"I declare that I had read this report and according to my opinion,
this report is enough to fulfill the purposed for award of the
Bachelor Degree in Mechanical Engineering
from the aspects of scope and quality"

Signature : ______________________

Supervisor : Dr. Mohd. Yusof Bin Sulaiman

Date : 30/5/06

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SHORELINE WAVE ENERGY DEVICE

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This report is submitted to the faculty of Mechanical Engineering as a partial to fulfillment of the award of Bachelor Degree in Mechanical Engineering

Faculty of Mechanical Engineering
Kolej Universiti Teknikal Kebangsaan Malaysia

May 2006

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" I declare that this report entitled " Shoreline Wave Device" Is the result of the work of myself except for the references which I had clarified the sources"

Signature : dily

Writer name: Noor Fadzlily Bt Mohd. Amin

Date : 25/5/06

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May Allah bless us..

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ABSTRACT

This report described a project to design shoreline wave energy device. This device is used to convert wave energy into electrical energy. This simple device consists of bicycle tyre which produced a circular motion by wave movement. The circular motion of the bicycle tyre drives the dynamo as a turbine to generate electrical energy which is able to light up the small lamp (menthol).

This project is widely on wave energy development at the shoreline. Mostly the shoreline devices that have been developed are used for bigger industry. With this project, shoreline device that will be developed is simple and its application is easier to understand.

Furthermore, this report described about the conversion of wave energy especially the conversion of wave energy into electrical energy by using applicable apparatus.

(Wave energy → Mechanical energy → Electrical energy)

This project also can be used as a learning support device because of this device is simple and its application is easier to understand especially for student.

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ABSTRAK

Secara khususnya laporan ini menerangkan tentang projek merekabentuk alat pengubah tenaga ombak di tepi atau pesisir pantai kepada tenaga elektrik. (Shoreline wave energy device). Alat ini merupakan alat pengubah tenaga ombak kepada tenaga elektrik yang terdiri daripada tayar basikal, dynamo dan mentol. Tayar basikal akan berputar apabila digerakkan oleh tenaga ombak. Putaran tayar basikal ini akan menggerakkan dynamo yang bertindak sebagai turbin untuk menukarkan tenaga kepada tenaga elektrik dan menyalakan mentol.

Projek ini lebih menekankan kepada pembangunan tenaga ombak di tepi atau di pesisiran pantai. Kebanyakan alat pengubah tenaga ombak di tepi pesisiran pantai biasanya dibangunkan untuk penggunaan indstri-industri besar. Melaui projek ini alat pengubah tenaga ombak di tepi pesisiran pantai yang dihasilkan adalah lebih ringkas dan aplikasi cara kerjanya lebih mudah difahami.

Selain daripada itu, projek ini menerangkan berkenaan dengan penukaran tenaga dari tenaga ombak kepada tenaga elektrik dengan menggunakan peralatan-peralatan yang bersesuaian. (Tenaga Ombak → Tenaga Mekanikal → Tenaga Elektrik)
Alat ini juga sesuai digunakan sebagai alat bantuan mengajar kerana ia lebih ringkas dan aplikasinya lebih mudah difahami khasnya oleh para pelajar.

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LIST OF SYMBOL

NOTATION	DEFINITION
m	Wave mass
ρ	Water density (kg/m^3)
w	Wave width
a	Wave amplitude
h	Wave height
k	Wave number
λ	Wave length
ω	Wave frequency
T	Wave period
P.E	Potential energy
K.E	Kinetic energy
F	Wave force

Subscript

E_W	Total energy
E_{WD}	Energy density
P_W	Power
P_{WD}	Power density

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CHAPTER 1

INTRODUCTION

1.1 PROJECT INTRODUCTION

This project is to developed (design and fabricate) a shoreline wave device. This device used at the shoreline to convert wave energy into electrical energy. Conversion of energy in this project is as below:

(Wave energy →Mechanical energy →Electrical energy)

Shoreline devices have the advantage of relatively easier maintenance and installation and do not require deep water moorings and long underwater electrical cables. The less energetic wave climate at the shoreline can be partly compensated by the concentration of wave energy that occurs naturally at some locations by refraction and/or diffraction. The three major classes of shoreline devices are:

- the oscillating water column (OWC)
- the convergent channel (TAPCHAN)
- the Pendulor

For decades, scientists have been trying to tap wave power as a source of renewable energy. According to the World Energy Council, " an international consortium promoting sustainable energy. " Ocean waves could supply twice as much electricity as the world now consume. But, wave action is so dispersed, it's difficult to harvest this power economically.

