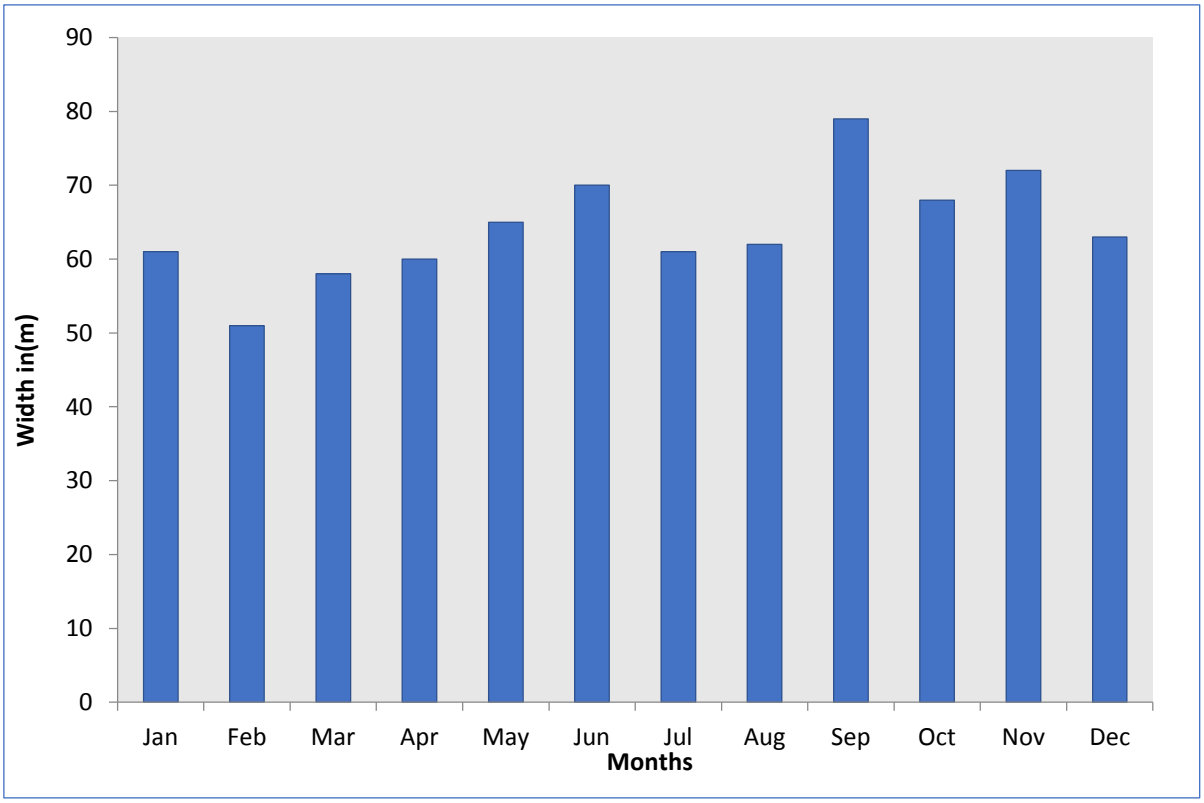


Fig.6 Surf zone width

Table.2 Sediment transport rate (Net Northerly)

Methods	Rate (m^3/year)
Komar	114491.62
CERC	119249.75
Distribution	115062.56

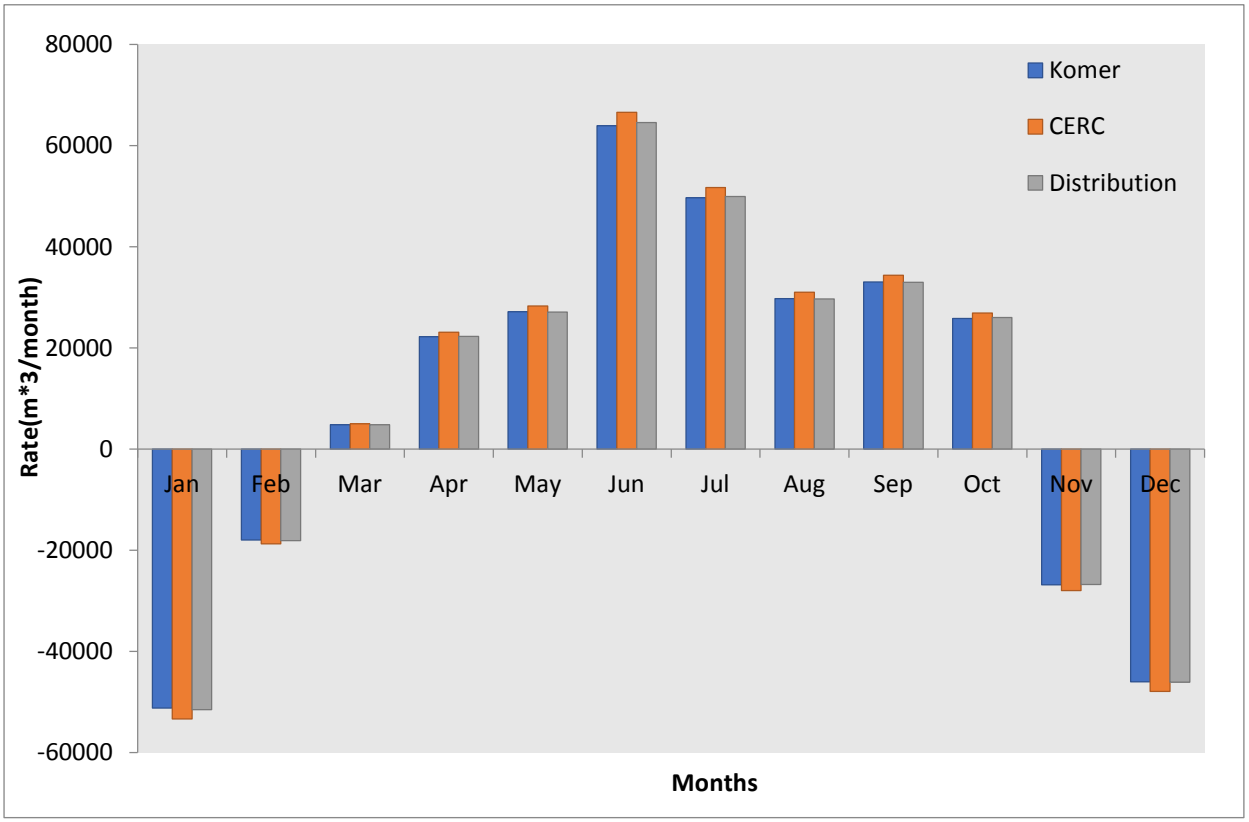


Fig.7 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROINS

A series of 6 transitional groynes have been proposed to protect the coastal stretch (570m) of Pudhunadukuppam. **Fig.8** depicts an overview of the proposed groynes over bathymetry provided by the Tamilnadu fisheries department on 09/05/22, groyne field and **Plate *(IITM - PNK - GY - 101 - 01)*** presents the layout in detail. The groynes, G1, G5, and G6, are each 20 metres long, with G1 and G5 extending up to a water depth of 1.5m and G6 extending to a water depth of 1.3 m. Groyne G2 and G4 each 40m in length will extend up to a water depth of 1.9m and 2.0m respectively, G3 of 80m in length will extend up to a water depth of 2.7m.

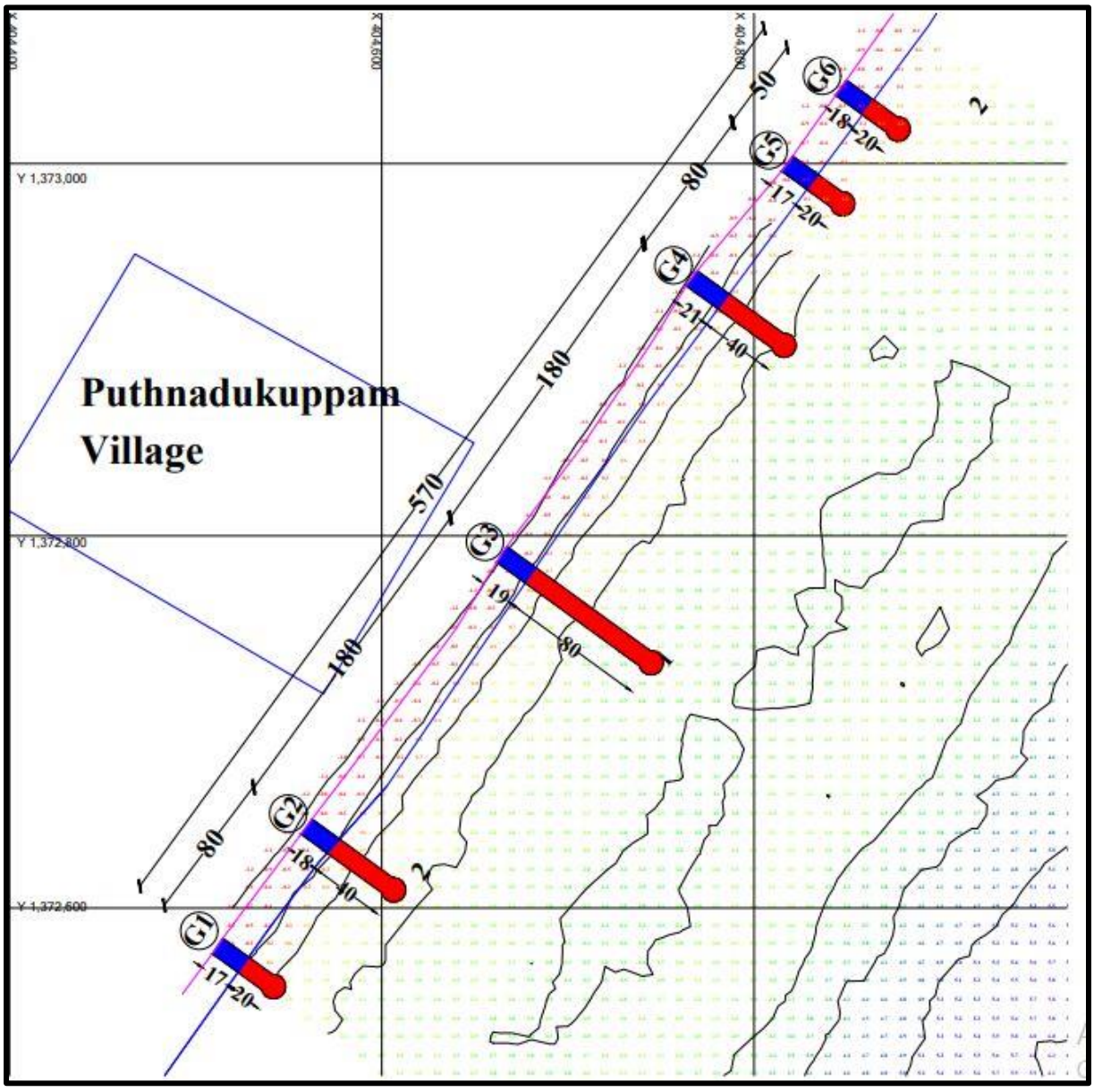


Fig.8 Layout of groin field

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.**

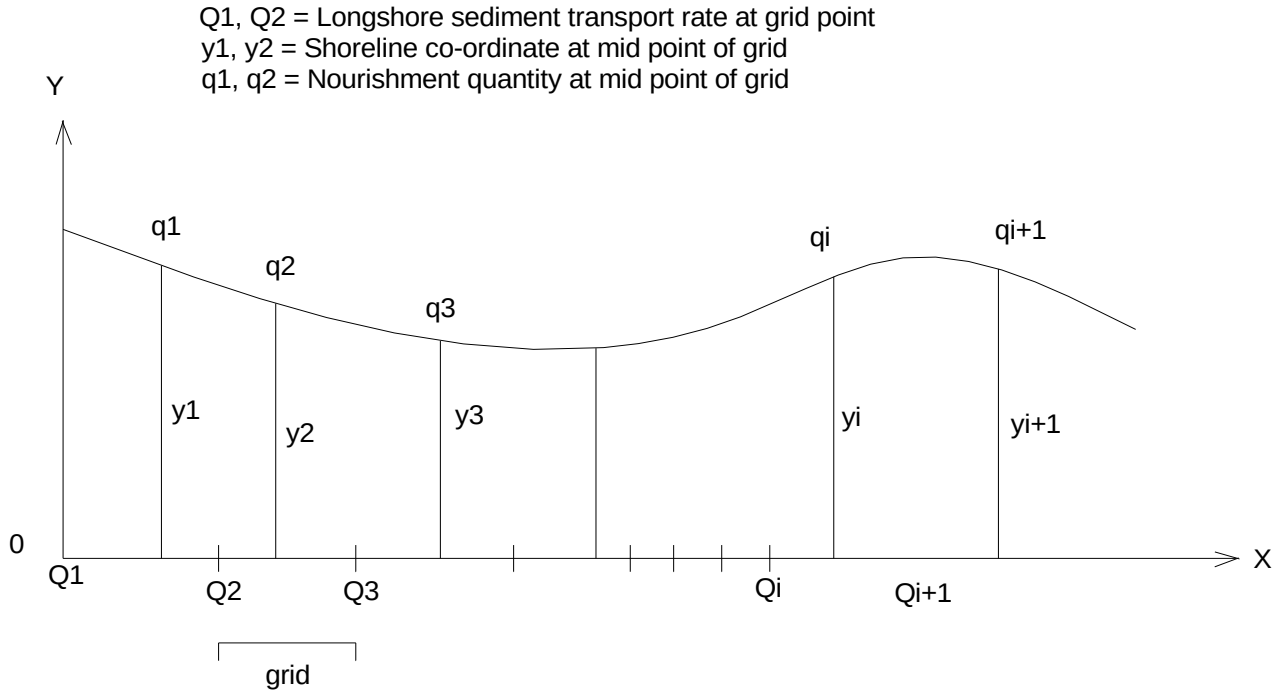


Fig 9. Schematic diagram for finite difference scheme

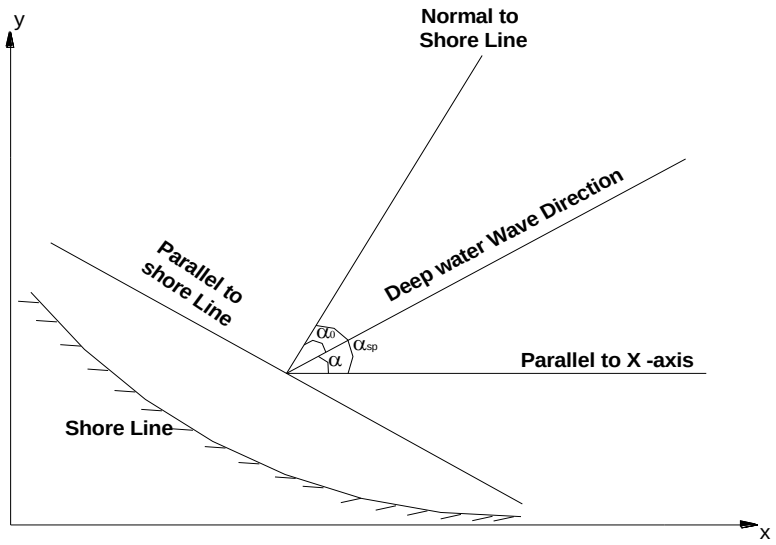


Fig 10. Definition sketch of angles considered

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 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, 5years, 10years, 15 years, 20 years and 25 years after the construction of the groynes and has been presented by superimposing the shoreline patterns.

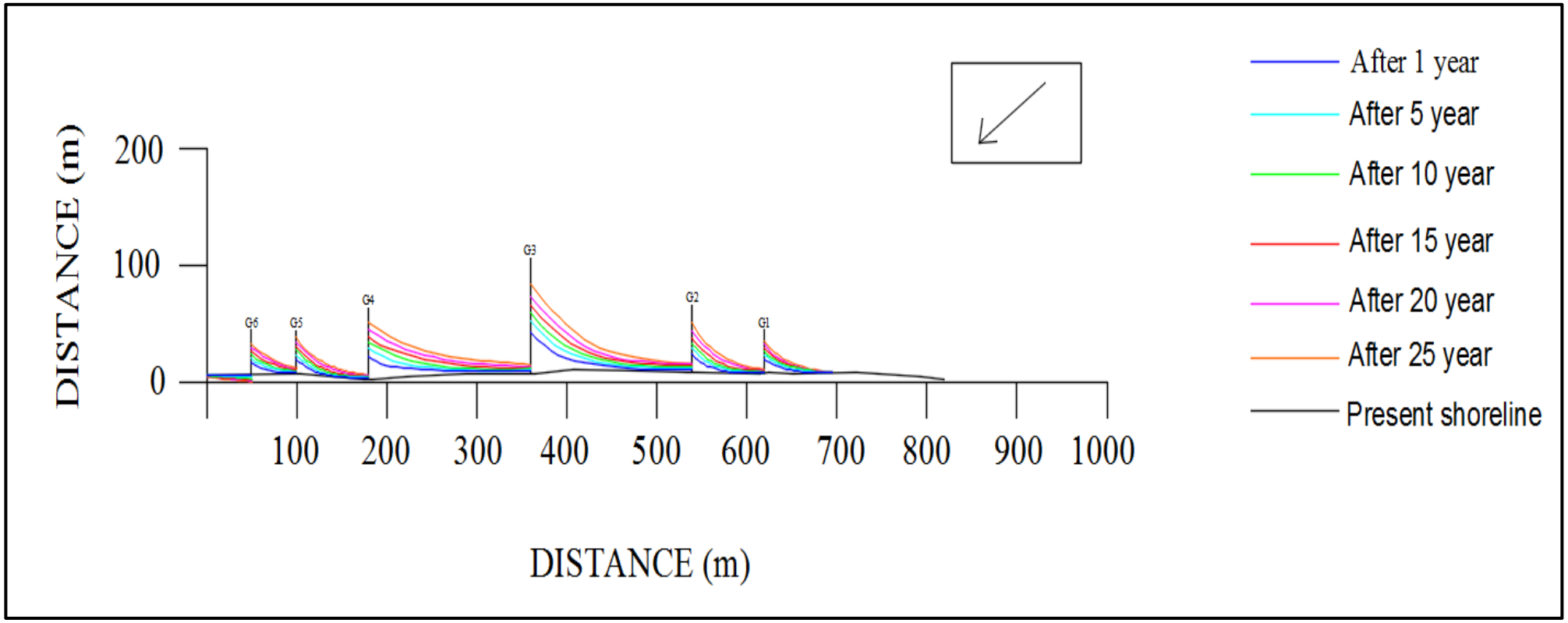


Fig.11 Shoreline evolution

8.0 WAVE MODELLING

8.1 General

The study aims at providing an in-depth analysis on the wave characteristics along the series of groins at Pudhunadukuppam. 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 1.5 km. **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.

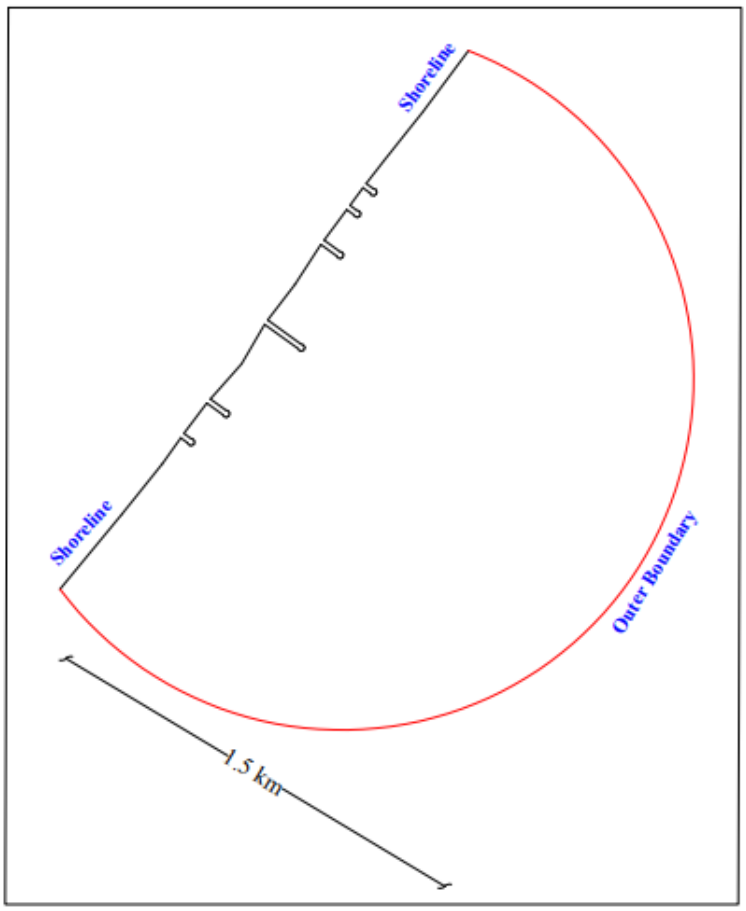


Fig. 12 Computational domain

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 479 nodes with a spacing of 5m and the inner shoreline is modeled by nodes with a spacing of 5m. Then an unstructured mesh is created with an average spacing of 5m inside the domain. This leads to a total number of 41260 nodes with 81688 numbers of triangular elements. The mesh is shown in **Fig. 13.**

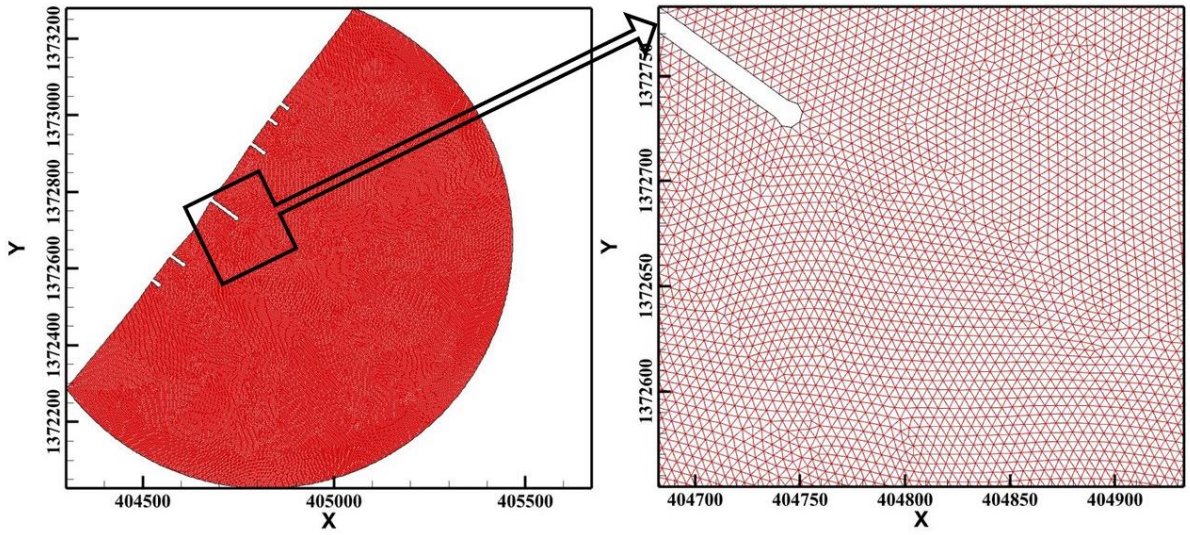


Fig.13 Mesh Structure adopted for the wave propagation modeling

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.

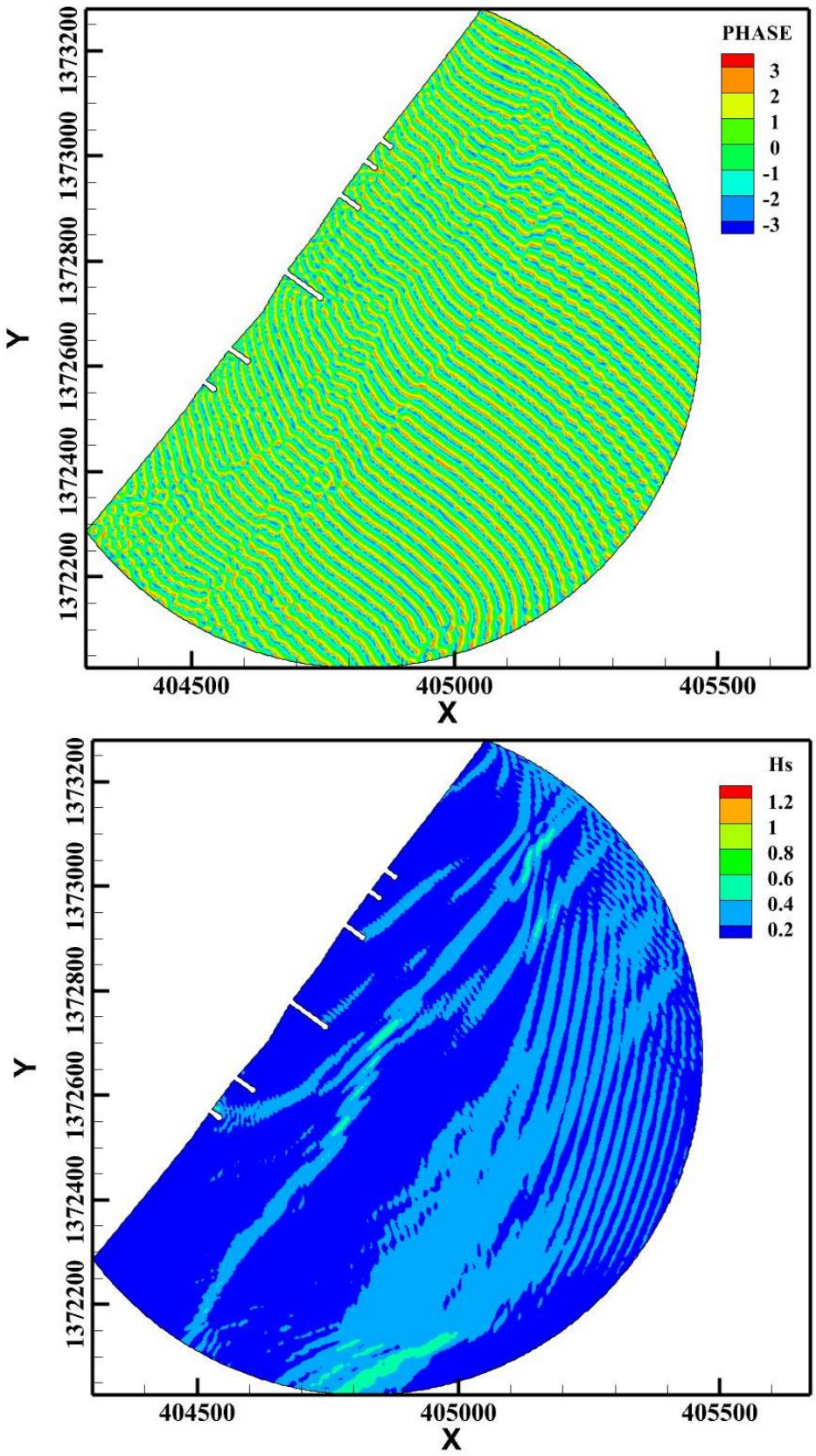


Fig.14 Phase distributions and Wave height distribution for the wave approach angle from 45^0

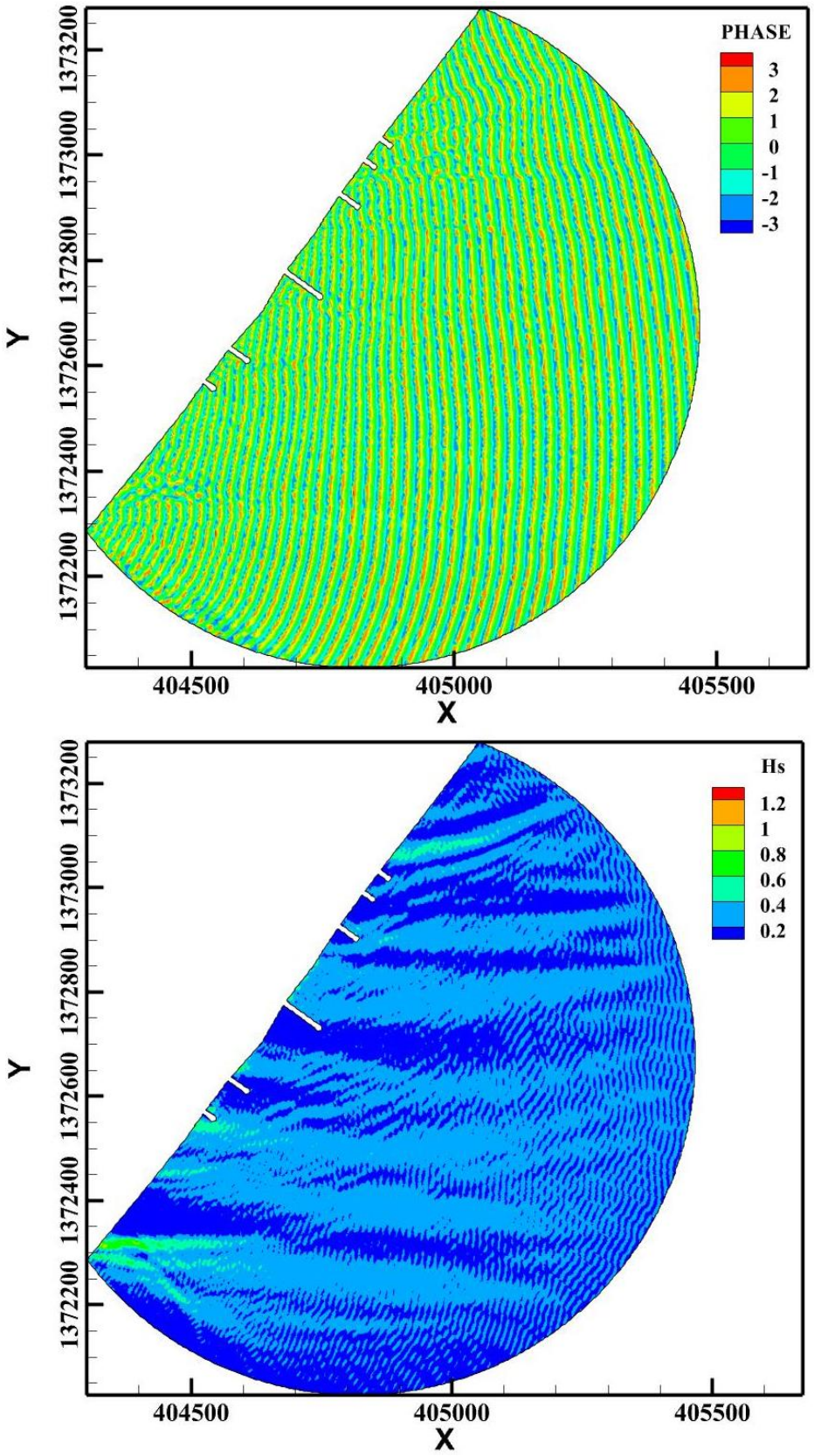


Fig.15 Phase distributions and Wave height distribution for the wave approach angle from 90^0

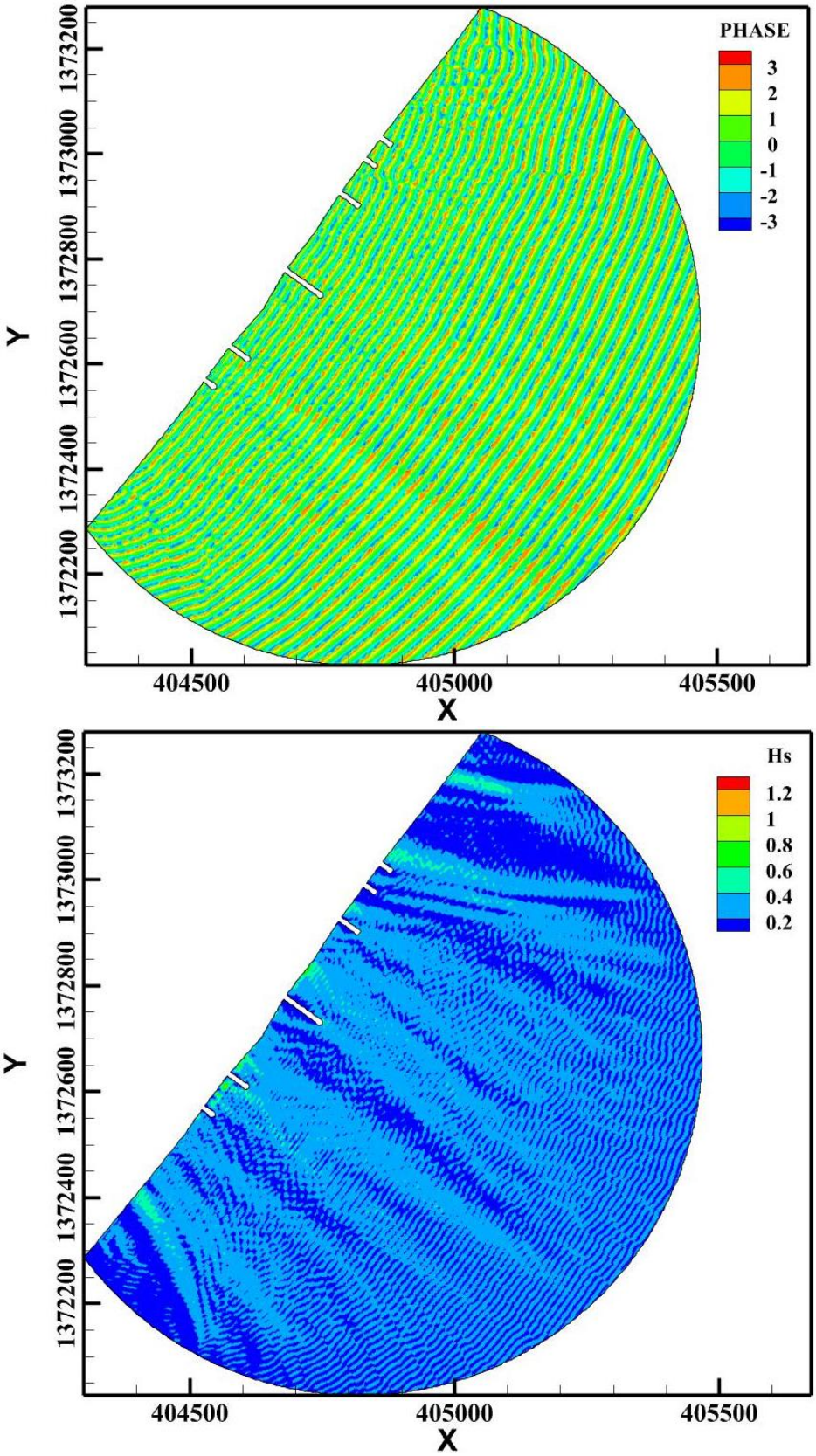


Fig.16 Phase distributions and Wave height distribution for the wave approach angle from 135^0

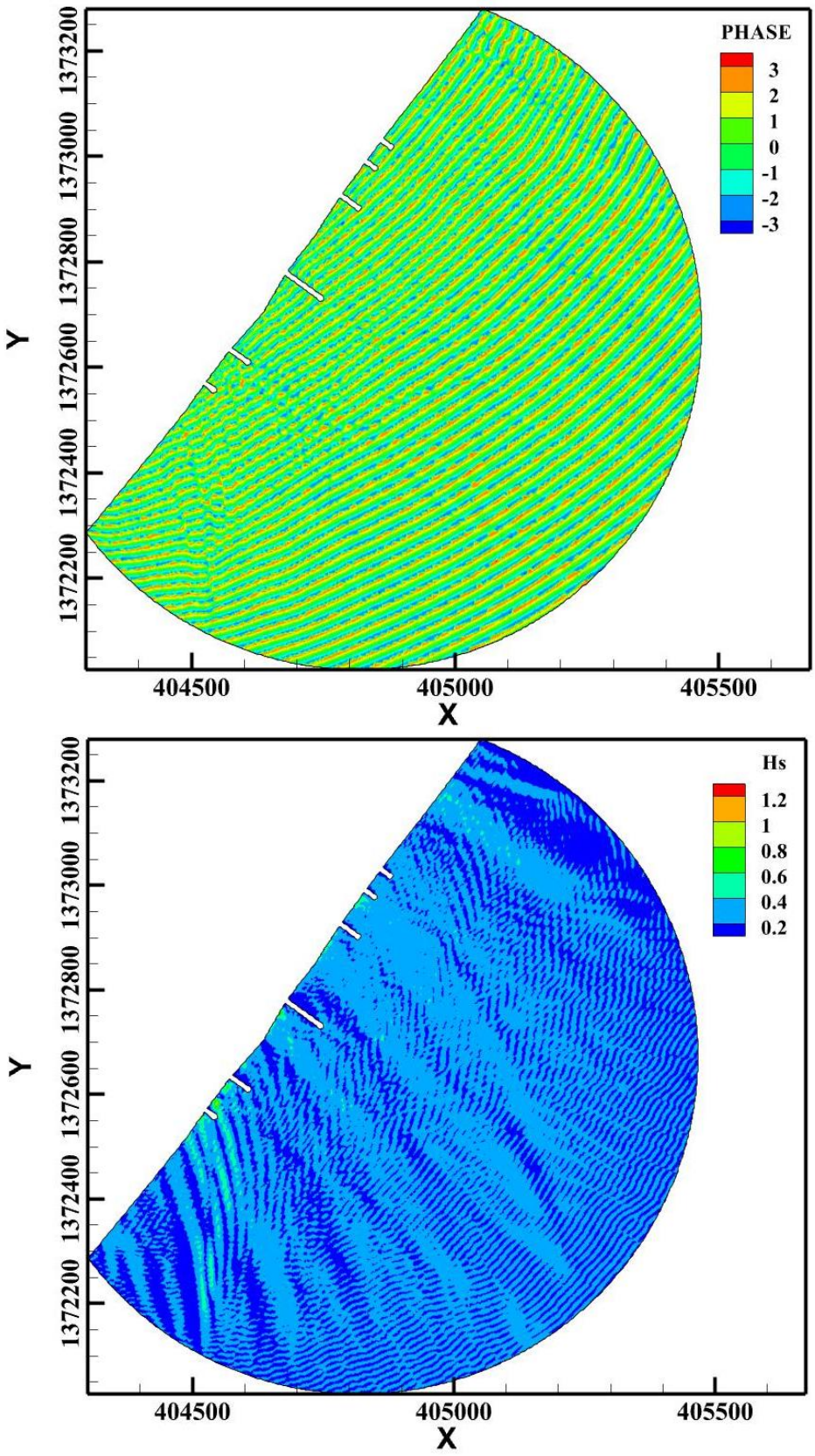


Fig.17 Phase distributions and Wave height distribution for the wave approach angle from 155^0

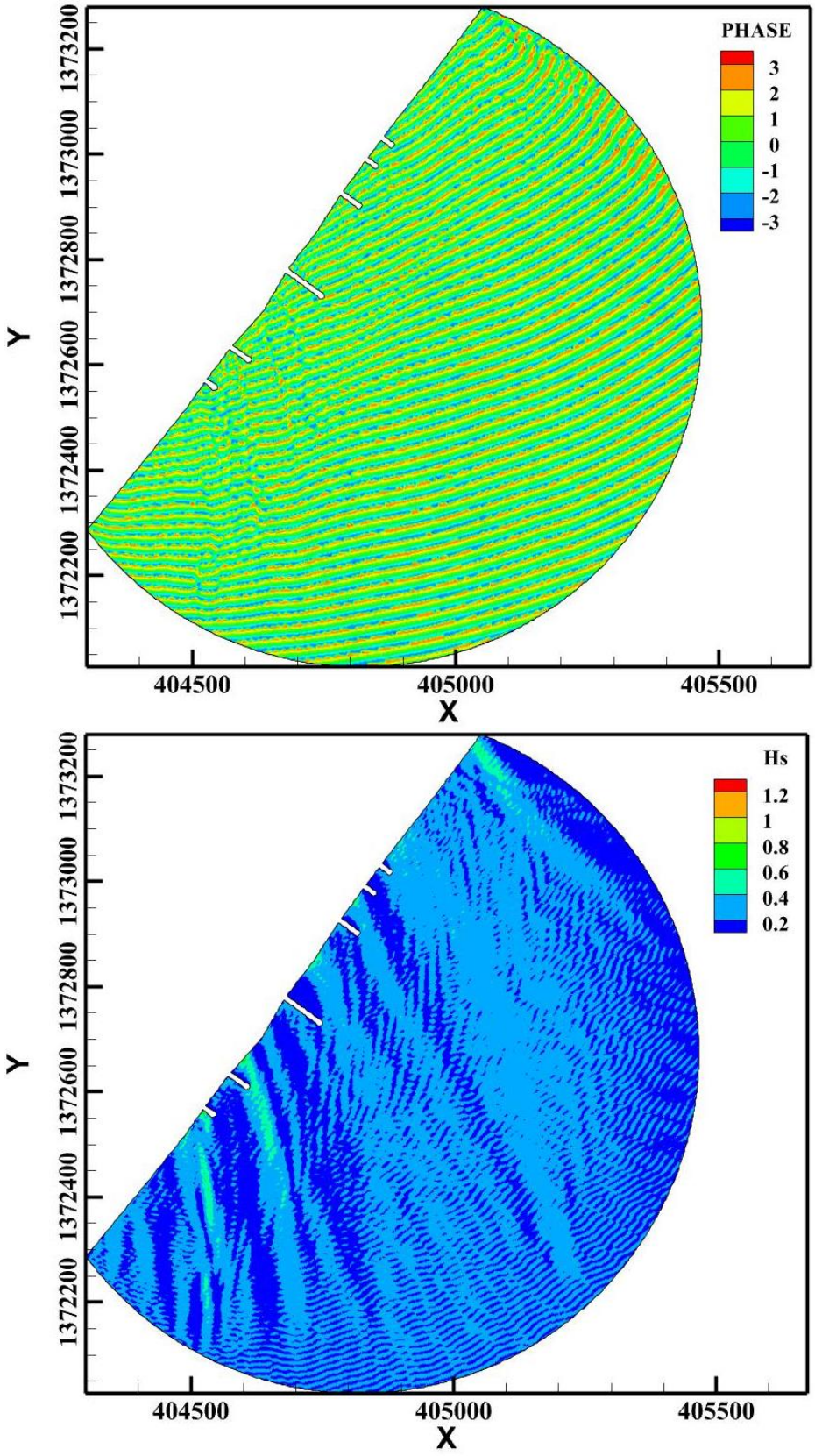


Fig.18 Phase distributions and Wave height distribution for the wave approach angle from 180^0

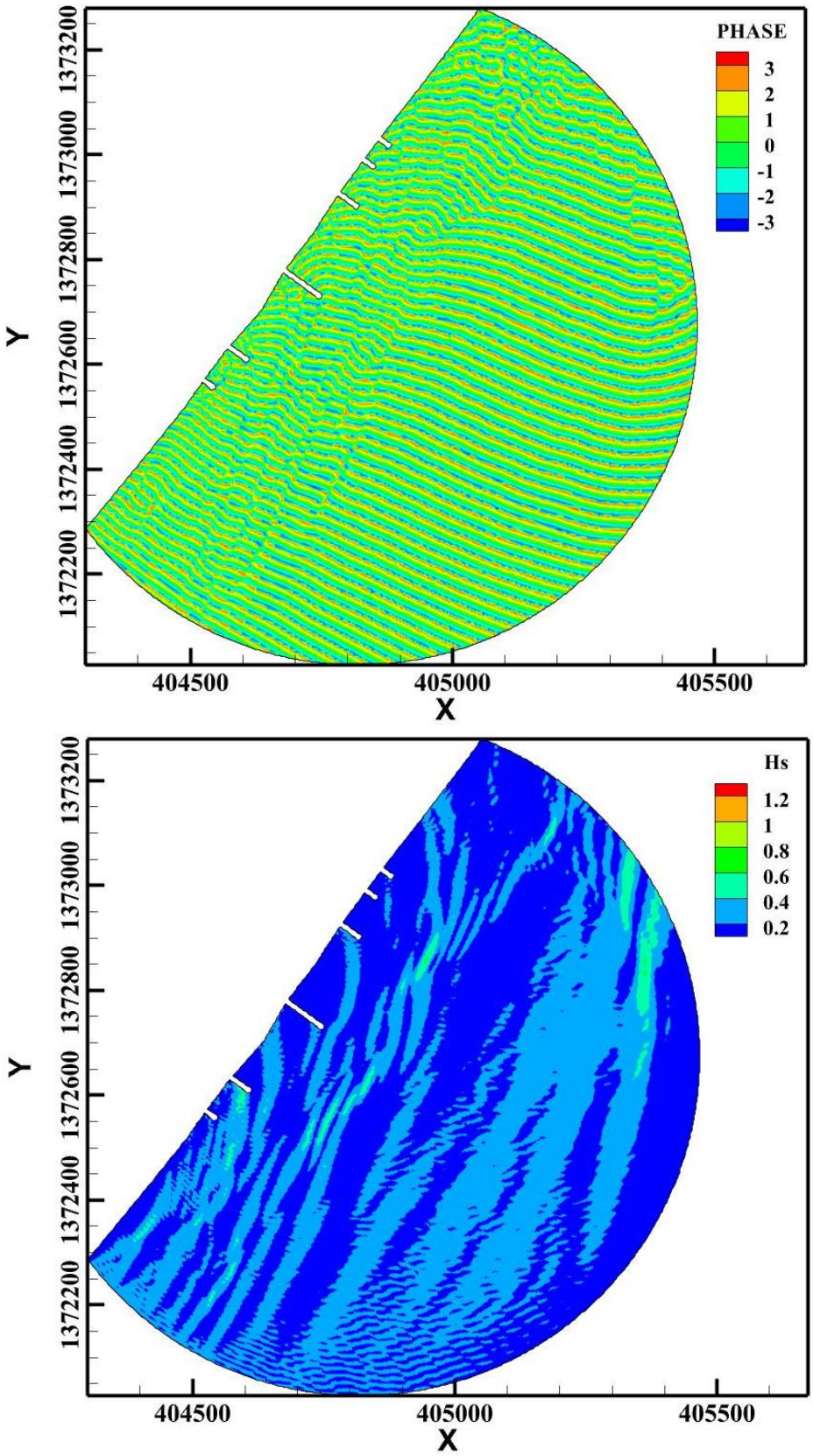


Fig.19 Phase distributions and Wave height distribution for the wave approach angle from 200^0

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

d = 2.7+1.2+0.8= 4.7m

(+) 0.8 is storm surge

Hmax = 0.78 x 4.7

= 3.66 m

Significant wave Height = Hmax /1.6 =2.30 m

Take Design wave height as 2.30 m.

