1. Material Data Required Before Silo Selection

Reliable bottom selection starts with measured material behavior. Nominal silo volume alone does not determine stored mass, flow pattern or discharge reliability.

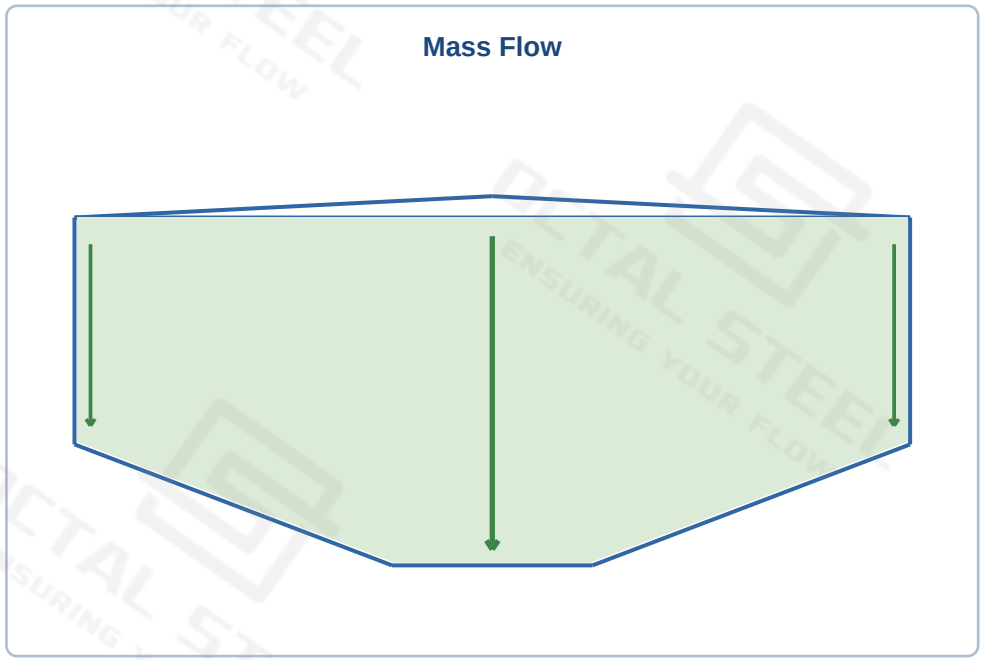
Required Input	What Must Be Confirmed	Design Effect
Bulk density	Loose, aerated and settled values	Stored mass, wall loading, foundation load and usable capacity
Flowability	Cohesion, wall friction and consolidation behavior	Bottom geometry, outlet size and need for flow assistance
Moisture condition	Normal, seasonal and upset values	Caking, corrosion, storage stability and restart behavior
Particle size and fines	Size distribution and dust fraction	Segregation, vent-filter duty, wear and outlet behavior
Abrasiveness	Wear tendency at bends, impact zones and outlets	Local liners, protected outlets and conveyor selection
Storage and discharge duty	Retention time, turnover, required rate and residual limit	Flat bottom, hopper bottom, reclaim coverage and feeder duty

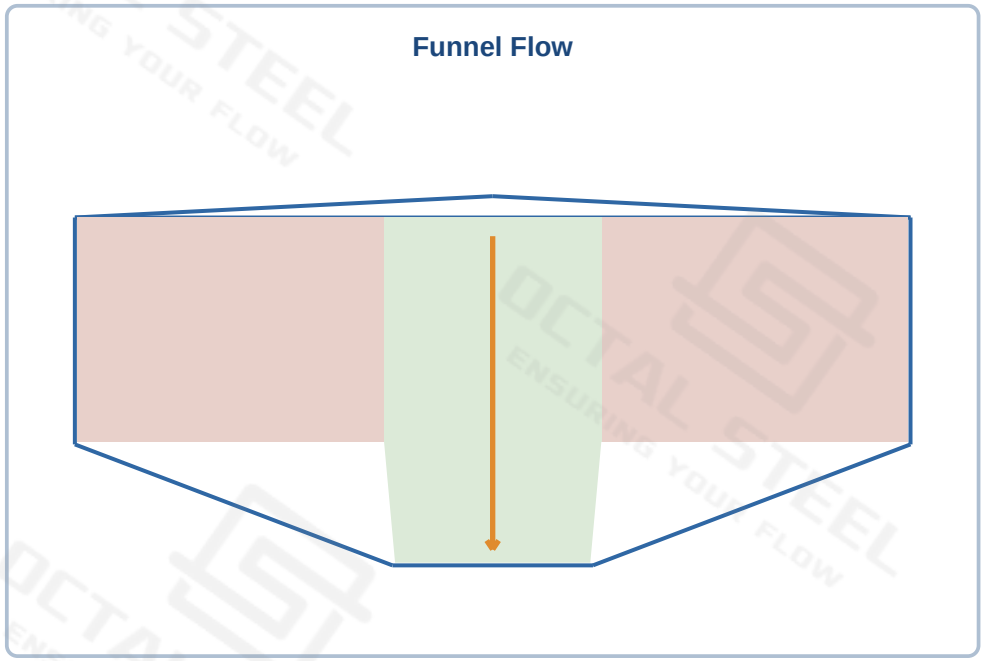
Use an agreed **design bulk density**. Loose, aerated and settled densities are different operating states.

