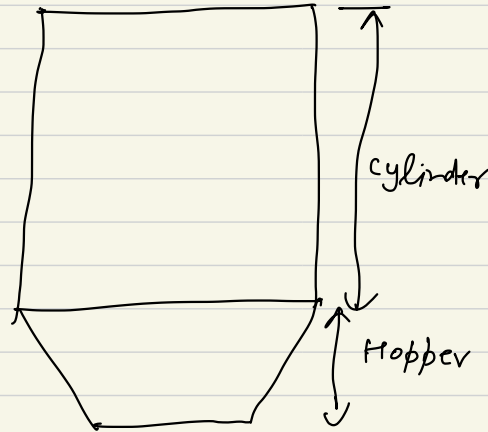


## Lecture - 9

- Bins are wider & short in height
- Silos are tall & smaller in dia



Flow of bulk solids:

—————x—————

Factors affecting flowability of  
granular solids & powders:

—————x—————

- moisture content
- Humidity
- Temp
- Pressure
- Particle size

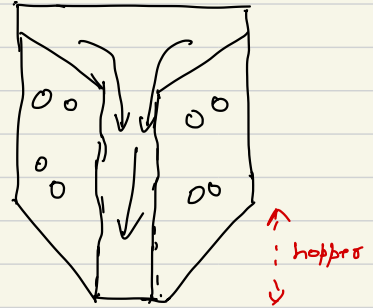
Other imp. properties

- Angle of repose
- Bulk density
- frictional forces
- Compressibility

\* usually three type of flow patterns are observed:

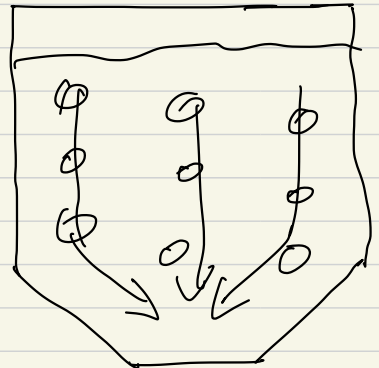
### ① Funnel-flow pattern:

- Best suited for free flowing, non-segregating bulk solids & not recommended for cohesive solids
- A cylindrical flow channel develops at the centre of bin above discharge outlet while the material against the bin walls remains stationary
- if hopper walls are not steep or if inside wall of the vessel is rough, a funnel flow pattern will develop & stagnant areas will appear



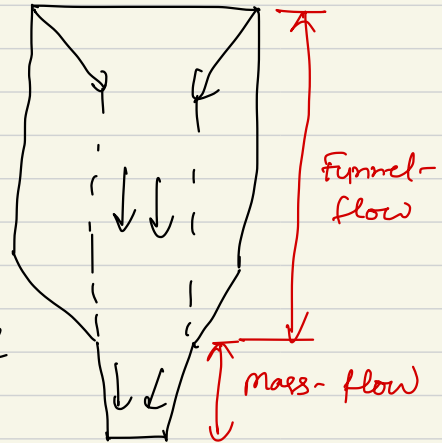
### ② Mass-flow pattern:

- ideal for cohesive solids
- All the bulk solids move whenever any of it is withdrawn
- Stagnant zones are eliminated.



### ③ Expanded flow bin:

- Combination of both mass & funnel flow
- Funnel flow is observed in upper portion while mass flow is observed in lower section of the vessel



### Problems associated with flow of bulk solids:

- No flow: A high pressure often packs the solids more tightly rather increasing the flow. A stable arch is formed over hopper outlet & solids don't fall even material below is removed. The arch is strong enough to support weight of material above it and must be broken by arch breakers or by air jets to induce flow again. vibrations tend to strengthen the arch as they cause more compaction of solid particles.

- Erratic flow: Frequent formation & collapse of arches result in fluctuating discharge causing uneven vibrations which can lead to structural damage & personnel injuries.
- Flushing or flooding: when arch collapses, the solid fall uncontrollably into open channel under pressure.
- Segregation: During filling of a storage vessel, the finer particles move towards the central portion while larger particles move towards the wall which cause finer particles to discharge first & coarser particles last.