Government of India
Ministry for Water Resources, River Development and Ganga Rejuvenation
CENTRAL WATER & POWER RESEARCH STATION
Khadakwasla, Pune - 411 024
☏ : 020- 24103200, 24103450
Fax: 020 - 24381004 ✉ : pchandra_2003@yahoo.co.in www.cwprs.gov.in

No. MMCE/PROJ/2018 Dated:

To
Chief Mangar (PPD)
JNPT,
Administrative Building, Sheva
Taluka - Uran
Navi Mumbai 400007

Subject : Mathematical model studies for Shoreline changes for the development of proposed port at Vadhavan, Maharashtra.

Sir

Enclosed please find two copies of Technical Report No. 5559 titled 'Mathematical model studies for Shoreline changes for the development of proposed port at Vadhavan, Maharashtra'.

The receipt of the same may please be acknowledged.

Thanking you,

Yours faithfully,

Encl: Technical Report in duplicate

1/2/18

(Dr. Prabhat Chandra)
Scientist 'D'

CC : Director for information

CC : Dr Prabhat Chandra, Sc-D / Sc-D (TC)/ Shri T Nagendra, Sc-E

A. REPORT DOCUMENTATION SHEET

Technical Report No. 5559	Date: January, 2018

Title MATHEMATICAL MODEL STUDIES FOR SHORELINE CHANGES FOR THE DEVELOPMENT OF PROPOSED PORT AT VADHAVAN, MAHARASHTRA.

Officers Responsible for Conducting the Studies :

Shri Santosh Kumar Kori, Assistant Research Officer under the guidance of Dr. Prabhat Chandra, Scientist 'D' , Mrs. A. M. Vaidya, Ex Scientist 'D' and overall supervision of Shri T Nagendra, Scientist 'E'.

Name and Address of Organization Conducting the Studies :

Mathematical Modelling in Coastal Engineering, Coastal and Offshore Engineering Laboratory, Central Water and Power Research Station, Pune, India

Name and Address of Authority Sponsoring the Studies

Chief Mangar (PPD), JNPT, Administrative Building, Sheva, Taluka - Uran' Navi Mumbai 400007

Synopsis

The JNPT proposes to develop a satellite port at Vadhavan, Maharashtra. The proposed location of Vadhavan is about 160 km north of JNPT and has deep draft of about 20 m which makes it feasible to handle bigger size of container ships. Breakwater of about lengths 10.1 km is proposed in development of Satellite port at Vadhavan, this can have impact on adjacent shoreline. Mathematical model studies carried out at CWPRS for shoreline changes for the development of port at Vadhavan. Spectral wave model MIKE 21-SW was used to obtain near-shore wave climate by transformation of wave height and wave direction from deep water to 10 m depth near development area which indicated that the predominant wave directions are from the sector between 220^0 N to 300^0 N directions with maximum significant wave height of the order of 2.5 m. Estimation of littoral drift distribution was carried out with LITDRIFT model which indicated that average net transport in a year would be of the order of 0.07 million cum towards North. Studies for simulation of shoreline changes was carried out with LITLINE model which showed that due to the proposed construction of offshore breakwater, there would be negligible deposition of sand behind the breakwater. Further, there would be negligible impact on the adjacent shoreline due to the proposed development.

Keywords

Wave Transformation, Littoral Drift, Shoreline Evolution

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MATHEMATICAL MODELLING IN COASTAL ENGINEERING

TECHNICAL REPORT No. 5559

JANUARY 2018

MATHEMATICAL MODEL STUDIES FOR SHORELINE CHANGES FOR THE DEVELOPMENT OF PROPOSED PORT AT VADHAVAN, MAHARASHTRA.

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MATHEMATICAL MODEL STUDIES FOR SHORELINE CHANGES FOR THE DEVELOPMENT OF PROPOSED PORT AT VADHAVAN, MAHARASHTRA.

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1. INTRODUCTION

Jawaharlal Nehru Port Trust (JNPT) handles more than 40% of India's total container traffic and serves a vast hinterland comprising all of northern and western India. There are limited space in JNPT and thus it was proposed to develop a satellite port for JNPT. Satellite ports help to overcome issues such as limited land availability and draft adequacy. The proposed location for development of this satellite port is at Vadhavan which is at about 160 km north of JNPT. Vadhavan is situated at 19°55' N and 72°39' E (Fig. 1) and has deep draft of about 20 m, which makes it feasible to handle bigger size of container ships. The most of near-shore sea bed is flat and rocky. The site is exposed to waves incident from SW quadrant with significant wave height of about 3.5 m. The site has a tidal variation of about 5.5 m between Low Tide and High Tide. The final layout for this Satellite port (Fig. 2) was evolved through extensive mathematical modeling studies for tidal hydrodynamics and wave tranquility. The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the head land of Vadhavan.

Alongshore sediment transport takes place when wave approach obliquely to the shore and eventually break. The wave breaking releases energy which brings sediment into suspension and alongshore littoral current transport of the sediments. The cycle of sediment transport by the waves to and from the coast is continuous which has aided in maintaining the equilibrium of the coastline over the geological times. Any changes to the sediment transport due to natural and manmade development results in the imbalance of the shoreline dynamics leading to accretion or erosion.

The proposed development of Satellite port at Vadhavan involving breakwater length of about 10 km can have impact on adjacent shoreline. In this regard, JNPT requested CWPRS to undertake mathematical model studies for assessment of Shoreline change for the development of proposed port at Vadhavan, Maharashtra.

In the present report, the detailed mathematical model studies using LITPACK modules; LITDRIFT and LITLINE, have been described for assessing the shoreline changes .

