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

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outline

1. Intoroduction

2. A design method of the sea wall
   1. Case of Tsunami non-overflow
   2. Case of Tsunami overflow

3. A design method of water apron
   1. Overflowing bottom pressure
   2. Working length of water apron

4. Conclusion

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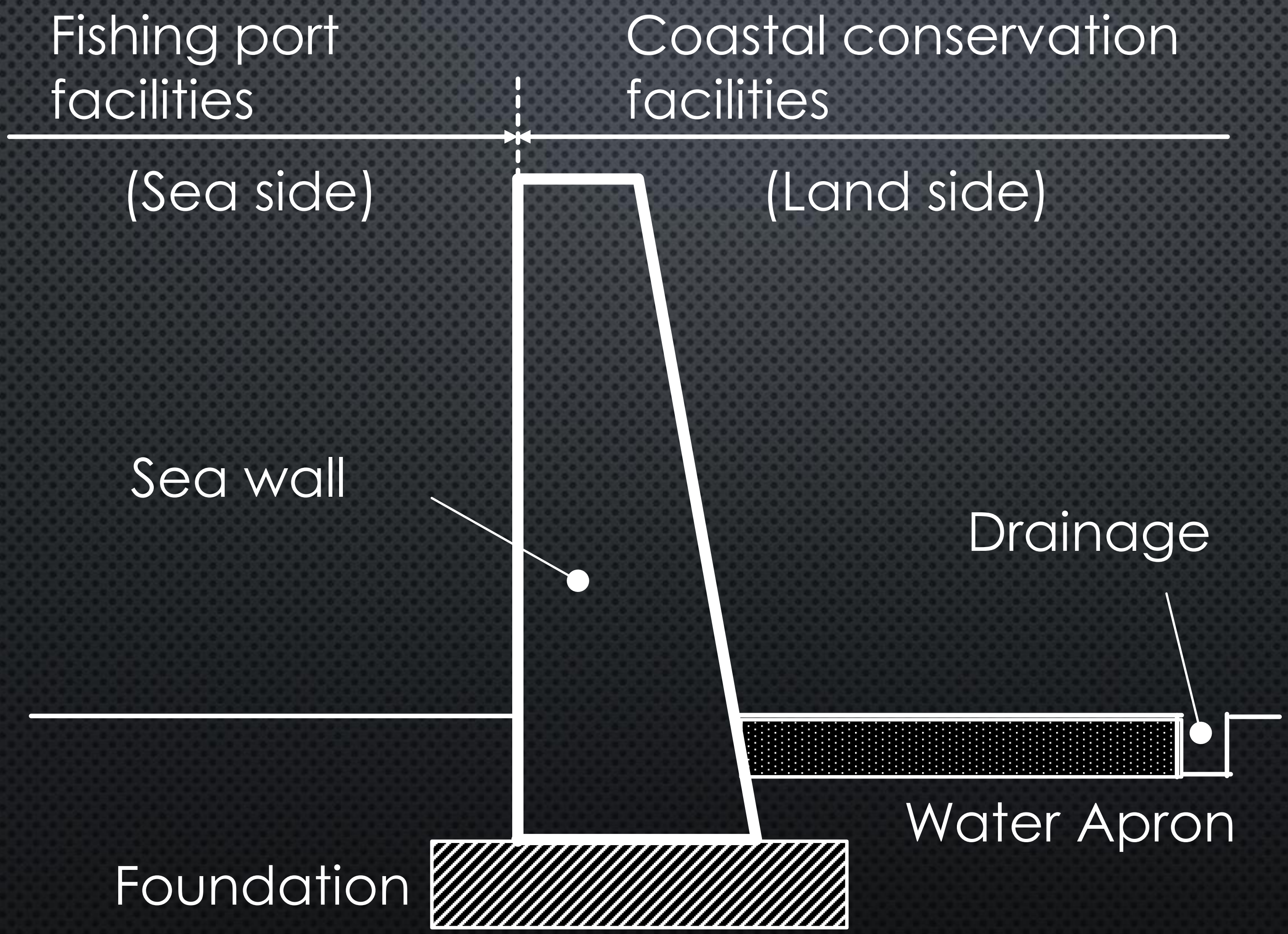
1.1 Facility name of the fishing port



1.2 Damage of the fishing port by 2011 tsunami

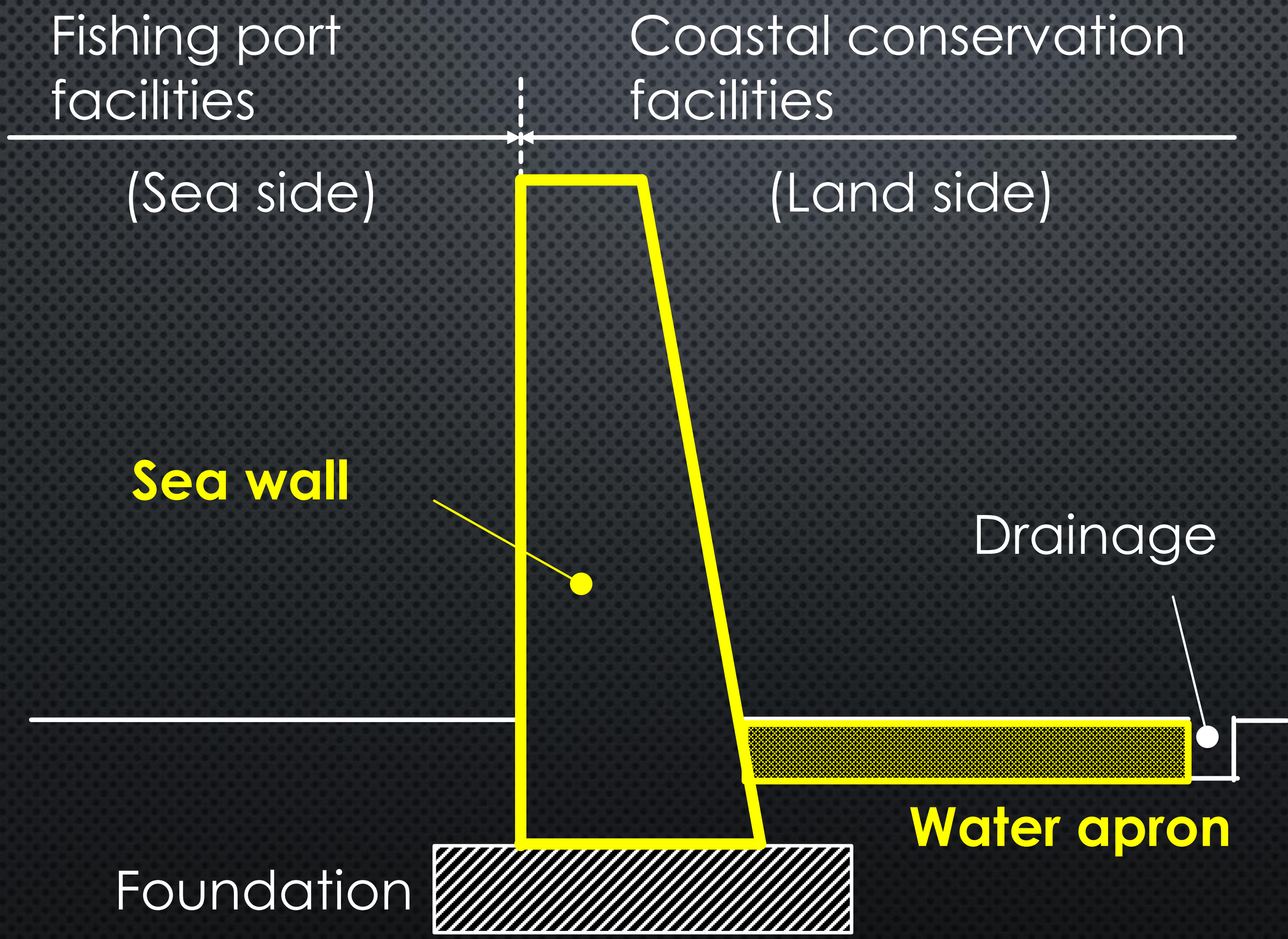
On **March 11, 2011**,
a magnitude 9 earthquake occurred
of the coast of northeast Japan.

