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MALAHAYATI UNIVERSITY
BANDAR LAMPUNG
INDONESIA

CIVIL, ARCHITECHTURE AND ENVIRONMENTAL VOLUME 1

PROCEEDING

SECOND ANNUAL
UNIVERSITAS MALAHAYATI
INTERNATIONAL CONFERENCE
ON GREEN TECHNOLOGY AND
ENGINEERING

On April 15-17th,2009

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UNIVERSITAS MALAHAYATI
BANDAR LAMPUNG
2009

FOREWORD

The second (2th) International Conference on Green Technology and Engineering 2009 (ISGTE 2009), faculty of Engineering Universiatas Malahayati, was conducted on 15-17 April 2009. The conference was organized by Faculty of Engineering and collaborated with International Islamic University Malaysia (IIUM) and University Putra Malaysia (UPM).

The participants of the conference are about 300 participants come from 9 countries and more than 60 higher institution, among others: Unhas, ITS, UI, Tri Sakti, ITB, Unila, Unsri, Unibraw, Unpad, Undip, Unsyah, UPM (University Putra Malaysia), IIUM (International Islamic University Malaysia), UTM (University Technology Malaysia), UTHM, University of Pashawar Pakistan, Univ. Melbourne Australia, Tokyo Institute of Technology Japan, Yangon Technological Univ., and others, which reflect the importance of Green Technologi and Engineering. The concept of sustainable development based on the environmental firmament nowadays has become central issues are very important and the topic of this issue can create awareness of the societies to involve in the development of their country toward the sustainable development.

The Conference provide platform for researchers, engineers and academician to meet and share ideas, achievement as well as experiences through the presentation of papers and discussion. These events are important to promote and encourage the application of new techniques to practitioners as well as enhancing the knowledge of engineers with the current requirements of analysis, design and construction of any engineering concept. The conference also functions as platform to recommend any appropriate remedial action for the implementation and enforcement of policies related to environmental engineering fields. Furthermore, this seminar provides opportunities to market faculties' expertise in the field environmental engineering, civil engineering, structural engineering, mechanical engineering and so on.

On behalf of steering committee, we would like to express our deepest gratitude to the foundation Alih Teknology, Rector Universitas Malahayati, International Advisory Board Members, the Keynote Speakers, and to all participants. We are also grateful to all organizing committee and all the reviewers, without whose efforts such a high standard for the conference could not have been attained. We would like to express our deepest gratitude to the Faculty of Engineering Universitas Malahayati for conducting such conference.

Bandar Lampung, 15 April 2009

Agung Efriyo Hadi
The Organizing Chairman

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CONTENT

ARCHITECTURE ENGINEERING

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LEMBAR PENGESAHAN

Second Annual Universitas Malahayati International Conference on Green Technology and Engineering

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1. Judul	:	Study Dispersion Effects of Wave Propagation over Mangrove Models in Shallow Water using 2-D Hyperbolic Wave Equation.
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The Second International Conference
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Study Dispersion Effects of Wave Propagation over Mangrove Models in Shallow Water using 2-D Hyperbolic Wave Equation

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Abstract

The aim of this research is to study dispersion effects of wave propagation over mangrove models in shallow water environments. This numerical modeling of wave propagation is using two dimensional parabolic wave equation. In this study, numerical solution of the parabolic wave equation is using finite difference method. For solving the 2nd order derivatives of the wave equation, the finite-difference method is one of several methods using discrete approximations that can be used to calculate linear combination of approximation of the function, at grid points. Second order of accuracies explicit finite-difference method are employed to simulate wave propagation.

The mangroves were modeled in other to dissipate waves propagate over them. To reduce reflections from non physical boundaries, Reynolds boundary condition method was used. A line source was used to model wave sources. Ricker wavelet is used as a line source. In the environment setup of the model, assumed the waves propagate in shallow water with the depth (*d*) is equal to 5 meter. Results of this research present wave propagation and dispersion effects, at location before and after the mangrove models. The results present the dispersion effects of the mangroves clearly. If results with the different scenarios or different situation are compared, where the model was using full mangroves with the narrow channel, present more dispersions and more dissipated than only using a half of the mangroves. It is concluded that wave propagation over mangroves can be modeled numerically, to study and to investigate dispersion effects of the mangroves as green breakwaters.

