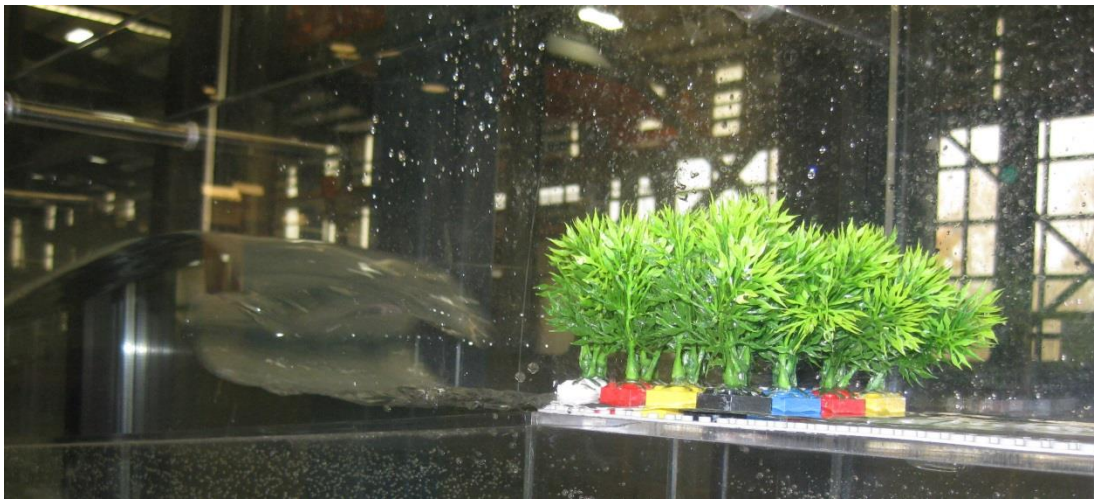
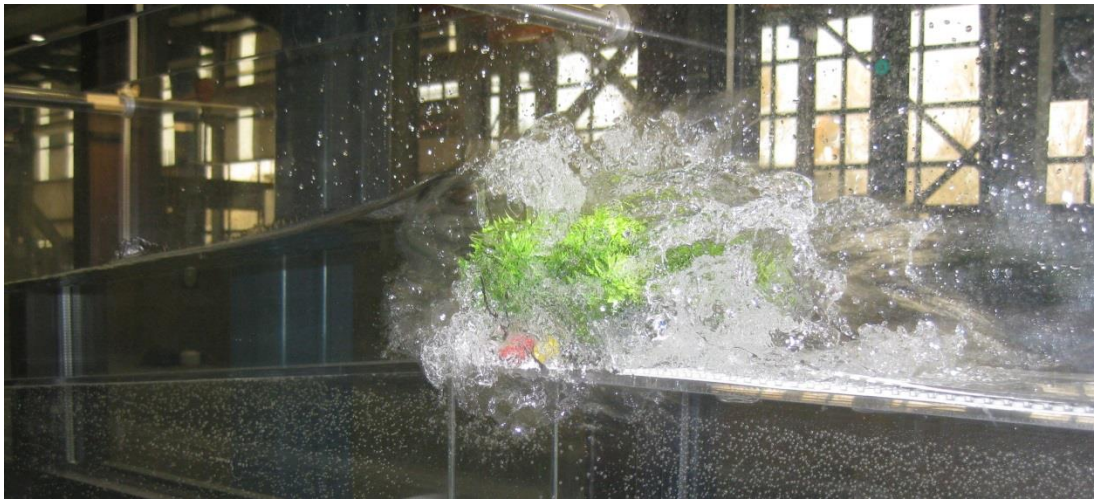
NEES Tsunami Research Education and Outreach

Coastal Forest Kit

for the Mini Wave Flume





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Introduction

This kit will introduce K-12 and undergraduate college students to tsunami flow and the effects that coastal vegetation has on this flow. Three sets of instructions are included to suggest activities and discussion to accompany this kit. The instructions are labeled as "Easy", "Intermediate" and "Advanced" to accompany specific age groups. Instructors may choose what instructions to use at their own discretion. The Lego trees included with this kit were custom made, so care must be taken to ensure they are not damaged.

Overview

The "Coastal Forest Kit for the Mini Wave Flume" provides information to students on how coastal vegetation can affect tsunami run-up. The main concepts to communicate to students are:

i. Tsunamis can damage infrastructure and pose a huge threat to people living by the coast.
ii. Engineers can help protect people from natural hazards, namely tsunamis.
iii. Coastal vegetation could be used as protection from tsunamis, although it can also channelize flow and create hazardous conditions.

