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JUDUL: WAVE ENERGY AT COASTAL AREA OFF LAHAD DATU TOWN, SABAH.

IJAZAH: DEGREE OF BACHELOR OF SCIENCE WITH HONOURS IN MARINE SCIENCE

SAYA AHMAD SAIFULLAH B. MAZLAN (HURUF BESAR) SESI PENGAJIAN: 2007/2008

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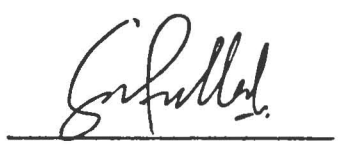

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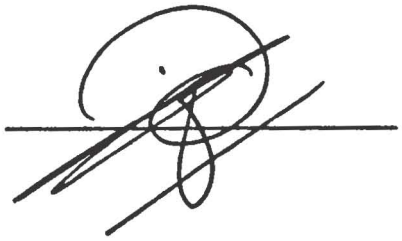

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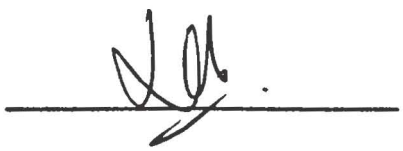

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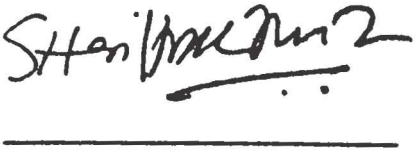

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Abstrak

Tenaga ombak merupakan faktor semulajadi yang membentuk struktur sesebuah pantai. Pemetaan tenaga ombak dipesisir pantai Lahad Datu adalah berdasarkan kepada data-data sekunder dari April 2000 hingga March 2005. Kajian terhadap taburan tenaga ombak dikawasan kajian adalah mengambil kira struktur batimetri dasar laut di kawasan terbabit. Objektif utama kajian adalah untuk memeta tenaga ombak di pesisir pantai, memeta batimetri struktur dasar laut, dan mengenal pasti struktur geomorfologi yang dipengaruhi tenaga ombak. Kajian di jalankan dengan mengumpul data-data sekunder dari sumber-sumber yang dipercayai iaitu Jabatan Kerajaan seperti Jabatan Meteorologi Negara dan agensi agensi swasta.. Data dianalisa dengan mengaplikasikan rumus Longinov (1966). Data yang diperolehi juga dianalisa dengan mengunakan perisian *Surfer 7* untuk menghasilkan Data bathimetri dan taburan tenaga ombak di kawasan kajian. Hasil dari analisis data-data sekunder, tenaga ombak dikawasan kajian dipengaruhi oleh struktur batimetri dasar laut. Tenaga ombak yang merebat ke pantai semakin berkurang apabila menghampiri pesisir pantai. Selain itu kewujudan geomorfologi pantai seperti hutan paya bakau, gugusan kepulauan dibahagian barat pesisir pantai Lahad Datu menyokong keadaan tenaga ombak yang lemah di kawasan tersebut. Keadaan tenaga ombak yang rendah dan selamat dikawasan kajian mendorong aktiviti-aktiviti pembangunan dikawasan pantai. Namun, sebarang perubahan kenaikan terhadap tenaga ombak memberikan impak yang besar terhadap struktur pantai.

Abstract

Wave energy is natural phenomenon that shaping the structure of the coastal area. The modelling of the wave energy at the coastal area off Lahad Datu town was carried based on data from April 2000 until March 2005. The study towards the wave energy distribution within the area was taken into account the bathymetry structure of the particular area. Objectives of the study are to model the wave energy at the coastal area off Lahad Datu town, to generate the bathymetry maps of the coastal area, and to determine the geomorphology features that affected by the wave energy. This study was done by collecting the secondary data from the government agencies such as Meteorological Department and private agencies. Data then were analysed by applying the Longinov (1966) wave energy equation. The obtained data also were analyse by using the *Surfer 7* software to obtain the bathymetry and the wave energy distribution data. The results from the analysis showed that the wave energy within the area mere affected by the features of the seafloor bathymetry. The wave energy that refracted towards the coastline dissipates as it near the coastal area. Beside that the existence of the coastal geomorphology such as mangroves, group of islands at the eastern part of the studied area support that the wave energy was relatively low within the area. The low wave energy is considered safe within the area and this encourages the coastal development. However, any changes increased in the wave energy will give great impact towards the coastal area.

