THE HYDRAULIC EXPERIMENTAL STUDY ON TSUNAMI FORCES AGAINST STRUCTURES

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1. Introduction.

Asian tsunami 2004 occurred and caused very terrible damage to many countries. However, this gigantic disaster left many valuable phenomena to be able to more understand about this tsunami itself. A recorded video from Patong beach, Phuket, Thailand showed a phenomena of the decrease of tsunami wave when hit a big and firm enough building. From this video we could understand that the existence of big and strong structures along coastline would be very useful to the people as shelter or also as resistant to decrease the wave force in the back. In the past, there were some proposed method to evaluate the tsunami force on structures, but it is still hard to find the researches which are focused to investigate the tsunami characteristic to the group of building. For those reason, the hydraulic experiment on tsunami forces against structure have done to find out the phenomena of wave's decrease and it's characteristic due the group of building.

2. The experimental procedures.

The experimental setting and the conception of model arrangement are shown in Fig.1 and 2 respectively. Measurement of wave force acting on model used the force gage and measuring the wave profile and also inundation depth in the front face of model used the wave gage. The incident wave was generated by wave maker paddle. Due to the non linear effect, the wave was amplified when entering the sloppily area to be very steep and breaks down on shallow water area, overflows the shoreline and inundates the land.

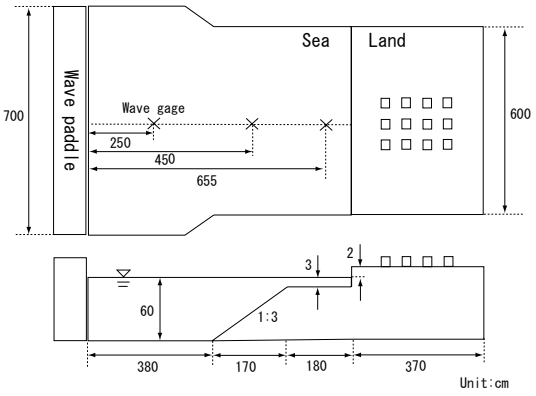

Fig.1.The experimental setting

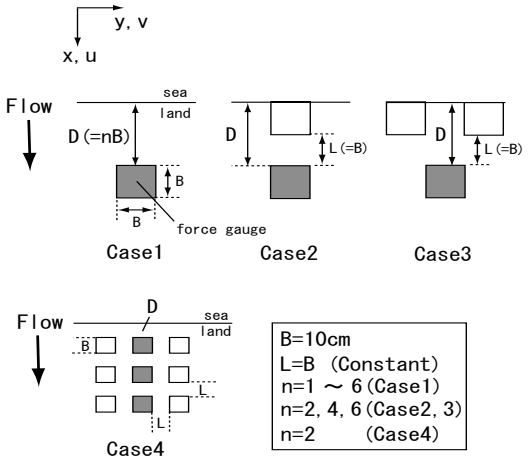

Fig.2.The arrangement of models

3. The experimental result

The effect of model arrangement to decrease the wave force for six cases is shown in Fig.3. From that graphical result we could understand that the placement of resistant exactly in front for certain distances would decrease the wave force larger than the diagonally in front to right and left side of measured model. However the result of Case 3 gave an understanding that the

interval of distance between resistant and measured model would cause the very different result to wave force. For Case 3, after hitting resistant model the waves was split into two main flows, but on certain distance before measured model the wave recover its form, concentrate to the middle and hit the model with more significant of velocity and volume of water. From these phenomena, we could understand that the placement of building are not only consider the need of resistant model and the distance from shoreline but also to have to consider the wave direction and the distance between the resistant and measured model.

4. The determination of wave force as hydrostatic pressure assumption.

According this assumption, we could assume the wave force by using the maximum wave pressure and by integrating it to width of the model. The horizontal wave force equation could be expressed to obtain the wave force. In this case, it just needs inundation depths value. The comparison result between the estimation and measured value is shown in Fig.5. The estimated result is overestimate in most of position than measured result. Even though, using this assumption could not give good agreement to determine the wave force but it might be adaptable for structural design formula in tsunami mitigation.

5. Numerical simulation

In this experiment used he shallow water equation, where the staggered finite difference leap frog scheme is used to solve governing equation and finite difference formula is used for numerical calculation. The mesh size and time-step size were fixed, $\Delta x = \Delta y = 0.01m$ and $\Delta t = 0.001s$

The comparative result of calculated and measured result is shown in Fig.5. The calculate result for all cases have underestimate result to measured result. This is caused by the accuracy of calculation to reproduce the wave inland area was poor, including the limit capacity of shallow water equation it self. The assumption as hydrostatic force also was not adequate to simulate the form of wave as surge force.

6. Conclusion.

The effect of resistant model and the way to place them to reduce the wave force could be grasped.

The use of some assumption and simulation determine the wave force, even though mostly giving overestimate result however for some extent might be adaptable for structural design formula.

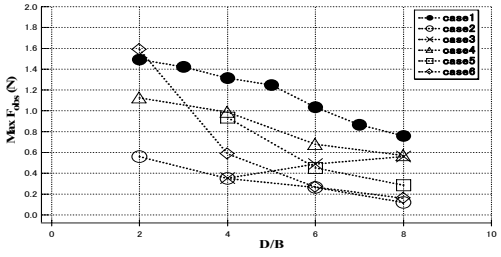

Fig.3.The result from laboratory observation

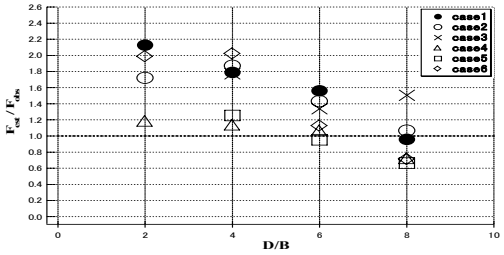

Fig.4. Comparison of estimated and observed forces.

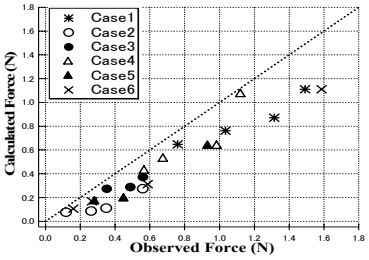

Fig.5. Comparison of calculated and observed forces.

References: Asakura et al: An experimental study on wave force acting on onshore structures due to overflowing. Proceeding of coastal engineering, JSCE Vol.47 (2) 2000 page 911-915.