JENIKE® & JOHANSON
SCIENCE ENGINEERING DESIGN

Improving Stockpile Capacity

SME – Denver, Colorado

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Jenike.com

Outline

- Stockpile types
- What limits stockpile capacity
- Concepts to improve stockpile capacity

Jenike & Johanson

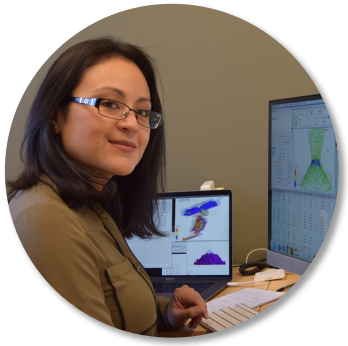
AUSTRALIA BRAZIL CANADA CHILE USA

Scientific approach – based on your materials – 55+ years of experience
Not a trial-and-error approach

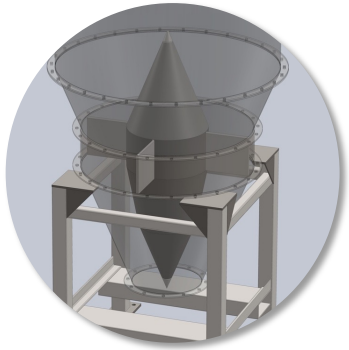
A specialized engineering firm focused on providing clients solutions to material handling applications

On-site Assessments & Inspections

Testing & Physical Modeling



Technology, Computer Simulations



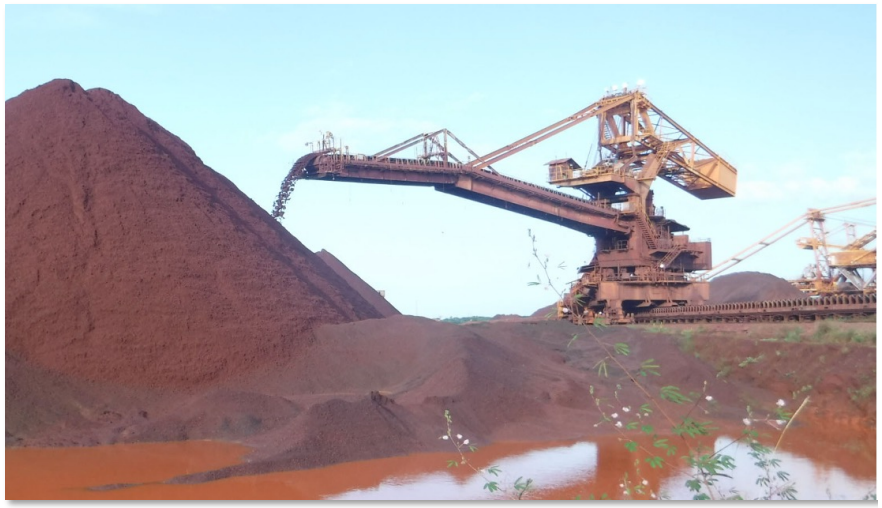
Conceptual Engineering, Flowability Review, Detailed Design, Equipment Supply

Stockpiles

- Economical storage
- 5 to 500,000 tonnes
- Capacity of the stockpiles can range from 7 to 45 days
- Covered or not
- Built by stackers, trippers, loaders
- Mobile equipment - loaders, scrapers
- Stackers / reclaimers - drag, bucket wheel
- Gravity - hoppers, feeders, gates

Stockpiles

- Disadvantage: rainwater and infiltration in the stack as a result of long lasting and continuous rainfall, affect flowability and in some cases slope stability.
- High moisture content ore can have significant consequences in process steps downstream of the stockpile
  - liquefaction and flooding
  - moisture content above the Transportable Moisture Limit.
- Proper gravity reclaim design can typically yield 15%-30% “live” capacity but can be as low as 3% - 6% with cohesive solids.



