Screening: “Making the right stuff!”

Petri Mehto

QUARRY ACADEMY

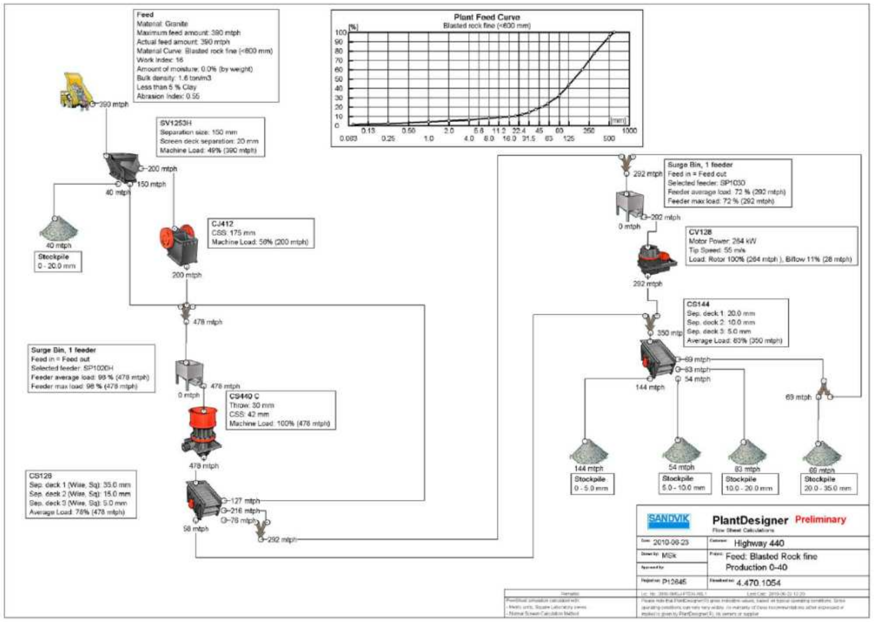
Improving Processes. Instilling Expertise.

ORICA VOLVO SANDVIK

Screening
Agenda

1. Screening theory
   - What is screening?
   - Terminology
   - Stratification / Free-fall screening
   - Throughput along the length
2. Screening equipment types
   - Inclined / horizontal / free-fall / others
3. Screen size selection
   - Width
   - Area
   - Carry-over capacity
4. Troubleshooting & optimizing
   - Mechanical failures:
     - Free movement
     - Natural frequency & resonance
   - Poor performance:
     - Feed arrangement
     - Open apertures in Screening Media
     - Correct stroke parameters

Basics of screening

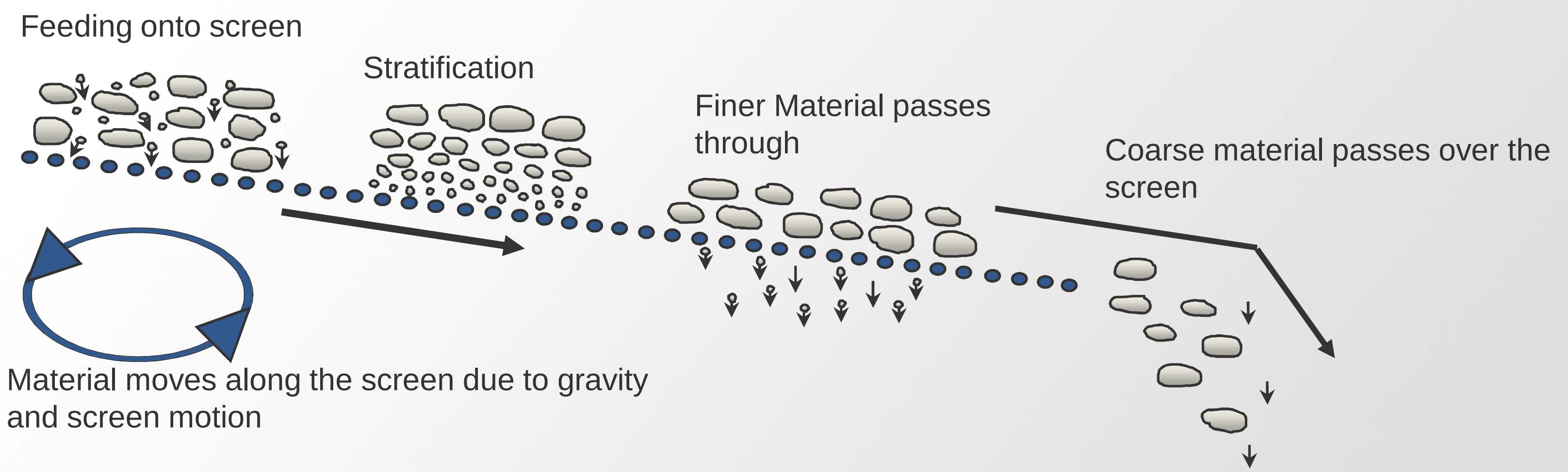


- What is screening?
  - Particles has been classified based on their size
- Where do we need screening?
  - Decrease the load of other process, like crushing
  - Ensure correct particle size for further process
  - Make the final, sellable products in construction
  - Remove the useless (adverse) particles from the process
- Screens as parts of total quarry economy:
  - Reduced power consumption in crushers, conveyors, etc
  - Reduced wear in crushers, chutes, etc
  - Reduced downtime in crushers, chutes, conveyors, etc
  - Make sellable products!