CONTENTS

LIST OF FIGURES

LIST OF PHOTOS

LIST OF SYMBOLS AND UNITS

L	Wavelength
H	Wave Height
a	Wave Amplitude
T	Wave Periods
f	Wave Frequencies
m	Metre
ft	Feet
kw	Kilowatt
%	Percent
$J\ m^{-2}$	Joule per metre square
E	Total wave energy per unit square
kmh^{-1}	Kilometre per hour
ρ	Density
g	Gravity speed constant
kgm^{-3}	Kilogram per metre cube
ms	Metre per second
ms^{-2}	Metre per second square
°	Degree
‘	Minute
E_{0sw}	Wave energy for shallow water
gm^{-3}	gram metre cube

H	water depth
V_{17}	Wind speed at height of 17 metres above sea level
V^2_{17}	Power two of wind speed
V^5_{17}	Power five of wind speed
E	Exponent

LIST OF ABBREVIATIONS

e.g.	Example
Etc.	Others
&	and
N	North
E	East

CHAPTER 1

INTRODUCTION

1.1 Waves

Wave is an undulating motion of disturbance energy across a medium (e.g. air, water, solid) and it is formed as the result of energy being transferred through the medium. Ocean waves form at the surface of the sea due to the results of energy moving across the sea surface from its initial source such as wind and underwater earthquake.

There are several types of ocean waves and they are classified based on disturbing forces that created them (Garrison, 2005). There are many types of disturbing forces that tend to create waves, for example, wind force that trigger the wind wave which cover almost all part of the sea. There are also other types of disturbing forces that are able to create other types of wave such as underwater earthquake which may trigger the destructive tsunami. The wind wave or other types of sea wave, travel across the sea surface in the form of wave train until it reaches the shore where it tends to break and refract, which is where the wave slow and deflect in shallow water. The energy within the sea wave can be different at each bathymetric depth of the ocean floor as the wave travel across the sea surface. Thus, sea wave carries energy as it travel across the sea surface towards the shoreline.

The wave properties such as wave height and wave energy change due to the coastal geomorphology and the coastal bathymetry where the waves shoal towards the coastal line. The wave's height and the wave energy can vary within a certain coastal area.

1.2 Coastal Area

Among factors that shape the coastal area are the actions of waves, currents and tides. Coastal areas can be generally defined as the boundary between the land and the sea. Therefore, the coastline is greatly affected by the marine processes. It is usually shaped by physical processes such as deposition and erosion due to the waves and currents action. For example the most commonly known alongshore currents which results from an oblique angle of wave that reaches the shore (Brown *et al.*, 1989) carries the sediment within and deposits it along the coastline.

Different coastal geomorphology reacts with the wave action in different ways. The coastal area covered with vegetation such as mangroves tend to absorb the wave energy more as compared to open coast. The wave energy is dampened within the mangroves or the seagrass area. The wave energy is much higher within the rocky shore area as the erosion processes greatly occur within the area. Thus, the variability of the wave energy at the different geomorphology affects the marine ecosystems and the coastal community.

1.3 Waves Dynamics in Coastal area of Sabah

The eastern coastal areas of Sabah are greatly influenced by the waves from Sulu and Sulawesi Sea. Besides the wave energy, the area may also be affected by the natural phenomena such as cyclone and storm surge. Most of the human population live in the lowland areas near coastal areas. This is because it is a suitable area for agricultural activity. Coastal areas also played a major role in transportation and economic activities. High wave energy that occurs due to the strong wind, cyclone or other natural phenomena could give effect to most of the coastal lowland area. High wave energy due to the natural phenomena could bring disaster to the population that live within the unsheltered coastal area. Wave action could affect the coastal population daily activities as they greatly depend towards the coastal resources for food and shelter.

