Wave Absorbing System to Reduce the Impact of Tsunami

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Abstract

We confirmed that the existence of the stream opposite to the surface wave in the bottom of the sea and expect that if we stop the stream, the impact of tsunami decrease. We reproduced tsunami and found that the obstacle on the seabed reduce the impact of tsunami. In addition, we researched about the change of tsunami's energy

１． Introduction

The motive of our research is the huge earthquake which hit the Tohoku Area in Japan in 2011. A lot of people were killed by the tsunami. This happened because the dike could not stop the tsunami completely. We thought that dikes could not stop big waves and would spoil the scenery, so we considered a different way to save ourselves from tsunami`s impacts. The goal of our research is to propose a new way to reduce the damage of a tsunami by using the properties of a tsunami.

２． Hypothesis

From preceding studies and our experiments, we knew that there is a stream in the bottom of the sea, and the direction of the stream is opposite to that of the surface wave. We believe that if we stop the stream in the bottom of the sea, we can decrease the damage of tsunami.

３－１ . Experiment

We put oil colors on the bottom of a device for the sea at three points, then caused a tsunami, and observed the motion of the oil colors. We checked the existence and direction of the stream in the bottom of the sea caused by the tsunami.

picture 1

３－２． Result

The oil colors flew the opposite direction when the tsunami went through the point where we put oil colors. Therefore, we could observe the stream in the bottom of the sea. (picture 1)

３－３． Conclusion

The movement of water and change of pressure in the bottom of the sea caused the stream. We thought there were some relations between the stream in the bottom of the sea and the surface stream. We believe if we stop the stream in the bottom of the sea, we

can decrease the damage caused by tsunami.

4－1．Method

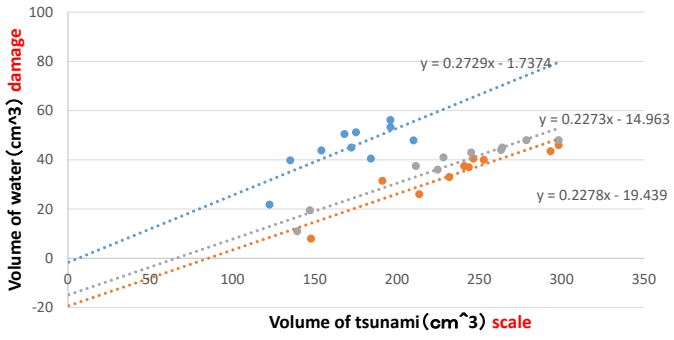
In order to prove this hypothesis, we reproduced a tsunami using a device we made and observed it. In this experiment, we used two obstacles in different shapes: two cubes and a rectangular parallelepiped. (picture 2) We put one of the obstacles on the bottom of the sea, made a tsunami, then measured the volume of water. In this experiment, we measured the volume ten times for each obstacle and ten times for when we did not put any obstacle.

▲rectangular parallelepiped obstacle　　▲cube obstacles

picture 2

4－2．Result 1

According to graph 1, the larger the tsunami was, the larger the amount of water that spilt from the device was. The amount of spilt water was smaller when we put obstacles than when we did not put any obstacle. And when we put a rectangular parallelepiped obstacle, the amount of spilt water was smallest.



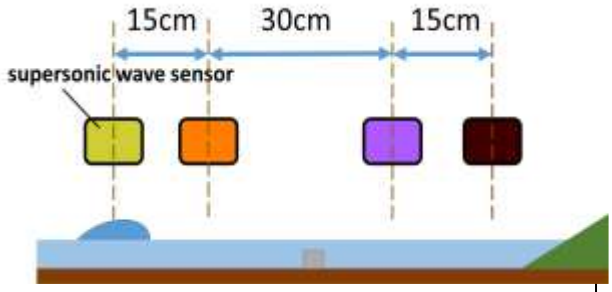
graph 1

4－3．Discussion 1

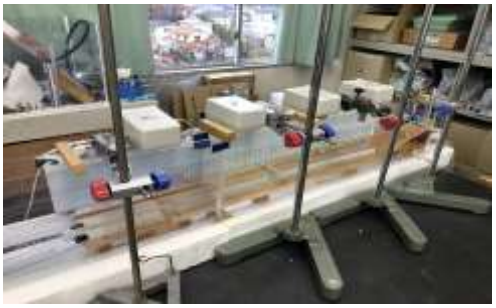
Obstacles set at the bottom of the sea can reduce the impact of tsunami. How large an impact obstacles reduce depends on their shape.

5－1．Experiment 2

We tried to find out how obstacles affect tsunamis by measuring the speed, volume and height of tsunami. In these experiments, we used only a rectangular parallelepiped shaped obstacle.