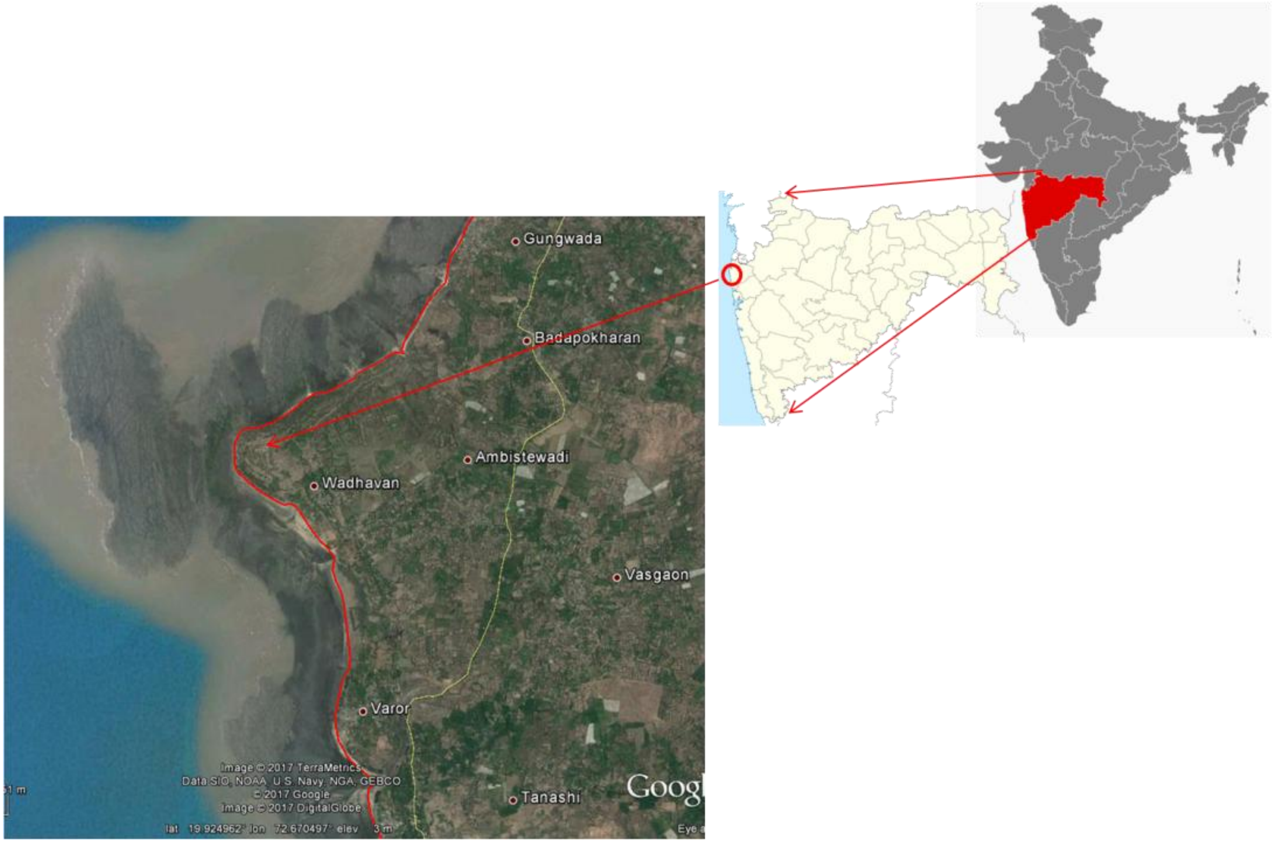


Fig. 1 : Location Map Of Study Area

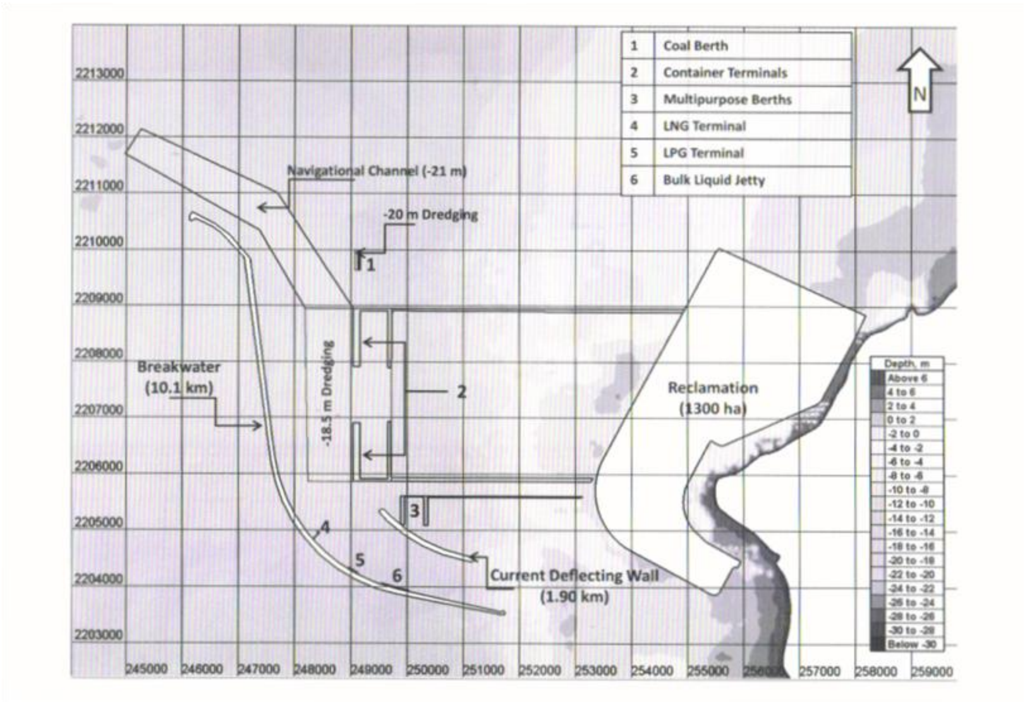


Fig. 2 : Port Layout

2. SCOPE OF STUDIES

The proposed studies have been divided in two parts:

1. Transformation of wave height and wave direction from deep water to -10 m depth near development area, using spectral wave model MIKE 21-SW to derive near-shore wave climate.
2. Mathematical model studies for estimation of littoral drift distribution and simulation of shoreline changes.

3. SITE CONDITIONS

3.1 Coastline at Vadhavan

The coastline orientation is at Vadhavan is approximately north south direction (Fig. 1). Bathymetry charts (Dahanu Port entrance Chart No 1141/2209, Tarapur Unbhat to Chinchani Chart No 739/2004 and Vadhavan Chinchani to Gungwada Chart No 713/2004) surveyed by MMB (Maharashtra Maritime Board) as provided by Project authority were used for the present study. The nearshore bathymetry at the site is having flat slope. It was observed from Google earth images of year 2004 to 2017 that coastline more or less remains in stable position and shows only minor changes seasonally.

3.2 Sediment Characteristics

Bed samples at different depths were provided by Project Authority (Test conducted by Bureau Veritas(India) Pvt. Ltd) on 15/11/2017. Details of sediment samples collected at depths between -2 to - 4 m are given Table 1 below :

Table 1 : Grain Size Distribution for Soil Samples at Various Locations

Sampling location	Easting	Northing	D_{50} (mm)
Dandepada	252850.51	2202778.18	0.01
	252615.50	2202745.80	0.0115
	252473.37	2202714.44	0.005
	252389.46	2202644.83	0.0076
Chinchani	254175.56	2200735.42	0.015
	252921.99	2201004.30	0.0114
	252698.02	2200930.75	0.0113
	252496.19	2200560.39	0.0138

From discussion with Project Authority, it was confirmed that in most of near-shore sea bed was rocky and D_{50} is about 6 micron consisting of mostly slit and clayey type bed material .

3.3 Littoral Drift

In the studies of Longshore sediment transport rates for the Indian Coast made by Chandramohan and Nayak in 1991, it has been estimated that the northerly drift along the Tarapur is 0.712×10^6 m^3/year and the southerly drift is 0.720×10^6 m^3/year. In north of Tarapur, near Umbergaon the northerly drift is 1.523×10^6 m^3/year and the southerly drift is 0.386×10^6 m^3/year while on the south of Tarapur, near, Bombay the northerly drift is 1.313×10^6 m^3/year and the southerly drift is 0.540×10^6 m^3/year. From various Google earth images, it is seen that net drift is towards North and the shorelines in the neighborhood of Vadhvan do not show any long term trend of erosion or accretion indicating that the coastline is more or less stable.

