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Prospects of Wave power in Bangladesh

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Abstract: - This study deals with the idea of wave power to produce electricity in coastal areas of bangladesh. The graphical representation of power vs. Wave height and power vs. Wave period in different locations in bangladesh has been shown by matlab simulation. A self made prototype for wave energy harnessing and its experimental output has also been presented. From many other wave energy conversion technique which one is most suitable for bangladesh is predicted here. Last of all the cost estimation for a small wave plant has been discussed.

Keywords: *Oscillating water column(OWC), Wave energy converter(WEC), Archimedes Wave Swing (AWS).*

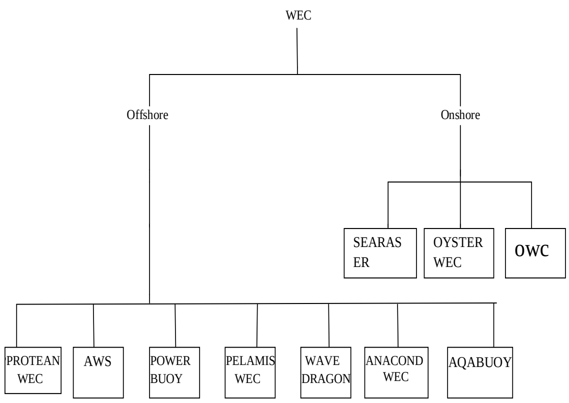
I. INTRODUCTION

The purpose of this paper is to demonstrate that Bangladesh can be enriched in power sector and can reduce the power crisis using wave power. Because wave energy is essentially a non-depleting source of emission free power. Waves are free and will not run out so the cost is in building the power station. It causes less environmental impact on the local communities compared to conventional thermo electrical power generation.There are very few safety risks with wave power generation.

The earth is moving time to time. The surface of earth becomes warm more or less due to sunlight and differential heat is absorbed by land and water. These temperature variations cause density variations which influenced by gravity and the moving globe cause winds. This wind creates ripples on still water. As the wind continues to blow the ripples turn into waves and if the fetch is long enough, the waves develop into the great ocean swells . Once formed ocean waves can travel great distances with minimal loss of energy until they break on some distant shore. Thus wave energy is constantly renewed[1]. It varies in intensity, but it is available twenty-four hours a day, 365 days a year.For utilizing this constantly renewed energy, in this paper, we've gathered various information like site choice, simulation of wave power with height, design of a wave plant, and experimental output of own created prototype.

II. HARNESSING WAVE ENERGY

WEC is required to take off wave energy. Of them three major techniques are vitally used.



2.1 Oscillating Water Column

OWC consists air filled chamber above the water line. By wave action the water level inside the chamber rises and falls, alternately pressurising the air. This pressurised air escapes from the chamber through a turbine-generator unit producing electrical power. As the water level in the chamber falls air is drawn back through the turbine-generator assembly to continue power production. Wells turbines are self rectifying so that the direction of turbine rotation remains constant throughout the power cycle[2].

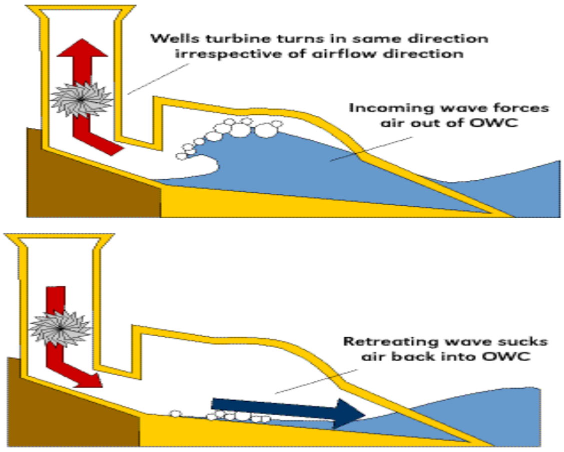


Fig. 1 Oscillating Water Column[4]

2.2 Pelamis

It is a semi submerged, articulated structure consisting cylindrical sections linked by hinged joints and is held on station by a compliant mooring system that allows the machine to weathervane to align itself head-on to incoming waves. As waves travel down the length of the machine they cause the structure to articulate around the joints. The induced motion of these joints is resisted by hydraulic rams that pump high-pressure oil through hydraulic motors which drives electrical generators to produce electricity[2].

