Screen Applications

Charles Hillman

QUARRY ACADEMY

Improving Processes. Instilling Expertise.

DYNO Dyno Nobel

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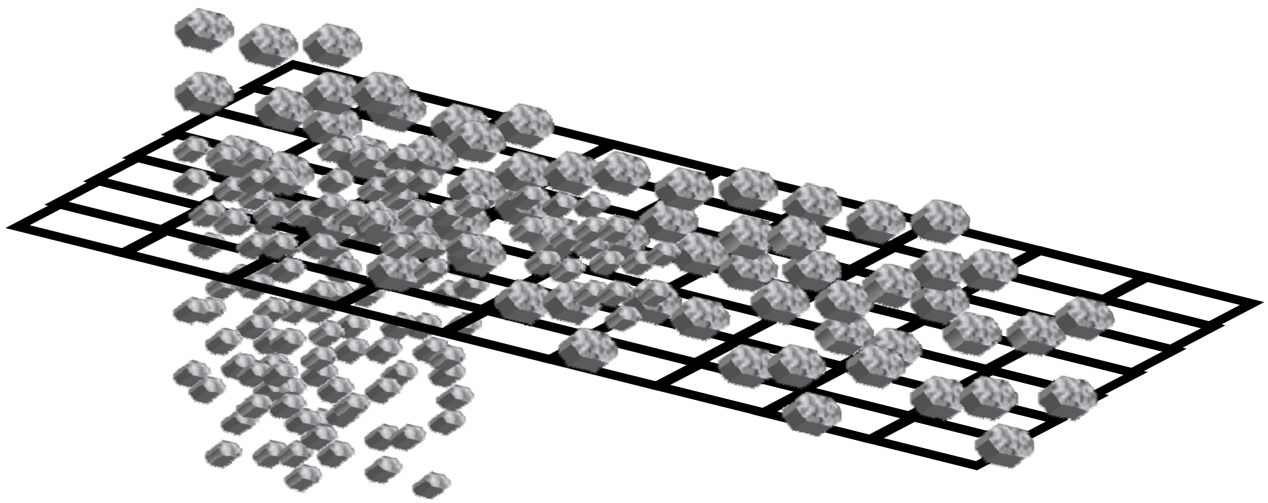
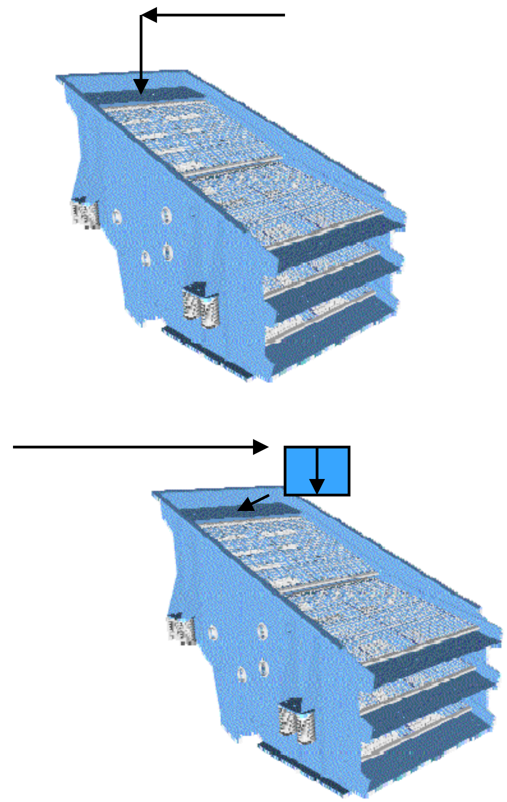
SANDVIK

Screening

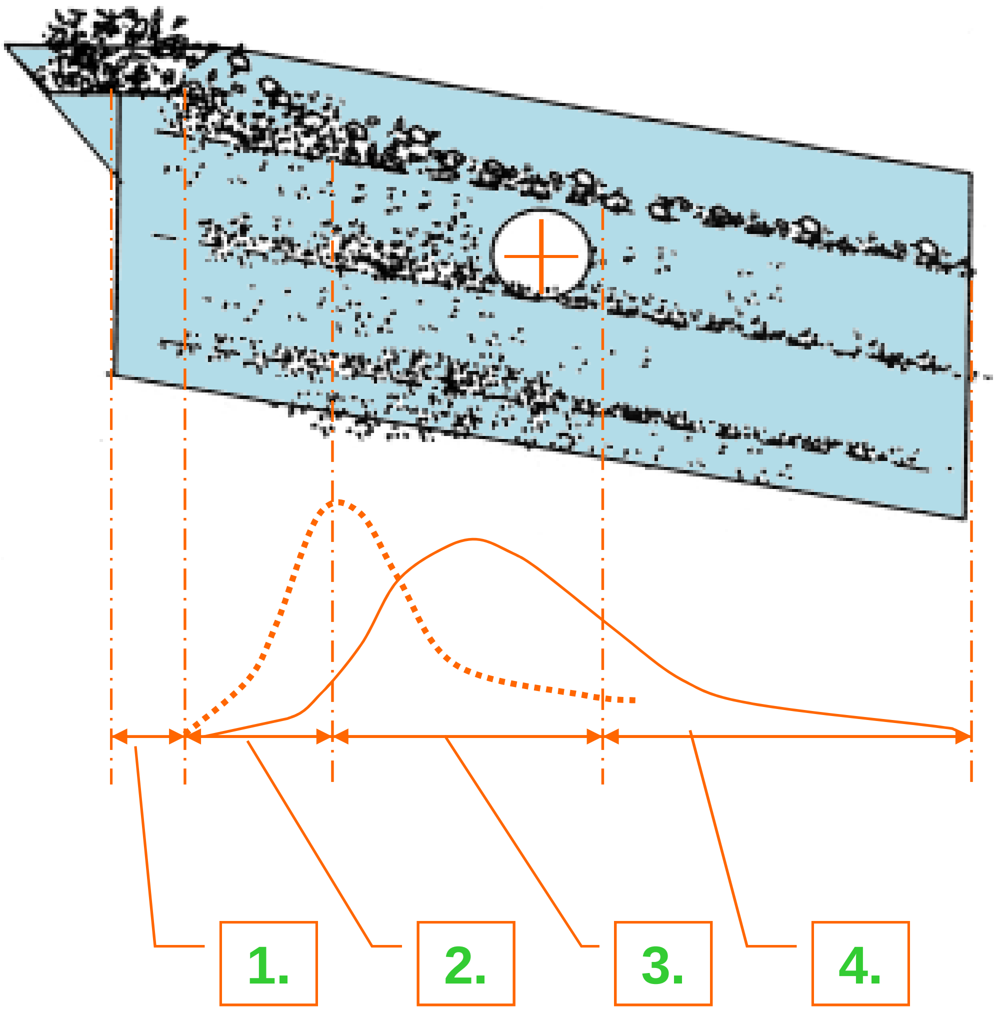
Separation using a media for sorting particles by particle size



How is a Screen To be fed ?

