SANDVIK ROCK PROCESSING
THE ART OF CRUSHING
What is a C&S system?
- Super Quarries & Mines: 600-2000 tph
- Medium Quarries: 300-600 tph
- Small Quarries & Mobiles: 150-300 tph
THE ART OF CRUSHING

- Raw material?
- How big? (Size of rawmaterial)
- How much? (Capacity)
- Final products?
- Contamination?
THE ART OF CRUSHING

- Feedcurves
- Max Topsize
- Impact Work index ($W_i$)
- Abrasion index ($A_i$)
- Type of rock / geology
- Density
  - $W_{i \text{ measured}} \times \text{B.D.}/1.6 = W_{i \text{ real}}$
- Moisture
- Contamination
# THE ART OF CRUSHING

<table>
<thead>
<tr>
<th>Crushing Rock</th>
<th>Crushing Gravel</th>
<th>Crushing Ore</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>✓ Limited reduction</td>
<td>✓ Limited reduction</td>
<td>✓ Maximum reduction</td>
</tr>
<tr>
<td>✓ Cubical shape</td>
<td>✓ Cubical shape</td>
<td>✓ Shape of no importance</td>
</tr>
<tr>
<td>✓ Over- and undersize is important</td>
<td>✓ Over- and undersize is important</td>
<td>✓ Over- and undersize of no importance</td>
</tr>
<tr>
<td>✓ Flexibility</td>
<td>✓ Flexibility</td>
<td>✓ Flexibility of minor importance</td>
</tr>
<tr>
<td>✓ Crushing and screening</td>
<td>✓ More screening than Crushing</td>
<td>✓ More crushing - less screening</td>
</tr>
<tr>
<td>✓ Range of products</td>
<td>✓ Contamination?</td>
<td>✓ One or two products</td>
</tr>
<tr>
<td>✓ Range of products</td>
<td>✓ Sellable Products !</td>
<td>✓ Sellable Products !</td>
</tr>
<tr>
<td>✓ Sellable Products !</td>
<td>✓ Sellable Products !</td>
<td>✓ Product to further processing !</td>
</tr>
</tbody>
</table>
THE ART OF CRUSHING

Final Products - Specifications

◆ Asphalt / Concrete
  ✓ Shape of material
  ✓ Over and undersize
  ✓ No contamination

◆ Railway ballast
  ✓ Curve limitations
  ✓ Shape of material
  ✓ Over and undersize
  ✓ No contaminations

◆ Base course / Sub base
  ✓ Curve limitations

⇒ Different in all countries
Product properties

British norms

German norms

French norms

“US” norms

Slots
Reduction Ratio (1)

\[
\text{Reduction Ratio} = \frac{F_{80}}{P_{80}}
\]

\(F_{80} = (80\% \text{ of feed mtrl})\)
\(P_{80} = (80\% \text{ of the product})\)
Reduction Ratio (2)

Normal reduction:

- Jaw crusher: 2-3
- Gyratory crusher: 3-4
- Cone crusher: 3-5
- Impact crusher (VSI): 4-6
- Impact crusher (HSI): 7-10
Reduction Ratio (3)

Using reduction ratio to predict required no. of crushing stages

\[ \frac{P_{80} \text{ Feed}}{P_{80} \text{ Products}} = \frac{400 \text{ mm}}{16 \text{ mm}} = 25 \]

Min. required plant reduction ratio:

- 2-stage Impact Plant: 10x7=70
  OK, Only for Ai <0.15
- 2-stage Jaw/cone Plant: 3x4=12
  NOT OK
- 3-stage Jaw/cone Plant: 3x3x4=36
  OK
Reduction Ratio 3

Impactors VS Compresive crushers

- **Impact crusher**
  - High reduction ratio
  - Low investment
  - High wear cost
  - Max $A_i = 0.15$

- **Jaw / Cone crusher**
  - Low reduction ratio
  - Big investment
  - Low wear cost

![Graph showing production and total cost for Impact and Jaw/Cone crushers]
Primary Crusher station

- Continuous process
- Conveyable product
- Remove Contaminations
Primary Crusher station
Primary Crusher station
Primary Crusher station
Intermediate storage

- Quality producing part of plant independent of Primary crushing and loading operation
- Even out variations in the material distribution. Uneven load gives problems in all machines coming after.
- Better total availability for the Plant
- Recommended stockpile volume for 2 shifts operation
Intermediate Storage (2)

1 feeder

3 feeders

2 feeders

4 feeders
Secondary Circuit

- Big feed opening
- High capacity
- Controlled feed
Secondary Crushers

Hydrocone H / S

Secondary Impactor
Production of railway ballast

C.S.S: 150-175 mm

Hydrocone S4800 C
Alt.
Hydrocone H6800 CXD

0-18  0-35  flake  Railway Ballast
Screening
Open / Closed circuit
Open Circuit

- Screening ahead of a crusher avoids packing.
- Less wear in the crusher.
- Higher total capacity.
- The product is controlled by the screening cloth and the setting of the crusher.
Open Circuit – Examples

