Inventing a Wave-Weakening Seawall

Group 2(physics)
1. Purpose
2. Keyword
3. Device
4. Experiment
5. Summary
6. Future research
Purpose

The Eurasian plate
The North American plate
The Pacific plate

Nankai Trough

The wave height Xm

20m
24m
31m

Philippine Sea plate

The wave height Xm

27m
32m
33m
These experiments:

- **Hard**: Block the waves
- **Weak**: Change the shape of seawalls; weaken the waves

△ Weaken the waves
1. Protect places people escape to
   Control the direction

2. Buy time to escape
   Slow down the speed
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Keyword

- Size
- Wave speed, Volumes of flow

} Similarity between reality and model

Consider fluid mechanics
\( F_r : \) Fluid number  \( m : \) mass  \( a : \) acceleration

\( g : \) gravitational acceleration  \( V : \) velocity  \( L : \) length

\( A : \) reality  \( B : \) model  \( h : \) depth of water

\[
F_{rA} = F_{rB}
\]

Fluid number: 
\[
F_r = \frac{ma}{mg} = \frac{V}{\sqrt{Lg}}
\]

\[
V_B = \sqrt{gh_B}
\]
Contents

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Device

- Height difference
- Length

Gray = Pulley
\[ V_B = \frac{0.828 \text{ m/s}}{0.8421 \text{ m/s}} \]
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Measurement Method

Seawall

Measurement Span (50cm)

2cm

120 Fps (frames per second) Video

Measurement Method
Seawall

Slit30°

Slit45°

Slit60°
Result 1

Type Slit

(Frame)

Slit30°  Slit45°  Slit60°
Control and set obstacles on the focus points

Control the waves and improve the wave-weakening effect
Seawall

- Stick Brown
- Stick Green
- Stick Blue
- Default
Result 2

Type Stick & Default

<table>
<thead>
<tr>
<th>Type</th>
<th>Frame</th>
<th>Stick Brown</th>
<th>Stick Green</th>
<th>Stick Blue</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>120</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
After Rearranged Analysis

Surface Area

<table>
<thead>
<tr>
<th></th>
<th>Stick Blue</th>
<th>Stick Brown</th>
<th>Stick Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>cm$^2$</td>
<td>189</td>
<td>227</td>
<td>245</td>
</tr>
</tbody>
</table>

(Analysis)
Change width  Change density

Reduce wave speed further
Summary

Slit types separated wave.

Protect places people escape to
The stick types have potential to reduce wave speed.

Buy time to escape
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</tr>
</tbody>
</table>
Future research

- To change the angle of the slits,
- Prevention of focus points
- Changing the density of sticks
- Making a seawall using both the types of seawalls
References


• National Institutes of Natural Sciences, Chronological Scientific Tables, Japan, Maruzen, 1995.

• Hirasaki Tetsuya, Mori Nobuhito, Yasuda Tomohiro, Azuma Ryokei, and Mase Hajime, Characteristics of Tsunami Generator Newly Implemented in Disaster Prevention Research Institute, Kyoto University, Japan, 2015.

• Tsubaki Touitirou, Araki Masao, Exercise in Hydraulics(Volume One), Japan, Morikitasyuppan, 1961.
Thank you for your time and attention!
<table>
<thead>
<tr>
<th>Lift</th>
<th>Length</th>
<th>20cm</th>
<th>30cm</th>
<th>40cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3cm</td>
<td>20cm</td>
<td>0.738461538m/s</td>
<td>0.751284869m/s</td>
<td>0.801165846m/s</td>
</tr>
<tr>
<td></td>
<td>30cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4cm</td>
<td>20cm</td>
<td>0.761904762m/s</td>
<td>0.786885246m/s</td>
<td>0.817586207m/s</td>
</tr>
<tr>
<td></td>
<td>30cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5cm</td>
<td>20cm</td>
<td>0.787393436m/s</td>
<td>0.807235726m/s</td>
<td>0.832105263m/s</td>
</tr>
<tr>
<td></td>
<td>30cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6cm</td>
<td>20cm</td>
<td>0.800593252m/s</td>
<td>0.83710475m/s</td>
<td>0.856507852m/s</td>
</tr>
</tbody>
</table>
\[ F_r : \text{fluid number} \quad m : \text{mass} \quad L : \text{length} \quad \rho : \text{density} \]
\[ g : \text{gravitation acceleration} \quad V : \text{velocity} \quad a : \text{acceleration} \]

\[
\frac{ma}{mg} = \frac{\rho L^3 \frac{V}{L/V}}{\rho L^3 g} = \frac{\rho L^2 V^2}{\rho L^3 g} = \frac{V^2}{Lg}
\]

\[ F_r = \frac{V}{\sqrt{Lg}} \]
\[ F_{rA} = F_{rB} \]

\[ \frac{V_B}{V_A} = \sqrt{\lambda} \]

Formula of wave speed:

\[ V_A = \sqrt{gh_A} \]
Fluid number $Fr$ : $m$ : mass $a$ : acceleration
$g$ : gravitational acceleration $V$ : velocity $L$ : length
$A$ : reality $B$ : model $h$ : depth of water

\[ V_B = \sqrt{\lambda gh_A} = \sqrt{\lambda g \frac{h_B}{\lambda}} = \sqrt{gh_B} \]
Green’s law

\[
\frac{H}{H_0} = \left( \frac{b_0}{b} \right)^{\frac{1}{2}} \left( \frac{h_0}{h} \right)^{\frac{1}{4}}
\]

\text{Bigger} \quad \text{Bigger} \quad \text{Bigger}
Viscosity: of spreading force
Kinematic viscosity: of spreading speed

<table>
<thead>
<tr>
<th></th>
<th>Pure water</th>
<th>Seawater</th>
<th>Castor oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (Pa·s)</td>
<td>$1.002 \times 10^{-3}$</td>
<td>$1.075 \times 10^{-3}$</td>
<td>$700$</td>
</tr>
<tr>
<td>Kinematic viscosity ($m^2/s$)</td>
<td>$1.004 \times 10^{-6}$</td>
<td>$1.049 \times 10^{-6}$</td>
<td>$0.723$</td>
</tr>
</tbody>
</table>

Very small
Example

\[ \tan \theta = \frac{1}{12} \text{ (about } 4.5^\circ) \]
Example

Focus Points

Focus Points

Water
How to measure the surface area

Example

Radius $\times 2 \times \pi \times$ Height

$= \text{Surface of Cylinder}$

$\times$

Number of Stick

Stick Blue

Surface Area