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Building Capable Of Producing Its Own Energy

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Abstract : **Conservation of energy states ''energy can neither be created nor can it be destroyed, it can only be transformed from one form to another" and in the end, how much of energy a project saves, is what matters the most, because, more the energy gets saved by a project the more desirable will be the project from socio-economic point of view. With this concept a new building efficient enough to produce and store the required amount of energy from natural source and thus can save upto 100% of energy than other normal building is being proposed. The natural sources considered here are solar energy, wind energy and hydro power. Thus in places where flow of natural waters is a common thing, wind blows very often and trapping the sun light, this building can have its own supply of energy. Assam is one of states in India which fits the first two beautifully, the third one being common. Using this energy the building could produce its own energy and in the end it can distribute the extra stored energy. With this it can earn a profit upto nearly about Rs. 50000000.00 (approx) and so even if its a mass construction it can cope up with its construction fee within few years..**
Keyword:- wind water and solar energy, efficient, self-energised.

1. INTRODUCTION

Science is getting more and more advanced day by day, parallely it is also showing its effect both in good and bad. However, by using the good, the bad effect can be minimized. Here with an idea of this we think of a building that could stand tall among all the building capable of producing its own required electricity that does have any bad effect on the environment and also can cause an economic upliftment of any locality. We use the conservation of energy principle as our guide using which we convert solar, wind and hydro power into electrical energy. Solar power is the conversion of sunlight into electricity directly using photovoltaic (PV) or indirectly using concentrated solar power (CSP).

They use lenses or mirrors as tracking systems to focus a large area of sunlight into small beam. Hydro-power is the power derived from the energy of falling or running water. In the case of falling water, using a trompe compressed air can be produced which then can be piped to drive other machinery at distance. In the case of running water whenever the river is in flood, it is at its most powerful and moves a great amount of sediment. This higher force results in the removal of sediments from the riverbed, causing locally erosion and transport sedimentation downstream.

Again wind power is the conversion of wind energy into useful form of energy such as electricity using wind turbines. In a wind farm hundreds of individual wind turbines are connected to large electrical power transmission power networks. More importantly onshore wind is an inexpensive source of energy

Assam, a state of North-eastern region of India with the mighty river Brahmaputra running through the middle bisecting Assam into upper and lower half. This blessing can be used to generate energy for a building without harming it. As the Brahmaputra exhibits a tidal bore, carries 24 hours flowing water throughout the year, due to pressure difference enormous wind continues to flow. As it is necessary, this building will be located near a shore or the river bank and it can be joined by the water ways and even underwater highway. That would be a good mode for exchange of large amount of goods from different places connected by that water body. Not only in Assam it can be constructed in any suitable location.

Being motivated from the Pearl River Tower that saves upto 60% of energy than normal building we thought of a building that could save upto 100% energy infact it will generate more energy than it requires and can distribute the rest of the energy. In Assam the major source of electricity production is from the water resources. But why only depend on water to produce electricity. Assam is not only blessed with the water resources of Brahmaputra but also environmental factors like the wind and the rays of the sun. Trapping this energy electricity can be developed for a building which would make it energy efficient building. The building will have some aerodynamically design curves with which air would be dragged in and self integrated wind turbine to generate energy from this wind. It will be so placed that even water resources would be easily available to generate energy. Even though three sources of energy is being used, in an environment where three sources of energy are not available we can apply even a single form of energy which is sufficient for a building to generate its energy. But the question that arise is about the economy of the building and as estimated the building is found to be economic The modification to be done on a normal

building so that it can have its own energy and the economy of the building are being discussed in details in the further topics.

The modification and features of the building can be studied under the hollowing head.

a. Location

b. Modification in substructure

c. Modification in superstructure

- Curve of the building
- Walls of the buildings
- Maintaining the environment

d. Energy of the building

e. Economy of the building.

2. CONSTRUCTION OF THE BUILDINGS

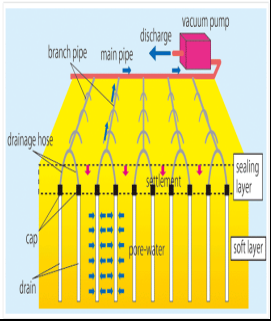
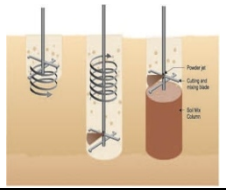
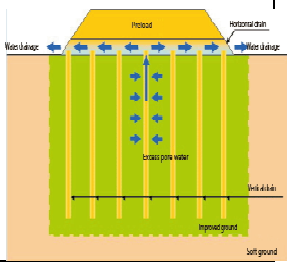
2.1 Location

The basic criterion of this building is to captured the freely formed natural energy and so it should be such located that the energy can be easily captured. In this building the energy that it is going to use are the energy due to free flow of water, energy from the flowing wind which is due to pressure difference and the sunlight would form tremendous amount energy. So the location to get this energy in the most efficient way is near the water bodies where this energy is freely and readily available.

