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THE SPACING OF PILLARS ON PROPOSED EXTENSION OF SEA LINK IN FRONT OF CLEVELAND BUNDER, MUMBAI: A GEOMORPHIC APPROACH

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ABSTRACT:

Civil Corporation of Greater Mumbai (MCGM) has proposed a waterfront road link along the Mumbai coast to facilitate the vehicular traffic. The proposed waterfront street, roughly 35.6 km long, involves construction of the street in light of recovery, spans, raised streets and passages along the western side of Mumbai. The whole length is partitioned into two sections, for example North Part and Southern Part. The south part is around 9.98 km from Princess Flyover to Worli Sea Link, and north part is 25.62 km from Bandra Sea Link to Kandivali Junction.

KEYWORDS : *Civil Corporation , Greater Mumbai (MCGM) , raised streets and passages.*

INTRODUCTION:

This proposed road is supposed to improves the quality of life by providing easy access to essential services ' and various products, access to improved health and education facilities, strengthening of the economy by easy transportation of the different materials of daily use, etc. It also claimed that it will resolve the traffic congestion in Mumbai.

This proposed road link should works on the personal satisfaction by giving simple admittance to fundamental administrations ' and different items, admittance to further developed wellbeing and schooling offices, fortifying of the economy by simple transportation of the various materials of day by day use, and so forth It additionally asserted that it will settle the gridlock in Mumbai.

OBJECTIVES –

The scope of work for the study is as follows:
a) to undertake wave analysis based on wave climate data around navigation channel
b) to provide extreme water level information in near shore area around navigation channel
c) to project the hydrodynamics and morphology changes along the channel near proposed coastal road
d) to provide advisories on the spacing of pillars near navigation channel so as to provide safe passage of fishing vessels

Wave and Tidal Environment -

Assessment of wave climate in the region is essential for a range of coastal works, of which the design of coastal structures is of primary importance. The wave climate also influences the morphology

of the near shore regions along with the near shore currents. Extreme waves generally occur during monsoon period and cyclonic storms and wave measurements during storms along the west coast of India are scarcely available. In order to obtain storm waves numerical modelling run by National Institute of Oceanography (NIO), submitted to MCGM in 2017, is used in this study.

The maximum wind speed among the storms passing through Mumbai is 24.83m/s was generated by the storm developed during recent storm in May 2011. The wind speed are taken from recording station at location 18.92°N; 72.82°E located in the Back Bay region.

The tidal elevations for Mumbai are taken as provided by the Naval Hydrographic Office Chart Number 2016. Tidal elevations for Mumbai Place Latitude (°N) Longitude (°E) Heights in meters above Chart Datum -

(MSL) Mumbai (Apollo Bandar) 18° 55' 72° 50'

MHWS	MHWN	MLWN	MLWS
4.4	3.31	0.98	2.5

From the tidal elevation data, the tidal range for Mumbai is 3.6m and the maximum elevation from the tides can be considered as 4.4m above Chart Datum. However, based on the information available from literature in public domain, the recorded maximum water level is 5.1m and maximum tidal range was 5.24m.

Wave approach

The West coast of India shows varied direction of wave approach due to Monsoon winds. The waves approaching the coastline, except tsunamis, are driven by wind. The wind direction during monsoon is from South West and thus the waves also approach coast from South West. This induces a shore parallel drift, technically referred to as Longshore drift which moves from south to north. Thus any object floating over the surface is drifted towards north in Monsoon period. In post-monsoon the wave approach shifts to the West. It means waves approach from West. The drift also moves shorewards. Thus the water becomes turbulent in spite of relatively calm conditions, especially where there is shallow rocky shore. As we approach pre-monsoon period the wind direction has turned to West-North-West. Thus the waves also approach shoreline from WNW. As the approach is oblique the littoral drift gets aligned to it. There is reversal of drift direction and the littoral current or drift moves from North to South. As a result the vessels drift northward when they approach harbour. At the end of pre-monsoon the wind direction suddenly changes towards South west.

This typical pattern controls the approach of boats into harbour. The approaches need to be wider. The need for such width more important where the draft available is less i.e. water is shallow as is the case in Cleveland bunder. The experiences of fisherfolk will tell same story.

Any change in the bathymetry in form of pillar, reclamation alters the wave pattern. Generally the wave front is broken and water becomes more turbulent. This has been seen in case of all bridges constructed on estuaries in Konkan. The erection of pillars in this case will definitely alter the wave refraction pattern and associated drift.

Hydro-Geo-Morphology of navigation channel and near shore area –

The bathymetric chart published by Maharashtra Maritime Board and Hydrographic chart published by Naval Hydrographic Office was used to study the morphology of bay area. The section of the charts given shows the depth of water as low as 0,4 meters along the edges of navigation channel. Also the channel passes through series of boulders on bay bed on both the sides. The depth of channel required is restricted to a small area and thus the entrance to harbour cannot be shifted.

A map showing the alignment of proposed sea link section superimposed over the hydrographic chart is also shown here. The diagram shows how the bridge is at fore front of shallow, narrow opening of navigation channel.

METHODOLOGY

A reference data set is taken from the report 'Studies on extreme waves, extreme water levels, storm surge, tsunami height and coastal morphology for Coastal Road project' prepared by National Institute of Oceanography (CSIR), Goa in July 2017.