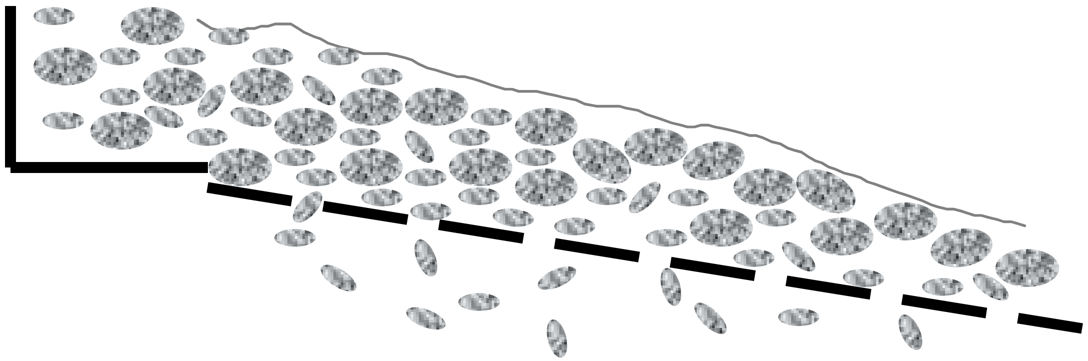


The Screening Process



1. **Stratification (on feed plate)**
2. **Stratification (on screening media)**
3. **Extraction of ”easy” undersize particles <75 % of hole size**
4. **Extraction of ”critical” undersize**

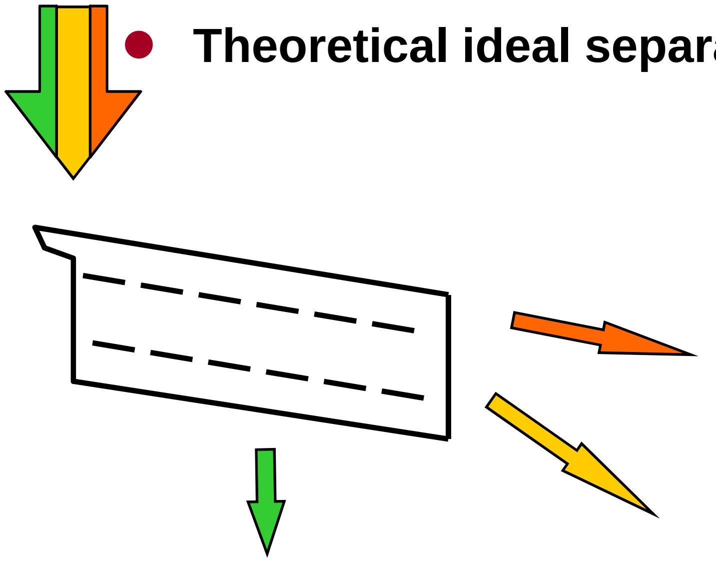
Stratification - Properties



- Horizontal transport of material along the screen deck
- Vibrations create a fluid state in the bed
- Small particles flow between large one - stratification
- Small particles fall through - selection based on probability
- Correct material bed is necessary for stratification and selection

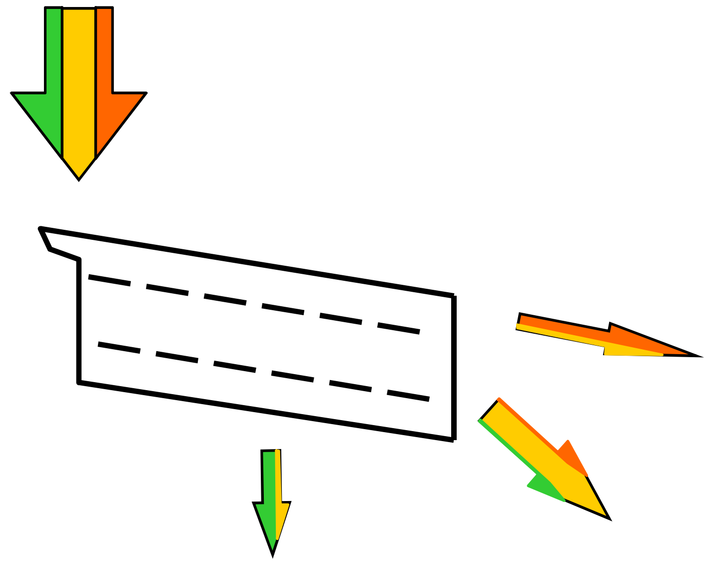
Screening Theory

- **Theoretical ideal separation**



- **Practical separation**

+/- 94%

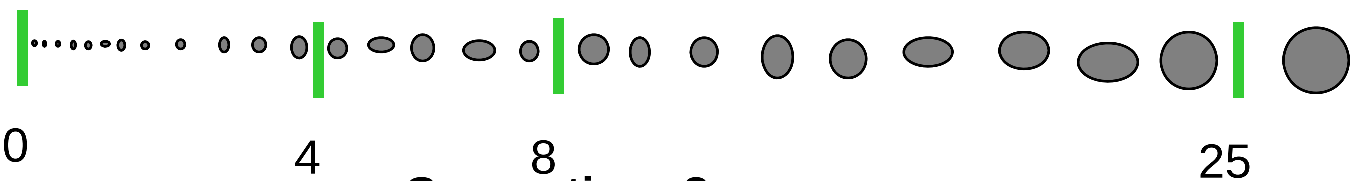


Mixed particles

Screening Theory - Example

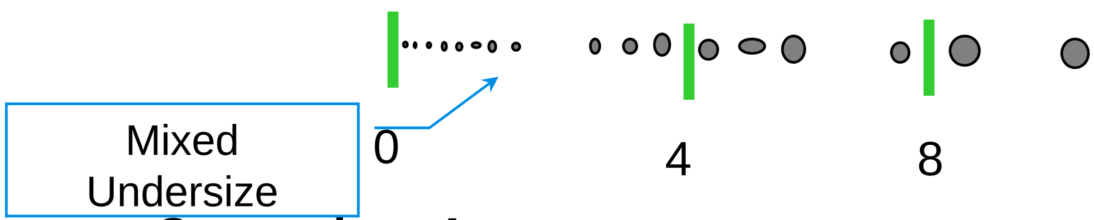
Fraction: 100 t/h 0-25 mm
Separation: 4 & 8 mm
Distibution: 40 % < 8 mm
25 % < 4 mm