Many of the fishing port facilities
were severely damaged by the **2011 tsunami**.

About 80% of the damage
of the sea wall was **overturning**.

About 30% of the damage
of the sea wall was **overturning without scouring**.

1.3 Target object of the facility of fishing port



1.4 Damage of the sea wall at Yamada

Date:08.08.2010

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Date:03.24.2011

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Date:08.08.2010

1.4 Damage of the sea wall at Yamada

Photo by Hiroshi Yagi

1.5 Damage of the fishing port by 2011 tsunami

We examined the tsunami pressure on sea wall and water apron.

We studied in hydraulic experiment and numerical simulation.

The scale of the hydraulic experiment for the sea wall is 1/81.

The scale of the hydraulic experiment for the water apron is 1/50.

Numerical simulation model used by CADMAS-SURF/2D.

The condition of tsunami is steady flow.

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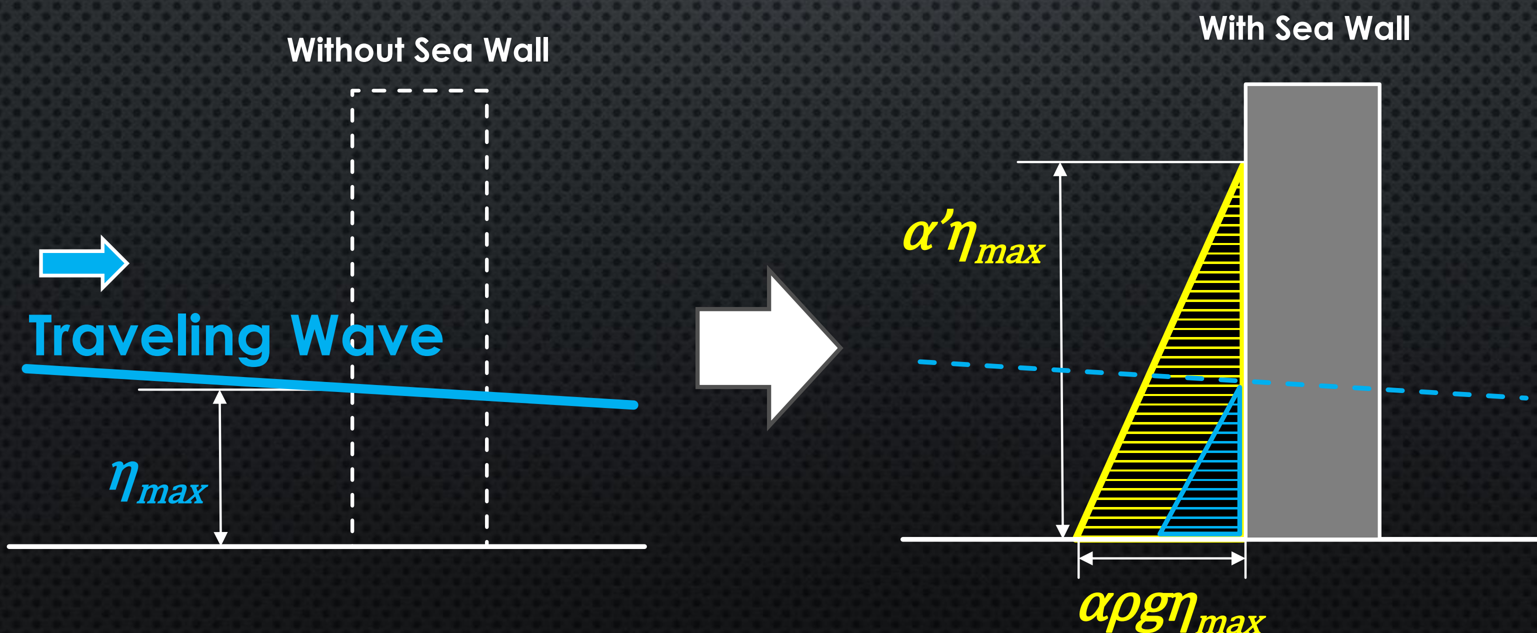
2.1 In case of non-overflowing the sea wall