Wave energy is also one of the factors that determine the distribution of the marine resources such as marine fishes and other invertebrates' organisms. It affects the distribution of the phytoplankton and the fish's larvae which is the primary producer and consumer for the marine ecosystem.

This study is conducted to identify the impact of different wave energy towards coastal area off Lahad Datu Town as the wave dynamics processes are still relatively unknown within this area. It would also enable us to give the suggestions regarding future development along the coastal area off Lahad Datu Town, Sabah.

1.4 Objectives

This study was conducted based on these objectives:

1. To calculate and model wave energy at different depth in coastal area off Lahad Datu Town.
2. To determine coastal area that may be affected by different wave energy from offshore of Darvel Bay.
3. To generate bathymetry map off Lahad Datu Town which affect the distribution of wave energy in coastal area.

CHAPTER 2

LITERATURE REVIEW

2.1 Sea Waves

The dynamics of the sea waves is still unknown and being intensively studied by researchers. The study of waves is long been conducted since Aristotle discovered the interaction between wind and the wave and since then, the study of sea waves have attracted oceanographers (Brown *et al.,* 1989). Sea waves can occur at the sea surface in many types and form, from the tinniest ripples to the biggest tide. Reddy (2001) stated that turbulence associated with ocean waves promote interchange between sea and atmosphere. Knowledge of the sea waves is necessary for understanding processes on the ocean surface (Reddy, 2001).

There are several important profiles of the sea waves that is needed to be known in order to understand its properties and dynamics. The highest part of the wave which above the average water level is called the wave crests, while it's opposite the lowest part of the wave that below the average water level is called the wave trough. The horizontal distance between two crests or two troughs is known as

the wavelength (L). The vertical measurement between crest and trough is the wave height (H) and wave amplitude (a) is half of the wave height (Figure 2.1). From the view of the time scale, Garrison, (2005) described the wave period (T) as referring to the time taken for a wave to move in a distance of a wavelength. The frequency (f) is the number of waves that pass through a fix point a second time interval.

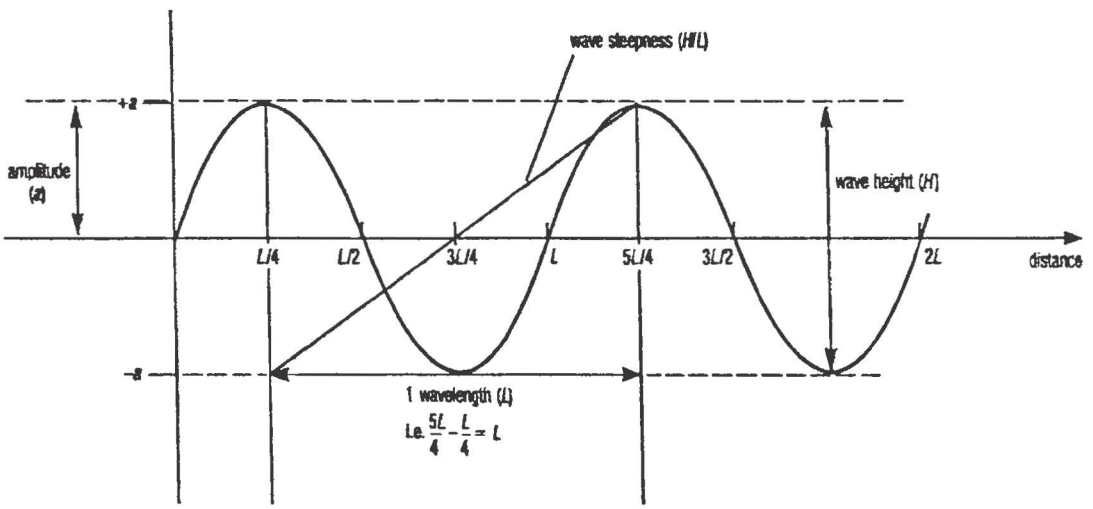

Figure 2.1: Sea wave profiles (Brown *et al.*, 1989).