Researchers have developed several mechanisms for capturing wave energy, including tapered channel systems that funnel waves into a turbine, underwater turbines powered by currents and float system that rise and fall on the water's surface, driving pistons that convert the motion into energy.

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In an oscillating water column approach, waves rolling into shore push up the water level inside a large, partially submerged concrete chamber built into the shoreline. The rising water forces the air trapped in the chamber through a hole and into a mouth of a turbine. When the waves recede, the falling water level in the chamber sucks air through the turbine in the opposite direction. The key to the system is its use of a so- called Well turbine, whose blades rotate in the same direction regardless of airflow direction. The spinning turbine drives generator that produces electricity

1.2 PROJECT TITLE

Shoreline Wave Device

Is a device to convert wave energy into another form of energy. The wave is taken near the beach. i.e.; shoreline. In this project shoreline wave device is used to convert wave energy into electrical energy.

(Wave energy→ Mechanical energy → Electrical energy

1.3 OBJECTIVE

1.3.1 Design and fabricate a device to convert wave energy into electrical energy.

1.4 PROBLEM STATEMENT

Mostly the examples of shoreline device are used in bigger industry and no design to satisfy small industry user or for small customer. On the other hand, all the design is complicated.

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1.5 SCOPE

1.5.1 Acquire wave data

1.5.2 Design and fabricate a wave energy test rig to measure shoreline wave characteristic

1.5.3 Improve design and fabrication of existing wave tank and accessories

1.5.4 Design and fabricate a wave wall energy conversion device

1.5.5 Test and analyze.

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CHAPTER 2

THEORY

2.1 Ocean Wave

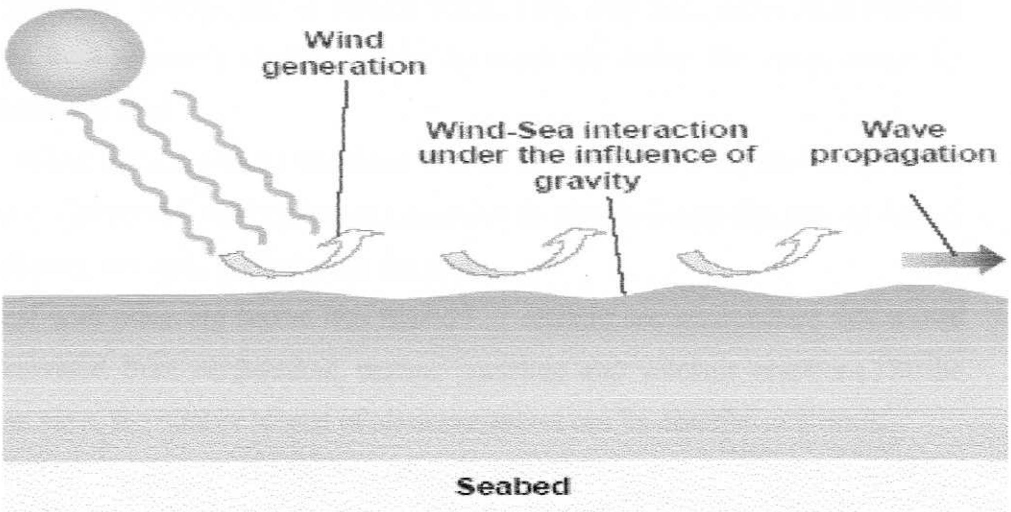

Figure 2.1: Ocean Wave

Ocean waves are tertiary form of solar energy, in that unequal heating of the earth's surface generates wind, and wind blowing over water generates waves. Despite the fact that nearly 75% of the earth's surface is covered with water, waves are largely unexplored source of energy, compared with the progress that has been made in harnessing the sun and wind.

The ocean wave was a natural phenomenon where the basic occurring of waves is caused by the friction of wind on water and it can be define as a water surface undulation where been generated by the energy transfer.

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The interactions of restoring forces from gravity and disturbing by wind were a propagating of the ocean waves.

Originally, most ocean waves generated from the wind blowing across the surface of ocean water. Waves in deep water don't affect the water below them at a depth greater than half their wavelength. Since wavelengths of wind-generated waves at sea are rarely any longer than 150 meters, water below 75 meters isn't stirred by it at all.

Waves are generated by the force of the wind blowing over the ocean's surface. The regular breakers seen on most beaches originate at sea and can come from a variety of storms. They contain large amounts of energy stored in the velocity of the water particles and in the height of the mass of seawater in a wave front above the mean level of the sea.