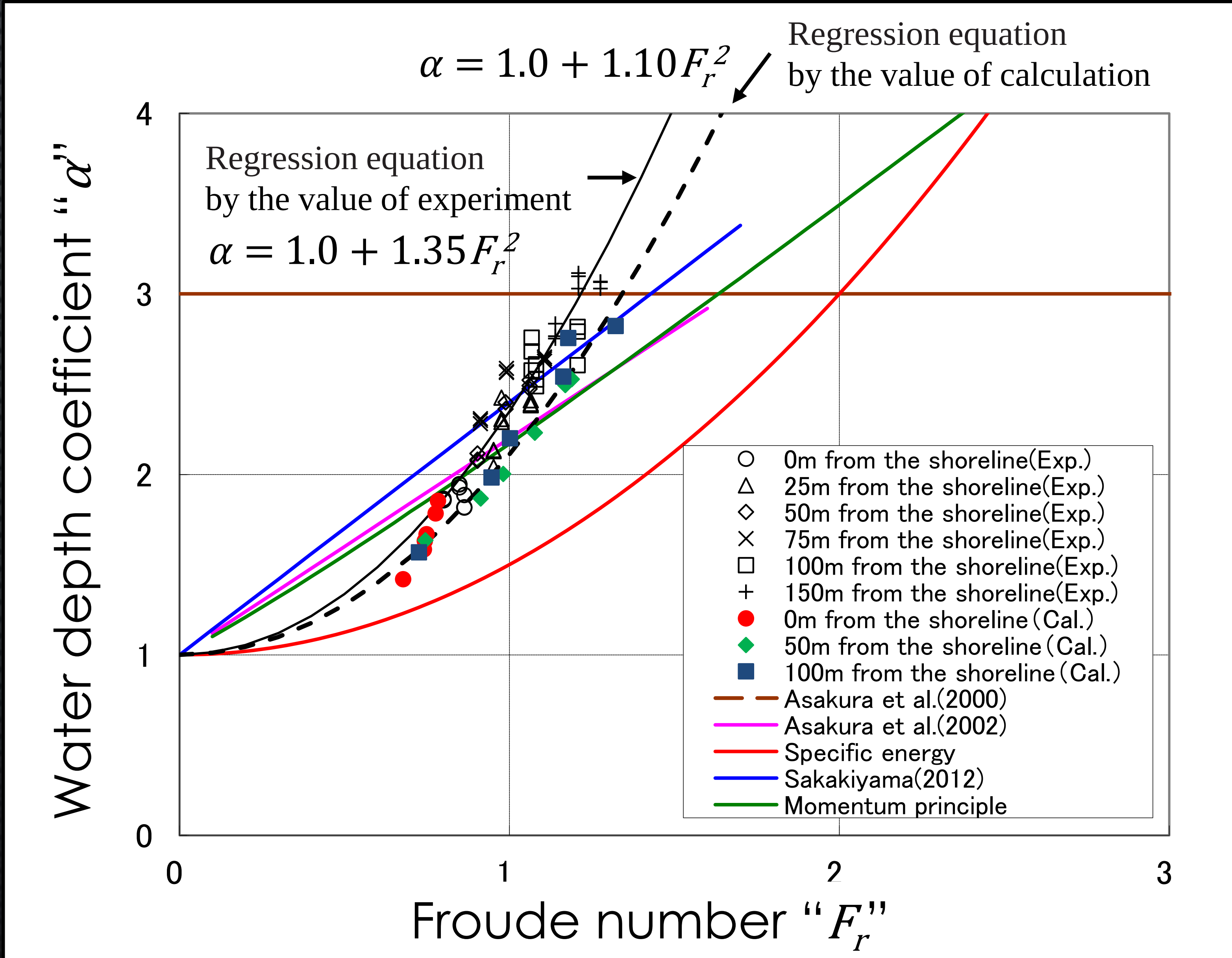
We hope **useful calculation method** of the tsunami pressure on sea wall.

The tsunami pressure assumed a **triangular distribution**.

We studied the value of the depth coefficients α and α'.



2.1 In case of non-overflowing the sea wall



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2.1 In case of non-overflowing the sea wall

We can estimate the tsunami pressure on sea wall by the traveling wave height without sea wall.

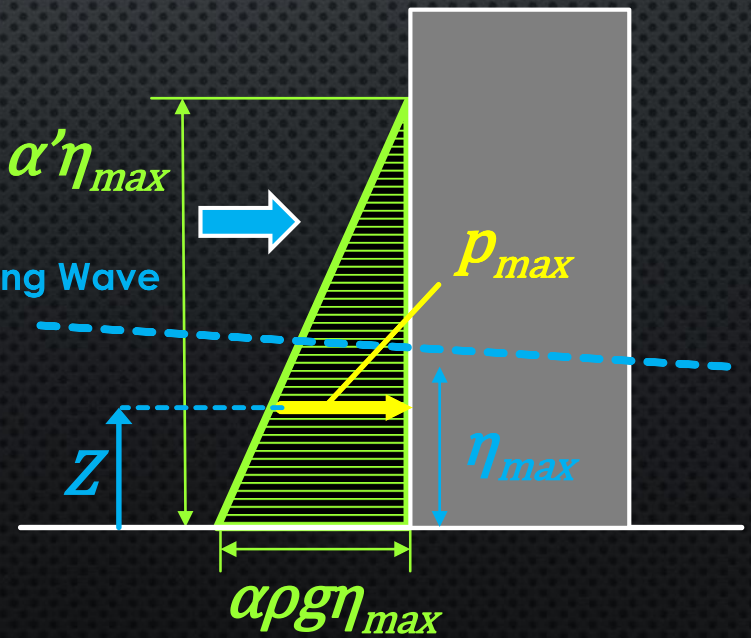
Input : Z, η_{max} → output : p_{max}

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

$$\alpha = 1.0 + 1.35 F_r^2$$
$$(0.0 \leqq F_r < 1.5)$$

As the result of experiment
Fr on the front point of sea wall

$$\alpha' = \max\{3, \alpha\}$$



2.2 In case of overflowing the sea wall

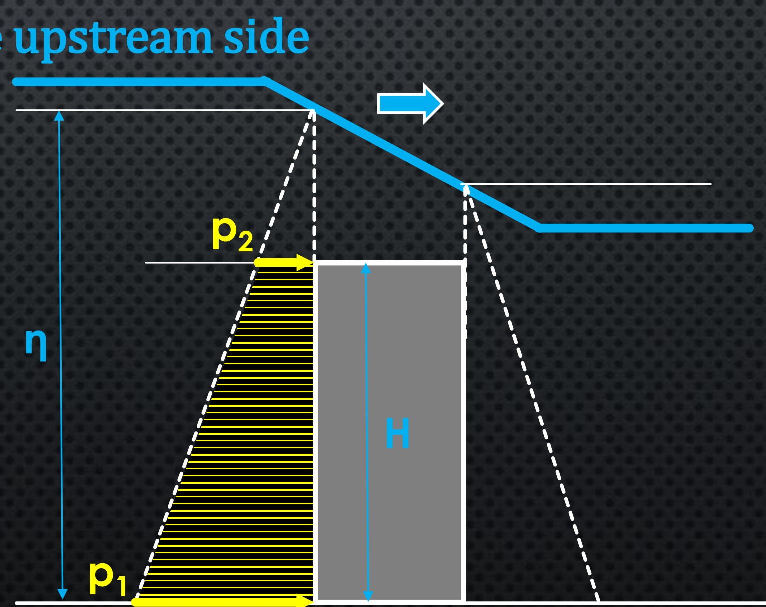
We can estimate the tsunami pressure on sea wall by height of sea wall and overflowing level.