Gravity Reclaim Stockpiles

Common Flow Problems

Stockpiles

Stockpile ratholes and/or arching

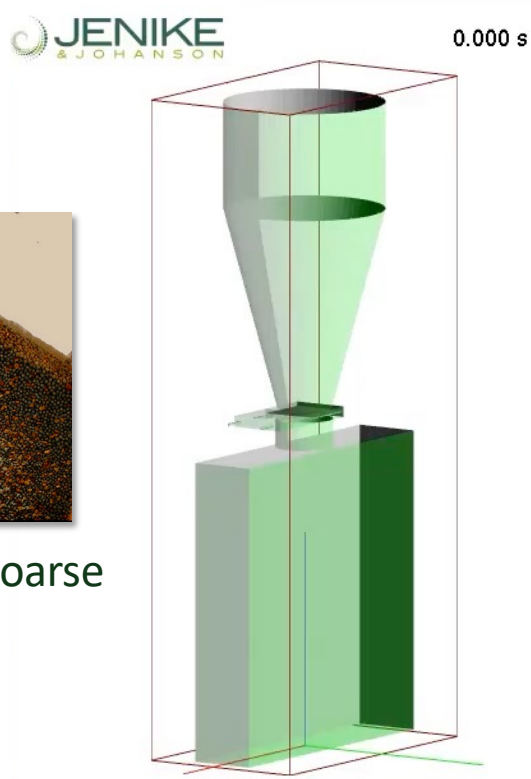
Limited live capacity

Sifting Segregation

Coarse → high permeability, easier to discharge

Fines → low permeability, more difficult to discharge depending on equipment

Coarse Fines Coarse



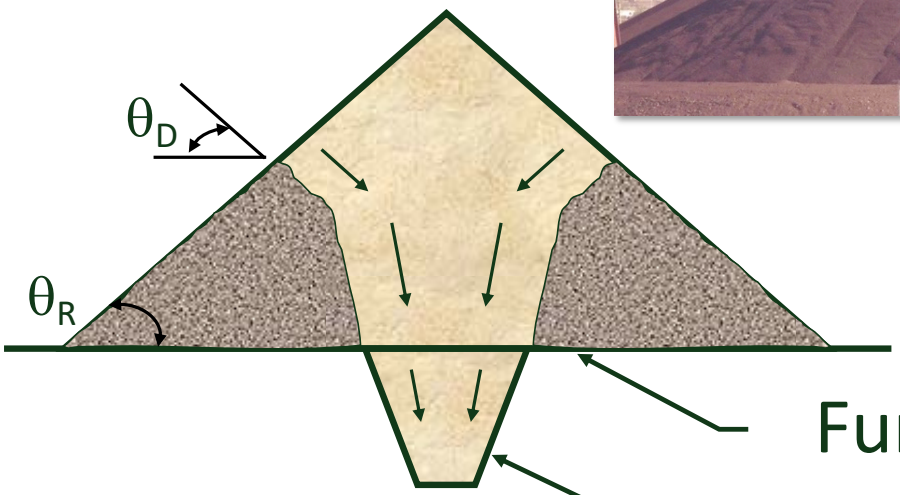
Consequences of Flow Problems

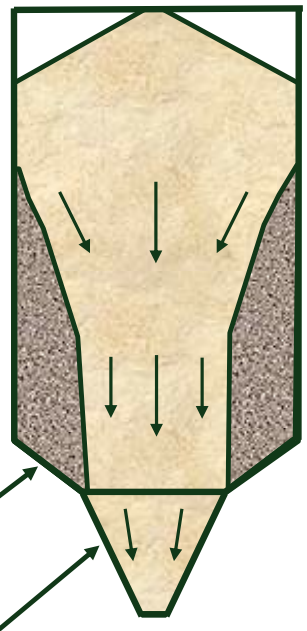
- Limited “live” storage capacity
- Poor operations
- Excessive downtime
- Structural failure due to collapsing ratholes
- Safety issues

A very dangerous practice – can be deadly!