The water's surface acts like a great conveyor belt, delivering power from great distances. Waves vary in several ways. They vary from location to location and also from season to season. Where the winds are steady the waves persist for long periods of time.

When the wave nears the shore, friction between it and the land slows down the wave. The wave literally piles up, becoming so high and steep that gravity causes it to fall over, or break, crashing into the shore.

Different with other big waves like tsunami or seismic sea wave where this waves was generated from earthquakes, marine landslide and volcanic eruptions. In the different view, the tidal or largest of all ocean waves can be describe as a result.

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2.2 Ocean surface wave spectrum

In the spectrum part the waves is categorizes following on the period or frequency of waves. Period is defined as length of time taken for an entire wave to pass a point meanwhile the frequency was the inverse of the period (1/T). The gravitational forces exerted on the earth by the moon and sun generated the tidal wave which also can define with the longest periods of ocean waves. Tides move sediment perpendicular to the shore and control the daily movement of the surf up and down the foreshore. Breaking waves produce the long shore currents that transport sediment parallel to the shore[1].

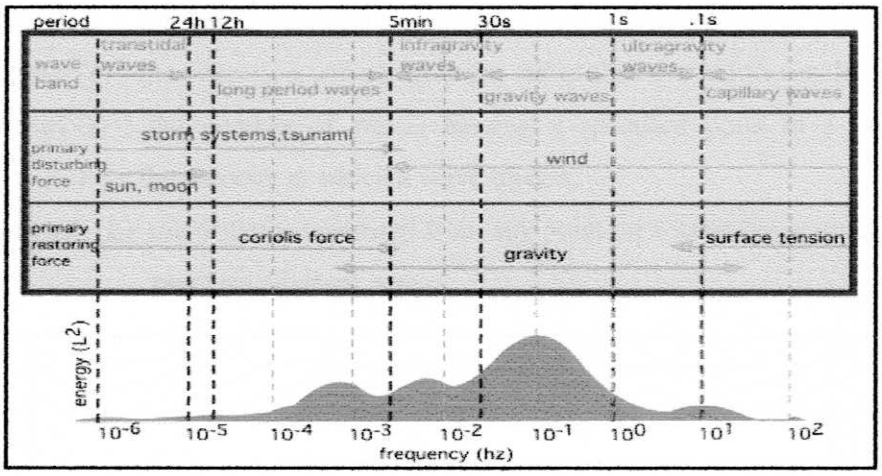

Figure 2.2: Approximate distribution of ocean surface wave energy

The process of classifying of the water waves within the disturbing and restoring forces involved with:

Wind waves : wind is the disturbing force and gravity is the restoring forces

Tides : sun is the disturbing Force.

Capillary waves : wind is the disturbing force and surface tension of water is the restoring forces

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2.3 Wave classification

The classified of wave were according either from the waves pass through the body of material or move along interface. Some example of body waves is primary and secondary seismic waves and the surface waves are coming from Raleigh waves which were characterized by an orbital motion and the Love waves.

The surfaces of wave is consists of :

Wave crest : the highest point of a wave.

Wave trough : the lowest point of a wave.

Wave height (H): the vertical distance from the crest to a trough of a wave.

Period (T) : the time it takes for one wave to pass a specified point.

Amplitude (a) : the distance a wave moves the water above or below sea level.

Frequency (f) : the number of waves passing a specified point in a time unit.

Celerity (C) : the velocity at which a wave travels.

Wavelength (L): the distance measured from any point on a wave the equivalent point on adjacent wave[2]

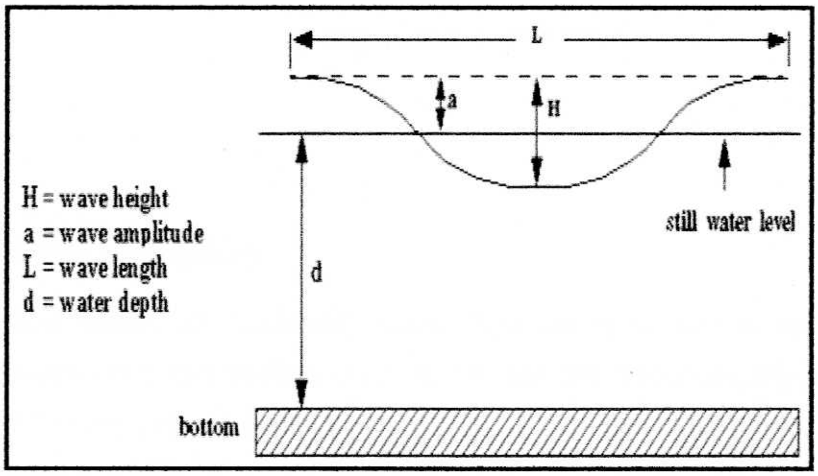

Figure 2.3: Description of wave

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2.4 Wave theory

The theory of waves is applied to predict and describe wave shape and wave behavior:

2.4.1 Airy Wave theory

Also known as sinusoidal waves. The accuracy is high on low amplitude waves in deep water and different when predicting wave behavior in shallow water where the accuracy is low. This wave theory commonly used because it is the least mathematically complex. When determine wave velocity the effects of wave height is not necessary to be taken.

