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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

ENVIRONMENT ENGINEERING

LEMBAR PENGESAHAN

Second Annual Universitas Malahayati International Conference on Green Technology and Engineering
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Analysis Wave Diffraction Using 2D Hyperbola Equation

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Abstract

Wind waves has high impact on the coastal area, either to the shoreline or to the structure of the buildings in the coastal area. To protect the coastal area from the waves, the coast needs a protection structure such as breakwater. Aims of the structure are to reduce and to destroy the wave energy.

The aims of the research are to see the natural phenomenon of the surface wave propagation, and how is the impact of the wave propagation if it is happen in the reality, the same as the condition of the simulation as the scenario planned. In this research, the wave equation that we used for the modeling of wave propagation that pass through the submerged breakwater was a 2-D Hyperbolic wave equation.

Breakwater can be modelled numerically to study and to investigate dispersion effects. Based on results of this research concluded that the energy of the wave can be reduced significantly by submerged breakwater, so the coastal area can be protected.

KEYWORDS**:** analysis diffraction effects, submerged breakwater, 2-D hyperbolic wave equation

1. Introduction

Wind waves has high impact on coastal area, either to the shore line or the structure of the buildings in the coastal area. To protect the coastal area from the waves, the coast needs protection structure such as breakwater. Aims of the structure are to reduce and to destroy the wave energy. The conditions of the coastal area nowadays is not in good condition due to the abrasion, erosion and sedimentation because the lack of protection to the coast. The natural protection which are exist such as mangrove or coral, most of them are not in good condition due to the human factor, so that the coast has no protection from the impact of the wave.

Nowadays many researchers are interested in the natural protection of the coastal area such as coral rock which is close to the beach, to reduce the wave energy. Many researchers in sciences and engineering used numerical modeling to simulate the movement of the waves in two dimensions. Aims of the research are to see the natural phenomenon of the wave propagation in the surface, and how is the impact of the wave propagation if it is happen in the reality, the same as the condition of the simulation as the scenario planned. These phenomenon give many ideas to researchers about the protection of the coastal area by coral rock or to build the configuration of stone which is look like coral rock. They are expected that these configuration is possible to protect the sea shore as the coral rock do and these sometimes called as submerged breakwater.

2. Methodology

Research methodology used in this research is 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, the wave equation that we used for the modeling of wave propagation [3] that pass through the submerged breakwater is 2-D Hyperbolic wave equation as follow,

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

Where:

η = the elevation of the surface

$C = \sqrt{g.h}$ = the speed of wave propagation

g = gravitation

To find a solution of the 2-D hyperbolic wave equation above we are going to use the explicit finite-difference method.

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

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

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

From the equation (2), (3) and (4) and with substituted c = $\sqrt{g.h}$ (Miharja, 1989) we can find full equation as follow:

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

The equation (5) is a solution of the explicit finite-difference method from the 2-D hyperbolic wave equation. The surface of the wave propagation modeled is bounded by a limit which does physically not exist. The condition of the limit above sometime called as the limit condition. The equation for the limit condition is as follow:

$$\frac{1}{C}\frac{\partial p(+a,t)}{\partial t} + \frac{\partial p(+a,t)}{\partial x} = 0 \qquad (6)$$

$$\frac{1}{C}\frac{\partial p(-a,t)}{\partial t} - \frac{\partial p(-a,t)}{\partial x} = 0 \qquad (7)$$

3. Setting Model

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 coral. In this research, to model wave propagation is using four scenarios (scenario 1, 2, 3 and scenario 4).

For the scenario 1, breakwater which reveal to the surface with the form of trapezoidal, in the center of the breakwater location is opened. It is intended as a way for the waves to propagate over and pass the coral model (see Fig. 1)

For the scenario 2, also the breakwater are located in the same direction with the scenario 1, but the breakwater is submerged. And we called submerged breakwater (see Fig. 2)

For the scenario 3, Breakwater which reveal to the surface with the form of rectangular, in the center of the breakwater location is opened. It is intended as a way for the waves to propagate over and pass the coral model (see Fig. 3).

