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**Potong mana yang tidak berkenaan*

THE STUDY OF THE WAVE ENERGY MACHINE

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ABSTRAK

Perbezaan pemanasan bumi telah mengakibatkan penghasilan angin seterusnya menghasilkan ombak. Ombak terhasil akibat daripada tiupan angin pada kawasan air yang luas. Tenaga gelombang boleh dianggap sebagai satu bentuk kesan daripada tenaga suria. Alat penukar tenaga ombak tepi pantai mempunyai kelebihan penyelenggaraan dan pemasangan yang mudah, tidak memerlukan air yang dalam dan kabel-kabel yang elektrik yang panjang di dalam air. Beberapa sistem yang biasa digunakan untuk mendapatkan kekuatan gelombang di tepi pantai adalah pendulor, saluran tertumpu (TAPCHAN), dan air berayun turus (OWC). Teori yang melibatkan mekanik gelombang adalah klasifikasi gelombang dan teori gelombang. Selain itu, parameter-parameter seperti panjang gelombang, tinggi ombak, tempoh dan kekerapan akan ditumpu dan dikaji dengan melakukan beberapa ujikaji. Pengiraan dicampur mendefinasikan tenaga gelombang jumlah. tenaga boleh ini menjadi menghitung oleh menambah ilmu kinetik dan tenaga keupayaan Pengiraan perlu dilakukan untuk mendapatkan tenaga ombak. Tenaga ini bolah dikira dengan menjumlahkan tenaga kinetik dan tenaga keupayaan. Peralatan mengukur daya ombak dan ketinggian ombak telah digunakan untuk mengkaji ketinggian dan daya tolakan ombak. Alatan ini menggunakan spring dan pelampung sebagai mekanisma kerja.Tangki gelombang adalah satu alatan untuk mengkaji tingkah laku ombak. Kerja-kerja pembuatan dalam memajukan tangki gelombang sedia ada dan pembuatan alat penukar tenaga gelombang dilakukan untuk menyiapkn projek ini.

ABSTRACT

Winds are generated by the differential heating of the earth and as a result of their blowing over large areas of water; part of their energy is converted into waves. Wave energy can be considered as a concentrated form of solar energy. For shoreline wave energy converter device that have advantages of easier maintenance and installation and do not require deep-water moorings and long underwater electrical cables, several systems used to get the wave power. They are the pendulor, the convergent channel (TAPCHAN), and the oscillating water column(OWC). The theories involve the wave mechanics are the wave classification and the wave theory. Besides, the parameters such as the wave length, wave height, period and frequency been investigate and study by doing some experiment. Calculation involve in defining the total wave energy. This energy can be calculated by adding the kinetics energy with the potential energy. Devices for measuring the wave force and wave height have been used to study the wave force and the wave height. The devices used the spring and the buoy as the working mechanism. Wave tank is a laboratory setup for observing the behavior of waves. To finish this project, the fabrication work involved in developing the wave tank and the wave energy converter device been done.

CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF SYMBOL

L	=	wave length (m)
T	=	period
d	=	depth (m)
k	=	wave number
H	=	Wave height
E	=	wave energy
t	=	time
F	=	Frequency (1/T)
C	=	celerity (L/T)
H/2	=	amplitude
P.E	=	Potential energy
m	=	mass
ρ	=	water density
W	=	wave width (m)
k	=	wave number ($2\pi/\lambda$)
λ	=	wave length ($gT^2/2\pi$)
ω	=	wave frequency (rad/sec)
K.E	=	kinetic energy
E_{WD}	=	Energy density
Pw	=	Power
P_{WD}	=	Power density
V	=	the volume of the object submerged
g	=	standard gravity (9.81 N/kg)

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Background

Oceans cover almost three-fourths of the earth's surface. The oceans and the land beneath them could provide all of the energy the world needs for years to come. The oceans contain a huge energy resource that can be exploited to feed the global energy demand. The most developed conversion systems concern: tidal energy, which results from the gravitational fields of the moon and the sun; thermal energy (Ocean Thermal Energy Conversion or OTEC), resulting directly from solar radiation; marine currents, caused by thermal and salinity differences in addition to tidal effects and ocean waves, generated by the action of the winds blowing over the ocean surface.

The power present in ocean waves has been recognized for centuries although mostly in terms of its destructive potential. However, the possibility of obtaining useful energy from ocean waves has been considered for some centuries. The first patent of a wave energy device was registered in France by the Girards father and son at the end of 18th century and since then more than one thousand patents have been filed in various countries.

The most obvious form of ocean energy is the power of waves which is what the project been done on. For energy conversion, wave power can be captured on or near

shore as well as off shore. Off shore systems use the motion of the waves either to create an electrical charge, or to operate hydraulic pumps. The pressurized fluid from the pumps powers a turbine. There are several technique that been using for onshore systems which are the pendulor, the tapchan and the oscillating water column.

