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Studies on Nearshore Processes at Yarada Beach (South of Visakhapatnam Harbour), East Coast of India

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Influence of breakwaters on Yarada beach (3.5 km length) stability and distribution of wave induced longshore currents in this region were studied. Monthly observations on variation in beach levels, distribution of wave induced longshore currents and visual observations on breaker heights and breaker angles were made at 8 stations from Jan. 1978 to Jan. 1979. There was accretion in Yarada beach with a net addition of about 12,000 m^3 of sand during the study period. Seasonal erosion and accretion patterns differed from place to place along the beach. Wave induced longshore current direction was towards NE from March to Sept. and towards SW from Nov. to Feb. and its speed varied between 0.1 and 0.4 m sec^{-1} during study period.

Yarada beach is situated south of Dolphin's Nose, the promontory which partly protects the entrance channel of Visakhapatnam harbour. The net littoral drift along the shoreline in this area is towards NE. In order to stabilize the eroding beach on the downdrift side, sand is being bypassed from the sand trap located on the updrift side to the downdrift beaches. The present study evaluates beach changes and pattern of accretion and erosion during different months (Jan. 1978 to Jan. 1979) at Yarada beach which is located at updrift side.

The Yarada beach is about 3.5 km long and flanked in between Dolphin's Nose and Yarada Hill (Fig.1). On the northern part of Yarada beach, there is a small hillock called Red Hill protruding into the sea. Part of the beach in between Dolphin's Nose and Red Hill is comparatively narrow with about 70 m width. The remaining stretch of the beach in between Red Hill and Yarada Hill is a long and wide sandy beach of more than 150 m width with dunes on the backshore. The annual wave features in this area are: (i) they generally approach the coast from S during March to Sept. and from E during Dec. to Feb., (ii) in Oct. and Nov. (transition period) the direction changes from S to E; from Jan. to April sea is usually calm with average wave heights not > 1 m; from May to Sept. (SW monsoon period) sea becomes rough, with wave heights of 1 to 3 m; and from Oct. to Dec., other than the cyclonic period, sea is calm, (iii) Wave periods vary from 9 to 12 sec. for the greater part of the year. The beach levels along Visakhapatnam coast are generally higher in March and April than in October and November[3].

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Materials and Methods

Eight stations were established along the Yarada Beach from Dolphin's Nose to Yarada Hill (Fig.1). Monthly measurements on beach profiles were made during the lowest low tide level up to 1 m depth into sea. A Dumpy level, 4 m levelling staff, 2.5 m long steel ranging rods and a magnetic compass were used for beach profile surveys. Changes in beach levels were recorded for every 5 m intervals along the profile section. The breaker heights and approximate breaker angles were observed visually and were recorded. Wave periods were observed by noting the average time required for passing of 10 waves at a point. The average magnitude and direction of longshore currents

