Particle Shape - Cubicity
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Design of a Plant circuit

?

How do we get a cubical product from a Hydrocone crusher or a Merlin VSI?

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Good shape fractions

- **Rail-way Ballast 32-56(63) mm from secondary crusher**

- **Concrete fractions 8-16, 16-32 mm and sand**

- **Asphalt fractions 4(5)-8, 8-11, 11-16 and 16-22 mm.**

- **Most critical fraction to get cubical are the 4-8 or 5-8 mm and crushed concrete sand (machine sand)**
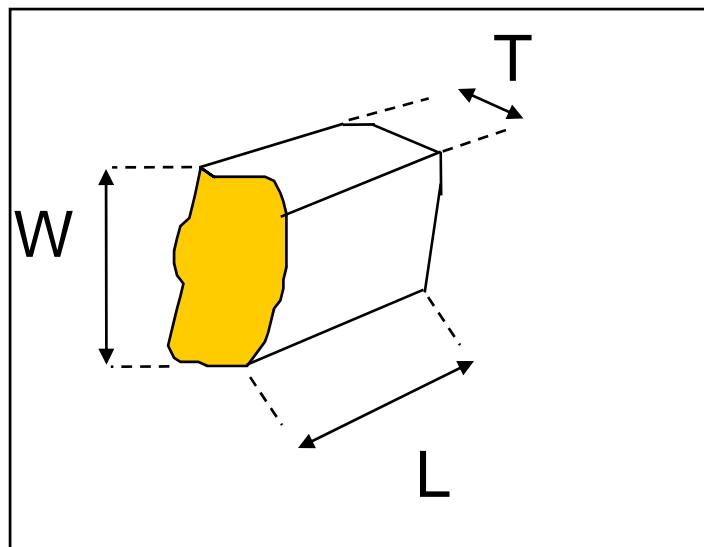
Test norms

Test methods for determining cubical shape
- Europe
  - ✓ Shape index (SI) where L/T > 3
  - ✓ Flakiness Index (FI) W/T where W/T > 0.6
- British Standard BS 812, Flake Index, the slot hole width is 3/5 of the median dimension of the fraction.
- ASTM – Superpave L/T > 5
- Others, Russia, China, India etc

Feed materials

Rule of thumbs

- Higher Impact Work Index (WI) gives in H/C larger CSS
- Materials with coarse crystalline structure usually give better shape than fine crystalline material.
  - ✓Coarse crystalline is for example Granite, Gneiss.
  - ✓Fine crystalline is for example Basalt, Diabase
- Sedimantary rocks can be difficult to shape up due to the laminar structure in the material
  - ✓ Laminar structure in for example Slate, Sandstone
- Long feed fractions normally gives better shape
  - ✓Top feed size < 3/4 of intake opening
  - ✓In Merlin VSI 0-fraction increase the cubicity
- Contaminations reduce the possibility of produce good shape

Important guidelines H/C

To get cubical products from the Hydrocone
- The crusher should always be choke fed
- Surge Bin with feeder and the Surge Bin equipped with max/min level indicators.(min level indicator interlocked with the feeder).
- Max level indicator in the feed Hopper of the Hydrocone to be interlocked with the feeder.
- Long fraction (4-32 mm) gives high pressure in the crushing chamber and more interparticle crushing
- Max feed size ¾ of intake
- Preferable reduction ratio 3.
- Smaller crushers give better shape in fine fractions
- ASR

Important guidelines VSI

To get cubical products from the Merlin

- The crusher should always be even fed
  - ✓ Capacity, watch up for under feeding
  - ✓ Particle size distribution, well mixed
- 0 – fraction reduce impact crushing and increase abrasion breakage which increase cubicity
- Max feed size ¾ of intake
- Preferable By-Flow™ process.
- Can be used as fraction(s) upgrader

