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STABILITY OF SUSPENDED SEDIMENT TRANSPORT MODEL FOR FEASIBILITY STUDY OF VARIOUS PORT LAYOUTS AT GULF OF CAMBAY, INDIA

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Numerical investigations in respect of solving Navier-Stokes equations as well as convection-diffusion equation for suspended sediment transport with source / sink terms are addressed with reference to simulation of flow field and sediment transport in a computational domain of 60 km2 having complicated bathymetry including large tidal flats, three zero meter contours from shoreline towards offshore and four open boundaries (fourth boundary being partly closed and partly open). The model area (Fig.-1) is located in the Gulf of Cambay which is subjected to a maximum tidal range of the order of 8 m resulting in wide tidal flat (approximately 15% of the model area) having tidal current more than 2 m/s and movement of high sediment laden water (even 5000 ppm at some locations) and observed velocity at eight locations in model domain. Pre model studies including field observation scenario have been carried out by two agencies having expertise in consultancy as well as field data collection. In such a highly complicated domain with non-linear hydraulic and sedimentation characteristics, numerical simulation faced two type of stability problem in governing equations representing tidal movement and suspended sediment transport in stabilizing solution from point of view of CFL criteria (CFL No) and Peclet no. for tidal movement and suspended load movement respectively. Three-dimensional modeling for large coastal area is still cumbersome and it is a formidable task to collect data for calibrating and validating the 3D model.

The flow field was simulated using a numerical model based on ADI finite difference technique. The theoretical formulations of the existing ADI numerical models are not adequate to deal with such a high nonlinearity involved inside the model area. The hydrodynamic as well as suspended sediment stability for the site of Gulf of Cambay has been established through modified CFL as well as Peclet no. as refered in literature on stability of two governing equations and accordingly flow fields with eddy patterns / separation of flow have been presented so as to estimate comparative maintenance dredging for the proposed four port layouts following simulation of advective diffusion equation of sediment transport.

The port construction in this region requires long approach bund breakwater to reach the deeper water. As such, feasibility of any proposed port in this area largely depends upon the requirement of maintenance dredging and the impact of large construction in the surrounding area. Numerical simulation of feasibility study for various port layouts inside complex and typical hydraulic region of Gulf of Cambay have been carried out for proposed four port layouts, so as to arrive at minimum maintenance dredging. Proposal-I consists of 2.5 km long solid approach bund extending up to 2m depth contour and attached with 650m long breakwater (B/W) aligned at 3100 N placed between 2m and 20m depth contour. Proposal-II consists of a similar approach bund and

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B/W as in Proposal-I except 850m opening in the approach bund between first two zero-meter contours from the shoreline. The turning basin of 600m diameter located at the lee side of 600m long B/W is proposed to be dredged to 13m below CD. Proposal-III consists of a 3 km long approach trestle with 700m long berthing jetty at 20 m contour in front of the approach trestle protected by a 1.3 km long offshore breakwater. The offshore breakwater has two arms of 740m and 575m with an obtuse angle in-between. The turning basin of diameter 600m has been proposed between berthing jetty and breakwater. Proposal-IV consists of an enclosed basin with an opening of approximately 300m towards offshore. The approximate lengths of breakwater are at northern, southern and eastern side are 800m, 600m, and 900m respectively.

The 2.5 km long closed approach bund for proposal I and approach bund with 850 m opening between two zero-m outer contours for proposal II modify the flow field in the surrounding area. The closed bund creates slack zone on its lee side (southern) including tidal flats. This will cause siltation and building up of tidal flats. As the net silt movement is towards south, the northern side will build up faster. As there is a proposal of reclamation of tidal flats, the same is favourable. Typical flow fields for four alternative layouts are shown in Fig.2. Siltation and deposition pattern in four alternatives are shown in Fig.3. The maintenance dredging for these Proposals I & II would be of the order of 1.2 and 1.6 million cubic meters (MCM) respectively. For Proposal-III and IV, the amount of maintenance dredging would be of the order of 0.25 MCM and 0.20 MCM.