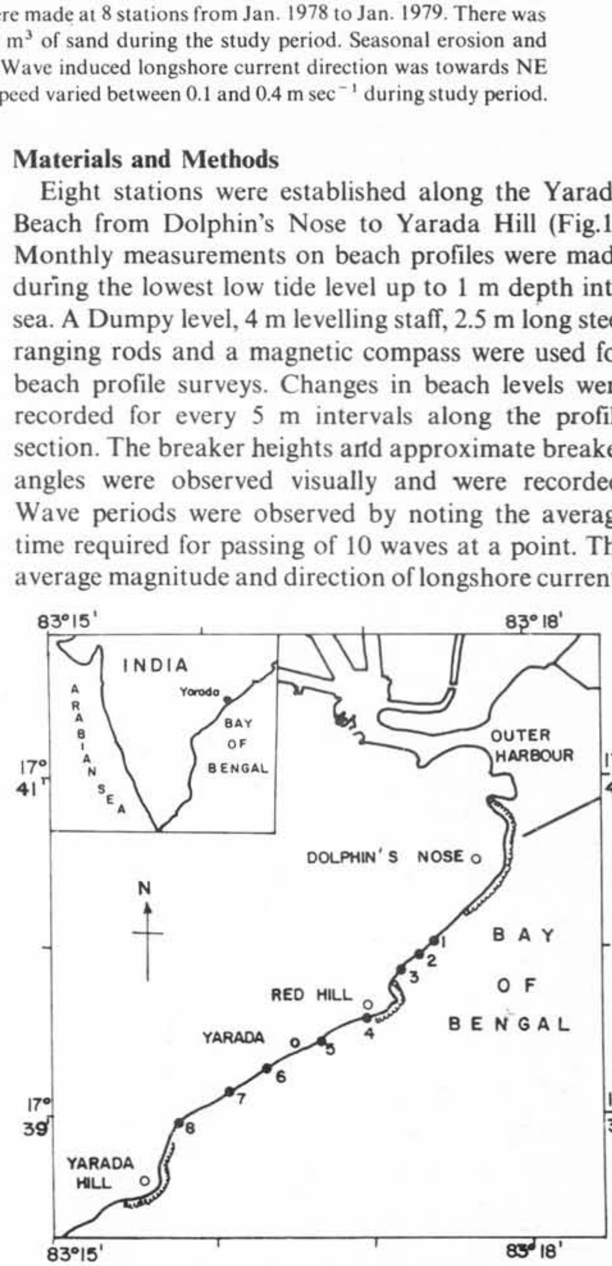

Fig. 1—Location map

were measured at every 50 m distance along the coast by releasing neutrally buoyant rubber balloons on the surf zone and noting the distance travelled by them in 2 min. Trapezoidal rule was used to compute the volume of sediment for a unit length of the beach. Taking the lowest profile at a section as datum, volume of sand accreted during different months at different sections was computed (Table 1).

Results and Discussion

Visually observed average and maximum breaker heights, average wave period and approximate breaker angle in different months are shown in Fig.2. Distribution of observed wave induced longshore current speed and direction during different months are shown in Fig.3. The general direction of longshore current was towards NE from March to Sept. and towards SW from Nov. to Feb. The direction was transitional and variable in Oct. Frequently a reversal of direction was observed near st 4. The presence of hill promontory (Red Hill) and the scattered rocky outcrops in the surf zone near this station may be causing the changes in current distribution. In between st 1 and st 3, comparatively weak longshore currents of the order of 0.1-0.15 m.sec^{-1} were observed during the period of study. This is quite evident from the morphological formation of this particular stretch, a shallow bay immediately behind the harbour breakwater and the Dolphin's Nose Hill. Along the remaining stretch of the beach between st 4 and st 8, the longshore current varied between 0.1 and 0.2 m.sec^{-1} during Feb., April, May and Oct. Along this stretch, it varied between 0.2 and 0.3 m.sec^{-1} during June to Sept. and Jan. and it exceeded 40 m.sec^{-1} in Nov. The speed was 0.1 m.sec^{-1} in Dec.

The volume of material deposited per unit length of the beach with reference to minimum beach level is given in Table 1. It shows that at st 4, erosion had taken place during SW monsoon (May to Sept.) and at sts 3 and 6 to 8 erosion occurred during NE monsoon (Oct.-Feb.). Near to sts 1, 2 and 5 erosion took place both during SW and NE monsoon. These changes in depositional and erosional patterns along this beach have been influenced by the promontories and the harbour breakwaters which act as littoral barriers. Though the wave climate during SW monsoon is severe, beach near sts 3 and 6 to 8 were stable without any erosion during SW monsoon. It might be due to the obstruction caused by the harbour breakwaters on the longshore sediment movement, causing deposition in the updrift side beaches. Due to seasonal erosion and accretion the elevational and width of the beach subjected to changes are given in Table 2.

In an annual beach cycle the quantum of sand fluctuations per metre length of the beach near st 2 was maximum about 226 m^3 and near st 1 was minimum about 49 m^3 (Table 1). At other stations it was between 100 and 130 m^3 except at st 8 where it was about 184 m^3. It is estimated that during the study period the total quantity of sediment subjected to beach process was 0.46×10^6 m^3. The beach had largest quantity of