- **For the front side tsunami pressure** P_I

Input : H, η → **output :** P_1, P_2

$$P_I = \frac{1}{2}(p_1 + p_2)H$$

$$\begin{cases} p_1 = \alpha_I \rho g \eta \\ p_2 = p_1(\eta - H)/\eta \\ \alpha_I = -0.17(H / \eta) + 1.27 \\ \qquad (0.4 \leqq H / \eta < 1.0) \end{cases}$$



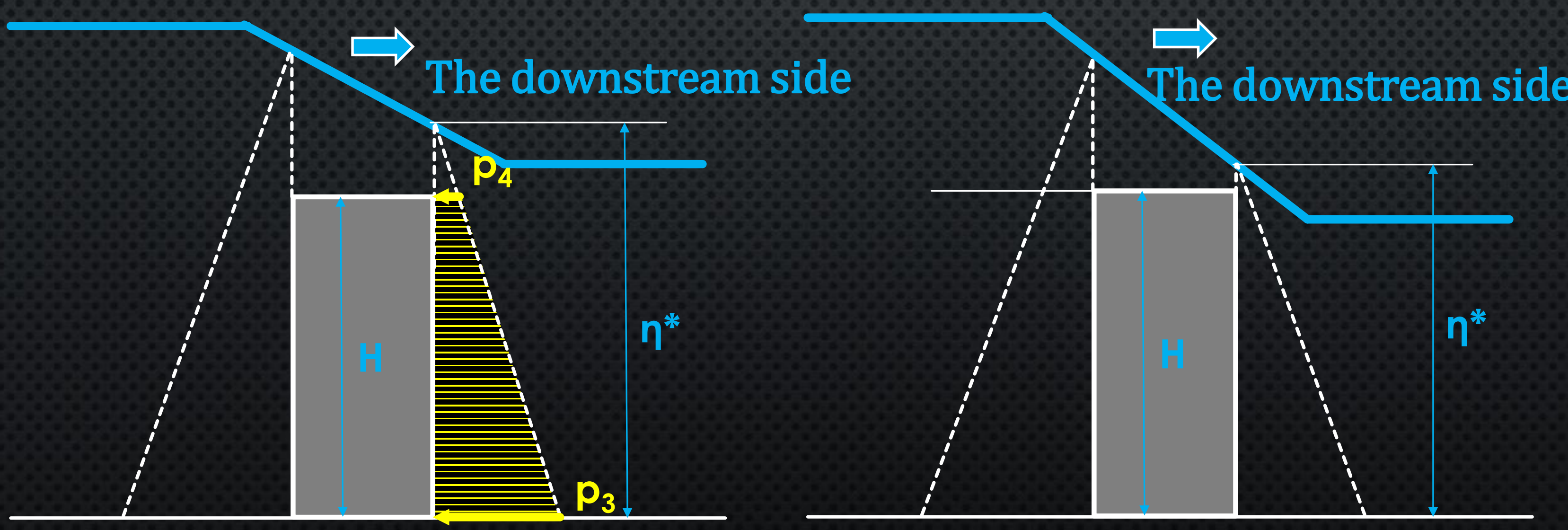
2.2 In case of overflowing the sea wall

- For rear side tsunami pressure P_B

Input : H, η^* → output : P_3, P_4

$$P_B = \frac{1}{2}(p_3 + p_4)H_B \quad \begin{cases} p_3 = \alpha_{IB}\rho g \eta^* \\ p_4 = p_3(\eta^* - H_B)/\eta^* \\ H_B = \min(\eta^*, H) \end{cases}$$

① α_{IB}=0.4 ($H/\eta^* < 0.8$) ② α_{IB}=0.0 ($H/\eta^* \geqq 0.8$)



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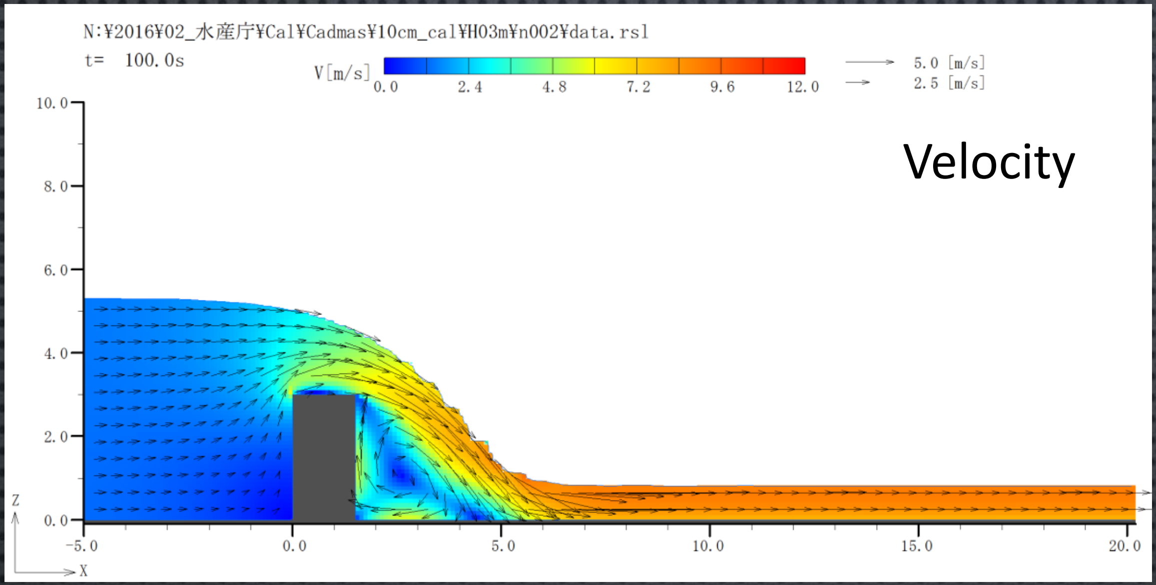
3.1 A design method of water apron