Expanded Flow

θ_D = Drawdown angle
θ_R = Angle of repose

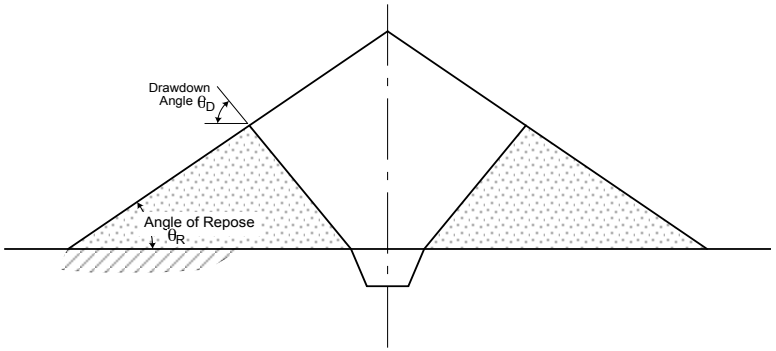




Funnel Flow

Mass Flow

Angle of Repose, Flow Channel, Drawdown Angle



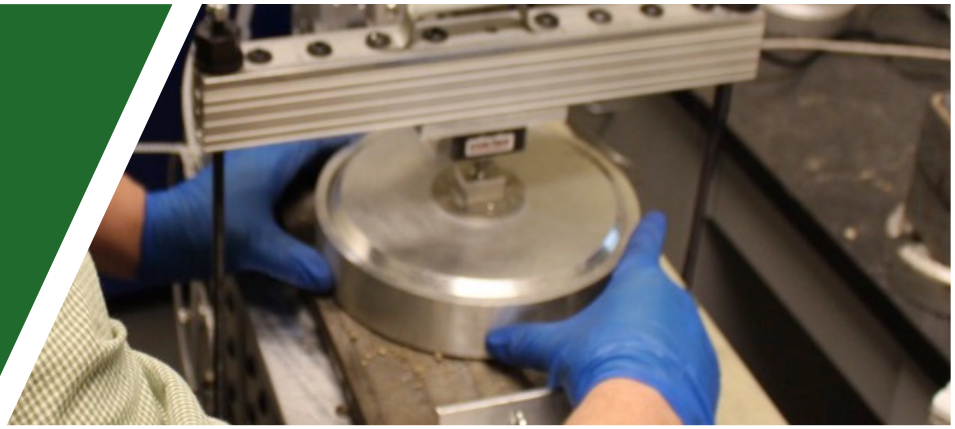
Which one will it be??

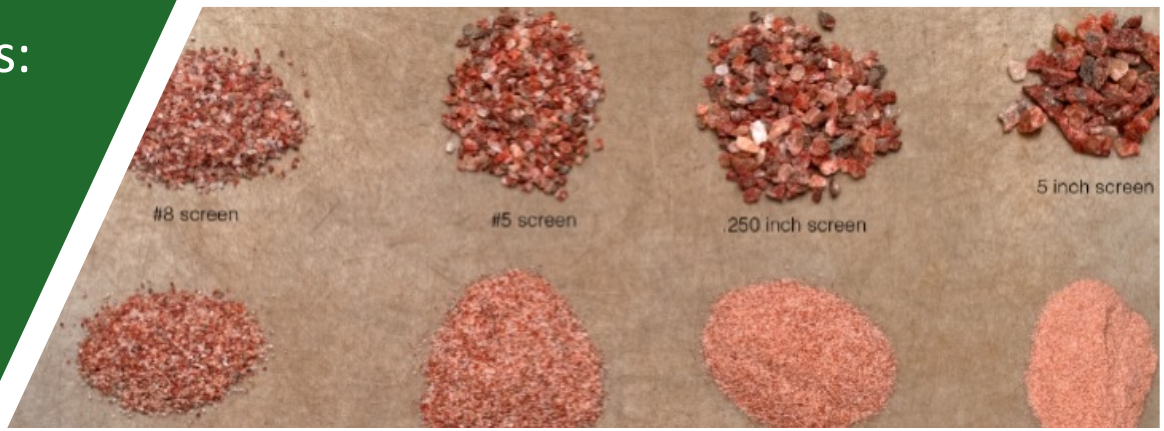
Material Properties Needed for Analysis

Standard tests:

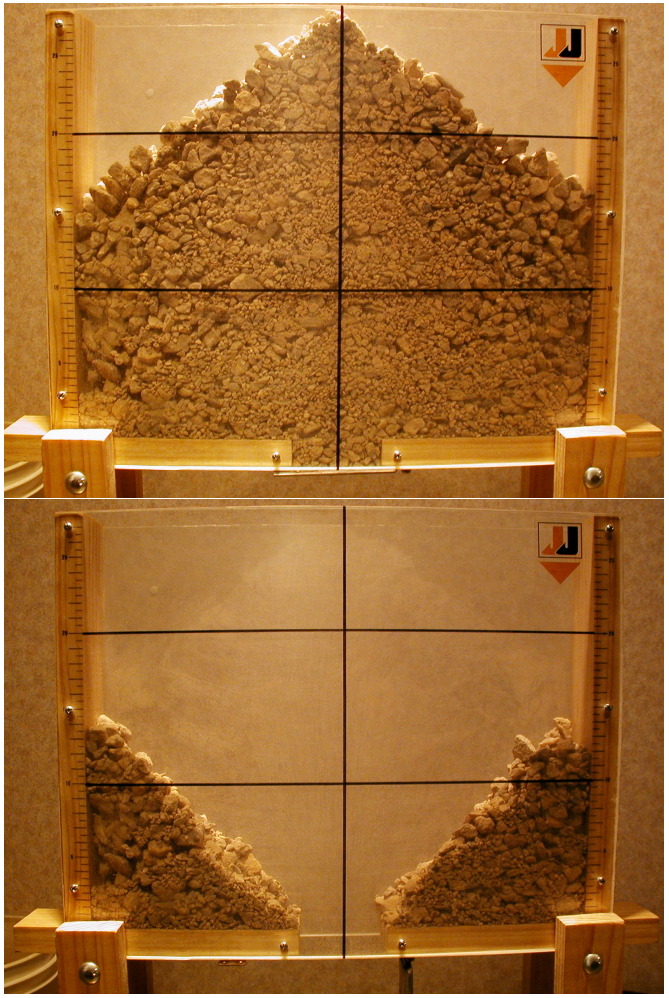
- Cohesive strength
- Bulk density/compressibility
- Wall friction
- Particle density
- Particle size distribution
- Segregation potential