KEYWORDS: dispersion effects, parabolic wave equation, finite difference, mangrove

1. Introduction

Wave propagation theory was used by scientists and engineers, in particular civil engineers in developing models for wave propagation. Usually engineers involve the theory in developing numerical models in coastal environments, of particular importance in civil engineering, while scientists develop the numerical models which are of importance in geophysical exploration. In this

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paper, the hyperbolic wave equation is used to describe free surface water wave propagation in shallow water.

Surface water wave propagation researches have been conducted in [4, 5, and 6]. The other researcher [4] has been done by using physical modeling or experimental research. Physical breakwater was modeled to study wave run-up, reflection, dissipation and dispersion effects. Wave propagation across a submerged breakwater has been modeled to investigate transmission or dispersion effects [5]. Artificial reefs have been produced by one of several reef ball foundation which having research in reef restoration and coastal protection [6].

This research was intended to study dispersion effects of mangroves which were modeled to dissipate wave propagation over them numerically. Mangroves can be used as natural or green breakwater to protect coastal zone from wave attacks.

2. Methodology

Research methodology used in this research was only using a numerical method. Using the method, cost of the research is more least if it is compared with physical modeling and field modeling researches.

In this research, wave equation used to model wave propagation over mangrove model was a two dimensional hyperbolic equation [3] as follows,

$$\frac{\partial^2 \eta}{\partial t^2} = c^2 \left\{ \frac{\partial^2 \eta}{\partial x^2} + \frac{\partial^2 \eta}{\partial y^2} \right\} \quad (1)$$

where,

η = elevation of water surface

c = wave velocity

c = $\sqrt{g.d}$

d = water depth

A solution of the 2-D hyperbolic wave equation used in this research is explicit finite-difference method. Using this method, the equation could be approximated as follows,

$$\frac{\partial^2 \eta}{\partial t^2} = \frac{\eta_{i,j}^{n-1} - 2.\eta_{i,j}^{n} + \eta_{i,j}^{n+1}}{\Delta t^2} \quad (2)$$

$$\frac{\partial^2 \eta}{\partial x^2} = \frac{\eta_{i-1,j}^{n} - 2.\eta_{i,j}^{n} + \eta_{i+1,j}^{n}}{\Delta x^2} \quad (3)$$

$$\frac{\partial^2 \eta}{\partial y^2} = \frac{\eta_{i,j-1}^{n} - 2.\eta_{i,j}^{n} + \eta_{i,j+1}^{n}}{\Delta y^2} \quad (4)$$

Using Equations (2), (3) and (4) and obtained wave velocity as $c=\sqrt{g.d}$ [3], so we can rearrange a solution for the above equation as follows,

ISSN 1978-5933

$$\frac{\eta_{i,j}^{n-1}-2.\eta_{i,j}^{n}+\eta_{i,j}^{n+1}}{\Delta t^2} = g.d.\left[\frac{\eta_{i-1,j}^{n}-2.\eta_{i,j}^{n}+\eta_{i+1,j}^{n}}{\Delta x^2}+\frac{\eta_{i,j-1}^{n}-2.\eta_{i,j}^{n}+\eta_{i,j+1}^{n}}{\Delta y^2}\right] \qquad (5)$$

Equation (5) is an approximation solution for explicit finite-difference of the 2-D hyperbolic wave equation.

Modeled surface wave propagation is restrict-ed by boundaries, as physically it is not real. The boundaries usually mentioned as nonphysical boundaries or open boundaries. To simulate the waves in other to be able to propagate pass the nonphysical boundaries, mathematical equation is applied on the boundaries to minimize or reduce nonphysical reflection from computational array boundaries, a number of techniques have been developed, having advantages and disadvantages.

In this research, a boundary condition method which usually used in modeling of wave propagation is transparent boundary condition method. The boundary condition method is needed to reduce waves propagate through to over nonphysical boundaries. From the boundaries, reflected waves are not allowed. Equation used as open boundaries is as introduced by Reynolds in [1] as follows,

$$\frac{\partial \eta}{\partial t}+c\frac{\partial \eta}{\partial x}=0 \qquad (6)$$

Using Equation (6) above, nonphysical reflections from the boundaries are possible to be reduced. Using hyperbolic wave equation and Reynolds transparent boundary condition method, surface wave propagation could be modeled.

Using different values of the wave velocities, mangroves could be modeled. How far dispersion and dissipation effects caused the mangroves could be investigated.

3. Environment set-up

In the numerical modeling, as a source is line source. to model surface wave source, a source model of Ricker wavelet is applied as used in [3]. Source waves employed as line waves which having the same direction with the mangroves. In this research, to model wave propagation is using two scenarios (scenario A and scenario B).