3.4 Tidal Levels

Tidal levels near Dahanu are given in Table 2 below :

Table 2 : Tidal Levels

Highest High Water (HHW)	5.5 m
Mean High Water Spring (MHWS)	5.0 m
Mean High Water Neap (MHWN)	4.7 m
Mean Sea Level (MSL)	2.8 m
Mean Low Water Neap (MLWN)	1.0 m
Mean Low Water Spring (MLWS)	0.7 m
Lowest Low Water (LLW)	0.0 m

3.5 Wave Data in Deep Sea

The offshore wave data of 14 years from 1999 to 2012 year off Vadhavan, by India Meteorological Department as observed from ships plying in deep waters were analyzed. The frequency distribution of wave heights for entire year for the above offshore wave data is given in Table 3. Corresponding wave rose diagram is presented in Fig. 3

Table 3 : Percentage Occurrence Of Wave Height & Wave Direction Off Vadhavan For Entire Period (Jan-Dec)

H(m)	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-3.5	3.5-4	4-4.5	>4.5	Total
D(deg)										
10	1.84	0.38	0.22	0.02	0.08	0.00	0.02	0.00	0.02	2.58
20	1.36	0.52	0.16	0.04	0.04	0.00	0.00	0.00	0.02	2.14
30	1.48	0.44	0.08	0.00	0.06	0.00	0.02	0.00	0.02	2.10
40	1.58	0.50	0.08	0.00	0.02	0.00	0.00	0.00	0.00	2.18
50	1.20	0.42	0.24	0.00	0.02	0.02	0.00	0.02	0.00	1.92
60	0.38	0.12	0.04	0.00	0.00	0.00	0.02	0.00	0.02	0.58
70	0.84	0.22	0.12	0.00	0.02	0.02	0.00	0.00	0.00	1.22
80	0.52	0.14	0.00	0.06	0.02	0.00	0.00	0.02	0.00	0.76
90	0.84	0.22	0.12	0.00	0.04	0.02	0.00	0.00	0.04	1.28
100	0.34	0.10	0.08	0.00	0.04	0.00	0.00	0.00	0.00	0.56
110	0.26	0.16	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.50
120	0.48	0.10	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.66
130	0.50	0.16	0.04	0.00	0.02	0.00	0.00	0.00	0.00	0.72
140	0.66	0.22	0.14	0.16	0.04	0.00	0.02	0.00	0.00	1.24
150	0.56	0.16	0.12	0.08	0.00	0.00	0.00	0.00	0.00	0.92
160	0.76	0.18	0.14	0.02	0.04	0.02	0.00	0.00	0.00	1.16
170	0.60	0.12	0.20	0.04	0.02	0.00	0.00	0.00	0.00	0.98
180	1.98	0.70	0.28	0.04	0.04	0.00	0.00	0.00	0.00	3.04
190	0.60	0.16	0.24	0.06	0.04	0.00	0.04	0.00	0.00	1.14
200	0.98	0.48	0.22	0.08	0.04	0.06	0.02	0.00	0.02	1.90
210	0.70	0.34	0.30	0.12	0.08	0.04	0.02	0.00	0.00	1.60
220	0.98	0.44	0.32	0.32	0.26	0.08	0.10	0.06	0.06	2.62
230	1.30	0.62	0.70	0.32	0.50	0.20	0.20	0.02	0.08	3.94
240	0.98	0.44	0.84	0.50	0.60	0.22	0.26	0.04	0.14	4.02
250	0.88	0.90	1.02	0.50	0.92	0.48	0.50	0.04	0.08	5.31
260	0.88	0.60	0.90	0.44	0.66	0.46	0.36	0.10	0.14	4.54
270	2.62	1.40	2.02	1.16	1.60	0.36	0.62	0.18	0.18	10.13
280	1.04	0.74	1.06	0.52	0.78	0.28	0.28	0.08	0.12	4.90
290	1.44	0.80	1.08	0.84	0.74	0.26	0.14	0.02	0.08	5.39
300	1.68	1.06	0.84	0.44	0.34	0.12	0.10	0.02	0.00	4.60
310	2.00	1.00	0.74	0.18	0.32	0.00	0.06	0.02	0.00	4.32
320	3.40	0.76	0.76	0.10	0.20	0.06	0.02	0.00	0.00	5.29
330	2.50	0.72	0.42	0.14	0.06	0.06	0.02	0.02	0.00	3.94
340	2.68	0.88	0.30	0.14	0.06	0.02	0.02	0.00	0.00	4.10
350	2.34	0.62	0.52	0.04	0.06	0.00	0.00	0.00	0.00	3.58
360	3.20	0.64	0.26	0.06	0.00	0.00	0.00	0.00	0.04	4.20
Total	46.33	17.44	14.71	6.43	7.75	2.78	2.84	0.66	1.06	100.00

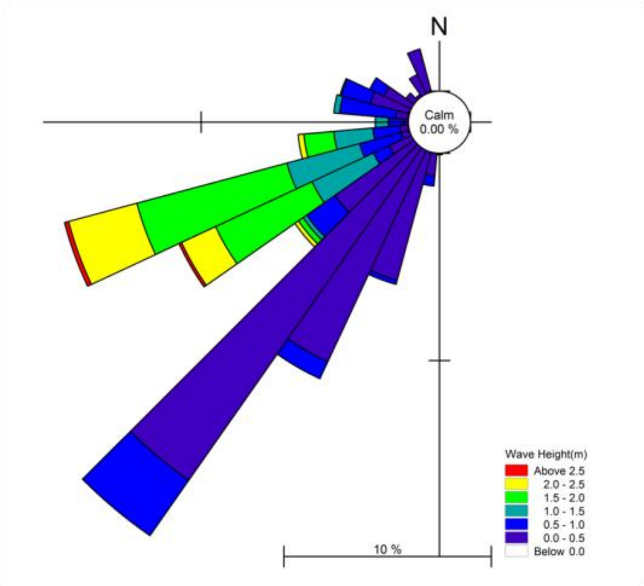


Fig. 3 : Offshore Wave Rose Diagrams

These deep water wave data were transformed by Mike-21 SW model to get the nearshore wave climate at the port.

4.0 MATHEMATICAL MODEL STUDIES FOR WAVE TRANSFORMATION

Mathematical model studies for transformation of wave height and wave direction from deep water to -25 m and -10 m depth were carried out using spectral wave model MIKE 21-SW. Brief description of the mathematical model MIKE 21-SW is given below.

4.1 Mike 21-SW Model

As waves travel from deep sea to shallow coastal waters, they undergo changes in wave direction and wave height due to the processes of refraction and shoaling. The computation of wave transformation from deep to shallow coastal waters was carried out using MIKE 21-SW model.

MIKE 21 SW is a state-of-the-art third generation spectral wind wave model based on unstructured mesh. The model simulates the growth, decay and transformation of wind generated waves and swells in offshore and coastal areas. It takes into account refraction and shoaling of waves, which are important in the transformation of waves from offshore to inshore. It also includes physical phenomena of wave growth by action of wind, dissipation due to white-capping, dissipation due to bottom friction, and dissipation due to depth induced wave breaking.

4.2 Wave Transformation From Deep Water To Nearshore

The nearshore wave climate at Vadhavan was obtained by transforming the ship observed deepwater wave data, using MIKE 21 SW model. Model area considered for the wave transformation studies is shown in Fig. 4. Bathymetry in the model region of about 1120 km X 300 km area was schematized by unstructured mesh. The model was run to obtain near-shore wave climate at the Inshore Point (Fig. 4) in -24 m and -10 m depth contour. The frequency distribution of waves at the Inshore Point for entire year is given in (Tables 4 & 5). The corresponding rose diagram is shown in Fig. 5 & Fig. 6 respectively .