Screening

Basics of Screening

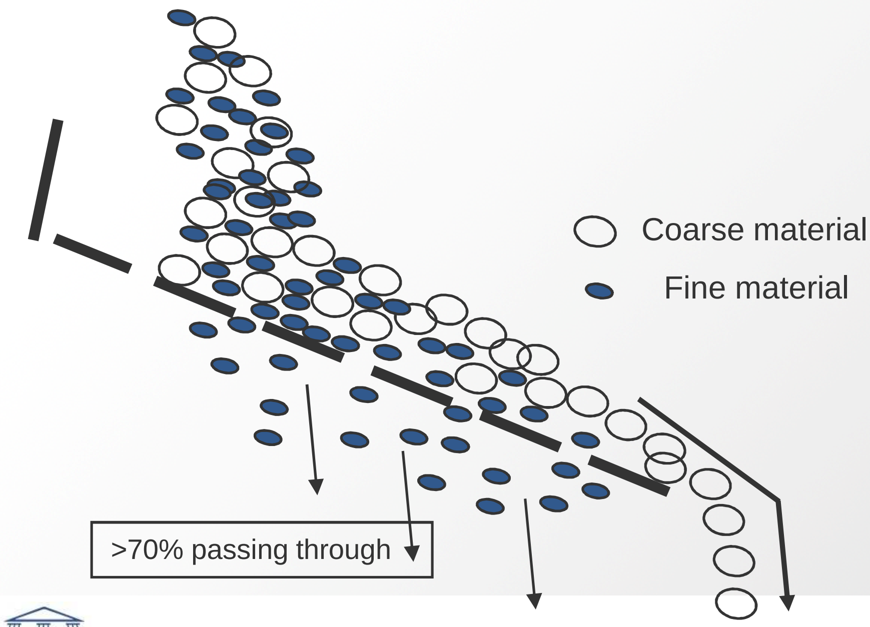
<u>Conventional Screening – based on stratification</u>



Screening

Basics of Screening

Free-Fall screening- no stratification, always free holes available for fines

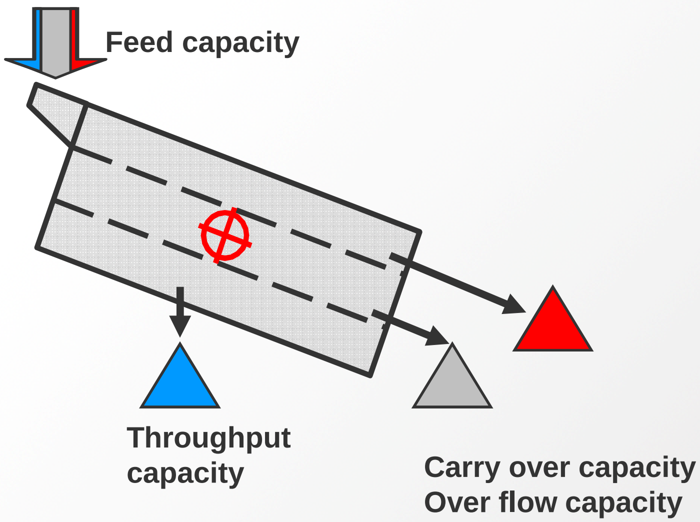


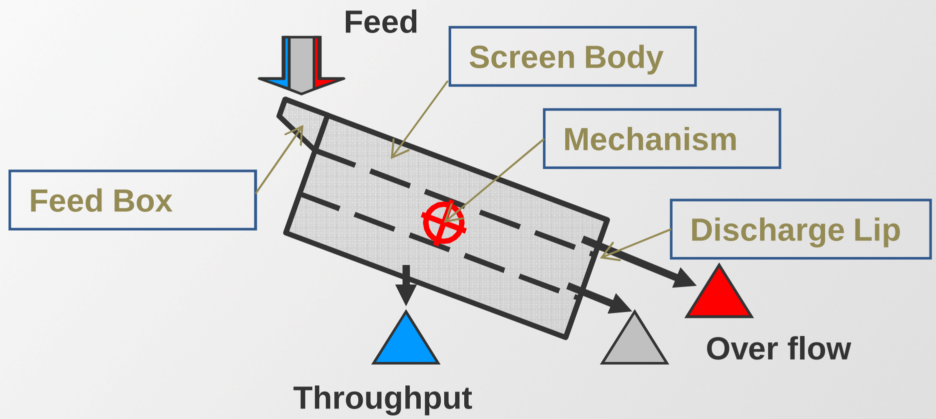
- Screen decks inclined to keep vertical movement
- No bed depth allows small particles to fall trough media.
- High horizontal velocity keep big particles off the feed zone
- Higher utilization of screening area
- Vibrations to create horizontal movement

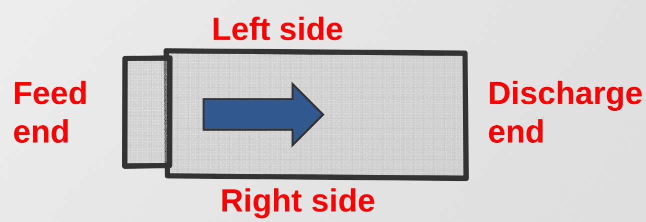
- ➔high throughput capacity per screen area in fine fractions

Screening

Terminology







Screening

Terminology

G-force = acceleration of screen

= K x rotation speed x rotation speed x stroke length

$$= \frac{\text{speed (rpm) x speed (rpm) x stroke (mm) x 5.6}}{10\ 000\ 000}$$

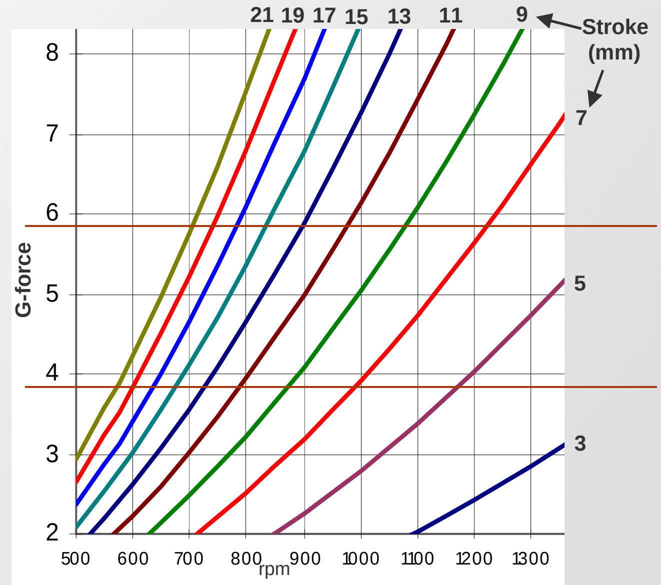
Example:

G-force = 800 x 800 x 11 x 5.6 / 10000000

= 3.9

Normally: 3 - 4 G on inclined screens

3.5 – 6 G on horizontal screens

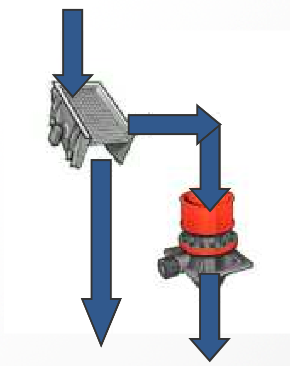


speed	stroke	G	Lh10
100	100	100	100
110	100	121	47
100	110	110	73
105	100	110	69

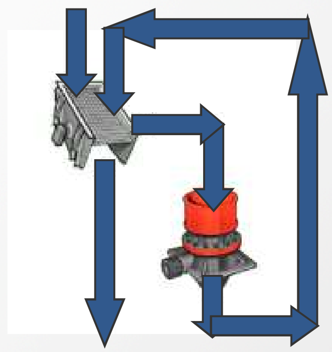
Screening

Terminology

Open circuit



Closed circuit

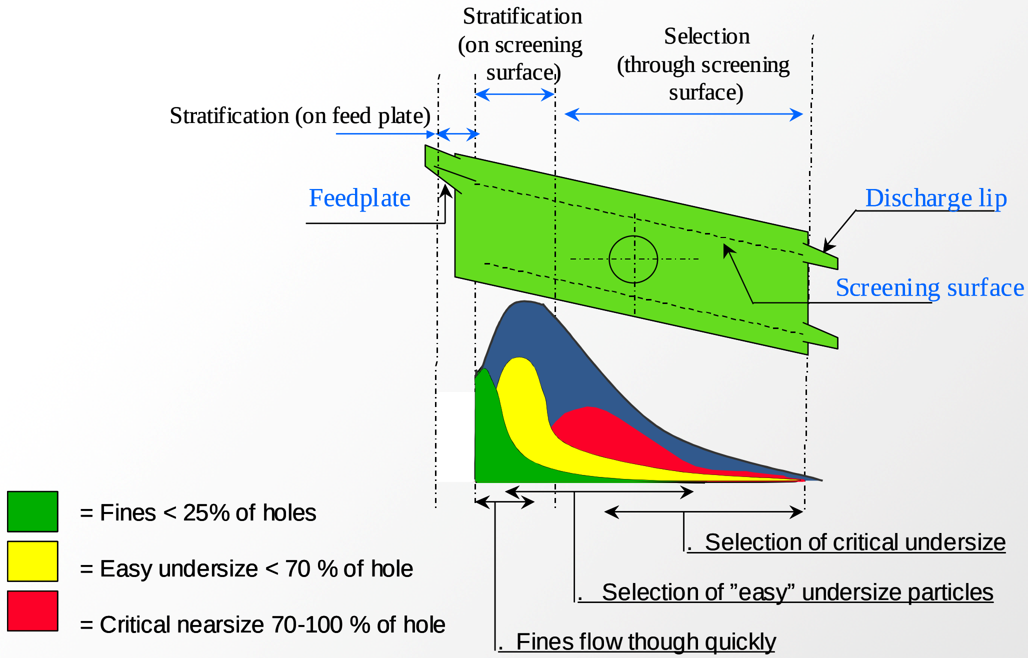


Blinding

Pegging

