**Granular Flow**
**2024 NHERI DesignSafe-CI REU**
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- **Summary-** Students will learn about granular flow (which is the mechanism behind landslides), its effects, and possible mitigation by creating granular flow and baffles models.

- **Engineering Connection-** Students will tie the designs of the models to real analysis of landslide resistant model.

- **Audience-** 3-5 grade

- **Lesson Objectives**- -Understand what granular flow is and why it happens
  - Create granular flow model to understand the effects of granular flow
  -Students engineer barriers that can best withstand the granular flow.
  **Educational Standards-** Texas Education Agency. (2017). §112.15. Science, Grade 4, Adopted 2017.

- **Material List: Granular flow: -**water, coffeground, sand, pepples, big plastic container, red solo cup
  - **Baffle:** legos, water bottle, paper sample cups, plastic sample cups
  - **Boundary:** clear plastic stackable container, rubber/wooden door stoper
  - **Buildings:** paper houses, Lego houses, wooden houses

- **Introduction-** Introduce the engineering design process through an experiment to understand how researchers and engineers mitigate the effects of landslide.

- **Procedure-** Explain how someone else can implement your lesson plan by creating a list of instructions separated by the secondary titles below.
  - Background knowledge: Scientific method, natural disasters, motion
  - Before the activity:
    - Make interactive Granular flow presentation for 3$^{rd}$ to 5$^{th}$ graders, that explains what granular flow is and its effects.

        - Make granular flow mixture by mixing coffee ground, sand, pebbles in plastic container
        - Pour out mixture in red solo cup at each station
        - Make incline by placing door stopper under the taller side of the clear plastic container
        - Set up each type of houses at each station
        - Set incline at each station
        - Lay out different type of barrier material at each station
        - Create worksheet that include observations and analysis of the barriers' performance.
        - Handout worksheet
    - During the activity:
        - Give presentation on granular flow at the start of the activity, include instructions
        - Student choose houses they think would best resist damage
        - Students make barrier, based on the material at their current station
        - Students add water to solo cup to get a thick mud consistency
        - Students set up barrier inside clear plastic container
        - Pour granular mixture into clear plastic container
        - Observe affects and fill in worksheet for that station
        - Go to next station and recreate experiment with different baffle type and/or house type
        - Repeat done with stations
    - After the activity:
        - Students clean up
- **Assessment-** Student discuss their analysis on the best material for house type and barriers and explain why they chose that material type based on their observations.

- **Wrap-up-** Instruct students to recreate landslide using the following online simulation: https://hillsidetrust.org/landslide-info/