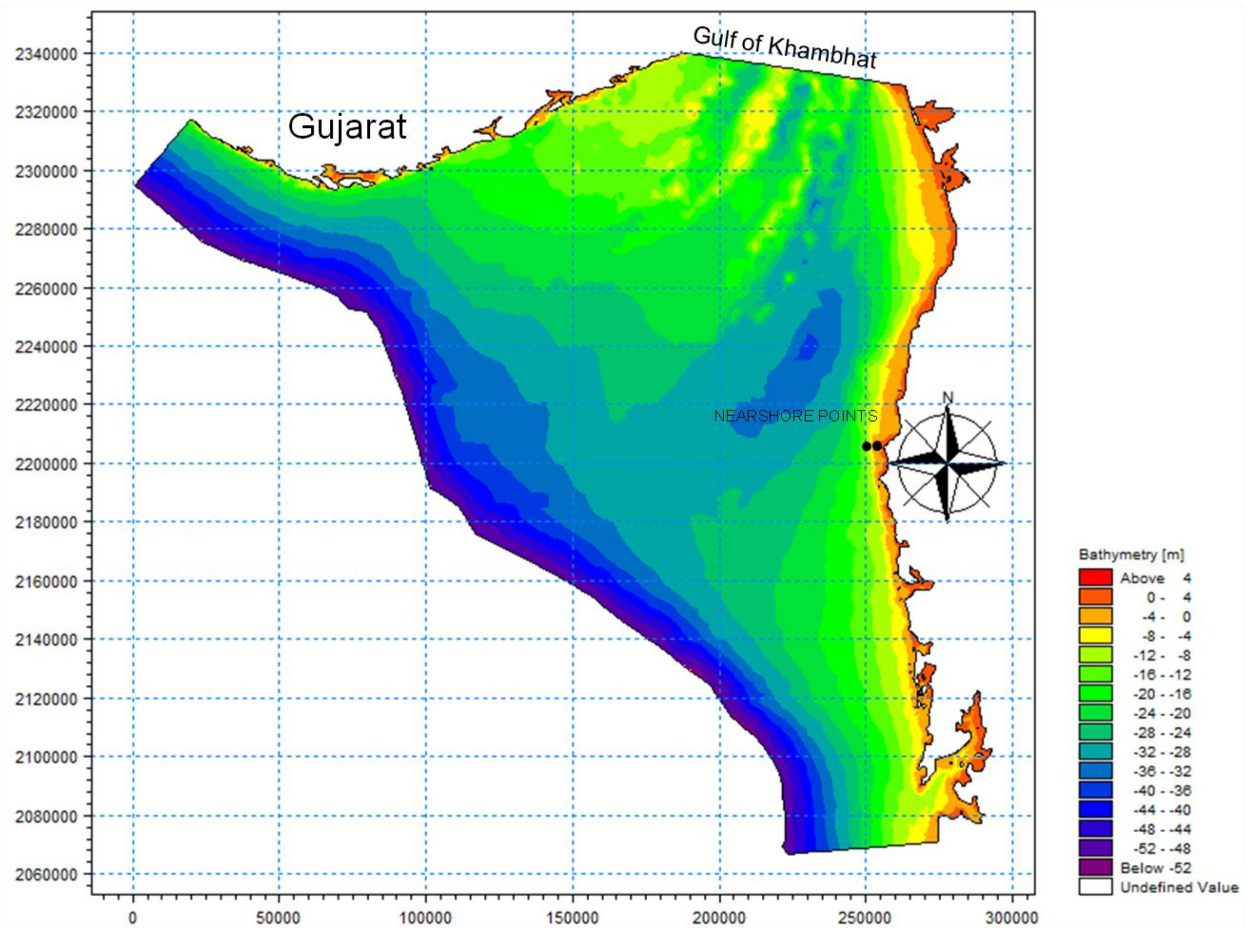


Fig. 4 : Bathymetry For Wave Transformation

Table 4 : Percentage Occurrence Of Wave Height &Wave Direction At Vadhavan In 24 m Depth For Entire Period(Jan-Dec)

H(m)	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-3.5	3.5-4	Total
D(deg)							Clam%	54.48
200	0.35	0	0	0	0	0	0	0.35
210	0.49	0	0	0	0	0	0	0.49
220	1.95	0	0	0	0	0	0	1.95
230	2.30	0.07	0.28	0.14	0	0	0	2.78
240	0.84	3.83	4.18	1.60	0.14	0	0	10.58
250	2.30	4.24	8.42	2.23	0.14	0	0	17.33
260	1.32	1.88	1.67	0.07	0	0	0	4.94
270	0.84	0.84	0.07	0	0	0	0	1.74
280	2.78	0.35	0	0	0	0	0	3.13
290	1.39	0.07	0	0	0	0	0	1.46
300	0.77	0	0	0	0	0	0	0.77
Total	15.31	11.27	14.61	4.04	0.28	0	0	100.00

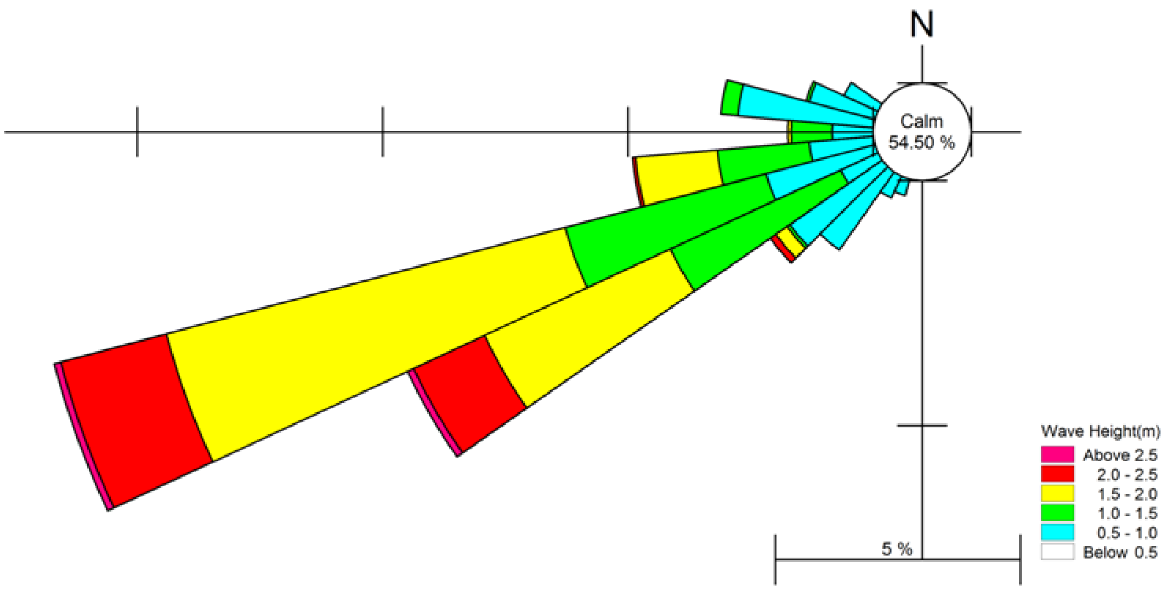


Fig. 5 : Near Shore Wave Rose Diagrams at -24 m Depth

Table 5 : Percentage Occurrence Of Wave Height &Wave Direction At Vadhavan In 10 m Depth For Entire Period(Jan-Dec)