- For stockpile stability calculations:
  - Liquid permeability
  - Chemical mineralogical analysis
  - Hydraulic properties (saturation hydraulic conductivity and water retention curves)

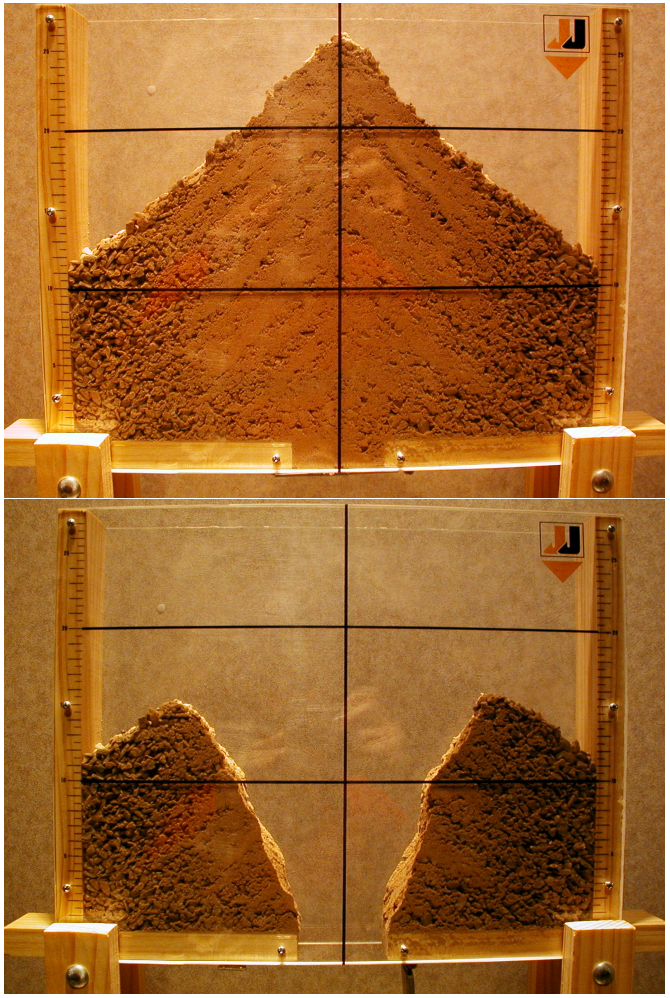




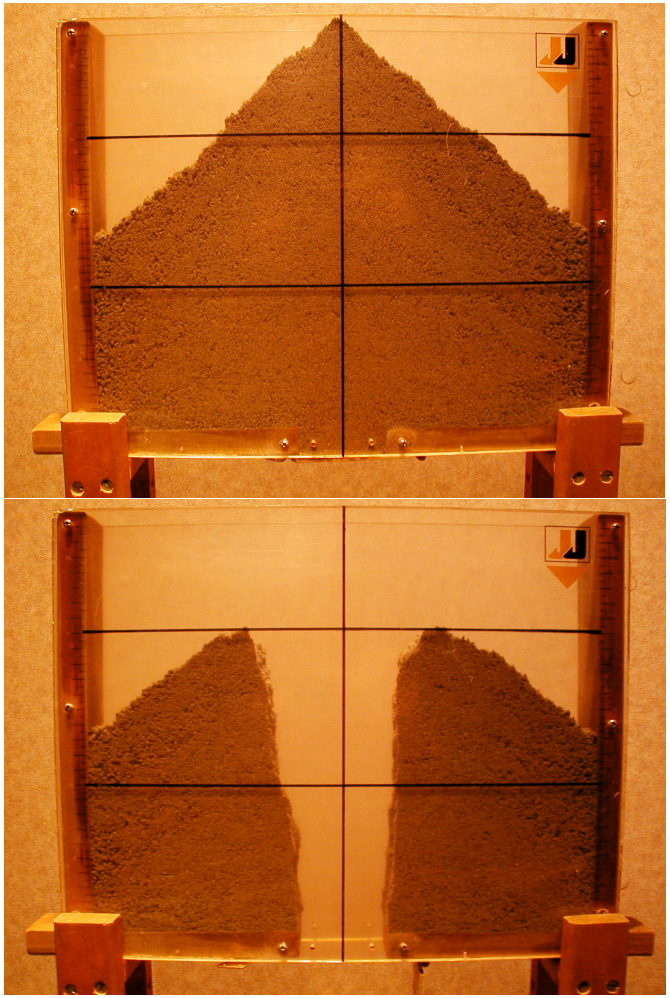
Coarse Stockpile



Coarse and Fines Stockpile



Fines Stockpile

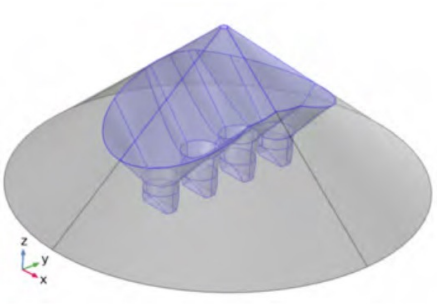
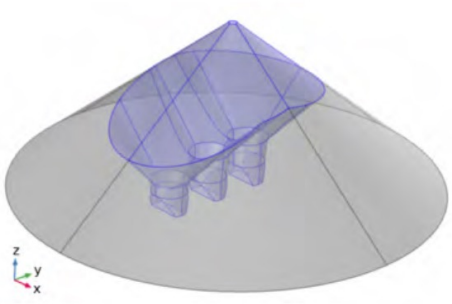
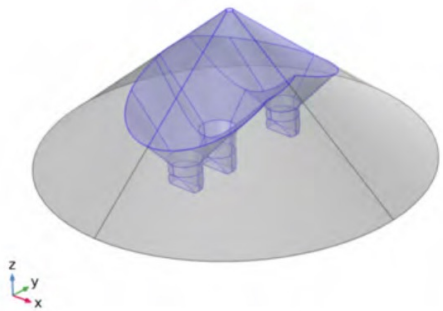


New applications for gravity stockpile design