Feed: 0-25 mm



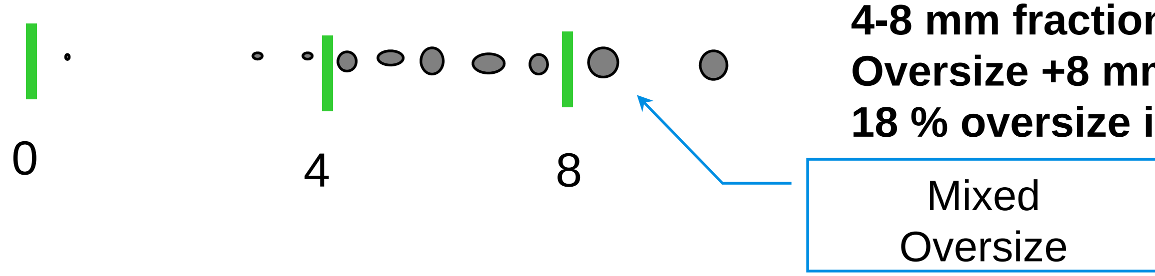
- Separation: 8 mm -

Separation: 8 mm



0-8 mm fraction = 40 t/h
Oversize +8 mm = 4 t/h
10 % oversize in 0-8 mm

Separation: 4 mm

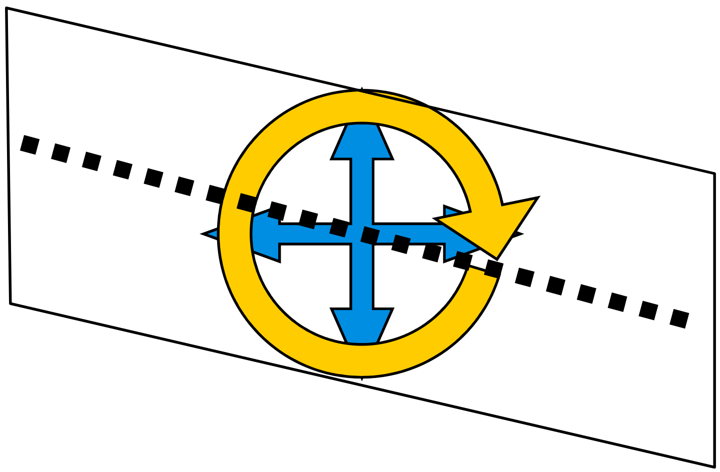


4-8 mm fraction = 25 t/h
Oversize +8 mm = 4 t/h
18 % oversize in 4-8 mm

Screening Principles

- **Circular motion**

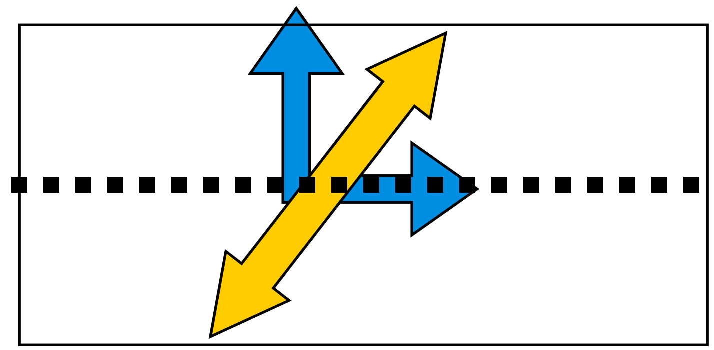
Requires inclined decks!



Incline Uses Gravity
+/- 20 degree. Energy Efficient

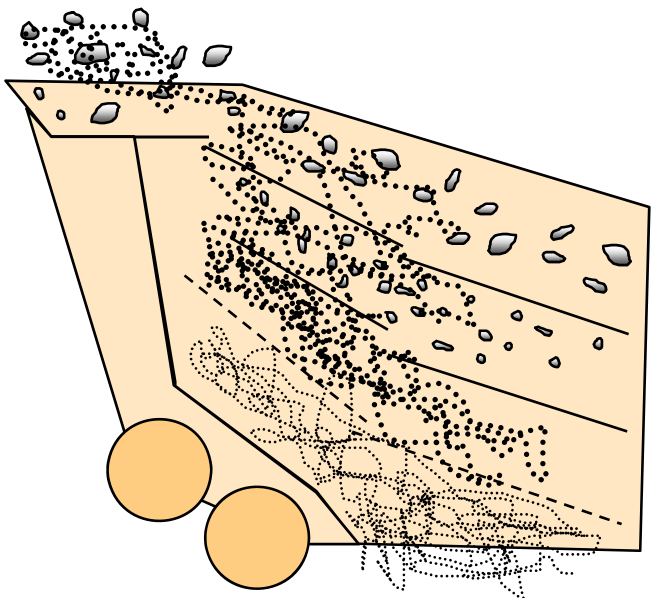
- **Linear motion**

Horizontal or inclined decks



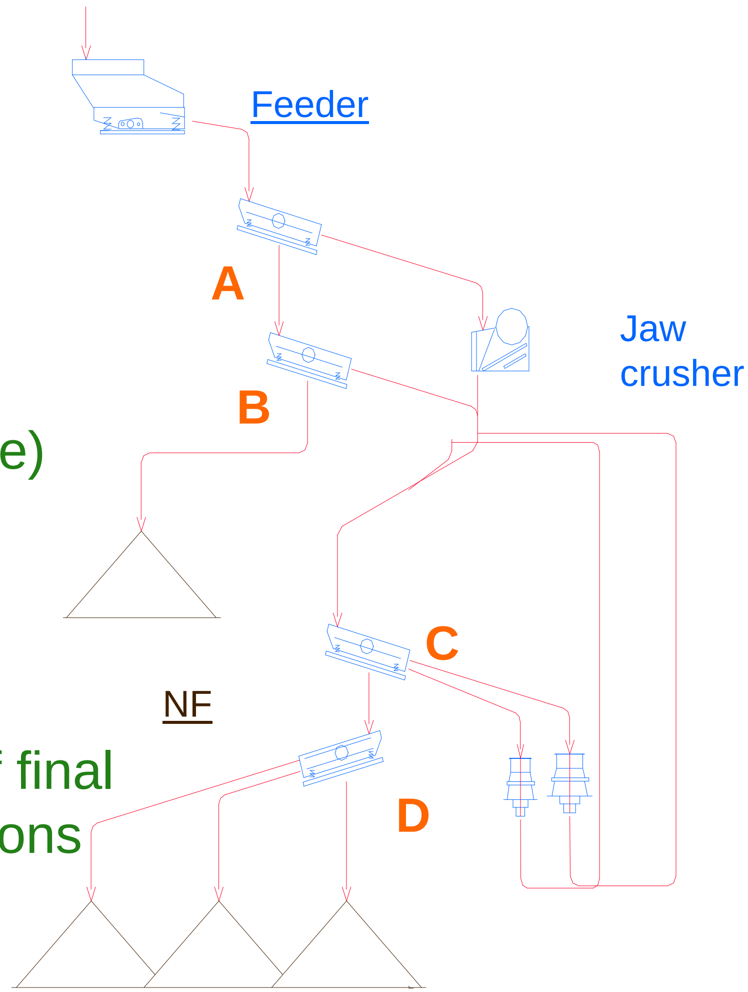
Retention Time is 1.5-2.0 longer

Free-Fall - Properties



- Screen decks inclined to keep vertical movement
- Low bed depth allows small particles fall trough media.
- High horizontal velocity keep big particles of the feed zone
- Higher utilization of screening area
- Vibrations to create horizontal movement

Screening Applications



A = Coarse screening
- primary stage

B = Natural fines
removal (waste)