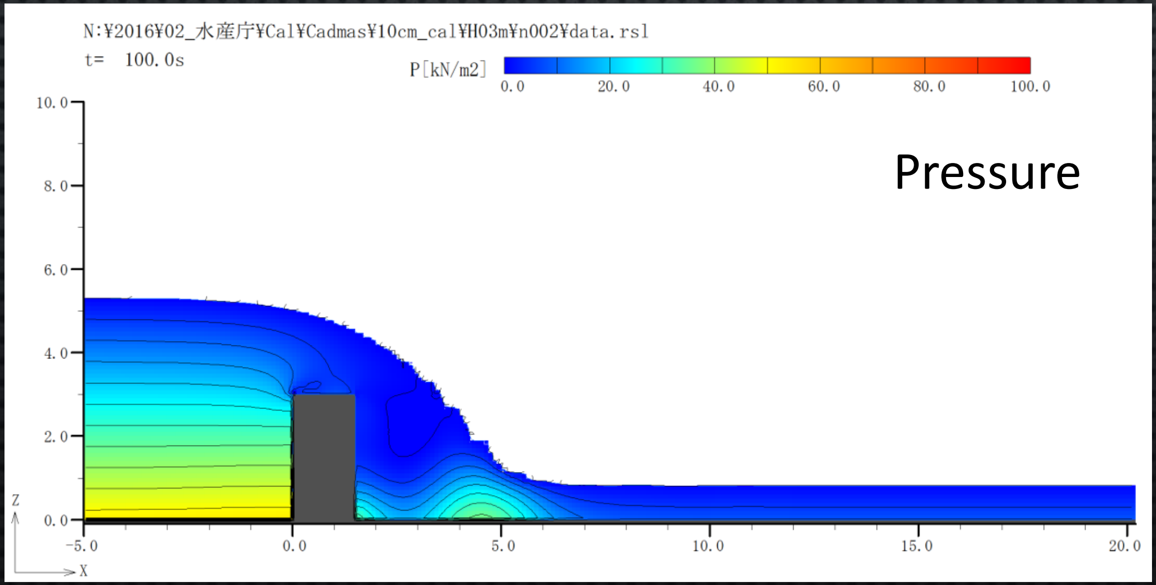
The overturning damage of the sea wall with water apron was small.

If installing a water apron, we can reduce overturning damage of sea wall.

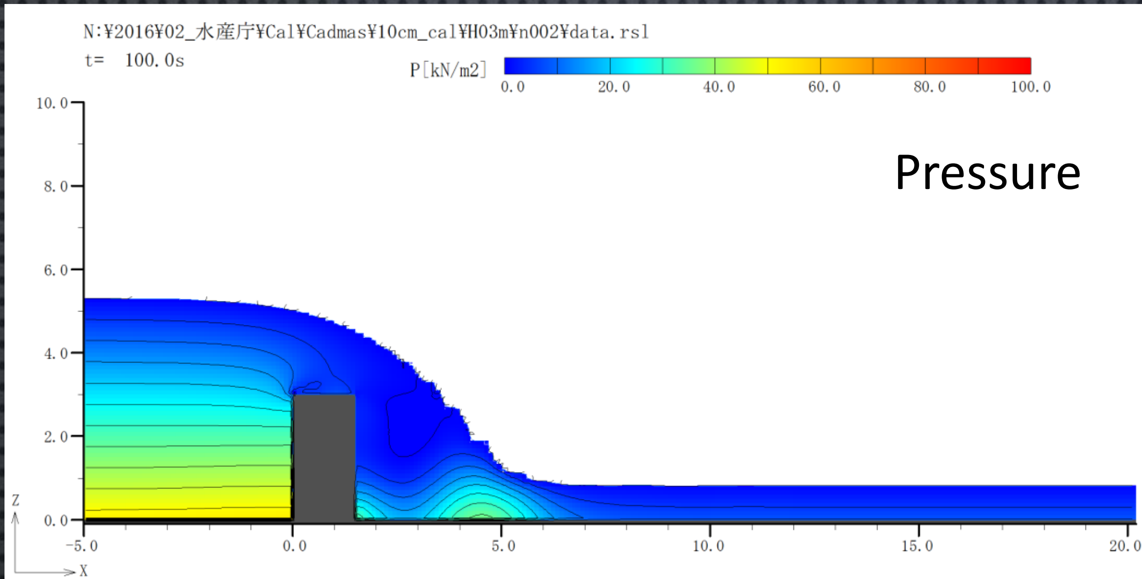
We studied the estimation method of the pressure and working length for water apron.

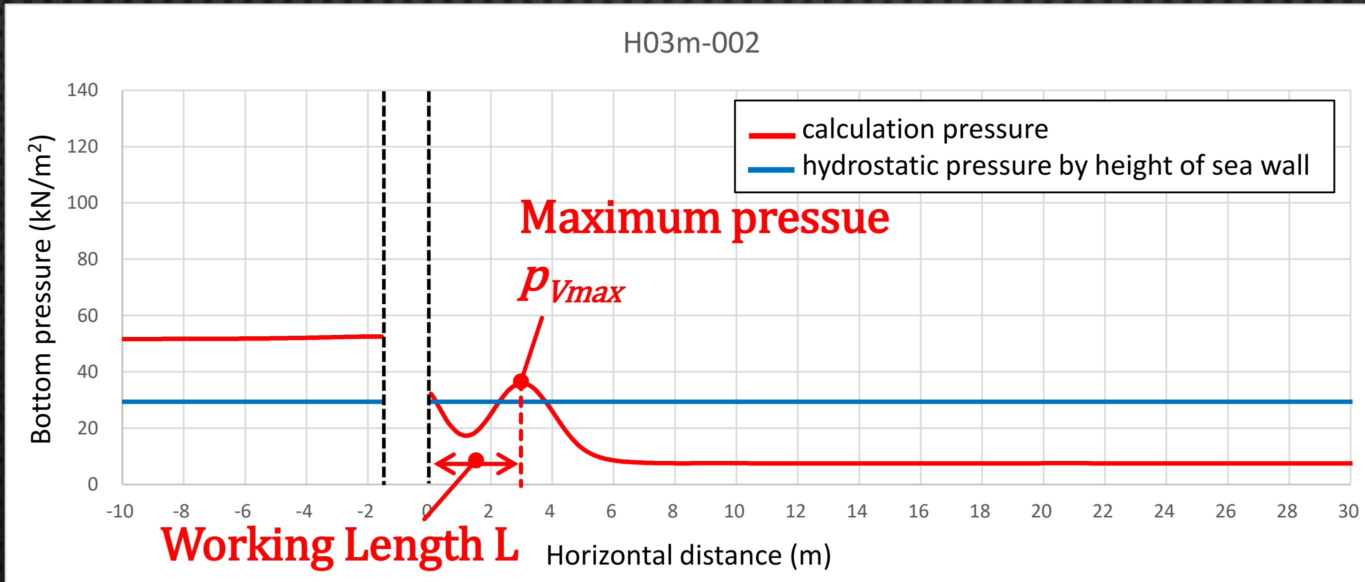
3.2 Example with the sea wall height of 3 m