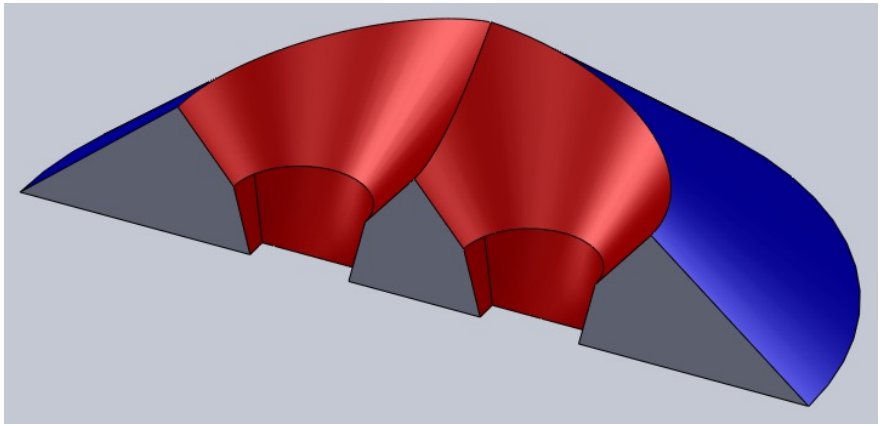
- Inputs to design
  - Fill or stacking method – single fill point, tripper conveyor,…
  - Total and live capacity requirements
  - Footprint/pile height, tunnel layout
  - Hopper/feeder configuration, material of construction, spacing, number, locatio
  - Feeder requirements – minimum, average, and maximum instantaneous flow rate
  - Abrasive wear, corrosion, freezing
- Use test data to accurately predict live capacity
- Obtain functional/conceptual design recommendations to get everyone in agreement.