9.2 Design of layers

The following describes a typical groyne design.

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). 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 2.5T to 4T in two layers to withstand the design wave height of 2.30m at the maximum water depth (-) 2.7m 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 = 4m

Crest elevation

The crest elevation of the groynes 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, (+) 4.5m crest elevation is maintained up to +1.2m 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 groin are given in **Plates *(IITM - PNK - GY - 101 - 02) to (IITM - PNK - GY - 101 - 09).***

10.0 BILL OF QUANTITIES

Puthunadukuppam - 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**
0.0 m to (-) 1.0 m	10.00	26.20	18.40	22.30	223.00	156.10	413.67
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 (+) 1.4	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchor	20.50	23.00		23.00	471.50	330.05	874.63
					Total	**Stones**	**2515.94**

Puthunadukuppam - 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**
0.0 m to (-) 1.0 m	10.00	26.90	17.40	22.15	221.50	155.05	410.88
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 (+) 1.4	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**1776.72**

Puthunadukuppam - 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**
0.0 m to (-) 1.0 m	10.00	15.70	14.90	15.30	153.00	107.10	283.82
at 0.0 m	10.00	14.90	14.90	14.90	149.00	104.30	276.40
						Total	**560.21**

Puthunadukuppam - 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**
0.0 m to (-) 1.0 m	10.00	8.70	7.80	8.25	82.50	57.75	153.04
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 (+) 1.4	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**698.41**

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	4.50	11.60	3.00	840.08		
Armour Layer	2.63	7.65	2.56	233.05		
			Total Armour layer		318.69	**844.53**
Toe mound layer						
Toe mound	1.30	17.00	14.60	1020.99		
	1.30	9.70	7.30	296.88		
			Total Toe mound layer		380.16	**1007.41**
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**
20 m	**3360.47**	**2531**	**1568**	**1163**

Puthunadukuppam - G2 (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**
(-) 1.5 m to (-) 1.9 m	11.00	34.60	29.50	32.05	352.55	246.79	653.98
(-) 1.0 m to (-) 1.5 m	11.00	29.50	26.20	27.85	306.35	214.45	568.28
(-) 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	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 (+) 1.4	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchor	16.50	23.00		23.00	379.50	265.65	703.97
					Total	**Stones**	**3534.24**

Puthunadukuppam - G2 (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**
(-) 1.5 m to (-) 1.9 m	11.00	36.60	33.80	35.20	387.20	271.04	718.26
(-) 1.0 m to (-) 1.5 m	11.00	33.80	26.90	30.35	333.85	233.70	619.29
(-) 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	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 (+) 1.4	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**3133.10**

Puthunadukuppam - G2 (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**
(-) 1.5 m to (-) 1.9 m	11.00	16.50	15.70	16.10	177.10	123.97	328.52
(-) 1.0 m to (-) 1.5 m	11.00	15.70	15.70	15.70	172.70	120.89	320.36
(-) 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	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	**1152.33**

Puthunadukuppam - G2 (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**
(-) 1.5 m to (-) 1.9 m	11.00	9.50	9.20	9.35	102.85	72.00	190.79
(-) 1.0 m to (-) 1.5 m	11.00	9.20	8.70	8.95	98.45	68.92	182.62
(-) 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	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 (+) 1.4	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**1066.72**

Head portion (-1.9 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	4.90	12.40	3.00	1025.53		
Armour Layer	2.90	8.00	2.50	273.94		
			Total Armour layer		394.58	**1045.65**
Toe mound layer						
Toe mound	1.30	17.80	15.40	1126.80		
	1.30	10.40	8.00	347.46		
			Total Toe mound layer		409.15	**1084.25**
Core Material	4.10	10.40	2.50	602.55	316.34	**838.29**
Filter Layer	0.30	19.90	19.30	361.91	190.00	**503.50**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**4579.89**	**3971**	**2237**	**1570**

Puthunadukuppam - G3 (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 (-) 2.7 m	24.00	40.30	38.90	39.60	950.40	665.28	1762.99
(-) 2.0 m to (-) 2.5 m	20.00	38.90	35.30	37.10	742.00	519.40	1376.41
(-) 1.5 m to (-) 2.0 m	12.00	35.30	29.50	32.40	388.80	272.16	721.22
(-) 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	6.00	26.20	21.40	23.80	142.80	99.96	264.89
0.0 m to (-) 0.5 m	4.00	21.40	18.40	19.90	79.60	55.72	147.66
at 0.0 m	4.00	18.40	25.90	22.15	88.60	62.02	164.35
0 to (+) 0.5 m	10.00	25.90	25.90	25.90	259.00	181.30	480.45
(+) 0.5 m to (+) 1.4	9.00	25.90	25.90	25.90	233.10	163.17	432.40
shore anchor	20.50	23.00		23.00	471.50	330.05	874.63
					Total	**Stones**	**6741.63**

Puthunadukuppam - G3 (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 (-) 2.7 m	24.00	49.70	46.20	47.95	1150.80	805.56	2134.73
(-) 2.0 m to (-) 2.5 m	20.00	46.20	38.20	42.20	844.00	590.80	1565.62
(-) 1.5 m to (-) 2.0 m	12.00	38.20	33.80	36.00	432.00	302.40	801.36
(-) 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	6.00	26.90	23.10	25.00	150.00	105.00	278.25
0.0 m to (-) 0.5 m	4.00	23.10	17.40	20.25	81.00	56.70	150.26
at 0.0 m	4.00	17.40	17.40	17.40	69.60	48.72	129.11
0 to (+) 0.5 m	10.00	17.40	17.40	17.40	174.00	121.80	322.77
(+) 0.5 m to (+) 1.4	9.00	17.40	17.40	17.40	156.60	109.62	290.49
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**6729.94**

Puthunadukuppam - G3 (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 (-) 2.7 m	24.00	16.50	16.50	16.50	396.00	277.20	734.58
(-) 2.0 m to (-) 2.5 m	20.00	16.50	16.50	16.50	330.00	231.00	612.15
(-) 1.5 m to (-) 2.0 m	12.00	16.50	15.70	16.10	193.20	135.24	358.39
(-) 1.0 m to (-) 1.5 m	10.00	15.70	15.70	15.70	157.00	109.90	291.24
(-) 0.5 m to (-) 1.0 m	6.00	15.70	14.90	15.30	91.80	64.26	170.29
0.0 m to (-) 0.5 m	4.00	14.90	14.90	14.90	59.60	41.72	110.56
at 0.0 m	4.00	14.90	14.90	14.90	59.60	41.72	110.56
						Total	**2387.76**

Puthunadukuppam - G3 (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 (-) 2.7 m	24.00	10.20	10.10	10.15	243.60	170.52	451.88
(-) 2.0 m to (-) 2.5 m	20.00	10.10	9.60	9.85	197.00	137.90	365.44
(-) 1.5 m to (-) 2.0 m	12.00	9.60	9.20	9.40	112.80	78.96	209.24
(-) 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	6.00	8.70	8.30	8.50	51.00	35.70	94.61
0.0 m to (-) 0.5 m	4.00	8.30	7.80	8.05	32.20	22.54	59.73
at 0.0 m	4.00	7.80	6.00	6.90	27.60	19.32	51.20
0 to (+) 0.5 m	10.00	6.00	6.00	6.00	60.00	42.00	111.30
(+) 0.5 m to (+) 1.4	9.00	6.00	6.00	6.00	54.00	37.80	100.17
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**1837.75**

Head portion (-2.7m 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	3.70	9.60	2.50	474.05		
			Total Armour layer		515.08	**1364.97**
Toe mound layer						
Toe mound	1.30	19.35	16.93	1345.44		
	1.30	11.67	9.25	448.61		
			Total Toe mound layer		470.84	1247.72
Core Material	4.80	11.67	2.48	860.52	451.77	**1197.19**
Filter Layer	0.30	21.43	20.85	421.01	221.03	**585.72**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
80 m	**8185.67**	**7927**	**3635**	**2423**

Puthunadukuppam - G4 (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**
(-) 1.5 m to (-) 2.0 m	18.00	35.30	29.50	32.40	583.20	408.24	1081.84
(-) 1.0 m to (-) 1.5 m	8.00	29.50	26.20	27.85	222.80	155.96	413.29
(-) 0.5 m to (-) 1.0 m	6.00	26.20	21.40	23.80	142.80	99.96	264.89
0.0 m to (-) 0.5 m	4.00	21.40	18.40	19.90	79.60	55.72	147.66
at 0.0 m	4.00	18.40	25.90	22.15	88.60	62.02	164.35
0 to (+) 0.5 m	11.00	25.90	25.90	25.90	284.90	199.43	528.49
(+) 0.5 m to (+) 1.4	10.00	25.90	25.90	25.90	259.00	181.30	480.45
shore anchor	20.50	23.00		23.00	471.50	330.05	874.63
					Total	**Stones**	**3955.60**

Puthunadukuppam - G4 (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**
(-) 1.5 m to (-) 2.0 m	18.00	38.20	33.80	36.00	648.00	453.60	1202.04
(-) 1.0 m to (-) 1.5 m	8.00	33.80	26.90	30.35	242.80	169.96	450.39
(-) 0.5 m to (-) 1.0 m	6.00	26.90	23.10	25.00	150.00	105.00	278.25
0.0 m to (-) 0.5 m	4.00	23.10	17.40	20.25	81.00	56.70	150.26
at 0.0 m	4.00	17.40	17.40	17.40	69.60	48.72	129.11
0 to (+) 0.5 m	11.00	17.40	17.40	17.40	191.40	133.98	355.05
(+) 0.5 m to (+) 1.4	10.00	17.40	17.40	17.40	174.00	121.80	322.77
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**3382.22**

Puthunadukuppam - G4 (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**
(-) 1.5 m to (-) 2.0 m	18.00	16.50	15.70	16.10	289.80	202.86	537.58
(-) 1.0 m to (-) 1.5 m	8.00	15.70	15.70	15.70	125.60	87.92	232.99
(-) 0.5 m to (-) 1.0 m	6.00	15.70	14.90	15.30	91.80	64.26	170.29
0.0 m to (-) 0.5 m	4.00	14.90	14.90	14.90	59.60	41.72	110.56
at 0.0 m	4.00	14.90	14.90	14.90	59.60	41.72	110.56
						Total	**1161.97**

Puthunadukuppam - G4 (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**
(-) 1.5 m to (-) 2.0 m	18.00	9.60	9.20	9.40	169.20	118.44	313.87
(-) 1.0 m to (-) 1.5 m	8.00	9.20	8.70	8.95	71.60	50.12	132.82
(-) 0.5 m to (-) 1.0 m	6.00	8.70	8.30	8.50	51.00	35.70	94.61
0.0 m to (-) 0.5 m	4.00	8.30	7.80	8.05	32.20	22.54	59.73
at 0.0 m	4.00	7.80	6.00	6.90	27.60	19.32	51.20
0 to (+) 0.5 m	11.00	6.00	6.00	6.00	66.00	46.20	122.43
(+) 0.5 m to (+) 1.4	10.00	6.00	6.00	6.00	60.00	42.00	111.30
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**1114.11**

Head portion (-2.0 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	5.00	12.60	3.00	1075.76		
Armour Layer	3.00	8.20	2.50	295.13		
			Total Armour layer		409.83	**1086.06**
Toe mound layer						
Toe mound	1.30	18.00	15.60	1154.06		
	1.30	10.60	8.20	362.64		
			Total Toe mound layer		415.49	**1101.06**
Core Material	4.20	10.60	2.50	637.90	334.90	**887.48**
Filter Layer	0.30	20.10	19.50	369.33	193.90	**513.83**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**5041.66**	**4270**	**2263**	**1628**

Puthunadukuppam - G5 (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 (+) 1.4	7.00	25.90	25.90	25.90	181.30	126.91	384.36
shore anchor	20.50	23.00		23.00	471.50	330.05	874.63
					Total	**Stones**	**2570.94**

Puthunadukuppam - G5 (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 (+) 1.4	7.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**1888.30**

Puthunadukuppam - G5 (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**

Puthunadukuppam - G5 (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 (+) 1.4	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**713.71**

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	4.50	11.60	3.00	840.08		
Armour Layer	2.63	7.65	2.56	233.05		
			Total Armour layer		318.69	**844.53**
Toe mound layer						
Toe mound	1.30	17.00	14.60	1020.99		
	1.30	9.70	7.30	296.88		
			Total Toe mound layer		380.16	**1007.41**
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**
20 m	**3367.42**	**2610**	**1568**	**1178**

Puthunadukuppam - 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 (+) 1.4	8.00	25.90	25.90	25.90	207.20	145.04	384.36
shore anchor	20.50	23.00		23.00	471.50	330.05	874.63
					Total	**Stones**	**2570.94**

Puthunadukuppam - 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	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 (+) 1.4	8.00	17.40	17.40	17.40	139.20	97.44	258.22
shore anchor	20.50	13.00		13.00	266.50	186.55	494.36
						Total	**1888.30**

Puthunadukuppam - 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**

Puthunadukuppam - 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 (+) 1.4	8.00	6.00	6.00	6.00	48.00	33.60	89.04
shore anchor	20.50	6.00		6.00	123.00	86.10	228.17
						Total	**724.84**

Head portion (-1.3m water depth)						
SPEIFICATIONS	**h (m)**	**R (m)**	**r (m)**	**VOLUME(m^3)**	**VOLUME INCLUDIG POROSITY (m^3)**	**QUANTITY IN (TONNES)**
Armour Layer						
Armour Layer	3.80	10.30	3.00	580.65		
Armour Layer	1.90	6.30	2.60	124.95		
			Total Armour layer		239.24	**634.00**
Toe mound layer						
Toe mound	1.30	15.70	13.30	860.20		
	1.30	8.70	6.30	231.57		
			Total Toe mound layer		330.03	**874.58**
Core Material	3.20	8.70	2.60	351.91	184.76	**489.60**
Filter Layer	0.30	17.80	17.20	288.52	151.47	**401.40**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3204.93**	**2378**	**1435**	**1126**

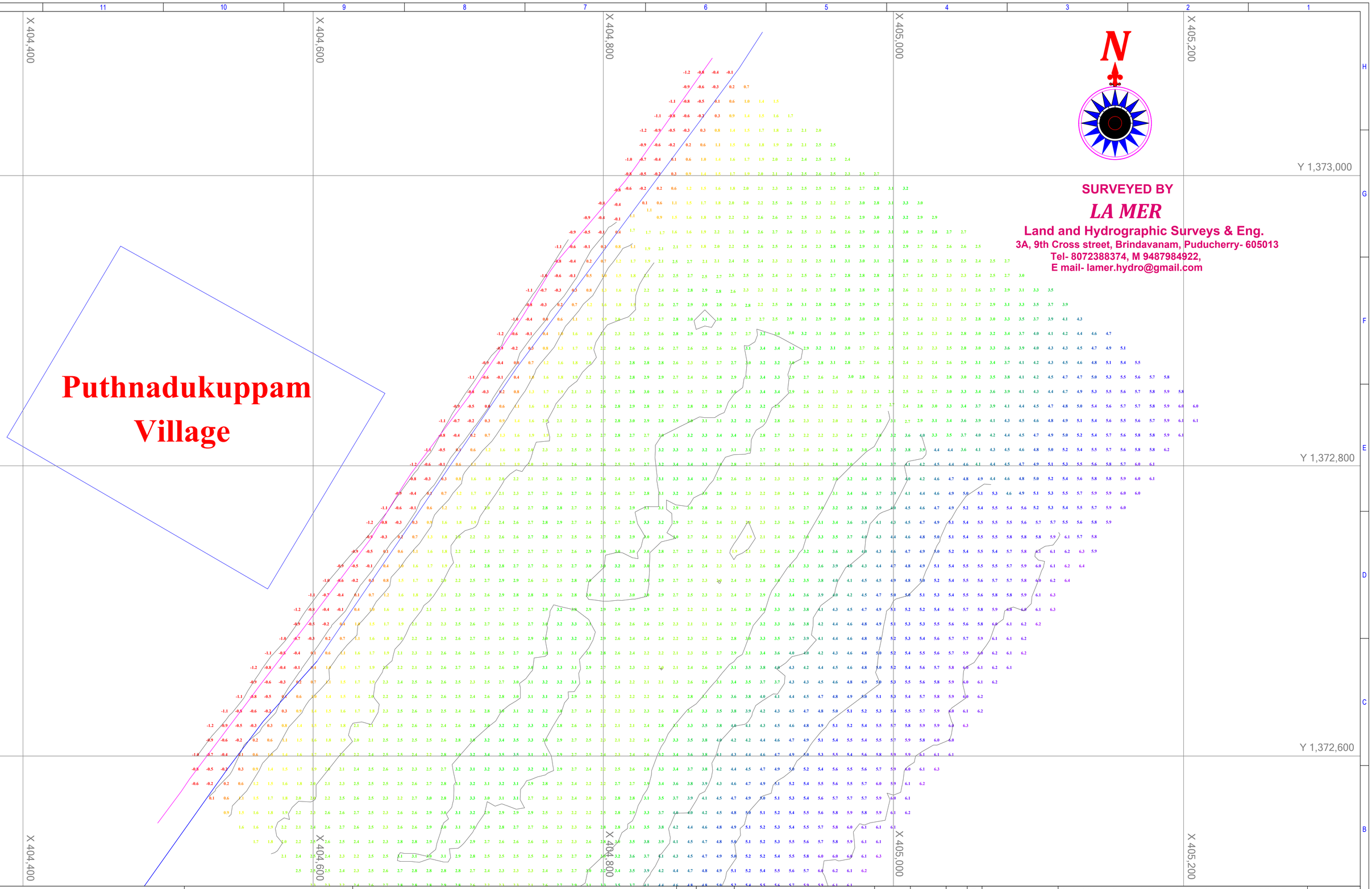
10.1 Total Quantity of Groynes

QUANTITY IN TONNES PUTHUNADUKUPPAM	
GROYNES G1 TO G6	
ARMOUR LAYER (Rubble mound)	27740
CORE LAYER	23688
TOE MOUND LAYER	12706
FILTER LAYER	9089
Total Quantity of Groynes	**73223**

11.0 RECOMMENDATION

A comprehensive study was carried out on arriving at the coastal protection measure for a stretch of 570 m along the coast of Pudhunadukuppam (latitude 12°24'54.57"N and longitude 80° 7'19.11"E), as per the request of The Fisheries Department, Tamilnadu. After deriving the offshore wave climate from the wind climate, the driving forces, breaker wave characteristics were obtained, which were then applied to estimate the longshore sediment characteristics, both its magnitude and direction. The net sediment transport of the study area is estimated to be about 1.16 Lakhs per annum directed towards North. To combat erosion, a transitional groin filed of 6 groynes. The proposed groynes field 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 also the bathymetry. IIT Madras should be informed prior to the commencement of the construction.

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



SURVEYED BY

LA MER

Land and Hydrographic Surveys & Eng.

3A, 9th Cross street, Brindavanam, Puducherry- 605013

Tel- 8072388374, M 9487984922,

E mail- lamer.hydro@gmail.com

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

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	24.08.2022	ISSUED FOR CONSTRUCTION	CS	TR

ORIGINAL SIZE:A1

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

DATE: 24.08.2022

Scale as shown REV 0

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 MARCH 2022.

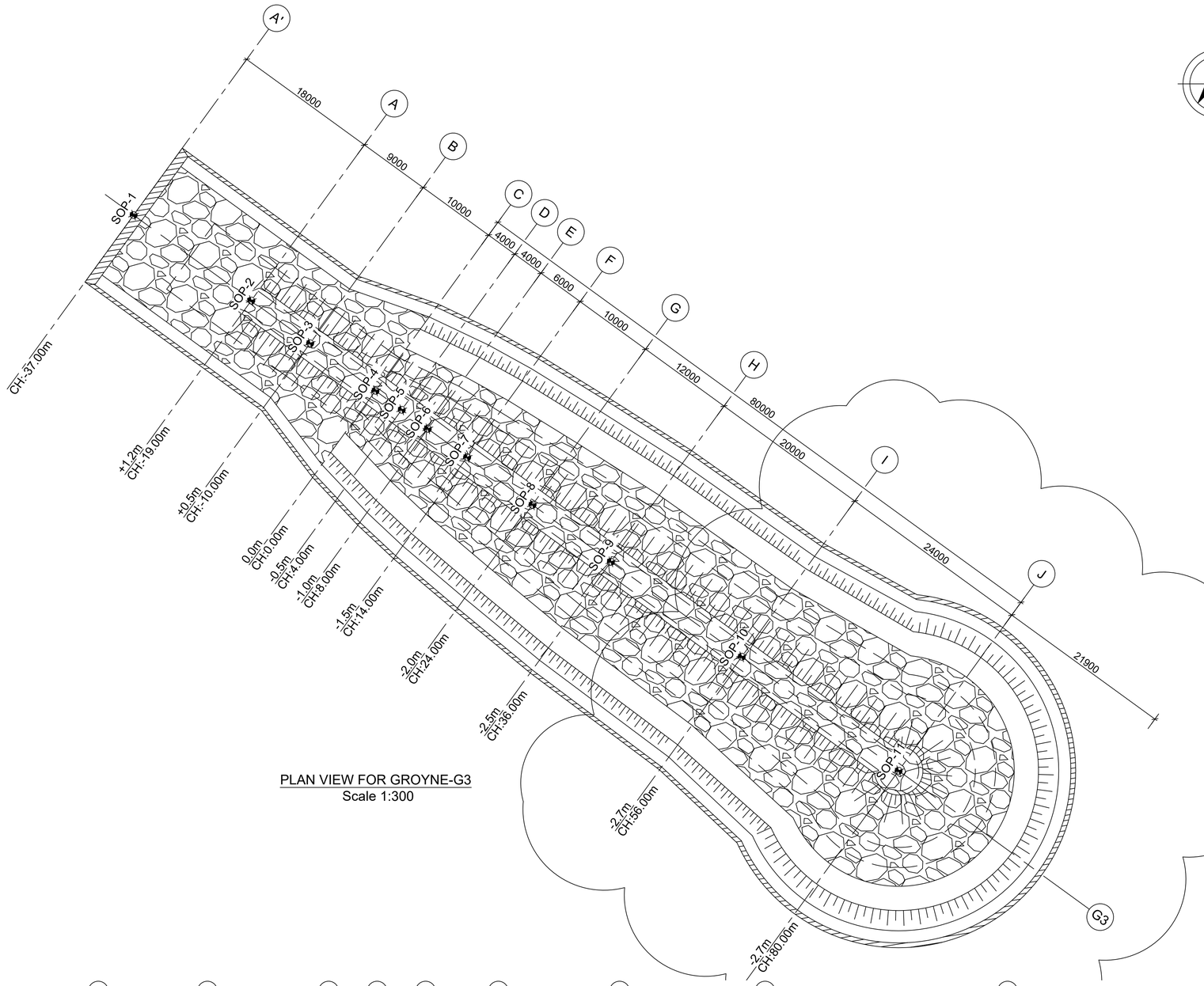
Legend	
Blue	- HIGH TIDE TO LOW TIDE
Red	- LOW TIDE TO ROUND HEAD

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

REV.	DATE (DDMMYY)	DESCRIPTION	DESIGN	DRAWN
0	24.08.2022	ISSUED FOR CONSTRUCTION	CS	TR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.	DATE: 24.08.2022
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.	
DRAWING TITLE:	PUDHUNADUKUPPAM OVERALL GROYNE LAYOUT	
DRAWING NO:	IITM - PNK - 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	



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

PLAN VIEW FOR GROYNE-G3
Scale 1:300

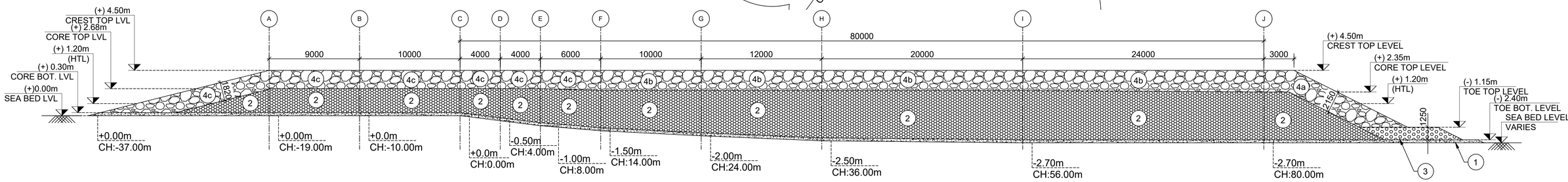
GROYNE SETTING OUT POINTS:-

SOP	EASTINGS (m)	NORTHINGS (m)
SOP 01	404649.95	1372800.53
SOP 02	404664.51	1372789.95
SOP 03	404671.80	1372784.66
SOP 04	404679.89	1372778.78
SOP 05	404683.12	1372776.43
SOP 06	404686.36	1372774.08
SOP 07	404691.21	1372770.55
SOP 08	404699.31	1372764.68
SOP 09	404709.02	1372757.63
SOP 10	404725.20	1372745.87
SOP 11	404744.62	1372731.77

CHAINAGE, (m)	PRIMARY ARMOUR
CH. -37.00 TO +14.00	1.5T TO 2.5T STONES
CH. +14.00 TO +80.00	2.5T TO 3.5T STONES
CH. +80.00 TO HEAD PORTION	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-PNK-GY-101-01
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PNK-GY-001

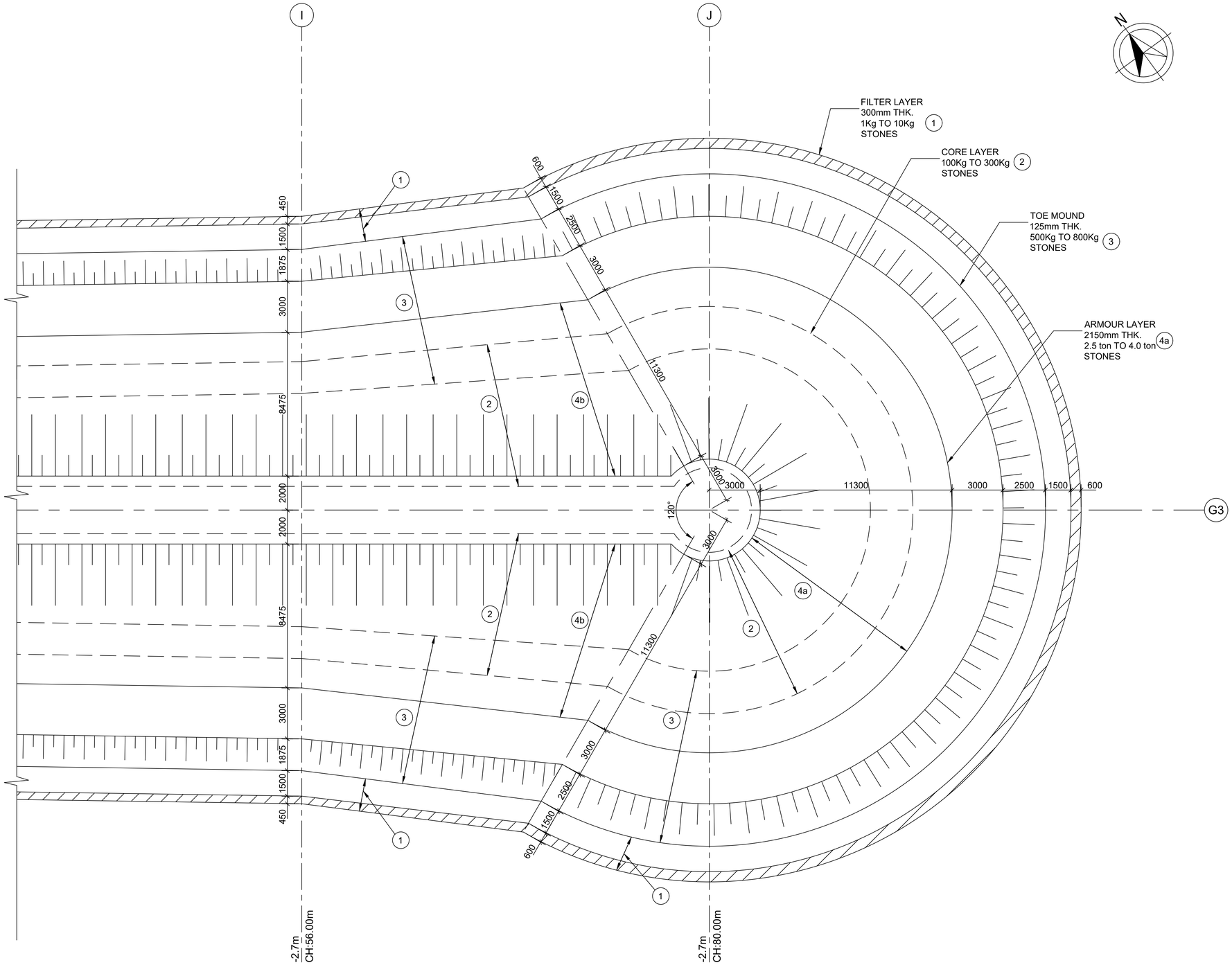
71

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	24.01.2023	ISSUED FOR CONSTRUCTION	CS	TR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (2 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 02
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

DATE: 24.01.2023
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-PNK-GY-101-01
   b) IITM-PNK-GY-101-02
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PNK-GY-001

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	24.01.2023	ISSUED FOR CONSTRUCTION	CS	TR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (3 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 03
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

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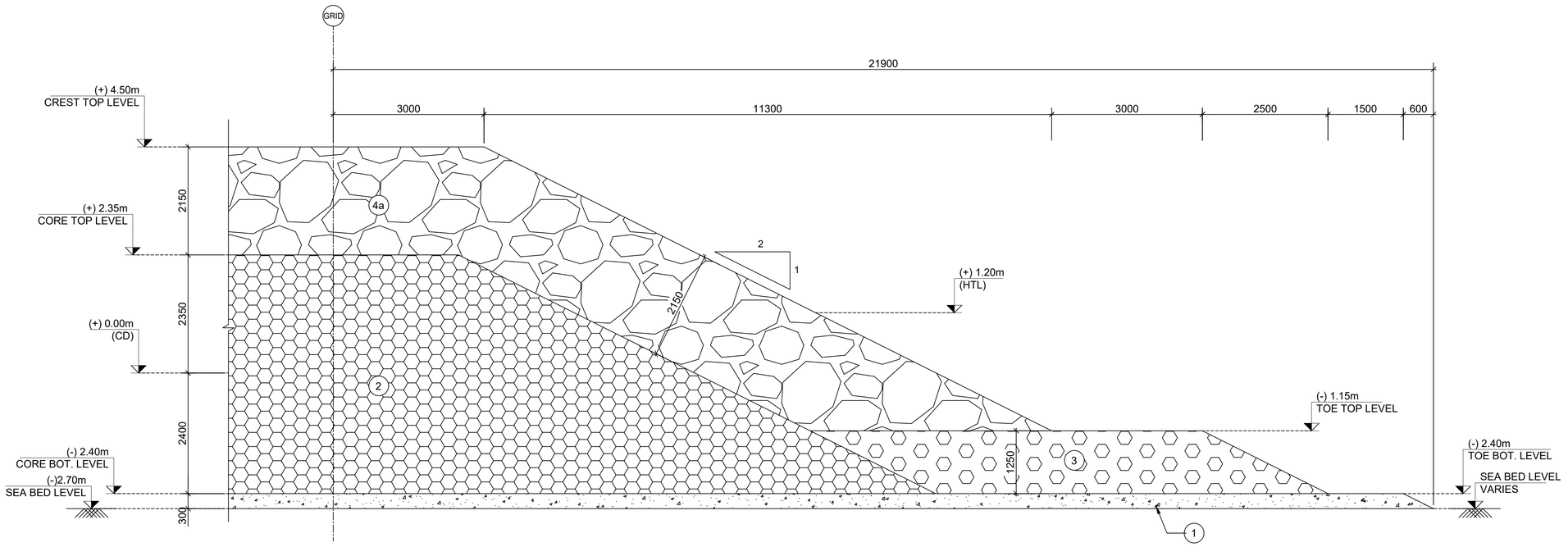

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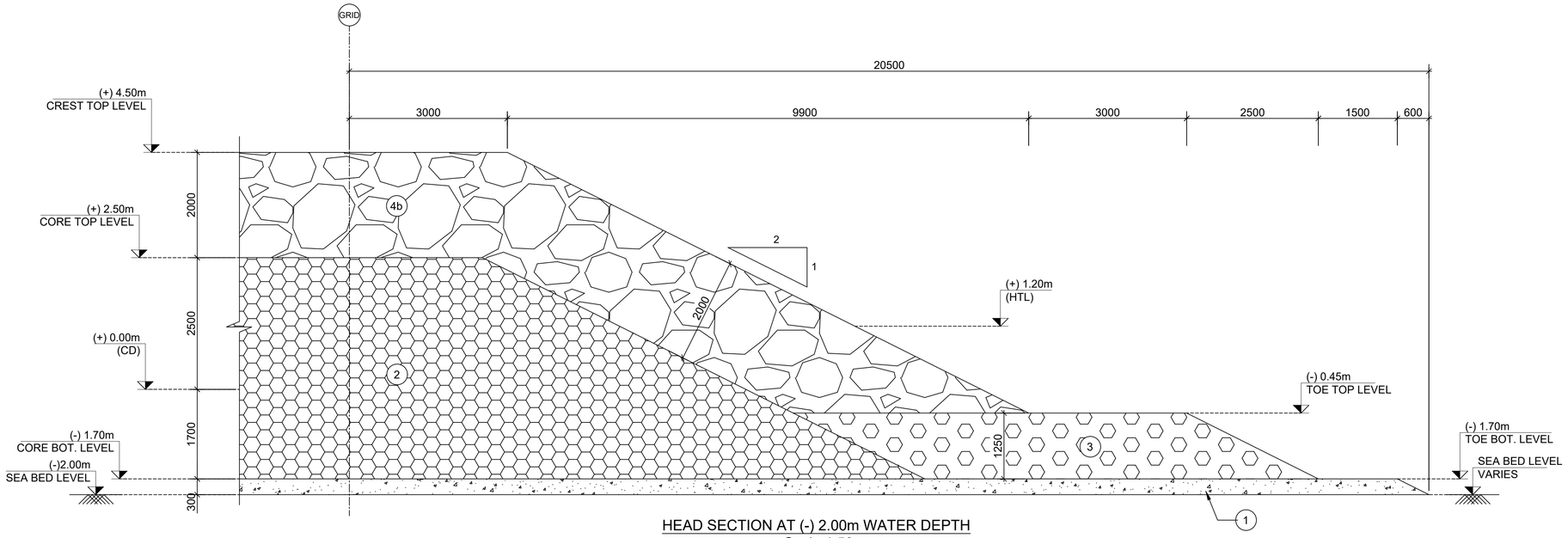

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NOTES :-

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-PNK-GY-101-01
   b) IITM-PNK-GY-101-02
   c) IITM-PNK-GY-101-03
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PNK-GY-001 73

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ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (4 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 04
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

DATE: 24.08.2022
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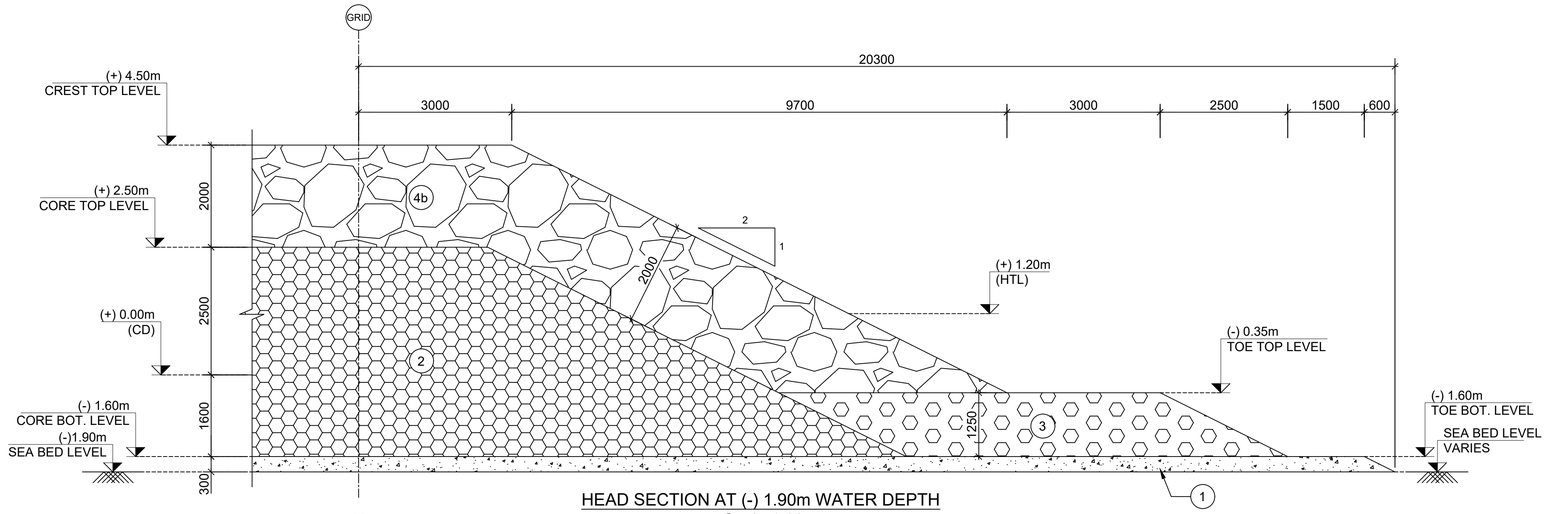

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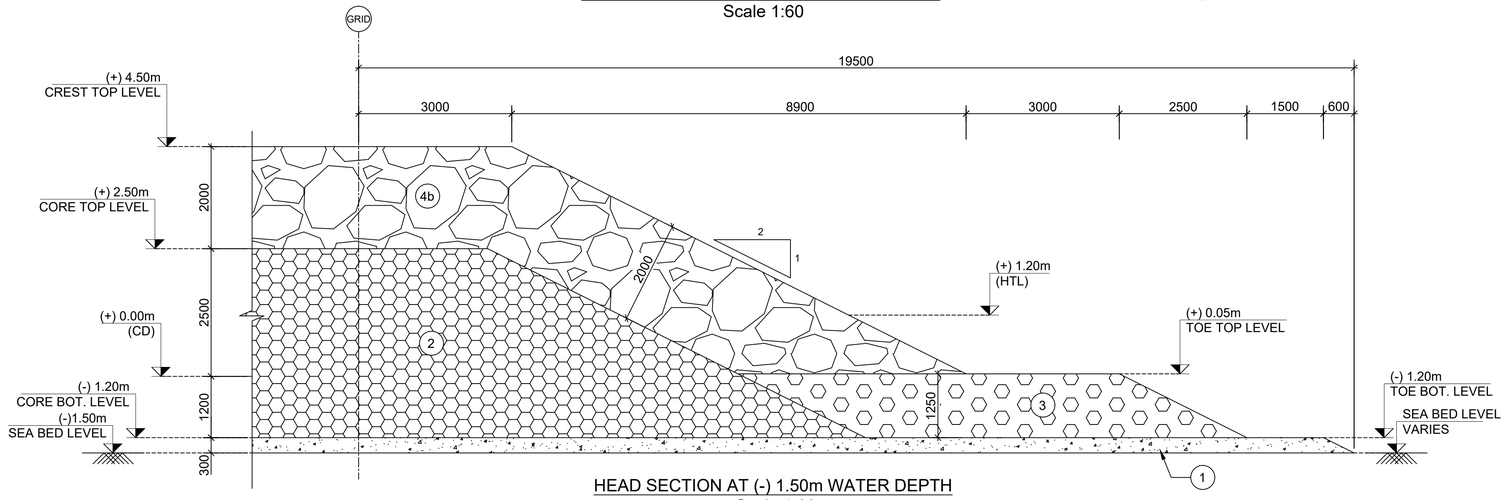

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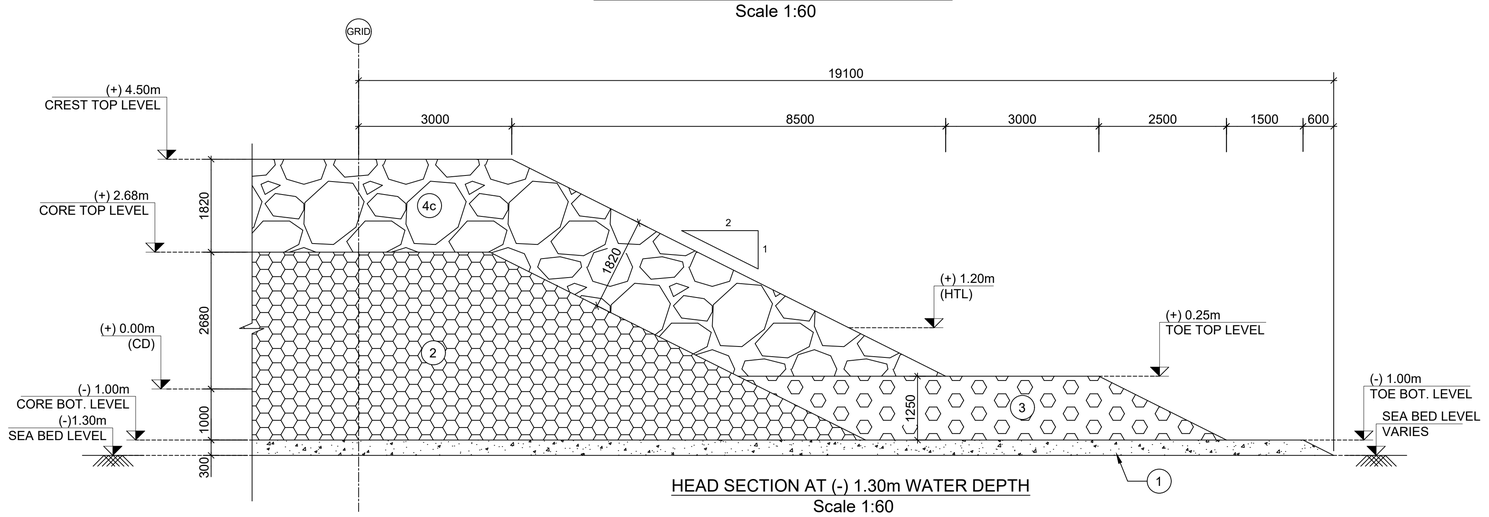

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NOTES :-

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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-PNK-GY-101-02
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2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
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ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (5 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 05
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

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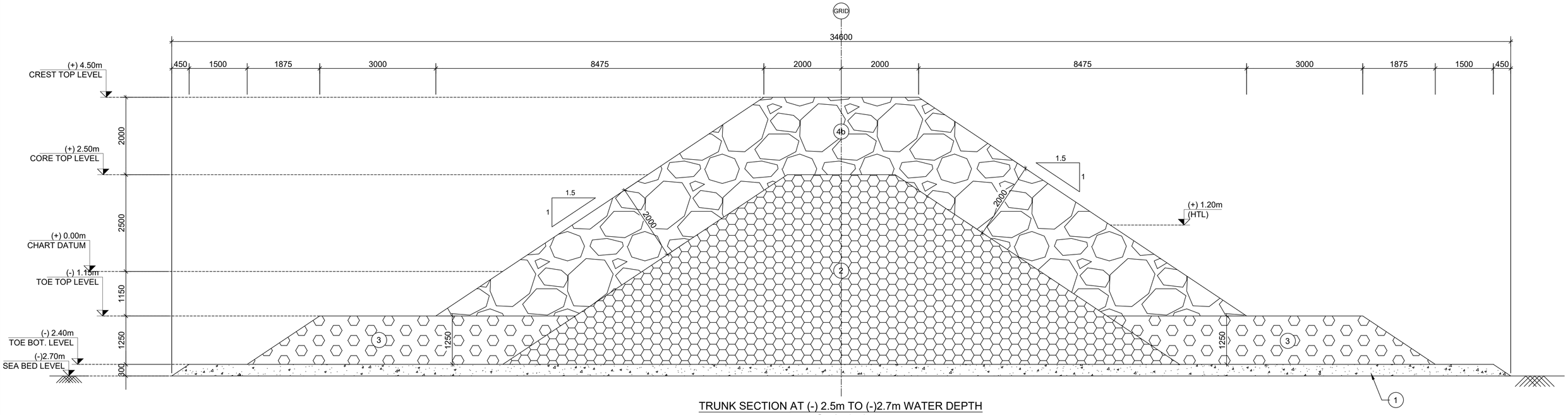

TRUNK SECTION AT (-) 2.5m TO (-)2.7m WATER DEPTH
Scale 1:50

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, 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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ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (6 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

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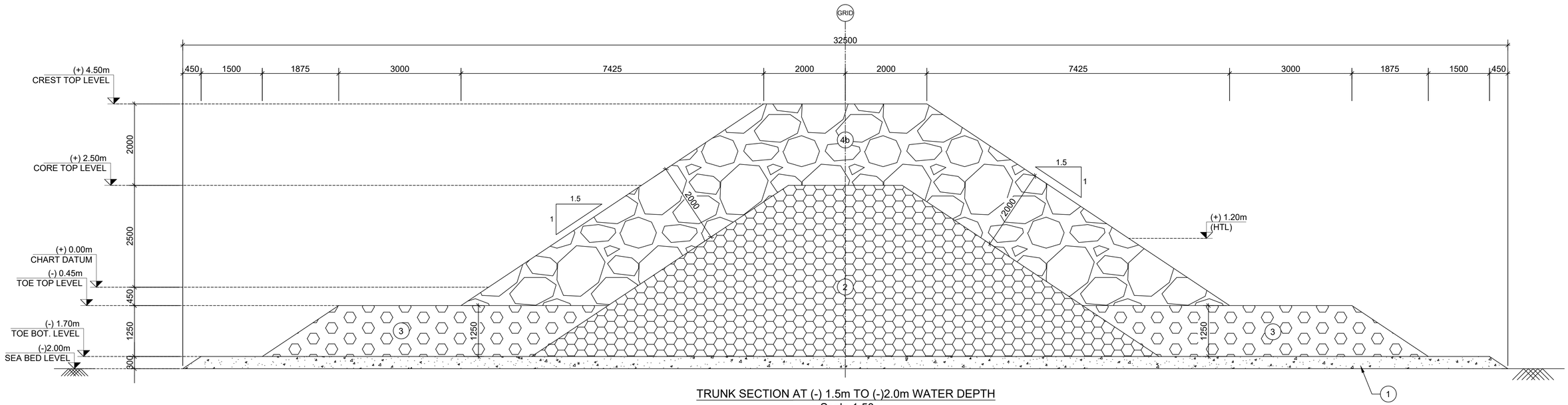

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Scale 1:50

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

NOTES :-

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3. ALL CO-ORDINATES ARE GIVEN IN METER REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM).