This activity also encourages creativity and problem solving. Each set of activity instructions covers the same basic concepts, but invites different discussion based on the age and grade level of students. Be sure to communicate to students how tsunamis are formed and explain the damage that tsunamis can do to coastal areas. Students should have a basic understanding of this before beginning the activity, and especially before discussion on coastal vegetation occurs. Students should enjoy this hands-on activity while also learning about engineering, tsunamis, and coastal vegetation.

Figure 1: Mini-Wave Flume at the O.H. Hinsdale Wave Research Laboratory in Corvallis, Oregon

Equipment and Materials

Lego Trees

- The Lego Trees (Figure 2) were custom made using 2 x 3 Lego blocks and artificial aquatic plants from a pet supply store. The plastic plants were attached to the Lego blocks using super glue. Allow to dry after use, do not store wet.
- Twenty-three Lego Trees are included in this kit. Sixteen are needed, seven are extras.
- Lego Trees have removable tree trunks for durability if someone pulls too hard on the trunk of the tree.
- If a Lego Tree is damaged, it will be easier to repair using super glue than to fabricate a new one.

Figure 2: Lego Tree

Water Depth Measurement Device

- Four are included in this kit (Figure 3). Three are needed.
- A wooden plank is used to secure a paper strip, which allows one to record the water depth at a location. The placement of the water depth measurer is detailed later in each procedure.
- Two rubber bands attach the paper strip to the wooden plank.
- Paper strips can be cut from an ordinary piece of paper; preparation should take place prior to the experiment.

Figure 3: Water Depth Measurement Device

Lego Tower and Person

- An assortment of Lego people (Figure 4) and blocks (Figure 6) is included for the pleasure of the visitors.
- The Lego tower and people serve to entertain and engage the visitors; instructors may use them as they please.

Figure 4: Assortment of Lego People

Figure 5: Lego person on Tower

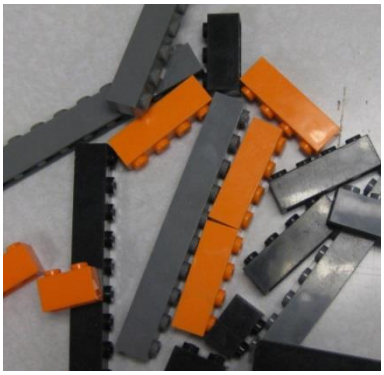

Figure 6: Assortment of Lego Blocks

Easy Activity (recommended for children and K-5 students)

Part 1) Introduction and Discussion

- Thank the students for visiting and ask basic questions, such as "Who wants to be an engineer when they grow up?" and "What do you think an engineer does?"
- Ask the students what sorts of places and structures waves impact, and why we want to protect these places/structures.
- Explain how coastal vegetation may be implemented to protect coastal areas and the people who work and live in them.
- Explain that our activity focuses on the effect that coastal vegetation has on wave flow and protecting coastal structures from wave forces.
- Explain the engineering solving process, designing, building, and testing of solutions.

Part 2) Building and Testing

- Trial 1:
    - Attach a piece of paper to the wooden plank by using the two rubber bands.
    - Hold the wood flush with the plexiglass wall and the gray cover (Figure 7).
    - Place the Lego person on the volunteer's tower inside the wave flume.
    - Explain how the wave-making paddle works.
    - Run a wave.
    - Mark the water depth on the paper with a pencil.