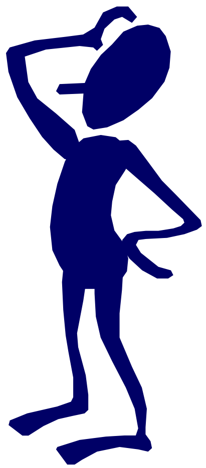
C = Screening in closed
circuit with two stage
crushing

D = Separation of final
product fractions

Second and third
stage cone
crushers

The Screen Area Sizing method

- Based on **separation**, not on hole size. Product ?
- Based on accuracy, percentage over & or undersize. Spec.?
- ⇦ What is actually required of the final product ! Use / Where?
- **Aggregates oriented market / Shape**
- Disregards ”efficiency” concept (Quick Cut/Re-direct)
- Intended for screening of zero to ”x” fractions (Long)
- Very accurate for fine screening (Surface Area Bed depth)
- Constant revisions ,(Multiple tasks or media)
- Media Type (Open Area / Metal /Synthetic)
- Washing Plant



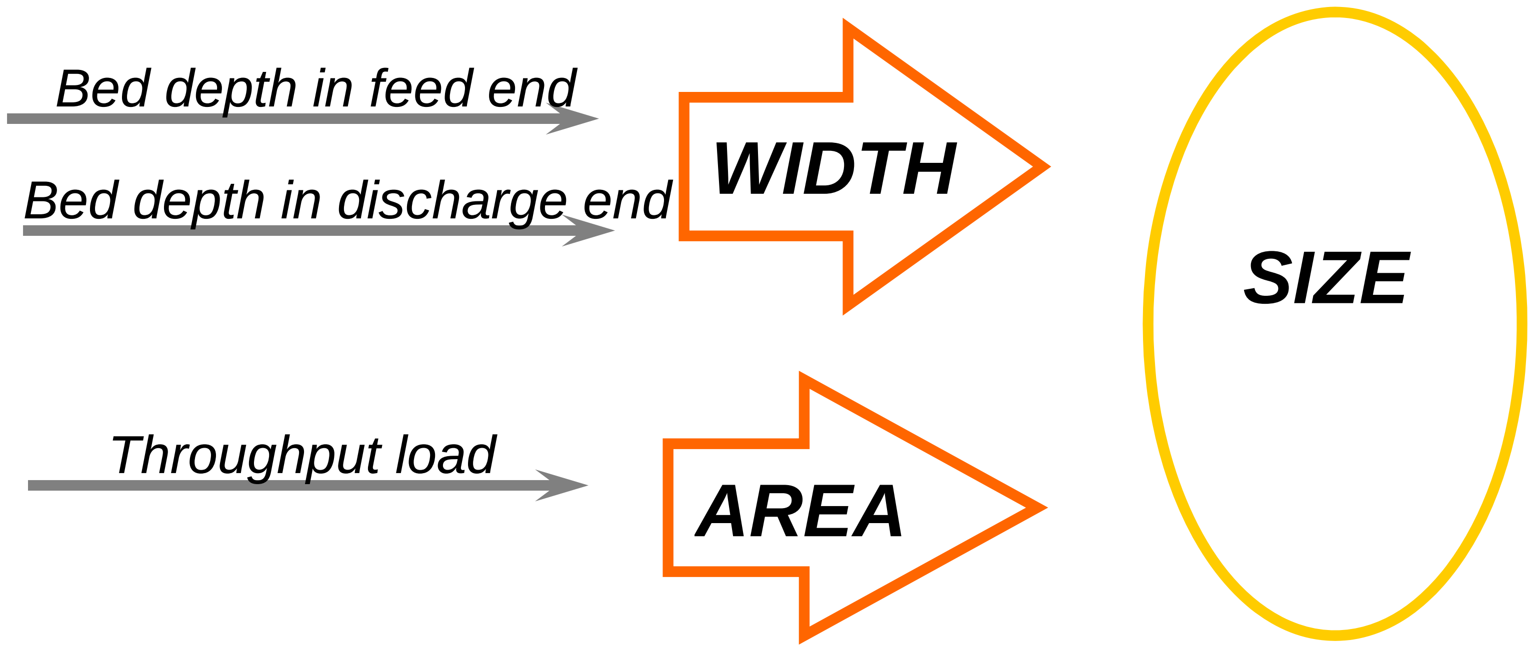
Screening Area Factors

Schemarubrik

Screen area

- **Material**
  - Feed curve
  - Moisture content
  - Bulk density
  - Material type
  - Particle shape
- **Media**
  - Media material
  - Media type
- **Machine**
  - Machine type
  - Inclination
  - Movements
- **Duty**
  - Separation size
  - Fraction length
  - Accuracy
  - Wet or Dry
  - Feed capacity

Calculation method:

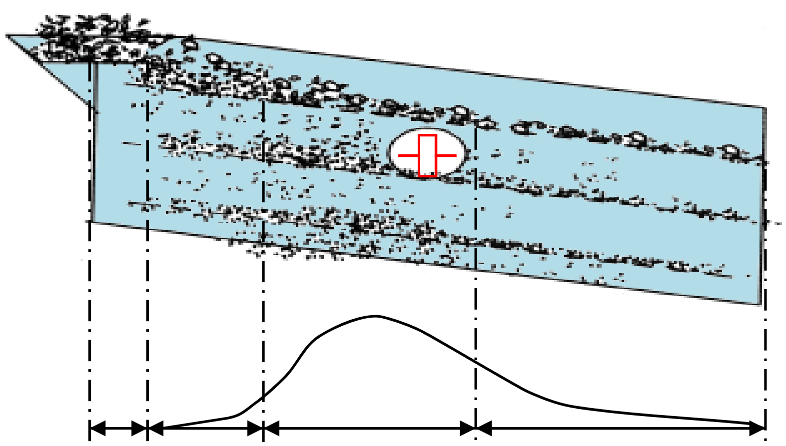


What bed depth is right for stratification?