LEGEND:-

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- (2) - CORE 100kg TO 300kg
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- (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-PNK-GY-101-02
   c) IITM-PNK-GY-101-03
   d) IITM-PNK-GY-101-04
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ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
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DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (7 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 07
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 60036

DATE: 24.08.2022
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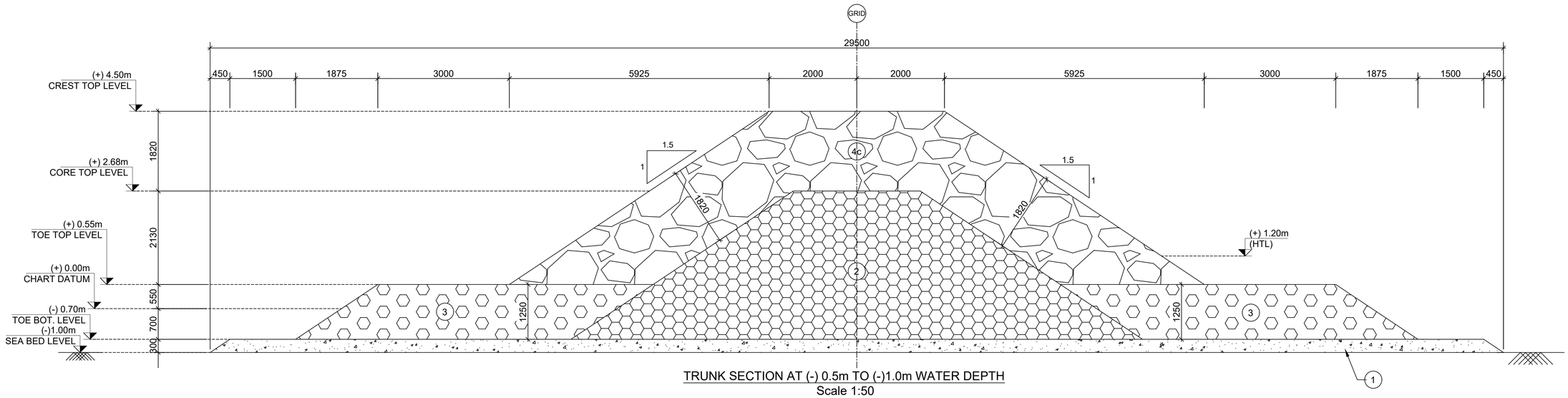

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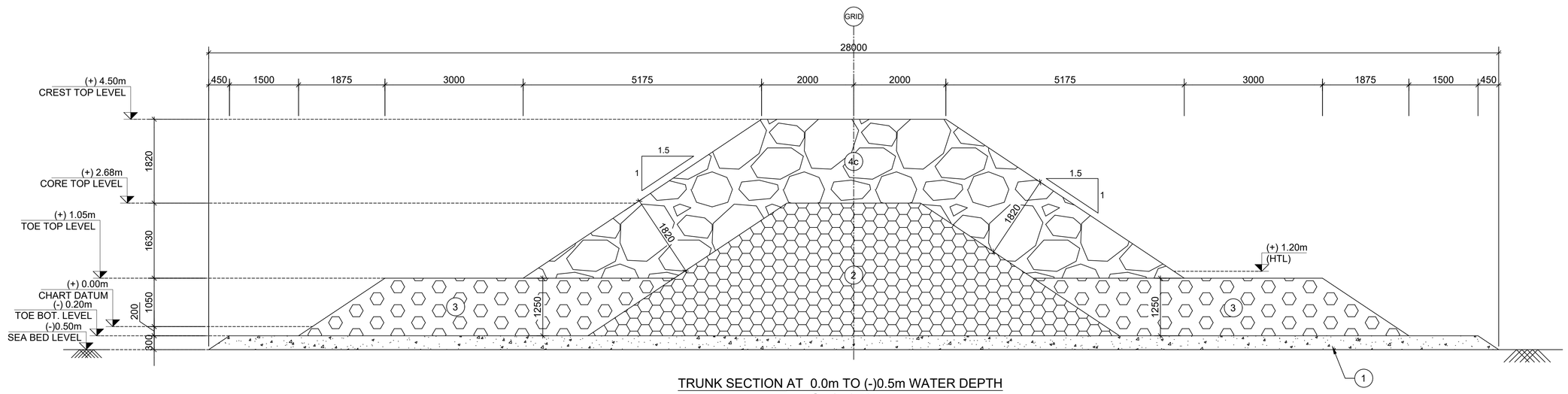
Scale 1:50



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

Scale 1:50

NOTES :-

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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-PNK-GY-101-01
   - b) IITM-PNK-GY-101-02
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   - d) IITM-PNK-GY-101-04
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CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WEFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (8 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 08
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DATE: 24.08.2022

Scale as shown

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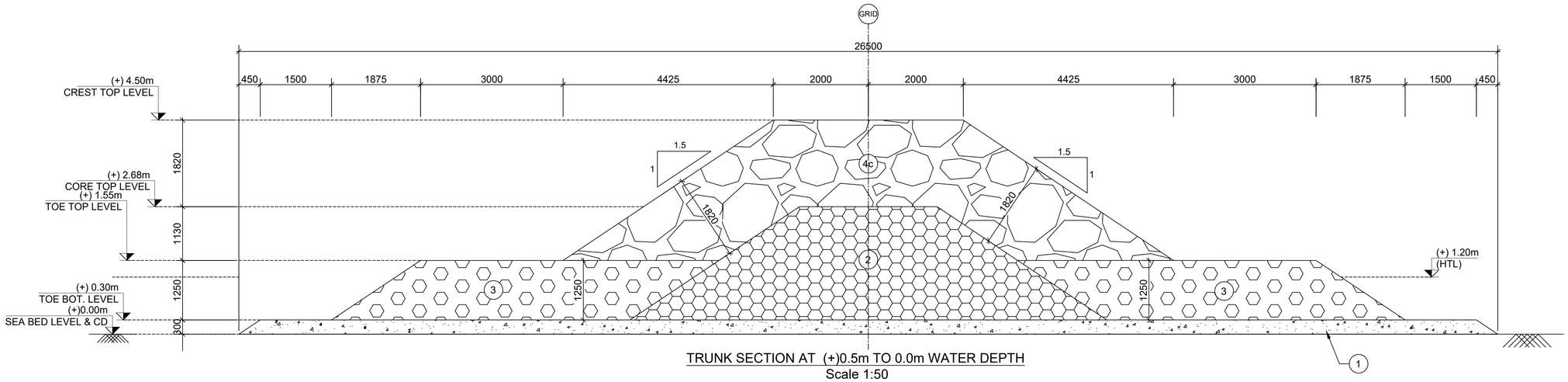
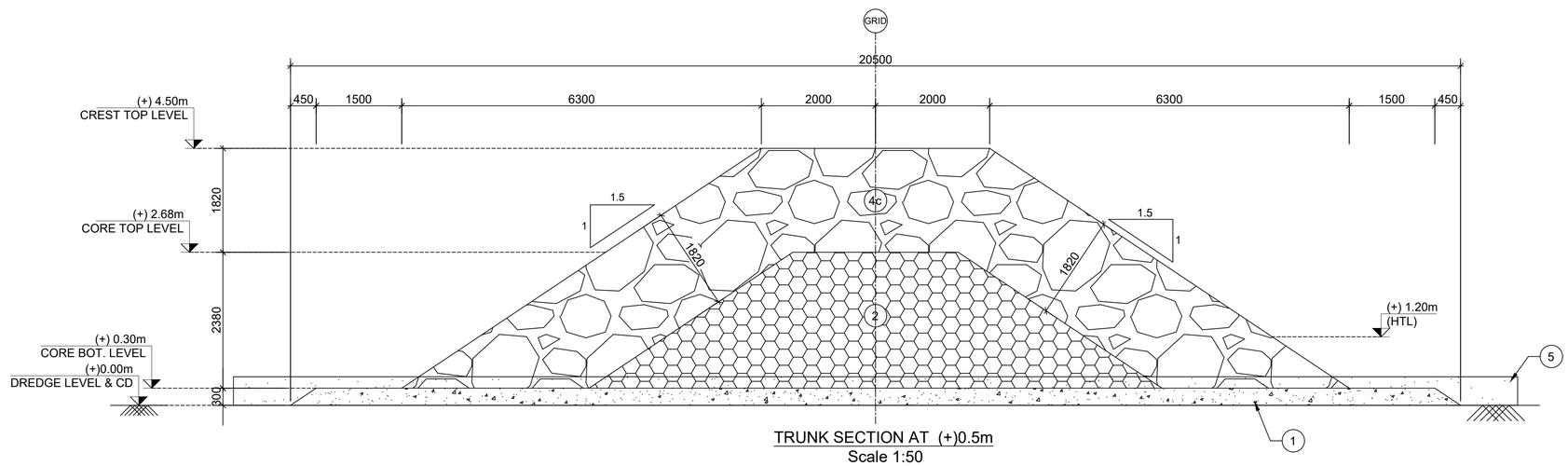


TRUNK SECTION AT (+)0.5m TO 0.0m WATER DEPTH

Scale 1:50



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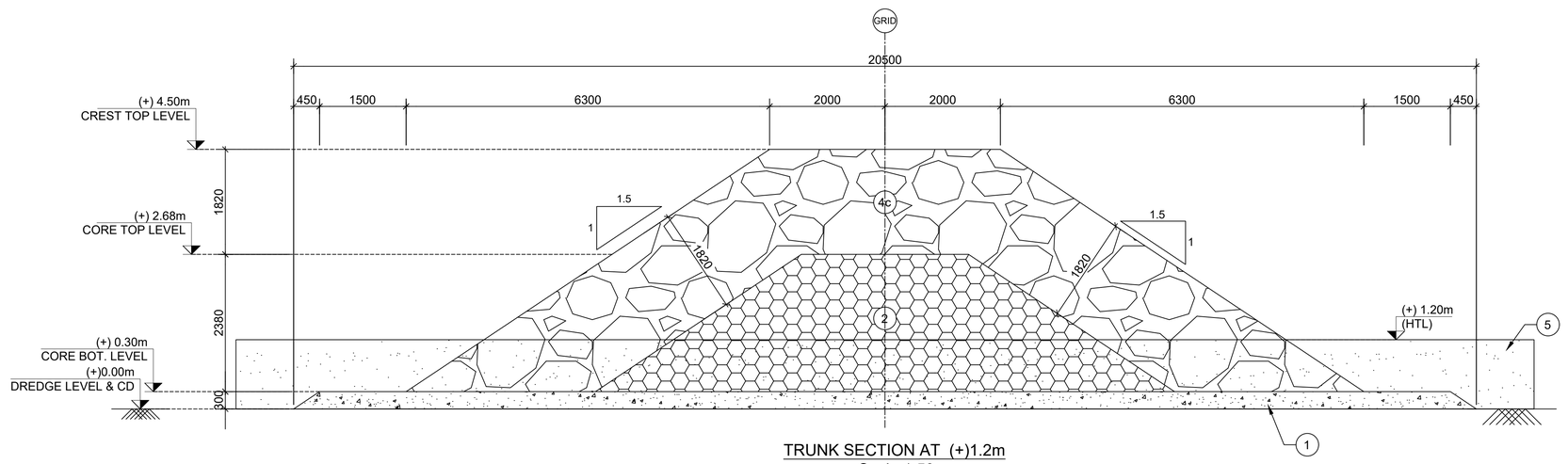

TRUNK SECTION AT (+)1.2m

Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
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- 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-PNK-GY-101-02
   - c) IITM-PNK-GY-101-03
   - d) IITM-PNK-GY-101-04
   - e) IITM-PNK-GY-101-05
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   - h) IITM-PNK-GY-101-08
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   - a) IITM-PNK-GY-001

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PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PUDHUNADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PUDHUNADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (9 OF 9)
DRAWING NO:	IITM - PNK - GY - 101 - 09
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 24.08.2022

Scale as shown

REV 0

PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYA NADUKUPPAM IN CHENGALPATTU DISTRICT

Client

Fisheries Department, Tamilnadu

Consultants

Prof. V.Sundar

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 Fisheries Department, 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 Pazhaya Nadukuppam. The coastal site of the Pazhaya Nadukuppam is located at latitude 12°25'17.57"N and longitude 80°7'35.28"E, Chengalpattu district. Prior to the implementation of preventative measures, the Tamilnadu Fisheries Department conducted a bathymetry and topographical study of the area. The location of Pazhaya Nadukuppam is shown in **Fig.1.**

Fig.1 Location of Pazhaya Nadukuppam 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 groin field suitable for Pazhaya Nadukuppam 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 600m off the coast of Pazhaya Nadukuppam has been provided by the fisheries department, Tamilnadu the on 9th May 2022 (Surveyed on 15th march 2022) which is shown in **Fig.2** and **Plate *(IITM - PAZK - GY – 001).***

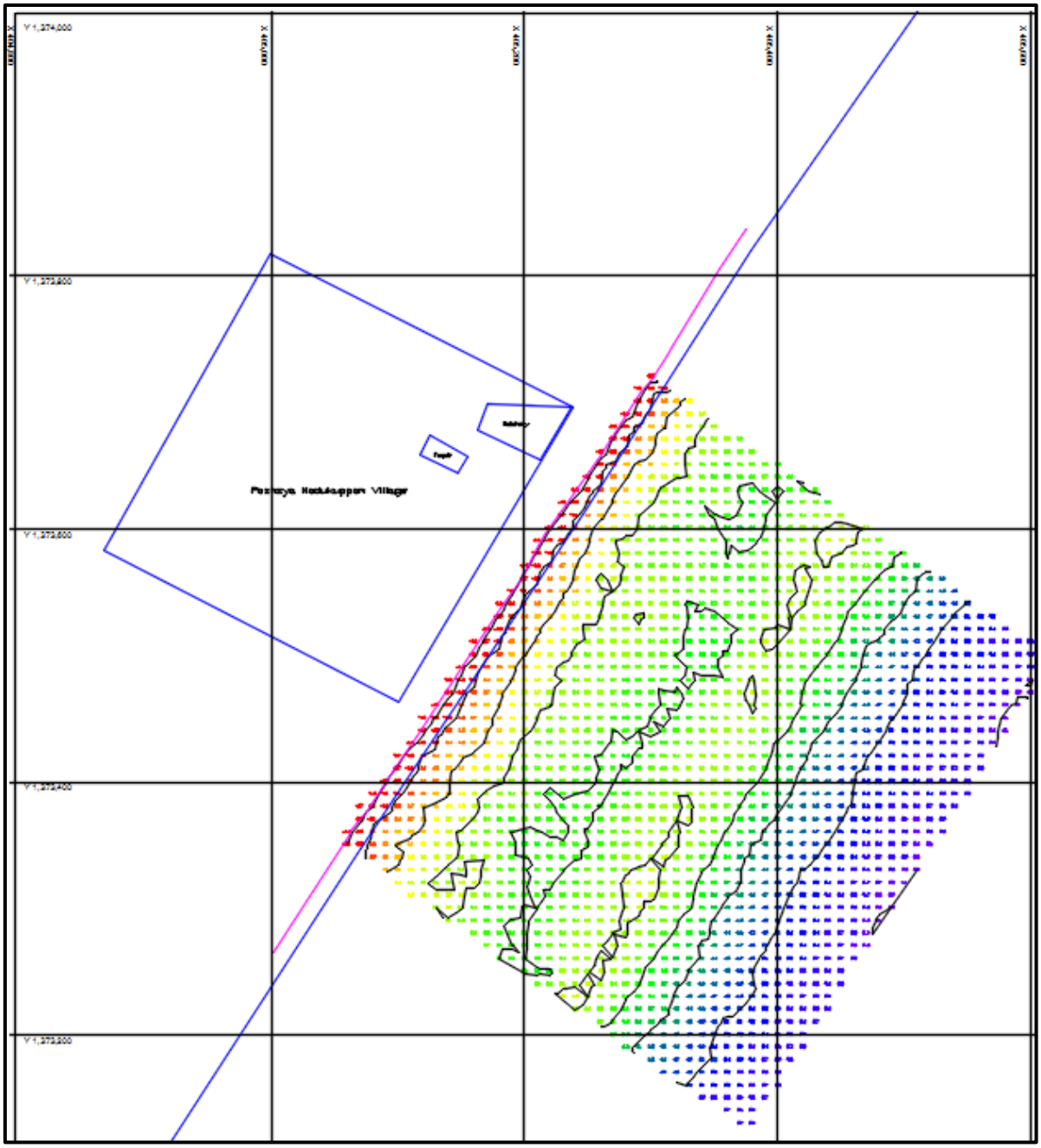


Fig.2 Bathymetry off Pazhaya Nadukuppam stretch provided by fisheries department, Tamilnadu

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°22'30.00"N, 80°15'0.00"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. **Fig.3** represents the annual occurrence of wave climate. It is noticed that the offshore wave climate of Chengalpattu is predominantly from east and south east.

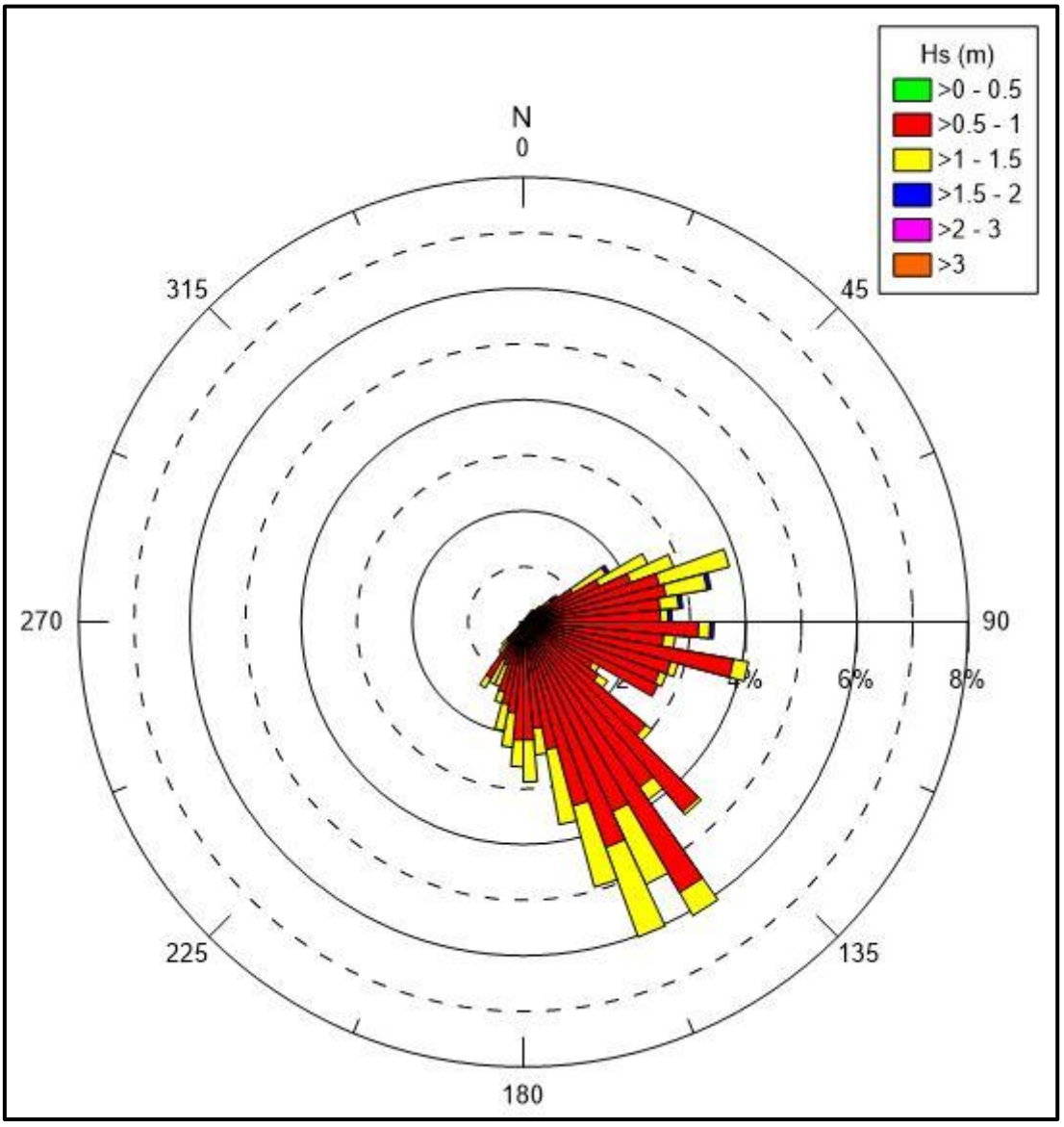


Fig.3 Wave rose diagram representing the significant wave height (m) along the direction for an annual year

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°0'0.00"N, 80°15'0.00"E) and (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 Pazhaya Nadukuppam 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 0.83 m to 1.29 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 march to October, and towards South in January, February, November and December. 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.6** for the different months. It shows that the maximum surf width of about 79 m occurs 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 138040.32m^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(m)	Wave period, T(sec)
1	January	66	0.9	5.3
2	February	93	0.7	5.2
3	March	133	0.8	5.6
4	April	150	0.9	5.2
5	May	149	1.0	5.3
6	June	176	1.1	5.3
7	July	185	0.9	5.3
8	August	168	0.8	6.2
9	September	157	1.0	7.1
10	October	148	1.0	5.6
11	November	104	1.0	6.2
12	December	75	0.9	5.6

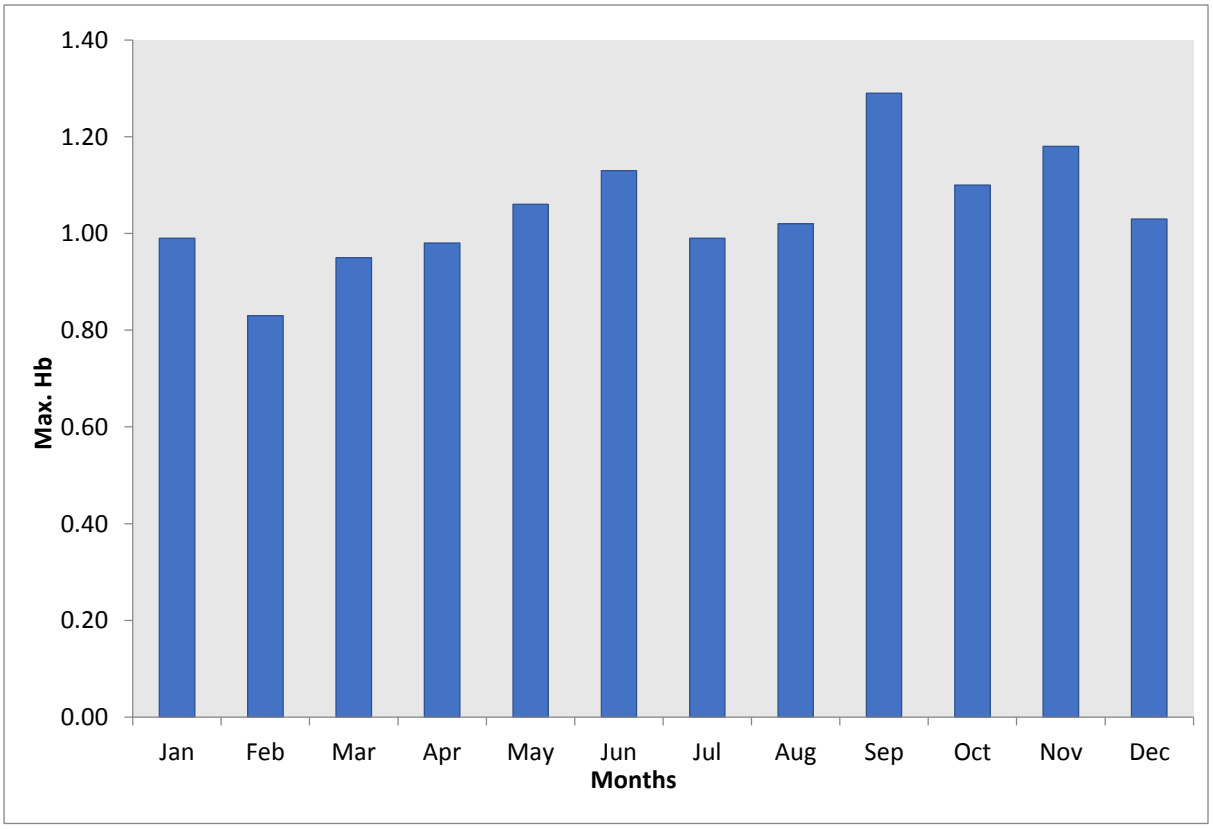


Fig.4 Breaker wave heights in m

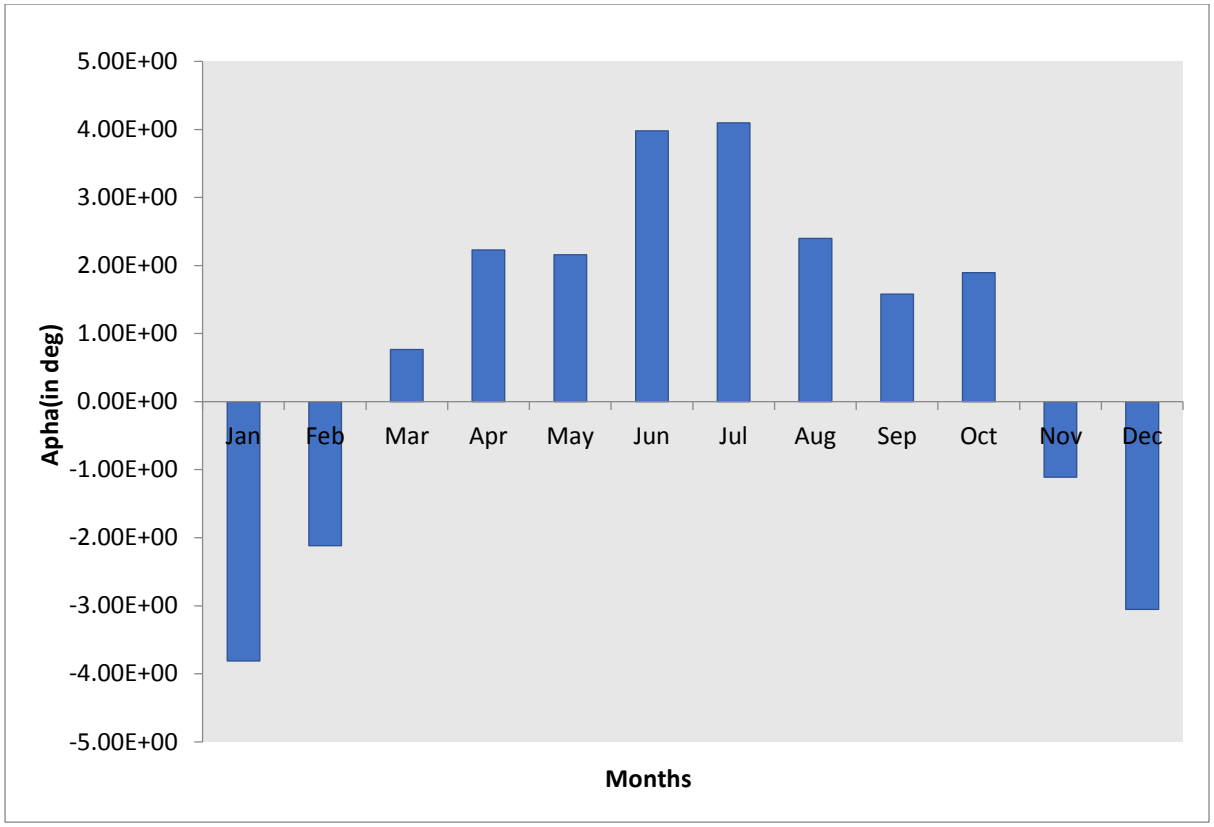


Fig.5 Wave breaker angle

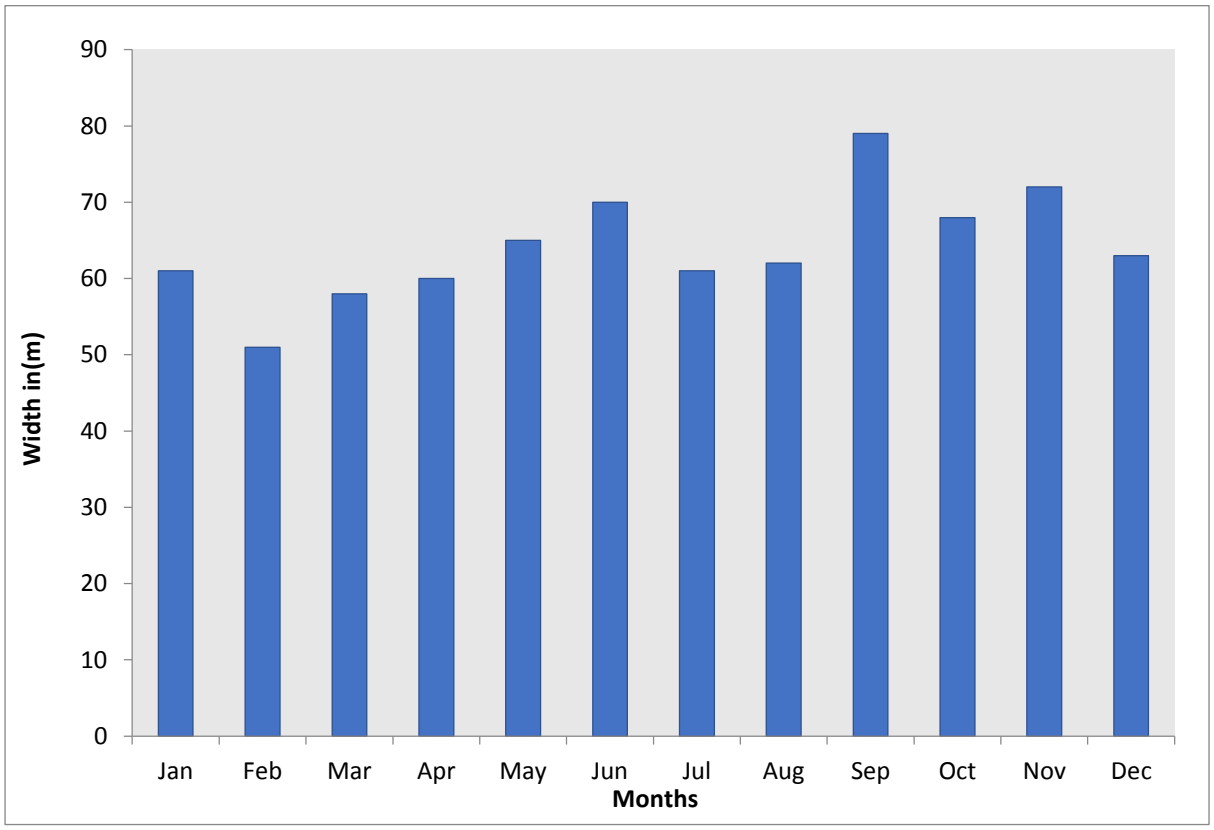


Fig.6 Surf zone width

Table.2 Sediment transport rate (Net Northerly)

Methods	Rate (m^3/year)
Komar	135968.70
CERC	141619.37
Distribution	136532.88

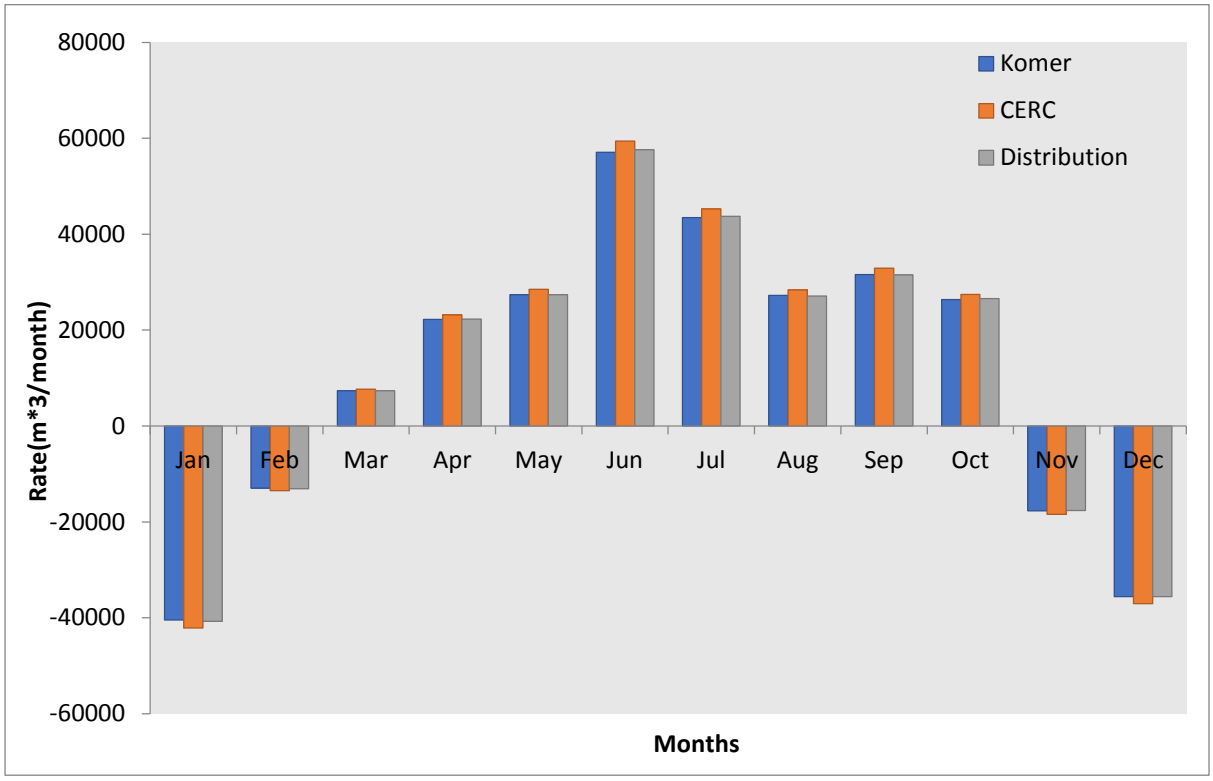


Fig.7 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROYNES

A series of 6 transitional groynes have been proposed to protect the coastal stretch (570m) of Pazhaya Nadukuppam. **Fig.8** depicts an overview of the proposed groynes over bathymetry provided by the Tamilnadu fisheries department on 09/05/22, groyne field and **Plate *(IITM - PAZK - GY - 101 – 01)*** presents the layout in detail. The groynes, G1, G2, and G6, are each 20 metres long, with G1 and G6 extending up to a water depth of (-) 1.3m and G2 extending to a water depth of (-) 1.1m. Groyne G3 and G5 each 40m in length will extend up to a water depth of 2.0m and (-)2.5m respectively, G4 of 80m in length will extend up to a water depth of (-)2.7m.

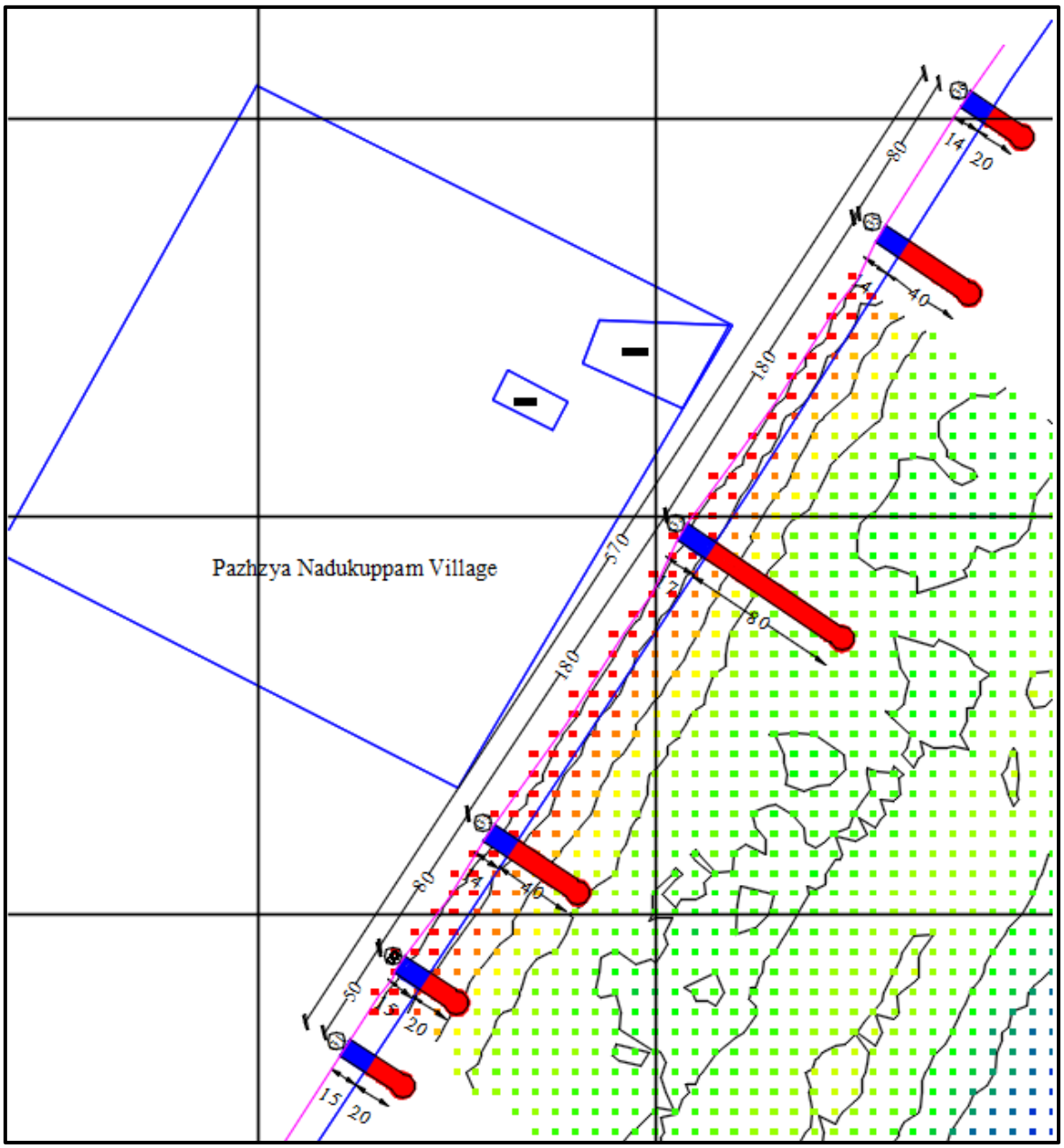


Fig.8 Layout of groin field

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.**

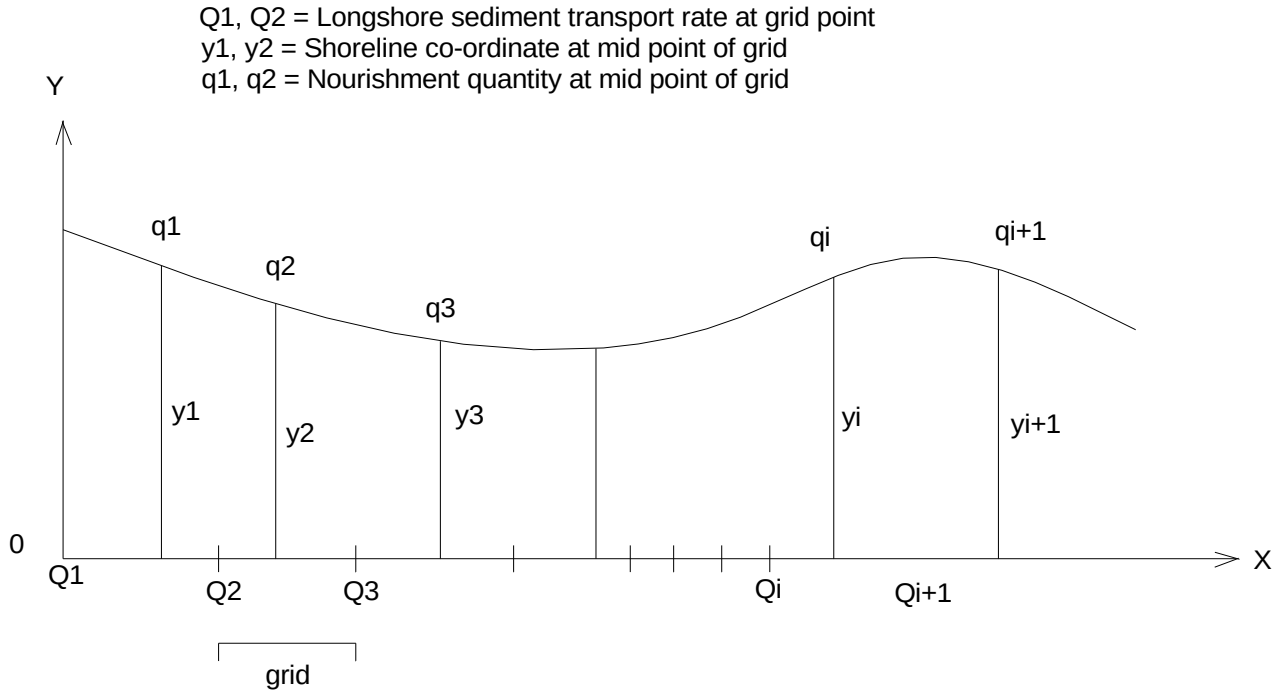


Fig 9. Schematic diagram for finite difference scheme

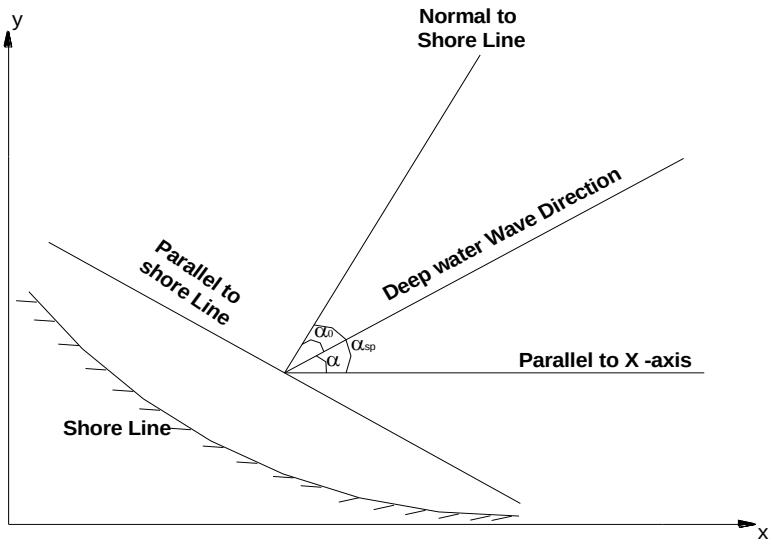


Fig 10. Definition sketch of angles considered

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 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. 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 groins and has been presented by superimposing the shoreline patterns.

