"*Development of a Lab Scale Flume* Experimental *Setup for Studying Dynamics of Granular Flow".*

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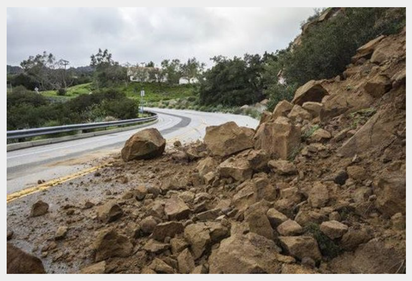
MOTIVATION AND INTRODUCTION

- Lab-scale flume project to study granular flow dynamics.
- Replicates real-world conditions like slope gradients and sediment concentrations.
- Focuses on understanding and mitigating debris flow impact.
- Conducts detailed analysis in a controlled environment.
- Critical for research in mountainous regions prone to debris flow hazards..



landslide near IIT Mandi.

EXPERIMENTAL SETUP

Flume setup consists of:

- Flume
- Flume stand
- Gate release system
- Pulley mechanism
- Inclination aspects
- Ring light
- Camera

METHODOLOGY

- Finalising the material
- Construction of flume
- Construction of support apparatus
- Testing and experimenting
- Data analysis

MATERIAL
Some materials initially taken into account:

- Plexiglass
- Acrylic sheet
- Quartz glass
- Polystyrene
- Fiberglass

Toughened glass stood out for it's
➔ Durability
➔ Transparency
➔ Scratch resistance

CONSTRUCTION OF FLUME

- Dimensions of flume:
  Length-1.5m
  Width-0.4m
  Height-0.7m
- Satisfies constraints like portableness,volume of debris and cost effectiveness
- L- Holders and silicone gel were used to provide structural integrity.
- Two grooves were made at 0.15m and 0.30m
- Grooves were made to facilitate insertion of gates
- These helped in testing 9 aspect ratios

CONSTRUCTION OF SUPPORT APPARATUS

- Flume stand with slope changing aspect.
- Consists of wheels facilitating the movement.
- Pulley mechanism to avoid any premature release.
- Helps to lift the gate with less force comparatively.
- With a good support and height to accommodate the gate when lifted.

Stand facilitating pulley mechanism.

Experimental setup consisting of flume supported by flume stand and pulley stand.

Instance of an experiment with coarse sand with aspect ratio=3

TESTING AND EXPERIMENTING

- Fine sand and coarse sand were used
- Positioning of camera and ring light.
- Segmentation into photos from recorded videos.
- Tested 5 aspect ratios with 0.15m grooved gate
- Tested 4 aspect ratios with 0.30m grooved gate
- Every aspect ratio was tested with both types of sand.

Instance of an experiment with fine sand and aspect ratio=3

- To calculate void ratio , $e = V_v/V_s$
- e = 62.5 %
  Where ,
  e - void ratio
  V_v - Volume of voids in the Material
  V_s - Volume of solids in the Material

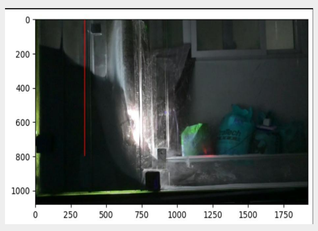
- To calculate porosity , $n = V_v/V_T$
- n = 39.7%
  Where ,
  n - porosity
  V_v - Volume of voids in the Material
  V_T - Total Volume of Material

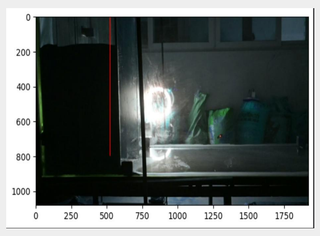
- To Calculate Relative Density,
  $D = e_{max} - e / e_{max} - e_{min}$
  D = 57.1%
  Where ,
  D - Relative Density
  e_{max} - maximum possible value of e
  e_{min} - minimum possible value of e
  e - void ratio