For the scenario A, the mangroves are located close to the top boundary or close to the line source where having the same direction. in the center of the mangroves location is opened. It is intended as a way for the waves to propagate over and pass the mangroves model (see Figure 1)

For the scenario B, also the mangroves are located in the same direction with the scenario A, but the mangroves is located from the center of the domain through to the right boundary (see Figure 2)

Grid schemes used to model mangroves effects are such as be presented in Figure 3. Where at the positions of rectangular grid points, velocities (c) are set to zero, because at the positions, waves are not allowed to propagate or equal to zero.

ISSN 1978-5933

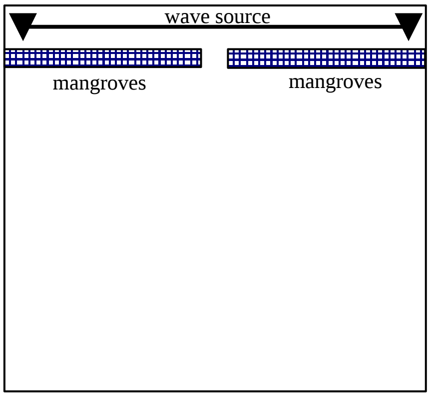

Figure 1. Environment setup for scenario A

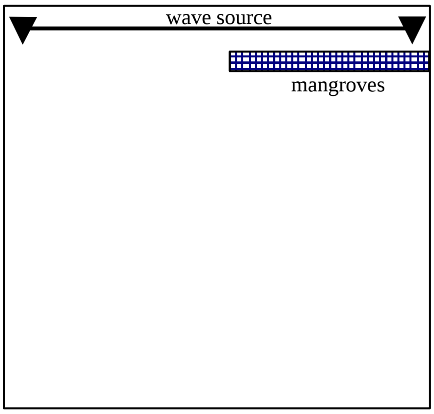

Figure 2. Environment setup for scenario B

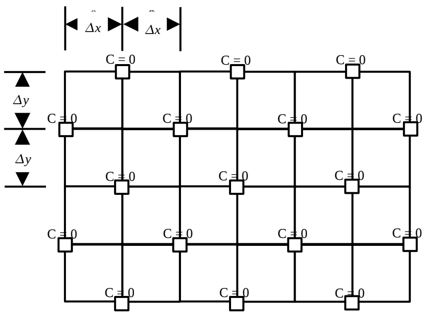

Figure 3. Grid scheme for Mangrove models.

4. Results and Discussion

Results of this research are presented in two scenarios, scenario A and scenario B. For results of the scenario A are presented in Figure 4, Figure 5, Figure 6, and Figure 7. For results of the scenario B are presented in Figure 8, Figure 9, Figure 10, and Figure 11 as follow,

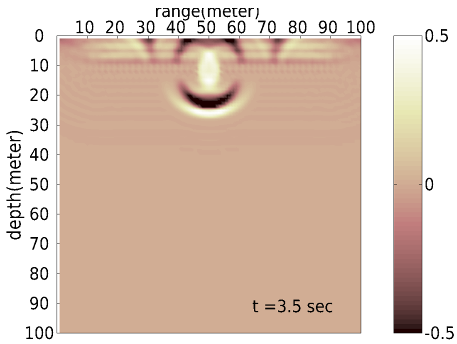

Figure 4. Snapshot of wave propagation at t =3,5 sec (scene A)

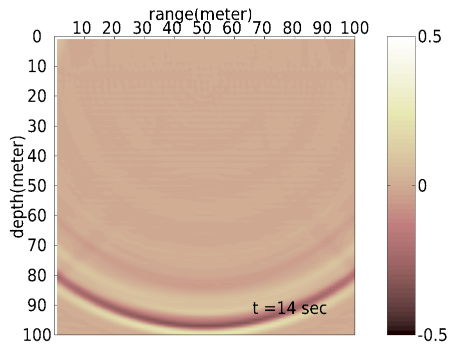

Figure 5. Snapshot of wave propagation at t = 7 sec (scene A)

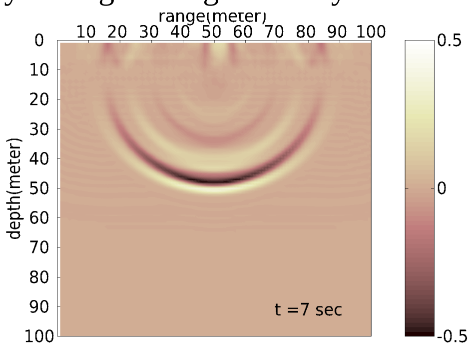

Figure 6. Snapshot of wave propagation at t = 14 sec (scene A)