This project is focusing on designing and assembling the wave energy converter device that manipulate the wave energy and transfer it to electrical energy. Several experiments and tests will be prepared in order to achieve the main idea.

1.2 Project title

The study of the Wave Energy Machine

A devise that been used to convert wave energy to electrical energy. The device will be used onshore to get the wave energy. The energy conversion in this project:-

[wave energy ⟶ mechanical energy ⟶ electrical energy]

1.3 Objective of the research

- To develop and assemble wave energy converter that will be use onshore.
  In order to develop this device, onshore wave characteristic must be known.
- To study the design and fabricate wave energy machine
  In designing the machine, the right dimension must be known by doing several tests on the design.

1.4 Problem statement

Every single design of wave energy converter that exist nowadays is made to supply high energy power that been used for heavy industrial. There is no design for generating small range of power to be use onshore.

1.5 Scope of project

The purpose of this project is to design and fabricate a wave energy machine that converts wave energy to electrical energy. Determining the right dimension of the machine is also the main purpose of this project. This is important to make sure the machine works smoothly. The dimension of the arm, paddle and the water depth will be determined when the project complete.

CHAPTER 2

LITERATURE REVIEW

The tides are generated by the rotation of the earth within the gravitational fields of the moon and sun that cause the surface of the oceans to be raised and lowered periodically and amount of energy available from a tide varies approximately with the square of the tidal range. Ocean thermal energy conversion (OTEC) generated from two sources of heat at different temperatures. The maximum efficiency (the efficiency of the Carnot cycle) of an heat engine operating between the (absolute) temperature Tw of the warm water and the temperature Tc of the cold water. The Rankine cycle is the only practical thermodynamic cycle that has been developed for the OTEC. Winds are generated by the differential heating of the earth, and, as a result of their blowing over large areas of water; part of their energy is converted into waves. They mention that resulting waves depends on the wind speed, the length of time for which the wind blows and the distance over it blows. The original solar power levels of typically ≈100 W/m2 can be converted into waves with power levels of typically 10 to 50 kW per meter of wave crest length. The main devices for shoreline which has advantages of easier maintenance, easier installation and do not require deep-water moorings and long underwater electrical cables, are the oscillating water column (OWC), the convergent channel (TAPCHAN), and the pendulor. For the offshore device that have powerful wave regimes available in deep water (typically more than 40 m water depth), no device has yet been demonstrated at full scale but reduced models of some have been

temporarily deployed in the sea. These devices needs to be at or near the water surface and requires flexible moorings and underwater electrical transmission cables in order to extract energy from the waves (Pontes and Falcão,2008).

According to Kane (2008), Overtopping Devices uses a ramp, up which waves can run and overtop into a basin located behind it. The basin then empties back into the ocean, driving a low-head turbine. The device can be either shore-based or floating.

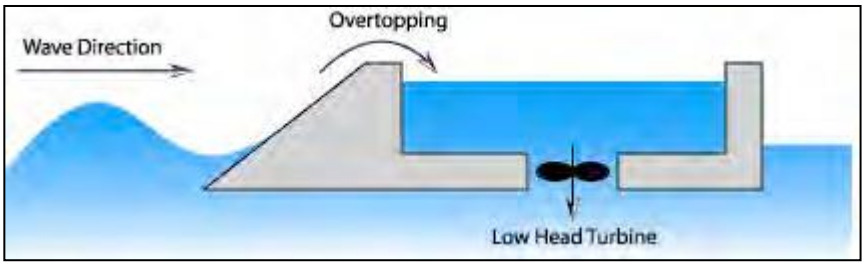
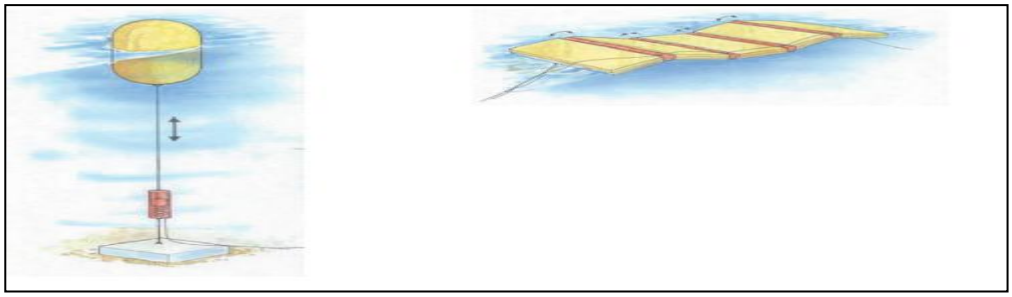


Figure 2.1 Overtopping Devices

Buoyant Moored Device floats on or below the water surface and converts the orbital motion of surface waves into electricity using an absorber system. Two different types of Buoyant Moored Device which are Taut moored device that extracts energy from the relative motion between buoy and sea floor and hinged contour device which the energy of oscillating waves is captured by the movement of hinges that link adjacent floating panels.