H(m)	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-3.5	3.5-4	Total
D(deg)							Clam%	57.67
220	0.14	0	0	0	0	0	0	0.14
230	0.69	0	0	0	0	0	0	0.69
240	2.42	1.66	0.69	0.14	0	0	0	4.91
250	3.18	9.47	7.81	0.69	0	0	0	21.15
260	1.59	3.60	2.77	0.35	0	0	0	8.31
270	1.45	0.83	0	0	0	0	0	2.28
280	2.84	0.21	0	0	0	0	0	3.05
290	1.18	0.07	0	0	0	0	0	1.25
300	0.55	0	0	0	0	0	0	0.55
Total	14.04	15.84	11.27	1.18	0.00	0.00	0.00	100.00

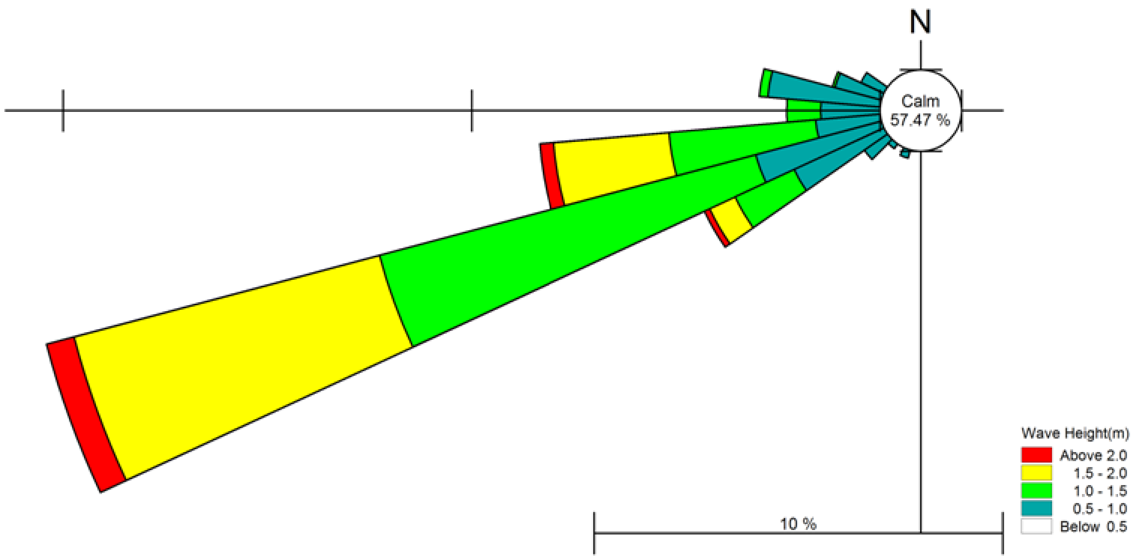


Fig. 6 : Near Shore Wave Rose Diagrams at -10 m Depth

5.0 MATHEMATICAL MODEL STUDIES FOR ESTIMATION OF LITTORAL DRIFT DISTRIBUTION AND SIMULATION OF SHORE LINE CHANGES

Mathematical model studies for estimation of littoral drift distribution and simulation of shoreline changes were carried out using LITPACK model. Brief description of the mathematical models is given below.

LITPACK software was used for computation of littoral drift and simulation of shoreline changes due to construction of the breakwaters. LITPACK is a professional engineering software package for the modelling of non-cohesive sediment transport in waves and currents, littoral drift, coastline evolution and profile development along quasi-uniform beach.

The LITDRIFT module simulates the cross-shore distribution of wave height, setup and longshore current for an arbitrary coastal profile. It provides a detailed deterministic description of the cross-shore distribution of the longshore sediment transport for an arbitrary bathymetry for both regular and irregular sea states. The longshore and cross-shore momentum balance equation is solved to give the cross-shore distribution of longshore current and setup. Wave decay due to breaking is modelled, either by an empirical wave decay formula or by a model of Battjes and Janssen. LITDRIFT calculates the net/gross littoral transport over a specific design period. Important factors, such as linking of the water level and the beach profile to the incident sea state, are included. Based upon the results from LITDRIFT, LITLINE simulates the coastal response to gradients in the longshore sediment transport capacity resulting from natural features and a wide variety of coastal structures. LITLINE predicts the coastline evolution by solving a continuity equation for the sediment in the littoral zone. This model type will calculate the movements of the coastline position with respect to a straight baseline. The model is based on a one-line theory, in which the cross-shore profile is assumed to remain unchanged during erosion/accretion and with unlimited supply of sand available. Thus, the coastal morphology is solely described by the coastline position (cross-shore direction) and eventual changes of dune geometry at a given long-shore position.

LITPACK is a 1-D model. The flow around a breakwater comprises complicated 2-dimensional circulations, which cannot be fully assessed by any 1-dimensional model. With respect to coastline evolution modelling, the prime effect of a Offshore breakwater is its sheltering effect. In the shadow region between the Offshore breakwater and the coastline, the wave disturbance and the driving forces for a long shore current are reduced (and may even reverse, depending on the relative size and proportions of the breakwater). This will lead to a decrease in the longshore sediment transport. It is this effect that is modelled in LITLINE, and it is solely used to assess the stability of the local coastline through the changes to the longshore transport rates. The annual sediment budget is found by the contribution of transport from each of the wave incidents occurring during the year. Thus the total annual drift is the sum of the contributions from all the incident waves.

5.1 Estimation Of Littoral Drift Rate

LITDRIFT module of LITPACK software was used to estimate annual littoral drift rates and its distribution on the profile normal to the shoreline. Since bathymetry near the development area is complex, eight different profiles normal along the shore were considered for drift estimation. Location of these profiles are shown in Fig. 7 while, cross-shore section is shown in Fig. 8(a to h) and details are given in Table 6. These cross shore profile are based on bathymetry (Dahanu Port entrance Chart No 1141/2209, Tarapur Unbhat to Chinchani Chart No 739/2004 and Vadhavan Chinchani to Gungwada Chart No 713/2004) surveyed by MMB (Maharashtra Maritime Board) provided by Project authority.

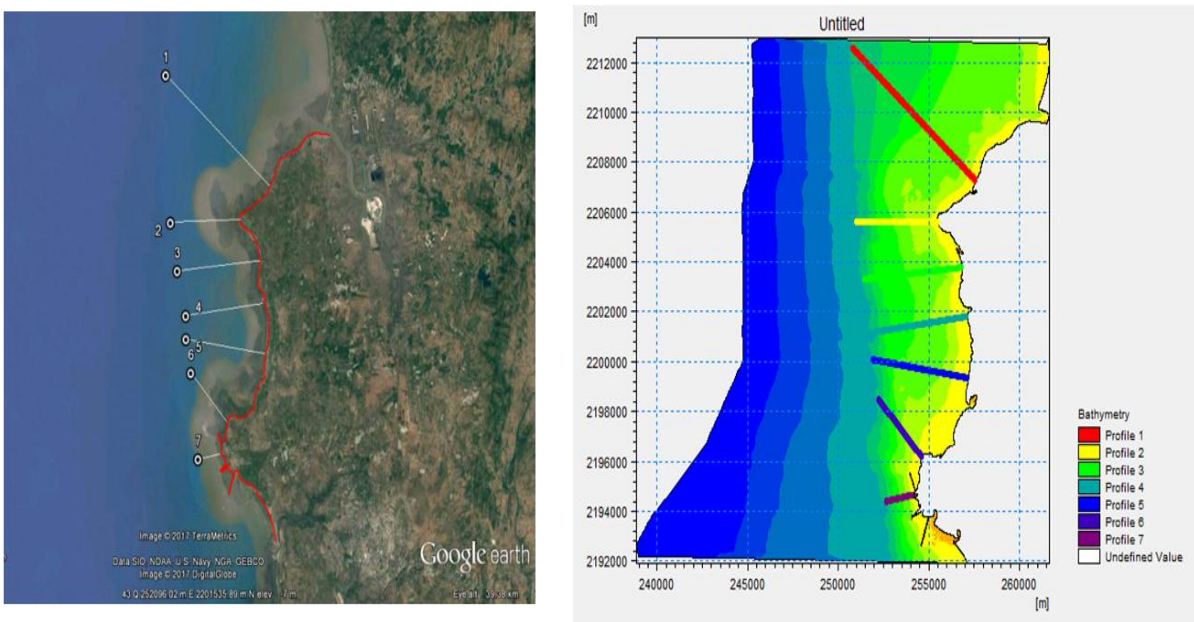
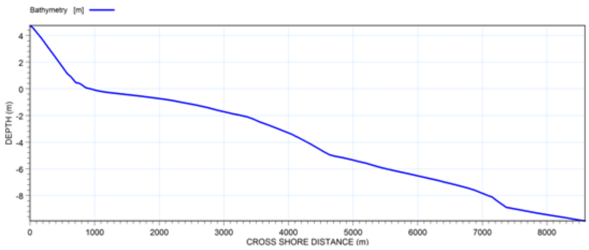