Coarse sand

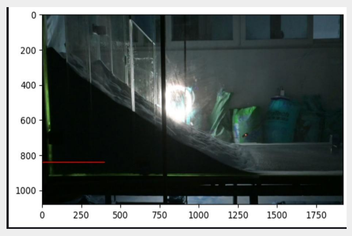
Fine sand

DATA ANALYSIS

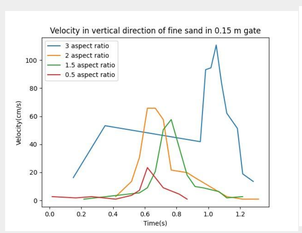


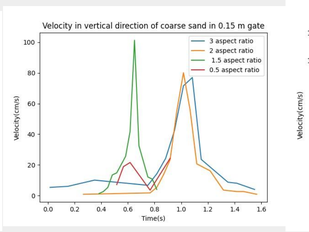


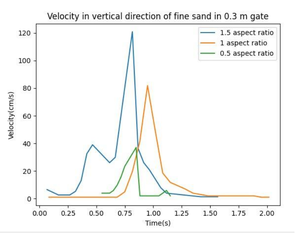
- Use of backlighting technique
- Ring light was set exactly opposite to the flow and camera.
- Analysing pixels/unit using scale
- Measuring distance travelled by a particle in consecutive frames
- Calculating time taken from frequency
- Analysing horizontal and vertical velocity
- Reference lines for both gates are shown in the figures

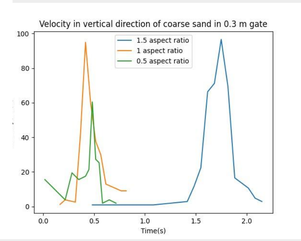


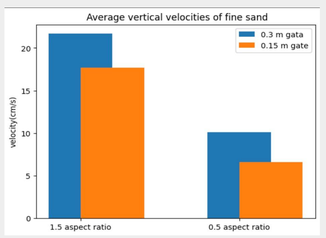
RESULTS OF DATA ANALYSIS

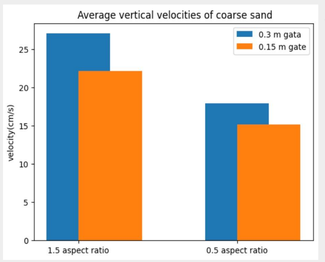


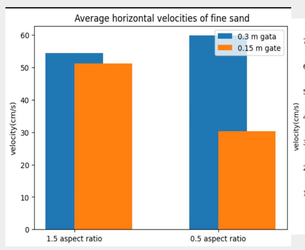


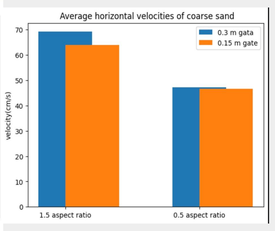




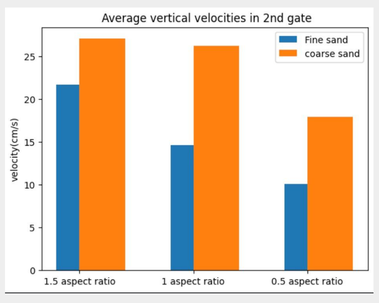


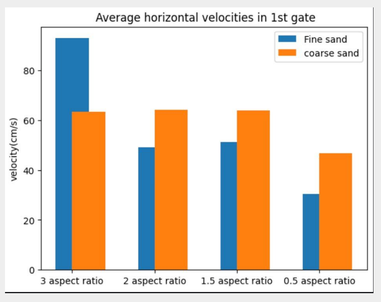


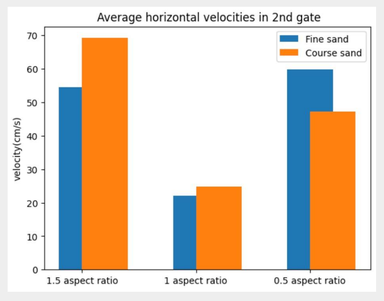




Comparison between fine sand and coarse sand







Comparison between velocities at two grooves(0.15m and 0.30m)

ADVANTAGES

- Scaling down natural phenomena in a lab setting
- Researchers can simulate different scenarios
- Variables can be well controlled
- Cost effective
- Reproducible
- Technology Integration
- Experiments can be done quickly and efficiently
- Enables researchers to perform sensitivity analysis

FUTURE ASPECTS

- Experiments involving slope changes
- Varying water content in debris
- Pressure impact on obstacles
- Particle Image Velocimetry
- Varying particle size
- Influence of channel roughness
- Analyze particle size segregation
- Effect of vegetation on debris flow

CONCLUSION

- Dimensions of flume and positioning of grooves played a major role in analysing granular flow
- Higher aspect ratios result in increased velocity.
- Vertical and horizontal velocities of fine sand exceed those of coarse sand.
- Velocities from the 0.30m gate are generally higher than those from the 0.15m gate.

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