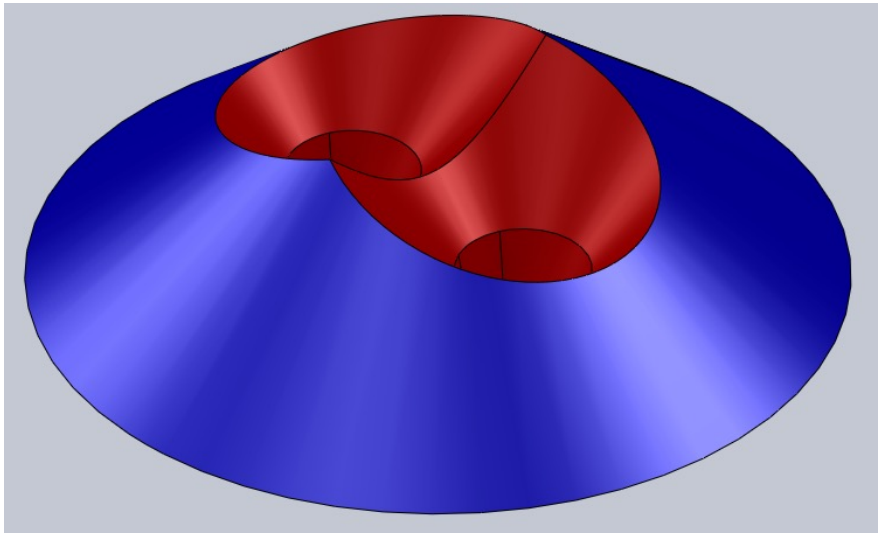
Gravity Reclaim Stockpiles Analysis

Using flow properties test data, run capacity calculations based on feeder configuration.

		
Case I-a: Hematite-4 feeders	Case I-b: Hematite-3 feeders	Case I-c: Hematite-3 feeders

Stockpile Modeling – Conical Pile



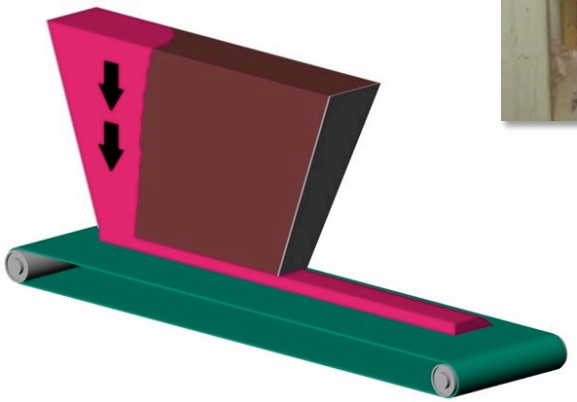


Retrofit existing gravity reclaim stockpiles

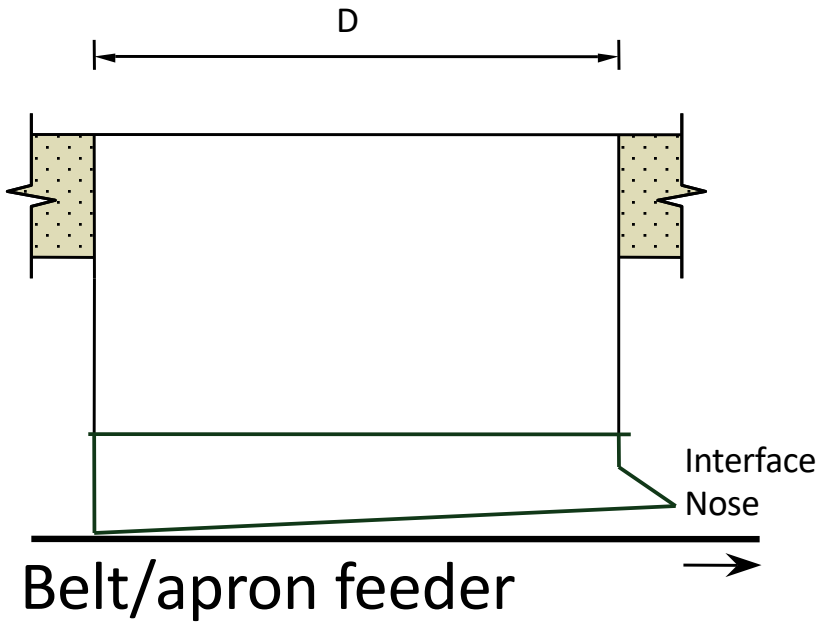
- Consider how stockpiles are stacked.
- Consider stockpile management and operation.
- Can you change the number of outlets, outlet shapes, hopper design, feeder type/configuration….??