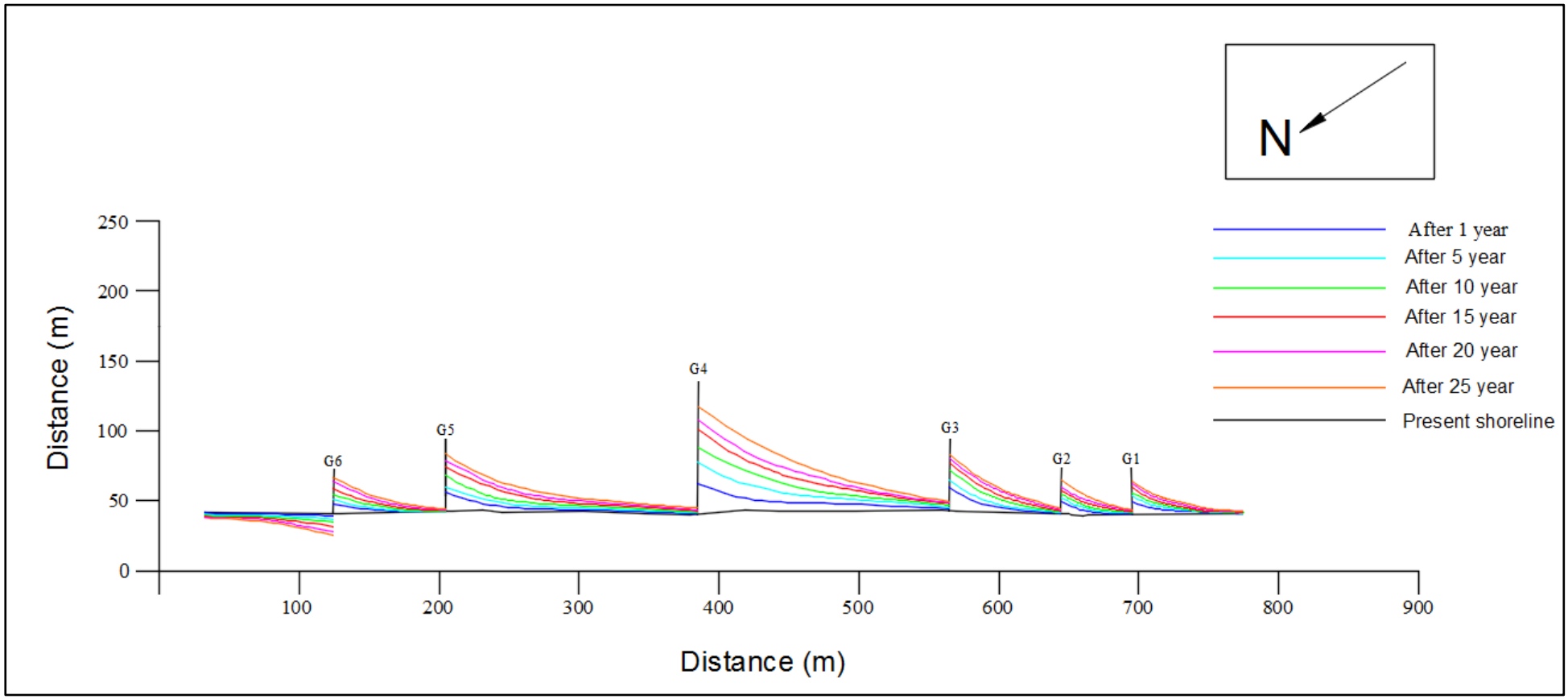


Fig.11 Shoreline evolution

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 Pazhaya Nadukuppam. 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 1.5 km. **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.

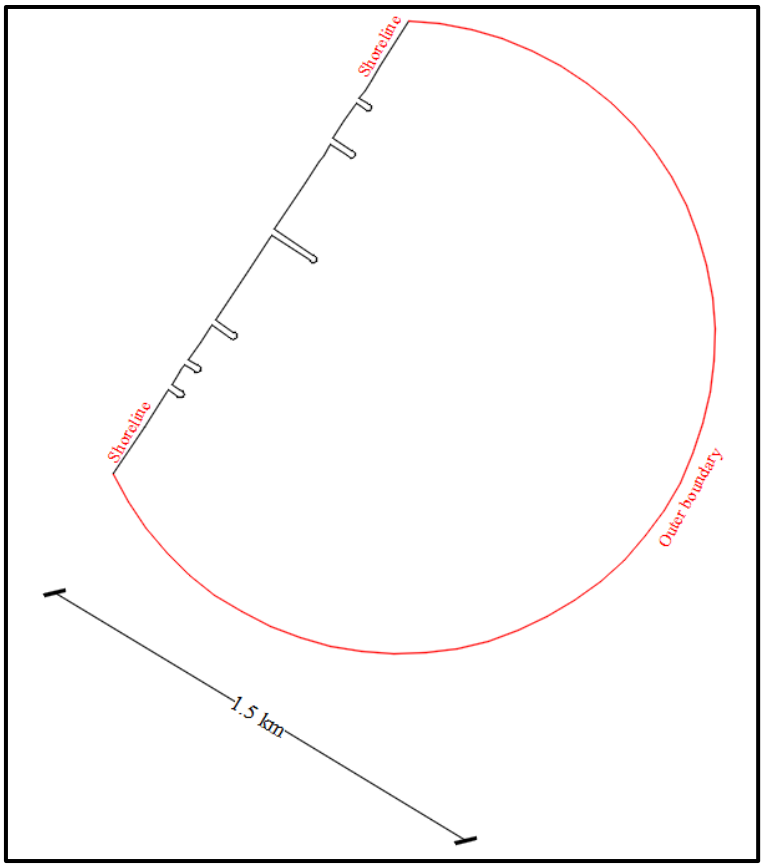


Fig. 12 Computational domain

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 223 nodes with a spacing of 5m and the inner shoreline is modeled by nodes with a spacing of 5m. Then an unstructured mesh is created with an average spacing of 5m inside the domain. This leads to a total number of 12205 nodes with 23990 numbers of triangular elements. The mesh is shown in **Fig. 13.**

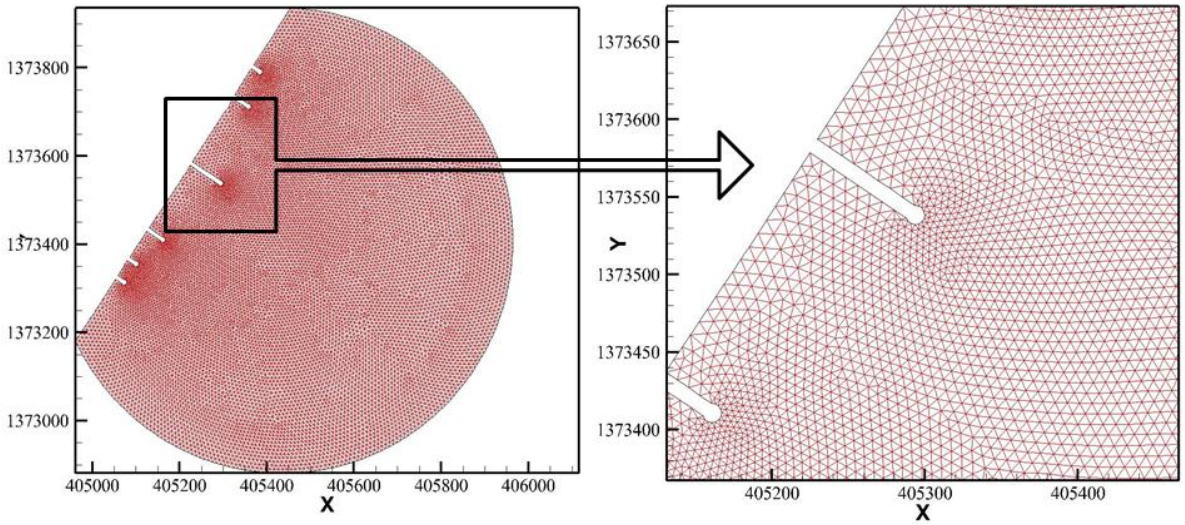


Fig.13 Mesh Structure adopted for the wave propagation modeling

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.

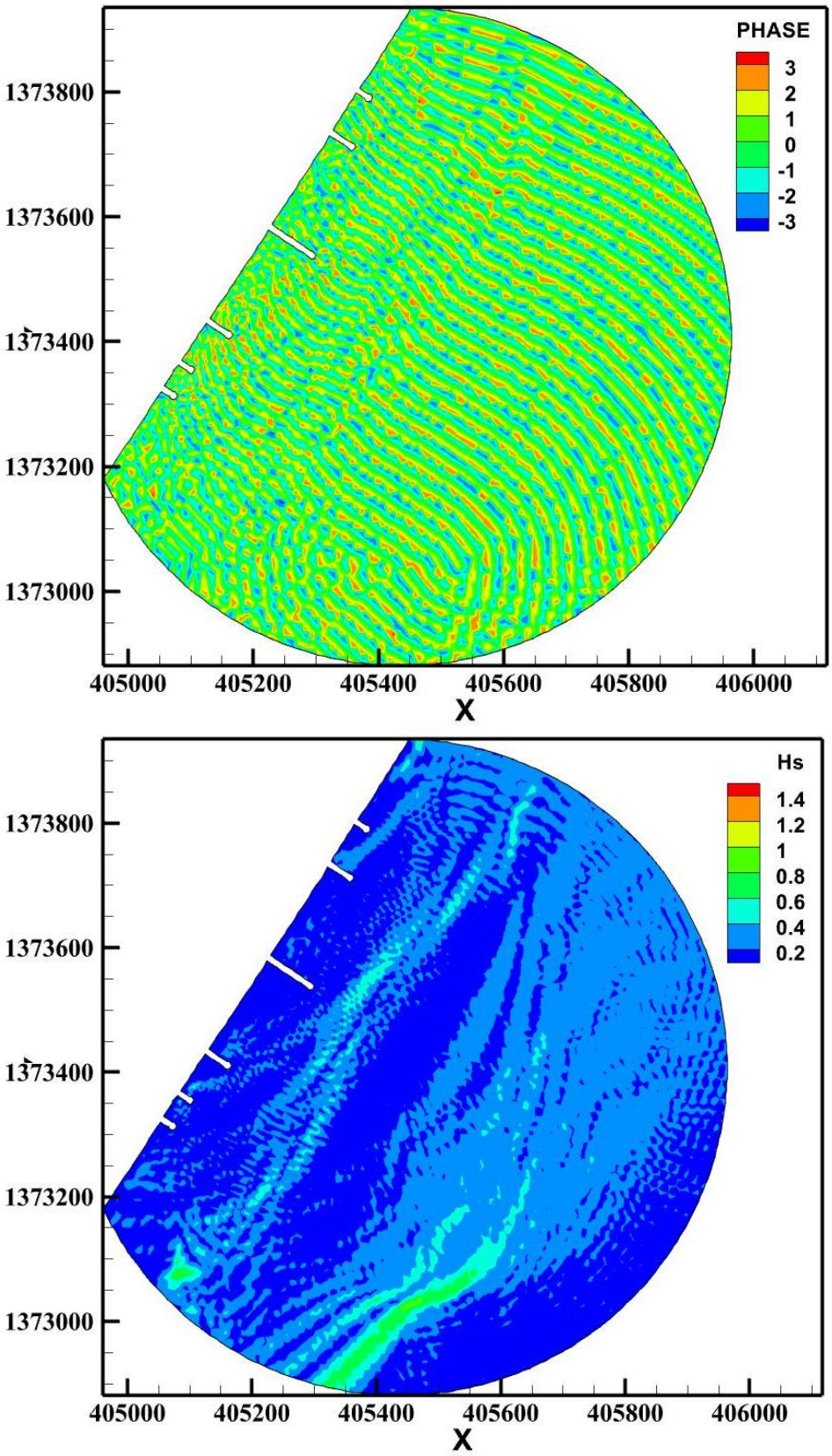


Fig.14 Phase distributions and Wave height distribution for the wave approach angle from 45^0

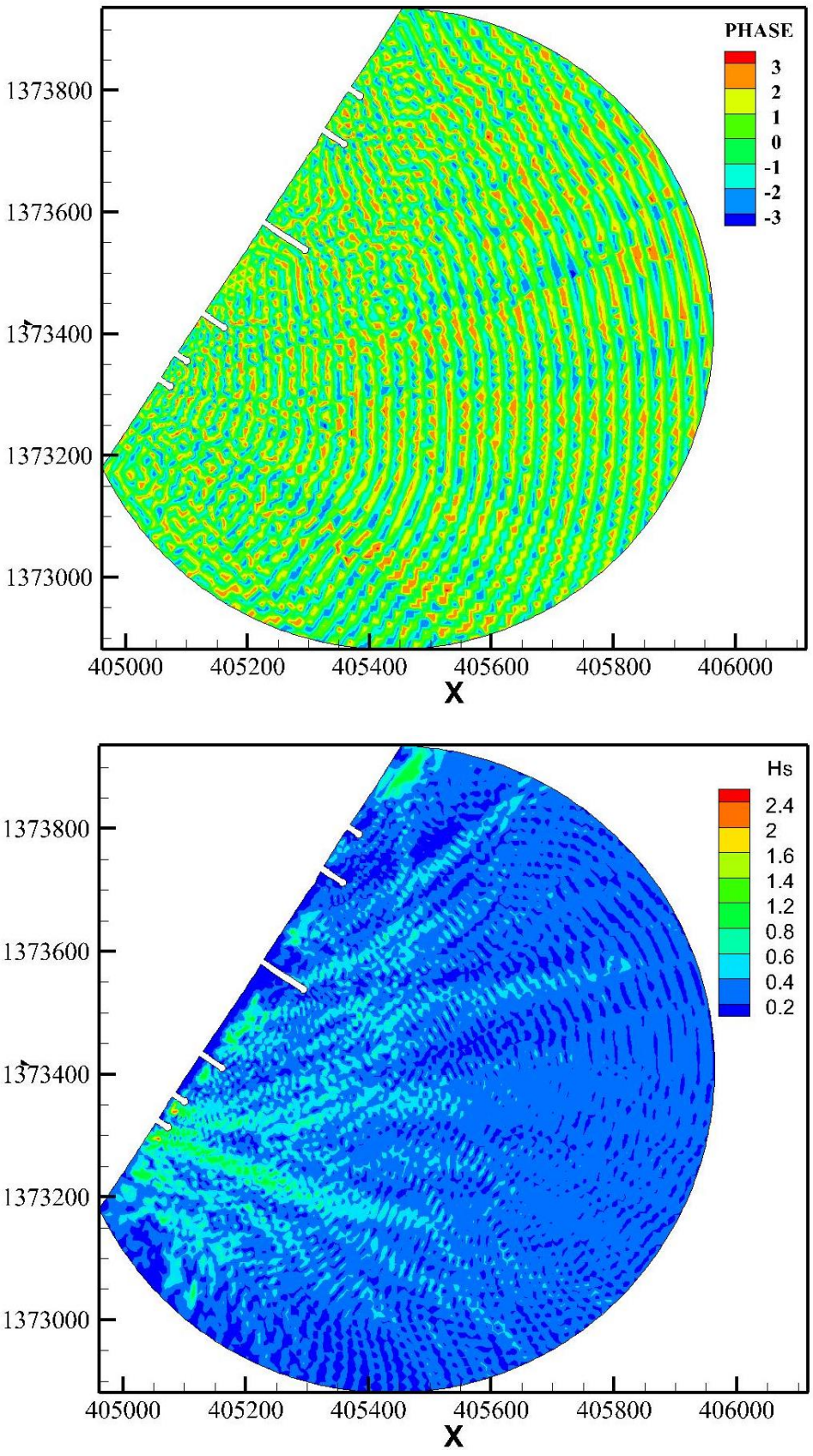


Fig.15 Phase distributions and Wave height distribution for the wave approach angle from 90^0

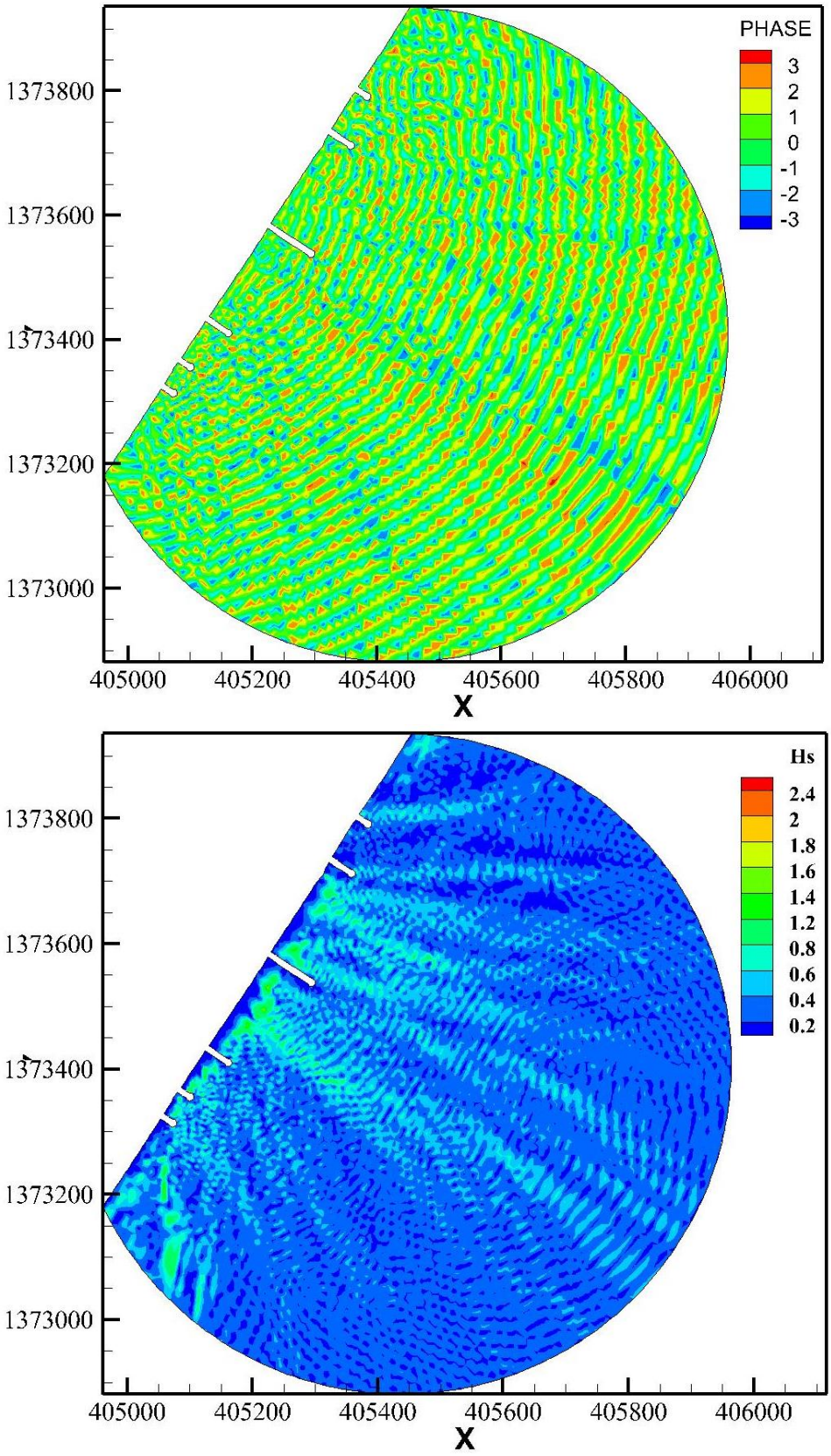


Fig.16 Phase distributions and Wave height distribution for the wave approach angle from 135^0

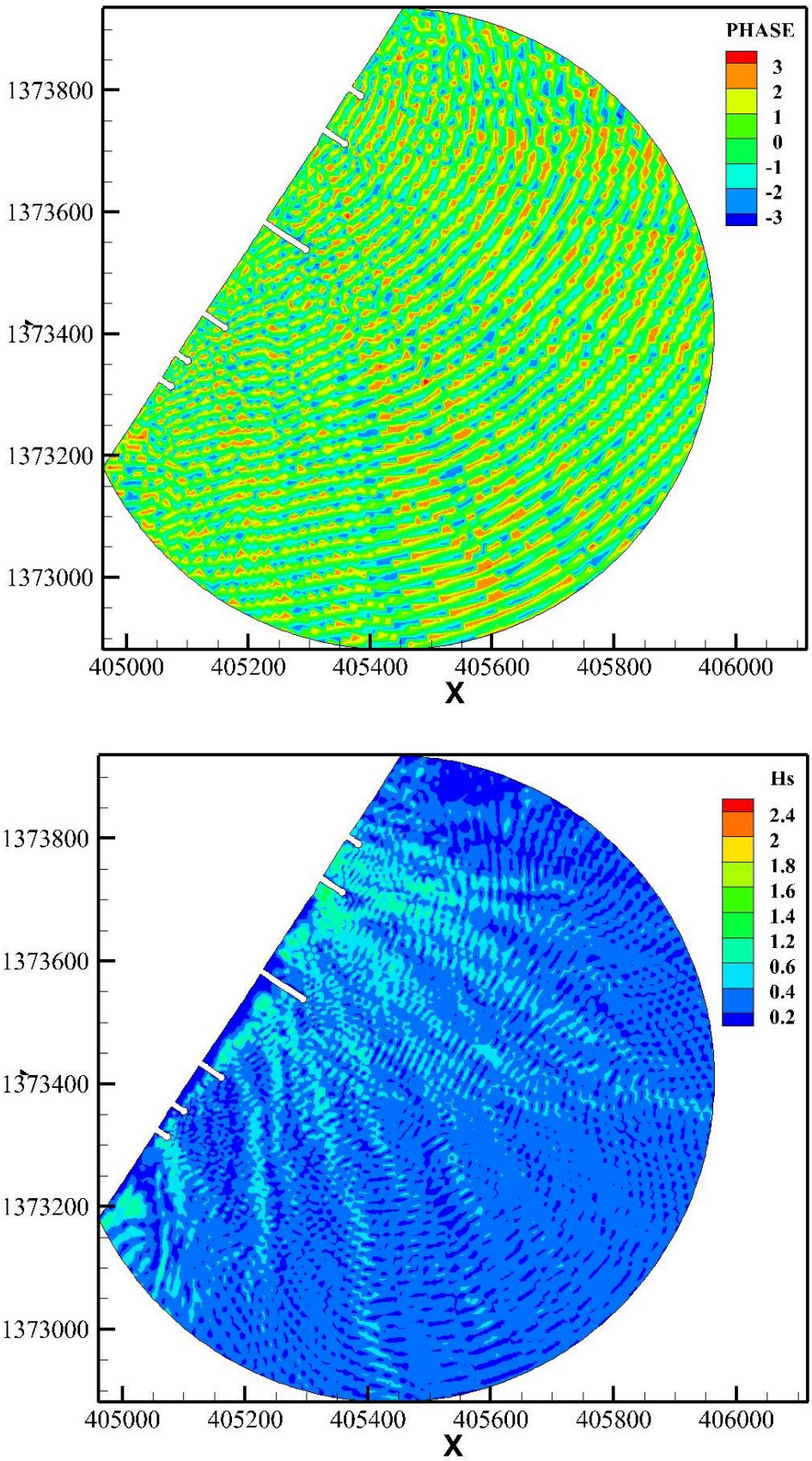


Fig.17 Phase distributions and Wave height distribution for the wave approach angle from 155^0

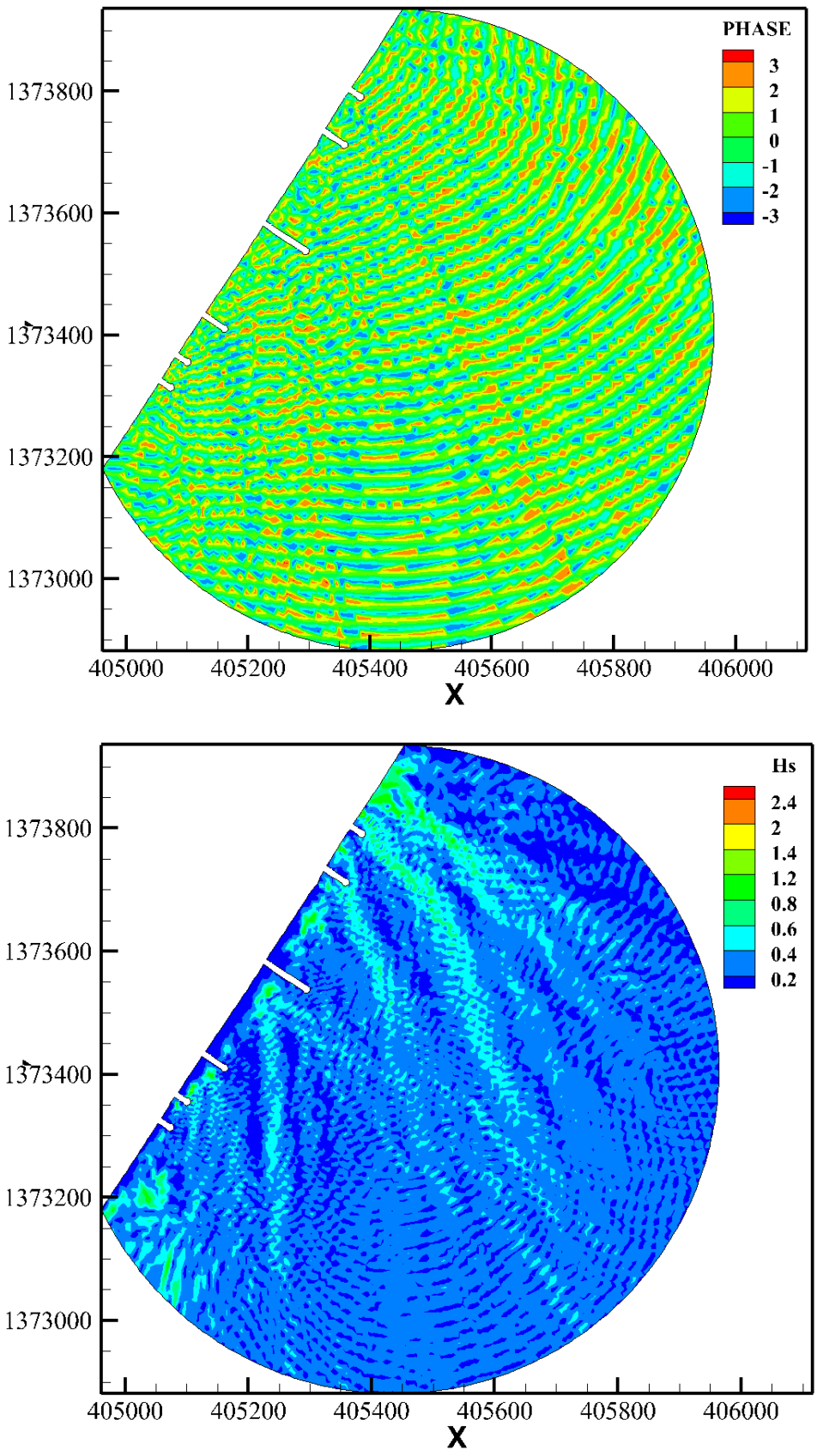


Fig.18 Phase distributions and Wave height distribution for the wave approach angle from 180^0

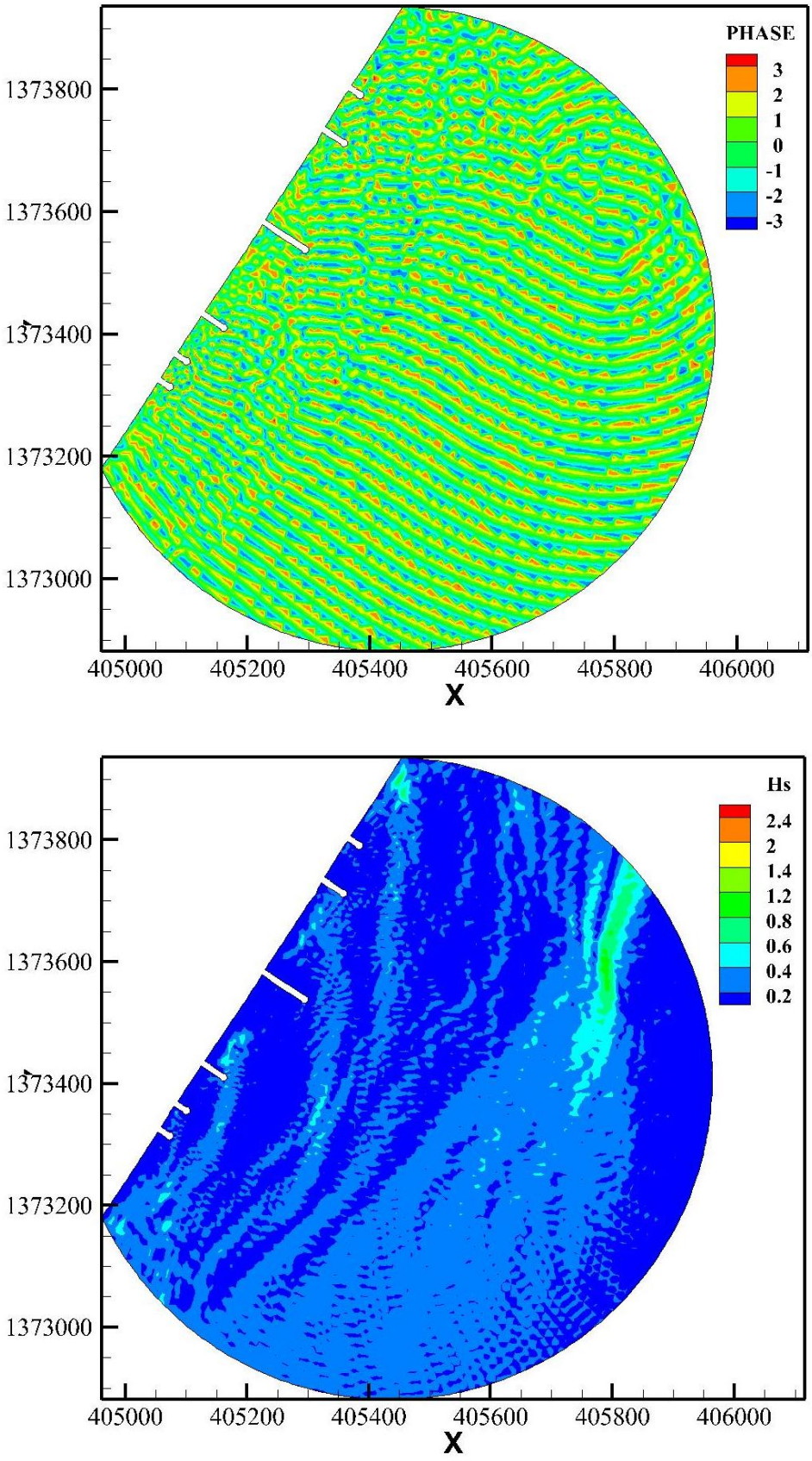


Fig.19 Phase distributions and Wave height distribution for the wave approach angle from 200^0

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 groynes can thus be set as the sum of MHWS and the design water depth is,

d = 2.7+1.2+0.8= 4.7m

Hmax = 0.78 x 4.7

= 3.66 m

Significant wave Height = Hmax /1.6 =2.30 m

Take Design wave height as 2.30 m.

9.2 Design of layers

The following describes a typical groyne design.

Armour Layer

The size of the armour stones for the groynes 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 2.5T to 4T in two layers to withstand the design wave height of 2.30m at the maximum water depth (-) 2.7m 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 = 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, (+) 4.5m crest elevation is maintained up to +1.2m 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 groin are given in **Plates *(IITM - PAZK - GY - 101 - 02) to (IITM - PAZK - GY - 101 - 09).***

10.0 BILL OF QUANTITIES

Pazhaya Nadukuppam - 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	8.00	25.90	25.90	25.90	207.20	145.04	384.36
(+) 0.5 m to (+) 1.2 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**2578.91**

Pazhaya Nadukuppam - 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	8.00	17.40	17.40	17.40	139.20	97.44	258.22
(+) 0.5 m to (+) 1.2 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**1810.48**

Pazhaya Nadukuppam - 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**

Pazhaya Nadukuppam - 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	8.00	6.00	6.00	6.00	48.00	33.60	89.04
(+) 0.5 m to (+) 1.2 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**767.51**

Head portion (-1.3 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	4.30	11.20	3.00	756.29		
Armour Layer	2.40	7.30	2.60	198.52		
			Total Armour layer		292.83	**776.00**
Toe mound layer						
Toe mound	1.30	16.60	14.20	970.05		
	1.30	9.70	7.30	296.88		
			Total Toe mound layer		353.41	**936.54**
Core Material	3.70	9.70	2.60	488.23	256.32	**679.25**
Filter Layer	0.30	18.70	18.10	318.95	167.45	**443.74**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3354.91**	**2490**	**1497**	**1211**

Pazhaya Nadukuppam - 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**
0.0 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	8.00	25.90	25.90	25.90	207.20	145.04	384.36
(+) 0.5 m to (+) 1.2 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**2527.44**

Pazhaya Nadukuppam - 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**
0.0 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	8.00	17.40	17.40	17.40	139.20	97.44	258.22
(+) 0.5 m to (+) 1.2 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**1695.93**

Pazhaya Nadukuppam - 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**
0.0 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	**552.79**

Pazhaya Nadukuppam - 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**
0.0 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	8.00	6.00	6.00	6.00	48.00	33.60	89.04
(+) 0.5 m to (+) 1.2 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**748.49**

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	**3239.34**	**2294**	**1467**	**1176**

Pazhaya Nadukuppam - G3 (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**
(-) 1.5 m to (-) 2.0 m	10.00	35.30	29.50	32.40	324.00	226.80	601.02
(-) 1.0 m to (-) 1.5 m	9.00	29.50	26.20	27.85	250.65	175.46	464.96
(-) 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	7.00	18.40	25.90	22.15	155.05	108.54	287.62
0 to (+) 0.5 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
(+) 0.5 m to (+) 1.2 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3627.64**

Pazhaya Nadukuppam - G3 (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**
(-) 1.5 m to (-) 2.0 m	10.00	38.20	33.80	36.00	360.00	252.00	667.80
(-) 1.0 m to (-) 1.5 m	9.00	33.80	26.90	30.35	273.15	191.21	506.69
(-) 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	7.00	17.40	17.40	17.40	121.80	85.26	225.94
0 to (+) 0.5 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
(+) 0.5 m to (+) 1.2 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**2962.06**

Pazhaya Nadukuppam - G3 (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**
(-) 1.5 m to (-) 2.0 m	10.00	16.50	16.50	16.50	165.00	115.50	306.08
(-) 1.0 m to (-) 1.5 m	9.00	16.50	15.70	16.10	144.90	101.43	268.79
(-) 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	7.00	14.90	14.90	14.90	104.30	73.01	193.48
						Total	**1161.23**

Pazhaya Nadukuppam - G3 (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**
(-) 1.5 m to (-) 2.0 m	10.00	9.60	9.20	9.40	94.00	65.80	174.37
(-) 1.0 m to (-) 1.5 m	9.00	9.20	8.70	8.95	80.55	56.39	149.42
(-) 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	7.00	7.80	6.00	6.90	48.30	33.81	89.60
0 to (+) 0.5 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
(+) 0.5 m to (+) 1.2 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1089.16**

Head portion (-2.0 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	5.00	12.60	3.00	1075.76		
Armour Layer	3.00	8.20	2.50	295.13		
			Total Armour layer		409.83	**1086.06**
Toe mound layer						
Toe mound	1.30	18.00	15.60	1154.06		
	1.30	10.60	8.20	362.64		
			Total Toe mound layer		415.49	**1101.06**
Core Material	4.20	10.60	2.50	637.90	334.90	**887.48**
Filter Layer	0.30	20.10	19.50	369.33	193.90	**513.83**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**4713.70**	**3850**	**2262**	**1603**

Pazhaya Nadukuppam - G4 (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 (-) 2.7 m	28.00	42.70	38.90	40.80	1142.40	799.68	2119.15
(-) 2.0 m to (-) 2.5 m	22.00	38.90	35.30	37.10	816.20	571.34	1514.05
(-) 1.5 m to (-) 2.0 m	8.00	35.30	29.50	32.40	259.20	181.44	480.82
(-) 1.0 m to (-) 1.5 m	6.00	29.50	26.20	27.85	167.10	116.97	309.97
(-) 0.5 m to (-) 1.0 m	6.00	26.20	21.40	23.80	142.80	99.96	264.89
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	9.00	25.90	25.90	25.90	233.10	163.17	432.40
(+) 0.5 m to (+) 1.2 m	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**	**6922.40**

Pazhaya Nadukuppam - G4 (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 (-) 2.7 m	28.00	46.70	46.20	46.45	1300.60	910.42	2412.61
(-) 2.0 m to (-) 2.5 m	22.00	46.20	38.20	42.20	928.40	649.88	1722.18
(-) 1.5 m to (-) 2.0 m	8.00	38.20	33.80	36.00	288.00	201.60	534.24
(-) 1.0 m to (-) 1.5 m	6.00	33.80	26.90	30.35	182.10	127.47	337.80
(-) 0.5 m to (-) 1.0 m	6.00	26.90	23.10	25.00	150.00	105.00	278.25
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	9.00	17.40	17.40	17.40	156.60	109.62	290.49
(+) 0.5 m to (+) 1.2 m	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	**6696.36**

Pazhaya Nadukuppam - G4 (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 (-) 2.7 m	28.00	17.20	16.50	16.85	471.80	330.26	875.19
(-) 2.0 m to (-) 2.5 m	22.00	16.50	16.50	16.50	363.00	254.10	673.37
(-) 1.5 m to (-) 2.0 m	8.00	16.50	16.50	16.50	132.00	92.40	244.86
(-) 1.0 m to (-) 1.5 m	6.00	16.50	15.70	16.10	96.60	67.62	179.19
(-) 0.5 m to (-) 1.0 m	6.00	15.70	14.90	15.30	91.80	64.26	170.29
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	**2419.29**

Pazhaya Nadukuppam - G4 (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 (-) 2.7 m	28.00	10.20	10.10	10.15	284.20	198.94	527.19
(-) 2.0 m to (-) 2.5 m	22.00	10.10	9.60	9.85	216.70	151.69	401.98
(-) 1.5 m to (-) 2.0 m	8.00	9.60	9.20	9.40	75.20	52.64	139.50
(-) 1.0 m to (-) 1.5 m	6.00	9.20	8.70	8.95	53.70	37.59	99.61
(-) 0.5 m to (-) 1.0 m	6.00	8.70	8.30	8.50	51.00	35.70	94.61
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	9.00	6.00	6.00	6.00	54.00	37.80	100.17
(+) 0.5 m to (+) 1.2 m	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	**1894.98**

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**
80 m	**8366.44**	**7901**	**3659**	**2478**

Pazhaya Nadukuppam - G4 (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**
(-) 2.0 m to (-) 2.5 m	9.00	38.90	35.30	37.10	333.90	233.73	619.38
(-) 1.5 m to (-) 2.0 m	7.00	35.30	29.50	32.40	226.80	158.76	420.71
(-) 1.0 m to (-) 1.5 m	6.00	29.50	26.20	27.85	167.10	116.97	309.97
(-) 0.5 m to (-) 1.0 m	7.00	26.20	21.40	21.40	149.80	104.86	277.88
0.0 m to (-) 0.5 m	6.00	21.40	18.40	18.40	110.40	77.28	204.79
at 0.0 m	5.00	18.40	25.90	25.90	129.50	90.65	240.22
0 to (+) 0.5 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
(+) 0.5 m to (+) 1.2 m	7.00	25.90	25.90	26.45	185.15	129.61	343.45
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3779.47**

Pazhaya Nadukuppam - G4 (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**
(-) 2.0 m to (-) 2.5 m	9.00	46.20	38.20	42.20	379.80	265.86	704.53
(-) 1.5 m to (-) 2.0 m	7.00	38.20	33.80	36.00	252.00	176.40	467.46
(-) 1.0 m to (-) 1.5 m	6.00	33.80	26.90	30.35	182.10	127.47	337.80
(-) 0.5 m to (-) 1.0 m	7.00	26.90	23.10	25.00	175.00	122.50	324.63
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	7.00	17.40	17.40	17.40	121.80	85.26	225.94
(+) 0.5 m to (+) 1.2 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**3186.43**

Pazhaya Nadukuppam - G4 (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**
(-) 2.0 m to (-) 2.5 m	9.00	16.50	16.50	16.50	148.50	103.95	275.47
(-) 1.5 m to (-) 2.0 m	7.00	16.50	16.50	16.50	115.50	80.85	214.25
(-) 1.0 m to (-) 1.5 m	6.00	16.50	15.70	16.10	96.60	67.62	179.19
(-) 0.5 m to (-) 1.0 m	7.00	15.70	14.90	15.30	107.10	74.97	198.67
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	**1171.62**

Pazhaya Nadukuppam - G4 (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**
(-) 2.0 m to (-) 2.5 m	9.00	10.10	9.60	9.85	88.65	62.06	164.45
(-) 1.5 m to (-) 2.0 m	7.00	9.60	9.20	9.40	65.80	46.06	122.06
(-) 1.0 m to (-) 1.5 m	6.00	9.20	8.70	8.95	53.70	37.59	99.61
(-) 0.5 m to (-) 1.0 m	7.00	8.70	8.30	8.50	59.50	41.65	110.37
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	7.00	6.00	6.00	6.00	42.00	29.40	77.91
(+) 0.5 m to (+) 1.2 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1110.12**

Head portion (-2.5 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	5.50	13.50	3.00	1334.11		
Armour Layer	3.50	9.20	2.50	417.22		
			Total Armour layer		481.37	**1275.62**
Toe mound layer						
Toe mound	1.30	19.00	16.50	1288.21		
	1.30	11.60	9.20	443.47		
			Total Toe mound layer		443.49	**1175.25**
Core Material	4.70	11.60	2.50	835.35	438.56	**1162.18**
Filter Layer	0.30	21.00	20.50	405.61	212.94	**564.30**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**5055.09**	**4349**	**2347**	**1674**

Pazhaya Nadukuppam - 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	7.00	25.90	25.90	25.90	181.30	126.91	336.31
(+) 0.5 m to (+) 1.2 m	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**2530.87**

Pazhaya Nadukuppam - 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	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	7.00	17.40	17.40	17.40	121.80	85.26	225.94
(+) 0.5 m to (+) 1.2 m	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**1778.20**

Pazhaya Nadukuppam - 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**

Pazhaya Nadukuppam - 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	7.00	6.00	6.00	6.00	42.00	29.40	77.91
(+) 0.5 m to (+) 1.2 m	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**756.38**

Head portion (-1.3 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	4.30	11.20	3.00	756.29		
Armour Layer	2.40	7.30	2.60	198.52		
			Total Armour layer		292.83	**776.00**
Toe mound layer						
Toe mound	1.30	16.60	14.20	970.05		
	1.30	9.70	7.30	296.88		
			Total Toe mound layer		353.41	**936.54**
Core Material	3.70	9.70	2.60	488.23	256.32	**679.25**
Filter Layer	0.30	18.70	18.10	318.95	167.45	**443.74**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3306.86**	**2457**	**1497**	**1200**

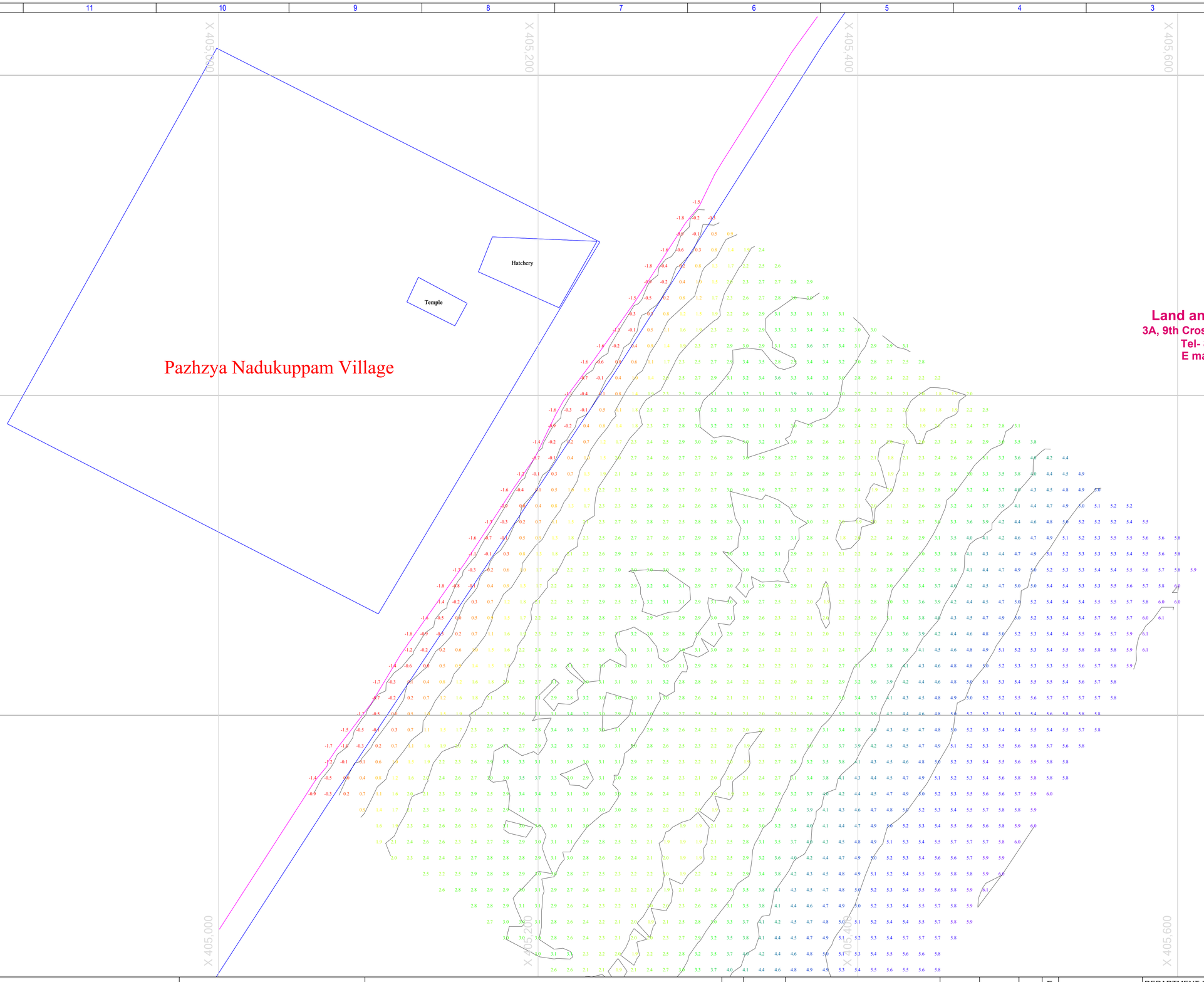
10.1 Total Quantity of Groynes

QUANTITY IN TONNES PAZHAYA NADUKUPPAM	
GROYNES G1 TO G6	
ARMOUR LAYER (Rubble mound)	28036
CORE LAYER	23342
TOE MOUND LAYER	12729
FILTER LAYER	8168
Total Quantity of Groynes	**72275**

11.0 RECOMMENDATION

A comprehensive study was carried out on arriving at the coastal protection measure for a stretch of 570 m along the coast of Pazhaya Nadukuppam (latitude 12°25'17.57"N and longitude 80°7'35.28"E), as per the request of The Fisheries Department, Tamilnadu. After deriving the offshore wave climate from the wind climate, the driving forces, breaker wave characteristics were obtained, which were then applied to estimate the longshore sediment characteristics, both its magnitude and direction**.** The net sediment transport of the study area is estimated to be about 1.38 Lakhs per annum directed towards North. To combat erosion, a transitional groin filed of 6 groynes. The proposed groyne field 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 also the bathymetry. IIT Madras should be informed prior to the commencement of the construction.