3.2 Example with the sea wall height of 3 m





Bottom pressure

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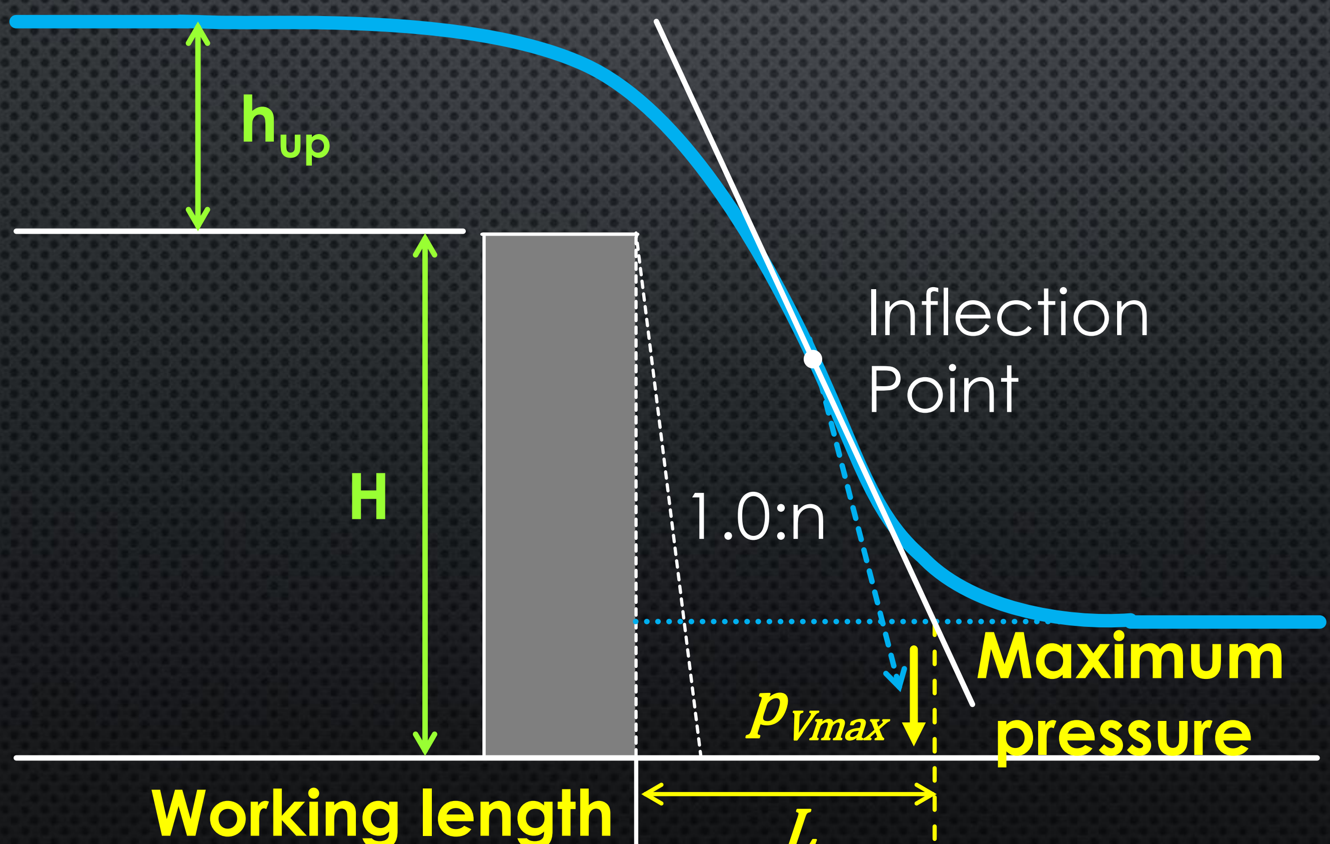
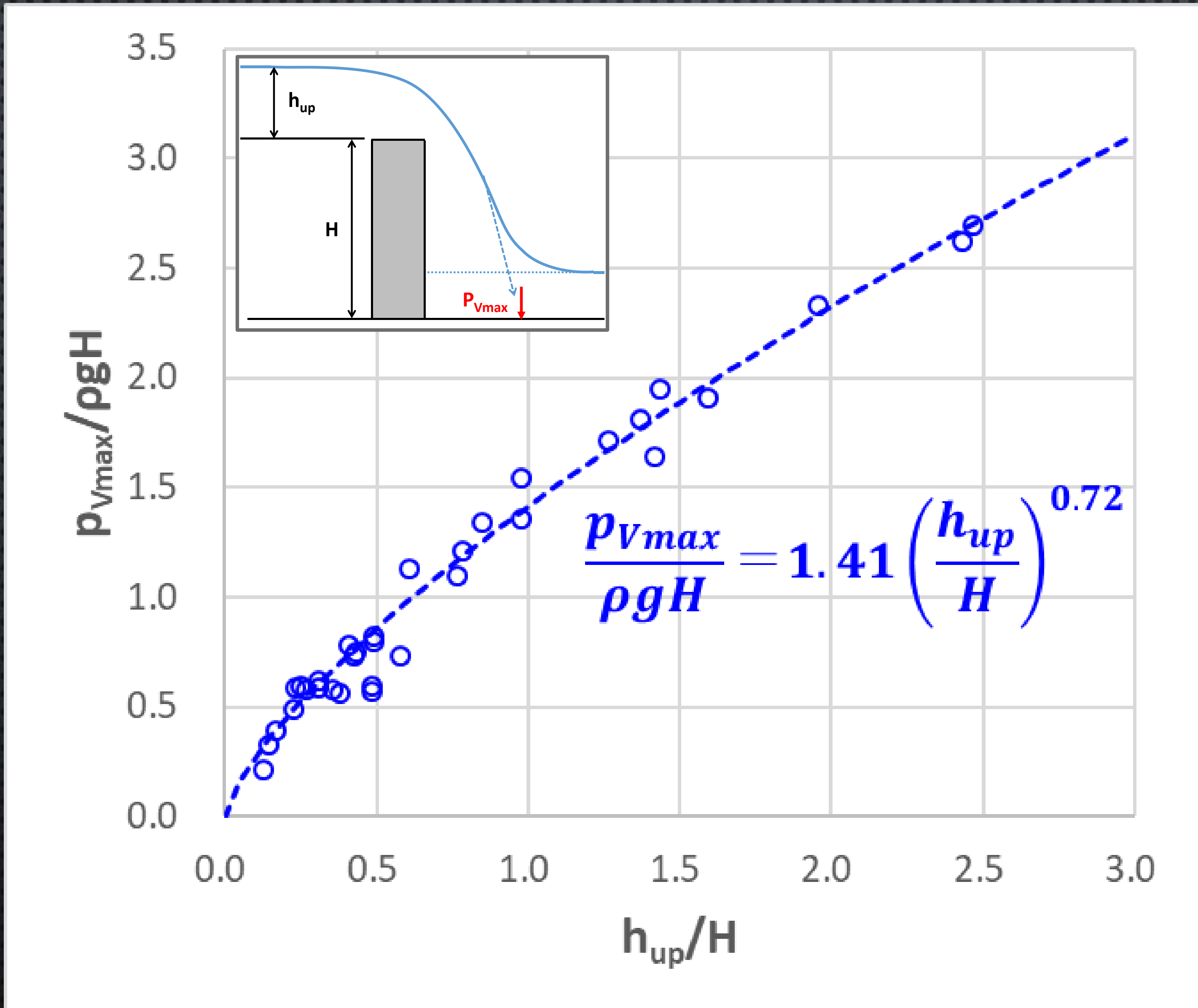
3.3 Tsunami falling pressure on water apron