For the scenario 4, also the breakwater are located in the same direction with the scenario 3, but the breakwater is submerged (see Fig. 4).

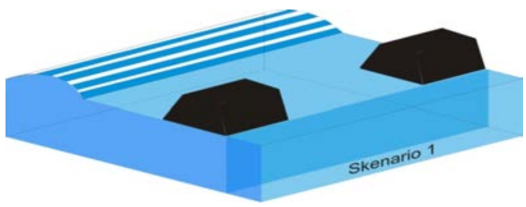

Fig. 1. Set up for scenario 1 (trapezoidal breakwater).

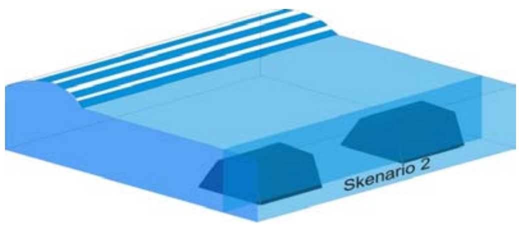

Fig. 2. Set up for scenario 2 (trapezoidal submerged breakwater).

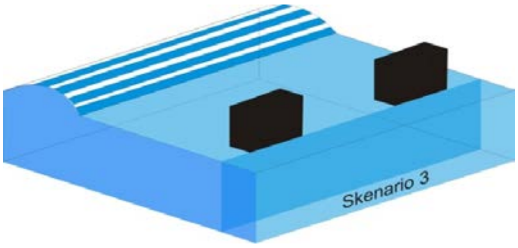

Fig. 3. Set up for scenario 3 (rectangular breakwater).

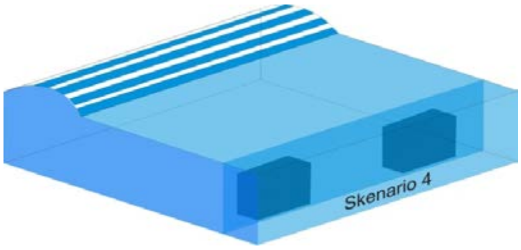

Fig. 4. Set up for scenario 4 (rectangular submerged breakwater).

4. Results

Results of this research are presented in four scenarios, scenario 1,2,3 and scenario 4. For results of the scenario 1 are presented in Fig. 5, Fig. 6, and Fig. 7. For results of the scenario 2 are presented in Fig. 8, Fig. 9, and Fig. 10. For results of scenario 3 are presented in Fig. 11, Fig. 12 and Fig. 13. For results of the scenario 4 are presented in Fig. 14, Fig. 15 and Fig. 16 as follow,

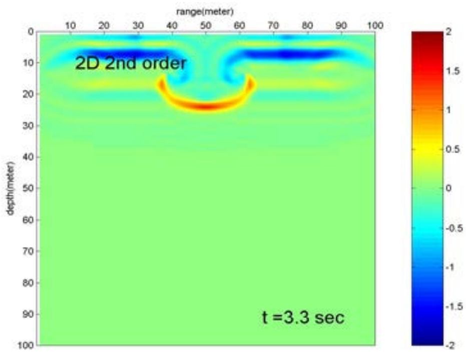

Fig. 5. Snapshot of wave propagation at t = 3.3 sec (scene 1)

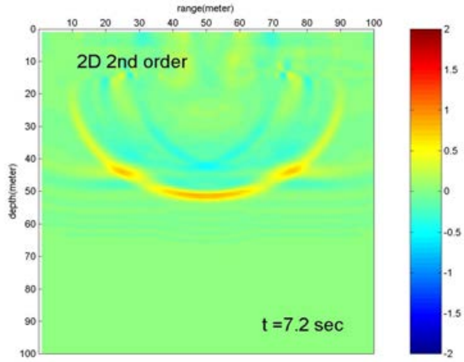

Fig. 6. Snapshot of wave propagation at t = 7.2 sec (scene 1)