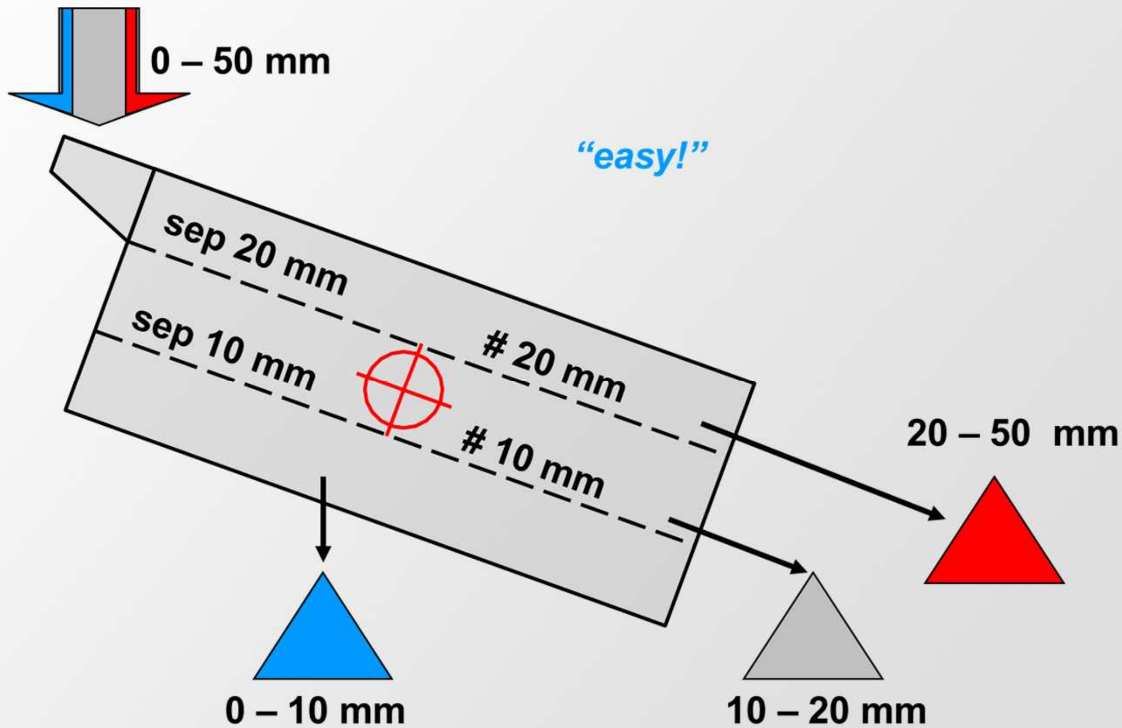
Screening

Throughput along the screen length



Screening

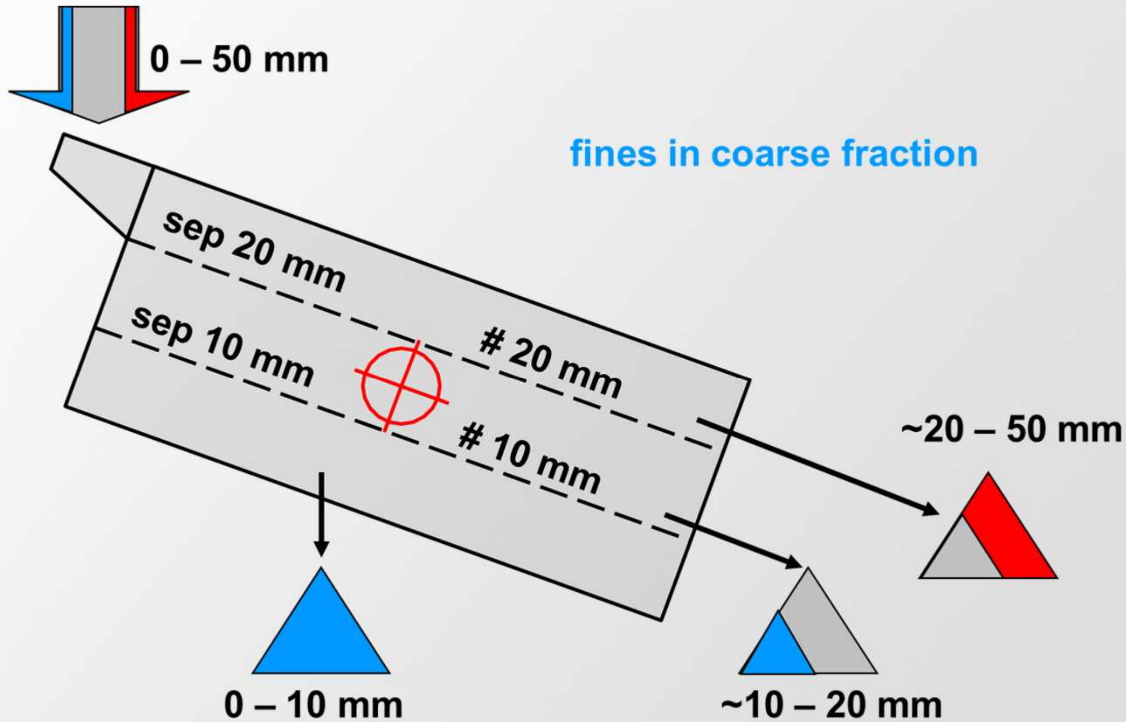
“Proper screening”



QUARRY ACADEMY

Screening

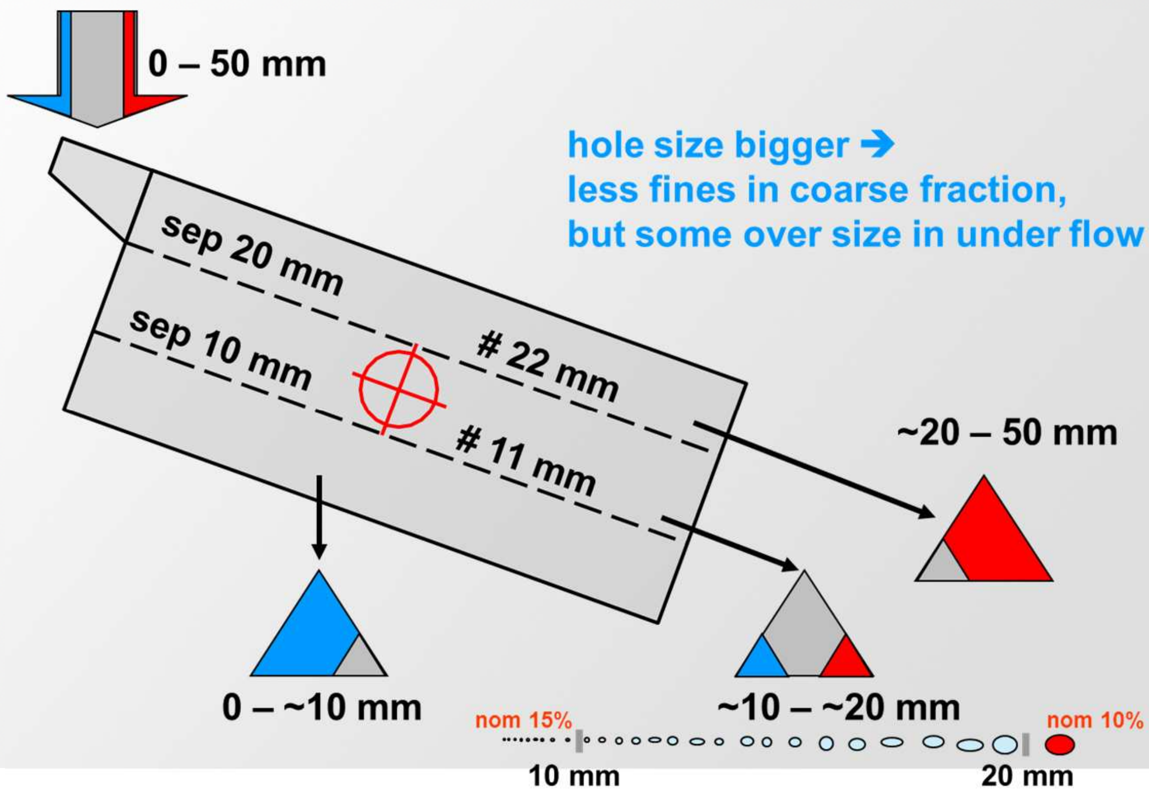
“Proper screening”



QUARRY ACADEMY

Screening

“Proper screening”

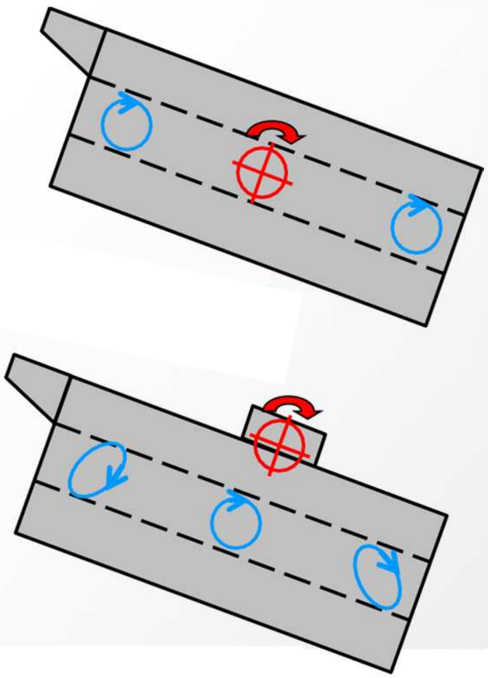


Use your efforts to optimize the “economical out-flow” of your screen!