2.2 Modification in the substructure

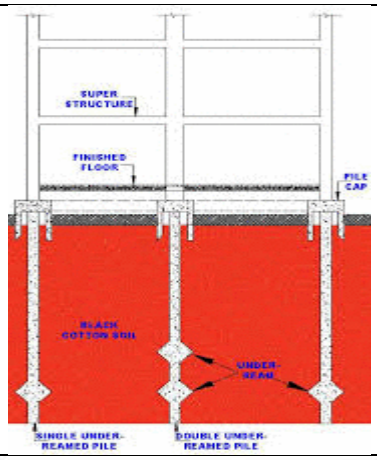
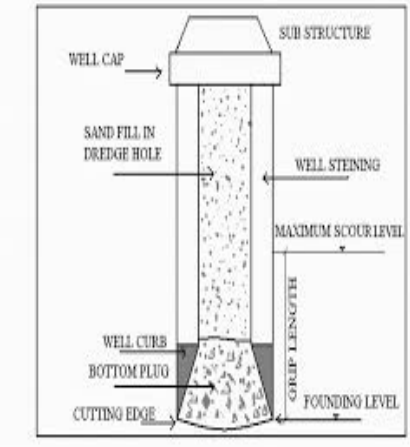
The first and the foremost step in construction is to make it safe economically and so the foundation is the most important part. But the soil near the water bodies are very loose and thus the problem of settlement is much more. To over this the following techniques can be use:-

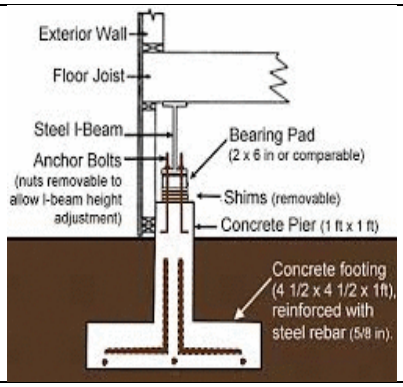
Table 1. Modification On Soil Condition

Techniques	Pictures
Vacuum consolidation where special kind of pipes is inserted to required depth and than by connecting to vacuum the trapped water and air is taken out.	
Deep soil mixing where concrete or lime is inserted by the driller to sufficient depth and make the soil stable by forming cemented columns	
Wick drains can be use which is covered with geo-fabric. As it is inserted to the soil a surcharge is given which pushes the water to the drains and are taken out	

As the soil gets improved the foundation can be used for the building is deep foundation among them
The recommended foundation is shown in table2.

Table 2. Type of Foundation

Type	Pictures
Under reamed Pile (economic)	
Well foundation (uneconomic)	

Adjustable[1] foundation (economic)	

3. MODIFICATION IN THE SUPER-STRUCTURE

3.1 Curve of the building

The curve of the building is being inspired by the aerodynamics of fast cars and the plane where the resistance to the air is teared off along certain direction. The curve of the building is such that as the air passes through it, the curve will push the air inside the corridors in the side which is made in a conical way and as the area inside the corridor reduced the velocity will be increased and this air will strike the turbines fitted within the building and produce the energy(fig1). The area of the corridor will be regulated as the required velocity of air.

In Guwahati the velocity of air is about 5km/hour So by using the continuity equation ($a_1v_1=a_2v_2$) the corridor will be constructed where v_1 is the average velocity, a_1 and a_2 are the area of inlet and outlet respectively which will be constructed as per required velocity v_2.

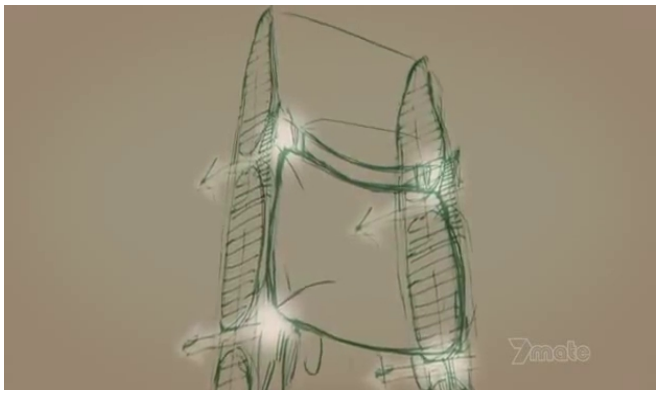


Figure 1. Curve Of A Building

3.2 Walls of the building

The walls of the building would be a double skin glass wall[2] ,which will be installed in such a way that the outer layer will made of low emissivity glass than the inner layer with a gap between both the glasses. This will allow the sun light to enter but the radiation due to the sun would be stopped to a high amount. As the temperature is about 30-40 ^{0}c in Assam, this could allow a comfortable environment for working. The glass should be checked for the worst condition of environment and than installed. This technique has been so far used in many buildings in Europe ,China etc.