- ***A thin bed:***
  - Becomes easily fluid, helps stratification
  - Means shorter distance for fine particles to sift down to the deck
  - Means less pegging tendensy, stones are not pressed down
- ***A thick bed:***
  - Slower speed gives more time on screen and more time for selection
  - Sufficient bed prevents bouncing

What bed depth is right for accuracy? (Discharge end)

- Max bed depth at discharge is 3 - 5 times separation
- Min bed depth is 1 time separation
  - ✓ If too thick, all stones have probably not had enough chances to pass
  - ✓ With too thin bed, material will be bouncing which destroys the stratification & accuracy



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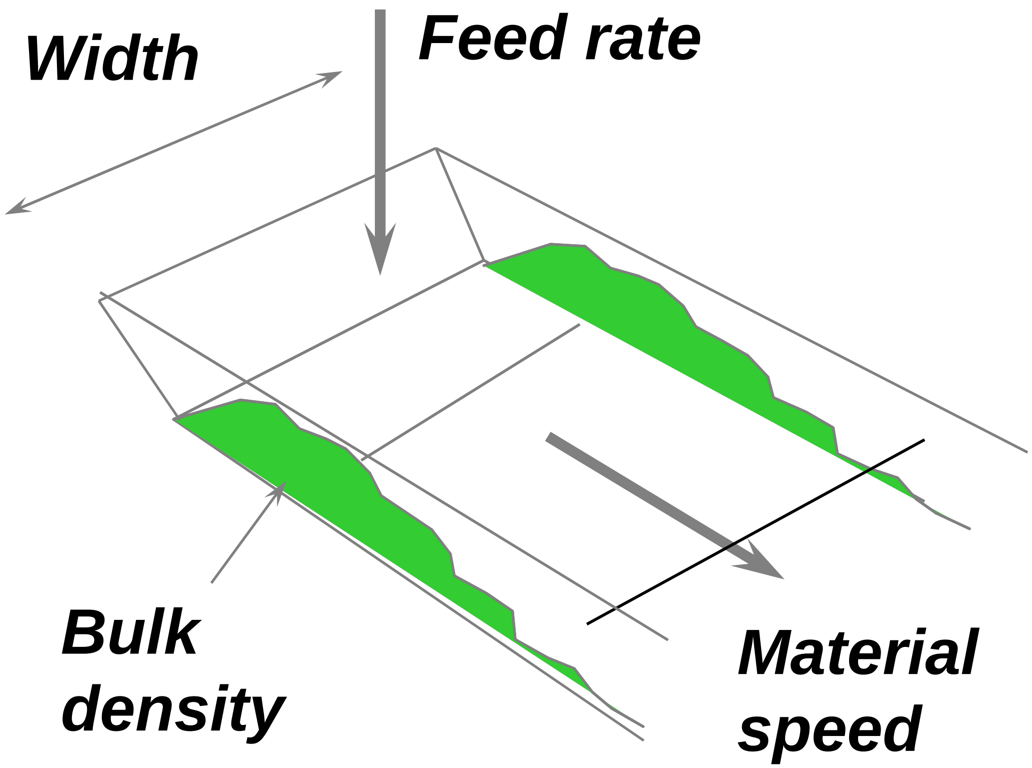
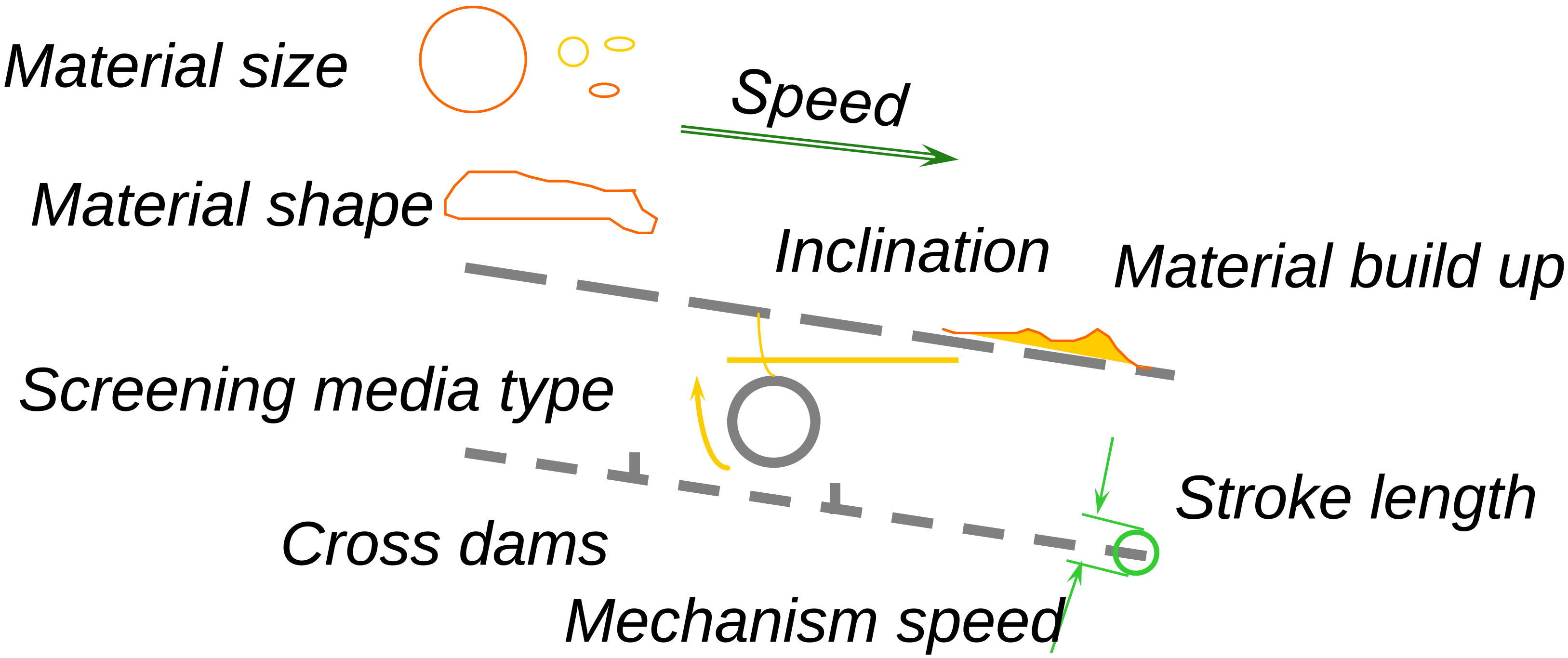
Factors affecting bed depth:



Factors affecting material speed



Moisture problems and solutions

- **Use maximum stroke (Increase Stroke).**
- **Use flexible media such as:**
  - ✓ Flexible rubber/polyurethane
  - ✓ Thin wire mesh, piano wire/harp screens
  - ✓ Z –Wire
- **Water sprays**
- **Ball decks**
  - ✓ Works on screens with low inclination

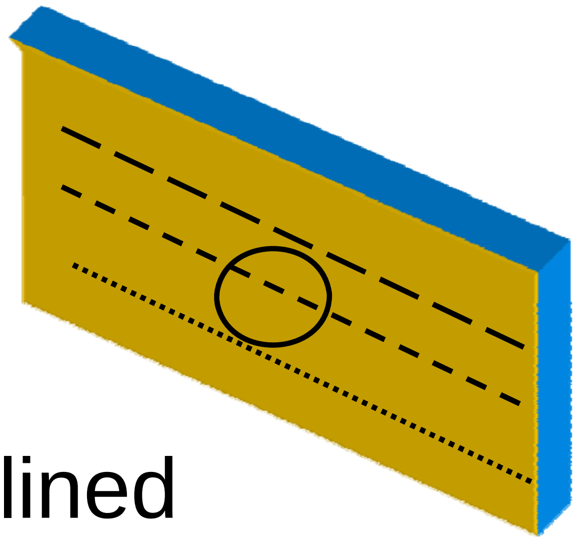
Capacity through deck, factors

$$Q_{spec} = A \times B \times C \times D \times E \times F \times G \times H \times I \times J \times K \times L$$