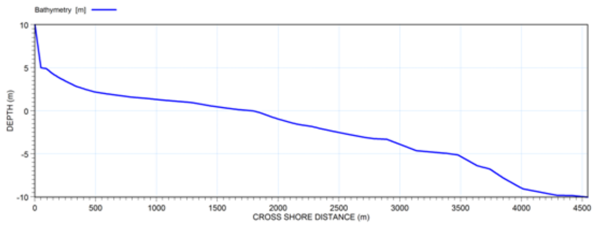
Fig. 7 : Cross Shore Profile Locations

Table 6 : Cross Shore Profile Details

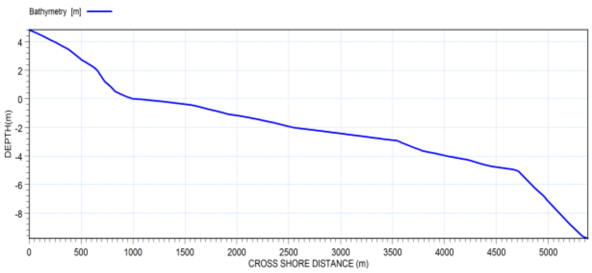
Profile No	Shore		Sea		Line orientation (Deg N)	Grid spacing	Profile Length (m)	No of grid points
	Easting	Northing	Easting	Northing				
1	257518	2207215	250790	2212575	308	5	8690	1738
2	255495	2205674	251000	2205600	270	5	4500	900
3	256783	2203715	251415	2203310	265	5	5400	1080
4	257086	2201700	251945	2201180	263	5	5200	1040
5	257110	2199304	251940	2200080	278	5	5200	1040
6	254560	2196110	252235	2198480	314	5	3300	660
7	254050	2194615	252650	2194400	260	5	1500	300
8	255495	2205674	235495	2205674	270	5	20000	4000



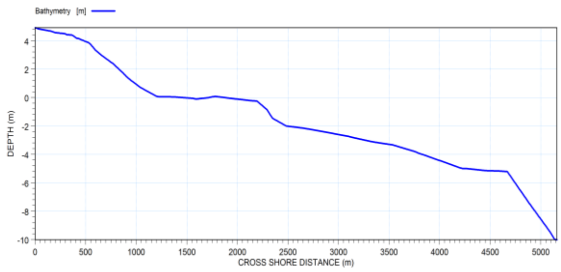
8 (a) : Cross Shore Profile P1



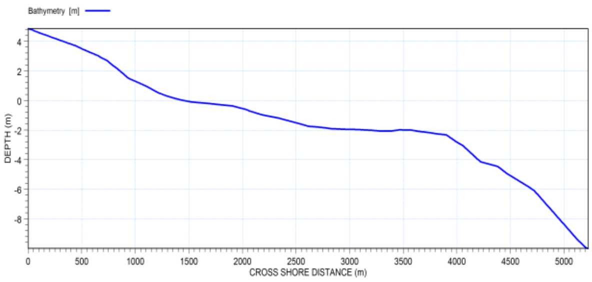
8 (b) : Cross Shore Profile P2



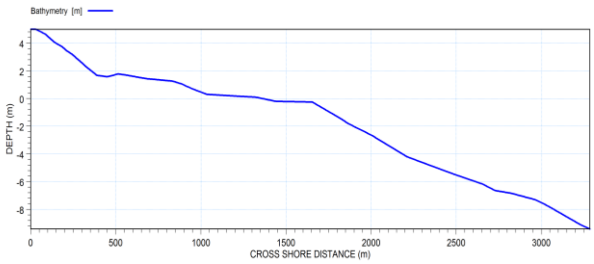
8 (c) : Cross Shore Profile P3



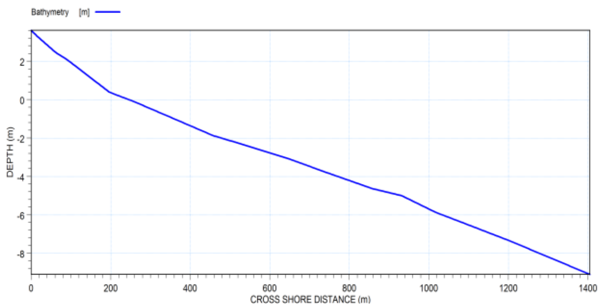
8 (d) : Cross Shore Profile P4



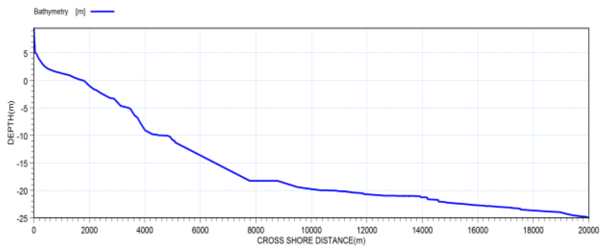
8 (e) : Cross Shore Profile P5



8 (f) : Cross Shore Profile P6



8 (g) : Cross Shore Profile P7



8 (h) : Cross Shore Profile P8

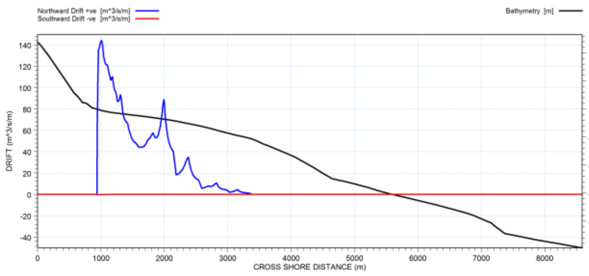
Fig. 8 : Cross Shore Profiles

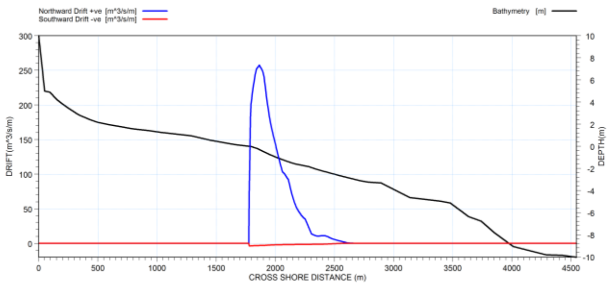
The model needs some calibration data which could be maps of historical coastline evolution, aerial photographs of the coastline from different years or estimates of erosion/deposition rates during a season with known wave conditions. In the absence of such calibrating data, the model calibration could not be possible for present study. Hence, the model approximation was done based on Google earth images. For Profile Nos. 1 to 7, the model was run for annual near-shore wave climate (based on -10 m depth, Table 5). For Profile No 8, the model was run for annual near-shore wave climate (based on - 24 m depth, Table 4). Using these near-shore annual wave climates, the northward, southward, net and gross transport rates were computed, given in Table 7 below. Annual northward and southward drift is shown in Fig. 9(a to h). The northward drift is plotted as positive while southward drift is plotted as negative