Define the **required discharge rate**, **allowable residual material** and **downstream equipment** before fixing the bottom arrangement.

2. Mass Flow and Funnel Flow

The principal discharge patterns are mass flow and funnel flow. Their difference is whether material at the hopper walls moves when material is withdrawn.

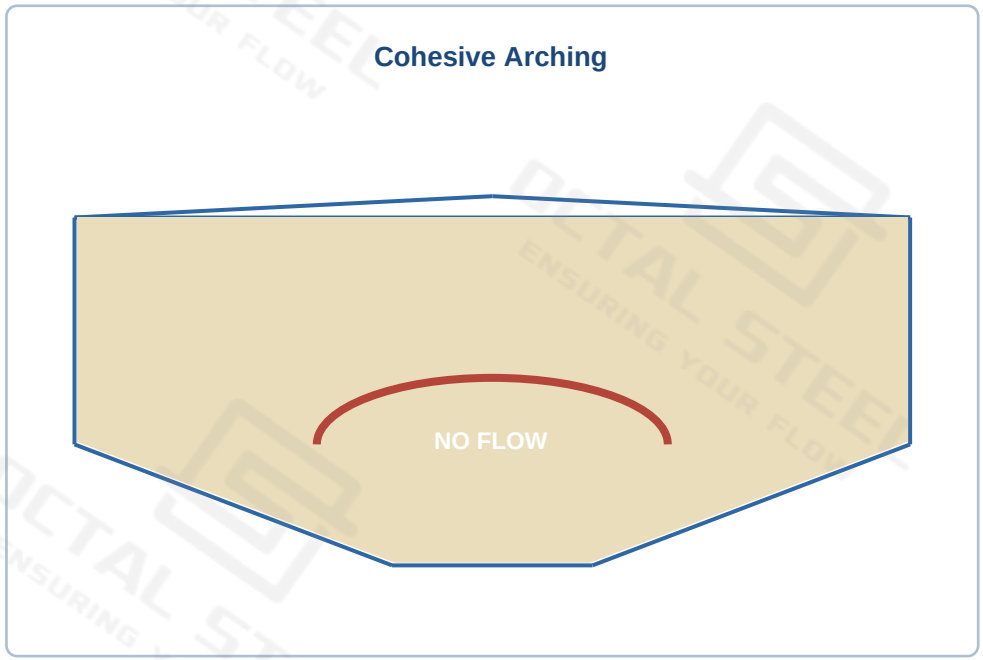


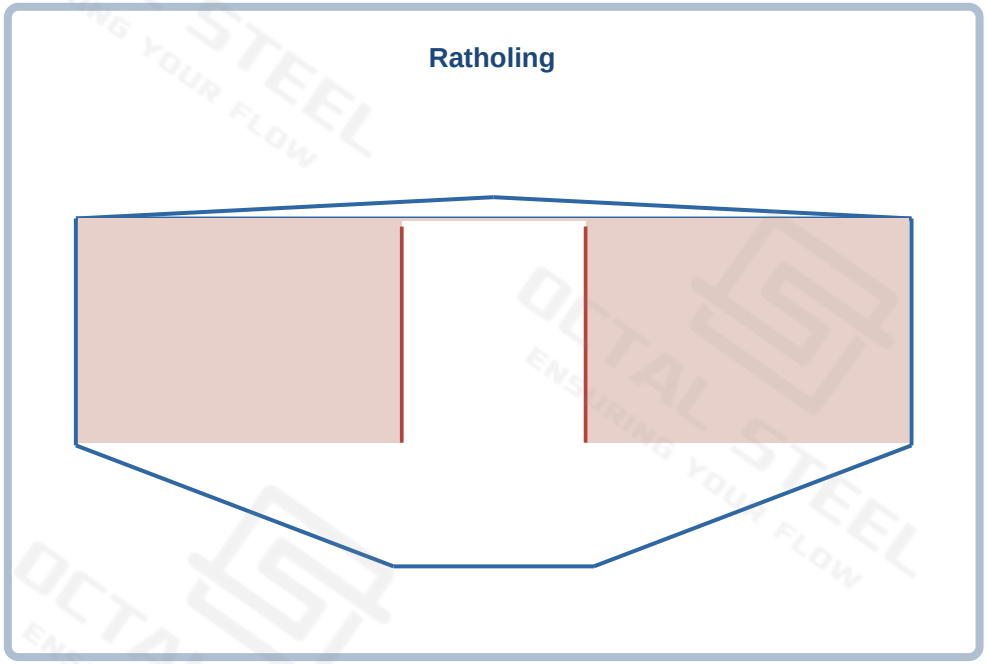


Flow Pattern	What Happens	Practical Consequence
Mass flow	All stored material is in motion during withdrawal, including material at the hopper walls.	Predictable residence time, lower segregation risk and minimal stagnant inventory.
Funnel flow	A central channel moves while material beside the walls remains stationary.	Reduced live capacity, variable residence time and possible stagnant side zones.

3. Arching and Ratholing

Arching and ratholing are distinct flow obstructions. Both are governed by the material's cohesive strength, consolidation state and the geometry of the outlet or flow channel.



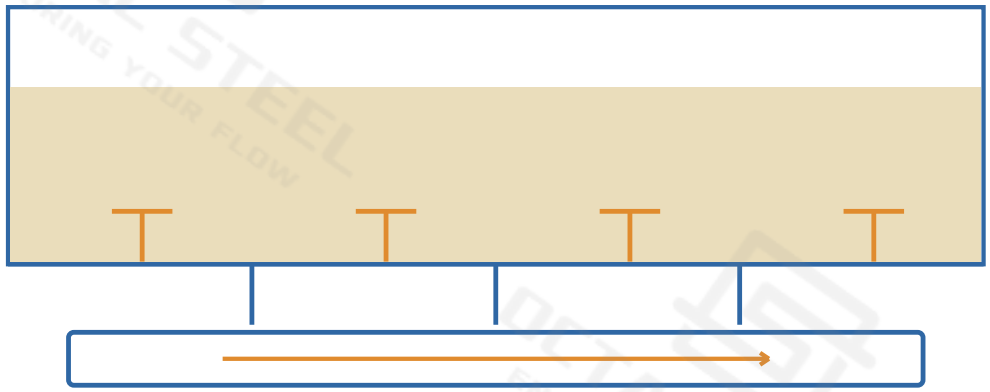


Condition	Definition	Design Response
