CT Next Generation Science Curriculum-embedded Performance Task

Grade / Course	Grade 4 / Earth Science
Task Name	**Shake, Rattle, and Roll**
Task Summary	Video clips showing images of earthquake prone regions during an earthquake introduce the phenomenon that anchors this activity. Then, working in small groups, students will use internet resources to find information about the surface motions caused by seismic waves and principles of constructing earthquake-resistant structures. Key ideas from that research will be identified and clarified during a whole-group, meaning-making discussion. Next, groups will plan and carry out investigations that address common structural concerns in buildings in earthquake prone areas. Working within the constraints of the problem students will use an engineering design process to design a structure that will withstand testing on an earthquake shake-table, as described by the criteria. Students will make a claim that states reasons for design modifications and provide evidence for their solution to the problem. Evidence should include earthquake research, problem addressed, and experimental data.
Related NGSS PE(s)	**4-ESS3-2:** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. **Clarification Statement:** Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity. **Assessment Boundary:** Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions. **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Lesson Level PE(s)	**LLPE-1:** Plan and carry out investigations using models of structures to determine how to optimize them for withstanding the forces of an earthquake. **LLPE-2:** Read and synthesize information about earth-quake resistant buildings to use as evidence when working collaboratively to design and refine a model of a structure that is able to withstand the forces of earthquakes.
Targeted Science and Engineering Practice(s) • Related SEP Element for Grades 3-5	**Developing and Using Models** • Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. (LLPE-1) • Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. (LLPE-1) **SEP 3: Planning and Carrying Out Investigations** • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (LLPE-1) • Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. (LLPE-1) **SEP 6: Constructing explanations (for science) and designing solutions (for engineering)** • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2; 3-5-ETS1-2; 3-5-

	ETS1-3; LLPE-1) **SEP 7: Engaging in argument from evidence** • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (LLPE-1) **SEP 8: Obtaining, Evaluating, and Communicating Information** • Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices. (LLPE-2)
Targeted Crosscutting Concept(s) • Related CCC Element for Grades 3-5	**Cause and Effect** • Cause and effect relations are routinely identified, tested, and used to explain change.
Targeted Disciplinary Core Idea(s) ***Component Idea** • Related DCI Element for Grades 3-5	**4-ESS3 Earth and Human Activity** ***4-ESS3.B: Natural Hazards** • A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (4-ESS3-2) **3-5-ETS1 Engineering Design** ***3-5-ETS1.B: Designing Solutions to Engineering Problems** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) ***3-5-ETS1.C: Optimizing the Design Solution** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)
Influence of Science, Engineering, and Technology on Society and the Natural World	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)
Targeted Common Core State Standard(s) – English Language Arts	**RI.4.3** - Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. **RI.4.7** - Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **RI.4.9** - Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. **W.4.2** - Write informative/explanatory texts to examine a topic and convey ideas and information clearly. **SL.4.1** - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

Related Common Core State Standard(s) - Mathematics	**MP.3** - Construct viable arguments and critique the reasoning of others.
Context and Alignment	This task should be included in a unit addressing Earth and Human Activity.
Task Components	**Part 1:** Introduction to effects of earthquakes and individual writing assignment the phenomenon presented in a video clip. **Part 2:** Orientation to available research resources. Suggested sites are provided. Collaborative research about seismic waves effects on Earth's surface and recommendations for constructing earthquake-resistant buildings. **Part 3:** Introduction to the ***model earthquake shaker table***. Introduction to common structural concerns in earthquake-prone areas. Investigate effects of selected construction factors on a model structures' ability to withstand simulated earthquake motions. **Part 4:** Develop class-wide criteria and constraints for the product; Prototype and optimize
Suggested Timeline	**Part 1:** 1 class period **Part 2:** 2 class periods **Part 3:** 2 class periods **Part 4:** 2 class periods
Task Materials	• Digital projector connected to one computer. • Computers or tablets with internet access. • Shaker tables to simulate earthquake motions o Foam upholstery cushions (approx. 12" x 12" x 4") o Sheets of 1/8" thick plywood or heavy cardboard (approx. 18" x 18") o (build more sophisticated versions, Google "earthquake shake tables" for ideas.) • Rulers • Scissors • Mini-marshmallows • Index cards • Toothpicks • Coffee stirrers • Pennies • Timer, stopwatch, or clock with second hand
Old CT Science Content Standard(s)	**4.1 –** The position and motion of objects can be changed by pushing or pulling. **4.1.a. -** The size of the change in an object's motion is related to the strength of the push or pull. **4.1.b.** - The more massive an object is, the less effect a given force will have on its motion.
Old CT Science Expected Performance(s)	**B8** - Describe the effects of the strengths of pushes and pulls on the motion of objects. **B9** - Describe the effect of the mass of an object on its motion.
Old CT Science Inquiry Standard(s)	**B INQ.1:** Make observations and ask questions about objects, organisms and the environment. **B INQ.2:** Seek relevant information in books, magazines and electronic media. **B INQ.3:** Design and conduct simple investigations. **B INQ.6:** Analyze, critique and communicate investigations using words, graphs and drawings. **B INQ.8:** Search the Web and locate relevant science information

