

A DESIGN METHOD OF THE SEA WALL AND WATER APRON BY THE TSUNAMI

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INTRODUCTION

Many of the coastal conservation facilities of the fishing port were severely damaged by the wave force of the 2011 Tohoku earthquake tsunami. We evaluated the tsunami wave force by conventional hydrostatic pressure for the sea wall of the fishing port. In addition, we considered the acting force and the acting range for the water apron of the sea wall during tsunami overflow, and presented a reasonable design of the sea wall.

The tsunami wave force for the sea wall is not sufficiently examine by the seabed gradient, the position of structure and the back slope of the sea wall. Facility name of the fishing port is shown in figure 1.

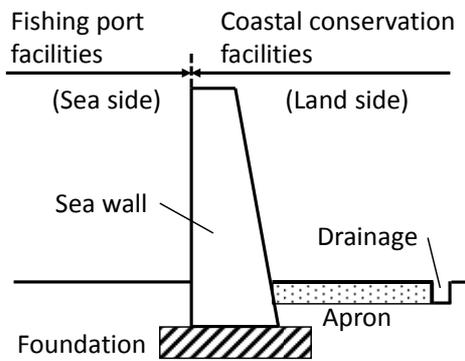


Figure 1 Facility name of the fishing port

$$\frac{P_{max}}{\rho g \eta_{max}} = \alpha \left(1 - \frac{Z}{\alpha' \eta_{max}} \right), \quad 0 \leq \frac{Z}{\eta_{max}} \leq \alpha' \quad (1)$$

$$\alpha = 1.0 + 1.35 F_r^2, \quad \alpha' = \max\{3, \alpha\}$$

Where Z is the wave acting height form ground, η_{max} is the traveling wave of tsunami, g is the acceleration due to gravity, ρ is the density of sea water.

If F_r is unknown, use to the flow depth at shore line as η_{max} , $\alpha=2.2$ and $\alpha'=3.0$.

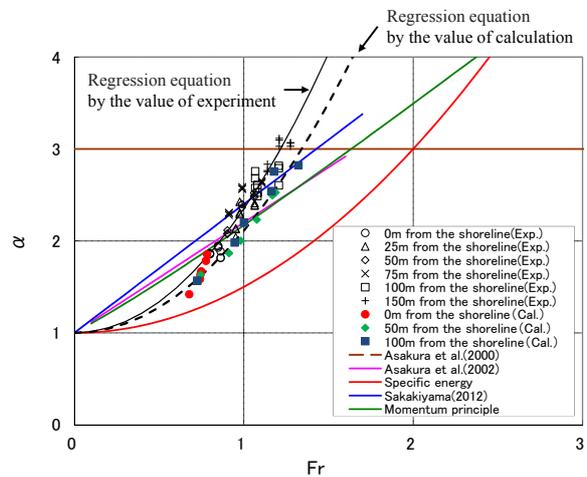


Figure 3 Relation F_r and α

EXPERIMENT AND SIMULATION

In this study, we evaluated the acting force and the acting range of tsunami using by the hydraulic experiment and the numerical simulation model (CADMAS-SURF/2D), and presented the estimation formulas of their.

WAVE PRESSURE FOR THE SEA WALL

For the wave force by the non-overflow of tsunami (see figure 2), figure 3 is shown the relationship between Froude number F_r and the dimensionless wave pressure coefficient α and α' . Equations 1 is the calculation formulas for the wave pressure P_{max} .

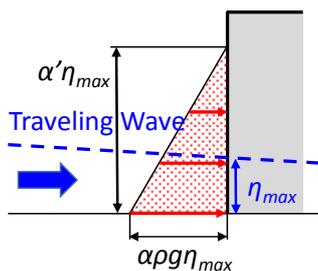


Figure 2 wave force of tsunami for structure

TSUNAMI ACTING TO WATER APRON

For the wave force by the overflow of tsunami (see figure 4), figure 5 is shown the relationship between the overflow water depth of upstream h_{up} and the maximum pressure for wave apron P_{Vmax} , figure 6 is shown the relationship between h_{up} and the acting range L .

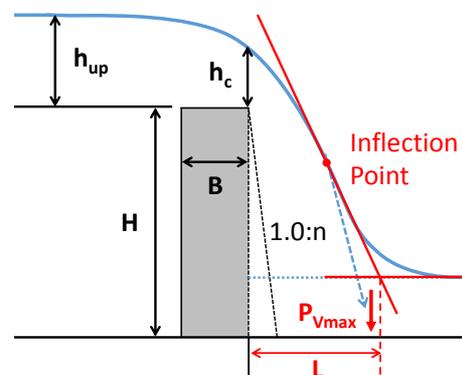


Figure 4 wave force of tsunami for apron

$$P_{Vmax} = 1.41\rho gH \left(\frac{h_{up}}{H}\right)^{0.72} \quad (2)$$

$$L = 1.85H \left(\frac{h_{up}}{H}\right)^{0.69} \quad \text{for } 0 < h_{up}/H < 1 \quad (3)$$

$$L = 1.85h_{up} \quad \text{for } 1 < h_{up}/H < 2.5 \quad (4)$$

Where H is the height of sea wall. The calculation example is shown in figure 7.

