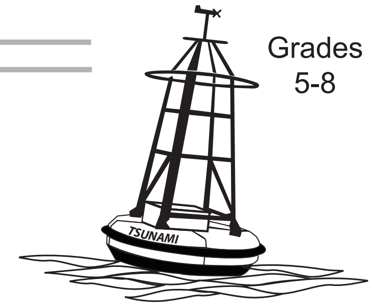
Structural Countermeasures



Grades 5-8

Overview:

In this lesson, students explore several existing structural tsunami countermeasures and then evaluate each solution for strengths and limitations.

Targeted Alaska Grade Level Expectations:

Science

[5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[5] SA1.2 The student demonstrates an understanding of the processes of science by using quantitative and qualitative observations to create inferences and predictions.

[8] SA2.1 The student demonstrates an understanding of the attitudes and approaches to scientific inquiry by recognizing and analyzing differing scientific explanations and models.

[6] SE1.1 The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by recognizing that technology cannot always provide successful solutions for problems or fulfill every human need.

[5] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by describing the various effects of an innovation (e.g., snow machines, airplanes, immunizations) on the safety, health, and environment of the local community.

Objectives:

The student will:
- identify the site planning technique used by structural tsunami countermeasures; and
- evaluate the possible strengths and limitations of several technological innovations used to decrease the impact of tsunamis on communities.

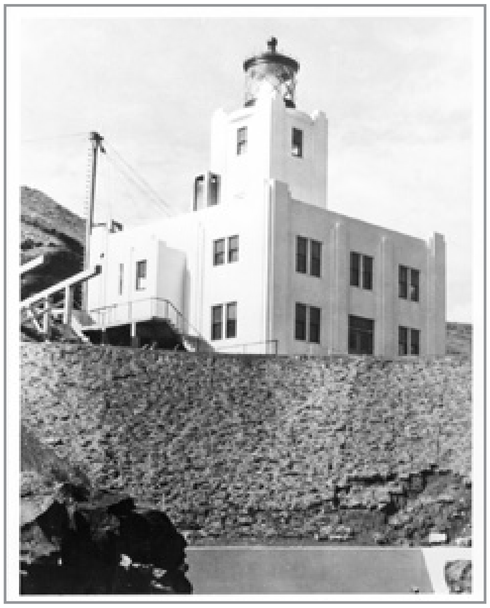
Materials:

- STUDENT WORKSHEET: “Community Considerations for Structural Countermeasures”
- VISUAL AID: “Structural Countermeasures”

Whole Picture:

Tsunami safety measures call for people to evacuate to higher ground. However the locations of some low-lying coastal communities do not permit everyone to make it to higher ground in time, especially in communities at high risk for local tsunamis where the time from generation to inundation may be only minutes. These communities often must consider the effects of the added risk from earthquakes. This has led some communities to consider options for minimizing the impact of tsunamis and earthquakes on their well-being. Education on eartquake and tsunami safety is key. Additionally, some communities have used structural countermeasures to evacuate people from hazard zones. Structural countermeasures also minimize the impact of the waves before reaching highly populated areas.

Nature is very powerful and not to be taken lightly. All structural countermeasures should be considered for strengths and limitations and never take the place of education on earthquake and tsunami safety. The December 26, 2004 Indian Ocean tsunami showed the potential of multistory reinforced concrete buildings for vertical evacuation when lives were saved as people headed to higher floors. However, the pictures below show the Scotch Cap Lighthouse in the Aleutians, a concrete building, before and after a tsunami in 1946.



Scotch Cap Lighthouse two months before the tsunami and the front view, after the earthquake and tsunami. The lighthouse was a few miles from the epicenter on Unimak Island, Alaska.

The primary strategy for saving lives immediately before tsunami waves arrive is to evacuate people from the hazard zone. Two methods are generally available:

- horizontal evacuation—moving people to more distant locations or higher ground; and
- vertical evacuation—moving people to higher levels.

This lesson requires students to identify the site planning technique employed and the strengths and limitations by each example. The Applied Technology Council, National Earthquake Hazards Reduction Program (U.S.), & National Tsunami Hazard Mitigation Program (U.S.) identify four basic site planning techniques that can be applied to projects to reduce tsunami risk:

Strategy 1: Avoiding
Avoiding a tsunami hazard area is, of course, the most effective mitigation method. At the site planning level, this can include constructing buildings and infrastructure on the high side of a lot or raising structures above tsunami inundation levels on piers or hardened podiums.

Strategy 2: Slowing
Slowing techniques involve creating friction that reduces the destructive power of waves. Specially designed forests, ditches, slopes, and berms can slow and strain debris from waves. To work effectively, these techniques are dependent on correctly estimating the inundation that could occur.

Strategy 3: Steering
Steering techniques guide the force of tsunamis away from vulnerable structures and people by strategically spacing structures, using angled walls and ditches, and using paved surfaces that create a low-friction path for water to follow.

Strategy 4: Blocking
Hardened structures such as walls, compacted terraces and berms, parking structures, and other rigid construction can block the force of waves. Blocking, however, may result in amplifying wave-height in reflection or in redirecting wave energy to other areas.

Strengths and limitations of each countermeasure may include but are not limited to: cost, potential damage, sufficient height to withstand tsunami, distance from population, addresses both earthquake and tsunami concerns, strength of construction material, potential for use in tsunami-free times, and aesthetic value.

Activity Procedure:

Choose one of the options below to present this lesson to students.