Arching / bridging	A stable arch forms across the outlet and stops flow.	Outlet size and shape must be checked against the material's cohesive strength.
Ratholing	A stable vertical channel remains after the central material has discharged.	Flow-channel size, wall friction and consolidation must be addressed; vibration alone may not solve the root cause.

4. Flat-Bottom Silo Configuration

Flat-bottom silos are used where large storage volume is required. Because gravity does not recover the full floor area, the reclaim system must be designed together with the floor and outlets.

Selection Item	Engineering Focus
Typical duty	Large inventory, long retention or bulk receiving.
Reclaim arrangement	Aerated zones, air slides, screw conveyors, drag conveyors, sweep augers or mechanical reclaimers.
Main checks	Reclaim coverage, outlet zoning, residual quantity and maintenance access.
Main limitation	A single central opening does not provide complete reclaim from a wide flat floor.



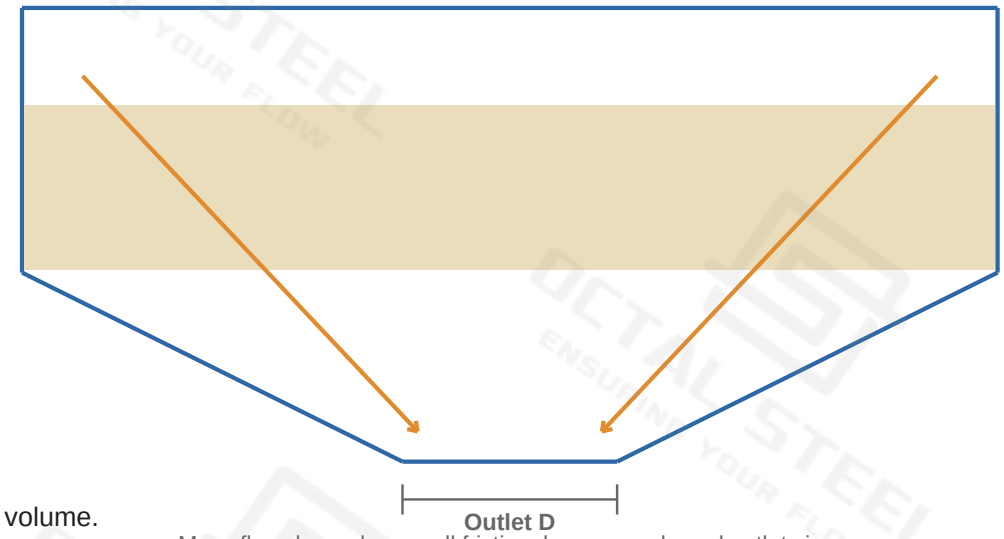
Multiple reclaim zones feed a common conveyor or air slide.