Table 7 : Littoral Transport Rates (m^3)

Profile No	Northward	Southward	Net *	Gross	Drift Direction
p1	102950	50	102900	103000	North
p2	70630	1410	69220	72040	North
p3	104750	3450	101300	108200	North
p4	79610	3440	76170	83050	North
p5	130850	1350	129500	132200	North
p6	46450	0	46450	46450	North
p7	32625	1815	30810	34440	North
p8	32805	25	32780	32830	North

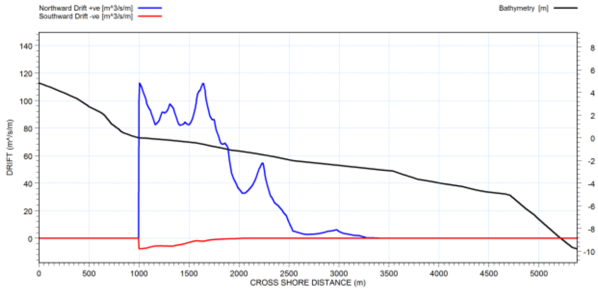
Note*: '-ve' Southward '+ve' Northward for the Net Drift

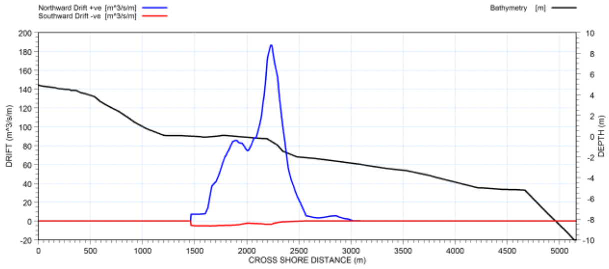




9(a) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P1

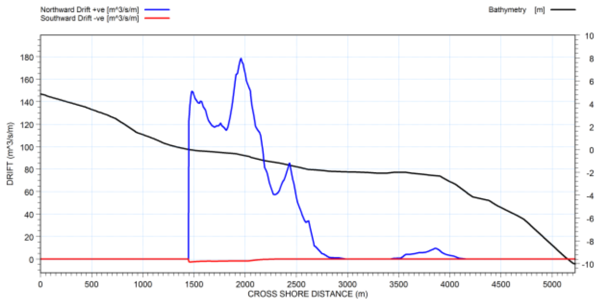
9(b) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P2

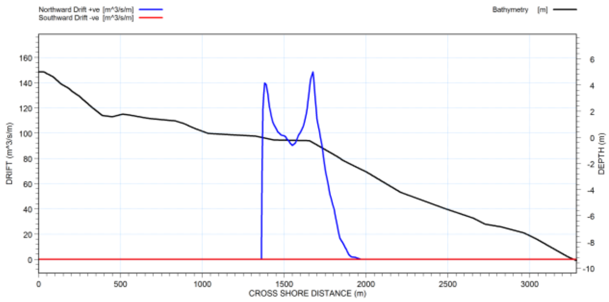




9(c) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P3

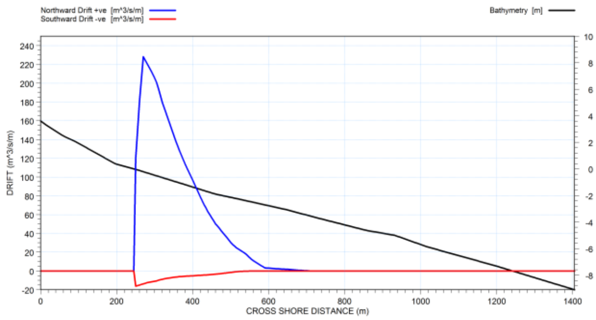
9(d) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P4

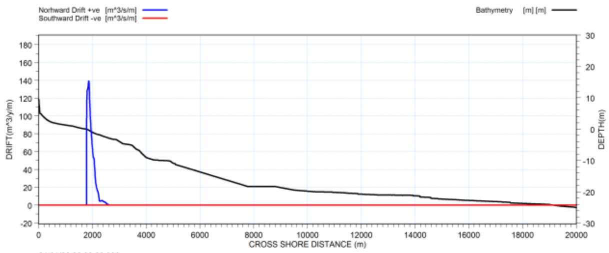




9(e) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P5

9(f) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P6





9(g) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P7

9(h) : Annual Northern & Southern Littoral Drift for Cross Shore Profile P8

Fig. 9 : Annual Northern & Southern Littoral Drift for various Cross Shore Profiles

5.2 Shoreline Evolution

In order to assess the impact of the port on the coastline, LITLINE module of LITPACK software was used. In the absence of measured shoreline, coastline was taken from C-MAP for the study. The length of the shoreline considered for the studies is 20 km (Fig. 10). The shoreline under study is between Dahanu and Tarapur. It was divided into 4000 grid points of grid size 5 m. The proposed Port layout (Fig.2) finalized based on extensive mathematical modeling for tidal hydrodynamics and wave tranquility studies was studied for shoreline evolution studies including offshore breakwater of length 10.1 km. Cross shore profile P8 and near shore annual wave climate in -24 m depth contour (Table 4) was considered for these studies. The model was run for 1, 2, 4 and 6 years with the proposed breakwater as shown in Fig. 11 & Fig. 12.