QUARRY ACADEMY

Types of screens

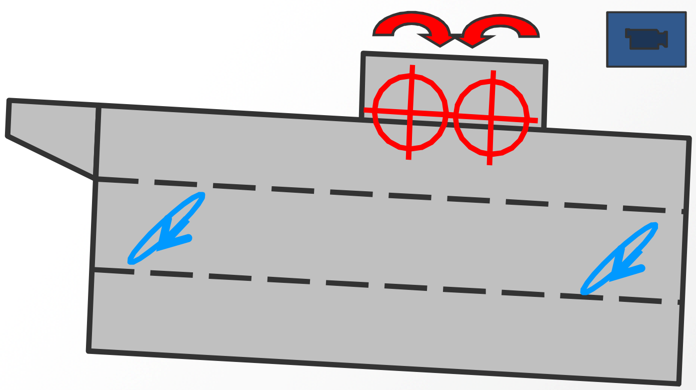
Circular stroke screens



- inclination 15 - 22 deg
- G-force 3.0 – 3.5
- Pros:
  - wide offering
  - not sensible for pegging
  - simple construction ➔ price
  - widely used
- Cons:
  - space needed
  - control to bed depth (➔efficiency vs capacity)
  - wear in scr media

Types of screens

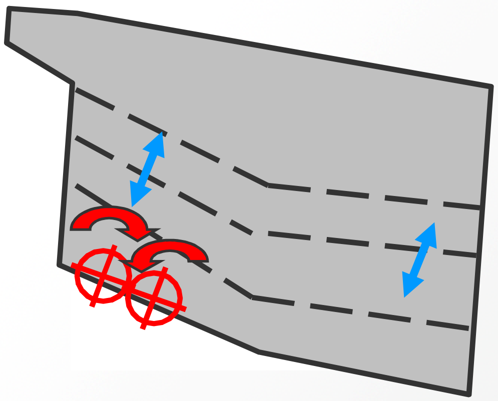
Linear (elliptic) stroke screen



- Inclination -3 - 10 deg
- G-force 3.5 – 6.5
- Pros:
  - high capacity and good efficiency
  - high carry-over capacity
  - lifetime of scr media
  - low headroom
  - adjustability
- Cons:
  - pegging with near size particles
  - more complicated drive ➔ price

Types of screens

Free-fall screens



- Inclination of deck varies
- G-force 3.5 – 5.5
- Pros:
  - really high through put capacity
  - space required
  - Price to capacity
  - Vibrating motor driven → easy maintenance
- Cons:
  - cleanness of products(SS)
  - “sensibility”

QUARRY ACADEMY

Types of screens

Other screen types

- Roller Screens
- Trommel Screens
- High Frequency Screens
- “Banana” screens
- Dewatering screens

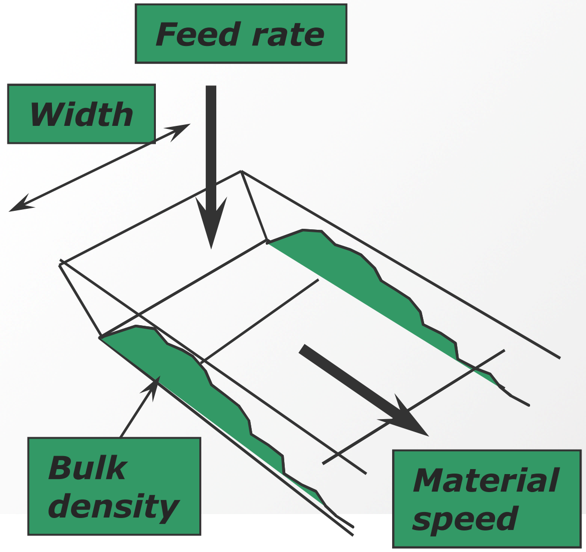
Screen size selection

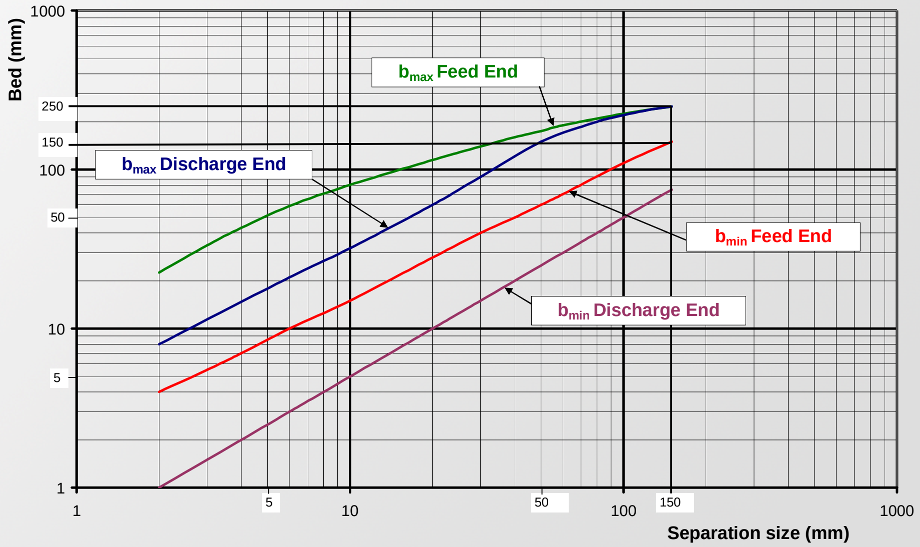
4 steps process

1. Selection of screen type
2. Selection of width
3. Selection of area
4. Check the carry over capacity

Selection of screen width

- Selection of width is based on correct bed depth over the decks
- The factors affecting bed depth