2.2 Types of sea waves

Wave occurs due to movement of energy. The energy or force that generate the sea wave is called disturbing energy or generating force. Besides that, there is also energy that tend to restore the waves to its undisturbed phase which is commonly known as restoring forces. According to Brown *et al.*, 1989, there are two types of restoring forces that maintain the progress of the sea surface wave which is the gravitational forces that exerted by the earth and the surface tension that form due to the tendency water molecules to stick together.

There are many methods in classifying the waves. One of the methods is classifying by the wavelength of the generated waves. They also can be classified on the restoring force; force that tends to restore the waves to its undisturbed phase or based on the disturbing forces that creates them. Sometime confusion can arise between the different types of wave. The wind generated wave that form over the sea surface commonly known as the wind wave. Wind which blows over the sea surface together with the surface tension tends to forms small waves, called ripples, or capillary waves (Garrison, 2005). As the winds tend to blow, more energy is transfer towards the wave. The waves grow larger in magnitude due to more transfer of momentum towards the sea surface. Thus the earth's gravity reacts as restoring force rather than capillary within these gravity waves. Beside the type of wave that has been mentioned earlier, there are other types of sea waves that form from different disturbing forces such as tsunami, tide and storm surge.

2.2.1 Tsunami wave

Tsunami is the most destructive type of wave which derived from the Japanese term for harbour wave (Woodroffe, 2003). It is commonly miscalled 'tidal wave' although it is not caused by tidal influence (Brown *et al.*, 1989). Tsunami is triggered by the seismic disturbance beneath the ocean floor due to the earthquake events, submarine landslide (Woodroffe, 2003) or volcanic eruption (Reddy, 2001). Tsunami that been generated tend to travel across the ocean is relatively has a small wave height, usually in the order of one metre and often remains undetected. However, it has long periods of about 15-20 min in between waves crest (Reddy, 2001). It is common for people on

board ships offshore to unaware of tsunami passing beneath them (Brown *et al.*, 1989). Although the range of the wave height at the open sea is small, as this wave entering the coastal area or the continental shelf, the wave height will greatly increase and this will bring a great disaster towards the coastal area especially to the population and the marine ecosystem within the coastal area. This phenomenon occurs due to the speed of the wave that been reduced due to the influence by the depth of the seafloor. However, the energy within the wave still remains the same and this results in a great increase in wave height. It has been recorded that where the tsunami occured, increase of wave height up to 11 metres has been observed and the subsequent rush of this destructive wave rises up to about 40 metres inland.

The date, 26th of December 2004 is a historic day due to the natural disaster that occured within our coast. An earthquake with the epicentre near Acheh triggered a tsunami wave with the wave height of about 8 metres and inundated the west coast of Peninsular Malaysia to about 350 metres inland. This tsunami wave which was triggered by a 9.0 Richter magnitude earthquake killed 68 people in Malaysia and caused a great loss of properties especially for the coastal inhabitants such as fisherman (Ibrahim, 2006).

2.2.2 Storm Surge

Storm surge is another type of destructive wave that can greatly affect the coastal residents. This destructive wave is triggered due to the climatic influence occuring as a result of storm such as typhoon that reach the coastal area.

One of the known most powerful natural phenomena that occurs on the face of earth is the tropical cyclone. The term 'Tropical cyclones' is typically due to it formation over ocean waters at the tropics. However the tropical cyclones have been given different names depending on their region of origin. In the western North Pacific, they are called typhoons, while in the Bay of Bengal they are referred to as severe cyclonic storms of hurricane intensity. In the Atlantic, Gulf of Mexico, Caribbean, and Pacific, North of the equator and east of the international dateline they are hurricanes (Potter & Colman, 2003). However, within the coastal area the storm surge has contributed to lose of lives and properties as it accounted 90% of the deaths in typhoons disasters. For example as what had occurred in Bangladesh, the most devastating storm surge struck in November 1970 which resulted in lost of human lives estimated at about 200,000 to 300,000 and couple of enormous economic damage, which must have led to more deaths later (Murty *et al.*, 1986).

Storm surge is referring to a rapid rise of sea level that occurs as a storm approaches a coastline. It occurs due to the low atmospheric pressure that occurs within the storm (Figure 2.2).

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