	TASK ADMINISTRATION / SEQUENCE OVERVIEW
Prerequisites	Experience working collaboratively in small groups. Familiar with norms for whole-class discourse.
Part 1 :	
Duration	1 class period + homework
Preparation	Provide a student packet for each student in your class. Prepare the video projector to show the class the earthquake video: https://www.youtube.com/watch?v=4Y-62Ti5_6s Check that it is accessible (not blocked by school's firewall) and functioning properly (compatible with the hardware being used). Assign student pairs or let students choose their own partners. For each pair, provide access to computers, tablets, or other devices with internet access so they may explore the suggested resources. Become familiar with all of the suggested digital resources yourself.
Activity Summary	Introduce students to the problem by showing video of earthquake movement and damage. https://www.youtube.com/watch?v=4Y-62Ti5_6s . Then ask: "What did you notice in this video clip?" "What do you wonder about the events and objects you observed while watching the video?" Record student ideas and questions on a whole-class I notice, I wonder chart posted for all to refer to later. Introduce task by stating, "During the next few lessons each of you will become a member of a structural engineering team. Engineers at our company keep trying to make buildings better able to withstand destructive forces of earthquakes. In a few days your team, will design and construct a scale model of a building that can withstand the forces associated with earthquakes using materials that are provided." Distribute the Student Packets and direct the class to read the introduction on page 1. Clarify the writing assignment if needed and allow the students to view the video clip (and any others you have identified) as a group or on individual devices. Let them know that this writing assignment is due at the end of the class period. Quickly look over the submitted free writing samples as a formative assessment of student understanding of the problem they will be addressing. Do not grade this part of the task for science content knowledge. Students will research the types of waves produced by earthquakes, the resulting motions of the earth's surface, as well as the forces that may affect the stability of the structure. Discuss it with them to assure that all of them understand the task:

Part 2:	
Duration	2 class periods
Preparation	Plan for organizing your students into design teams, each composed of 3 to 4 students. Have a pad of small sticky notes available. Arrange to have 1:1 student access to computers, tablets, or other devices with internet access. Check that the websites recommended for research are accessible (not blocked by school's firewall) and functioning properly (compatible with the hardware being used). Become familiar with all of the suggested resources yourself. LINKS: http://legacy.mos.org/etf/force.html http://www.iris.edu/hq/programs/education_and_outreach/animations/6 http://www.safestronghome.com/earthquake/01.asp http://www.iitk.ac.in/nicee/EQTips/EQTip09.pdf http://www.iris.edu/hq/files/programs/education_and_outreach/aotm/6/SeismicWaveBehavior_Building.pdf http://www.geo.mtu.edu/UPSeis/waves.html http://www.exploratorium.edu/faultline/activezone/index.html Return the Student Packets to the students.
Activity Summary	Welcome your geophysical scientists to work. Then initiate whole group discourse by asking: Say, "Think back to the videos we saw yesterday. During earthquakes, why do you think some buildings remain intact structurally, while others are destroyed? How can we find out how to build an earthquake resistant structure?" Organize students into the design teams you planned. Give them a few minutes to read and discuss the task presented on p. 2 of their packets. Offer to clarify any questions groups may have about the task. Ask a few students to explain the task to the class to check their understanding of the expectations. Allow the rest of the class period for the small groups to collaboratively explore the provided website. For efficiency, suggest they divide the responsibility through a jigsaw approach in their groups. Initiate the next day's research time, by asking, "What have you learned so far from the research that should help your group design effective earthquake resistant structures? What are some other key things you still need to know? With that focus in mind, groups should finish their research reviews and record relevant findings. If your students have not done research reviews before, provide clear expectations to help ensure their success.
Differentiation	Limit the number of links students are expected to utilize if you think they would be overwhelmed by the task at hand. Provide guiding questions to focus students' research.