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



N

SURVEYED BY

LA MER

Land and Hydrographic Surveys & Eng.

3A, 9th Cross street, Brindavanam, Puducherry- 605013
Tel- 8072388374, M 9487984922,
E mail- lamer.hydro@gmail.com

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

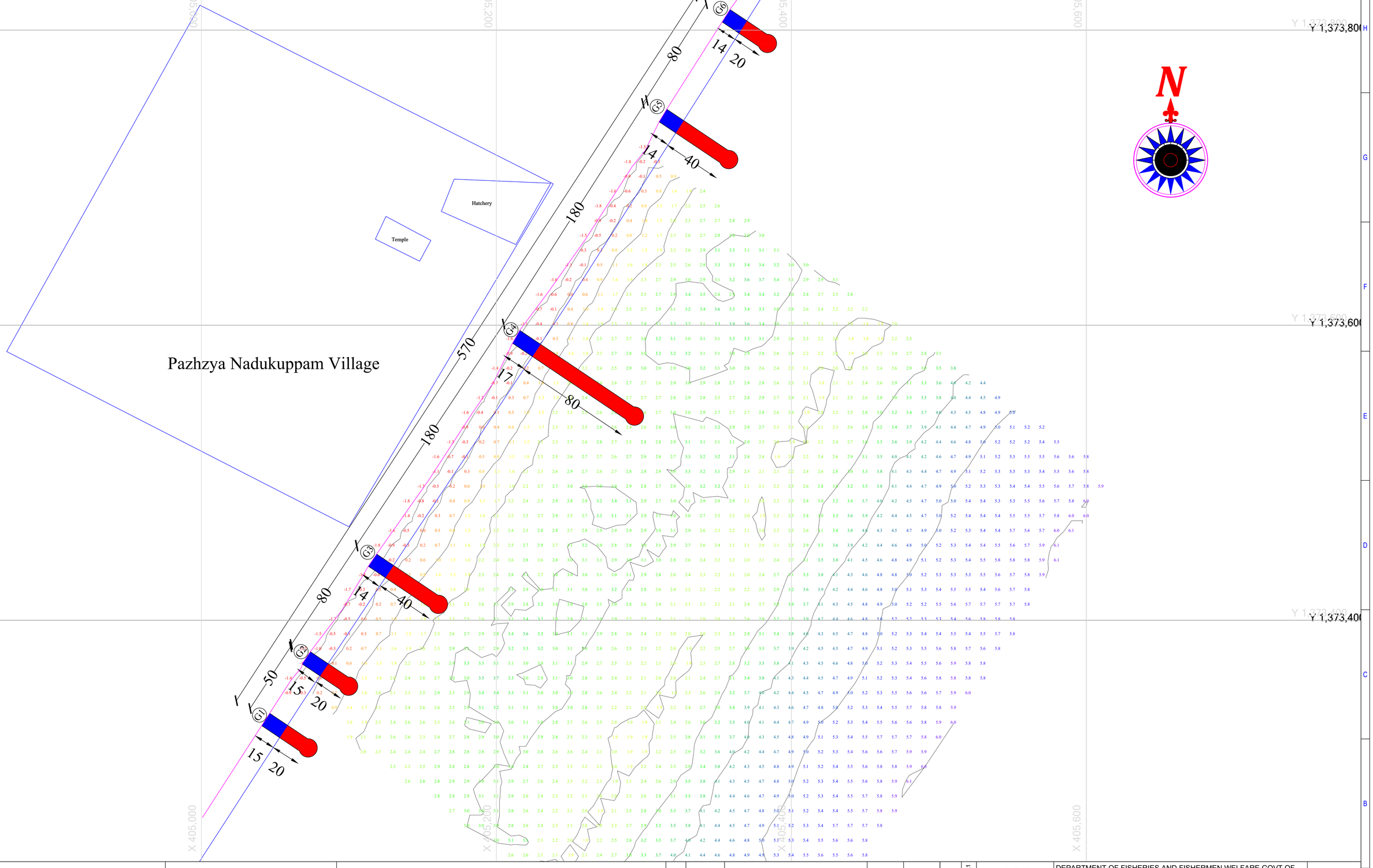
REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	AKE

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 PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM BATHYMETRY MAP
DRAWING NO:	IITM - PAZK - GY - 001
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI 600036

DATE: 27.10.2022

Scale as shown
REV 0



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 15TH MARCH 2022.

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

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

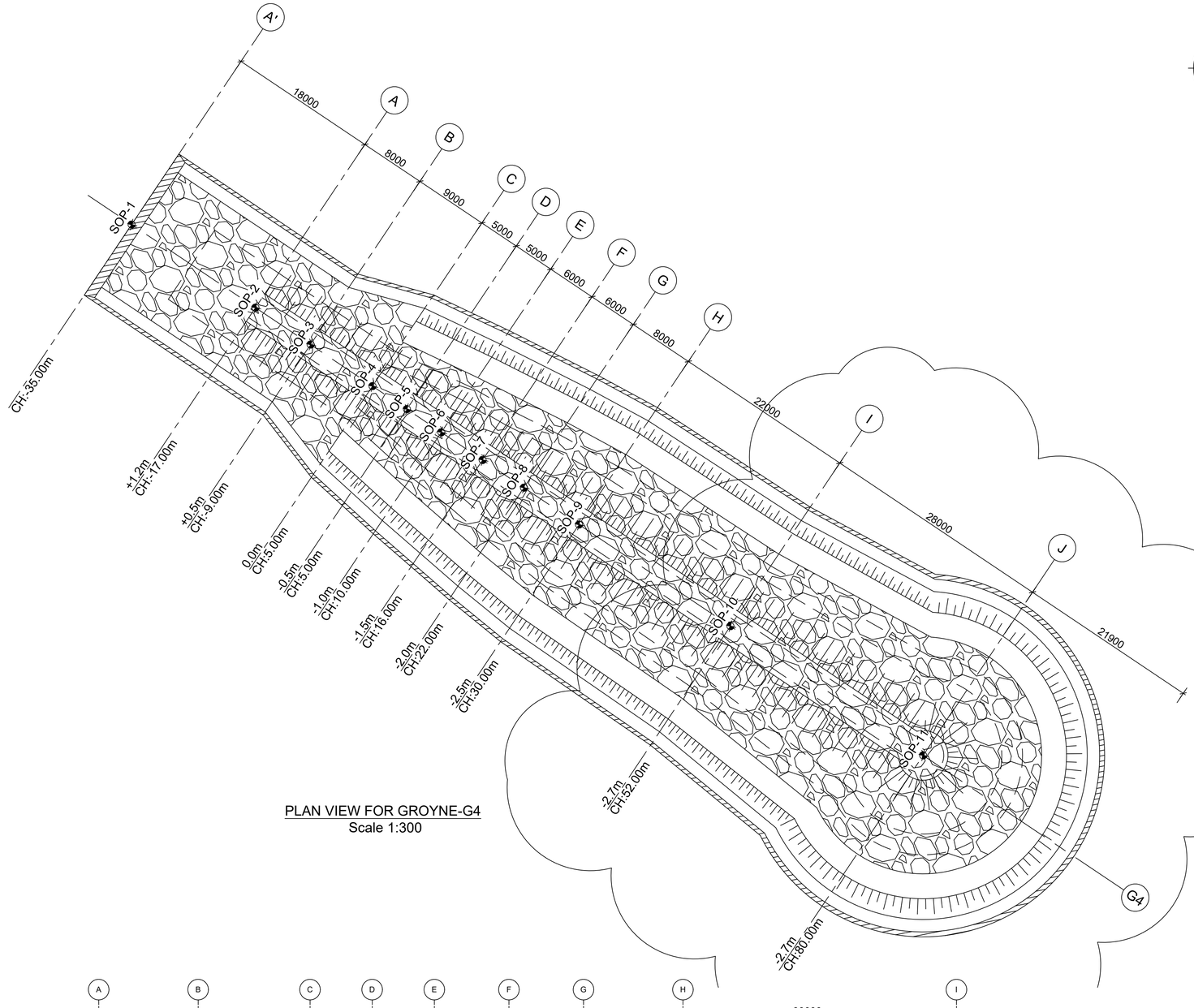
REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	CS

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 PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM OVERALL GROYNE LAYOUT
DRAWING NO:	IITM - PAZK - GY - 101 - 01
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.10.2022

Scale as shown REV 0



PLAN VIEW FOR GROYNE-G4
Scale 1:300

N

GROYNE SETTING OUT POINTS:-

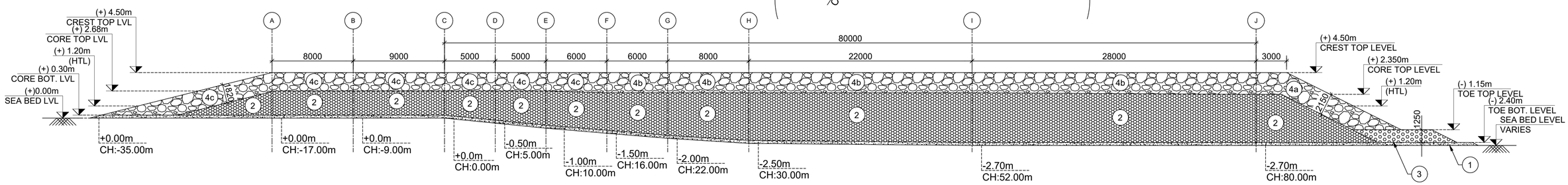
SOP	EASTINGS (m)	NORTHINGS (m)
SOP 01	405198.088	1373602.455
SOP 02	405213.038	1373592.430
SOP 03	405219.683	1373587.975
SOP 04	405227.158	1373582.962
SOP 05	405231.311	1373580.178
SOP 06	405235.464	1373577.393
SOP 07	405240.447	1373574.051
SOP 08	405245.430	1373570.710
SOP 09	405252.075	1373566.254
SOP 10	405270.347	1373554.002
SOP 11	405293.603	1373538.408

CHAINAGE, (m)	PRIMARY ARMOUR
CH. -35.00 TO +16.00	1.5T TO 2.5T STONES
CH. +16.00 TO +80.00	2.5T TO 3.5T STONES
CH. +16.00 TO HEAD PORTION	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

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



LONGITUDINAL SECTIONAL VIEW FOR GROYNE-G4
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 :-

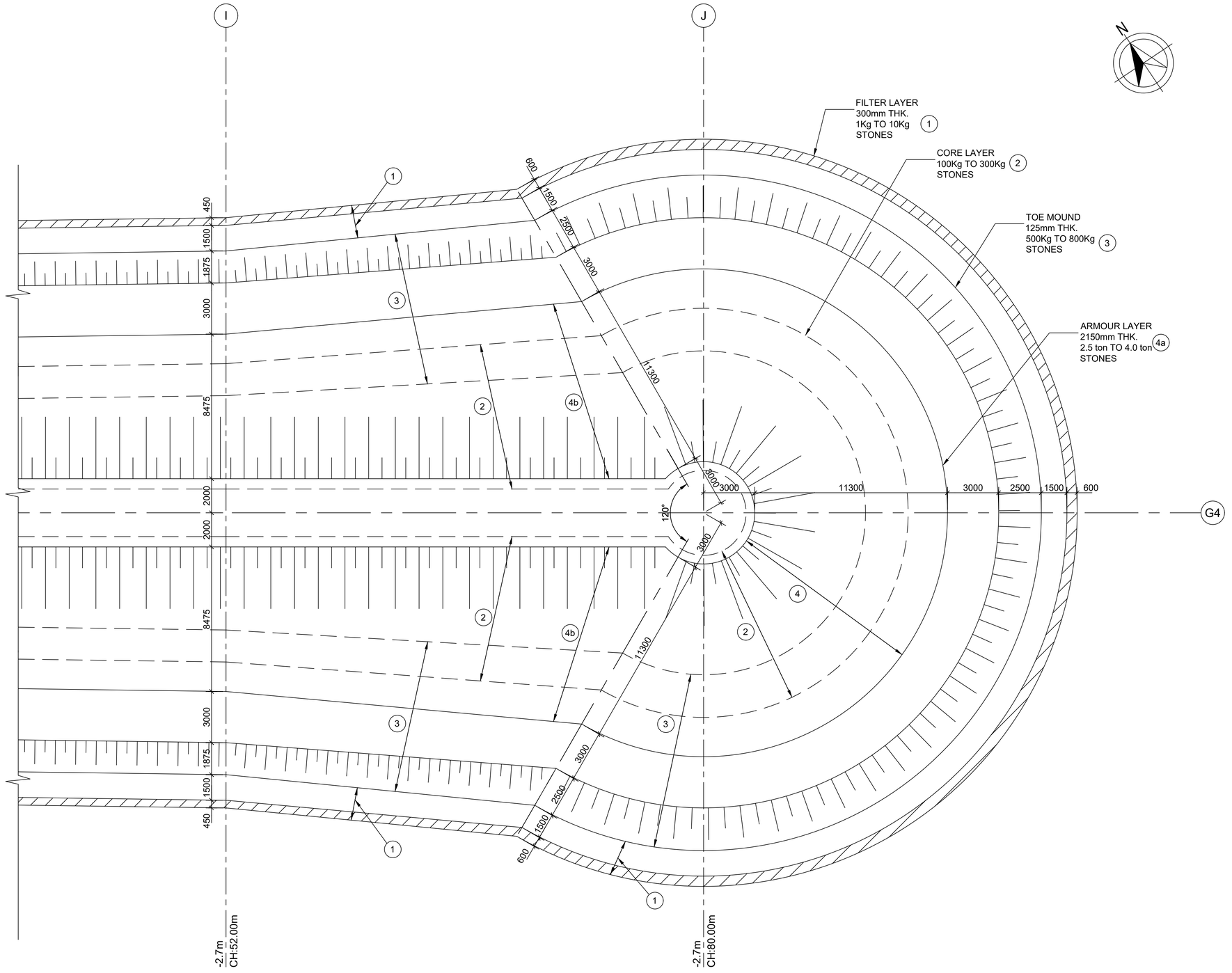
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-PAZK-GY-101-01
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001

126

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.	DATE: 27.10.2022
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.	
DRAWING TITLE:	PAZHAYANADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (2 OF 9)	
DRAWING NO:	IITM - PAZK - GY - 101 - 02	Scale as shown REV 0
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036	



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-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02

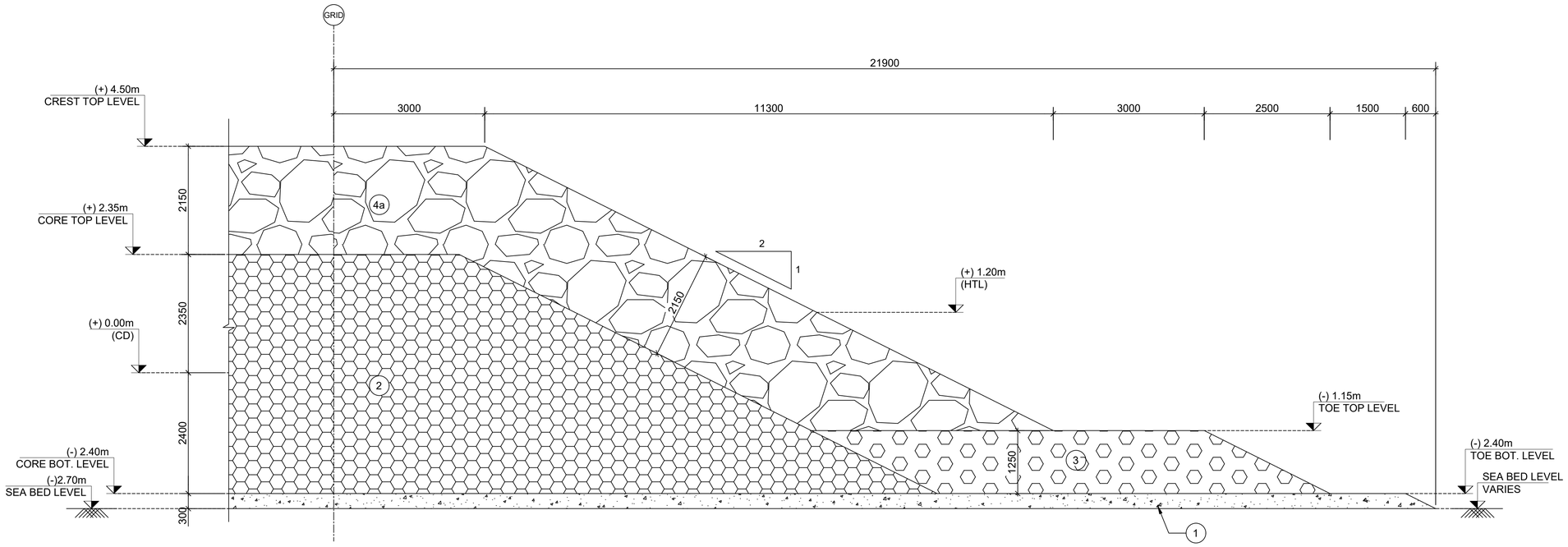
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

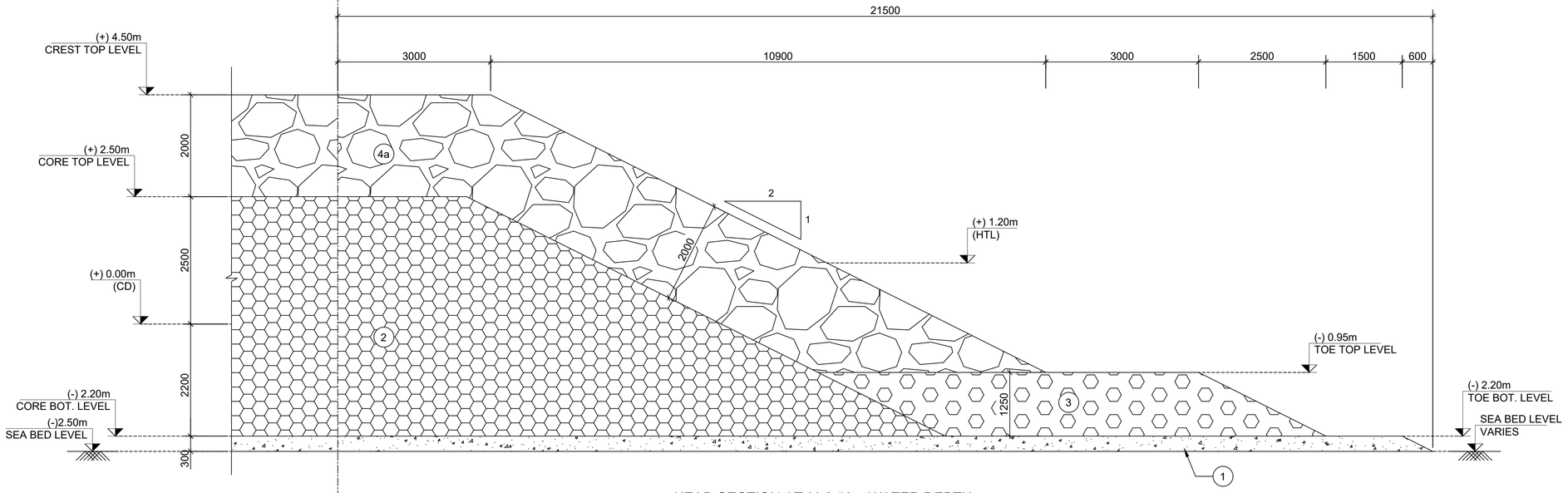
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (3 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 03
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 27.10.2022
Scale as shown
REV 0



HEAD SECTION AT (-) 2.70m WATER DEPTH
Scale 1:50



HEAD SECTION AT (-) 2.50m 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 :
   a) IITM-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02
   c) IITM-PAZK-GY-101-03
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001 128

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
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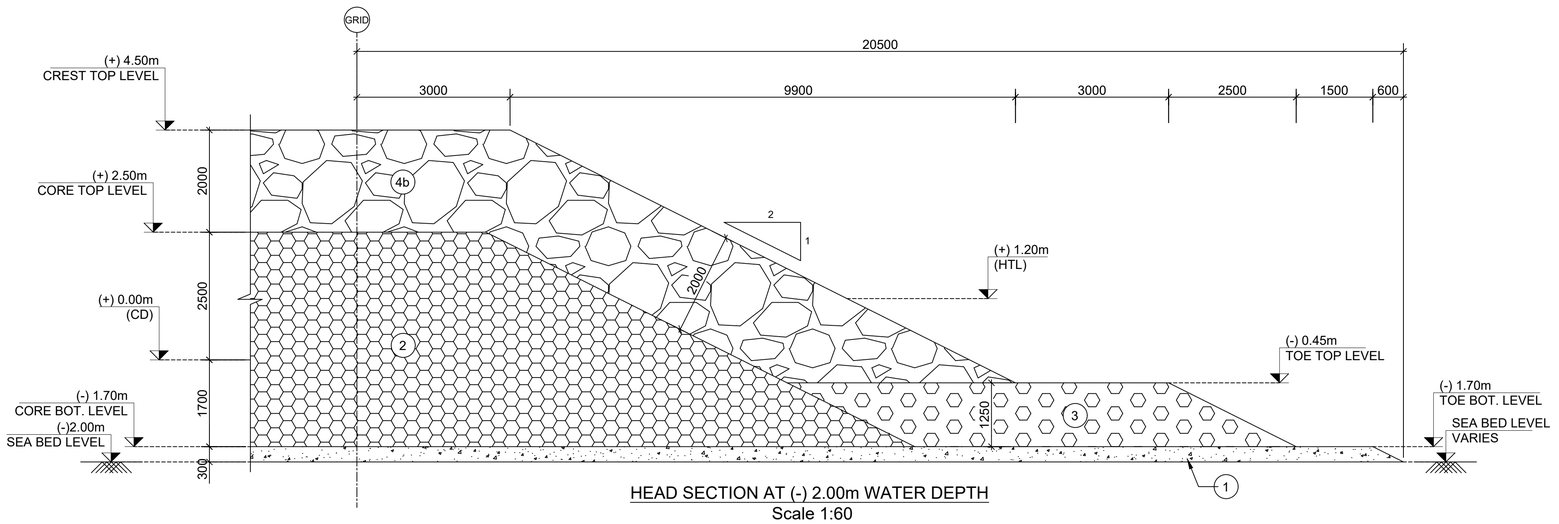
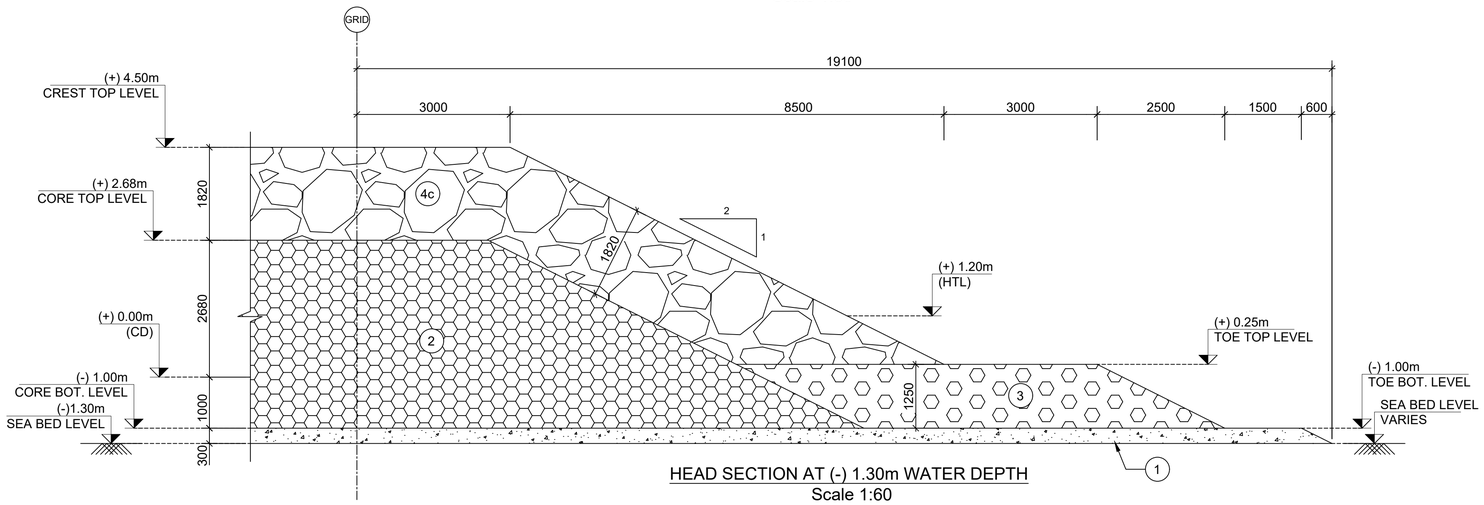
ORIGINAL SIZE:A1

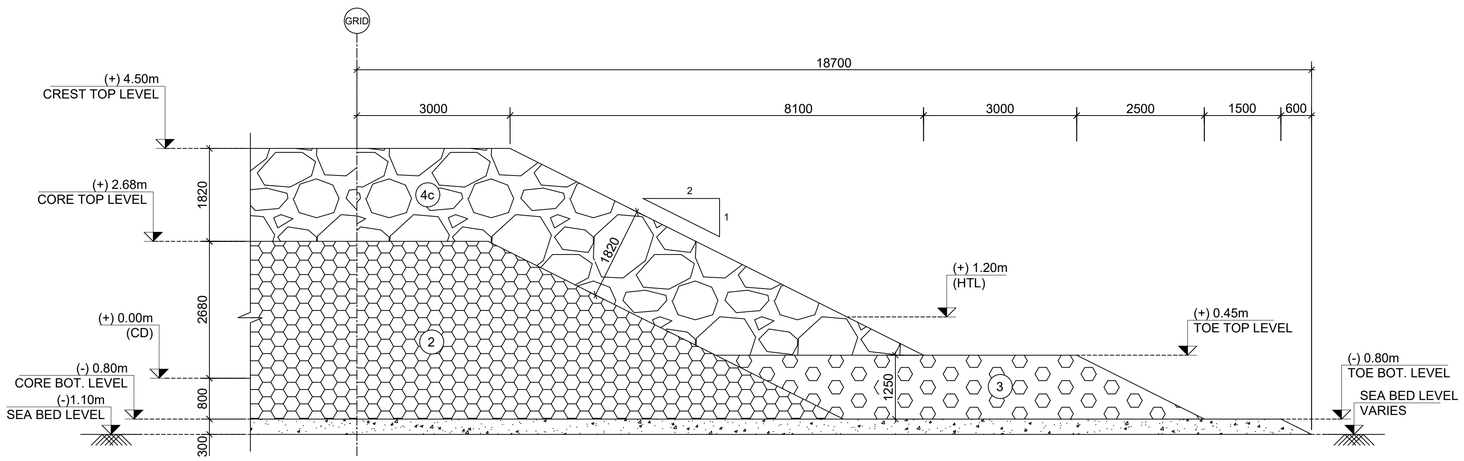
CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.	DATE: 27.10.2022
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT. PAZHAYANADUKUPPAM-GROYNE	
DRAWING TITLE:	GENERAL ARRANGMENT SHEET (4 OF 9)	
DRAWING NO:	IITM - PAZK - GY - 101 - 04	Scale as shown REV 0
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036	



HEAD SECTION AT (-) 2.00m WATER DEPTH
Scale 1:60



HEAD SECTION AT (-) 1.30m WATER DEPTH
Scale 1:60



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

NOTES :-

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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-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02
   c) IITM-PAZK-GY-101-03
   d) IITM-PAZK-GY-101-04
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001 129

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

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 PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (5 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 05
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 27.10.2022
Scale as shown
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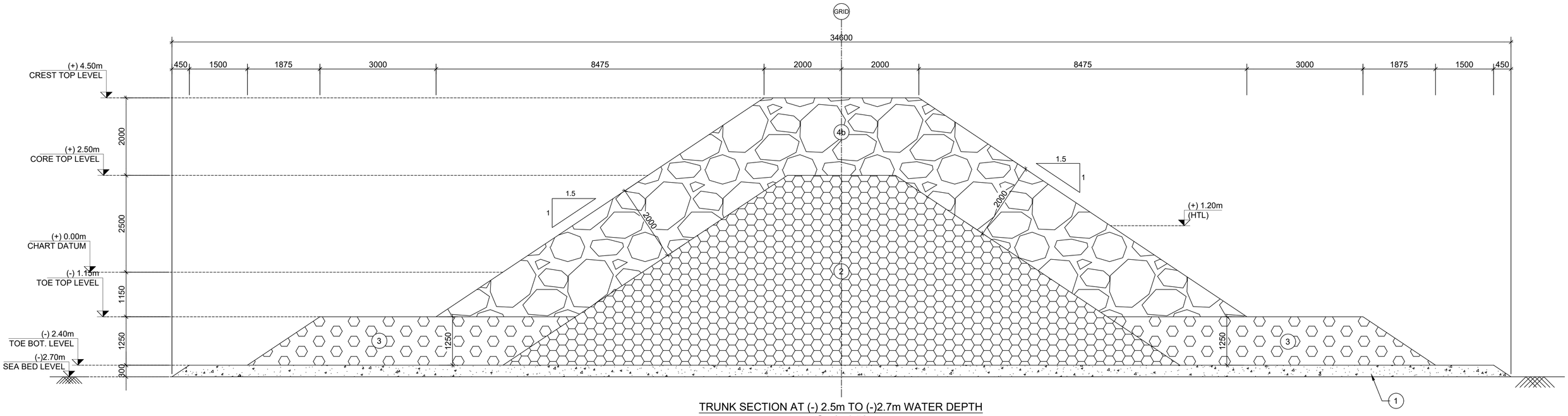

TRUNK SECTION AT (-) 2.5m TO (-)2.7m WATER DEPTH
Scale 1:50

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, 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-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02
   c) IITM-PAZK-GY-101-03
   d) IITM-PAZK-GY-101-04
   e) IITM-PAZK-GY-101-05
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001 130

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

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 PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT. PAZHAYANADUKUPPAM-GROYNE
DRAWING TITLE:	GENERAL ARRANGMENT SHEET (6 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 27.10.2022
Scale as shown
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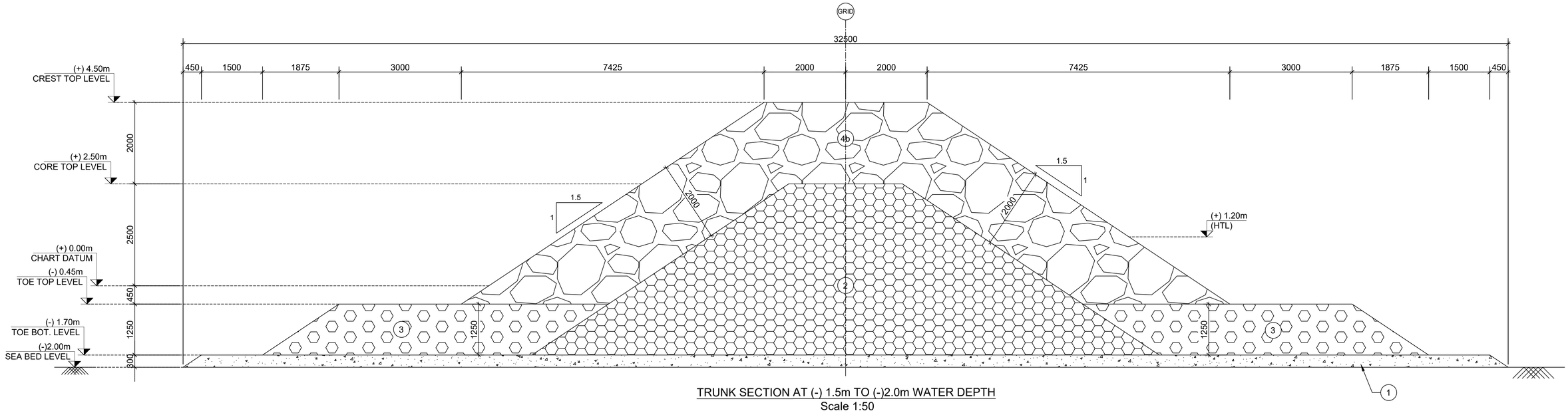
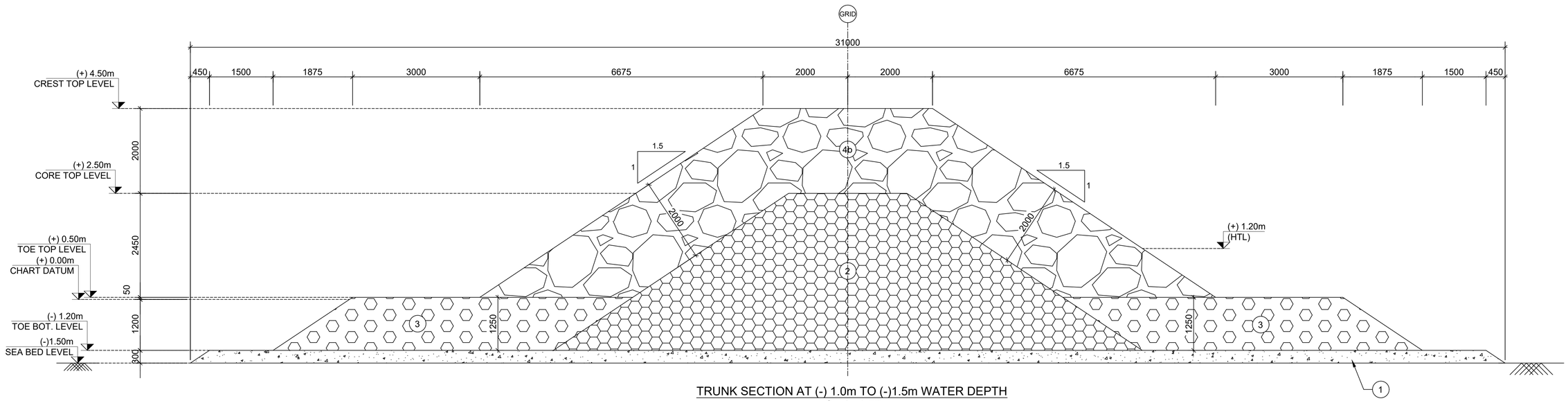


TRUNK SECTION AT (-) 1.5m TO (-)2.0m WATER DEPTH

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
- (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-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02
   c) IITM-PAZK-GY-101-03
   d) IITM-PAZK-GY-101-04
   e) IITM-PAZK-GY-101-05
   f) IITM-PAZK-GY-101-06
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

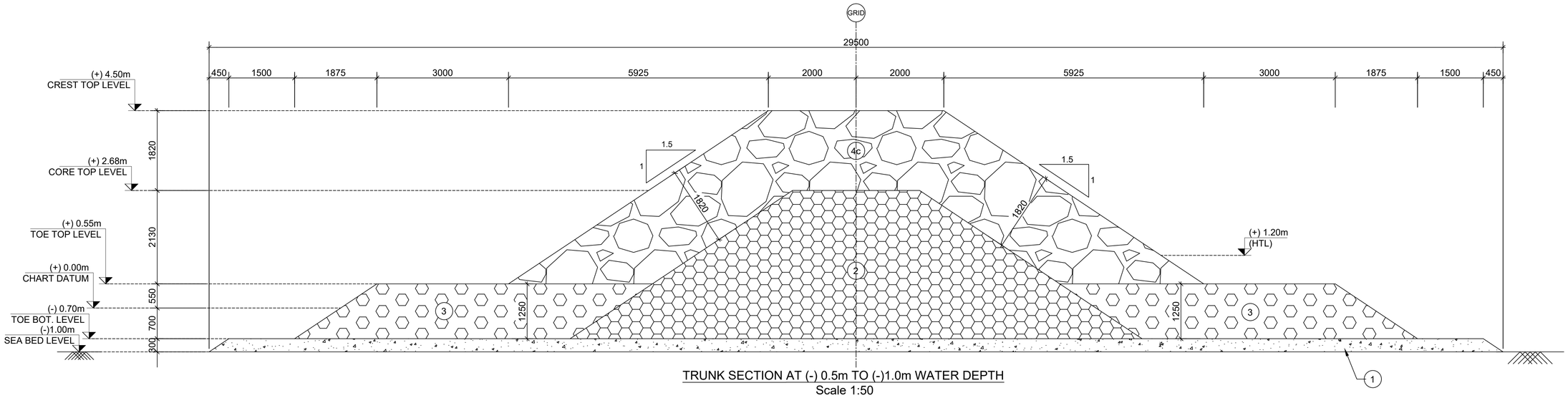
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (7 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 07
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 27.10.2022

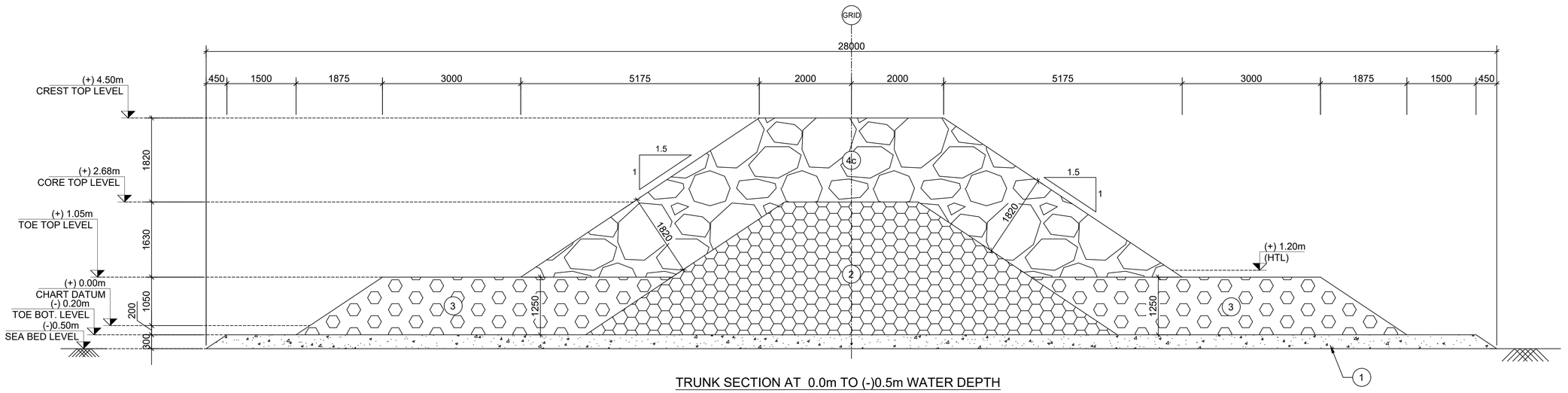
Scale as shown

REV 0



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

Scale 1:50



TRUNK SECTION AT 0.0m TO (-)0.5m 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, 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-PAZK-GY-101-01
   b) IITM-PAZK-GY-101-02
   c) IITM-PAZK-GY-101-03
   d) IITM-PAZK-GY-101-04
   e) IITM-PAZK-GY-101-05
   f) IITM-PAZK-GY-101-06
   g) IITM-PAZK-GY-101-07
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

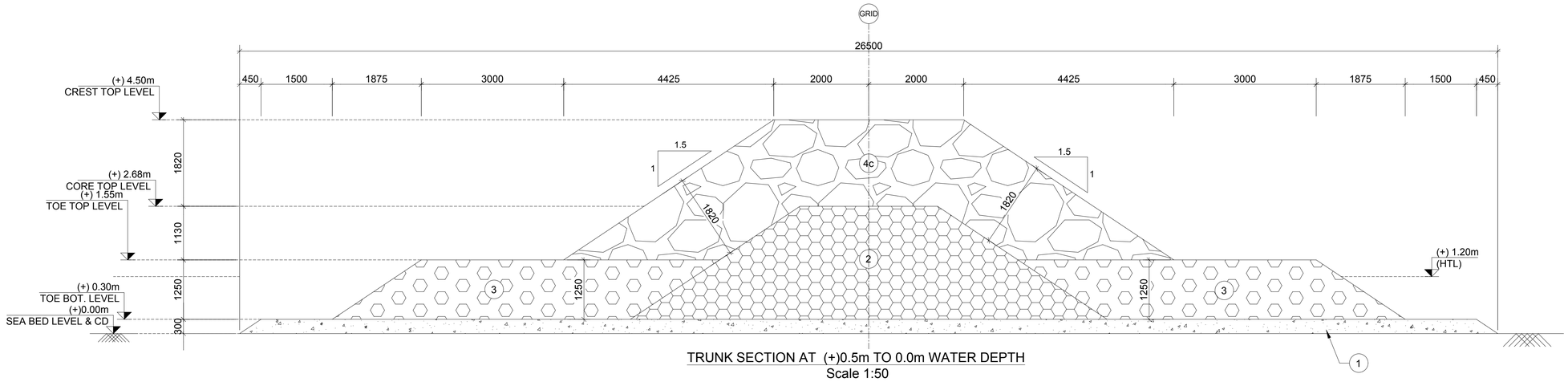
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT. PAZHAYANADUKUPPAM-GROYNE
DRAWING TITLE:	GENERAL ARRANGMENT SHEET (8 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 08
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