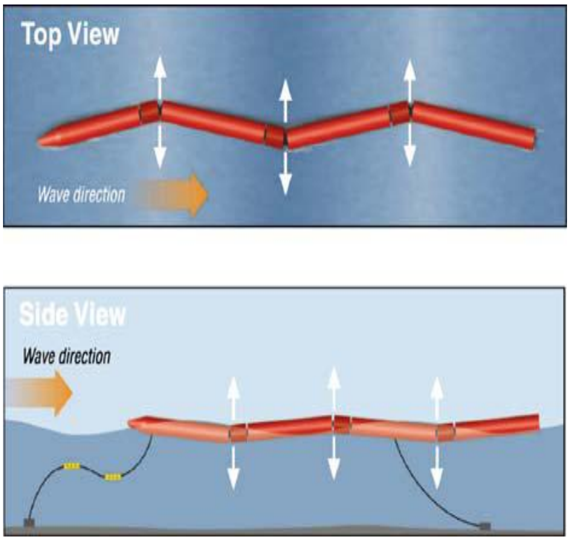


Fig. 2 Pelamis[5]

2.3 Archimedes Wave Swing

AWS is a fully submerged, bottom standing point absorber.It consists out of a cylindrical shaped floater containing entrapped air which oscillates due to pressure differences caused by surface wave action. The relative motion of the floater is converted into electricity through a linear direct induction generator. One unit is rated at 4 MW depending on the wave climate. The floater component has a diameter of 9.5 m and the device is designed for deployment in water depths ranging from 50-100 m[2].

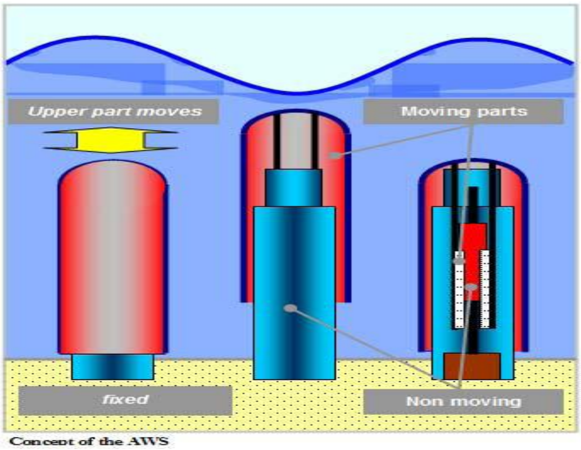


Fig. 3 Archimedes Wave Swing[2]

III. WAVE POWER IN BANGLADESH

Wave energy is a potential energy resource for electrification. But this is a matter of great regret that there is no wave plant in Bangladesh that has been yet built. Wave height in the Bay Of Bengal is of maximum 2.9m from recorded data.The approximate average wave height is 2.6m.And the wave period is about 8-9second. From where by energy calculation we can easily get 27kw from a single unit. At the same time we can think about the Saint Marteen. All this recorded data with simulation will be discussed here.

3.1 Recorded Data Of Wave Height In Different Region Of Bangladesh

3.1.1 Cox'sbazar

Local date	Monday, Jun 04								Tuesday, Jun 05							
Local time	00h	03h	06h	09h	12h	15h	18h	21h	00h	03h	06h	09h	12h	15h	18h	21h
Wave height (m)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.8	2.8	2.9	2.8	2.8	2.8	2.8
Wave period (s)	8	8	8	8	9	9	9	9	9	9	9	9	9	9	9	9

3.1.2 Saint Marteen

Local date	Wednesday, Jun 06								Thursday, Jun 07							
Local time	02h	05h	08h	11h	14h	17h	20h	23h	02h	05h	08h	11h	14h	17h	20h	23h
Wave height (m)	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0
Wave period (s)	5	5	5	5	6	6	6	6	6	6	6	6	7	7	7	7

3.2 Wave Power Formula

In deep water where the water depth is larger than half the wavelength, the wave energy flux is

$$P = \frac{\rho g^2}{64\pi} H_{m0}^2 T \left(0.5 \frac{KW}{m^3.s}\right) H_{m0}^2 T \ldots\ldots\ldots\ldots\ldots\ldots(I)$$

Where, P the wave energy flux per unit wave crest length (kW/m),$Hm0$ is the significant wave height (meter),T is the wave period (second),ρ is the mass density of the water (kg/m^3), and g is the acceleration by gravity (m/s^2).