- **Use when:** storage volume is the main duty and full gravity emptying is not required.
- **Define early:** the floor reclaim path and residual-material target before civil construction.
- **For powders:** aeration zones must be matched to the material and outlet sequence.

5. Hopper-Bottom Silo Configuration

Hopper-bottom silos direct material toward one or more outlets and are commonly used for frequent discharge, batching or process buffering. A steep cone alone does not guarantee reliable flow.

Selection Item	Engineering Focus
Typical duty	Frequent discharge, metered feeding or smaller process inventory.
Performance controls	Wall friction, hopper angle, outlet size, consolidation and feeder drawdown.
Typical equipment	Gate, rotary valve, screw feeder, air slide or controlled feeder.
Main limitation	Poorly flowing powder can still arch or rathole if geometry is not matched to measured flow properties.



Mass flow depends on wall friction, hopper angle and outlet size.

- **Use when:** controlled, repeated discharge is more important than maximum storage volume.
- **Confirm:** the feeder activates the full outlet; an undersized feeder can convert intended mass flow to funnel flow.
- **Do not select by angle of repose alone:** wall-friction and cohesive-strength data are more relevant.

6. Material-to-Discharge Selection Matrix

The matrix below links common storage materials to the first engineering checks for bottom and discharge selection. It is a screening tool, not a substitute for representative flow testing where the material is cohesive or variable.

Material / Condition	Primary Selection Check	Typical Discharge Arrangement
Free-flowing grain	Outlet position, preservation and reclaim coverage	Gravity outlet, chain conveyor or sweep auger
Cement	Storage time, consolidation and moisture protection	Aeration, air slide or screw conveyor
Fly ash	Aeration state, settled density and flooding tendency	Controlled fluidization and metered feeder
Fine mineral powder	Cohesion, wall friction and abrasiveness	Designed hopper, flow aid and wear-protected feeder
Dried sand	Particle size, outlet size and wear	Gravity outlet, belt conveyor or screw conveyor

Project Condition	Configuration Direction
Large storage + long retention	Flat-bottom silo with defined reclaim coverage and residual-material strategy.
Frequent discharge + metered feed	Hopper-bottom or process-bin arrangement with a feeder matched to the full outlet.
Cohesive powder or variable moisture	Representative flow testing before fixing hopper angle, wall finish or outlet size.
High fines + pneumatic filling	Coordinate venting, de-aeration, pressure protection and discharge control.

7. Discharge Performance and Commissioning Checks

Commissioning must verify the discharge pattern, not only whether material can leave the silo. Stable operation requires the expected rate, acceptable residual inventory and compatibility with the downstream feeder or conveyor.

Observed Condition	Typical Indication	Main Check
Normal	Stable rate and predictable feeder load	Outlet capacity, reclaim zoning and downstream matching
Starved	Rate declines or feeder receives insufficient material	Arching, rathole, dead zones, aeration or outlet restriction
Surging	Alternating starvation and flooding	Unstable flow channel, feeder control or excessive fluidization
Blocked	No flow after storage or restart	Caking, consolidation, outlet size or local buildup

Commissioning Checklist

- Confirm actual bulk density and moisture condition.
- Record start-up and steady discharge rates.
- Test after short and long holding periods.
- Inspect residual material outside the reclaim zone.
- Verify aeration pressure or airflow where fitted.
- Record feeder load, motor current and dust release.
- Confirm downstream equipment accepts the flow pattern.
- Document normal, starved, surging and blocked states.

Acceptance should cover **normal**, **starved**, **surging** and **blocked** conditions. A system that empties only under ideal conditions is not fully commissioned.