Q spec: Specific capacity (t/h x m^2)

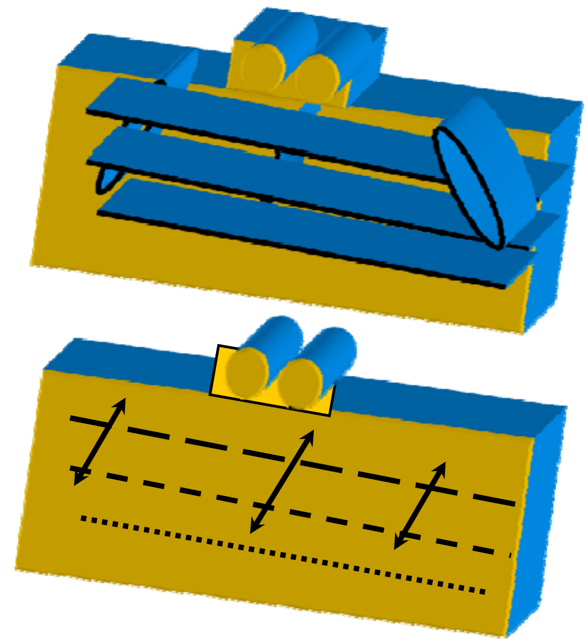
- **A: Separation**
- **B: Oversize**
- **C: Halfsize**
- **D: Type of material**
- **E: Bulk density**
- **F: Moisture**
- **G: Type of screen**
- **H: Wet screening**
- **I: Deck position**
- **J: Screening element**
- **K: Fraction length**
- **L: Accuracy demands**

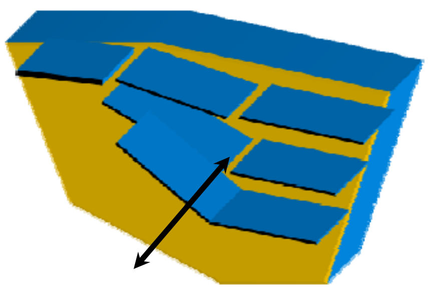
Screen Variations



Inclined

Horizontal





Multi-slope

Wobbler

Horizontal Linear Motion Screens

(Free Swing)

- ✓ Good accuracy
- ✓ High capacity per m^2
- ✓ Low build height
- ✓ Low wear on screening media
- ✓ Good drain, rinse and dewatering capacity

- Increased risk of pegging
- More complicated drive
- Higher energy usage
- More complex mechanism adjustments
- High Cost

Inclined Circular Motion Screens
(Free Swing)

- ✓ Wide application range
- ✓ Resistant to pegging
- ✓ Simple drive (Single or Dual)
- ✓ Light design
- ✓ Average Cost

- High build height
- Not best accuracy
- Not highest capacity
- Low retention time

Resonance Screens

- ✓ Good accuracy per m^2
- ✓ Very low build height
- ✓ Low tendency to pegg
- ✓ Allows for long screen lengths
- ✓ Low dynamic loads on foundations
- ✓ Many fractions from one deck possible

- Low capacity
- High weight
- Expensive
- High maintenance

Elliptical Motion Screens

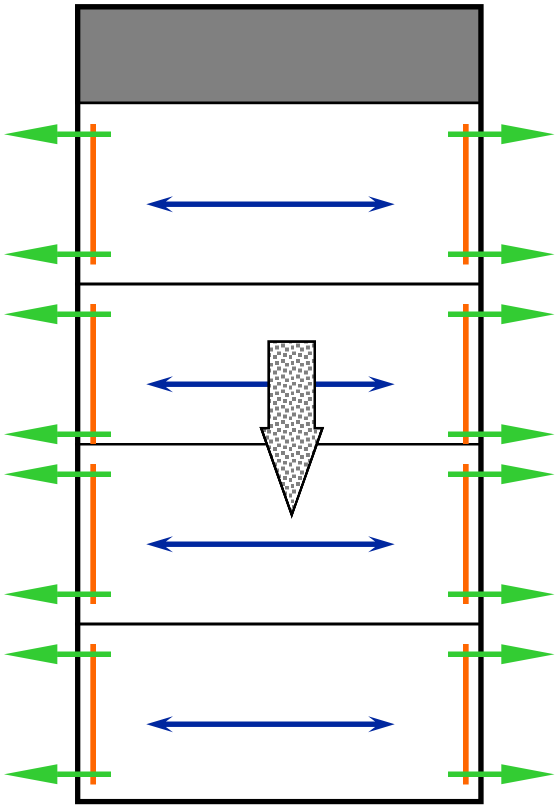
- ✓ **Good accuracy per m^2**
- ✓ **Low installation Head Room (Portable)**
- ✓ **Low tendency to peg**
- ✓ **Reduced wear on screening media (not always)**
- ✓ **High Capacity**
- ✓ **Flexiable Application**

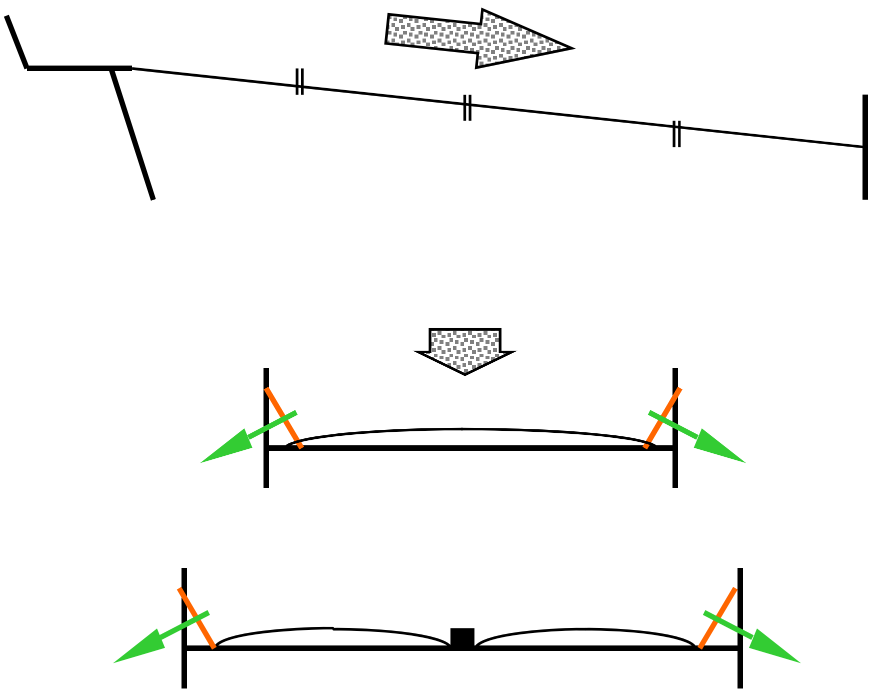
Dual Shaft

- Expensive drive with gearbox
- Highest energy use
- Can be tough to change cloth