3.3 Wave Power Characteristics By Matlab Simulation

3.3.1 Cox's bazar,Bangladesh

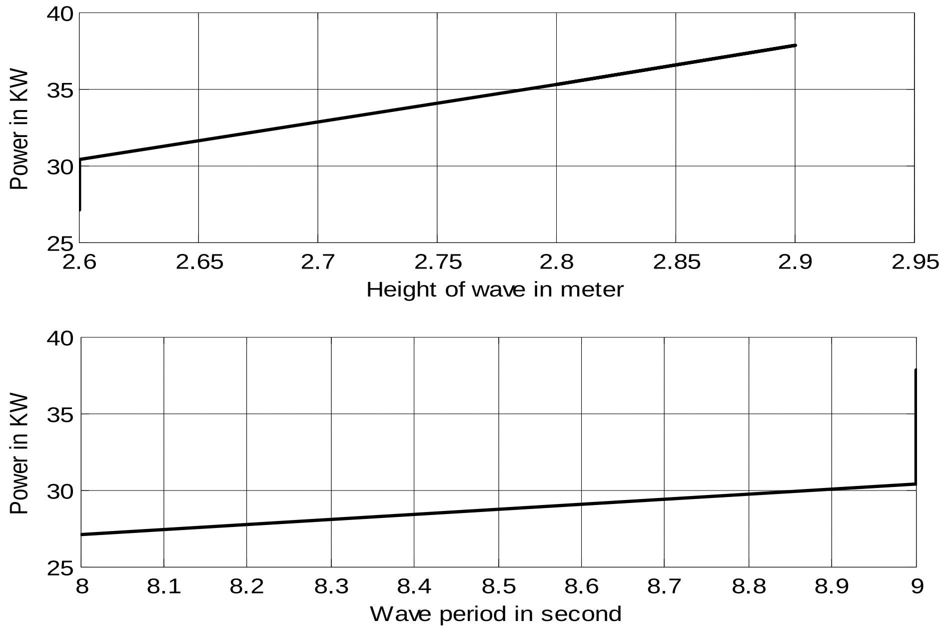


Fig. 4 Power vs wave height and wave period.

3.3.2 Saint Marteen,Bangladesh

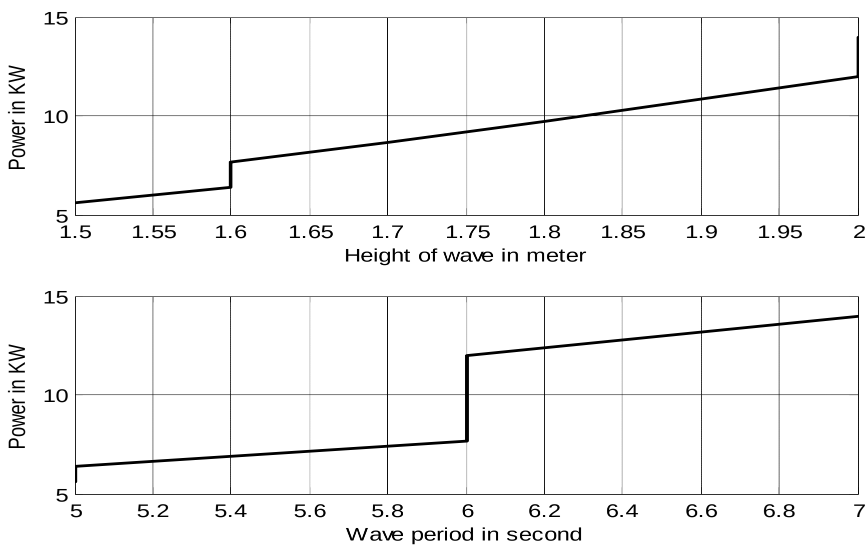


Fig. 5 Power vs wave height and wave period.

3.4 Suitable Wec's For Bangladesh

For onshore power take-off system the suitable one is OWC. The reason behind this as follows:

I) OWC uses Wells Turbine inside of it whose direction of rotation remains same whether the wave propagate in one direction first and then in reverse direction.
II) Produce a high air pressure.
III) Simple construction.
IV) No maintenance required.

For offshore power take-off system the suitable one is Pelamis. The reason behind this as follows:

I) In this type of WEC cyclinderical tube section's movement does not depend on the direction of wave.
II) Less cost required.
III) The Pelamis has a similar output to a modern wind turbine.
IV) Minimum environmental impact.
V) Survivability - 100 year wave.

IV. COST ANALYSIS

It's vitally important that whenever we want to go with some new idea for realistic implementation whether it is cost effective or not. For this purpose before realistic implementation the cost should be analysed truly. In this chapter we will forgo with a sample of 500MW wave farm and then we will design our required one.

