The 10th International Conference on Coasts, Ports and Marine Structures (ICOPMAS 2012)
Tehran, Iran, 19-21 Nov. 2012

A FAST ALGORITHM FOR CALCULATING LONG TERM NEAR-SHORE WAVE AND HARBOR PERTURBATION TIME SERIES

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Key Words: Wave transformation, Harbor perturbation, Long period time series, Fast algorithm

Introduction

Near-shore wave and harbor perturbation are functions of the offshore wave. Sometimes they must be calculated by time consuming 2D numerical simulations. However the offshore wave varies with time. The traditional way in this regard is to classify the wave time series and calculate the wave rose or a few effective waves. Nowadays, there is a growing interestedness in calculating the complete long-term time series of the near-shore wave or the harbor perturbation without the traditional simplifications regarding to the wave periods etc. There are also some relatively old near-shore software (like genesis) that need the long term near-shore wave time series as their input data. It is very time consuming and inefficient to fulfill the mentioned numerical simulations for a long term (for example 10 years) time series of wave data completely. The present paper illustrates a fast and efficient algorithm in this regard.

Eliminate Repeating Simulations

There are many repeating wave characteristics in a long term time series of wave. The simulation results are the same if the input waves are the same (height, period, direction, etc.). Therefore it is not necessary to repeat numerical simulation for the repeating waves. It is possible to divide the wave time series into separately wave events. Each event is simulated just once. Influencing factors other than wave may also be included in dividing the events if necessary (for example the water level).

The mentioned algorithm has been used in Litpack software by DHI for littoral drift simulation. The present study has applied the same algorithm – with some changes - to the near-shore wave calculation and the harbor perturbation calculations.

The Fast Algorithm

The present algorithm involves three steps. I) the input time series is analyzed and classified in order to define the table of the selected wave events. II) Each selected wave is simulated. The output waves (at the needed locations) are extracted from the simulation results. A projection table is developed that links each selected input wave event to its simulated result. III) The harbor perturbation time series (or the near-shore wave time series) is calculated using the input wave time series and the projection table.

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The role of input wave time series analyzing at the first step is to define the minimum and maximum values of the influenced wave characteristics and to determine the most efficient values for $\Delta\theta$, ΔT and ΔH. The Δ values are not necessarily constant along their corresponding domains. The most effective part of the domain is partitioned by smaller steps. Extreme events are added to the table directly. A computer program has been developed in C++ that handles step (I) automatically. The offshore wave classification is based at least on three wave parameters; direction, period and height. Wave height may be ignored for harbor perturbation. Usually the selected events to be simulated are about 150 for near-shore wave calculation and 30 for harbor perturbation problems.

Any suitable numerical model may be used in order to simulate the selected wave events (step II). This process may be carried out automatically using a batch file or by creating a single input file that involves all of the selected events (quasi-stationary simulation). Finally the resulted wave data are extracted from the simulation results at the requested points and are added to the projection wave table.

The output time series is calculated by comparing each wave event from the input time series with the rows of the projection table. If the event itself is found in the table, then the result is used directly. If not, the surrounding wave records are found in the table for interpolation. This procedure has been automated by developing a specific C++ program.

Results

The presented method in this paper have been used in three real projects regarding to the fishery harbors; Jofre, Beris and Ramin. The input wave time series involves 12 years of continues wave data with 3 hrs. interval. The results involve near shore wave data and in-harbor disturbance at several locations. The results have been compared by the normal continuous simulation method in some parts of the study. The results prove that the presented method is accurate, fast and efficient. The calculation time for near shore wave calculation at one harbor has been decreased from 30 days to 1 hr. without decreasing the accuracy. The method offers even more benefit for harbor perturbation study, because several layouts are controlled in this regard.

The same algorithm may be used for other physical processes too. In fact it has been used at Jofre Fishery Harbor for studying wind-wave generation inside Boushehr bay. The long term wind time series has been converted into the long term wave time series in this regard.

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