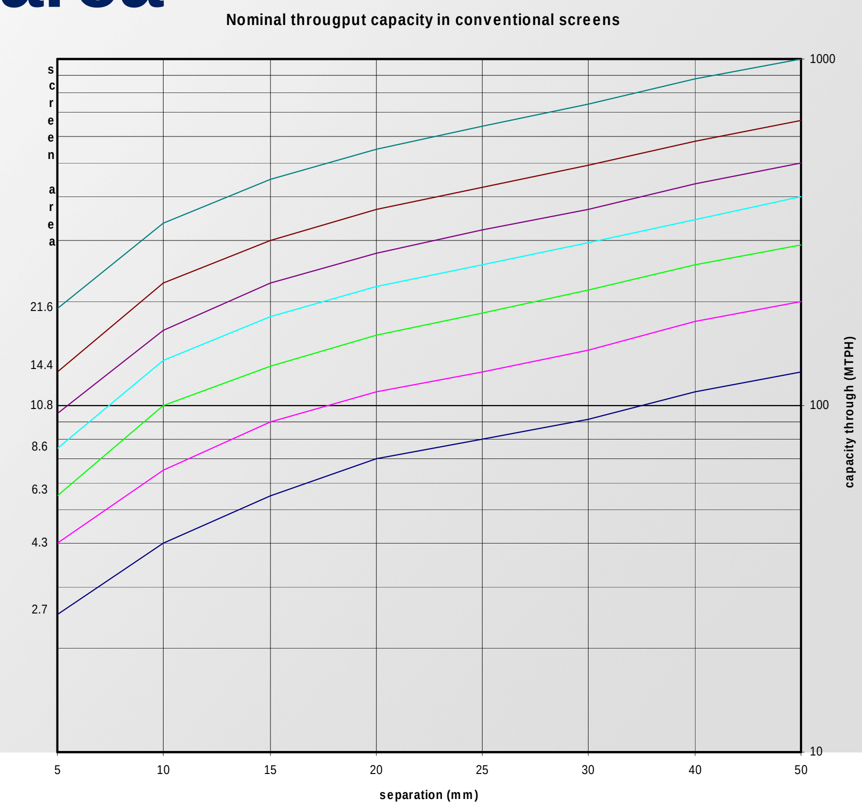




QUARRY ACADEMY

Selection of the screen area

- Circular stroke screens in 18 degrees inclination, top deck
- Feed is a hard rock crushed in a cone crusher, bulk density 1,6 t/m3
- 75 % of the feed is < separation
- 40 % of the material passing is < 1/2 separation
- Moisture content 1 %, dry screening
- Fraction length of the fraction over is 1,65
- Screening media is wire mesh
- Screening accuracy demand reasonable (10 % oversize in the fine and 15 % undersize in the coarse fraction)



QUARRY ACADEMY

Screening area calculation (Sandvik formula)

Basic formula for through put in conventional screening (*t/h per m²*):

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

- Q : Throughput capacity (*t/h per m²*)

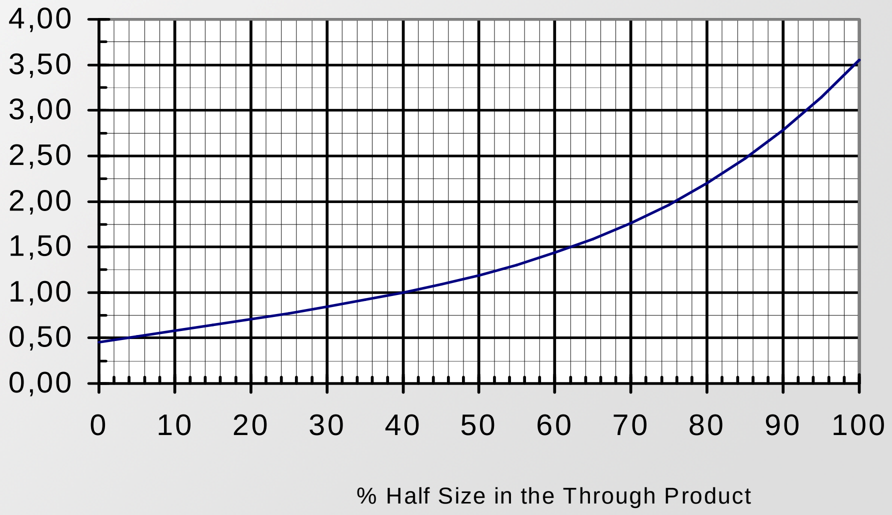
- A: Nominal capacity for separation
- B: Oversize (0.45 … 1.04)
- C: Halfsize (0.5 … 3.5)
- D: Type of material (1.0 … 1.2)
- E: Bulk density (0.5 … 1.2)
- F: Moisture (0.35 … 1.0)
- G: Type of screen (0.95 … 1.2)
- H: Wet screening (1.0 … 1.45)
- I: Deck position (0.7 … 1.0)
- J: Screening element (0.7 … 1.05)
- K: Fraction length (0.5 … 1.25)
- L: Accuracy demands (0.7…1.7)