4.1 Construction Costs for 500-MW Wave Farm, 2008 [3]

Cost Category	Amount
Onshore transformers and grid	$8,283,50
Cables	$6,130,000
Power conversion modules	$202,701,000
Mooring	$38,089,000
Concrete structures	$77,878,000
Building/facilities	$21,379,000
Installation work	$19,973,000
Total	**$374,433,500**

Source: *ECONorthwest analysis of EPRI data.*

4.2 Cost For Our Proposed 1.5MW Wave Plant

Cost Category	Amount
Pelamis power conversion module	$2,930,000
Pelamis manufactured steel sections	$1,641,000
Pelamis mooring	$4,86,000
Installation	$1,000,000
Subsea cables	$1,635,000
Grid interconnection	$1,90,000
Total cost	**$7,882,000**

V. PROTOTYPE SIMULATION

This section deals about the practical implementation of our research in a little space. All of the step done is as follows.

5.1 Apparatus Used

i. 7.5 foot long wood made box.
ii. Four piece dc motor(each of 6volt)
iii. Four piece small fan.
iv. Wood stand.

v. Multimeter.
vi. Light emitting diode.
vii. Connecting wire.
viii. Single phase induction motor.

5.2 Construction

First of all a 7.5ft long box using wood is made. The dc motors is made water proof by plastic prevailings. Now the four motors are placed in the wood stand perfectly. All the motors are connected in series. After making the wood box water proof by polythyene it is filled with water. And the wave is produced by Single phase induction motor with 220volt ac supply. Now the prototype is ready.

5.3 Working Principle

The wave energy we are discussing about is basically wind generated wave. In our prototype the artificial wind is produced by Single phase induction motor. Whenever this wave flows it acts upon the small fan or blade of the dc motor. As the armature of dc motor is connected with the blade and it starts rotating hence the armature starts to rotate across the magnet prevailing it. That the dc motor acts like a generator and produce voltage.

5.4 Experimental Output

Table 1 Experimental data from the prototype

Sl. no.	1-phase induction motor speed (rpm)	6v motor speed (rpm)	Wave height (m)	Wave period (s)	Voltage output (v)
01	2609	150	0.01	1	0.95
02	3200	225	0.015	1	1.2
03	3608	350	0.02	1	1.5

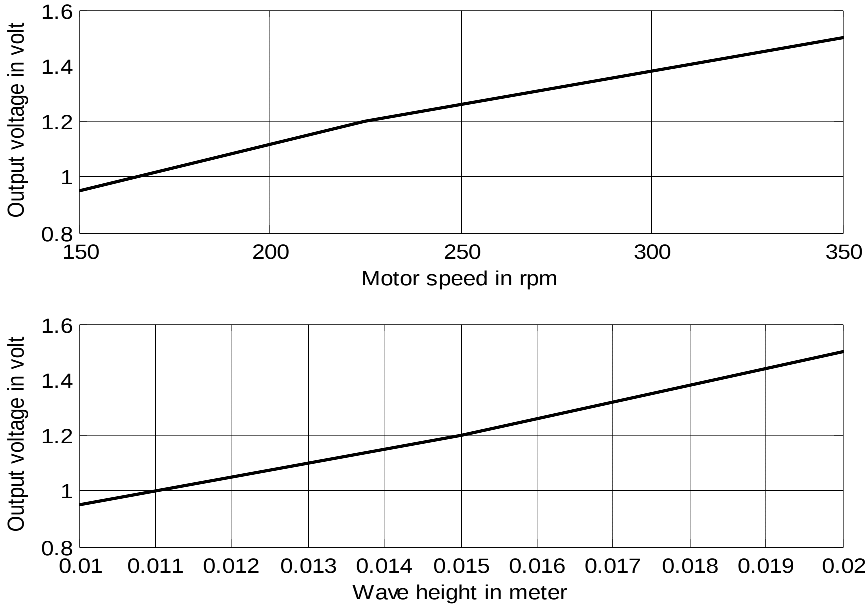


Fig 6 Output voltage vs motor speed and wave height.

We've used four motors(6v rating) in series and the output voltage(1.5v) is enough to glow a LED. From our experiment we can conclude that if we use more motors in series then more voltage will be generated.

VI. CONCLUSION

The wave power plant is suitable for deep water such as sea water. The sea is not confined within a box. But in our prototype we've created wave within a confined region. Hence the wave reflected back, which can't be happened in the sea. At the same time our wave height created was not fair. For this reason we've got less output(only 1.5volt). But it is clear from this research that the output power is proportional to the square of wave height. Our wave height was only 0.02m and output voltage was 1.5volt whereas the wave height in cox'sbazar is 2.8m. So it is no doubt that hopeful result will be get in Cox'sbazar , Saint Marteen.

VII. FUTURE WORK

Future researchers may create animated film based on wave power plant to present a clear view to the society to make a wave power plant & can give proposal to the government with the feasibility study to set a wave power plant.

VIII. ACKNOWLEDGEMENTS

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