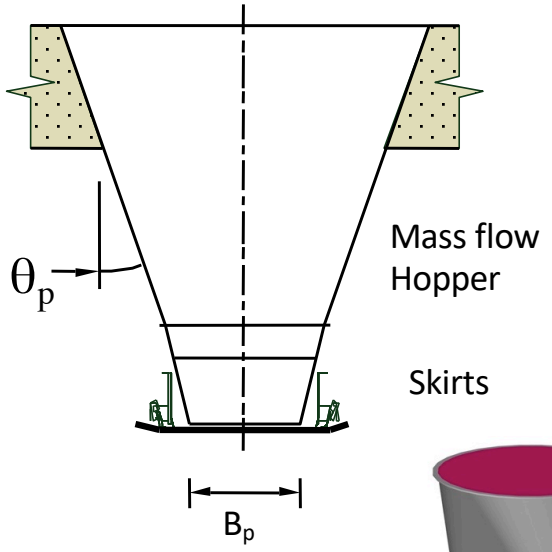
How well is your feeder working?

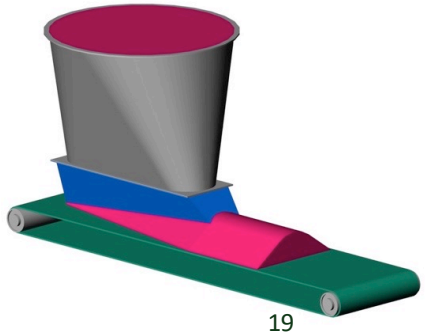
Poor Belt/Apron Feeder Design



Mass Flow Hopper/Feeder Critical







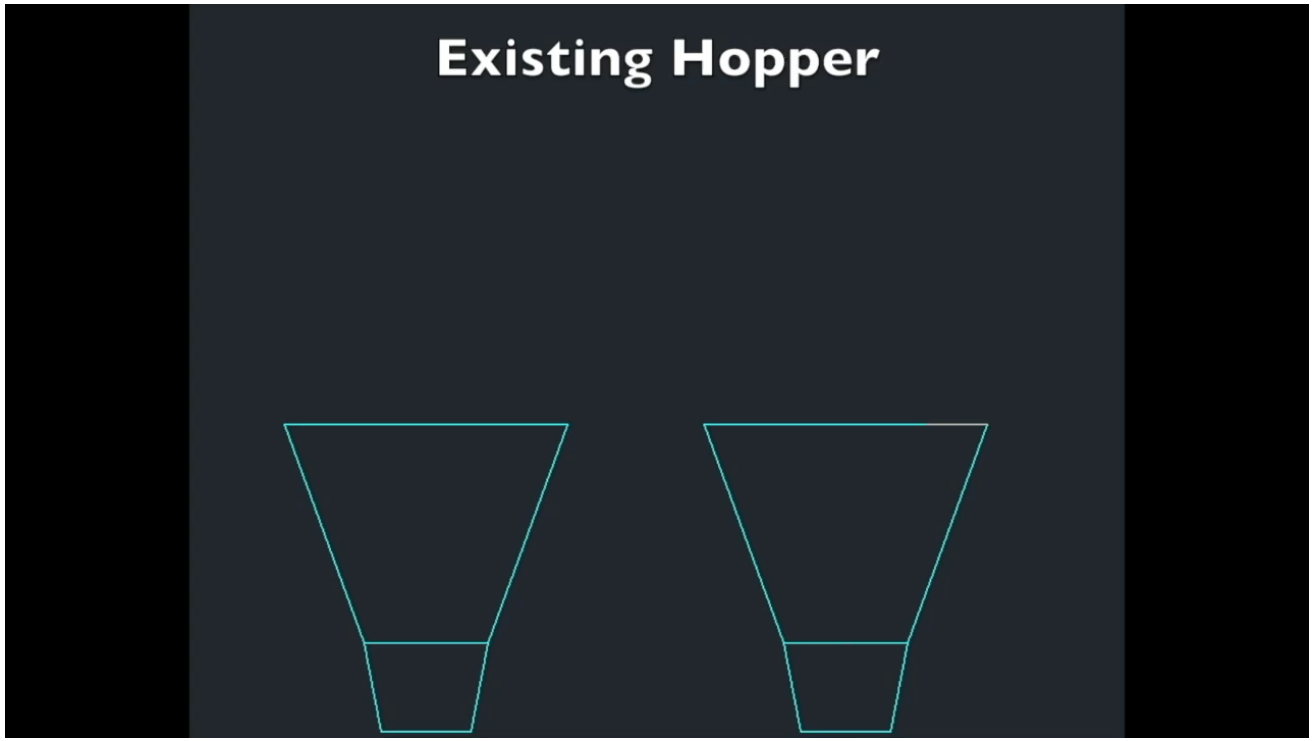
B_p = Outlet width for planar hopper to prevent arching
θ_p = Mass flow planar hopper angle if hopper length $\geq$ 3x width
D = Base of flow channel