Taut moored device Hinged contour device

Figure 2.2 Taut moored device and hinged contour device

Kane (2008), also mention about the Oscillating Water Column (OWC) that use an enclosed column of water as a piston to pump air. These structures that can float, be fixed to the seabed, or be mounted on the shoreline uses an air turbine to convert air flow into a high frequency rotational output required by the turbine machinery.

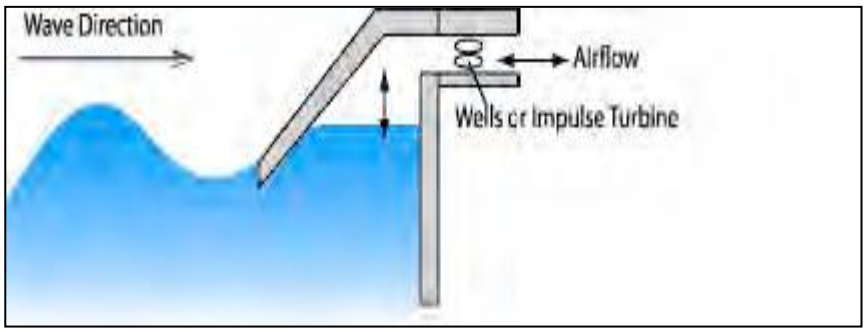


Figure 2.3 Oscillating Water Column (OWC)

Kane (2008), added that shoreline devices have lower maintenance and installation costs than offshore devices and do not require moorings and long underwater electrical cables. Near shore devices are structures situated in shallow waters (typically 10 to 25 m water depth) and the OWC is the main type of device, with several designs install worldwide. Offshore devices are situated in water depths of more than 40m which is more energetic wave resource, lower environmental impacts and larger wave resource.

Ocean power includes wave power, tidal power and thermal energy conversion. Two types of system for wave which is onshore and offshore. Offshore systems use waves either to create an electrical charge with a pump and a floating bobber or buoy, or to operate hydraulic pumps within the joints of a floating device resembling a string of

sausages. The pressurized fluid from the pumps powers a turbine. Onshore techniques include the pendulor, the tapchan and the oscillating water column. The pendulor uses a flap swung back and forth by waves to power a pump and generator. The tapchan is a tapered channel that forces waves higher and thus feeds water into a reservoir above sea level and then used to turn a turbine. Tidal Energy requires a large volume of fast-moving water that can be found either in location with a wide swing in tidal heights or with tidal flows that pass through a narrow channel. There are three types of ocean thermal energy conversion (OTEC) that been discuss which are closed-cycle, open-cycle and hybrid method. Closed-cycle uses warm seawater to vaporize a low-boiling point liquid that then drives a turbine to generate electricity. The vaporized liquid then is cooled and condensed back to liquid with cold seawater, and the cycle repeats. Open-cycle uses warm seawater to boil through lowered pressure and uses the resulting steam to drive the turbine. Cold water from the deep converts the steam back to (now desalinated) water. Hybrid method uses the steam from boiled seawater to vaporize a low-boiling point liquid, which then drives the turbine (internet source, 20 August 2008).

United Kingdom (UK) has scale down a project to establish the technology for extracting energy from ocean waves that will be used on a large scale to supply UK needs. Figure 2.4 shows how to convert the slow movement of water into electricity. In interfacing with the waves, converter must be constrained so that wave forces are resisted. This gives rise to the concept of a ‘frame of reference’ against which the converter. Frames of reference can be achieved using the sea-bed for fixing or mooring, mounting several converters on a common frame or spine so that relative motion is obtained between them, using the inertial force due to the gyroscopic action of a flywheel, relying on the mass and inertia of the device. Overtopping is a wave action that causes water to flow over a dam where it is stored, and allowed to run out through a turbine when needed. In this project, 300 device ideas were considered but only nine were continued through to the end. These devices were produced using the results of model tests and theoretical work. UK coast is in long wavelength waves, targeted to producing 2 GW over is a reasonable with the coastline length. For the power

conversion and transmission, hydraulic and mechanical systems are proposed and mostly used air as a working fluid. Maintenance and availability for fixed device would be expected to have a higher availability than an equivalent floating device. The floating device which could not be repaired at sea is likely to be at a considerable disadvantage (Taylor and Francis, 2003).