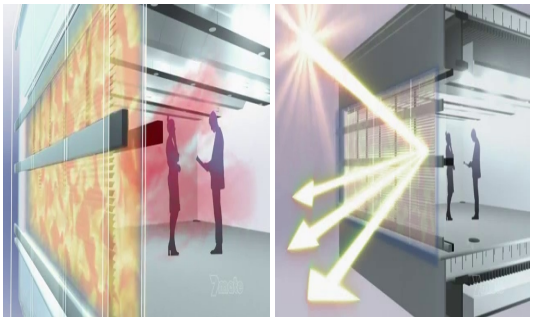


Figure 2. Working Of Double Walled Glass

3.3 Maintaining the environment.

As discussed earlier the environment is maintained by the doubled skinned glass [4] .But since it would not be sufficient to maintain the temperature so an additional technique is can be use known as chilled radiant ceiling. In this technique as the person is in the room, the heat of the body is exchanged with the cool of the ceiling and maintains a satisfactory environment just like working in an air conditioned room as shown in fig 3. But if humid air enters the room it will make the air condensed and water will fall like the rain drops. So it has to be tested before it is installed in the building.

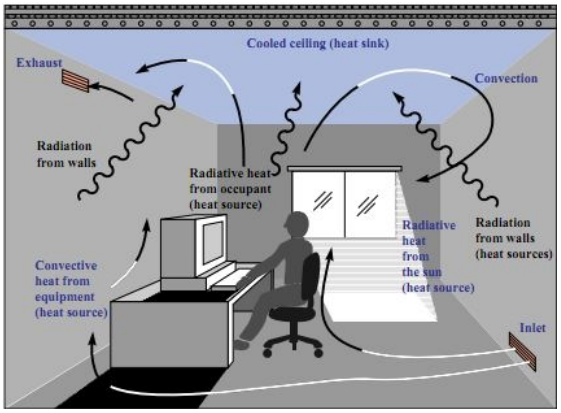


Figure 3. Working Of Cool Radient Ceiling

Further the regulation of the air becomes an important part of the building. As in normal building the air enter through the ventilators and are pushed down the fan which requires the energy. But in this building the air will pass through a vent and as air is buoyant it will rise up in the breathing zone. And due to this technique the air is just circulated once and remains pure but in normal building air is circulated 4 to 5 times and gets contaminated.

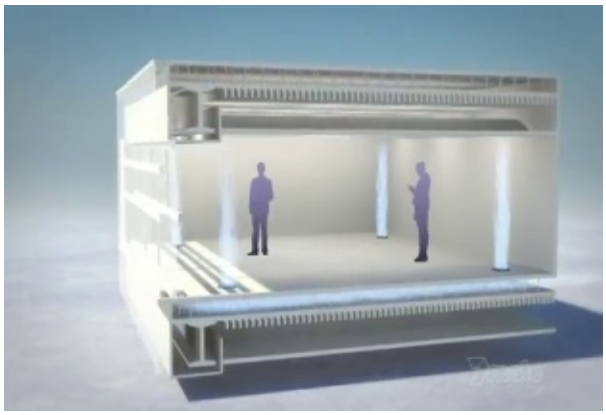


Figure 4. Working Of Vent

4. ENERGY OF THE BUILDING

There are mainly 3 main sources of energy

- Wind energy
- Water energy
- Solar energy

4.1 Wind energy

This building will have an integrated turbine at required height. Since due to large pressure difference the velocity of air in Assam is about 5 km/hour and using aerodynamics wind tunnel the velocity can be increased upto 3 times i.e. 15 km/ hour

By using the continuity equation $a_1v_1=a_2v_2$

Where, v_1 is the average velocity,

v_2 is the required velocity

a_1 and a_2 are the area of inlet and outlet respectively which will be constructed as required.