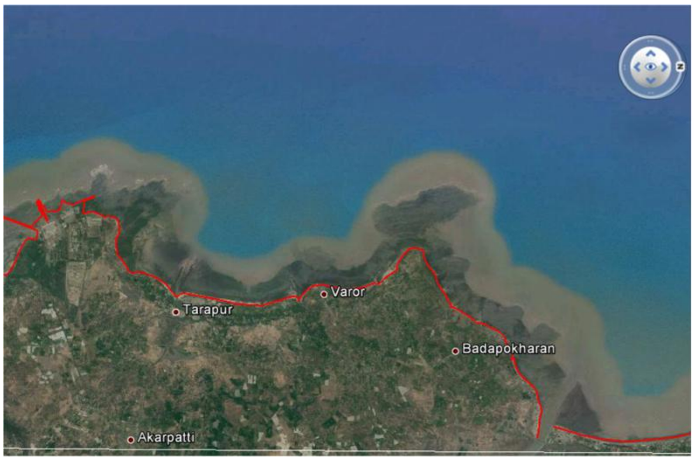


Fig. 10 : Shoreline Considered For Shoreline Evolution

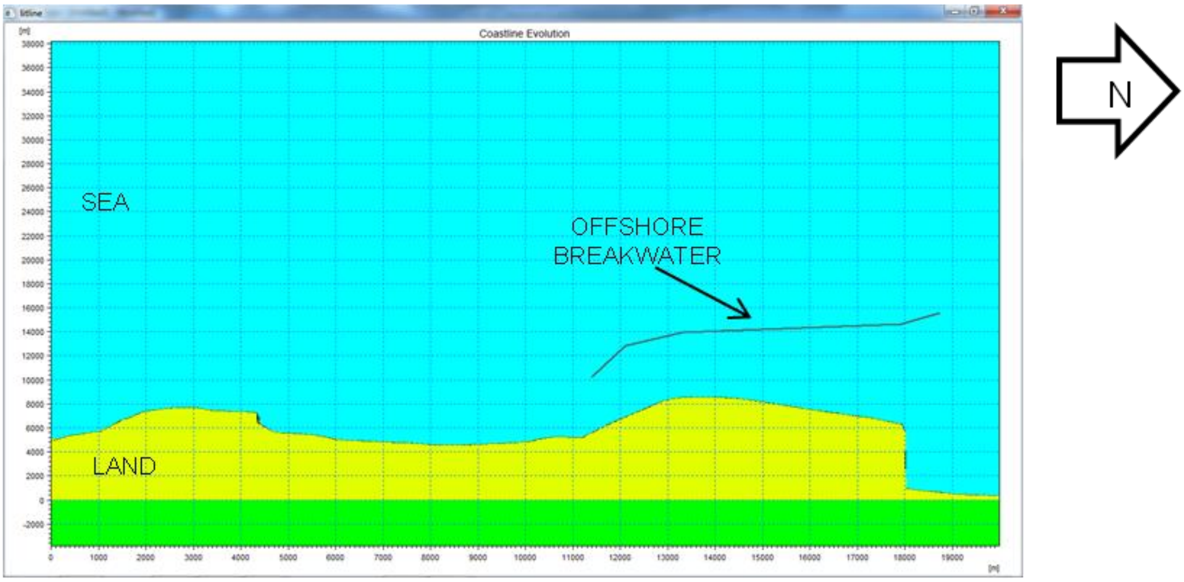


Fig. 11 : Model Output for Shoreline Evolution

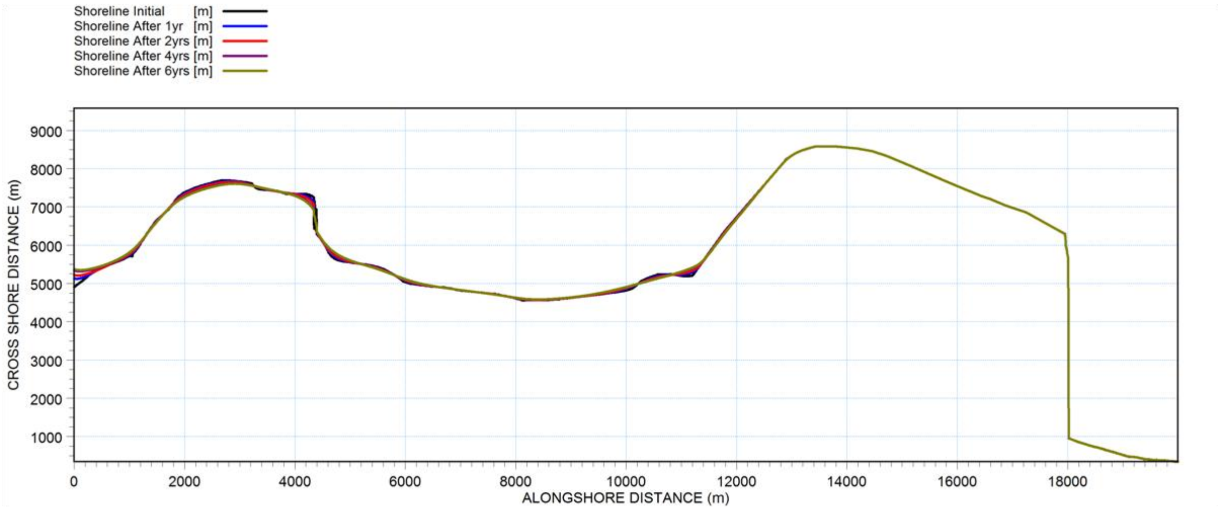


Fig. 12 : Model Output(Line Representation) for Shoreline Evolution

6.0 DISCUSSION OF THE RESULTS

Studies for estimation of littoral drift indicated that average net transport in a year is of the order of 0.07 million cum and is towards North.

For profile 1

The maximum transport occurs at about 995 m from the shoreline (i.e. High Water Line) at around -0.1 m depth contour. The transport is occurring up to about 2450 m from the shore (HWL) between 0.003 m and -2.1 m depth contours.

For profile 2

The maximum transport occurs at about 1765 m from the shoreline (i.e. High Water Line) at around -0.29 m depth contour. The transport is occurring up to about 890 m from the shore (HWL) between 0.001 m and -2.9 m depth contours.

For profile 3

The maximum transport occurs at about 1600 m from the shoreline (i.e. High Water Line) at around -0.57 m depth contour. The transport is occurring up to about 2450 m from the shore (HWL) between 0.006 m and -2.8 m depth contours.

For profile 4

The maximum transport occurs at about 2095 m from the shoreline (i.e. High Water Line) at around -0.1 m depth contour. The transport is occurring up to about 1665 m from the shore (HWL) between 0.0001 m and -2.77 m depth contours.

For profile 5

The maximum transport occurs at about 1890 m from the shoreline (i.e. High Water Line) at around -0.46 m depth contour. The transport is occurring up to about 2715 m from the shore (HWL) between 0.005 m and -3.7 m depth contours.

For profile 6

The maximum transport occurs at about 1600 m from the shoreline (i.e. High Water Line) at around -0.39 m depth contour. The transport is occurring up to about 635 m from the shore (HWL) between 0.007 m and -2.6 m depth contours.

For profile 7

The maximum transport occurs at about 270 m from the shoreline (i.e. High Water Line) at around -0.2 m depth contour. The transport is occurring up to about 1825 m from the shore (HWL) between 0.004 m and -3.5 m depth contours.

For profile 8

The maximum transport occurs at about 1760 m from the shoreline (i.e. High Water Line) at around -0.3 m depth contour. The transport is occurring up to about 2535 m from the shore (HWL) between -0.01 m and -2.9 m depth contours.

Fig. 12 shows shoreline changes likely to occur after 1, 2, 4 and 6 years. With the proposed breakwater shoreline advancement is negligible.

7.0 CONCLUSIONS

Mathematical Model Studies for Shoreline Changes for proposed port at Vadhavan, Maharashtra indicated that:

1. In the nearshore region of Vadhavan, in 10 m water depth, the predominant wave directions are from the sector between 220^0 N to 300^0 N. directions with maximum significant wave height of the order of 2.5 m.
2. Studies for estimation of littoral drift distribution indicated that, average net transport in a year is of the order of 0.07 million cum and is towards North.
3. Studies for simulation of shoreline changes indicated that the construction of proposed offshore breakwater of 10.1 km length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well.

4. In the absence of the measured wave data ship observed wave data by IMD in deep sea was used. Therefore, predictions about the shoreline advancement are to be considered as only indicative and it is difficult to quantify accurately the shoreline advancement.

REFERENCES

Chandramohan, P. and Nayak, B.U (1992). "Longshore Sediment Transport Model for the Indian West Coast"; Journal of Coastal Research; 8, 4, 775–787.