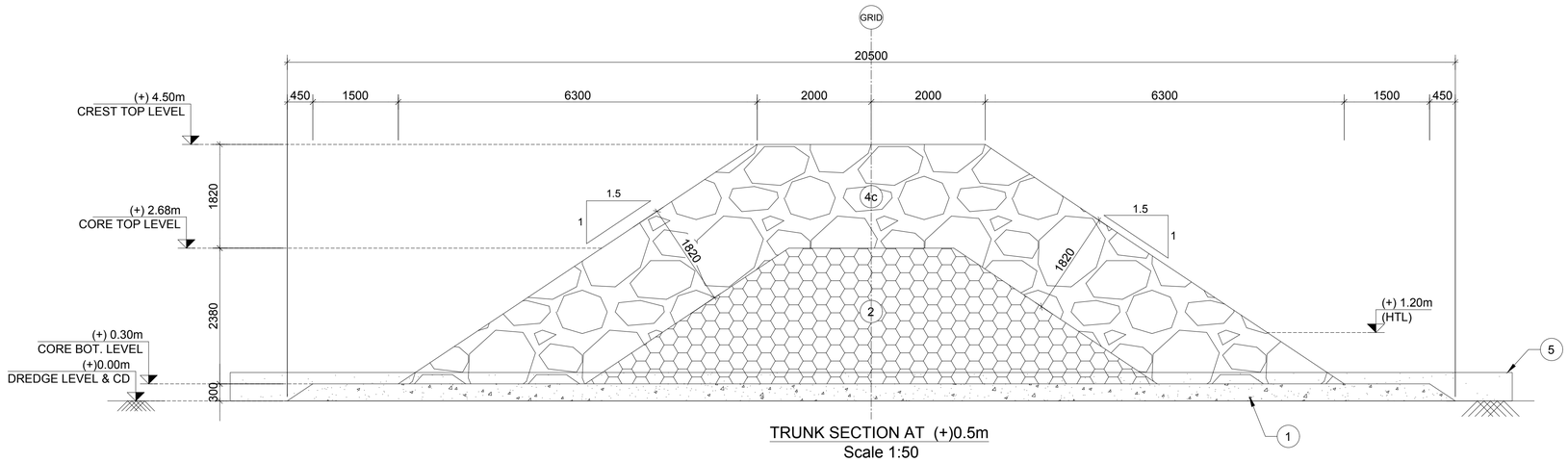
DATE: 27.10.2022

Scale as shown

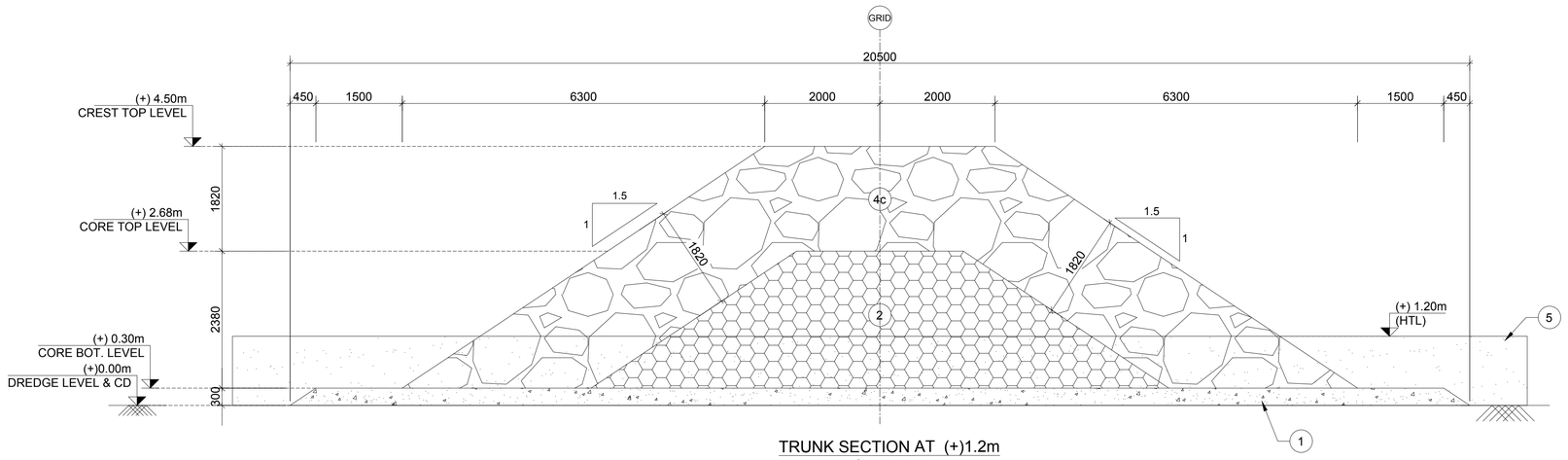
REV 0



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-PAZK-GY-101-01 e) IITM-PAZK-GY-101-05
   b) IITM-PAZK-GY-101-02 f) IITM-PAZK-GY-101-06
   c) IITM-PAZK-GY-101-03 g) IITM-PAZK-GY-101-07
   d) IITM-PAZK-GY-101-04 h) IITM-PAZK-GY-101-08
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-PAZK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	27.10.2022	ISSUED FOR CONSTRUCTION	CS	TR

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 PAZHAYANADUKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	PAZHAYANADUKUPPAM-GROYNE GENERAL ARRANGMENT SHEET (9 OF 9)
DRAWING NO:	IITM - PAZK - GY - 101 - 09
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.10.2022
Scale as shown
REV 0

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

Client

Fisheries Department, Tamilnadu

Consultants

Prof. V.Sundar

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 Kadalore Chinnakuppam. The coastal site of the Kadalore Chinnakuppam is located at latitude 12°26'51.01"N and longitude 80°8'38.96"E, in Chengalpattu district. Prior to the implementation of preventative measures, the Tamilnadu Fisheries Department conducted a bathymetry and topographical study of the area. The location of Kadalore Chinnakuppam is shown in **Fig.1.**

Fig.1 Location of Kadalore Chinnakuppam 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 Kadalore Chinnakuppam 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 520 m off the coast of Kadalore Chinnakuppam 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 - KCK - GY – 001).***

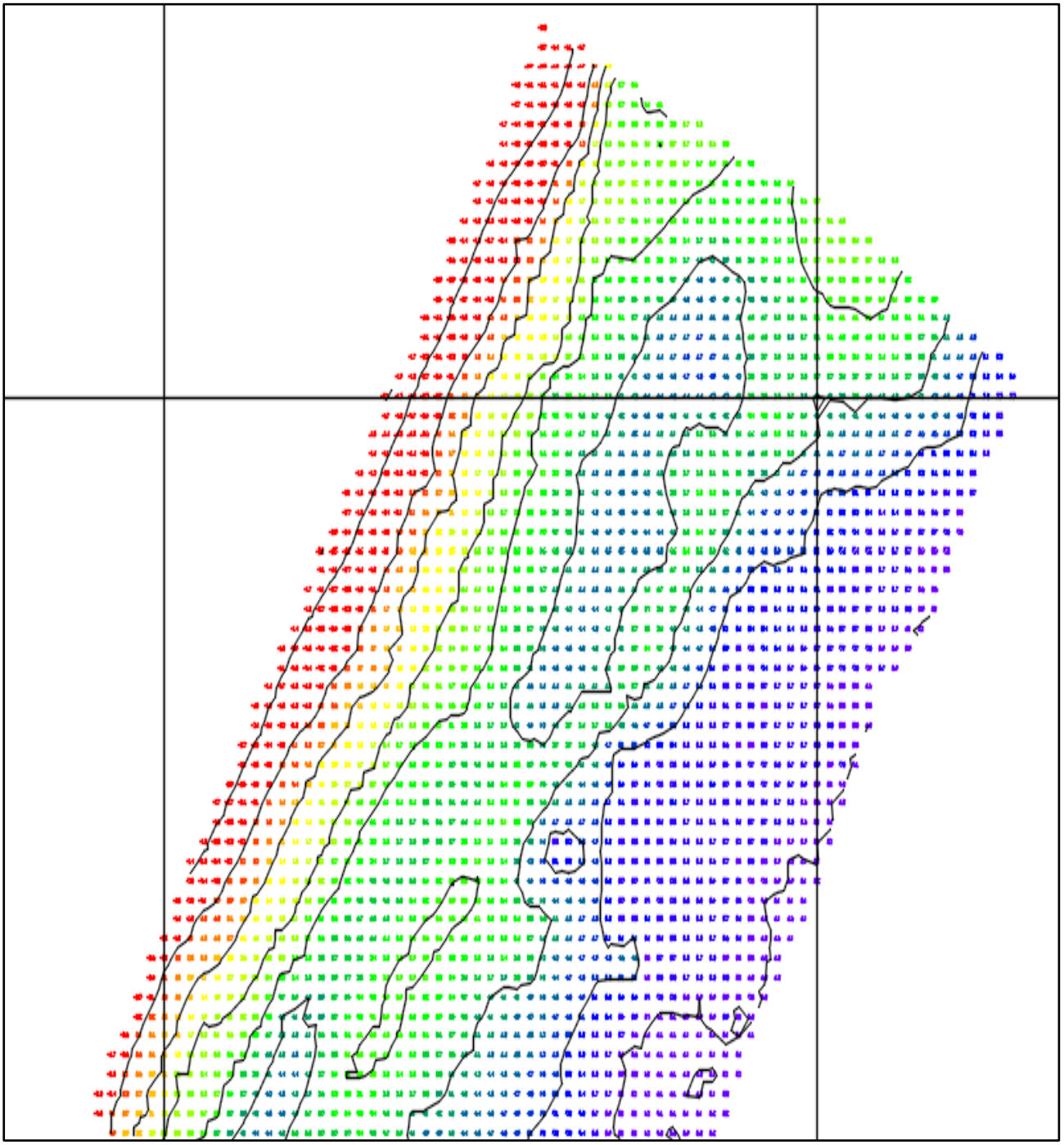


Fig.2 Bathymetry off Kadalore Chinnakuppam stretch provided by the Department of Fisheries, Tamilnadu

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°22'30.00"N, 80°15'0.00"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 noticed that the offshore wave climate of Chengalpattu is predominantly from east and south east.

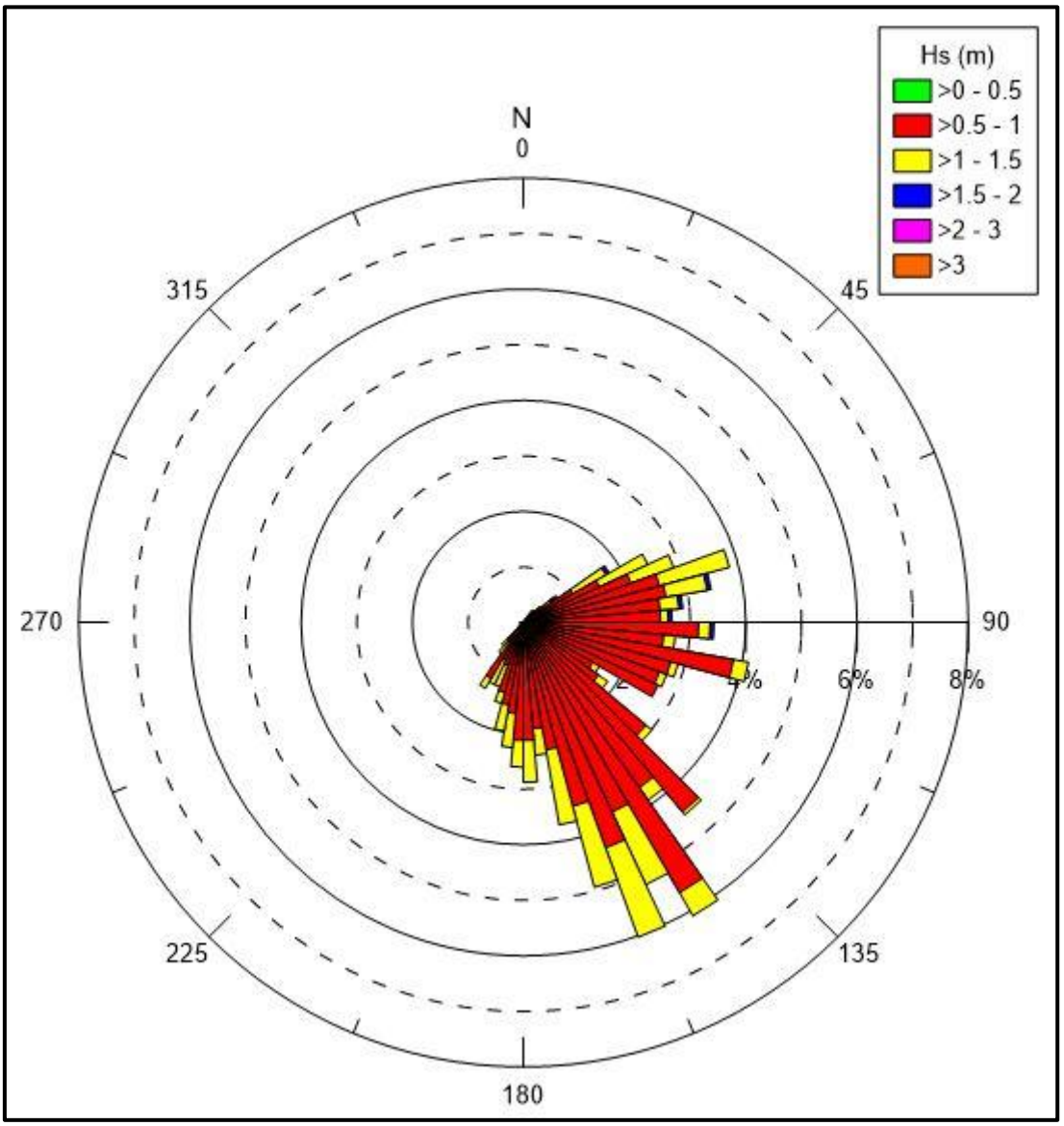


Fig.3 Wave Rose diagram representing the significant wave height (m) along the direction for an annual year

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°22'30.00"N, 80°15'0.00"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 Kadalore Chinnakuppam 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 0.83 m to 1.29 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 80 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 121700 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	66	0.9	5.3
2	February	93	0.7	5.2
3	March	133	0.8	5.6
4	April	150	0.9	5.2
5	May	149	1.0	5.3
6	June	176	1.1	5.3
7	July	185	0.9	5.3
8	August	168	0.8	6.2
9	September	157	1.0	7.1
10	October	148	1.0	5.6
11	November	104	1.0	6.2
12	December	75	0.9	5.6

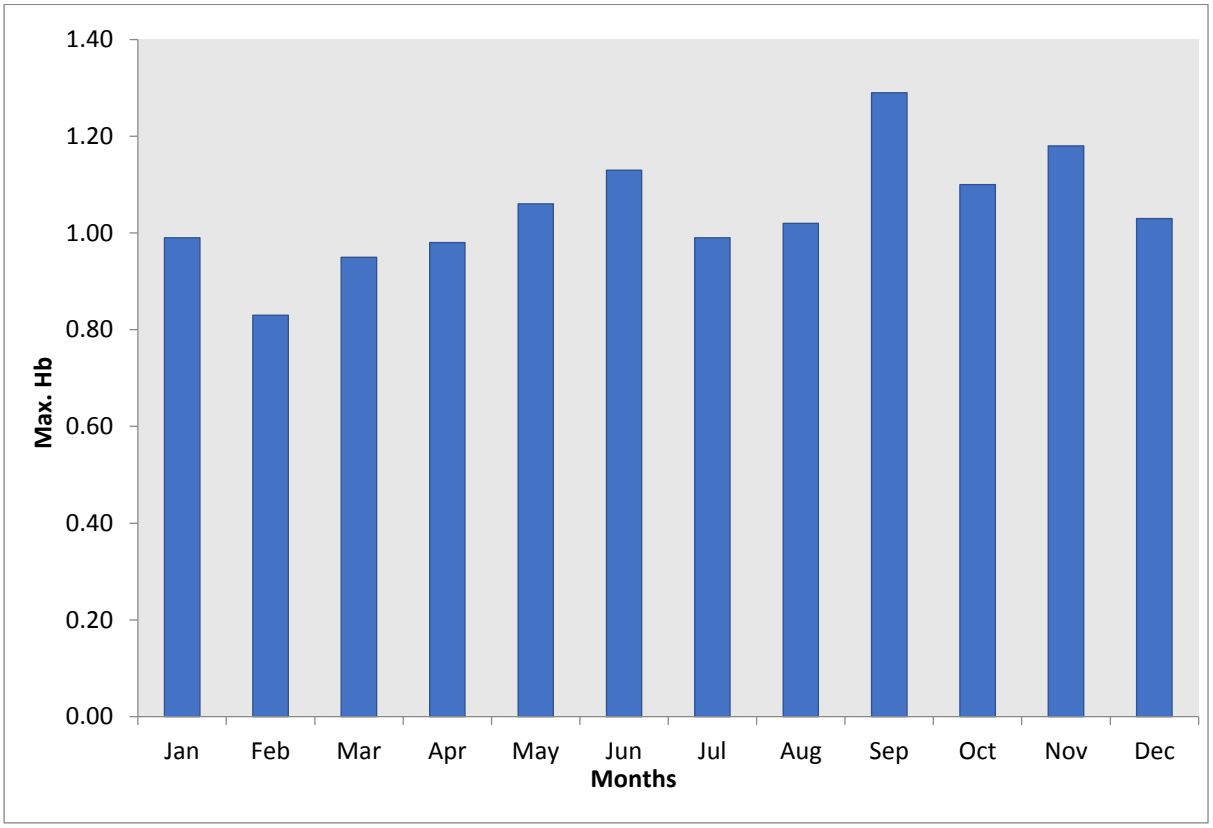


Fig.4 Breaker wave heights in meter

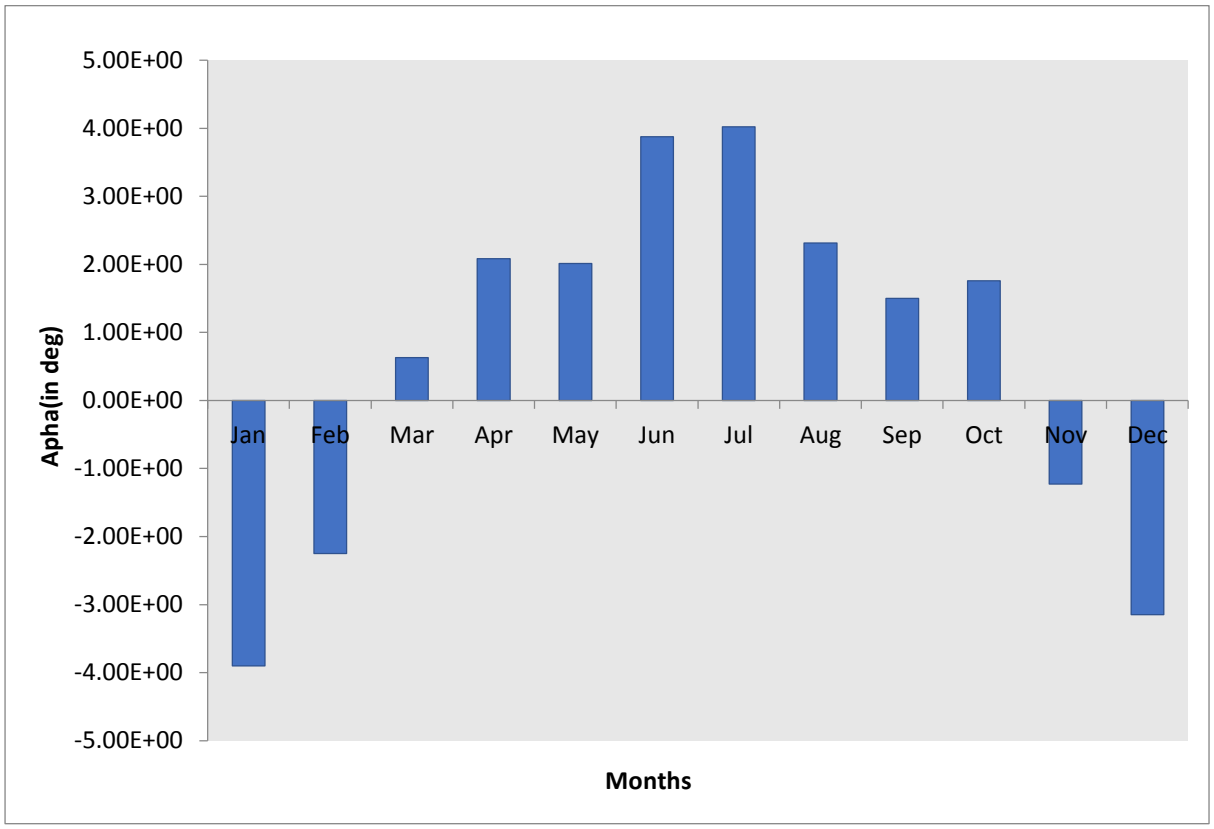


Fig.5 Wave breaker angle

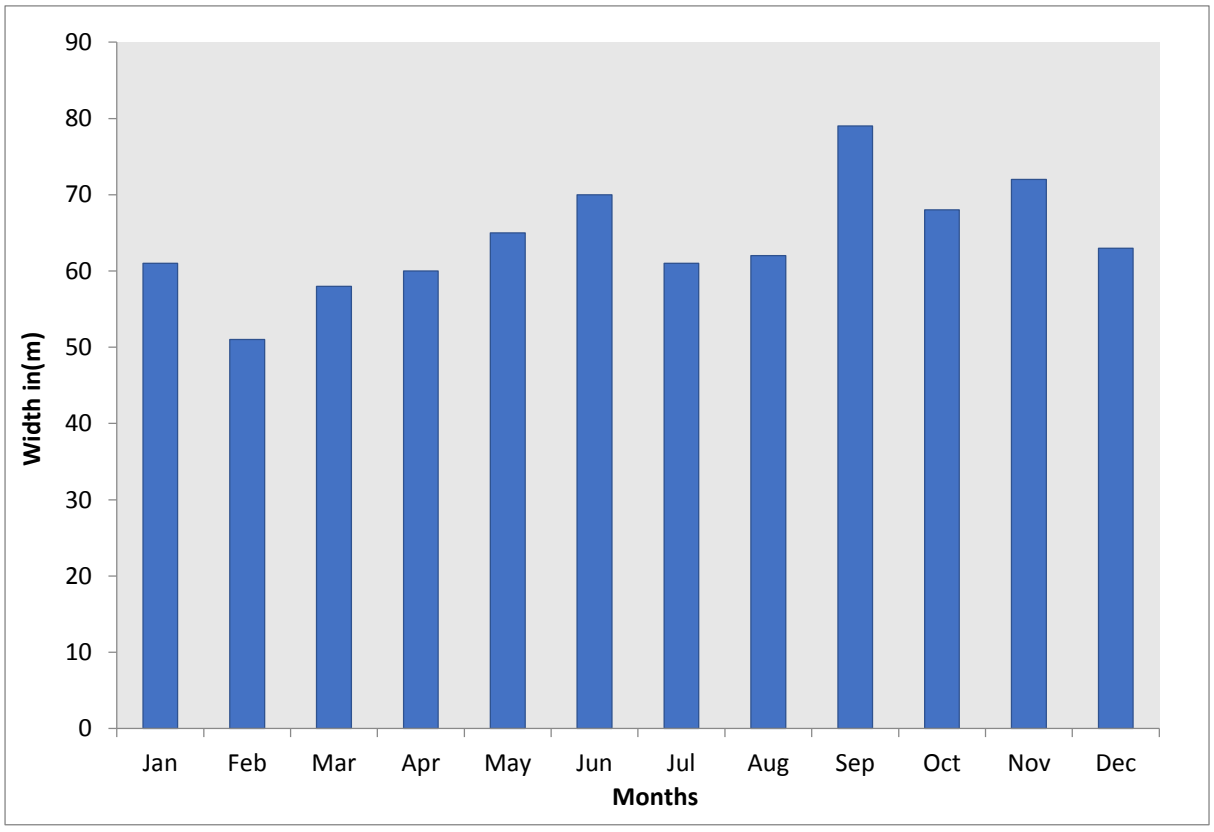


Fig.6 Surf zone width

Table.2 Sediment transport rate (Net Northerly)

Methods	Rate (m^3/year)
Komar	119900
CERC	124800
Distribution	120400

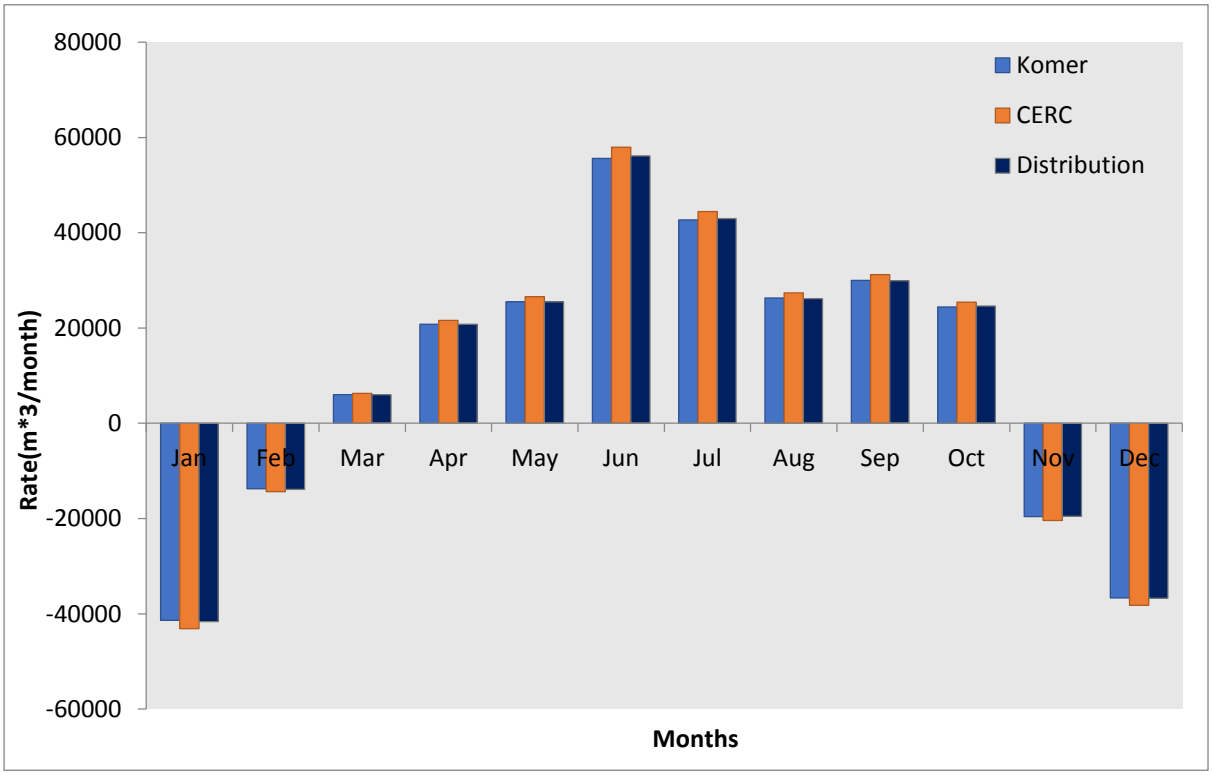


Fig.7 Longshore Sediment transport rate

6.0 PROPOSED LAYOUT OF GROYNES

A series of 5 transitional groynes have been proposed to protect the coastal stretch (520m) of Kadalore Chinnakuppam. **Fig.8** depicts an overview of the proposed groynes superposed over bathymetry provided by the Tamilnadu fisheries department on 09/05/22. The details of which are projected in **Plate *(IITM - KCK - GY - 101 – 01).*** The groynes G10 and G12, each of which measuring 40m in length, would reach a maximum water depth of about 2.0 m. Each of the G13 and G14 should measure 20 metres in length and extend to about 1.3 m and 2.5 m of water depth respectively. Groyne G11 which is 80 m long ,will extend to a water depth of 3.5 m. Kadalore Chinnakuppam was planned adjacent to Kadalore Ali Kuppam and Kadalur Periyakuppam in terms of its groynes length and spacing.

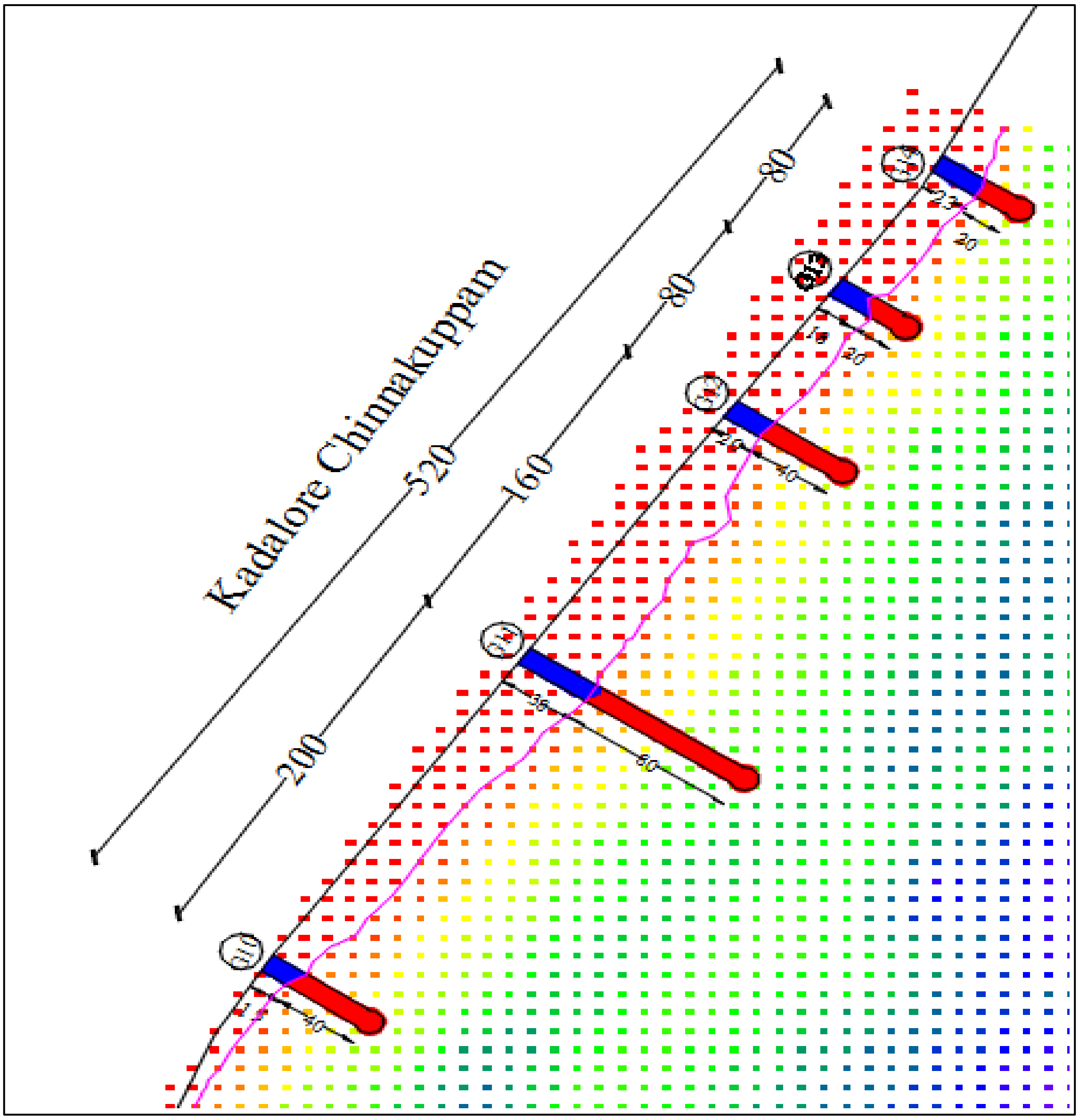


Fig.8 Layout of groynes field

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.**

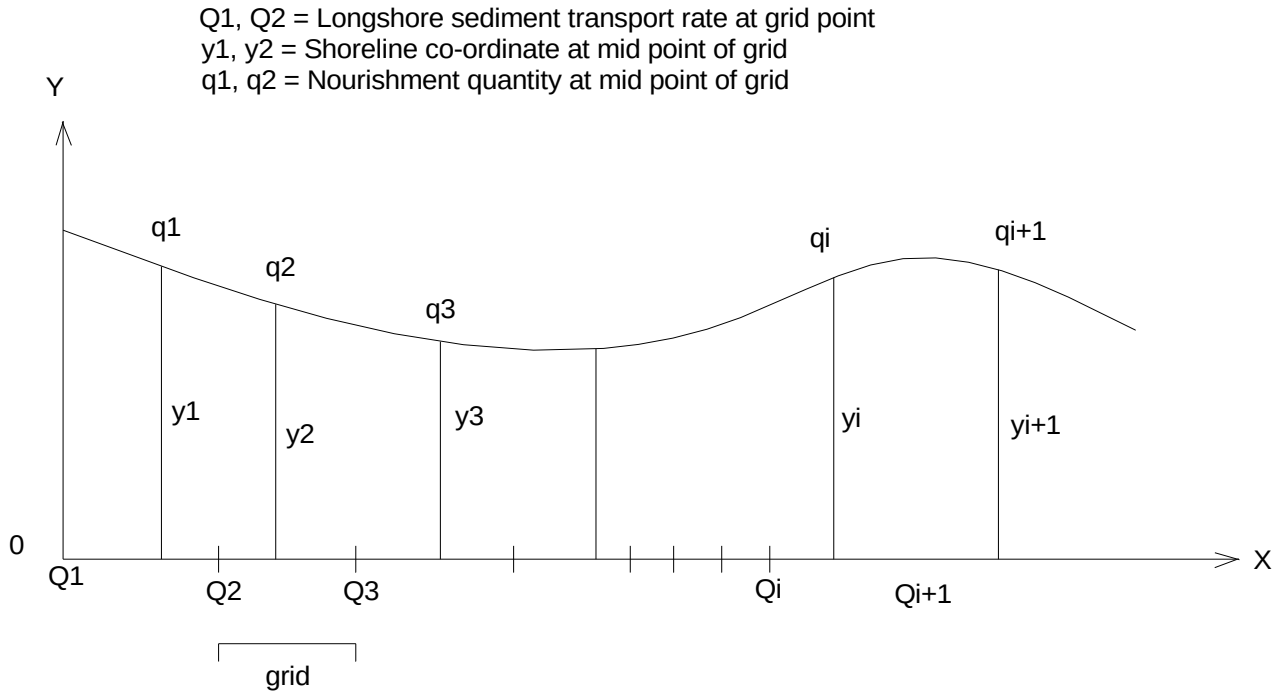


Fig 9. Schematic diagram for finite difference scheme

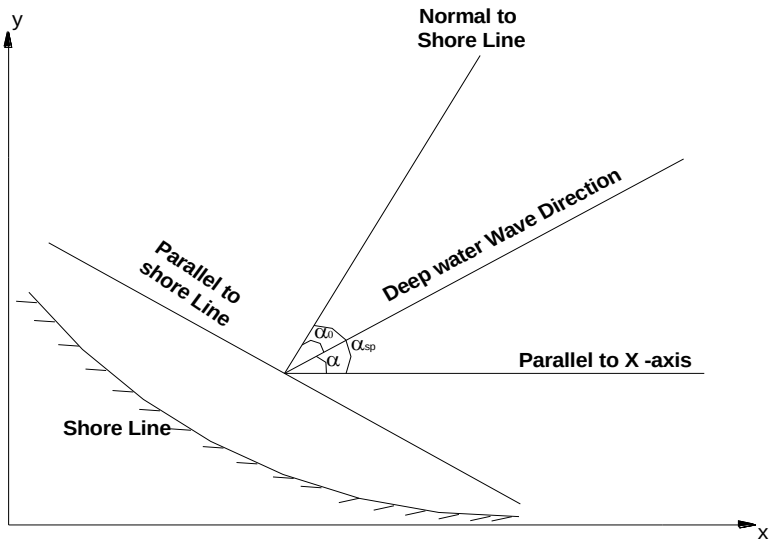


Fig 10. Definition sketch of angles considered

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, 5years, 10years, 15 years, 20 years and 25 years after the construction of the groynes and has been presented by superimposing the shoreline patterns.

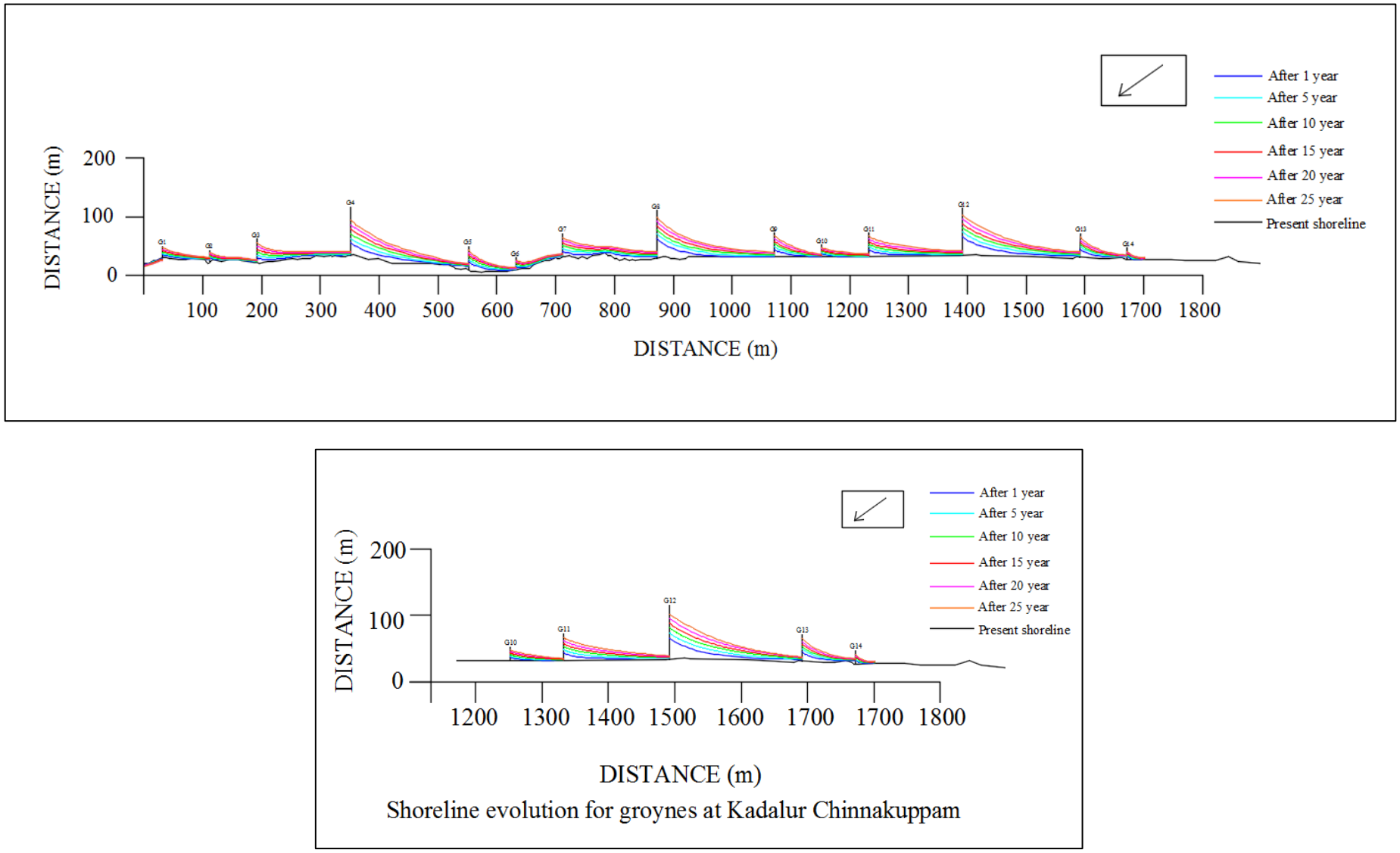


Fig.11 Shoreline evolution

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 Kadalore Chinnakuppam. 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 1.3 km. **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.

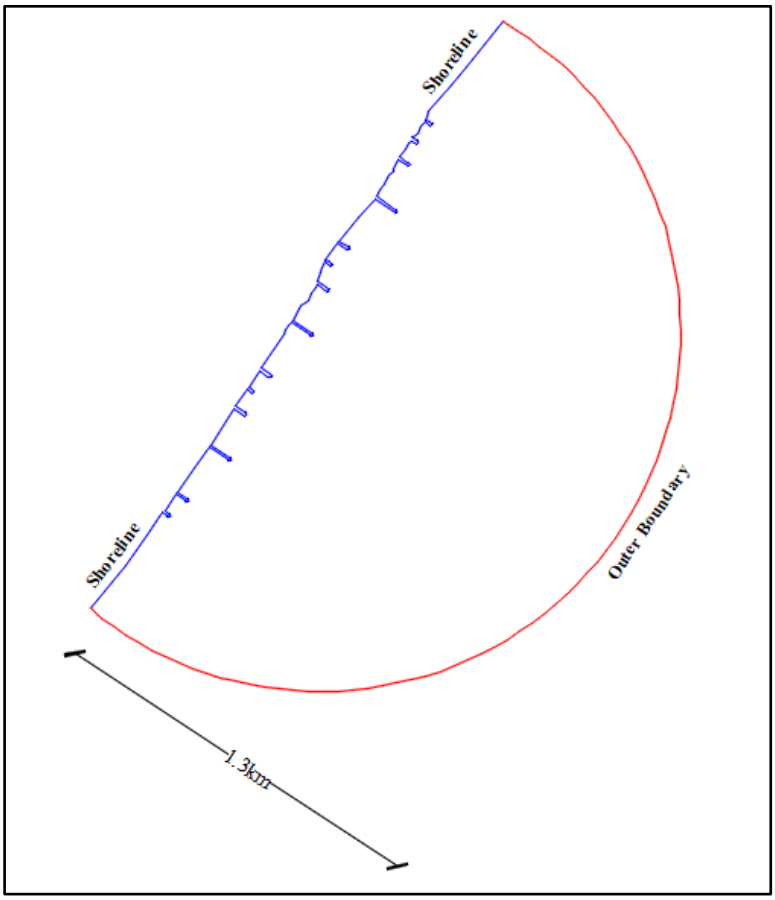


Fig. 12 Computational domain

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 827 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 125697 nodes with 249800 numbers of triangular elements. The mesh is shown in **Fig. 13.**

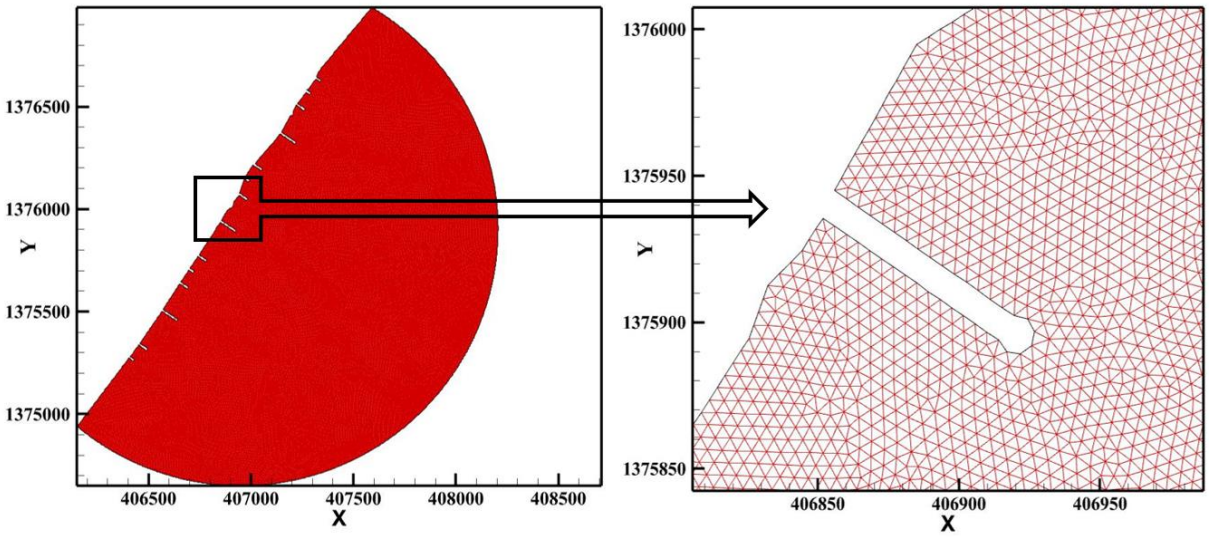


Fig.13 Mesh Structure adopted for the wave propagation modeling

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.