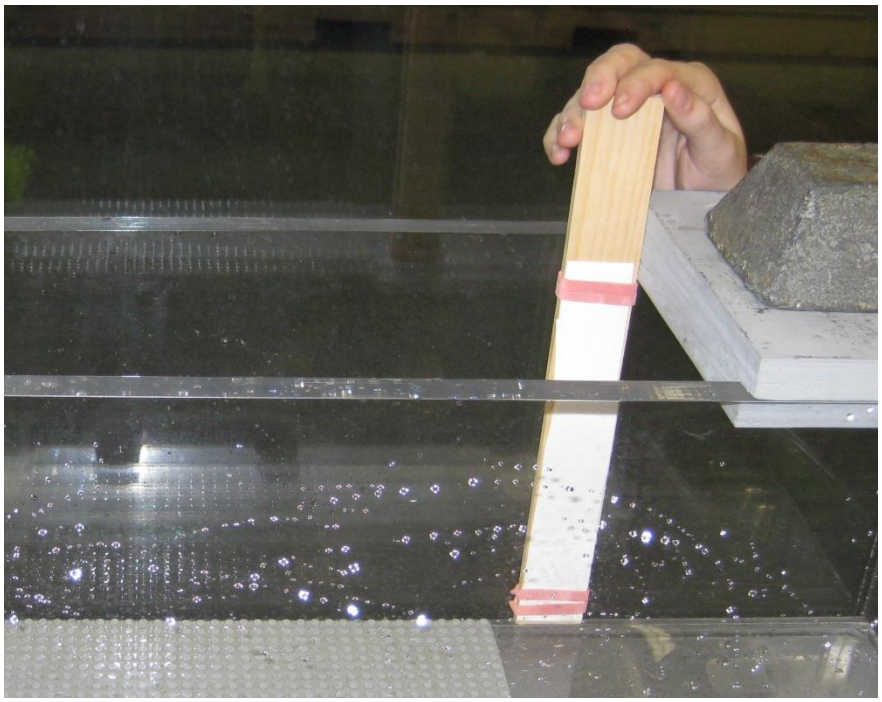

Figure 7: Placement of Water Depth Measurement Device

- Trial 2:
    - Arrange Lego trees in rows (Figure 8 & 9).
    - Attach a piece of paper to another wooden plank as before.
    - Run a wave.
    - Mark the water depth on the paper with a pencil.
    - Compare the water levels in Trial 1 & 2 (a lower level is expected for Trial 2 than 1).
    - Discuss how vegetation protects the Lego person and affects the water depth.

Figure 8: Double row of Lego Trees

- Trial 3:
    - Put students in groups.
    - Give each group a handful of Legos and ask them to build a tower to protect the Lego person. Allow approximately 8 minutes. Tower cannot be more than one Lego thick.
    - Test each structure. Let kids have fun with their towers.

Intermediate Activity **(Recommended for middle school students, grades 6-8)**

Part 1) Introduction and Discussion

- Thank the students for visiting and ask basic questions, such as "Who wants to be an engineer when they grow up?" and "What do you think an engineer does?"
- Ask the students what sorts of places and structures waves impact, and why we want to protect these places/structures.
- Explain that our activity focuses on the effect that coastal vegetation has on wave flow and protecting coastal structures from wave forces.
- Explain how coastal vegetation may be implemented to help protect these structures and the people who work and live in them.
- Explain that the main goal of engineering is to help people.
- Explain the engineering problem solving process, designing, building, and testing of solutions.
- Ask the students about typical engineering limitations such as time and material constraints.

Part 2) Building and Testing

- Trial 1:
    - Attach a piece of paper to the wooden plank by using the two rubber bands.
    - Hold the wood flush with the plexiglass wall and the gray cover (Figure 7).
    - Place the Lego person on the volunteer's tower inside the wave flume.
    - Explain how the wave-making paddle works.
    - Run a wave.
    - Mark the water depth on the paper with a pencil.
- Trial 2:
    - Put students in groups.
    - Show students the Lego trees.
    - Give each group a Lego layout (see attached in the Appendix) and let them create their vegetation pattern. Allow 5 minutes. The Lego blocks may not touch. Tell students that the goal is to reduce the water depth by the largest amount.
    - Run a wave over each group's vegetation layout. Volunteers may place a Lego person on a tower in the back of the vegetation pattern (for entertainment purposes only, the Lego person plays no functional role). Use a new piece of paper on the wooden plank each time and mark the water depth. The group with the lowest water depth wins.
    - Discuss how the vegetation affects the water depth. Does the vegetation have a damping effect? Do certain patterns damp more or less than others? Does the vegetation pattern increase wave flow? What would be the advantages of using coastal vegetation to decrease tsunami wave force?

Advanced Activity (Recommended for high school students, grades 9-12, and undergraduates)

Part 1) Introduction and Discussion

- Thank everyone for joining and ask a few questions such as "Who plans to be an engineer or has parents that are engineers?"
- Ask "How do you think we can protect our coasts from tsunami events?"
- Ask "What are the downfalls and benefits of these methods?"
- Explain that our activity focuses on the effect that coastal vegetation has on wave flow and protecting coastal structures from wave forces
- Explain the engineering problem solving process, designing, building, and testing of solutions.

Part 2) Building and Testing

- Trial 1:
  - Same as Trial 1 in intermediate activity.
- Trial 2:
  - Same as Trial 2 in intermediate activity.
- Additional Exercises:
  - Volunteer arranges the Lego trees in any of the attached layouts (Figures 9-12) and runs a wave.
  - Discuss how the specific layout affects flow. If there is plenty of time, the water depth could also be measured and compared for the different additional cases. It would be interesting to measure the water depth at different areas, particularly when channelization could have occurred.

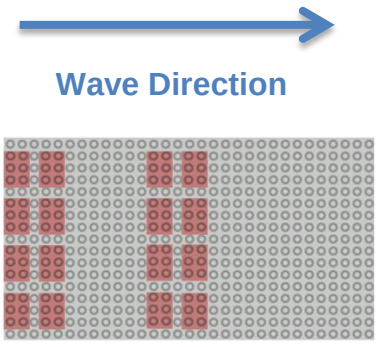

Figure 9: Double Row of Lego Trees

Figure 10: Block of Lego Trees

Figure 11: Double Column of Lego Trees creates channel

Figure 12: Patches of Lego Trees

Acknowledgements

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Appendix – Lego Layout