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Inner harbour wave agitation using boussinesq wave model

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ABSTRACT: *Short crested waves play an important role for planning and design of harbours. In this context a numerical simulation is carried out to evaluate wave tranquility inside a real harbour located in east coast of India. The annual offshore wave climate proximity to harbour site is established using Wave Model (WAM) hindcast wave data. The deep water waves are transformed to harbour front using a Near Shore spectral Wave model (NSW). A directional analysis is carried out to determine the probable incident wave directions towards the harbour. Most critical threshold wave height and wave period is chosen for normal operating conditions using exceedence probability analysis. Irregular random waves from various directions are generated confirming to Pierson Moskowitz spectrum at 20m water depth. Wave incident into inner harbor through harbor entrance is performed using Boussinesq Wave model (BW). Wave disturbance experienced inside the harbour and at various berths are analysed. The paper discusses the progresses took place in short wave modeling and it demonstrates application of wave climate for the evaluation of harbor tranquility using various types of wave models.*

KEY WORDS: Boussinesq wave model; Harbour tranquility; Wave disturbance; Wave climate.

INTRODUCTION

The function of a harbour is to provide safe anchorage for vessels and to facilitate smooth transfer of cargo between ships and adjoined land. Assured harbour tranquillity is not only essential for safe anchorage, but it is also important for efficient port operation. Essentially, harbour tranquillity reduces to the excitation of ships moored at anchorage or along a wharf and optimises the mooring forces. Larger ships may not experience wave agitation to the wind-waves, whereas a small boat may be violently swung by the same wave. Thus, harbour tranquillity needs to be judged from the viewpoint of wave climate at ship's berthing areas. In the viewpoint of port operation, the relationship between ship motion and cargo handling works as well falls in the judgement of harbour tranquillity. Hence establishing statistics of the wave climate outside the harbour and transforming it to inner harbour berth locations is a fundamental task. In coastal engineering practice, the behavior of short waves in shallow water has long been concerned. For the design of harbors, a detailed knowledge is required for the direction of propagation and magnitude of short waves. These waves attack moles, training works, breakwaters and other structures, they infiltrate through harbour entrances to disturb the waters within the harbour area, both directly and through accumulated, seiching actions, they are instrumented in bringing sediments into suspension while they often induce the currents that transport these sediments to quieter regions of deposition, and they may also adversely influence navigation directly. As a result of the practical interest in these waves, a considerable research effort has gone to predict their behavior along coasts and in and around harbors, terminals

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and other engineering works. By far the greatest part of this effort has been directed towards developing the techniques for physical modelling and a veritable arsenal has been accumulated for this purpose like field and laboratory instrumentation, wave generators with their associated data processing, control and evaluation equipment and a wide range of analytical procedures. In the past efforts expended in numerical modeling by producing several useful techniques (Abbott et al., 1978a). Today, the advancement in this direction to an extent replaced the physical modeling.

In this study, numerical simulations are carried out for a real harbour (Fig. 1) at Gangavaram adjoining to Bay of Bengal, East Coast of India to evaluate the wave tranquillity condition for the master plan of harbour layout. The wave agitation levels at the harbour vicinity are modeled using approximately a decades (1995-2004) offshore wave data. Offshore wave data obtained from wave model 'WAM' (WAMDI Group, 1988) are analysed and transformed to nearshore. The wave disturbances in the harbour basin and berth locations are assessed using Boussinesq Wave Model (Abbott et al., 1978b). This study on penetration of offshore wave climate in to a harbour is a demonstration of application of wave climate for decision support to port planning. In Indian context, this study is a useful reference for port planners to resolve the decisions viz. allocation of berths for various types of vessels, width of the harbour entrance, configuration of breakwaters etc.

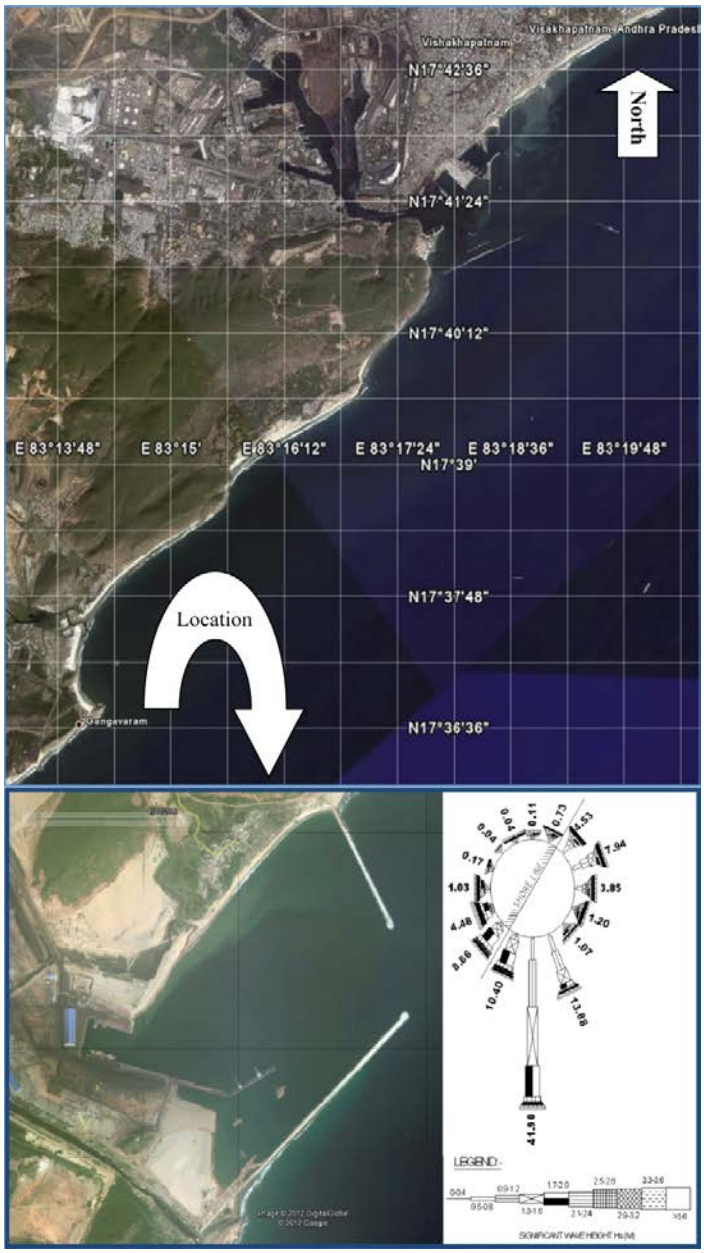

Fig. 1 Harbour Location and offshore wave rose.