Table 3 shows the velocity profile of the river Brahmaputra for the last 10 years at different places

Table 3. Wind Velocity Profile Of River Brahmaputra

Place	Velocity(km/hour)	Direction
Guwahati	5	S-W
Dibrugarh	6	S-W
Jorhat	6	S-W
Goalpara	4	N-E

This velocity after amplification gives the required energy. In such case, vertical turbines can be used because it will rotate no matter direction and turbulence of the air.

Thus the electricity produced can be estimated by the following formula

[3]Power(watts) = 0.5 * (swept area) * (density of air) * (velocity of air)

Where the density is constant, velocity can be obtained and thus to obtain required energy turbines can be designed with required swept area.

Let us take swept area of $2000cm^2$
Density 0.002gm/cm3
Velocity=200cm/sec
Power = 0.5*2000*0.002*200=200 watt per sec

Again as the wind energy is being tested and the pressure is being seen in different floors and the result were satisfactory as shown in fig 5.

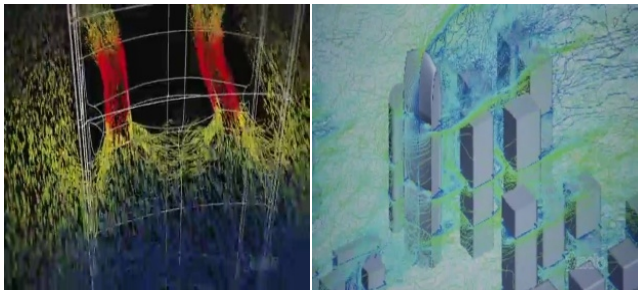


Figure 5. Wind Pressure At Different Floors Of The Building

4.2 Water energy

The next source of energy would be from the water. As the building would be located in near the water bodies it will have a sufficient amount of water. In a hydro electric pump, a flow rate of 15 liters per sec and at a head of 15 m will generate 1kw of energy sufficient for a general use of a house. Brahmaputra river has a flow rate of 78,726 liters per sec and even if half of the flow rate is used even than also it can produce sufficient energy for a building. We can use this kinetic energy of the river and make it strike it to a turbine to produce electricity same as wind turbine and as it is never ending flow energy thus created will also be never ending.

Amount of power can be calculated with the formula [4]

P=head*flow*62.4*0.746/(550*efficiency factor)

Here, p=power in kW

Head =52 meters=170.56ft

Flow=15l/sec=0.0492ft/sec

Efficiency factor= 0.5

Power(p)=170.56*0.0492*62.4*0.746/550*0.5

=1.4 kW

4.3 Solar energy

The solar energy i.e. energy form the sun is the most abundant in this nature. The sun emits $3.7*10^{20}$ MW of energy in the form of electromagnetic radiation out of which the earth receives about $1.8 *10^{11}$ MW. The energy obtain form PV solar panel depends on the duration of time exposed to the sunlight, efficiency of solar panel and total

area of solar panel. It can be calculated by using the following equation

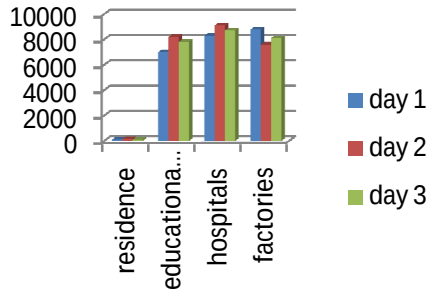
P=A*r*H*PR, where
A=total solar panel area (m^2) =1000m^2(assumed)
r=yield of solar panel (%) = 0.2
H=annual average solar radiatiation=5kWh/m^2/day
PR=performance ratio (constant=0.75)
Therefore power=1000*5*0.2*0.75/3600=0.2kW/s

Thus by using this modification in a normal building we can make it use free energy form the nature to generate its own energy. The energy calculated with the three sources are about 1.8kW per sec sufficient for a building. But the enviroment cannot be the same always and moreover there would be losses in installing the system subtracting more than half of the energy produced we take total energy per sec =0.5 kW

5. ECONOMY OF THE BUILDING

The building could be made to stand but the economic condition may not be satisfied. But as estimate is done for the economic state we get the following result.

Energy per second 0.5kW
Energy per day = 0.5*24*3600=43200kW
General energy consumed per with all the necessary equipments 9100kW (max) per day
Let us assume energy consumed =13200kW
Energy saved=30000kW
Rate per unit= Rs. 5.75
Money saved per day= 30000*5.75= Rs 172500
Monthly saving= Rs. 172500*30=Rs5175000.00
Yearly saving= Rs. 5175000*12= Rs. 62100000.00
Money used for maintenance=Rs 12100000.00
Therefore annual income= **Rs. 50000000.00**



Φιγυρε 6. Γραπη οφ ενεργψ χονσυμπτιον οφ διφφερεντ βυιλδινγ φορ τηρεε δαψσ.