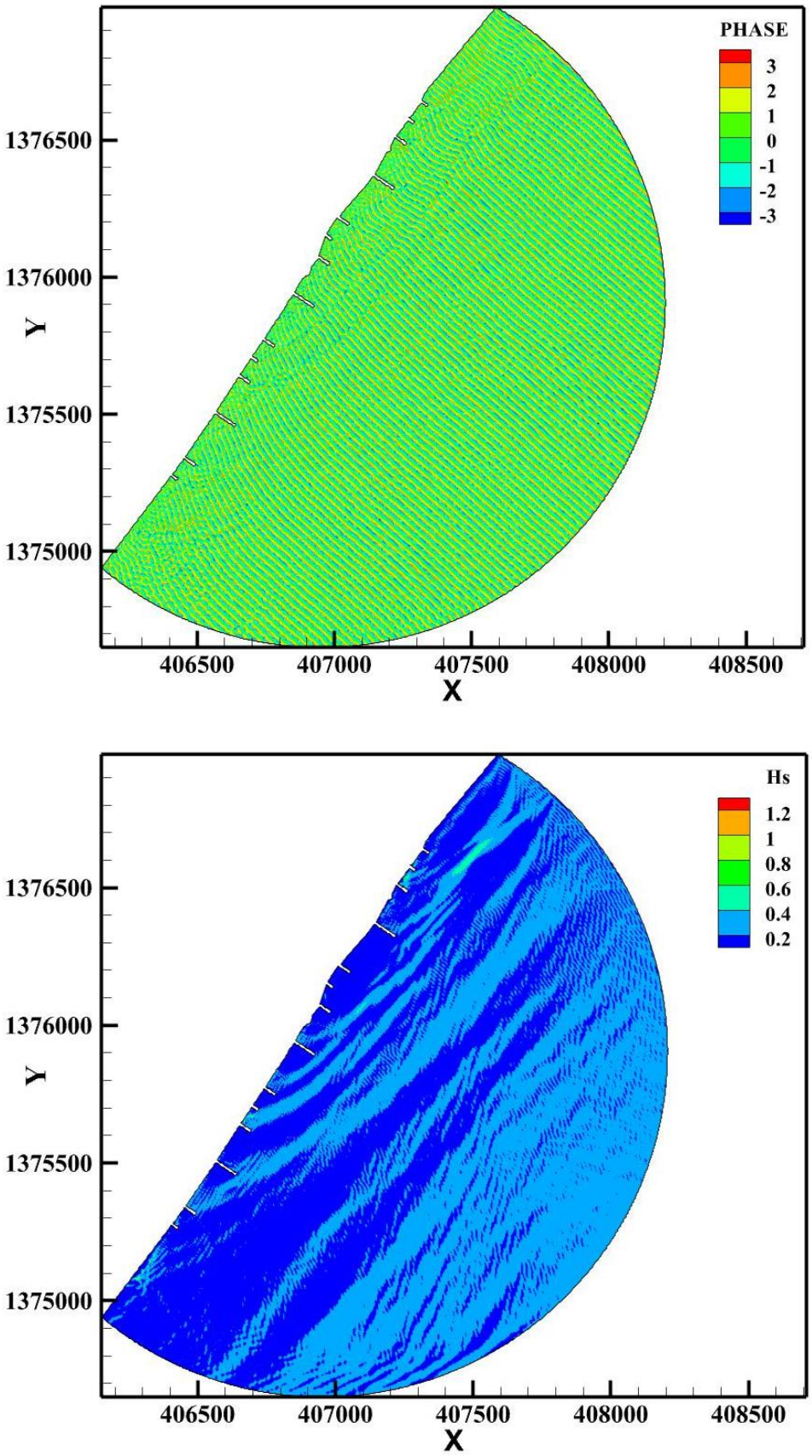


Fig.14 Phase distributions and Wave height distribution for the wave approach angle from 45^0

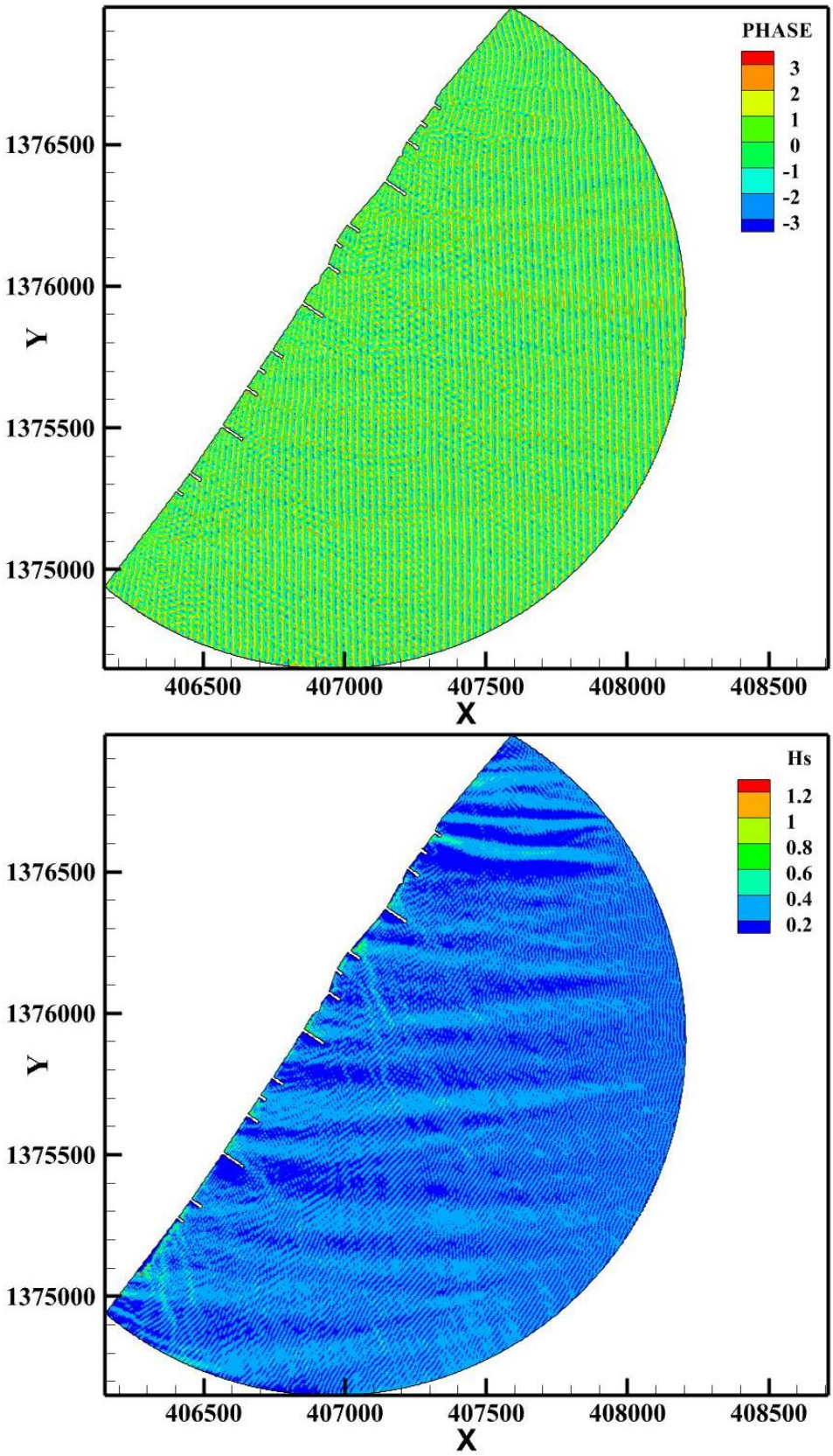


Fig.15 Phase distributions and Wave height distribution for the wave approach angle from 90^0

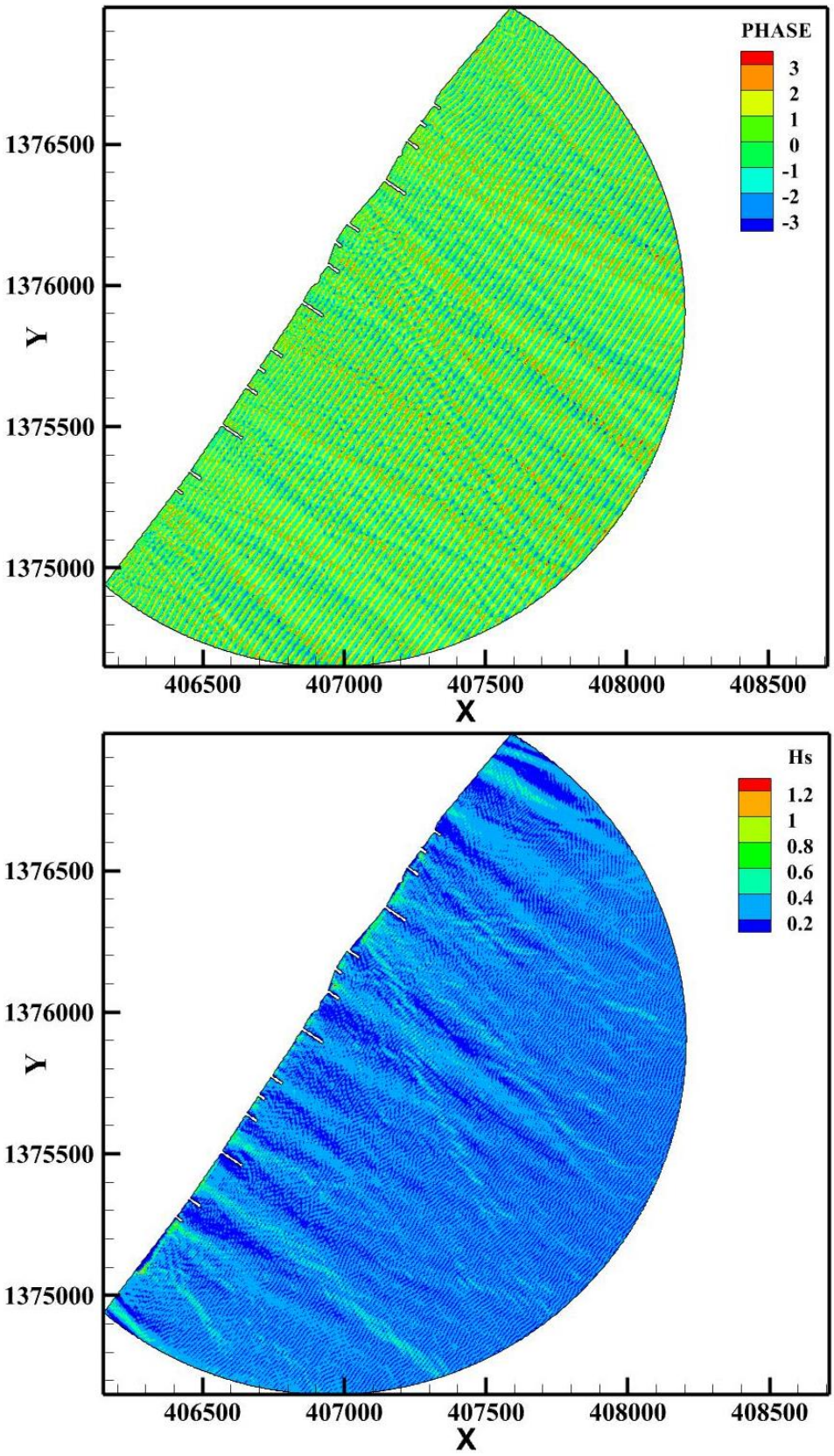


Fig.16 Phase distributions and Wave height distribution for the wave approach angle from 135^0

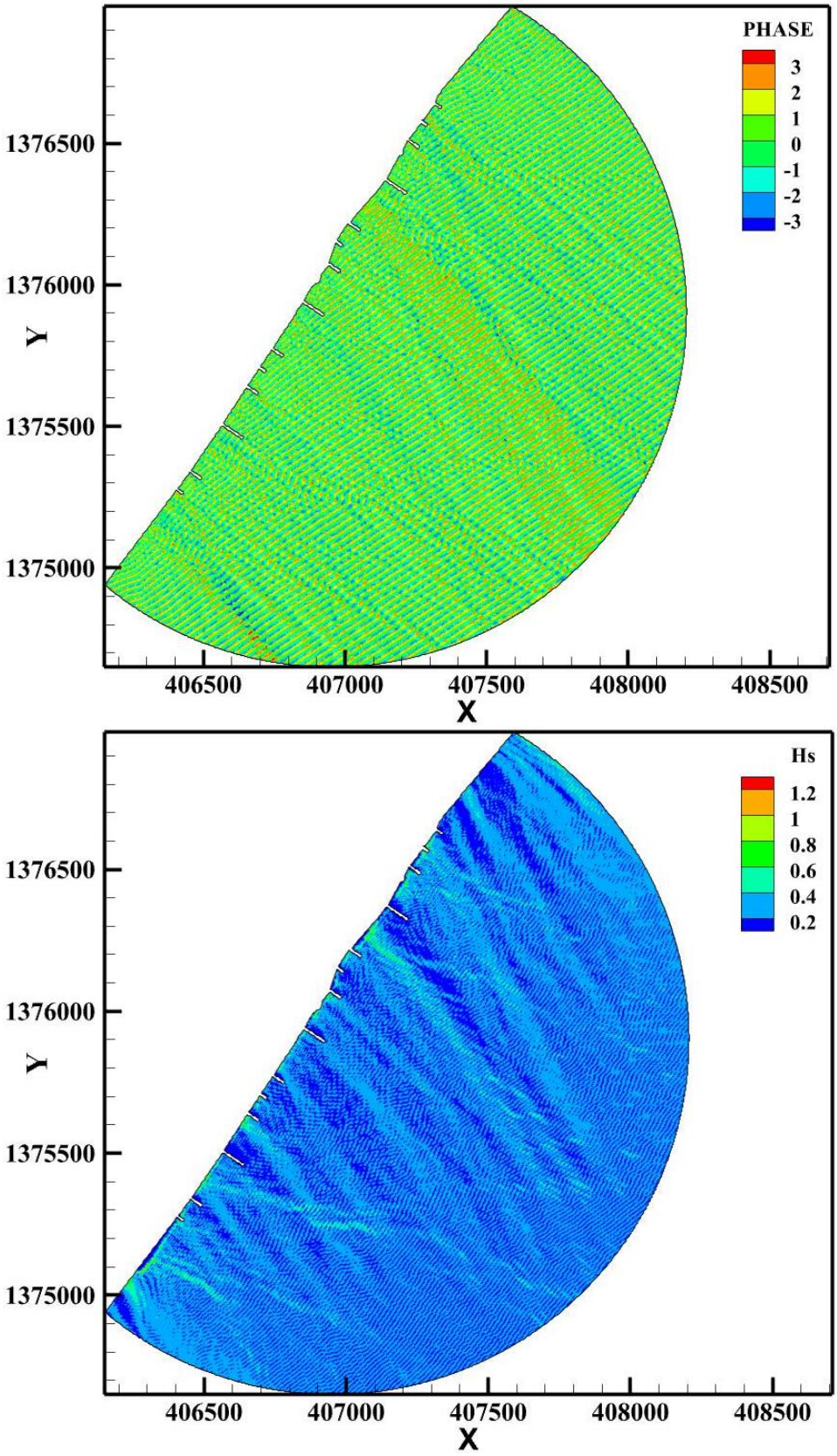


Fig.17 Phase distributions and Wave height distribution for the wave approach angle from 155^0

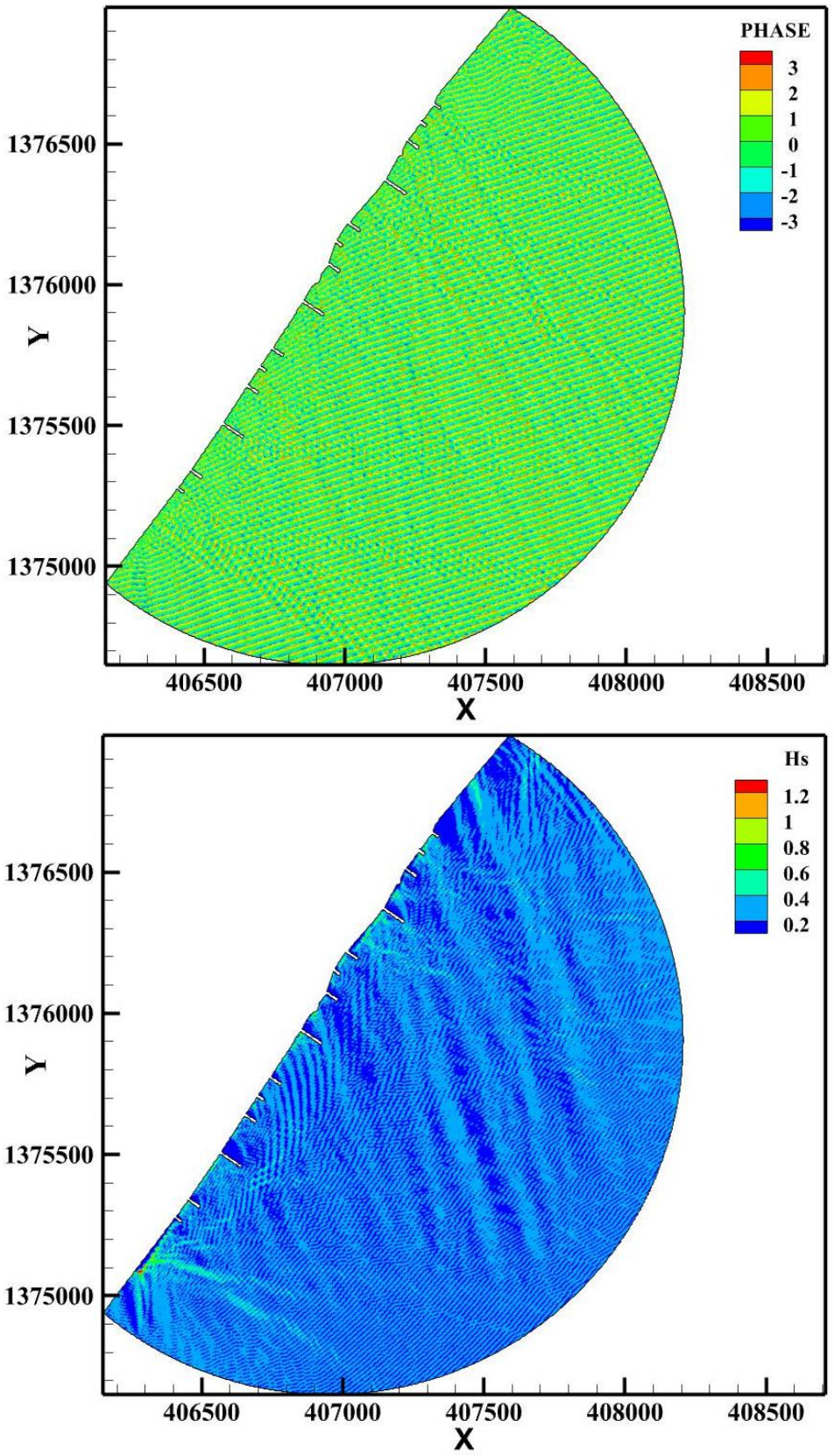


Fig.18 Phase distributions and Wave height distribution for the wave approach angle from 180^0

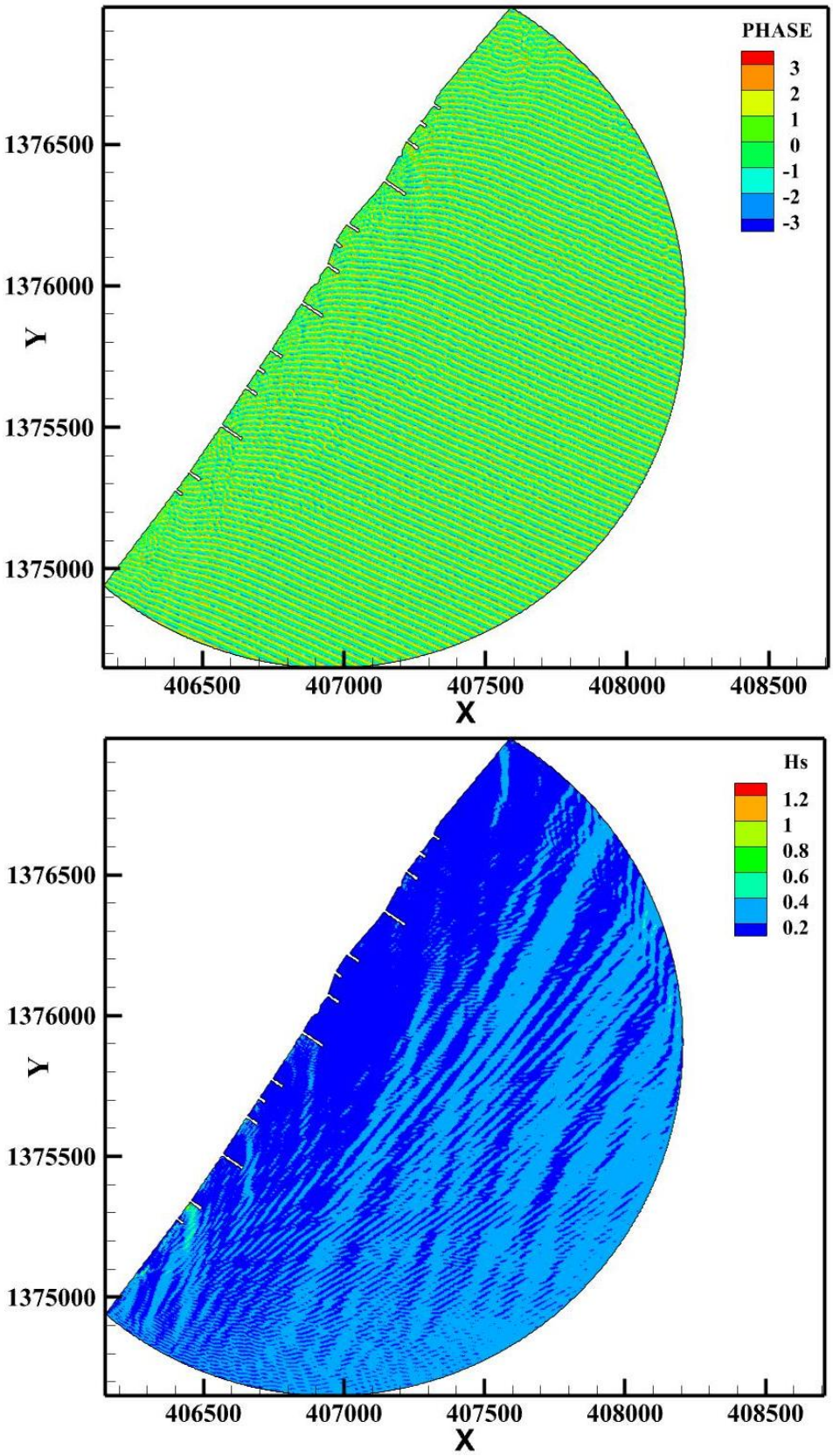


Fig.19 Phase distributions and Wave height distribution for the wave approach angle from 200^0

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 +1.2 m 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 = 3.5+1.2+0.8= 5.5 m

Hmax = 0.78 x 5.5

= 4.29 m

Significant wave Height = Hmax /1.6 =2.69 m

Take Design wave height as 2.69 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 4.0 T in two layers to withstand the design wave height of 2.69 m at the maximum water depth (-) 3.5 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 1.25 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 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 0.3 m.

The detailed plan, longitudinal sections and cross sections of the groyne are given in **Plates *(IITM - KCK - GY - 101 – 02)*** to ***(IITM - KCK - GY - 101 – 10).***

10.0 BILL OF QUANTITIES

Kadalur Chinna Kuppam - G10 (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**
(-) 1.5 m to (-) 2.0 m	10.00	35.30	29.50	32.40	324.00	226.80	601.02
(-) 1.0 m to (-) 1.5 m	8.00	29.50	26.20	27.85	222.80	155.96	413.29
(-) 0.5 m to (-) 1.0 m	11.00	26.20	21.40	23.80	261.80	183.26	485.64
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	8.00	25.90	25.90	25.90	207.20	145.04	384.36
(+) 0.5 m to (+) 1.2	7.00	25.90	25.90	25.90	181.30	126.91	336.31
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3674.29**

Kadalur Chinna Kuppam - G10 (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**
(-) 1.5 m to (-) 2.0 m	10.00	38.20	33.80	36.00	360.00	252.00	667.80
(-) 1.0 m to (-) 1.5 m	8.00	33.80	26.90	30.35	242.80	169.96	450.39
(-) 0.5 m to (-) 1.0 m	11.00	26.90	23.10	25.00	275.00	192.50	510.13
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	8.00	17.40	17.40	17.40	139.20	97.44	258.22
(+) 0.5 m to (+) 1.2	7.00	17.40	17.40	17.40	121.80	85.26	225.94
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**3012.61**

Kadalur Chinna Kuppam - G10 (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**
(-) 1.5 m to (-) 2.0 m	10.00	16.50	16.50	16.50	165.00	115.50	306.08
(-) 1.0 m to (-) 1.5 m	8.00	16.50	15.70	16.10	128.80	90.16	238.92
(-) 0.5 m to (-) 1.0 m	11.00	15.70	14.90	15.30	168.30	117.81	312.20
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	**1161.23**

Kadalur Chinna Kuppam - G10 (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**
(-) 1.5 m to (-) 2.0 m	10.00	9.60	9.20	9.40	94.00	65.80	174.37
(-) 1.0 m to (-) 1.5 m	8.00	9.20	8.70	8.95	71.60	50.12	132.82
(-) 0.5 m to (-) 1.0 m	11.00	8.70	8.30	8.50	93.50	65.45	173.44
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	8.00	6.00	6.00	6.00	48.00	33.60	89.04
(+) 0.5 m to (+) 1.2	7.00	6.00	6.00	6.00	42.00	29.40	77.91
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**1105.39**

Head Portion (-2.0 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	5.00	12.60	3.00	1075.76		
Armour Layer	3.00	8.20	2.50	295.13		
			Total Armour layer		409.83	**1086.06**
Toe mound layer						
Toe mound	1.30	18.00	15.60	1154.06		
	1.30	10.60	8.20	362.64		
			Total Toe mound layer		415.49	**1101.06**
Core Material	4.20	10.60	2.50	637.90	334.90	**887.48**
Filter Layer	0.30	20.10	19.50	369.33	193.90	**513.83**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**4760.35**	**3900**	**2262**	**1619**

Kadalur Chinna Kuppam - G11 (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**
(-) 3.0 m to (-) 3.5 m	12.00	48.80	45.00	46.90	562.80	393.96	1043.99
(-) 2.5 m to (-) 3.0 m	10.00	45.00	38.90	41.95	419.50	293.65	778.17
(-) 2.0 m to (-) 2.5 m	10.00	38.90	35.30	37.10	371.00	259.70	688.21
(-) 1.5 m to (-) 2.0 m	12.00	35.30	29.50	32.40	388.80	272.16	721.22
(-) 1.0 m to (-) 1.5 m	9.00	29.50	26.20	27.85	250.65	175.46	464.96
(-) 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	7.00	21.40	18.40	19.90	139.30	97.51	258.40
at 0.0 m	7.00	18.40	25.90	22.15	155.05	108.54	287.62
0 to (+) 0.5 m	23.00	25.90	25.90	25.90	595.70	416.99	1105.02
(+) 0.5 m to (+) 1.2	15.00	25.90	25.90	25.90	388.50	271.95	720.67
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**7668.94**

Kadalur Chinna Kuppam - G11 (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**
(-) 3.0 m to (-) 3.5 m	12.00	61.10	51.90	56.50	678.00	474.60	1257.69
(-) 2.5 m to (-) 3.0 m	10.00	51.90	46.20	49.05	490.50	343.35	909.88
(-) 2.0 m to (-) 2.5 m	10.00	46.20	38.20	42.20	422.00	295.40	782.81
(-) 1.5 m to (-) 2.0 m	12.00	38.20	33.80	36.00	432.00	302.40	801.36
(-) 1.0 m to (-) 1.5 m	9.00	33.80	26.90	30.35	273.15	191.21	506.69
(-) 0.5 m to (-) 1.0 m	13.00	26.90	23.10	25.00	325.00	227.50	602.88
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	7.00	17.40	17.40	17.40	121.80	85.26	225.94
0 to (+) 0.5 m	23.00	17.40	17.40	17.40	400.20	280.14	742.37
(+) 0.5 m to (+) 1.2	15.00	17.40	17.40	17.40	261.00	182.70	484.16
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**7090.09**

Kadalur Chinna Kuppam - G11 (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**
(-) 3.0 m to (-) 3.5 m	12.00	17.20	17.20	17.20	206.40	144.48	382.87
(-) 2.5 m to (-) 3.0 m	10.00	17.20	16.50	16.85	168.50	117.95	312.57
(-) 2.0 m to (-) 2.5 m	10.00	16.50	16.50	16.50	165.00	115.50	306.08
(-) 1.5 m to (-) 2.0 m	12.00	16.50	16.50	16.50	198.00	138.60	367.29
(-) 1.0 m to (-) 1.5 m	9.00	16.50	15.70	16.10	144.90	101.43	268.79
(-) 0.5 m to (-) 1.0 m	13.00	15.70	14.90	15.30	198.90	139.23	368.96
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	7.00	14.90	14.90	14.90	104.30	73.01	193.48
						Total	**2393.51**

Kadalur Chinna Kuppam - G11 (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**
(-) 3.0 m to (-) 3.5 m	12.00	11.00	10.50	10.75	129.00	90.30	239.30
(-) 2.5 m to (-) 3.0 m	10.00	10.50	10.10	10.30	103.00	72.10	191.07
(-) 2.0 m to (-) 2.5 m	10.00	10.10	9.60	9.85	98.50	68.95	182.72
(-) 1.5 m to (-) 2.0 m	12.00	9.60	9.20	9.40	112.80	78.96	209.24
(-) 1.0 m to (-) 1.5 m	9.00	9.20	8.70	8.95	80.55	56.39	149.42
(-) 0.5 m to (-) 1.0 m	13.00	8.70	8.30	8.50	110.50	77.35	204.98
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	7.00	7.80	6.00	6.90	48.30	33.81	89.60
0 to (+) 0.5 m	23.00	6.00	6.00	6.00	138.00	96.60	255.99
(+) 0.5 m to (+) 1.2	15.00	6.00	6.00	6.00	90.00	63.00	166.95
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**2098.01**

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	6.00	14.51	3.00	1652.08		
Armour Layer	3.80	9.83	2.50	506.93		
			Total Armour layer		601.21	**1593.19**
Toe mound layer						
Toe mound	1.30	21.43	17.51	1552.64		
	1.30	12.25	9.83	499.51		
			Total Toe mound layer		552.89	**1465.16**
Core Material	5.05	12.25	2.50	988.09	518.75	**1374.68**
Filter Layer	0.30	22.01	21.43	444.42	233.32	**618.30**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
80 m	**9262.14**	**8465**	**3859**	**2716**

Kadalur Chinna Kuppam - G12 (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**
(-) 1.5 m to (-) 2.0 m	14.00	35.30	29.50	32.40	453.60	317.52	841.43
(-) 1.0 m to (-) 1.5 m	9.00	29.50	26.20	27.85	250.65	175.46	464.96
(-) 0.5 m to (-) 1.0 m	7.00	26.20	21.40	23.80	166.60	116.62	309.04
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	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**	**3993.07**

Kadalur Chinna Kuppam - G12 (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**
(-) 1.5 m to (-) 2.0 m	14.00	38.20	33.80	36.00	504.00	352.80	934.92
(-) 1.0 m to (-) 1.5 m	9.00	33.80	26.90	30.35	273.15	191.21	506.69
(-) 0.5 m to (-) 1.0 m	7.00	26.90	23.10	25.00	175.00	122.50	324.63
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	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	**3274.35**

Kadalur Chinna Kuppam - G12 (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**
(-) 1.5 m to (-) 2.0 m	14.00	16.50	16.50	16.50	231.00	161.70	428.51
(-) 1.0 m to (-) 1.5 m	9.00	16.50	15.70	16.10	144.90	101.43	268.79
(-) 0.5 m to (-) 1.0 m	7.00	15.70	14.90	15.30	107.10	74.97	198.67
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	**1172.36**

Kadalur Chinna Kuppam - G12 (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**
(-) 1.5 m to (-) 2.0 m	14.00	9.60	9.20	9.40	131.60	92.12	244.12
(-) 1.0 m to (-) 1.5 m	9.00	9.20	8.70	8.95	80.55	56.39	149.42
(-) 0.5 m to (-) 1.0 m	7.00	8.70	8.30	8.50	59.50	41.65	110.37
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	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	**1169.39**

Head Portion (-2.0 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	5.00	12.60	3.00	1075.76		
Armour Layer	3.00	8.20	2.50	295.13		
			Total Armour layer		409.83	**1086.06**
Toe mound layer						
Toe mound	1.30	18.00	15.60	1154.06		
	1.30	10.60	8.20	362.64		
			Total Toe mound layer		415.49	**1101.06**
Core Material	4.20	10.60	2.50	637.90	334.90	**887.48**
Filter Layer	0.30	20.10	19.50	369.33	193.90	**513.83**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
40 m	**5079.13**	**4162**	**2273**	**1683**

Kadalur Chinna Kuppam - G13 (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**

Kadalur Chinna Kuppam - G13 (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**

Kadalur Chinna Kuppam - G13 (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**

Kadalur Chinna Kuppam - G13 (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 (-1.3 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	4.30	11.20	3.00	756.29		
Armour Layer	2.40	7.30	2.60	198.52		
			Total Armour layer		292.83	**776.00**
Toe mound layer						
Toe mound	1.30	16.60	14.20	970.05		
	1.30	9.70	7.30	296.88		
			Total Toe mound layer		353.41	**936.54**
Core Material	3.70	9.70	2.60	488.23	256.32	**679.25**
Filter Layer	0.30	18.70	18.10	318.95	167.45	**443.74**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**3499.04**	**2587**	**1497**	**1245**

Kadalur Chinna Kuppam - G14 (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**
(-) 1.5 m to (-) 2.0 m	6.00	35.30	29.50	32.40	194.40	136.08	360.61
(-) 1.0 m to (-) 1.5 m	4.00	29.50	26.20	27.85	111.40	77.98	206.65
(-) 0.5 m to (-) 1.0 m	4.00	26.20	21.40	23.80	95.20	66.64	176.60
0.0 m to (-) 0.5 m	3.00	21.40	18.40	19.90	59.70	41.79	110.74
at 0.0 m	3.00	18.40	25.90	22.15	66.45	46.52	123.26
0 to (+) 0.5 m	20.00	25.90	25.90	25.90	518.00	362.60	960.89
(+) 0.5 m to (+) 1.2	13.00	25.90	25.90	25.90	336.70	235.69	624.58
shore anchore	20.50	27.00		27.00	553.50	387.45	1026.74
					Total	**Stones**	**3590.07**

Kadalur Chinna Kuppam - G14 (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**
(-) 1.5 m to (-) 2.0 m	6.00	38.20	33.80	36.00	216.00	151.20	400.68
(-) 1.0 m to (-) 1.5 m	4.00	33.80	26.90	30.35	121.40	84.98	225.20
(-) 0.5 m to (-) 1.0 m	4.00	26.90	23.10	25.00	100.00	70.00	185.50
0.0 m to (-) 0.5 m	3.00	23.10	17.40	20.25	60.75	42.53	112.69
at 0.0 m	3.00	17.40	17.40	17.40	52.20	36.54	96.83
0 to (+) 0.5 m	20.00	17.40	17.40	17.40	348.00	243.60	645.54
(+) 0.5 m to (+) 1.2	13.00	17.40	17.40	17.40	226.20	158.34	419.60
shore anchore	20.50	13.50		13.50	276.75	193.73	513.37
						Total	**2599.41**

Kadalur Chinna Kuppam - G14 (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**
(-) 1.5 m to (-) 2.0 m	6.00	16.50	16.50	16.50	99.00	69.30	183.65
(-) 1.0 m to (-) 1.5 m	4.00	16.50	15.70	16.10	64.40	45.08	119.46
(-) 0.5 m to (-) 1.0 m	4.00	15.70	14.90	15.30	61.20	42.84	113.53
0.0 m to (-) 0.5 m	3.00	14.90	14.90	14.90	44.70	31.29	82.92
at 0.0 m	3.00	14.90	14.90	14.90	44.70	31.29	82.92
						Total	**582.47**

Kadalur Chinna Kuppam - G14 (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**
(-) 1.5 m to (-) 2.0 m	6.00	9.60	9.20	9.40	56.40	39.48	104.62
(-) 1.0 m to (-) 1.5 m	4.00	9.20	8.70	8.95	35.80	25.06	66.41
(-) 0.5 m to (-) 1.0 m	4.00	8.70	8.30	8.50	34.00	23.80	63.07
0.0 m to (-) 0.5 m	3.00	8.30	7.80	8.05	24.15	16.91	44.80
at 0.0 m	3.00	7.80	6.00	6.90	20.70	14.49	38.40
0 to (+) 0.5 m	20.00	6.00	6.00	6.00	120.00	84.00	222.60
(+) 0.5 m to (+) 1.2	13.00	6.00	6.00	6.00	78.00	54.60	144.69
shore anchore	20.50	8.00		8.00	164.00	114.80	304.22
						Total	**988.81**

Head Portion (-2.5 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	5.50	13.50	3.00	1334.11		
Armour Layer	3.50	9.20	2.50	417.22		
			Total Armour layer		481.37	**1275.62**
Toe mound layer						
Toe mound	1.30	19.00	16.50	1288.21		
	1.30	11.60	9.20	443.47		
			Total Toe mound layer		443.49	**1175.25**
Core Material	4.70	11.60	2.50	835.35	438.56	**1162.18**
Filter Layer	0.30	21.00	20.50	405.61	212.94	**564.30**

GROYNE	**QUANTITY IN TONNES**			
	ARMOUR LAYER (Stones)	**CORE LAYER**	**TOE MOUND LAYER**	**FILTER LAYER**
20 m	**4865.70**	**3762**	**1758**	**1553**

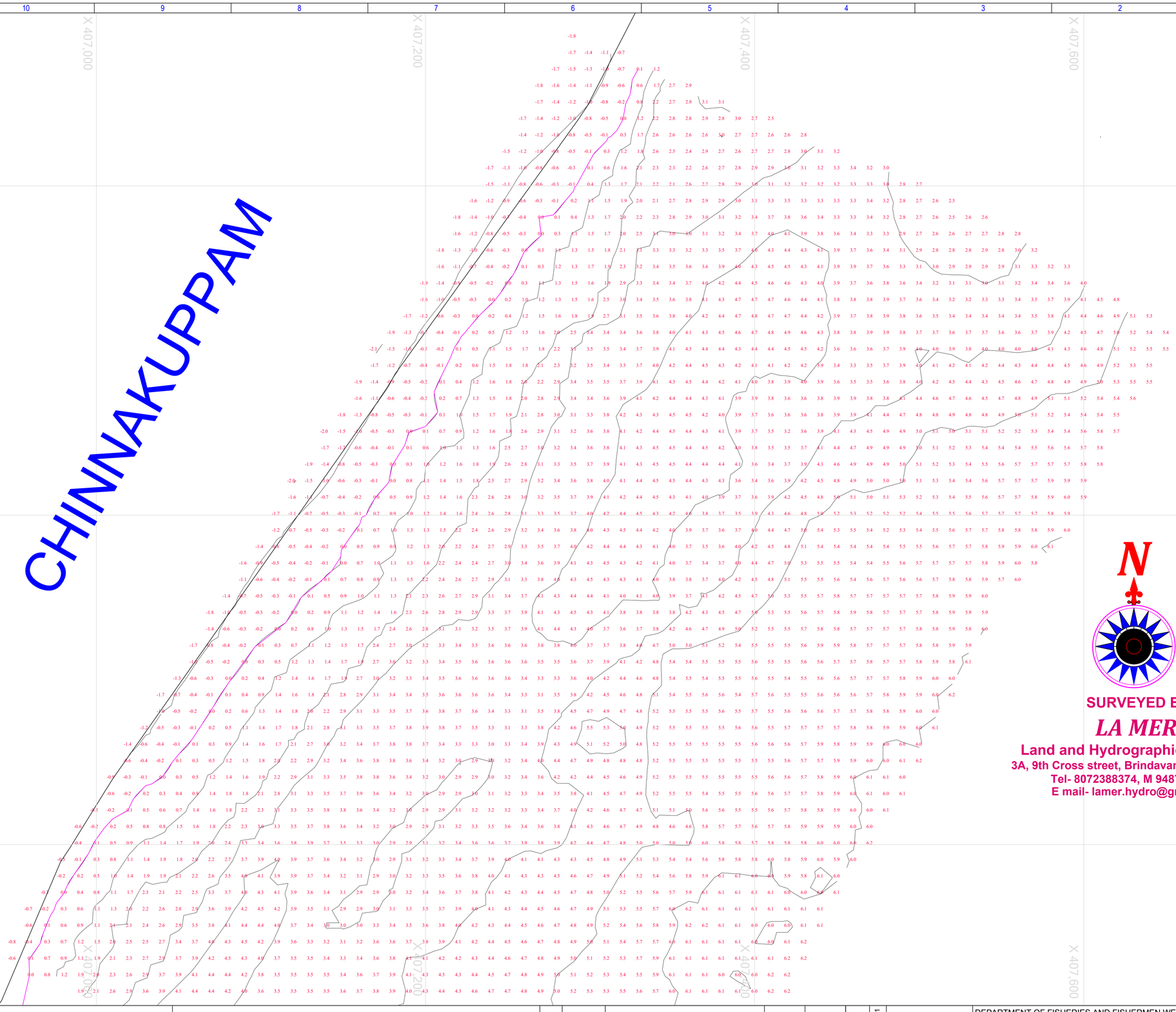
10.1 Total Quantity of Groynes

QUANTITY IN TONNES KADALORE CHINNAKUPPAM	
GROYNES G10 TO G14	
ARMOUR LAYER (Rubble mound)	27466
CORE LAYER	22875
TOE MOUND LAYER	11649
FILTER LAYER	8817
TOTAL QUANTITY OF GROYNES	**70807**

11.0 RECOMMENDATION

A comprehensive study was carried out on arriving at the coastal protection measure for a stretch of 520 m along the coast of Kadalore Chinnakuppam (latitude 12°26'51.01"N and longitude 80°8'38.96"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 1.2 Lakhs per annum directed towards the North. Kadalore Chinnakuppam was planned with respect to the adjacent site Kadalore Ali Kuppam and Kadalur Periyakuppam in terms of its groynes length and spacing. To combat erosion, a transitional groynes field of 5 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 also 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**



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

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REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION		

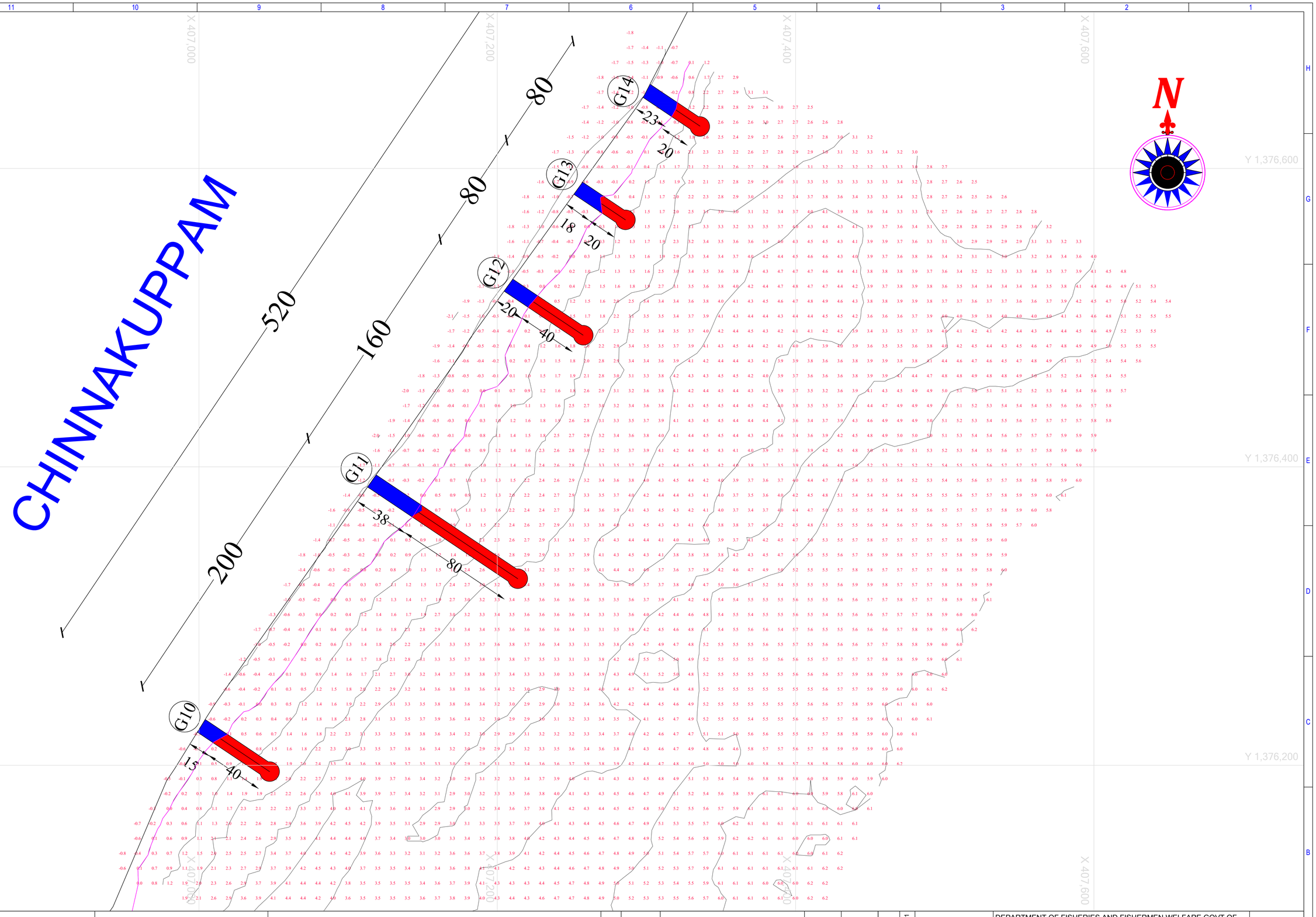
ORIGINAL SIZE:A1

SURVEYED BY
LA MER
Land and Hydrographic Surveys & Eng.
3A, 9th Cross street, Brindavanam, Puducherry- 605013
Tel- 8072388374, M 9487984922,
E mail- lamer.hydro@gmail.com

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

DATE: 20.10.2022

Scale as shown REV 0



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-KCK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	CS