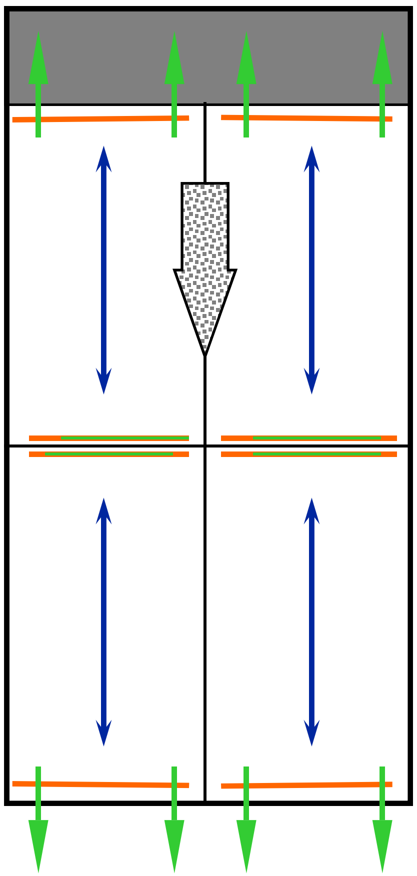
Triple-shaft screens

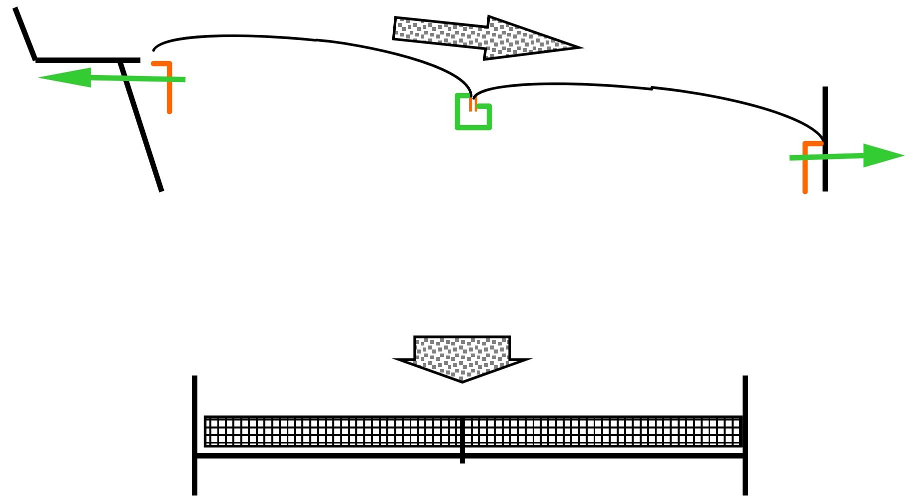
Tensioning Types (Side)



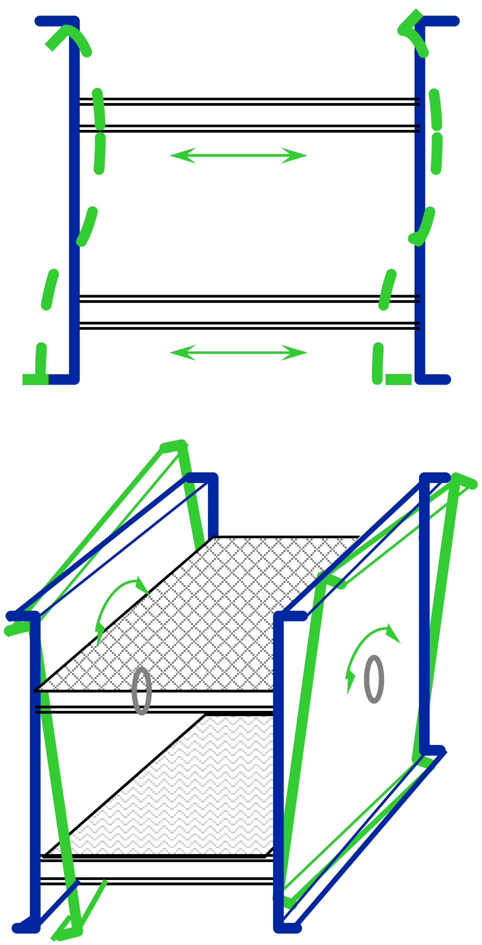


Tensioning types (Length/End)





Side Frame & Torsional movement



- ✓ Stiffer sideplates in vertical direction will help
- ✓ Diagonally stiffer frames will help

Factors Influencing Natural Frequencies

- ✓ Height & weight of sideplates
- ✓ Thickness & stiffness of sideplates
- ✓ Distance between decks
- ✓ Weight of decks and media
- ✓ Frame stiffnes in different directions
- ✓ Back plate design
- ✓ Unders Carrying Tray under screen
- ✓ Extra crossbeams over top deck
- ✓ Extent, quality and position of welds
- ✓ Corrosion, cracks and unproper repairs
- ✓ Springs & Screen Support Frame

How can carrying capacity be increased?

INCREASE MOMENTUM OF SCREEN ($M_1V_1=M_2V_2$)

- **Larger throw**
- **Increased RPM**
- **Heavier screen box maybe required**

INCREASE MATERIAL TRAVEL RATE

- **Steeper incline Angle**
- **Straight line motion versus circular motion**

CARRYING CAPACITY

- m = Eccentric weight (inclined screen) or live weight (horizontal screen)
- v = Material travel rate (fpm)
- s = Stroke (inches)
- n = Screen rotational speed (rpm)
- l = Length of screen deck (ft.)
- C_1 = Constant derived from performance data

$$\text{CARRYING CAPACITY} = \frac{m \times v \times s^2 \times n^2}{C_1 \times l}$$

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Bearing life:

Calculated using eccentric weight, throw, speed, basic dynamic capacity (BDC.) of bearing, and constants for vibrating equipment:

$$B_{10}\ \text{Life} = \frac{16{,}667}{\text{RPM}} \times \left[\frac{\text{BDC}}{\text{Fa} \times \text{P}} \right]^{\frac{10}{3}}$$

Fa = 1.2 factor for vibrating equipment

A = Number of bearings

$$\text{P} = \frac{\text{Eccentric weight} \times 1/2\ \text{throw} \times (\text{RPM})^2}{35{,}200 \times \text{A}}$$

- Speed changes will effect bearing life more than throw changes.
- Increasing the mass will decrease bearing life if the throw is maintained

Bearing life:

BEARING LIFE “continued”

Bearing Life:

- **Decreases as speed increases**
- **Decreases as throw increases**
- **Decreases as weight increases**