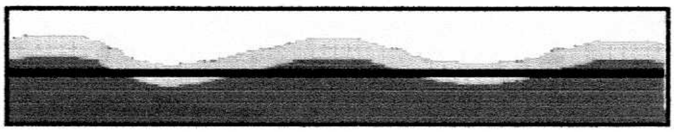

Figure 2.4.1: Airy Wave

2.4.2 Stokes Wave theory

Also known as Trochoidal waves. This theory is able to use for deep, intermediate and shallow-water waves. But the mathematically is complex When determine the velocity the effects of wave height is required to takes in the calculation

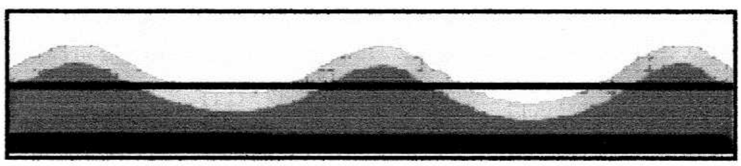

Figure 2.4.2: Stokes Wave

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2.4.3 Solitary wave theory

The theory of this wave state that an isolated crest moving in shallow water none oscillatory progressive waves (translatory) use only to describe shallow water waves or normally known as breakers. The formula mostly using for this wave are based on the Airy Wave theory

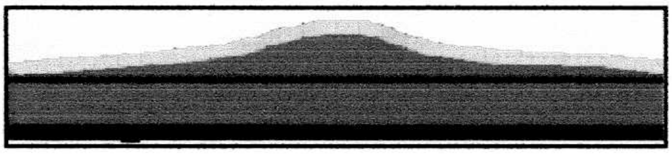

Figure 2.4.3: Solitary wave

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2.5 Wave parameters

Wave Length (L)

Define as the distance between successive wave crests in the horizontal. This parameter is only can measured by air photos because it's very complicated to measure and mostly calculated using the wave period (T)

$$L = \frac{gT^2}{2\pi} \tanh r$$

r = *kd* ***k*** *(wave number) = (2π)/L* ***d*** *=depth*

Note: when d/L>.5, as for deepwater waves, tanh**r** approaches *kd*, and when d/L<.5, as for shallow water waves, tanh**r** approaches 1.

Wave Height (H)

The height is defined as the distance from crest to trough in vertical and same value with the diameter of orbital deep water wave. In this part value of wave height can be assume as the energy of an individual wave which can be describe in below equation,

$$\text{E(wave energy)} = \frac{pgH^2}{8}$$

Significant Wave Height (H_3):

This value was produced from the average of the highest 1/3 of the waves from a wave spectrum. The observation of measuring wave that approach the shore is not able to do from shore and typically records of that is larger. The roughly visual measurement of wave height corresponds to the significant of the wave height.

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Period (T)

For the period, time (t) is taken on entire wave (L) to the pass a given point.

T = L/t

On field measurement the time passage of 11 wave crests will be and divide by 10 and the significant wave period (highest 1/3) can be measured in the surf. In differential between deep to shallow water period doesn't changed.

Frequency (F)

This value is present by values of waves per time. Define as a number of waves which pass a point per unit of time.

F = 1/T

Wave steepness

The wave breaks and reform if the value of wave steepness exceeds from 1/7.

H/L

Relative depth

d/L

This equation is used to distinguish between deep-water, intermediate, and shallow-water waves.

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Celerity

C = L/T

Phase velocity = speed of an individual wave.

Dispersion equation below is showings the different periods travel at different velocities. In these criteria the waves will become sorted as the motion of beyond the influence of the generating wind.

$$\frac{gT}{2\pi}\tanh\left(\frac{2\pi d}{L}\right)$$

Group Speed

The group speed is occurring on the wave train speed and to the individual wave.

Cgo = 0.5 Co for deep water

Cg = C for shallow water (phase velocity decreases)

Amplitude

This value is defined by calculating vertical distance between the crest or trough and the still-water level.

1/2H

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