The inferences are based on state of the art numerical modelling software suite (MIKE by DHI) is used to simulate the coupled hydrodynamics and morphology of the region used by NIO. The coupled model consists of modules for hydrodynamics, waves, mud transport and sediment transport. All these modules take feedback from each other as well as provide inputs to each other. For example, the hydrodynamic model or flow model provides flow conditions to the wave model which uses it to include the wave current interaction and provides the modified wave condition to the flow model. The modified wave conditions taken into the flow model then provides the modified flow conditions which are used in the morphology model and the mud transport model. The sediment and mud transport models also utilise the wave parameters from the wave model. In this manner, the coupled model provides output of modified flow, wave and changes in the bed morphology in the study region.

The mathematical models utilized in this study are portrayed in this part. The coupled displaying involving stream model, wave model, mud transport model and silt transport model is utilized to concentrate on the hydrodynamics and morphology sway in the district because of various situations.

The inputs considered to the numerical model are bathymetry, coastline, tides, winds and waves. In order to obtain reliable results from the model, reliable input data is required. The coastline from the available Google® imageries was considered as input to the numerical model. The shoreline was digitized and used in preparation of the bathymetry of the study region. The modified coastline considering the reclamation regions, as published by MCGM as 'FINAL DETAILED PROJECT REPORT VOLUME II: Design Report (Part-3)- Reclamation Report & Urban Design Report, Published in February 2017', is used further in the numerical models.

The bathymetry used in the model is taken from the NHO charts primarily meant for navigational purposes which cover specific areas of interest to shipping routes. Even though the NHO chart data is a good data to start with as input to a numerical model, it is observed that the data required for a specific site are sparsely available and also these charts are not frequently updated, therefore for critical projects it is always recommended to obtain fresh/recent bathymetry survey carried out. In the present study sufficient information on the bathymetry data exists from NHO charts, as well as bathymetry survey chart obtained from Maharashtra Maritime Board (MMB) which is used in the model studies.

The coupled mathematical model depicted in the accompanying segments is arrangement for different situations at first to discover the legitimacy of the model for the review district and afterward for various seaside setups. To test the legitimacy of the model, absolutely flowing constraining is given to the model and the model outcomes are contrasted and the flowing parts of the deliberate information. The flowing model is incorporated with the nearby breezes and waves from seaward as main impetuses. A definite hydrodynamics displaying study for the base case is done in a past report helped out through Mumbai Transformation Support Unit of the All India Institute of Local Self Government. The approval of the hydrodynamics model isn't introduced in this report.

At Section-III, increase in waves from southwest is observed for the coastal road scenario compared to the base case, while the waves from west were observed to reduce the ones coming from WNW and SW were supposed to get enhanced.. And at section-V the direction of waves from southwest observed to increase while the waves from WNW were found to reduce. These changes in wave directions in these sections could be attributed to the overall reworking of waves to adjust to the new coastline configuration. However, in order to ascertain any major changes in the wave climate, continuous monitoring of the waves are essential as suggested by NIO report.

Overall changes in the bed morphology due to the proposed coastal road shall be within limit of 0.2m which is not significant in the deep near shore region but can be crucial in shallow parts like the navigation channel. However, during the construction phase due to activities like trenching, placement

of armour stones or driving of sheet pile walls, etc., there could be changes in the near shore morphology. Such changes due to temporary construction activities would eventually be stabilized once these activities are complete shall remain in place and can cause permanent change in the area.

CONCLUSIONS

The extreme values of tidal surges, significant wave heights were studied in the near shore region along section of coastal road in front of Cleveland Bunder and navigation channel. For this area the ranges of high scenarios are presented in these conclusions. The conclusions from this study are:

- The design wave heights, tidal surge elevation and for the study region were taken as estimated using various numerical models in NIO report. The tidal range was taken from the available literature.
- The maximum storm induced wave height in the near shore region is estimated to be 4.89m in 20 m water depth. The maximum storm surge estimated for a cyclonic storm passed close to Mumbai coast is 1.5m for the recent cyclone.
- Based on long term wave hind cast data combined with storm waves, the design wave height at 20 m depth for O year return period is estimated as 7.2m while along coastal road project the design wave heights varied between 0.5m and 1.9m.
- The hydrodynamics off the Mumbai coast ascertained through measurements and validated numerical models. The numerical models used in the study provide reliable and reasonable results pertaining to hydrodynamics of the region. The comparison of flow vectors and flow along the transect points showed that there shall be significant change, in study area, in flow conditions due to coastal road facilities.
- The wave and tidal environment suggests that the navigation channel for approaching the Cleveland bunder is rocky, shallow and has higher turbulence.
- The vessels need a minimum span of 140 meters looking at the storm surge recorded on Mumbai coast for safe passage.
- The construction of pillars will increase the turbulence in the area making navigation more precarious.
- The difference in near shore morphology changes between the base case and the final coastal road alignment case, based on numerical model studies, is observed to be significant as the area is shallow.

RECOMMENDATIONS

- During the coastal road construction activities, it is likely that there would be changes in the local flow conditions. These changes would stabilise once the construction activity ceases.
- In order to keep a check on the changes in the tidal elevations, wave and flow conditions, it is essential to continuously monitor the hydrodynamics and water quality parameters before starting, as well as during the project execution phase and further for a period of 2 years after completion of project.
- Necessary precautions should be taken so as to minimise the turbidity of the coastal waters during the reclamation and/or other offshore/coastal construction activities.
- Periodic monitoring of the sandy beaches and the shoreline should be carried out through cross-section profiles measurements and shoreline change studies so that a record of status of the coast before, during and after the project is available.

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