Factor C

Amount of Halfsize

- Halfsize is % smaller than 1/2 the separation in through put

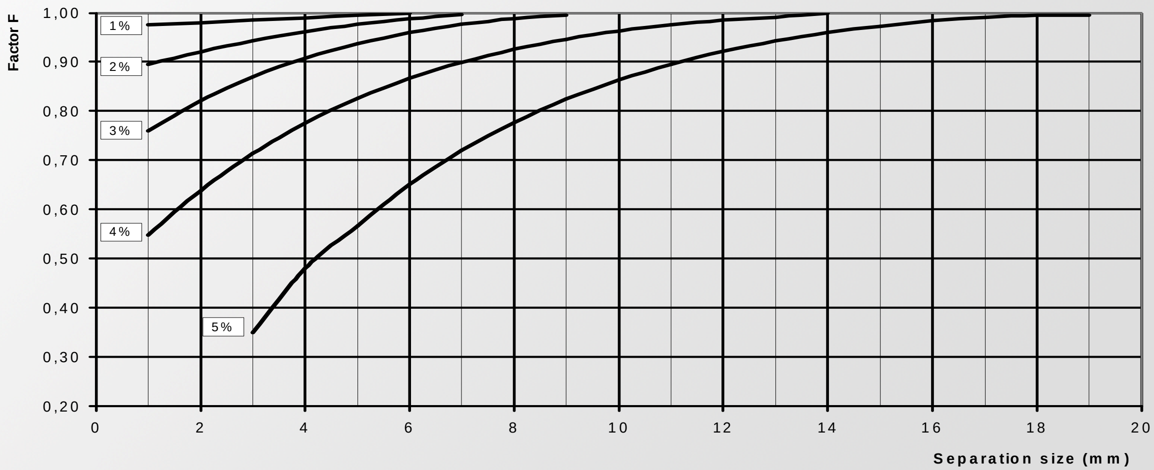
  - Small stones pass easily
  - Big stones goes over easily
  - Nearsize stones needs a lot of area to ”select



Factor F

Moisture content in feed

- Surface area to mass ratio bigger in fines -> moisture higher in fine fractions
- Material stick together
  - Blinding
  - Bridging



Factor L

Accuracy demand

- Accuracy of the fraction produced by the deck

Max Over/Undersize	Factor: L
10/10	0.7
10/15	1.0
10/20	1.2
15/20	1.3
20/25	1.5
20/30	1.7

Screens & Feeders

Troubleshooting

- Questions always asked before problem solving
- Failures, cracks:
  - Free movement
  - Natural frequency
- Poor performance
  - Correct selection
  - Correct screening media
  - Correct feed arrangement
  - Open apertures in Screening Media
  - Correct stroke parameters

Troubleshooting

Always asked questions ?

- What is the type and serial number of the unit?
- What is the feed capacity / feed size distribution?
- Is the feed in the middle of the screen?
- What kind of screening media has been used? Blinding or pegging?
- Is there enough space for free movement?
- What is the stroke length in each corner?
- What is the rotation speed of the mechanism?
- (What is the bed depth on feed end / discharge end on each deck?)
- (What is the speed of the material over the deck?)

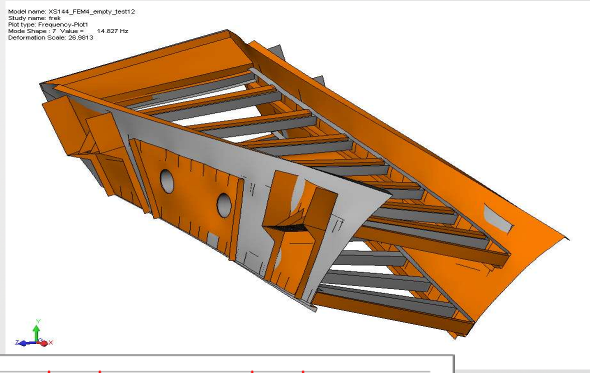
Free movement

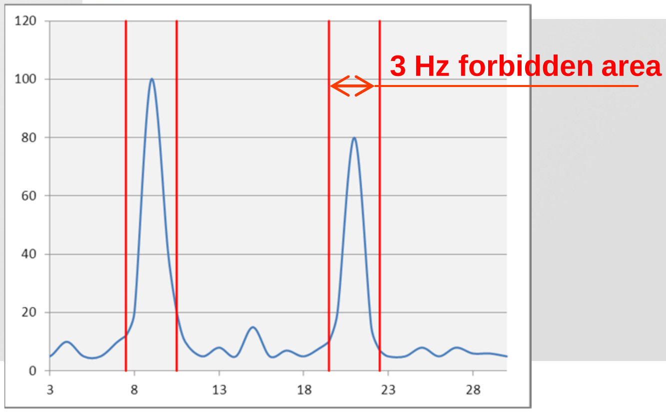
Troubleshooting

- Ensure that there is free space for the screen / feeder body to move also in start & stop
  - 80 mm in vertical
  - 60 mm in horizontal (on material flow direction)
  - 50 mm in lateral (side way)
- The material built-up over the support and chute structure has to be noticed
- If the screen / feeder body hits to structures or material built-up, the stress level in the body will be multiplied, which lead to the cracks (typically on deck structure or side plates)

Natural Frequency & Resonance

- Every screen or feeder has its specific natural frequency
- Running speed frequency comes from mechanism shaft rotation
- If these frequencies are too close to each other the screen will be in resonance.
- In resonance zone the screen body, typically the deck support frames will break down eventually! This may happen after only a few hours!
- Natural frequency is checked in factory before the delivery, but can change, if:
  - weight changes (heavier, lighter screening media, added rubber, etc.)
  - joints are loose or frame is worn
  - speed is altered



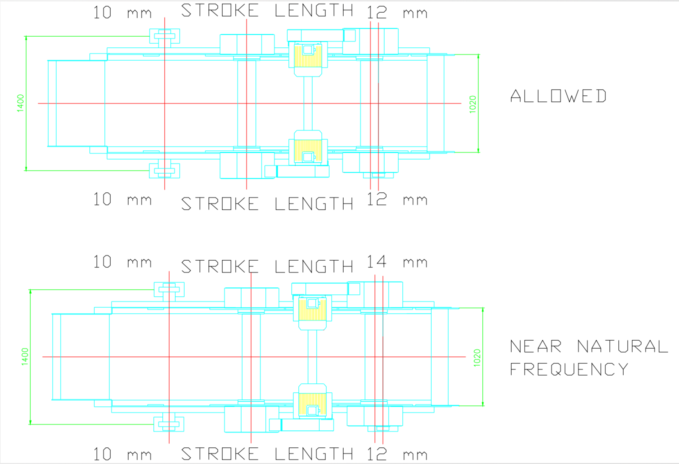


QUARRY ACADEMY

Natural Frequency & Resonance

- Symptoms of resonance:
  - Uneven stoke length on left / right
  - Material moves sideway in screen decks
    (on properly installed screens)
  - Cracks on screen body
    (if free movement)