Slotted Inlet Designed for Mass Flow

Note:

- Wear resistant tiles
- Valley angles

Physical Modeling of Flow Enhancer Insert

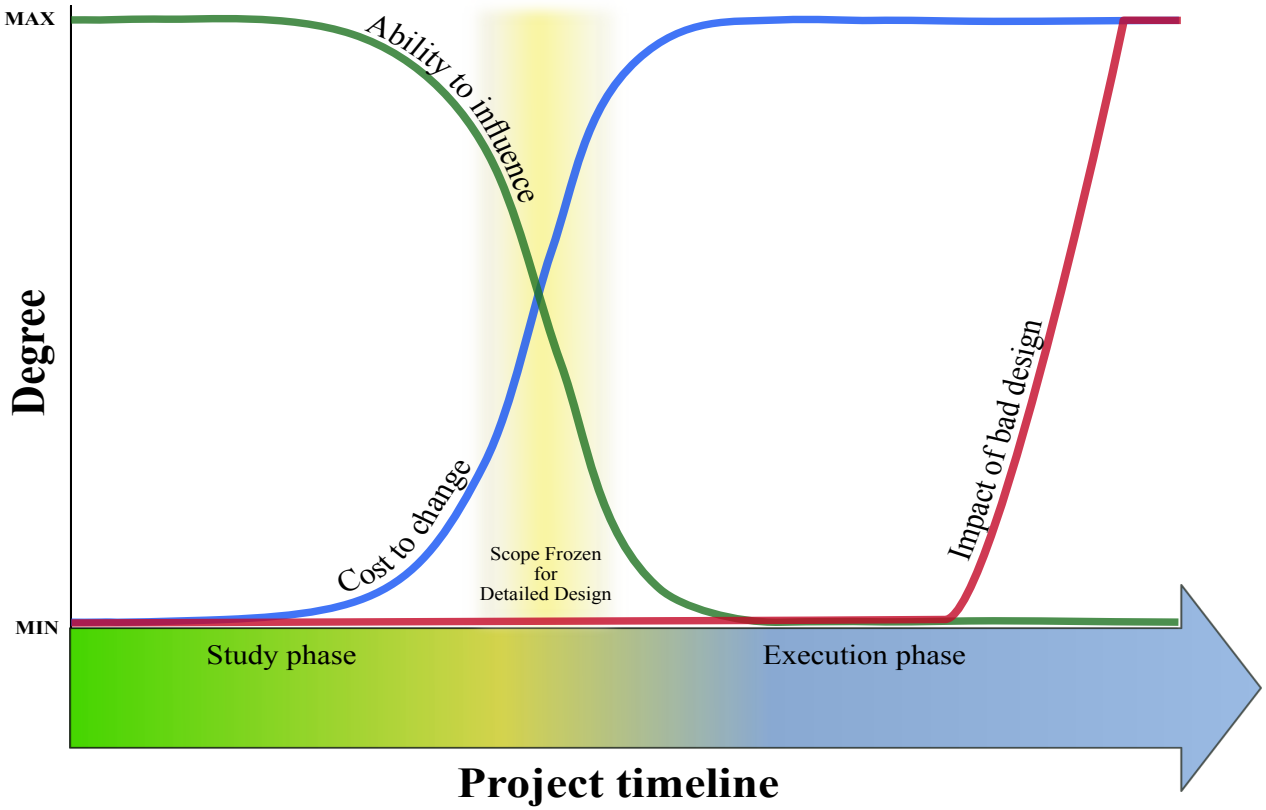


Added complexity

Everything can change within the stockpile!

- Ore chemistry
  - Friable hematite vs. hydrated ore vs. a blend (including various blend ratios)
- Particle size distribution
  - Fines vs. coarse
- Loading conditions as pile forms
  - Rainy vs. dry conditions during loading
- Consolidation pressure within the pile – effects compaction of material
  - Lower consolidation pressure at the pile surface vs. higher consolidation pressure at the bottom

Ability to Influence & Cost of Modification



Summary of Improving Stockpile Capacity

- Gravity reclaim stockpiles can have extremely limited “live” capacity (3% - 6%) with cohesive solids
- Measuring solids flow properties vital for effective gravity reclaim stockpile design
- Size, number, and layout of feeders in stockpile greatly influences reclaim capacity
- Proper gravity reclaim design can typically yield 15% - 30% “live” capacity

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