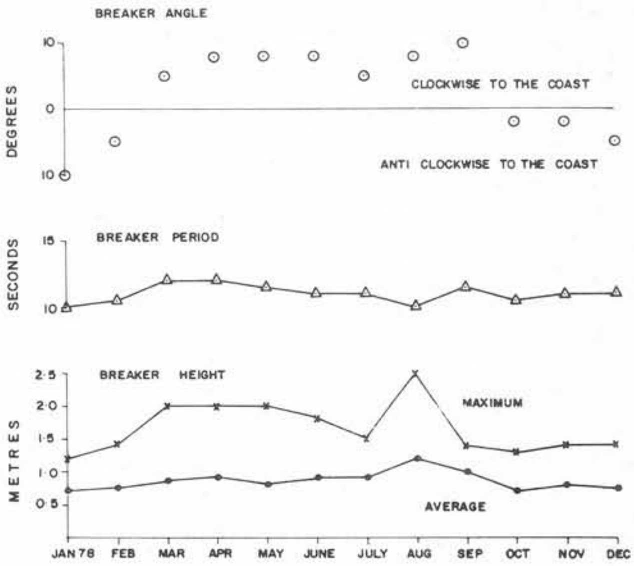

Fig. 2—Distribution of breaker height, period and angle

Table 1—Volume of Sand Deposited Per Unit Length of the Beach at Different Stations (m^3)

St	1978												1979
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
1	36	0	43	40	40	20	22	23	10	49	2	27	4
2	123	141	171	226	111	65	129	94	97	54	0	119	160
3	107	111	130	95	61	67	83	84	96	56	0	104	83
4	80	19	20	19	100	0	35	63	72	79	77	77	29
5	29	17	3	76	76	0	57	60	59	31	67	111	79
6	56	106	135	70	63	91	122	87	0	39	81	122	71
7	103	152	134	155	117	108	119	120	63	147	0	99	120
8	72	89	140	171	184	134	130	90	0	39	77	95	107