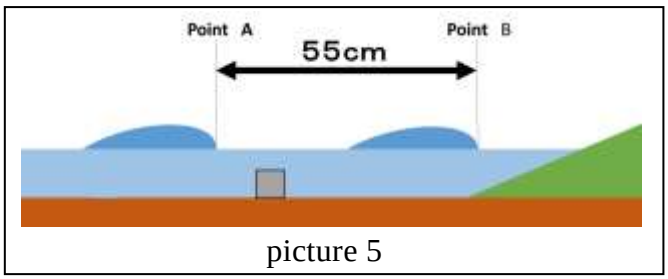


picture 3



picture 4

５－２．Method 2-A



picture 5

We measured the speed of the tsunami by using supersonic wave sensors which measured the distance from themselves to the surface of water. We set four sensors on the device (picture 3, 4), and measured the change of water level while the tsunami was passing under these sensors. Then we calculated its speed.

５－３．Method 2-B

We measured the volume and height of the tsunami at two points (picture 5) by taking photos, and calculated their decreasing rates.

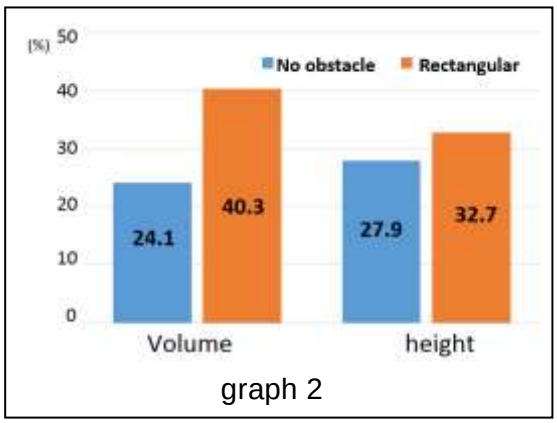
５－４．Result1 A

We put four sensors at the 1.50*10^-1, 3.00*10-1, and 1.50*10^-1s intervals. The tsunami ran through those area at a speed of 7.98*10^-1, 8.08*^10-1, and 7.98*10^-1m, so the speed of the tsunami was 7.98*10^-1, 8.08*10^-1, 7.98*10^-1m/s. According to this result, the obstacle does not change the tsunami's speed.

５－５．Result2-B

According to graph 2, the decreasing rates of the tsunami's volume and height were higher when we put the obstacle.

This result means that the obstacle decreases the tsunami's volume and height.



graph 2

５－６．Discuss2

The obstacle does not change speed. However, it decreases the tsunami's volume and height.

This means the cause of the decrease of the tsunami in Experiment 1 was the decrease in volume and height.

６－１．Experiment4　Method

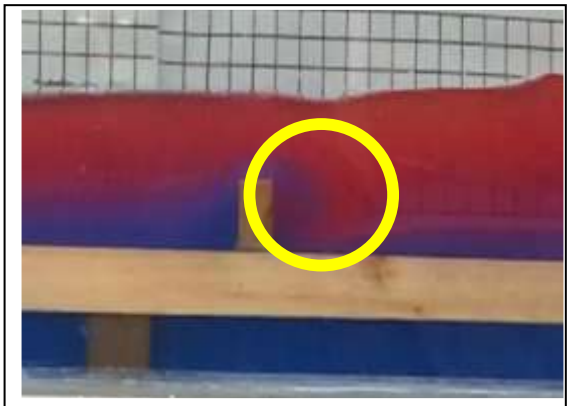
We changed the concentration of salt of a solution, and colored it red or blue. We poured it to make layers of colored solution into the device. Then, we observed the look of the tsunami we made and considered the decrease of volume and height of the tsunami.

６－２．Result

The tsunami made a vortex before it passed over the structure. We believe that the change of the flow's direction generated the vortex, and then the damage decreased. Our

original hypothesis was that the structure would decrease the damage of the tsunami by affecting the flow in the bottom of the sea. However, according to our experiments, we can see that the structure affects the flow on the surface of the sea.

６－３．Conclusion



picture 6

The obstacle we put in the bottom of the sea reduces the damage of the tsunami. After changed, the obstacle's shape, the amount that volume and height decreased. The obstacle cannot change the speed of a tsunami, but it can reduce some of the energy of the tsunami partly because of the vortex which occurs when tsunami flows above the structure. In general, a vortex consumes energy. A vortex changes the direction of flow for a tsunami, and these flows hit and offset with each other. Therefore, obstacles reduce the damage of a tsunami. In conclusion, we suggest that we put some obstacles which make many vortexes in the bottom of the sea before tsunamis happen and come to land. The more vortexes an obstacle makes, the weaker the tsunami become. The number of structures we should put in the bottom of the sea will depend on the structure's shape, and the number of vortexes that are generated by it.

７．References

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Forum8. 「12th Tsunami wo shiru 」

８．Key words

Tsunami energy vortex