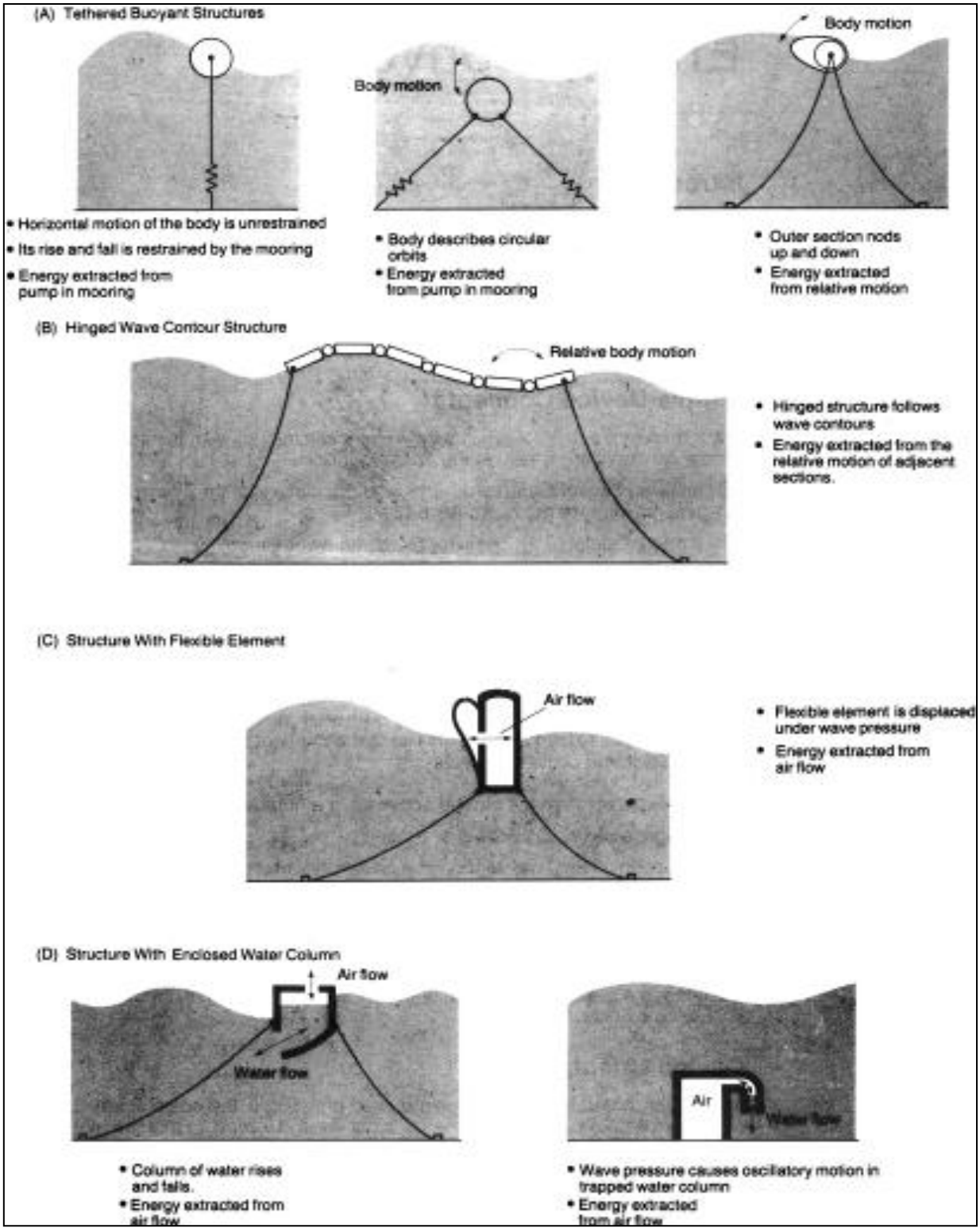


Figure 2.4:Tethered buoyant structure

Three main solutions to the energy crisis in New Zealand by renewable sources which are solar power, wind power, and water power. The most common method used is hydroelectric power, or electricity created by falling water. Other methods used include wave energy, tidal energy, and ocean thermal energy converter (OTEC).New Zealand has small average tidal range (2.37 m/7.78 ft), tidal generation is considered uneconomical because it needs to have a high tidal range (3-8 m/10-26 ft) and the potential to impound large volumes. OTEC is designed to create electricity in warm, tropical waters and uses them to evaporate a liquid such as ammonia or freon that boils at a very low temperature. The steam produced is forced through turbines to create electricity. Ocean waves created by winds on the surface of the sea and contain both kinetic and potential energy. The Energy transmitted to the ocean from the winds through friction between the air and surface of the seas across which they blow. Wave energy is an indirect byproduct (side-effect) of solar energy. Water in a wave does not actually travel but merely oscillates while the energy of the wave is translated across the surface of the ocean (Babar Mahmood, 2008).