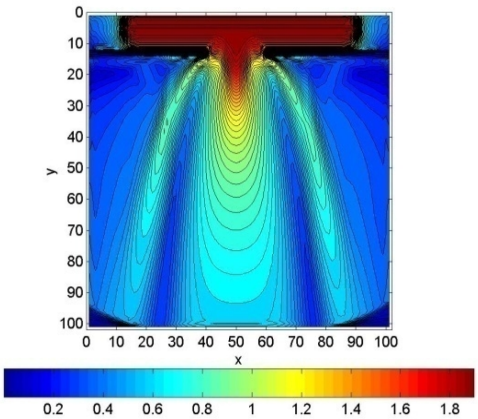

Fig. 7. Contour plot diffraction effect of the coral model (scene 1)

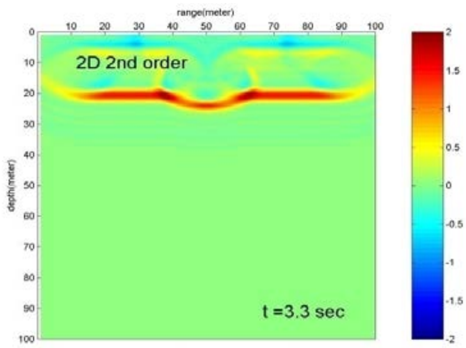

Fig. 8. Snapshot of wave propagation at t = 3.3 sec (scene 2)

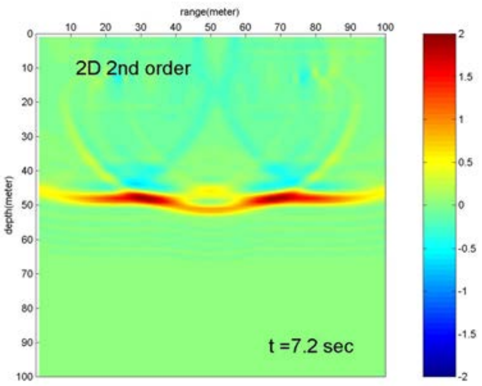

Fig. 9. Snapshot of wave propagation
at t = 7.2 sec (scene 2)

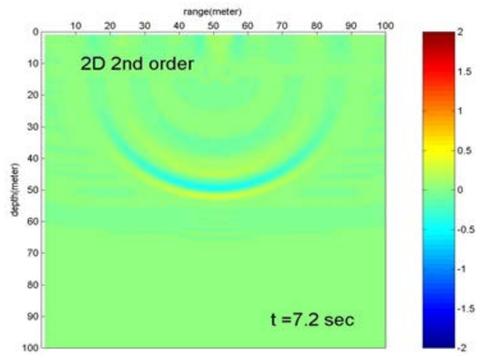

Fig.12. Snapshot of wave propagation
at t = 7.2 sec (scene 3)

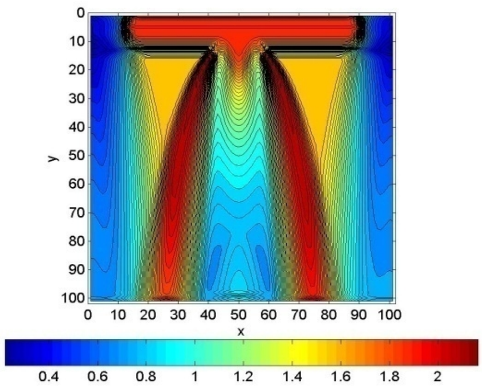

Fig. 10. Contour plot diffraction effect
of the coral model (scene 2)

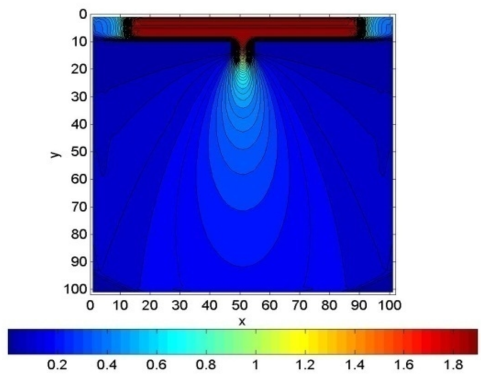

Fig. 13. Contour plot diffraction effect
of the coral model (scene 3)