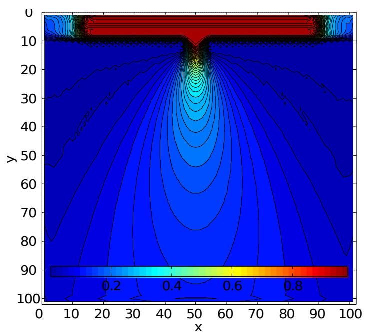

Figure 7. Contour plot diffraction effects of the mangrove model (scene A)

For results of the scenario B are presented as follow,

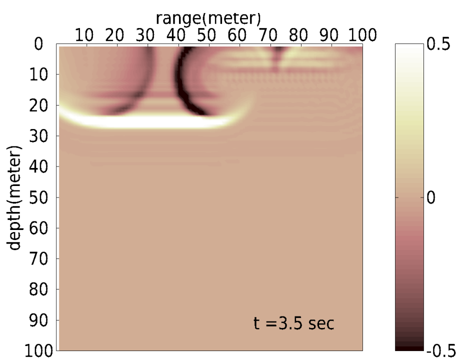

Figure 8. Snapshot of wave propagation at t = 3.5 sec (scene B)

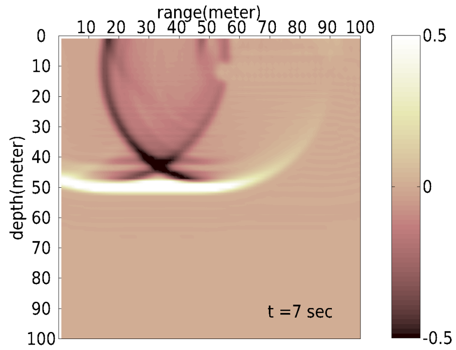

Figure 9. Snapshot of wave propagation at t = 7.0 sec (scene B)

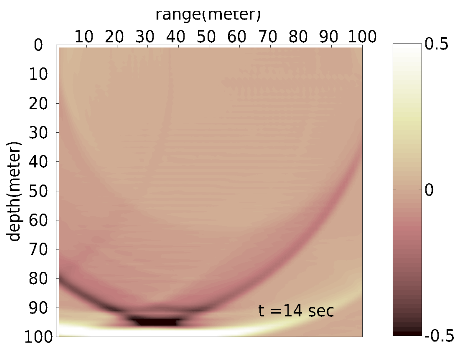

Figure 10. Snapshot of wave propagation at t = 14 sec (scene B)

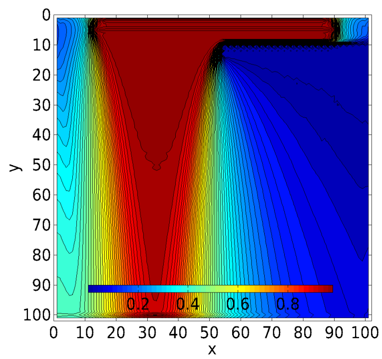

Figure 11. Contour plot diffraction effects of the mangrove model (scene B)

To generate and simulate wave propagation such as presented above, 101 times 101 grid points are used. The grid spaces Δx equal to Δy used in this model are 1 meter. The depth (h) which used in the numerical domain is 5 meters. The grid time Δt in this model is 0.01 second. So numerically, the model is stable, because Δt is less than $\Delta x / \sqrt{(gh)}$.

Second order of accuracies finite difference method are used to approximate the second order derivatives of the hyperbolic wave equation.

Snapshot results of scenario A can be compared with snapshot results of scenario B. In the scenario A, the wave propagation is completely dissipated, and the waves only propagate by the opened location in the mangrove model. the Waves propagate in the domain clearly dispersed. In the scenario B, the waves fully propagate from the left side position without mangroves and at the right side position, the waves almost dissipated by the mangroves (see Figure 4, 5, 6, 8, 9, and 10). Dispersion effects of the mangroves also can be studied from Figure 7 and Figure 11. For the scenario A, the waves almost dissipated significantly, and waves only propagate by a narrow channel of the mangrove model. For the scenario B, the waves is only dissipated from the right side where the location having mangroves.

4. Conclusions

Based on the results of this research concluded that mangroves can be modelled numerically to study and to investigate dispersion effects of mangroves as green breakwater.

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