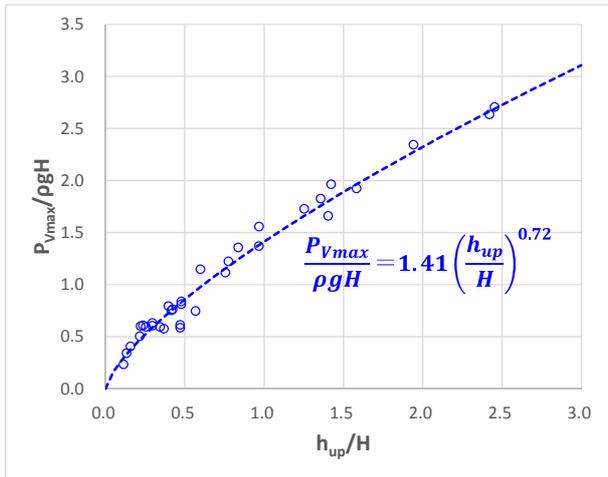


Figure 5 Relation h_{up}/H and P_{Vmax}

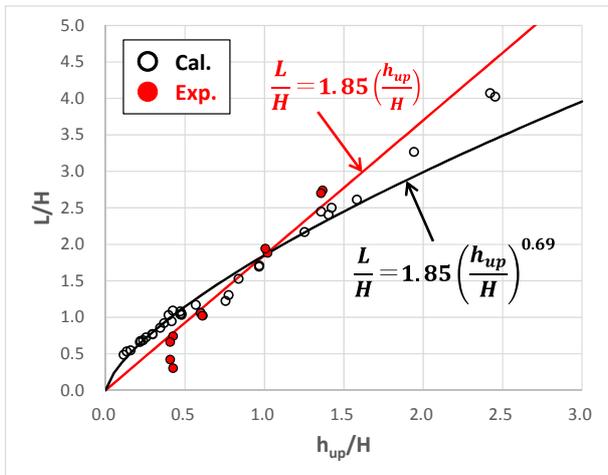


Figure 6 Relation h_{up}/H and L

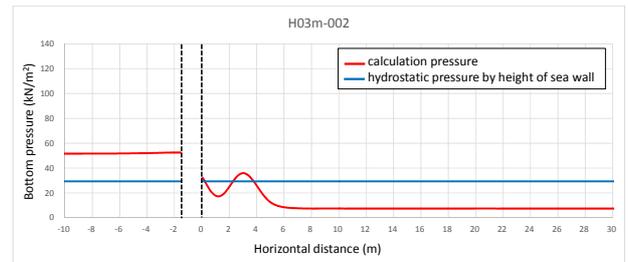
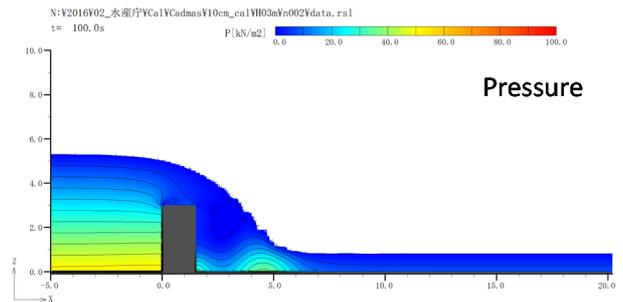
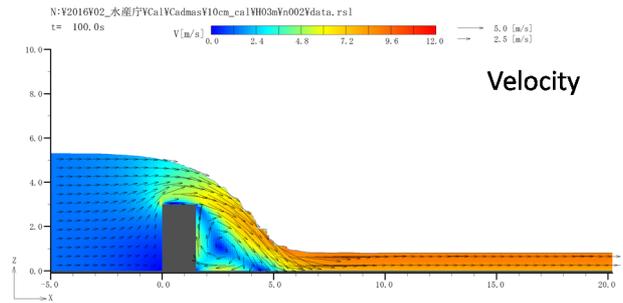


Figure 7 Calculation result example
($H=3.0\text{m}$, $h_c=1.56\text{m}$, $r=0$)

CONCLUSIONS

From these results, it is possible to calculate the acting tsunami force and the acting range for the sea wall, and the sea wall was designed efficiently by Tsunami attack.

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