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1. Problem statement

Demonstrate a working case of non-spherical particle movement using an open-source software package.

2. CAD

Created a 2D geometry representing the dam. The domain consists of four blocks (for water, oil, Galistan, and air) and an obstacle at the bottom.

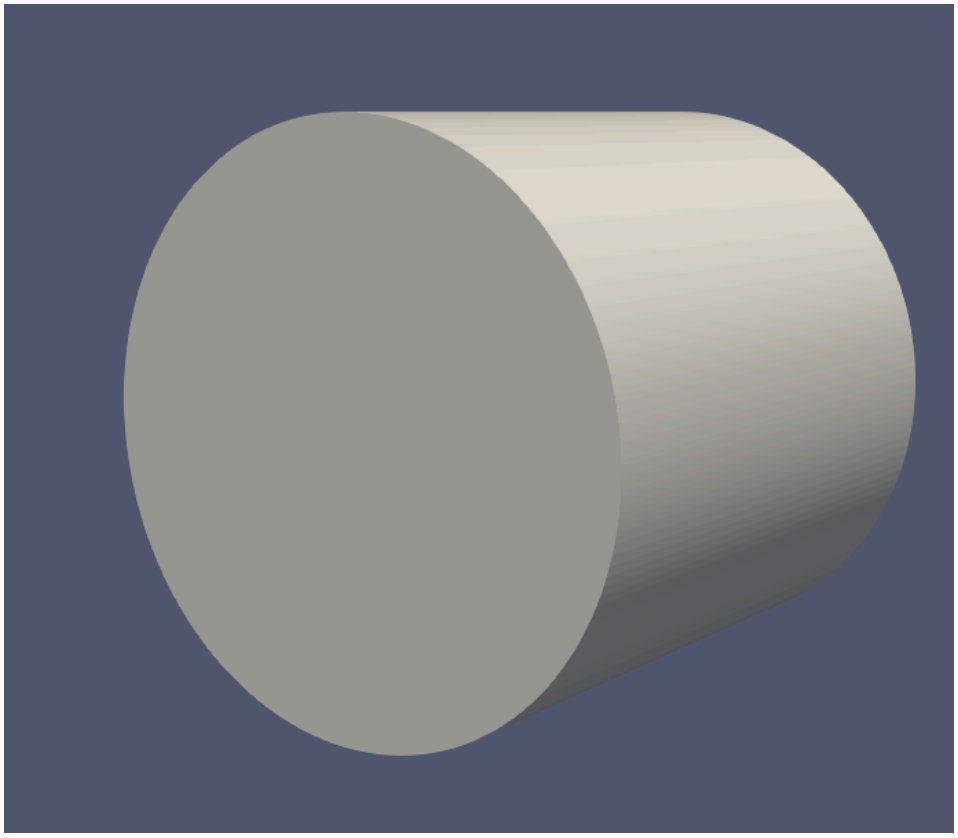

Fig 1. CAD Model

3. Meshing

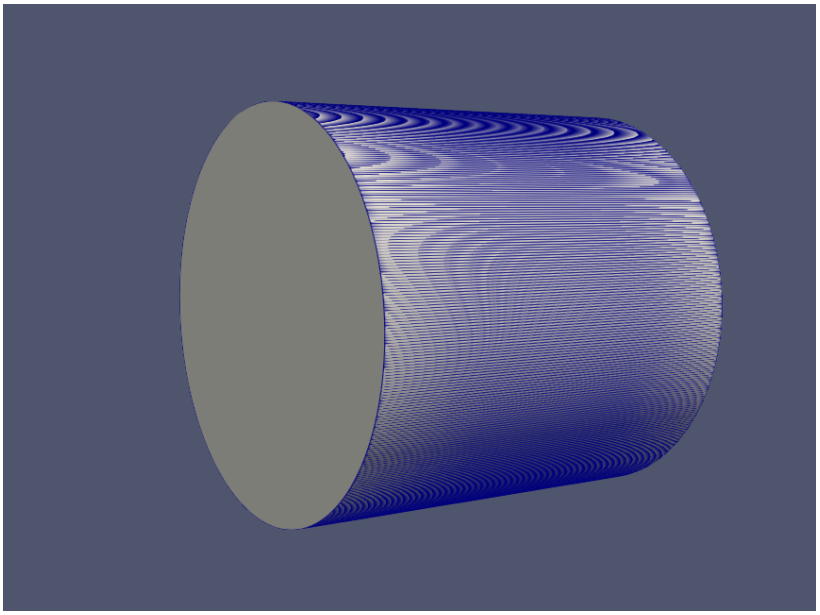

Fig 2. Structured meshing performed

Particle Size:

- The particles are represented as cuboids with dimensions specified by `particle_size = np.array([0.5, 1.0, 0.5])`.

Tube Discretization:

- The tube is plotted with a resolution of 100 points along its length and circumference, as specified by `np.linspace(0, tube_length, 100)` and `np.linspace(0, 2 * np.pi, 100)`.

Time Step:

- The time step for updating particle positions is `time_step = 0.01`

5. Data Visualization

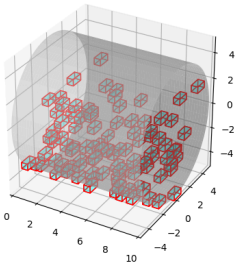

Fig3.1

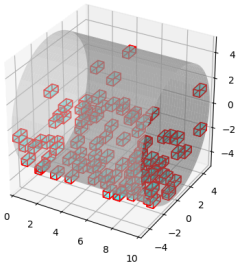

Fig3.2

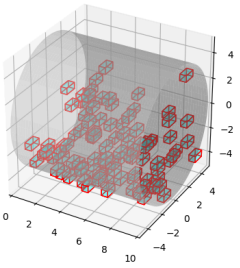

Fig3.2

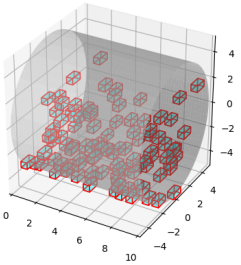

Fig3.4

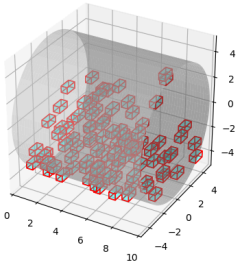

Fig3.5

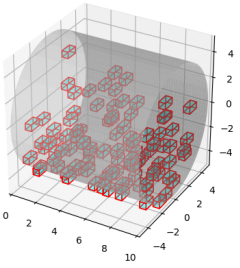

Fig3.6

Fig 3 Visualization of particle movement at random intervals stating its non-settlement over space and time. Further observations can be made by varying the number of particles and force applications on it.

We have used MatplotLib, PyPlot, Animation and Poly3Dcollection for this simulation. As `Poly3DCollection` is utilized for visualizing complex 3D shapes and polygons in simulations, offering customization options like color and transparency. It integrates seamlessly with `matplotlib`, ensuring efficient and detailed rendering suitable for scientific and engineering visualizations.

6. Physics

The method used here is the Discrete Element Method (DEM) which was proposed by Cundall et al., is a widely used method for studying particle systems. It offers several advantages: Records positions, forces, and velocities of particles and equipment separately and can easily be coupled with FEM (Finite Element Method) and CFD (Computational Fluid Dynamics)**.** The approach is inspired by Stokesian Dynamics for the computation of drag forces and torques when using the multi-sphere method for the representation of non-spherical particles.

7. Performance:

The current simulation is run using python script. Performance study has not been performed here. Comparisons can be made analyzing the shape effects of the particle and size for applications like ball milling process.

8. Accuracy:

The simulation accurately represents particle shapes as polyhedrons, including irregularities and sharp edges typical of real-world particles. This fidelity ensures that the simulation reflects the true geometrical complexities encountered in industrial processes.