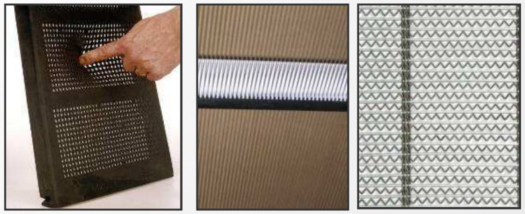
- Corrective actions:
  - Remove all “own additions”
  - Change the rotation speed



QUARRY ACADEMY

“Open” screening media

- Blinding- the closing down of an aperture by fines adhering to the wire/surface of the sizing media
- Pegging- the mechanical locking of an angular particle in an aperture.
- How to prevent blinding & pegging:
  - Use maximum G-force (especially stroke length in pegging)
  - Use flexible screening media



  - Use “Ball Deck”

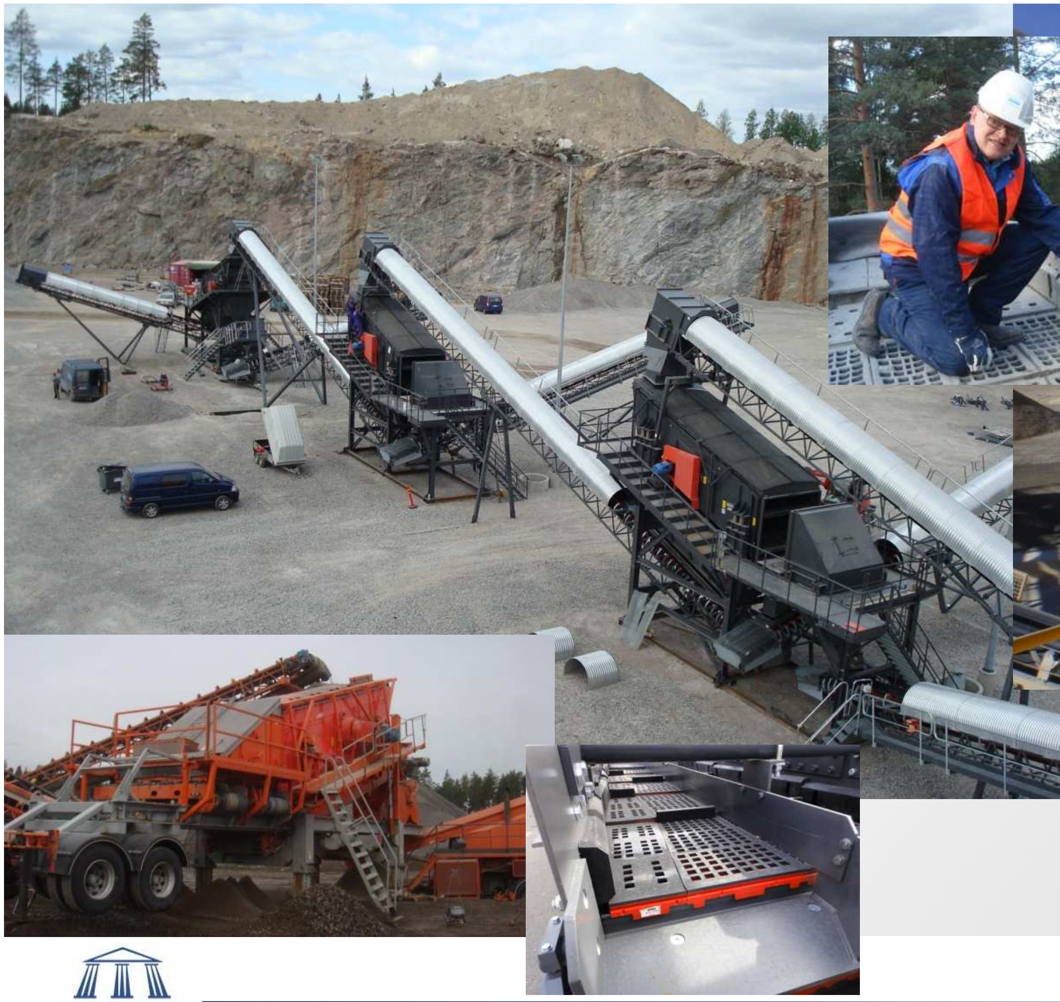
Correct feed arrangement

- The best arrangement is to feed the screen by “material flow” direction (stratification)
- The worst is to feed from side (stratification)
- Stratification in “side feed” will cause uneven bed depth to discharge end of the deck
- Stratification in “backward feed” means that all the bed has to be re-stratified before separation → extended need for the deck area
- Negative effects of “side feed” or “backward feed” can be minimized by correct chute arrangement
- The correct bed depth!!

Correct stroke parameters

- Stroke parameters = stroke length & stroke angle
- Wear life & maintenance costs view: as low G-force as possible, especially speed
- Performance view: as high G-force as possible, but enough opportunities for particles to pass through the deck, especially stroke
- Optimized view: as low G-force as possible with minimum rotation speed, but stroke length long enough to avoid pegging and enough G-force to ensure the proper stratification and selection
- Basic rule for stroke length: fines separation with minimal stroke (& high speed), scalping with long stroke (& low speed)

speed	stroke	G	Lh10
100	100	100	100
110	100	121	47
100	110	110	73
105	100	110	69



Questions?

QUARRY ACADEMY

Screening: “Making the Right Stuff”

Workshop (1 hours)

1. In attached photos / videos there is something to improve?
   1. What is wrong?
   2. How to correct?
2. Your main problems in screening? What has been / could be done to improve the situation?
3. (What are the most recommended screen types (and why) for following applications (see flow sheet):
   1. Scalping & Natural Fines removal on primary stage?
   2. Screening of fines before tertiary crusher?
   3. Sellable fractions for cement industry?)

www.quarryacademy.com

QUARRY ACADEMY

Improving Processes. Instilling Expertise.

ORICA VOLVO SANDVIK