Splitting of crusher feed

By-passing fine material

Scalping
Closed Circuit

- Calibrated product
- Higher reduction ratio.
- Better cubical shape
- More machines
- Lower capacity
Closed Circuit

- Closed circuit ~ 1/5 of screen feed circulating recommended
- Smaller or same setting (CSS) as separation.
- Higher wear
- Cubical shape
- Big screen

Discrepancy:
- Short jobs
- Prod of sand
Closed Circuit – Examples

- Screening after crusher
- Screening ahead of crusher
- Screening ahead of and after crusher
SCREENNING SUMMARY

Screen duties
A = Scalping screening
B = Close circuit screening
C = Final products screening
D = Natural fines screening
Final Crusher

Demands:
- Optimised feed
- Capacity
- Product shape
FINAL CRUSHER - Hydrocone

- Good Flexibility
- Higher crushing forces
- Limited good shape range
- Uniform reduction ratio

Aperture (mm)

%-Passing

Feed
H3800 F

Good shape product area
FINAL CRUSHER- Merlin VSI

- Better shape
- Uneven Reduction
- Limited topsize capacity
- High fines production
HYDROCONE – MERLIN RP

Hydrocone H3800 F
Ecc: 29 mm
C.S.S: 16 mm
ASR Plus

Merlin RP 107
Tip speed: 60 m/s
Bi-flow: 0%
150 kW

Curves show Hydrocone H3800 F and Merlin RP 107 in a medium hard granite (Wi=16) operation in open circuit.
Storage at Crusher

Choke fed Crusher;
- Higher Reduction
- Better shape (cubical)
- Better utilization of mantle and liners
- Bin volume; 5-10 min operation
Crusher feed
Stationary / Mobile

Stationary
- Long term Contracts
- Valuable products
- Range of products
- Production on demand
- Flexibility with many stages
- High Production control

Mobile
- Contract crushing
- Crushing at construction site
- Low product demands
- Few products
- Flexibility with Fleet
Mobile Units (1)

Mobility selection chart

- Portable
- Wheel-mounted
- Track-mounted

Movements/Year

1 5 25 100

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Mobile Units (2)
Mobile Units (3)

- Portable
- Wheel-mounted
- Track-mounted

Dismounting time vs. Hours

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Mobile Units (4)

Nom. loading Capacity (m³/h)

Machine Weight (Tonnes)

Wheel Loader

Excavator
2-Stage Plant

Capacity: 200 tph

Feed station

Jawmaster JM 1108 HD

Hydrocone H-4800 EC

Bin with Feeder

Screen CS 86-IV

0-4  4-8  8-16  16-32
3-Stage Plant

Capacity: 200 tph

Application Example

Feed station
Jawmaster JM 1108 HD

Hydrocone S-3800 EC

Bin with Feeder
Hydrocone H-3800 M

Screen CS 86-II

0-4 4-8 8-16 16-32
4-Stage Plant, Cone

Capacity: 200 tph

Feed station

Jawmaster JM 1108 HD

Jawmaster JM 1108 HD

Bin with Feeder

Hydrocone S-3800 EC

Bin with Feeder

Hydrocone H-3800 MF

Hydrocone H-3800 M

Screen CS 86-II

Screen CS 86-II

16-32 8-16 4-8 0-4
4-Stage Plant, VSI

Capacity: 200 tph

Feed station
Jawmaster JM 1108 HD

Hydrocone S-3800 EC
Bin with Feeder
VSI
Hydrocone H-3800 M

Screen CS 126-II

16-32 8-16 4-8 0-4
Application examples

SUMMARY

<table>
<thead>
<tr>
<th>Product distribution</th>
<th>0-4 mm</th>
<th>4-8 mm</th>
<th>8-16 mm</th>
<th>16-32 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-stage</td>
<td>33 t/h</td>
<td>19 t/h</td>
<td>41 t/h</td>
<td>107 t/h (*)</td>
</tr>
<tr>
<td>3-stage</td>
<td>43 t/h</td>
<td>29 t/h</td>
<td>66 t/h (*)</td>
<td>62 t/h (*)</td>
</tr>
<tr>
<td>4-stage</td>
<td>61 t/h</td>
<td>35 t/h *</td>
<td>54 t/h *</td>
<td>50 t/h *</td>
</tr>
<tr>
<td>4-stage, VSI</td>
<td>88 t/h</td>
<td>38 t/h *</td>
<td>44 t/h *</td>
<td>30 t/h *</td>
</tr>
</tbody>
</table>

* Good shape

- **2-stage**
  - Cheap
  - Easy to move
  - Bad shape
  - Low flexibility

- **3-stage**
  - Medium expensive
  - Could be moved
  - Medium shape
  - Good flexibility

- **4-stage**
  - Expensive
  - Difficult to move
  - Very good shape
  - Very good flexibility
Mining Plant

Jawmaster
JM 1312 HD

Hydrocone
S-4800 C

Hydrocone
H-4800 M

2x Hydrocone
H-4800 EF

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