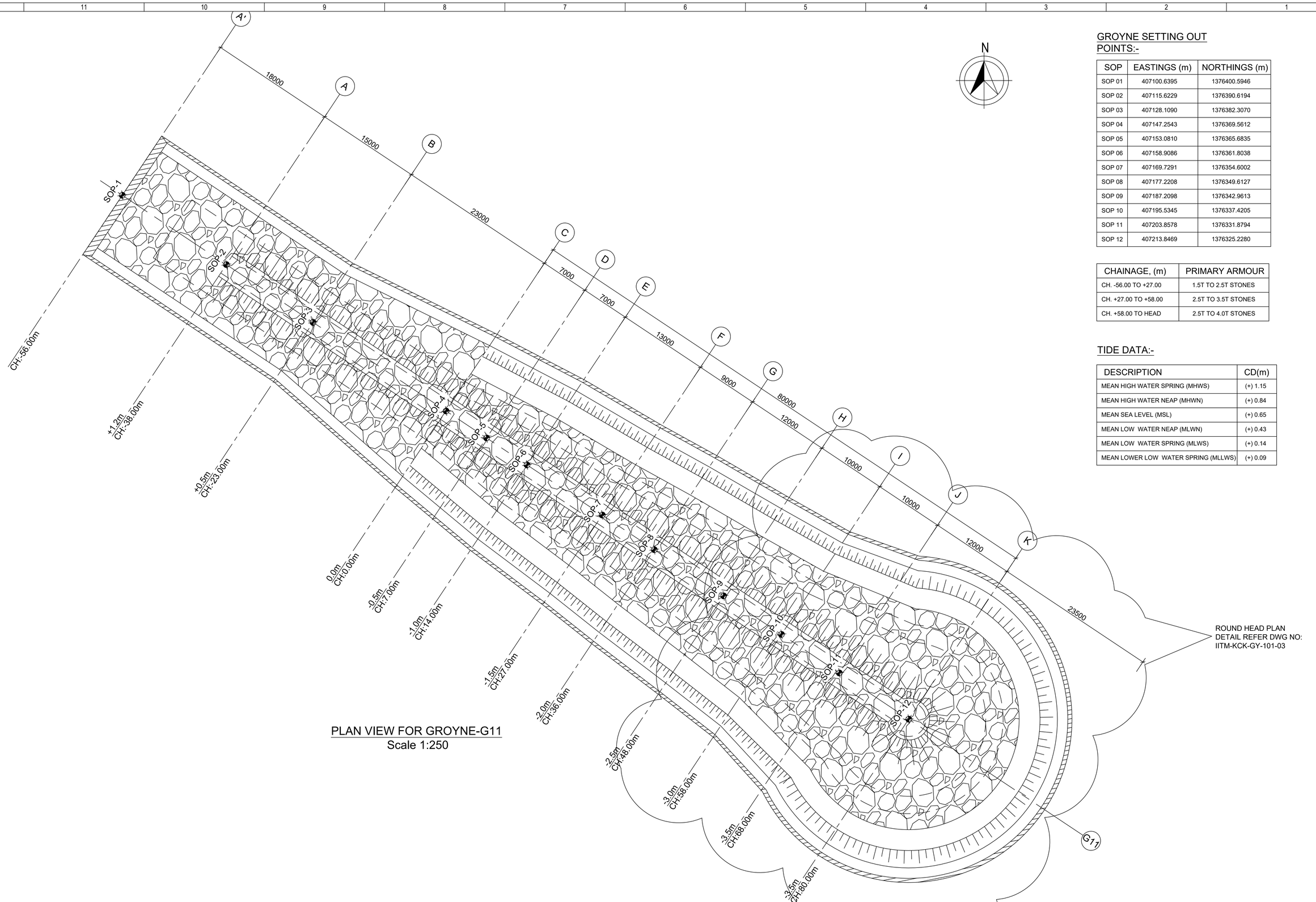
179

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 KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT.
DRAWING TITLE:	KADALUR - CHINNAKUPPAM OVERALL GROYNE LAYOUT
DRAWING NO:	IITM - KCK - GY - 101 - 01
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 20.10.2022

Scale as shown
REV 0



PLAN VIEW FOR GROYNE-G11
Scale 1:250

GROYNE SETTING OUT POINTS:-

SOP	EASTINGS (m)	NORTHINGS (m)
SOP 01	407100.6395	1376400.5946
SOP 02	407115.6229	1376390.6194
SOP 03	407128.1090	1376382.3070
SOP 04	407147.2543	1376369.5612
SOP 05	407153.0810	1376365.6835
SOP 06	407158.9086	1376361.8038
SOP 07	407169.7291	1376354.6002
SOP 08	407177.2208	1376349.6127
SOP 09	407187.2098	1376342.9613
SOP 10	407195.5345	1376337.4205
SOP 11	407203.8578	1376331.8794
SOP 12	407213.8469	1376325.2280

CHAINAGE, (m)	PRIMARY ARMOUR
CH. -56.00 TO +27.00	1.5T TO 2.5T STONES
CH. +27.00 TO +58.00	2.5T TO 3.5T STONES
CH. +58.00 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

NOTES :-

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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-KCK-GY-101-01
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001

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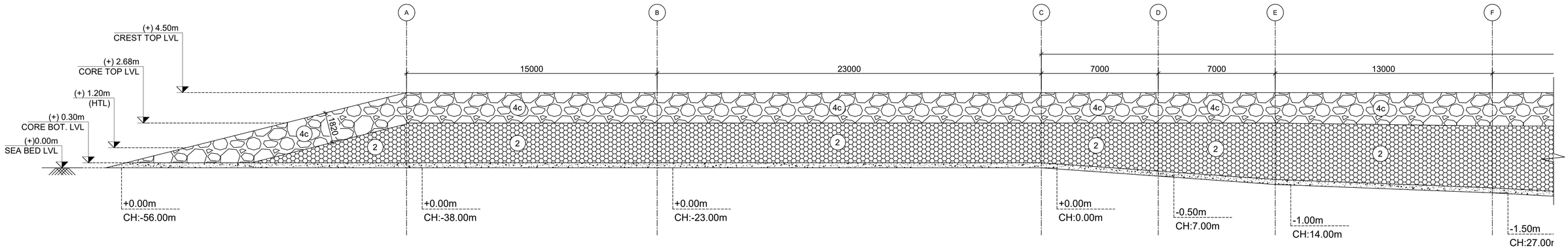
REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

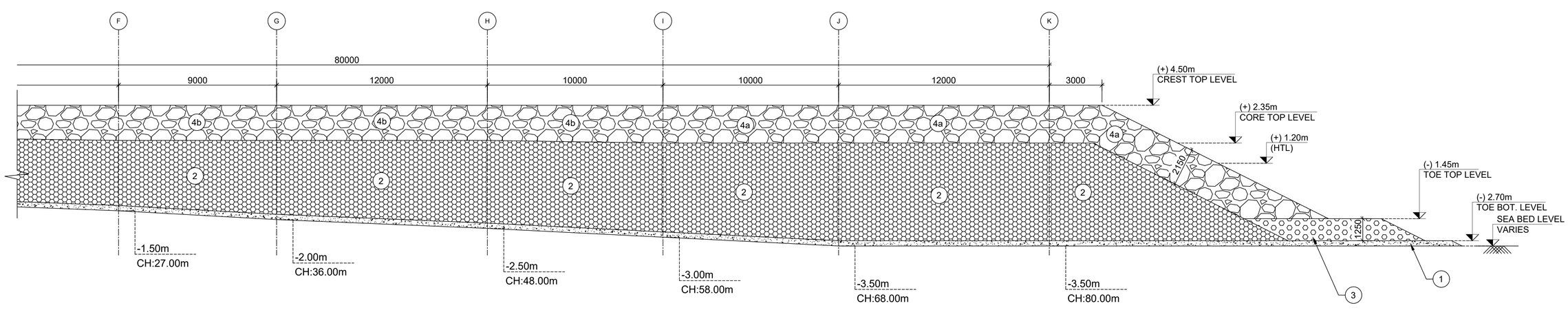
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (2 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 02
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022
Scale as shown
REV 0



LONGITUDINAL SECTIONAL VIEW FOR GROYNE-G11
Scale 1:120



LONGITUDINAL SECTIONAL VIEW FOR GROYNE-G11
Scale 1:120

CHAINAGE, (m)	PRIMARY ARMOUR
CH. -56.00 TO +27.00	1.5T TO 2.5T STONES
CH. +27.00 TO +58.00	2.5T TO 3.5T STONES
CH. +58.00 TO HEAD	2.5T TO 4.0T STONES

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 :-

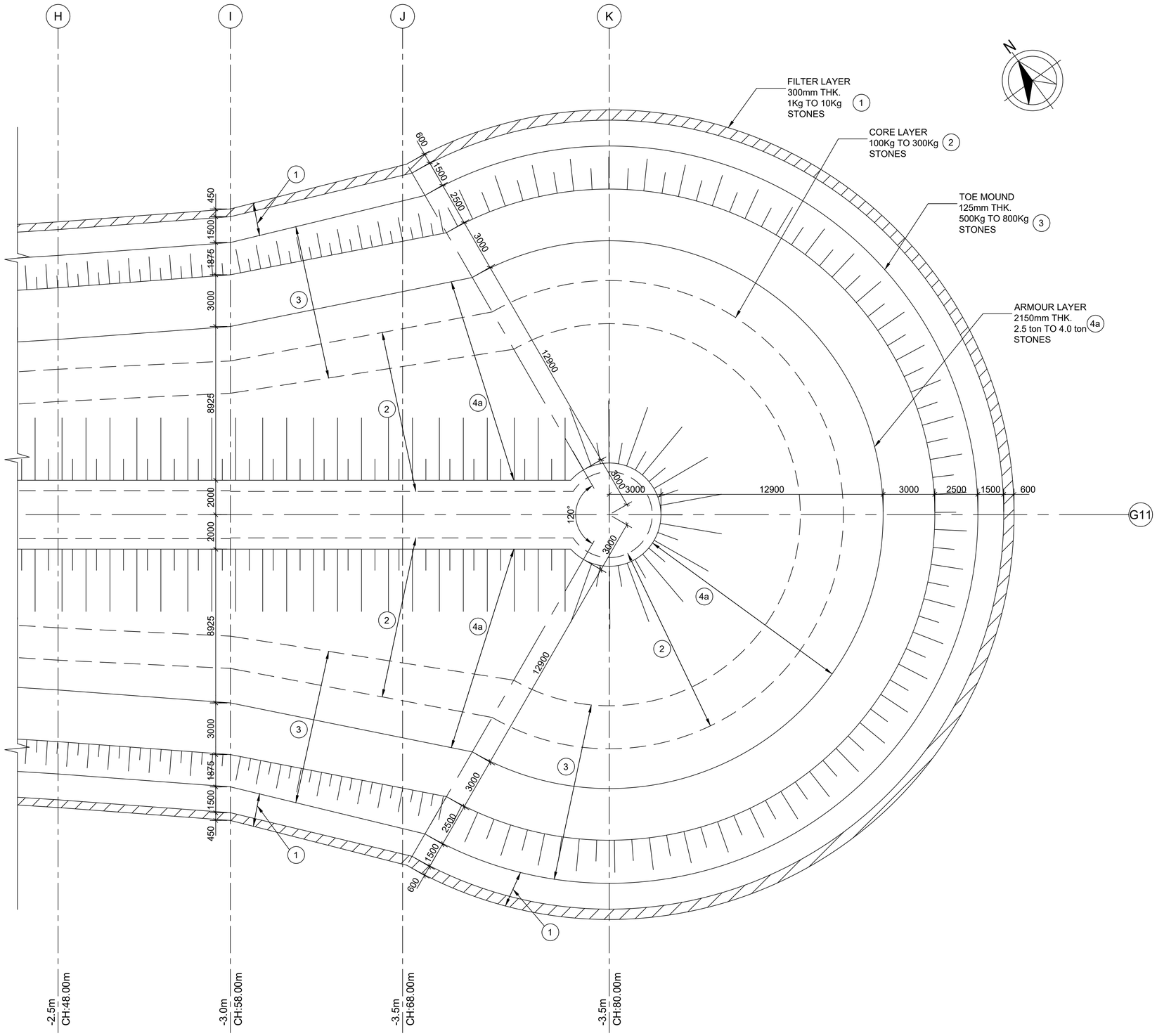
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	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 KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (3 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 03
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022
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 :-

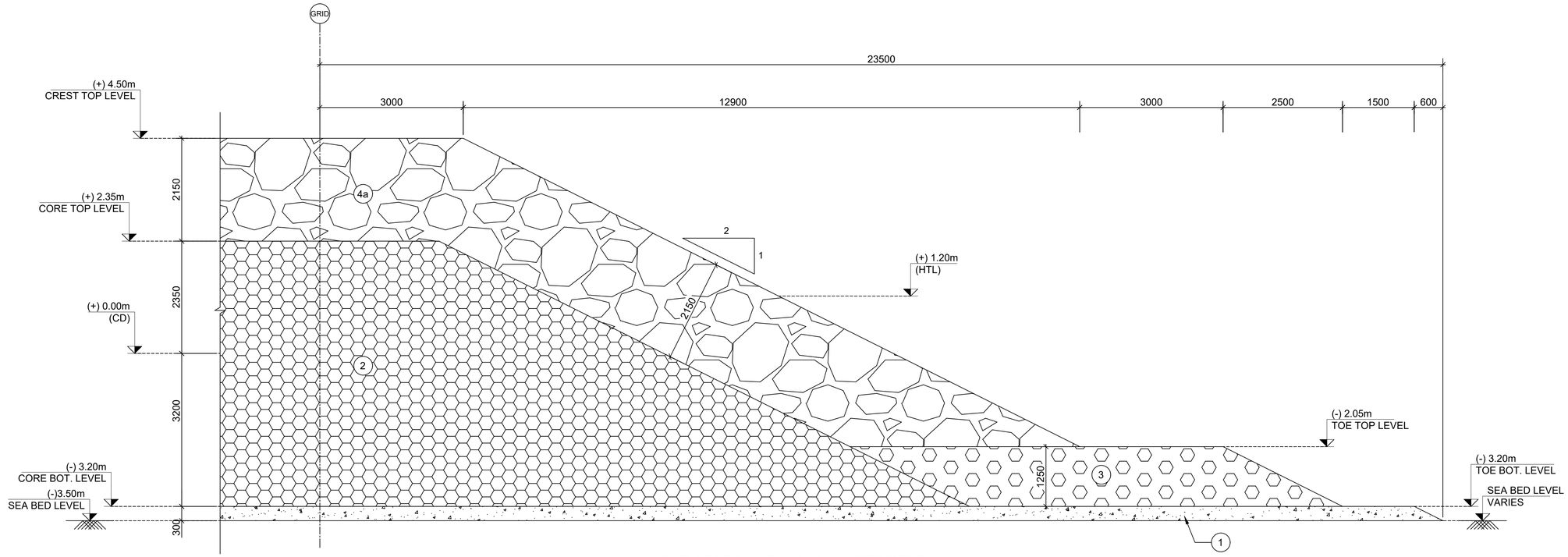
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
   c) IITM-KCK-GY-101-03
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

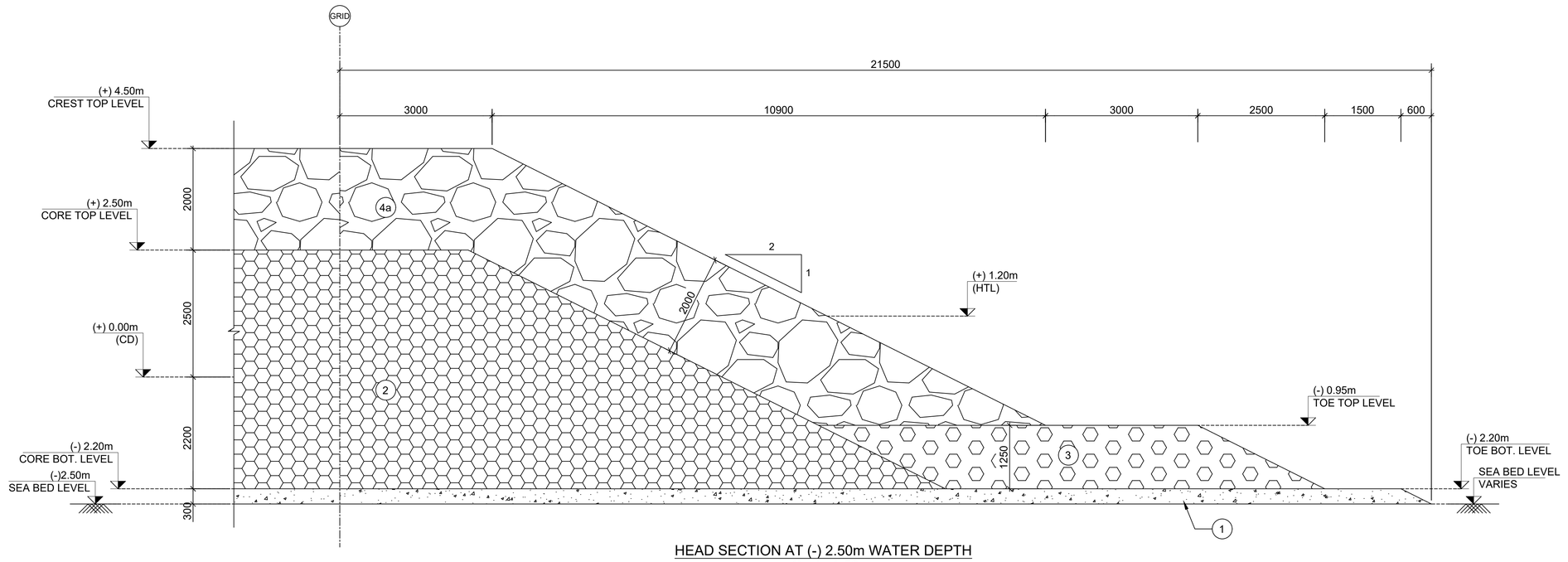
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (4 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 04
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022
Scale as shown
REV 0



HEAD SECTION AT (-) 3.50m WATER DEPTH
Scale 1:50



HEAD SECTION AT (-) 2.50m 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 :-

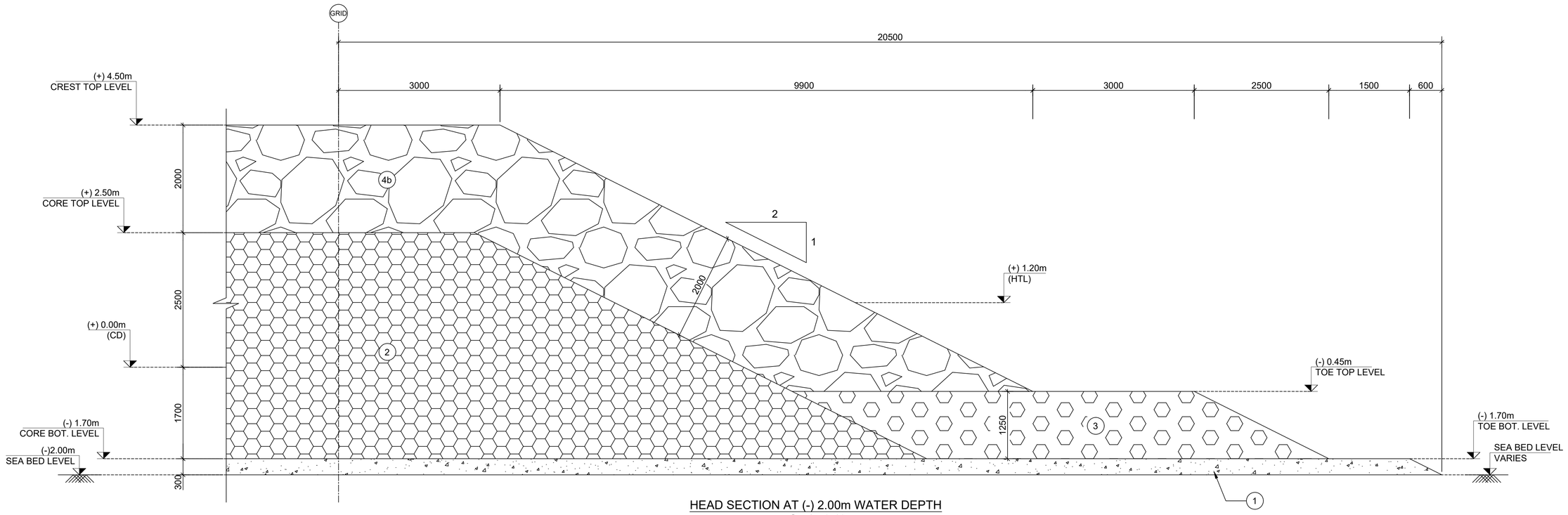
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
   c) IITM-KCK-GY-101-03
   d) IITM-KCK-GY-101-04
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001 183

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

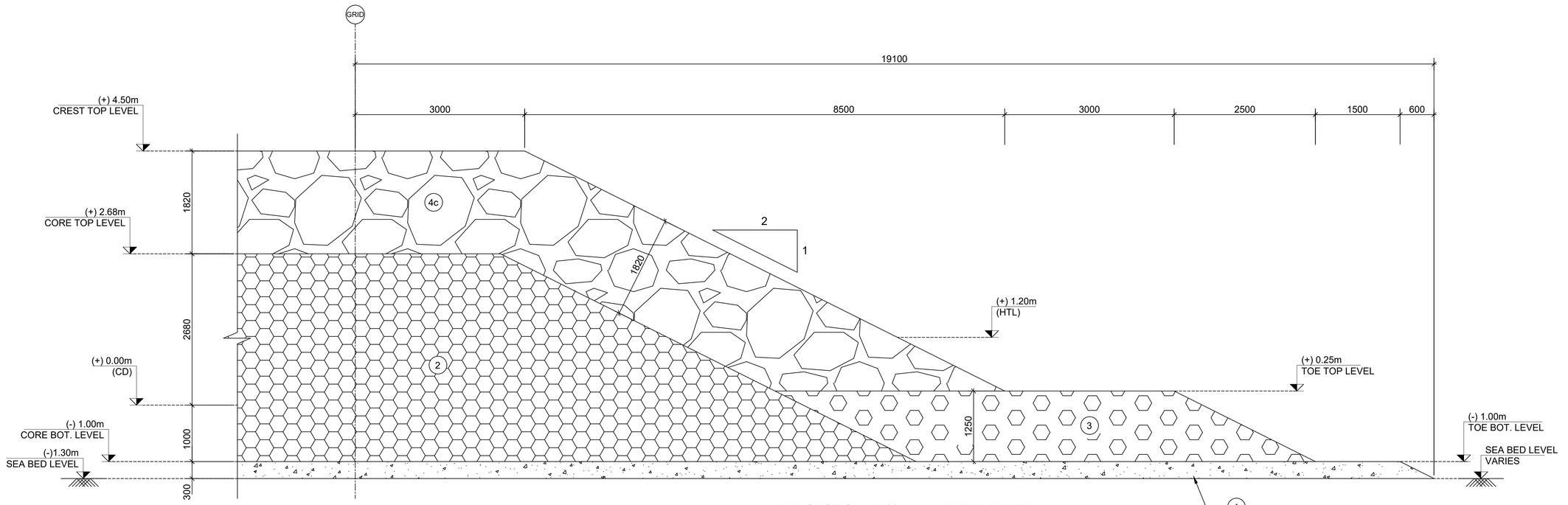
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (5 OF 9)
DRAWING NO:	IITM - KCK - GY - 101 - 05
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022
Scale as shown
REV 0



HEAD SECTION AT (-) 2.00m WATER DEPTH
Scale 1:40



HEAD SECTION AT (-) 1.30m 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
- 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 :-

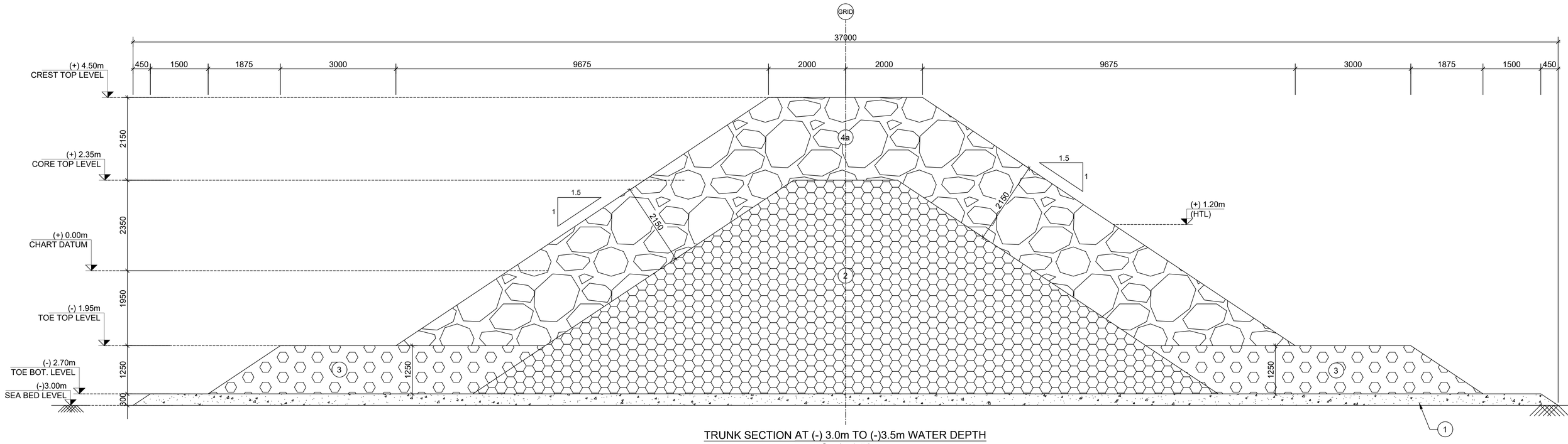
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
   a) IITM-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
   c) IITM-KCK-GY-101-03
   d) IITM-KCK-GY-101-04
   e) IITM-KCK-GY-101-05
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001 184

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

ORIGINAL SIZE:A1

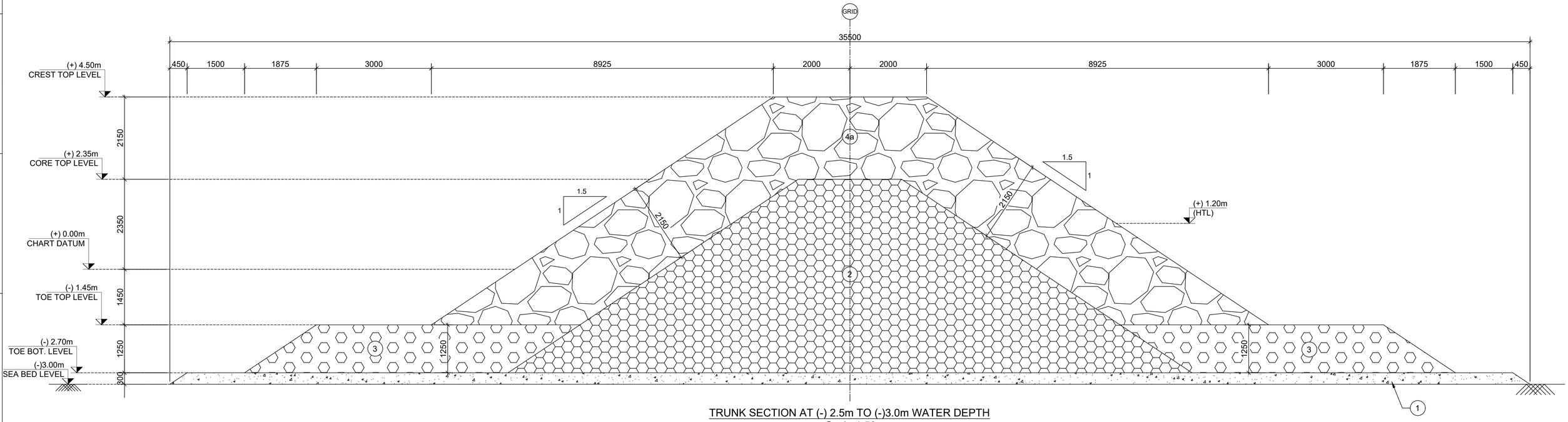
CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
	KADALUR - CHINNAKUPPAM GROYNE
DRAWING TITLE:	GENERAL ARRANGMENT SHEET (6 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022
Scale as shown
REV 0



TRUNK SECTION AT (-) 3.0m TO (-)3.5m WATER DEPTH

Scale 1:50



TRUNK SECTION AT (-) 2.5m TO (-)3.0m 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 :
   a) IITM-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
   c) IITM-KCK-GY-101-03
   d) IITM-KCK-GY-101-04
   e) IITM-KCK-GY-101-05
   f) IITM-KCK-GY-101-06
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001 185

REV.	DDMMYY DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

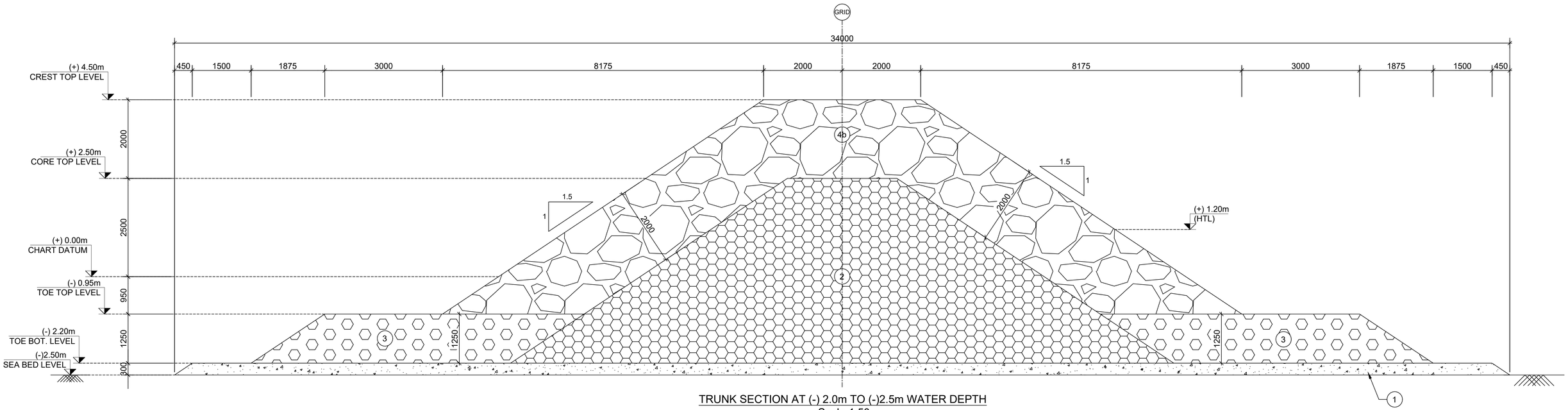
ORIGINAL SIZE:A1

CLIENT:	DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE,GOVT OF TAMILNADU.
PROJECT:	PROVIDING SHORE PROTECTION WORKS AND CONSTRUCTION OF FISH LANDING CENTRE AT KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (6 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 06
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

DATE: 20.10.2022

Scale as shown

REV 0



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-KCK-GY-101-01
   b) IITM-KCK-GY-101-02
   c) IITM-KCK-GY-101-03
   d) IITM-KCK-GY-101-04
   e) IITM-KCK-GY-101-05
   f) IITM-KCK-GY-101-06
   g) IITM-KCK-GY-101-07
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   a) IITM-KCK-GY-001

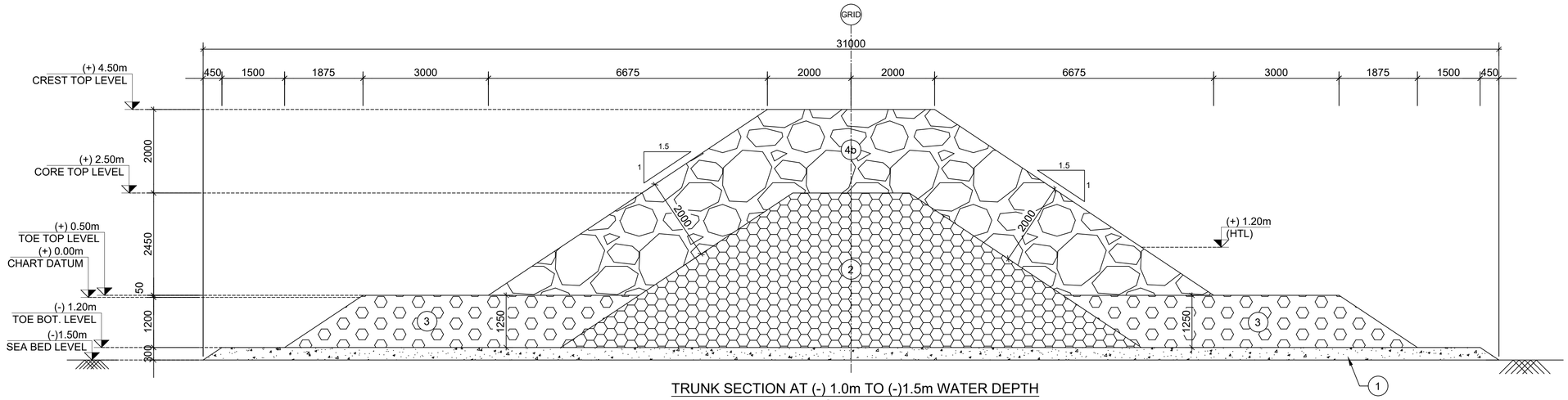
REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

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 KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (8 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 08
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

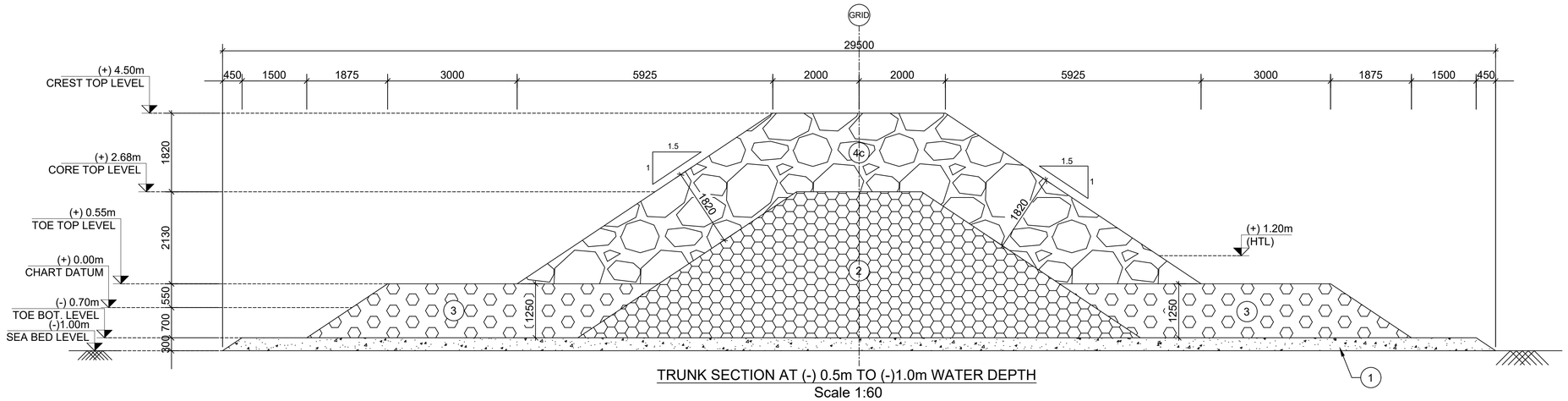
DATE: 20.10.2022

Scale as shown
REV 0



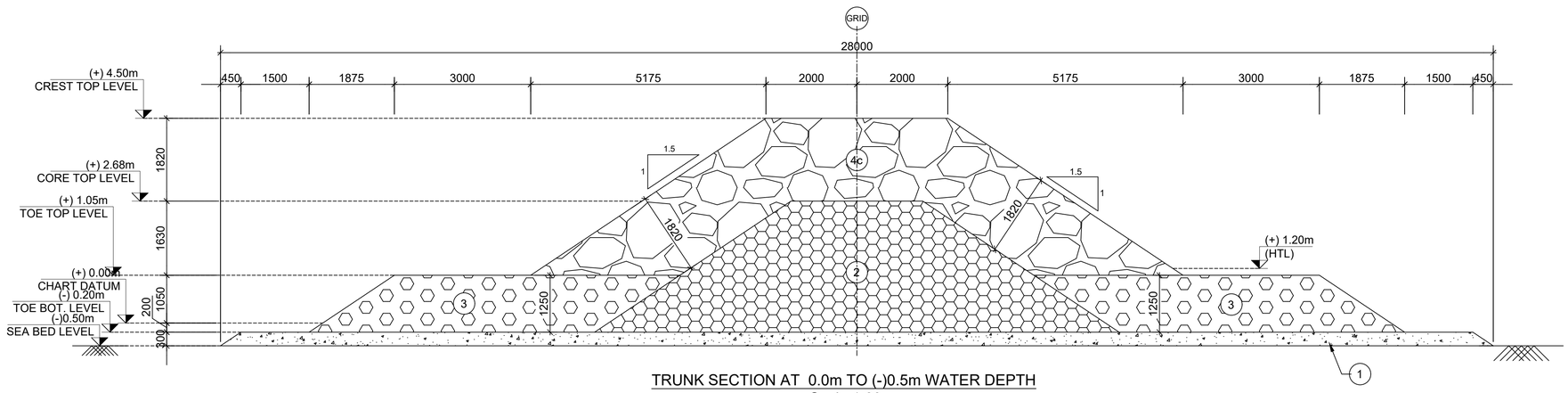
TRUNK SECTION AT (-) 1.0m TO (-)1.5m WATER DEPTH

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-KCK-GY-101-01
   - b) IITM-KCK-GY-101-02
   - c) IITM-KCK-GY-101-03
   - d) IITM-KCK-GY-101-04
   - e) IITM-KCK-GY-101-05
   - f) IITM-KCK-GY-101-06
   - g) IITM-KCK-GY-101-07
   - h) IITM-KCK-GY-101-08
2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:
   - a) IITM-KCK-GY-001

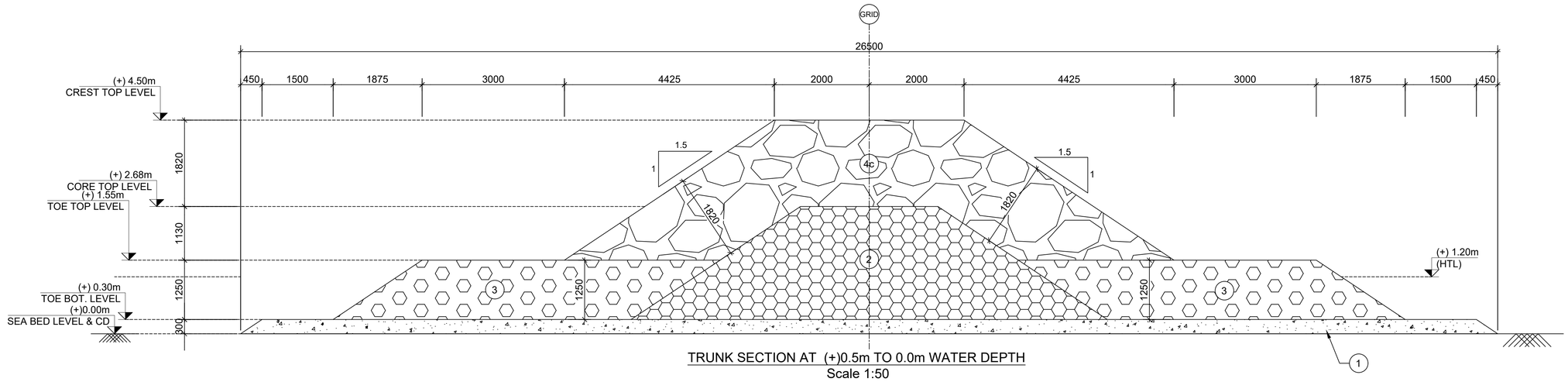
REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	ISSUED FOR CONSTRUCTION	CS	STR

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 KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (9 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 09
ENGINEERING FIRM:	DEPARTMENT OF OCEAN ENGINEERING IIT MADRAS CHENNAI - 600036

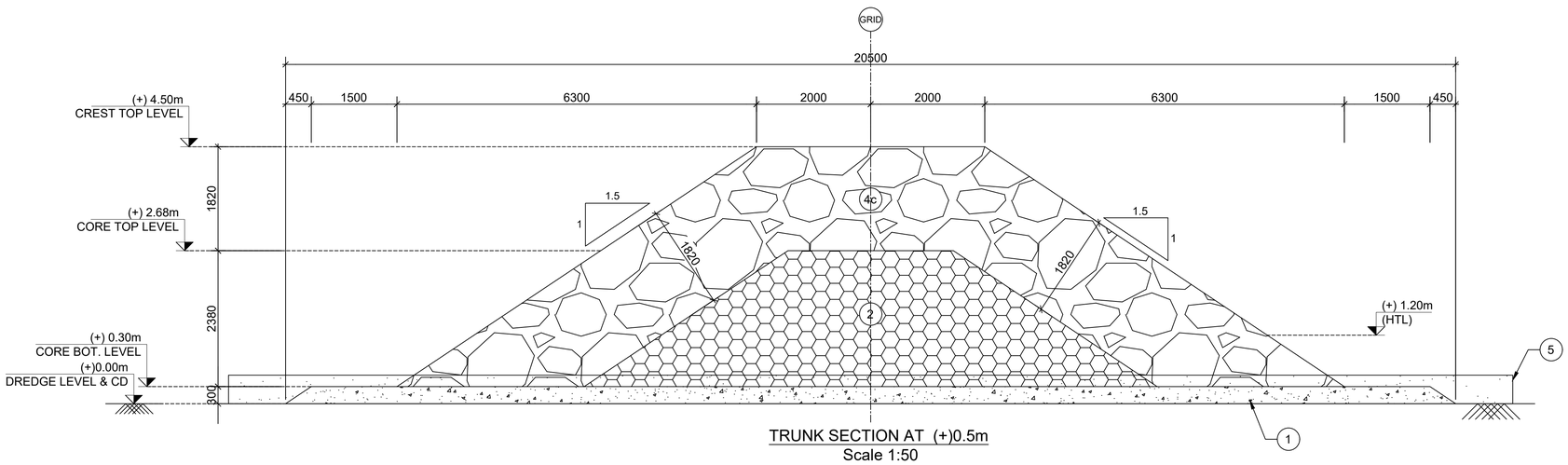
DATE: 20.10.2022

Scale as shown
REV 0



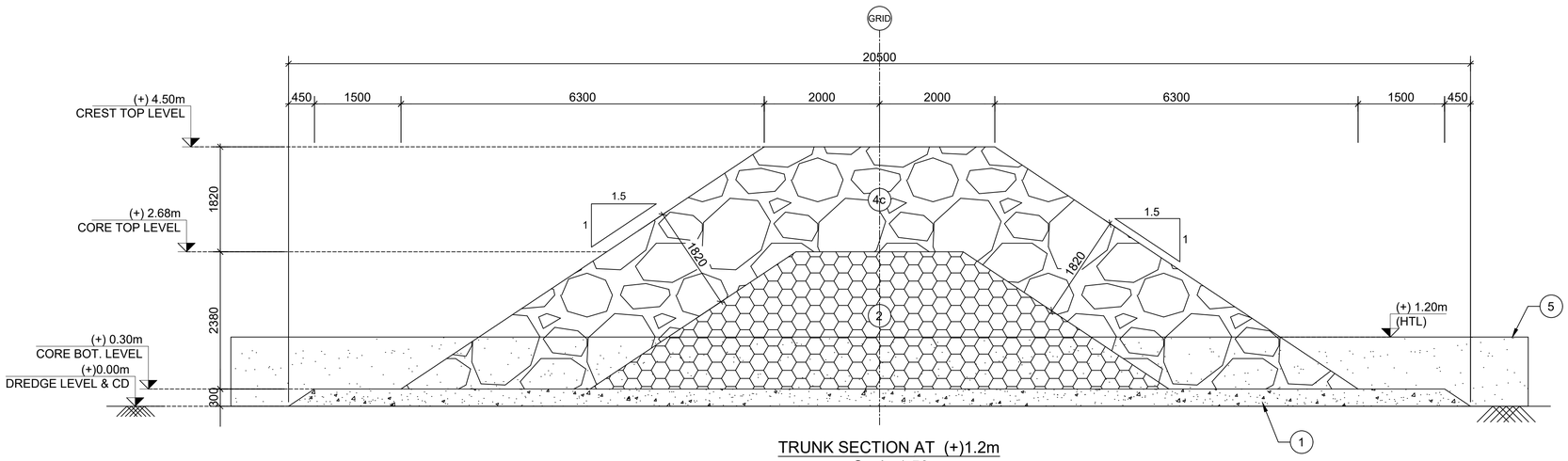
TRUNK SECTION AT (+)0.5m TO 0.0m WATER DEPTH

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

2. SEABED LEVEL REFER BATHYMETRY DRAWING NO:

a) IITM-KCK-GY-001

REV.	DDMMYY / DATE	DESCRIPTION	DESIGN	DRAWN
0	20.10.2022	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 KADALUR - CHINNAKUPPAM IN CHENGALPATTU DISTRICT
DRAWING TITLE:	KADALUR - CHINNAKUPPAM GROYNE GENERAL ARRANGMENT SHEET (10 OF 10)
DRAWING NO:	IITM - KCK - GY - 101 - 10
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ Prof.V.SUNDAR DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 20.10.2022

Scale as shown

REV 0