LUBRICATION: TYPE, TEMPERATURE AND VOLUME ARE IMPORTANT FACTORS

Checks for Performance

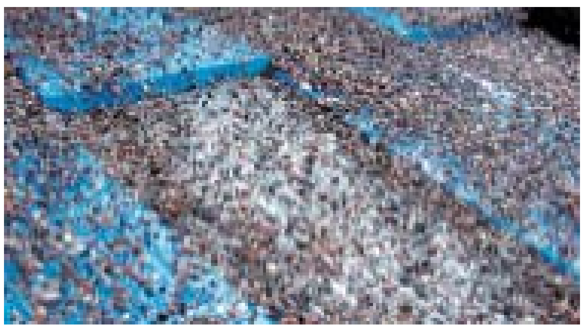
● Bed Depth	- Too High	- Carrying to many Unders
	- Too Low	- Bouncing/Spillage , Low Bed Depth
● Unbalanced	- Fed from The Side	- Heavy/Light Side Load
	- Underfed	- Low Bed depth
	- Cracked Structural/support	- Sags material travels to side
	- Rock n Roll	- Sagging Media / Timing/ feed (Surge)
	- Unstable Motion	- Feed /C/L Gravity/Frequency (critical)
● Low Cloth Life	- Poor feed	- High Drop Point, No or small feed Box
	- Poor feed Material	- Oversized material For Media Design
	- Wears Quickly	- Setting /Angle Material Abrasive
	- Low Lower deck Life	- Improper choice of Upper deck/feed
● Carry Over	- Unders Mixed w/Overs	- Too little Area/Bed Depth/ Media Type
	- Plugging decks	- Angular Fraction/ Hole type/ Media
	- Blinding	- Moisture Content / Media
● Performance	- Flattens/ Shakes Poorly	- Belt tension / Momentum/Speed
	- Poor Material Movement	- Check Cloth tension/ equal
	- Box Moves/ Not Material	- Springs Stiff/ weak/Poor Support (frame)
	- Material flows odd	- Cracked deck Support Frame (weld)
	- Material Moves Slow	- bad Belts/ Motor or Bearings

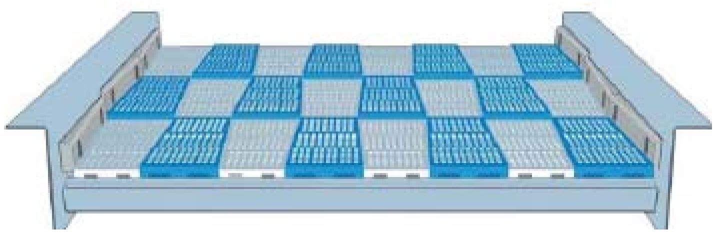
Track Temperature & frequency As well as belt tension & Media tension

Media/Screen Applications

Screen Location	Primary Scalp	Secondary Separation	Thirtary Separation	Final & Washing	Pros/Cons	Throw Inches	Accelera te-ration (G)
Inclined HD	X					1/4-1/2	2.5-3,5
Inclined Med.		X	X			1/4-3/8	2,5-4.4
Linear /Horizontal		X	X	X		1/4-3/4	5,0
Free-Fall HD	X	X				5/16-3/8	3,5-5.0
Free-Fall FLO			X				3,5-4.5
Steel Bars /Plate	X	X			Cost/Stress		
Rubber/Steel Lined	X	X			Weight/Cost		
Heavy Rubber		X			Life/Open Area		
Heavy Wire		X			Cost/Open Area		
Wire		X	X	X	Cost,Area/Life		
Rubber		X	X	X	Life/Cost,Area		
Poly/Synthetic			X	X	Life,Flexbility/Cost		
Light/Z-Wire/Piano				X	Area,Clean/Life		

Which Media ?





Media Options

Minimizing Common Screening Problems

Screening Problems	Wire Cloth	Harp Screen	Perforated Plate	Urethane	Rubber	Self-Cleaning
Plugging (wet)	Fair to Good 1,2	Excellent 1	Not Recommended	Good to Excellent	Fair	Excellent
Plugging (dry)	Fair to Good 1,2	Excellent 1	Not Recommended	Not Recommended	Fair	Excellent
Blinding or Sticking	Fair to Good 1,2	Excellent 3	Not Recommended	Fair	Not Recommended	Excellent
High Abrasion (dry)	Good 4	Good 1	Good to Excellent 5	Fair	Excellent	Good
High Abrasion (wet)	Good 4	Good 1	Good to Excellent 5	Excellent	Good	Good

1) oil tempered steel
2) slotted
3) stainless steel wire
4) premium wire
5) AR plate

Imagine !

Assume a Quarry has Three (3) finishing Screens

The three finishing screens operate at 85 %
The Quarry produces 500,000 TP Year
If we only improved the three Units to 92%

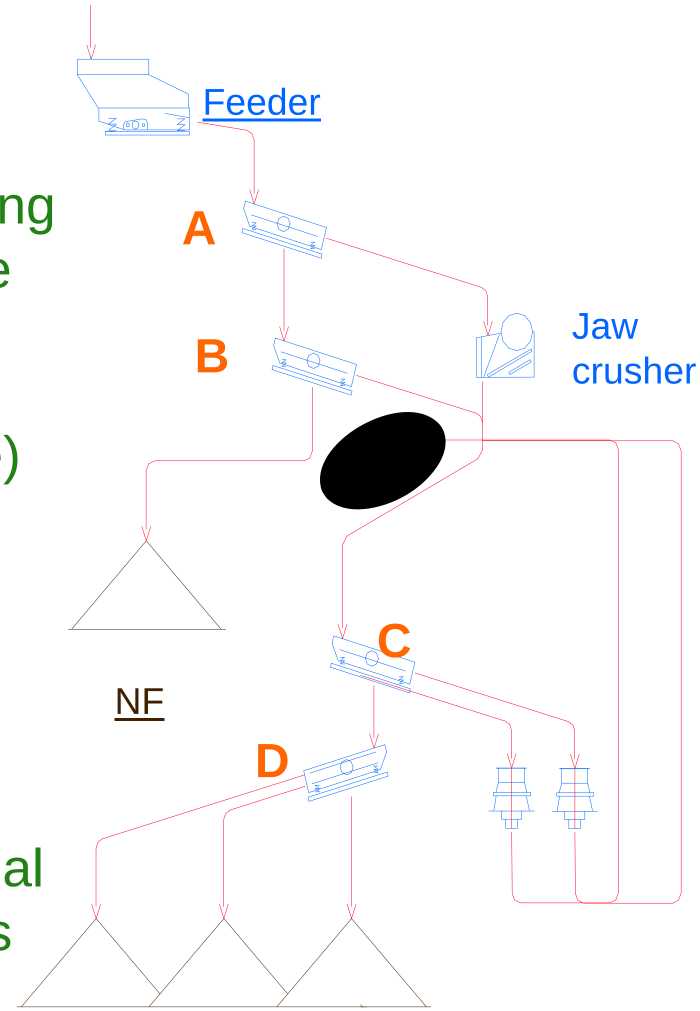
What could be the payback ?

Finish Screens see 320k x 1.07 =extra 22.4+1.6
24000 Tons *(More bottom line……)*
24 x $ 8.00 = 192 k

Which screen may have a carrying capacity problem?

A = Coarse screening
- primary stage

B = Natural fines
removal (waste)



C = Screening in
closed circuit with
two stage crushing

Second and third
stage cone crusheres

D = Separation of final
product fractions

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