Outline examination about the control possibility caused by the wind for the VLSI (1)

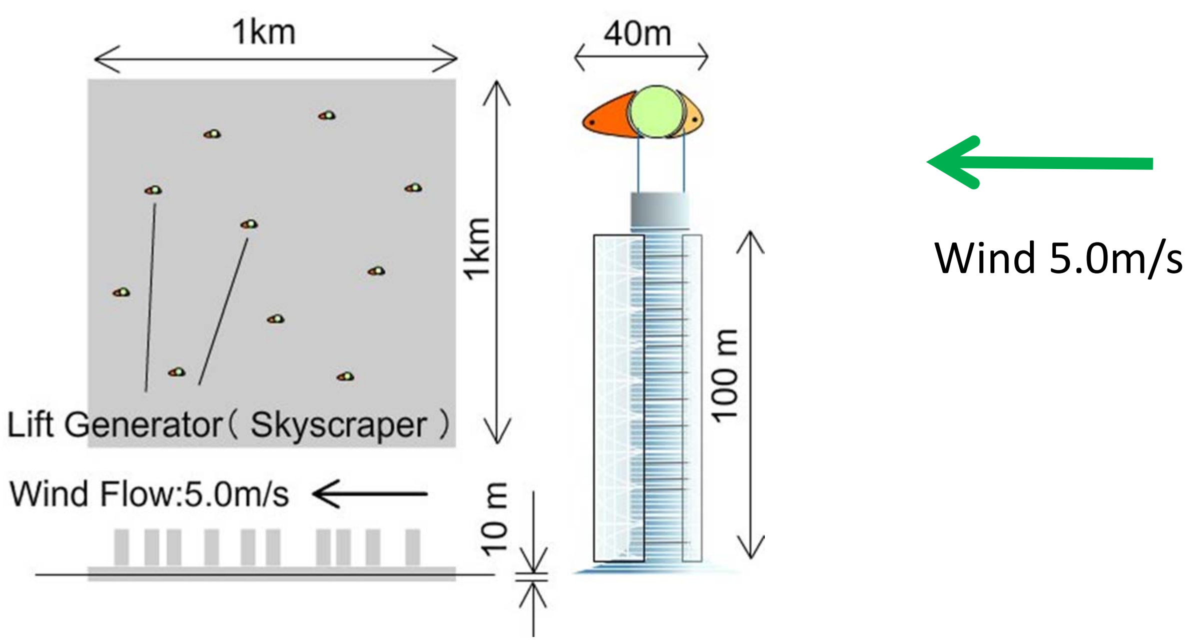
The following conditions are necessary about the positioning of the VLSI in the Ocean Republic concept.

1) VLSI can go around the ocean such as the Pacific, the Atlantic, the Indian Ocean along an ocean current clockwise or counterclockwise.

2) VLSI can avoid the obstacles of a typhoon, a reef, the island by using lift generator (skyscraper).

I want to check 2) here.

Here is a VLSI the length of which is 1km in length. VLSI receives wind of 5m/s (from the right direction of the chart below) from the front. I want to calculate how far in distance this VLSI can move to the upwards (in this figure) direction in a day. There are ten lift generator (skyscraper) in total on the VLSI. (the aspect ratio in vertical and horizontal for the scale in figures is same)



Length of the VLSI : 1km
Depth under the sea surface of the VLSI : 10m
Height of lift generator : 100m
Width of lift generator : 40m
Number of VLSI : 10
Speed of the wind : 5.0 m/s

Lift force of the aero foil wing can be calculated by using the following form. We think that the wind works ideally. Here L is the lift force of a lift generator (skyscraper)

$$L = \frac{1}{2} \rho_a V_w^2 S_L C_L \quad \cdots (1)$$

L: Lift (Infinite)

ρ_a: Density of air(1.3 kg/m³)

V_w: Speed of wind (5 m/s)

S_L: Area of a Wing (40m x 100m =4000m²)

C_L: Coefficient of lift (0.6)

We can get the force as 39000 kg.m/s² each lift generator (skyscraper)
So, if there is 10 lift generator, it will be 390000 kg.m/s². So this force push the VLSI upwards in the figure.

On the other hand, the force by sea water facing the front of the VLSI is calculated by the following form.

$$D_1 = \frac{1}{2} \rho_w V_v^2 S_{v1} C_x \cdots (2)$$

D_1: Sea water resistance to the downwards in the figure.