We can estimate the tsunami falling pressure on water apron.

Input : H, h_{up} → output : p_{Vmax} , L



3.2 The relation between H, h_{up} and P_{vmax}



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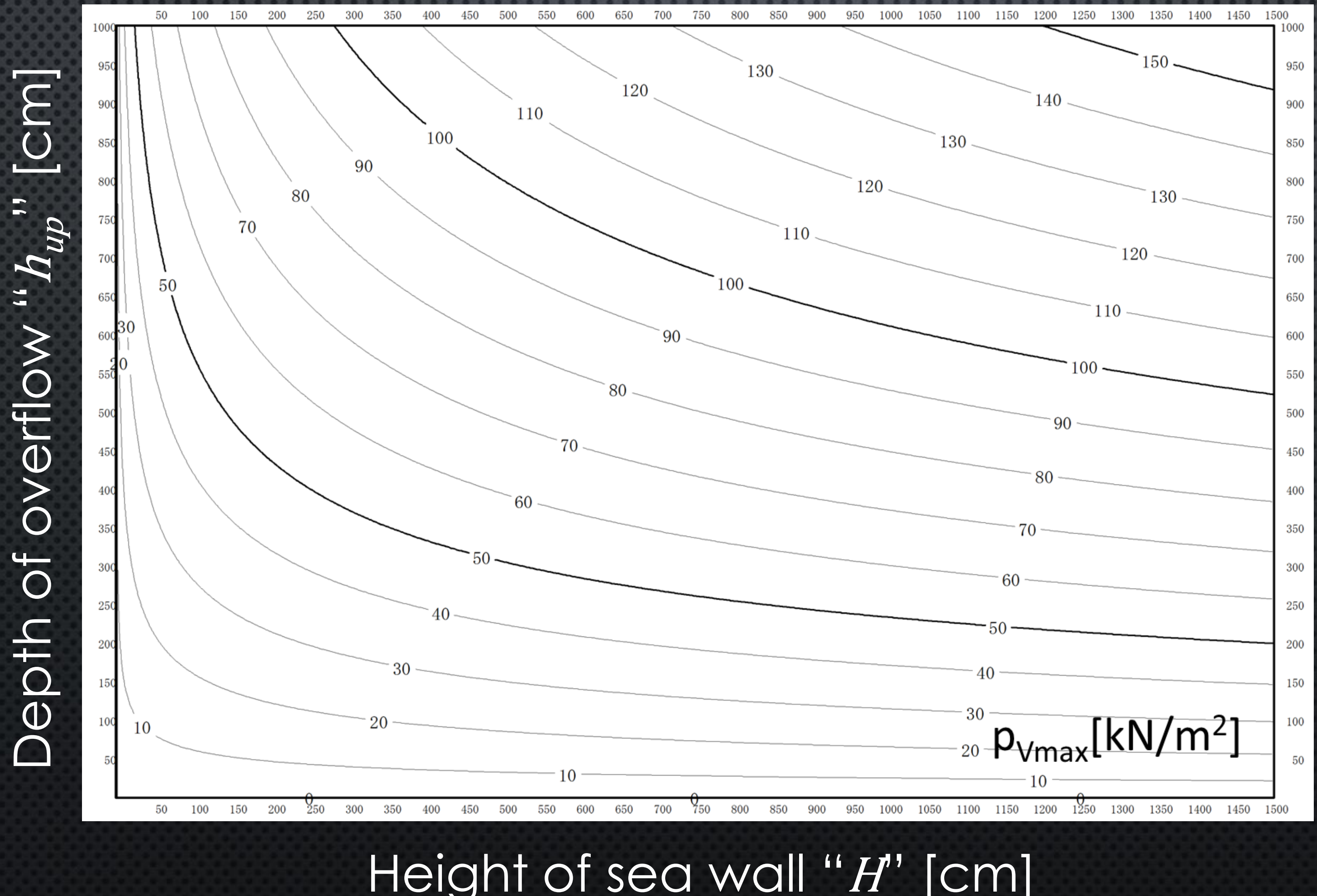
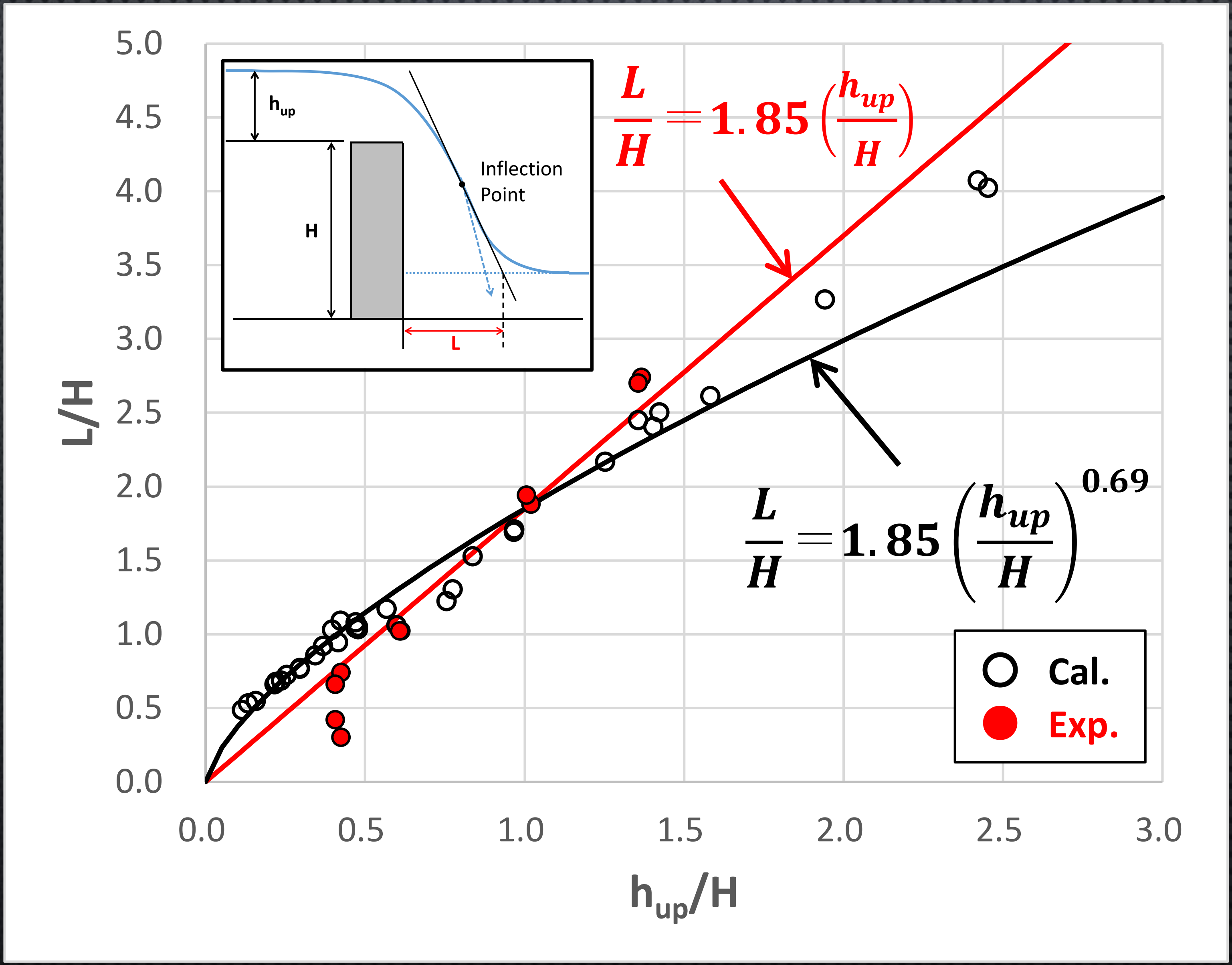
3.2 A calculation diagram of tsunami falling pressure