Option A: Student-led

1. Explain students will examine some existing tsunami and earthquake structural countermeasures. Emphasize structural countermeasures do not ensure safety, however, countermeasures coupled with public education of earthquake and tsunami safety can help minimize the damage to the community and loss of life.
2. Distribute STUDENT WORKSHEET: “Community Considerations for Structural Countermeasures.” Review and discuss the information on the first two pages.
3. Distribute one example from the VISUAL AID: “Structural Countermeasures” to each student or pair of students. Explain they will need to prepare in order to present the countermeasure to the class and guide their peers in determining the planning technique used and its strength and limitations.
4. As each counter measure is presented, the class completes the table on the student worksheet.

Option B: Teacher-led

1. Explain students will examine some existing tsunami and earthquake structural countermeasures. Emphasize that structural countermeasures do not ensure safety, however, countermeasures coupled with public education of earthquake and tsunami safety can help minimize the damage to the community and loss of life.
2. Distribute STUDENT WORKSHEET: “Community Considerations for Structural Countermeasures.” Review and discuss the information on the first two pages.
3. As a class, guide students in examining the countermeasures and identifying planning techniques and countermeasures.

Extension Ideas:

- Ask students to make a model of a countermeasure.
- After completion of the student worksheet, ask students to design a community on paper with tsunami countermeasures.
- Acess and play the Tsunami version of “Stop Disasters!” an online disaster simulation game developed by the UN/International Strategy for Disaster Reduction (www.stopdisastersgame.org).

Lesson Information Sources:

Applied Technology Council, National Earthquake Hazards Reduction Program (U.S.), & National Tsunami Hazard Mitigation Program (U.S.). (2008). *Guidelines for design of structures for vertical evacuation from tsunamis (*FEMA P647). Washington, D.C.: U.S. Dept. of Homeland Security, Federal Emergency Management Agency.

Dalrymple, R.A. & Kriebel, D.L. (Summer 2005). Lessons in engineering from the tsunami in Thailand. Volume 35, Number 2. *The Bridge.* National Academy of Engineering of the National Academies. Retrieved from http://www.nae.edu/nae/bridgecom.nsf/weblinks/MKEZ6DFQZW?-Open Document

Edward, J.K.P., Terazaki, M., Yamaguchi, M. (2006). The impact of tsunami in coastal areas: Coastal protection and disaster prevention measures, Experiences from Japanese coasts. COASTAL MARINE SCIENCE 30,(2),414-424.

International Tsunami Information Centre (http://ioc3.unesco.org/itic/).

National Tsunami Hazard Mitigation Program. (2001). DESIGNING FOR TSUNAMIS SEVEN PRINCIPLES FOR PLANNING AND DESIGNING FOR TSUNAMI HAZARDS. Retrieved from: http://purl.access.gpo.gov/GPO/LPS69015.

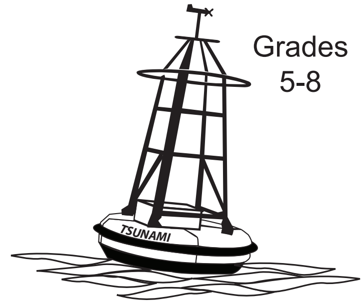
Answers:

Structural Countermeasure	Planning Technique: Avoiding	Slowing	Steering	Blocking	Strengths	Limitations
Berm	X				*Comparative low cost; helps strain debris from waves; may support a lot of people*	*Potential damage from erosion; might not be tall enough*
Existing High Ground	X				*Low cost; avoids entering a building after an earthquake; can support many people*	*May be too far from population; potential erosion damage*
Tasukaru Tower	X				*Low cost; allows water to pass through; easily placed in locations far from high ground*	*Small space for a long duration; might not be tall enough*
Tsunami Breakwater		X	X	X	*Slows and blocks tsunami at a distance from main population; helps with storms*	*Cost; poor aesthetic value; tetrapods can become tsunami debris; potential environmetal damage from decreased water circulation in bays*
Shirahama Elevated Shelter	X				*Built to withstand earthquakes and tsunami; accommodates 700 people; solar powered lighting; aesthetically pleasing*	*High cost*
Nishiki Tower	X		X		*Built for high intensity earthquakes and 10-ton tsunami debris; shelter; round design directs water flow; aesthetically pleasing*	*High cost; safe after earthquake?*
Tsunami Seawall			X	X	*Keeps water out if tall enough; protects from storms; concrete construction*	*Cost; might not be tall enough; blocks scenery*
Elevated Platform on Okushiri	X				*Can hold many people; scenic view point; allows water to pass through; concrete construction*	*Cost; safe after earthquake?; might not be tall enough; open construction exposes people to weather for long periods of time*
Water Gate on Okushiri			X	X	*Operates with seismic sensors, concrete construction*	*Cost; might not be tall enough; blocks scenery*
Tsunami Control Forest		X		X	*Helps block large ocean debris from populated areas; low cost*	*May compete with commercial access to shore; trees may become dangerous debris*
Open Space/Large Lot Zoning	X				*Decreases population and infrastructure in high-risk areas*	*May compete with commercial access to shore*

Name:___________________________

Community Considerations for Structural Countermeasures

Student Worksheet (page 1 of 3)



Grades 5-8

Background Information:

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Name:_________________________

Community Considerations for Structural Countermeasures

Student Worksheet (page 2 of 3)

Directions: In this activity, you will identify the site planning technique employed and the strengths and limitations of each structural countemeasure. The Applied Technology Council, National Earthquake Hazards Reduction Program (U.S.), & National Tsunami Hazard Mitigation Program (U.S.) identify four basic site planning techniques that can be applied to projects to reduce tsunami risk:

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Community Considerations for Structural Countermeasures

Student Worksheet (page 3 of 3)

Structural Countermeasure	Planning Technique: Avoiding	Planning Technique: Slowing	Planning Technique: Steering	Planning Technique: Blocking	Strengths	Limitations