Further as there is no connection of central AC so the thickness of the floor can be reduced. This in turn will reduce the use of cement and extra space would be left for further development.

6. ADVANTAGE OF THE MODIFICATION

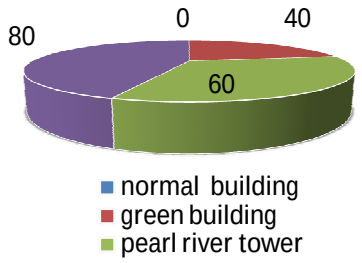
The advantage of this modification to a normal can be best studied under the following head

- **Economy of the building**

As calculated earlier the annual save of the building is about Rs. 50000000.00 the figure itself says about the economic condition of the building. Further not only in the building it can supply energy to the locality which can even turn more economic.
Further as there would be less mechanical equipments between the floors there is the save of concrete and reinforcement and in turn installation cost is reduced.

- **Energy efficiency**

As calculated the energy save by this building is 100% theoretically. And not only saves it distributes is stored energy that makes it even more efficient one. When compared with the other energy efficient building and by deducting 20% of efficiency of this building due to loss in the system because of environmental condition, losses in piles, head loss of water, maintenance cost, etc, when calculated we get the following graph and result as shown in fig 7.



Φιγυρε 7. Πιε διαγραμ σηοωινγ ενεργψ σαωε βψ διφφερεντ τψπεσ οφ ενεργψ εφφιχιεντ βυιλδινγ

- **Environmental issue**

One of the major advantages of this building is that it uses the environment to its full but does not destroy it. Infact as for its construction the bank of the river would protected against erosion and settlement which will help in conservation of nature.

Moreover as the building is not using artificial air condition system (AC), the emission of chlorofluorocarbon (CFC) is reduced which would reduce the depletion of the ozone layer and green house effect would be reduced.

- **Health and comfort of the people**

This building maintains a comfortable environment and also maintains the health of the people more efficiently than the others building.

The cool radiant ceiling [5] would help to maintain the normal physical environment of the body of the people in the building. Further one of the major advantages is that as vent system of air circulation would be used it would use the air only once and then in turn would decrease the rate of air borne disease as it would not be contaminated with frequent circulation.

- **Miscellaneous advantage**

As it would be directly exposed to the flowing wind, there is a chance of sway of the building due to pressure difference between the opposite side of the building. This could be overcome using the principle of aerodynamics structure. The wind tunnel, it would act as pressure releaser and the sway would not be a factor.

As it would be located near the water bodies it would have a nice scenario to view and that could attract tourist .As it would be located somewhat outskirt of the main central locality the congestion of traffic would be reduced to a significant amount

6. FUTURE DEVELOPMENT SCOPE

The building so modified would not be completed here. It have vast scope of future modification that could make it even more advance than the other buildings. Few of the modification are discussed below.

- As this building is located near the water bodies it can be joined by water ways and even under water highways[6] which in turn will reduce the fuel consumption , traffic volume etc. As an example, in the journey from Guwahati to Dibrugarh by road is 345 km but if it is connected by underwater highway it is of about 150 km. Therefore net approx of 250 km saved
  Cost of petrol per liter = Rs. 73.5
  Cost of diesel per liters = Rs.60. 62
  Mileage of a truck = 5 km/l
  Therefore liters of petrol required= 250/5=50 l
  Cost saved = Rs. 50* 60.62 = Rs. 3031 per truck.
  On calculating the traffic volume we have no. O truck on average =75 trucks per day
  Therefore per day save= Rs. 75*3031 = Rs. 227325
- As it would be located near a river we could have a oxbow lake or avulsion near the building. This can be re module to make some extra models. For example the water reservoir could be constructed to form avulsion, where the cost of excavation is reduces to a significant amount as it already excavated to a certain depth by the river.
- The waste of the building could be dumped in the module of avulsion and from there biogas can be produced.

7. CONCLUSION

Thus we can conclude that, the modification proposed to a building helps to produce its own energy by capturing the free energy from the nature with minimal pollution to the nature. The initial cost may seemed to be uneconomic but in long term, the project is economic and within few years the initial cost would be covered and hereafter it would have profit.

8. ACKNOWLEDGEMENT

We take the privilege to express our sincere and heartfelt gratitude to the International company Mott Mcdonald (Ghy branch) Assam Meteorological Department, Brahmaputra Board of Assam, for their co-operation and valuable guidance, constant encouragement and constructive criticism.

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