3.3 The relation between H, h_{up} and L



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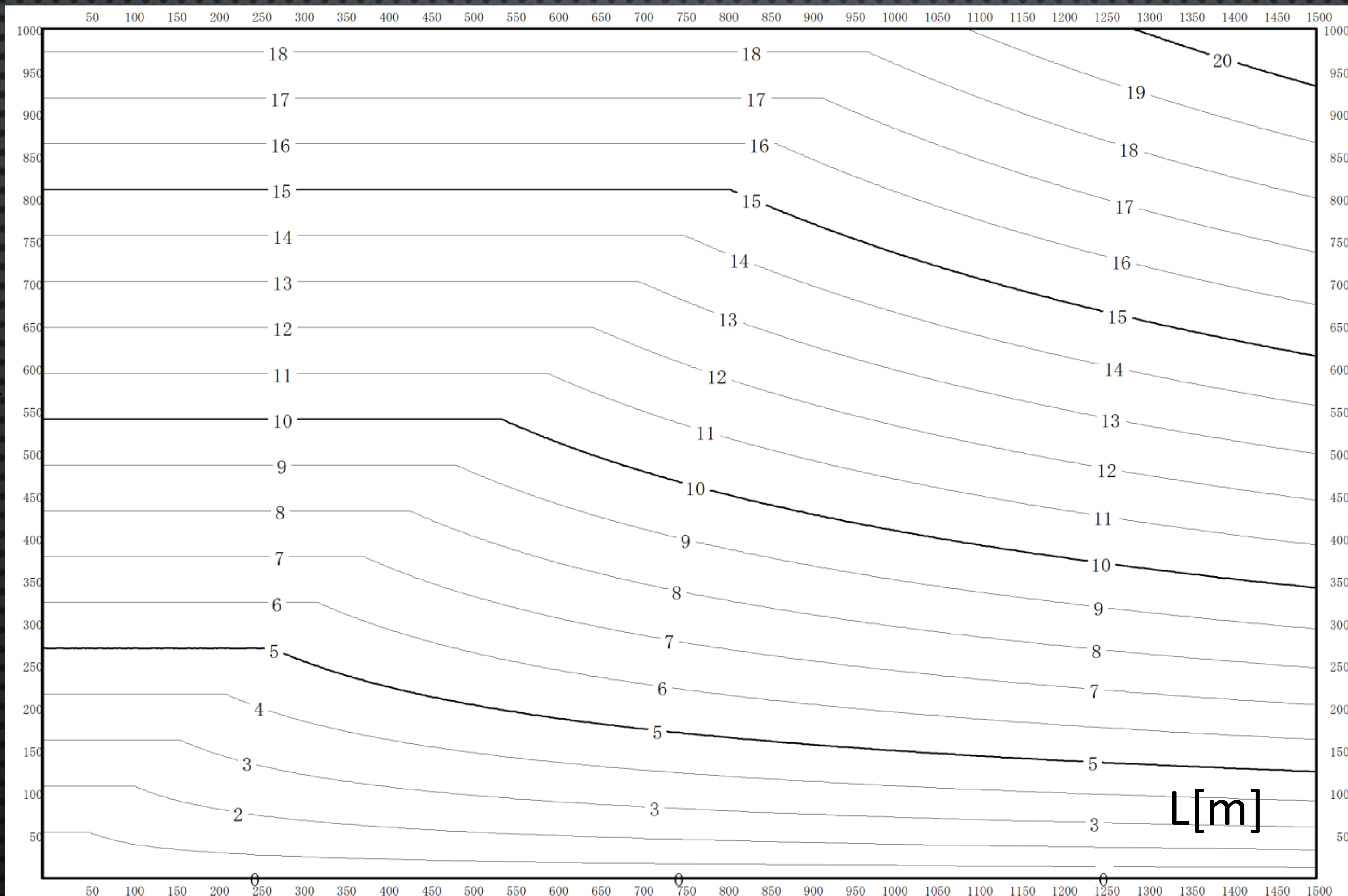
3.4 A calculation diagram of working length



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4. Conclution

4.1 We propose the evaluation method for tsunami pressure on sea wall.

① For the case of non-overflowing

② For the case of overflowing

4.2 We propose the evaluation method for tsunami pressure on water apron.

① For the tsunami falling pressure

② For the working length

Thank you for your kind attention.