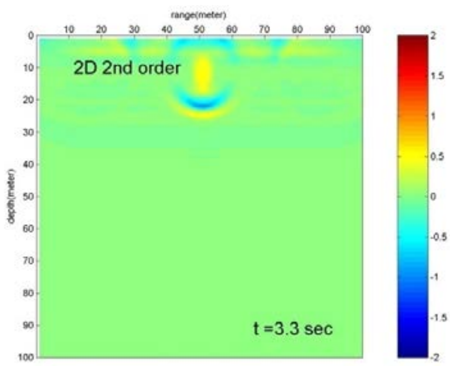

Fig.11. Snapshot of wave propagation
at t = 3.3 sec (scene 3)

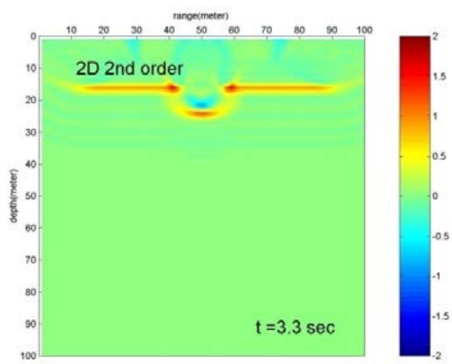

Fig. 14. Snapshot of wave propagation
at t = 3.3 sec (scene 4)

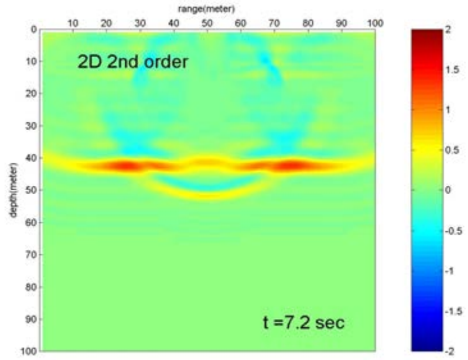

Fig. 15. Snapshot of wave propagation at t = 7.2 sec (scene 4)

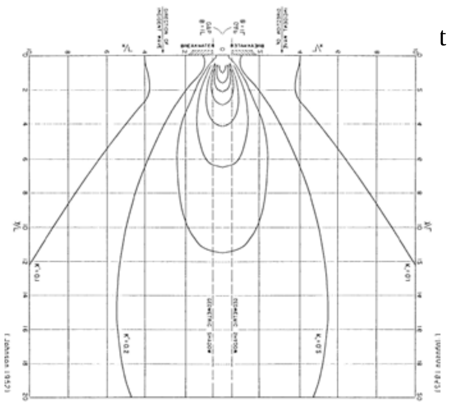

Fig. 17. Contour plot diffraction effect from Shore Protection Manual [7]

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

Snapshot results of the scenario 1 and 3 can be compared with snapshot results of the scenario 2 and 4. In the scenario 1 and 3, the wave propagation is completely dissipated, and the waves only propagate by the opened location. The waves propagate in the domain clearly dispersed. In the scenario 2 and 4, we use submerged breakwater, a half of the waves still propagate with slightly dissipated and the others wave propagate over the breakwaters from the top side and opened location. In the scenario 2 and 4, the energy of wave more less than before, the waves almost dissipated by the submerged breakwater (see Fig. 8, 9, 14, and 15). Dispersion effects of the breakwater also can be studied (see Fig. 7,10, 13 and 16) and especially for the Fig. 13 can be compare with the dispersion literature produced by Shore Protection Manual from U. S. Army [7] (see Fig. 17). The result indicated the good agreement with the published literature. For the scenario 1 and 3, the waves dissipated significantly, and waves only propagate by opened location of the breakwater. For the scenario 2 and 4 the wave almost dissipated, but few of the waves propagate pass trough the breakwater by the opened location.

5. Conclusions

Based on the results of this research concluded :

The energy of wave can be reduce significantly by submerged breakwater, so we can protect the coastal zone.

The Breakwater can be modelled numerically to study and to investigate dispersion effects.

Diffraction result of the model indicate the good agreement with the published literature.

1.1 References

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