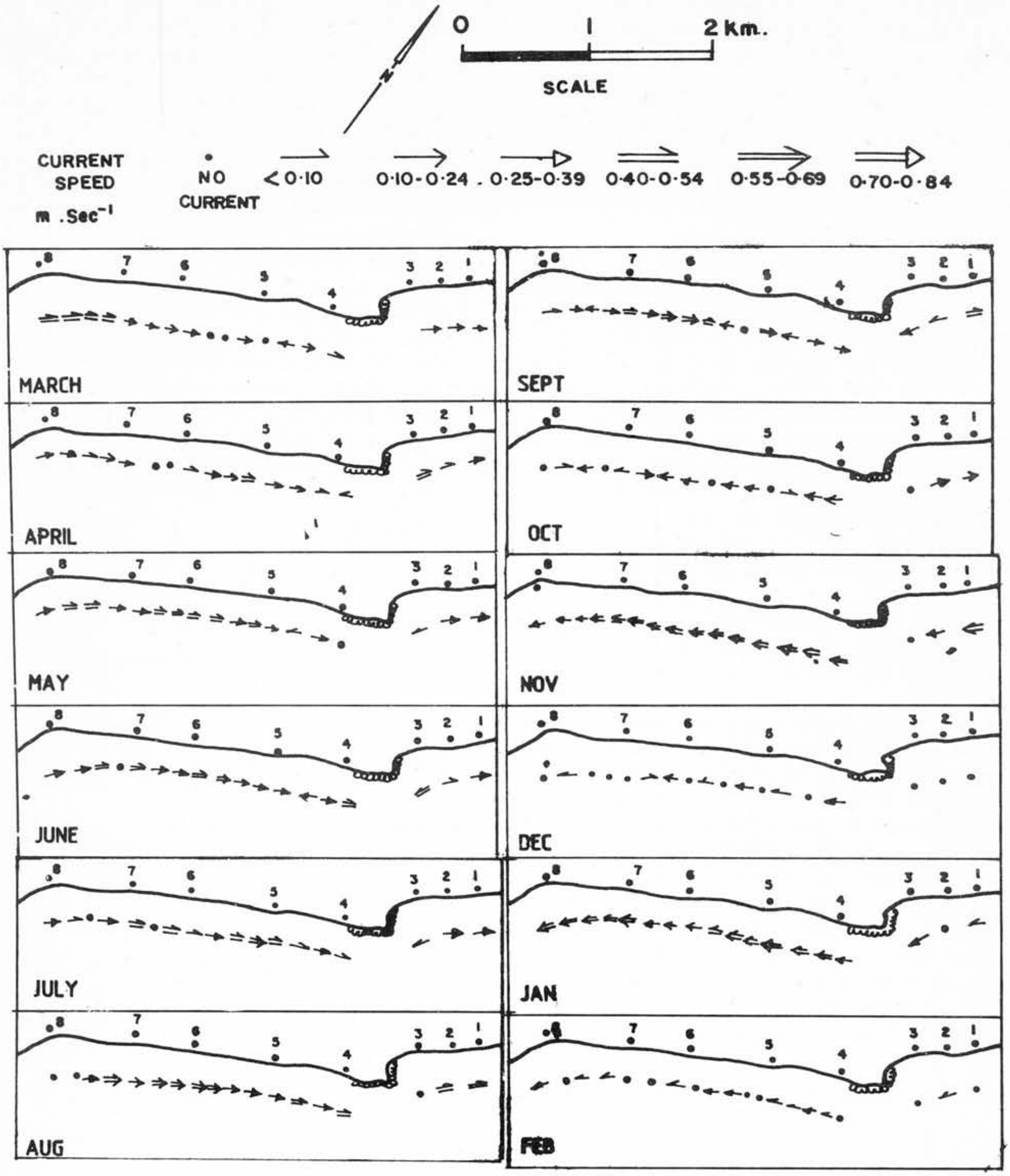

Fig. 3—Distribution of speed and direction of longshore currents

sediment of about 0.34×10^6 m^3 during March to May and Dec. and the lowest quantity of about 0.15×10^6 m^3 during Sept. and Nov. From this, it may be concluded that the breakwaters obstruct the northerly drift during SW monsoon thereby leading to the deposition of sand at Yarada beach.

The observed breaker angles and wave induced longshore currents (Figs 2 and 3) imply that the longshore sediment transport along this region is towards NE during SW monsoon and calm weather period (March-Sept.) and towards SW during NE monsoon period (Oct.-Feb.). Further it is reported[4]

Table 2—Change in Beach Elevation and Width at Different Stations

St.	Elevation (m)		Width (m)	
	Maximum	Mean	Maximum	Mean
1	1.6	1.1	65	33
2	2.8	1.2	80	47
3	2.8	1.6	80	50
4	2.8	1.6	60	33
5	2.2	1.4	65	25
6	2.8	1.8	45	18
7	2.2	1.4	70	50
8	2.6	2.1	80	49

that there is predominantly a northerly drift of 0.88×10^6 m^3 during SW monsoon and calm weather period and a southerly drift of 0.18×10^6 m^3 during NE monsoon period with a net northerly drift of 0.70×10^6 $m^3.y^{-1}$. Therefore, in an annual cycle, during SW monsoon and calm weather period the Yarada beach forms as updrift beach and the Visakhapatnam beach as downdrift beach whereas during NE monsoon period it is vice versa. Considering the relative quantity of longshore sediment transport during these 2 different directions it is observed that in a year the net transport occurs towards the northerly direction. Therefore, while formulating the net effect in an annual cycle, the Yarada beach behaves as updrift beach whereas the Visakhapatnam beach forms as downdrift beach due to the presence of harbour breakwaters.

During the period of study it is noted that the Yarada beach experienced an annual net deposition of 12,000 m^3 of sand. Consequently during this time the downdrift Visakhapatnam beach experienced net annual erosion[1]. The studies made on the basis of mathematical models[2] incorporating the present quantity of sediment bypassing across the Visakhapatnam harbour showed that the Yarada beach is in net accretion trend behaving as updrift beach and Visakhapatnam beach is in net erosion trend acting as downdrift beach.

It is further reported from the field studies[1] that there is an insufficiency in sand bypassing to the downdrift Visakhapatnam beach and it is in net erosional trend every year. This is in confirmity with present study that the updrift Yarada beach is in net depositonal trend arresting the part of littoral drift and causing the reduction in sediment supply to the downdrift Visakhapatnam beach. Thus the prevailing sediment process infers that the sediment bypassing rate to the Visakhapatnam beach can be increased little more which may not cause any destruction to Yarada Beach but at the same time it may improve for stabilizing downdrift Visakhapatnam beach.

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