Part 3	
Duration	2 class periods
Preparation	Materials for structures and testing should be available. Room set up for small group work in design teams.
Activity Summary	Students will build "model earthquake shaker tables" to simulate the different types of seismic waves related to an earthquake and determine the types of surface motion related to each wave. The basic model is a piece of plywood or cardboard on top of a foam cushion, but there are more sophisticated designs available on-line. Just do a Google search for "earthquake shake table" to locate them. Direct the class to read the instructions on page 3 of their packets and discuss them with their team mates. Clarify any questions that come up. Student groups will plan their experiment by choosing the independent variable they will test from a list of common structural concerns in buildings found in seismic areas. (The teacher could use the list below or could have students brainstorm their own list.) • Type of roof • Open Spaces • Unreinforced walls • Type of Footing • Height of Building • Flexibility • Useable Area • Distribution of Load It is best for groups in each class to each select a different independent variable to study. Though you could assign the variable to be explored to each group, letting groups reach consensus, then choosing their own focus tends to foster greater student engagement. If more than one group wants the same topic, you can randomly determine the order in which groups select (draw straws, pull numbers, etc.) Each member of each design group should complete the questions and drawings through page 9 of the packet. Carefully monitor progress as groups work and provide appropriate scaffolding through questioning. Tell groups to be prepared to present their findings to the class during the design team meeting that will begin 15 minutes before the end of the second period working on Part 3. (Let the students know the corresponding time/date for clarity.) During that meeting each group should concisely state their conclusion on a poster to be displayed for future reference.
Differentiation	Students who are unfamiliar with setting up a controlled experiment may require additional guidance. If some groups finish ahead of others, suggest that they repeat their trials to provide more validity to their findings.

Part 4:	
Duration	2 Class periods
Preparation	Materials for structures and testing should be available. Room set up for small group work in design teams.

Activity Summary	During a whole class, design team meeting, outline the final activity: Each team will consider findings from all of the teams' investigations on specific construction issues and design a new prototype. The class will first reach consensus about the criteria for success and the constraints for the project. Allow 5 minutes for discussion within design teams during which students will jot down ideas in the first table on page 10 of the Student Packet. Then, have 10 minutes of whole group discourse which will result in a list something like this:
	
	<u>Example List of Class Developed Criteria and Constraints</u>
	Criteria:
	• Structure withstands 10 seconds of shaking with no damage
	• Structure remains in original position after 10 seconds of shaking
	• Structure is at least 30 cm tall
	• Structure supports at least 10 pennies
	Constraints:
	• Structure includes no more than:
	  o 30 mini-marshmallows
	  o 50 toothpicks
	  o 4 index cards
	• Design team has only one pair of scissors
	• Structure may not be touched during testing
	
	Direct students to record the agreed upon criteria and constraints for the final structure in the table at the bottom of page 10 of their packets.
	
	Note that the provided rubric at the end of the student packet has blanks to be filled in with the criteria and constraints from the company (class) consensus discussion.
	
	Groups will sketch design concept, construct first prototype, keep records of design process, test prototype, analyze performance, identify needed changes, …. then repeat cycle at least 2 more times to produce an optimized structure. Engineering Logs for 3 design cycles are included in the student packet. Provide extra copies of the Engineering Logs for groups as needed.

Summative Assessment	See rubric in the student materials.