ρ_w: Density of sea water(1025 kg/m³)

V_v: Velocity of the VLSI (Infinite)

S_{v1}: Area of the front of VLSI (10m x 1000m =10000m²)

C_x: Coefficient of resistance (1.5 : Flat plate)

And there is friction between VLSI and sea water. The friction force is calculated by the following formula. The amount of D_1,D_2 is same with the force of total lift force of the 10 lift generator (skyscraper)

$$D_2 = \frac{1}{2} \rho_w V_v^2 S_{v2} C_f \quad \cdots (3)$$

D_2: Friction force with sea water

ρ_w: Density of sea water (1025 kg / m³)

V_v: Velocity of VLSI (Infinite)

S_{v2}: Bottom area of the VLSI (1000000m²)

C_f: Coefficient of friction of sea water (1.492 x 10^{-3} , see next page)

(3)C_f in formula (3) was calculated by the following Hughes' formula.

$$C_f = 0.066 \left(-2.03 + \log_{10} R_n \right)^{-2} \quad \cdots(4)$$

$$R_n = \frac{VL}{\nu} \quad \cdots(5)$$

V: 0.5 m / s（Assumed）
L: 1000 m
ν: 1.054 x 10^{-6} m^2/sec

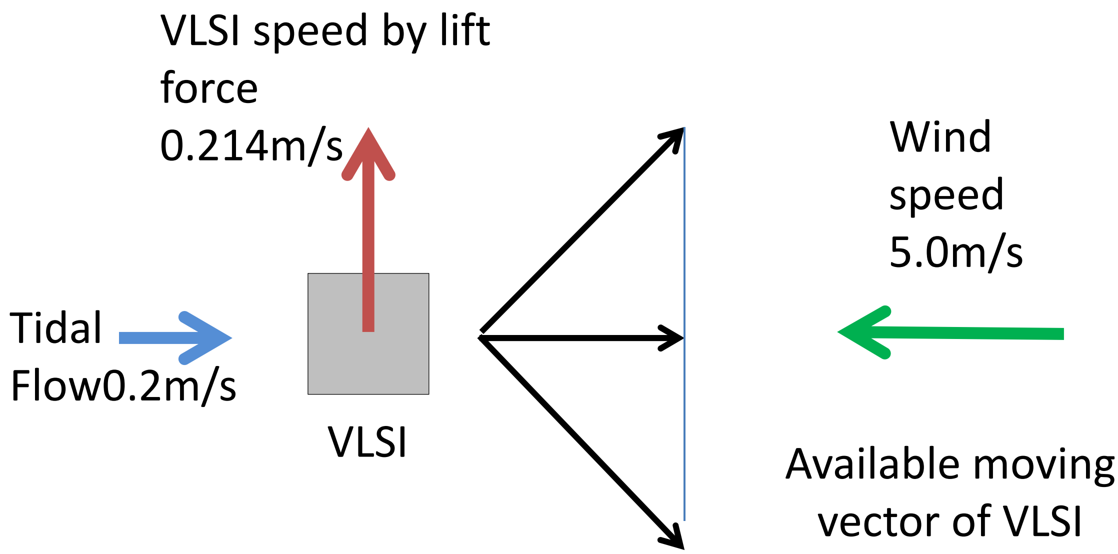
From (1),(2) and (3) , we can get **Vv** by using the following formula.
The value L (1) multiplied by 10 (390000 kg.m/s^2) is equal to the sum of D1 and D2.

$$10 \times L = D_1 + D_2 = \frac{1}{2} \rho_w V_v^2 S_{v1} C_x + \frac{1}{2} \rho_w V_v^2 S_{v2} C_f \quad \cdots(6)$$

We can get **Vv** by solving the above formula, and the value is **Vv** = 0.214 m/s
So, the shift distance of a VLSI per day is

$$0.214\text{m/s} \times 3600\text{sec.} \times 24\text{h} = 18.5\text{km} \quad \cdots(7)$$

So, it is 18.5km In distance which a VLSI can shift in a day and avoid collision between VLSI and some kind of obstacle.
How fast is it about the tidal flow in Pacific ocean or in Atlantic ocean.?
It is about 0.25 m/s to 0.50 m/ s by “The Handbook of Ocean Developing” published by Asakura shoten. The speed of VLSI can not exceed this value. So, if there is a VLSI moving at the speed of 0.20 m/s with the balance of each force of air and water flow, a VLSI can move and be controlled about 45 degrees' direction from a line of the direction of the VLSI.



In actual, how strong the wind blows in Pacific ocean or Atlantic ocean.?
The following is the data of JAMSTEC.

http://www.jamstec.go.jp/frcgc/jp/publications/news/no24/jp/04p.html

By the link data above, there is wind flow about over 5m/s constantly. So, the controllable area is more than the result of above calculation.

Reference:
1) The Handbook of Ship Designing (Association of Kansai Shipbuilders , 1981)
2) The Handbook of Ocean Developing (Asakura Shoten, 1975)