Particle Shape
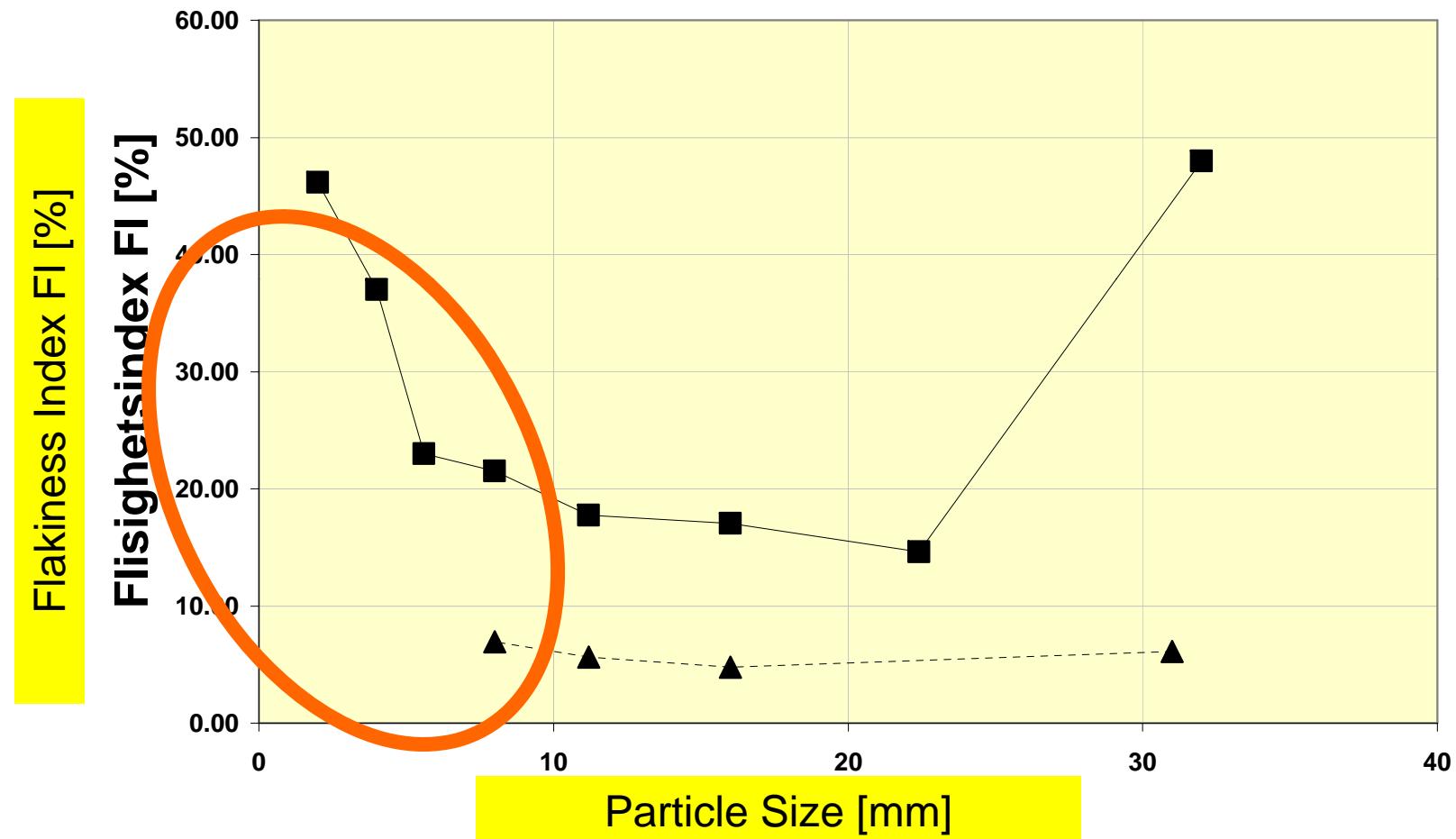
Cone Crushers
Effect of CSS and average feed size

Increased CSS

Flakiness Index [%]

Fraction [mm]

Increased Feed Size

Flakiness Index [%]

Fraction [mm]
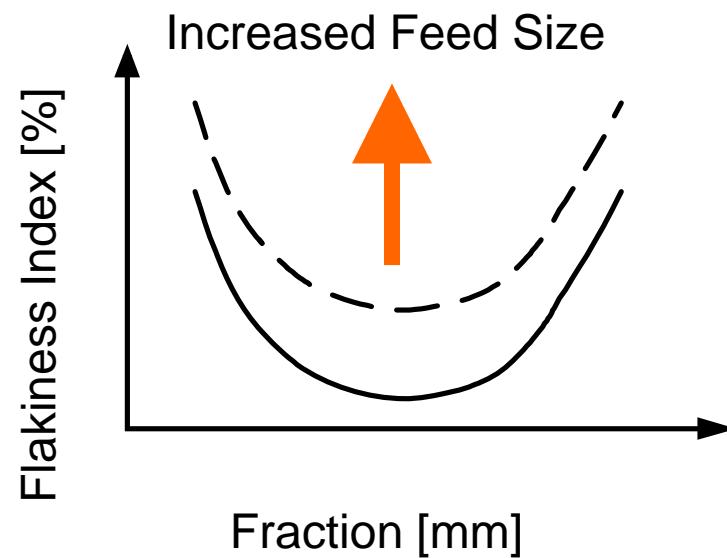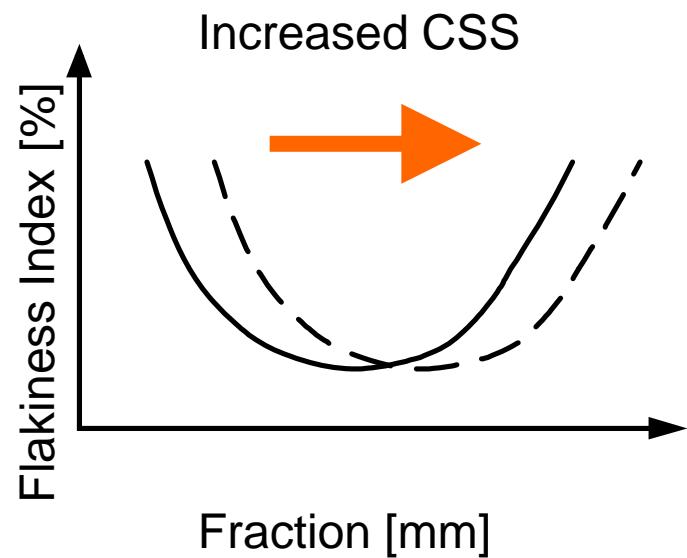
Particle shape in fine aggregates
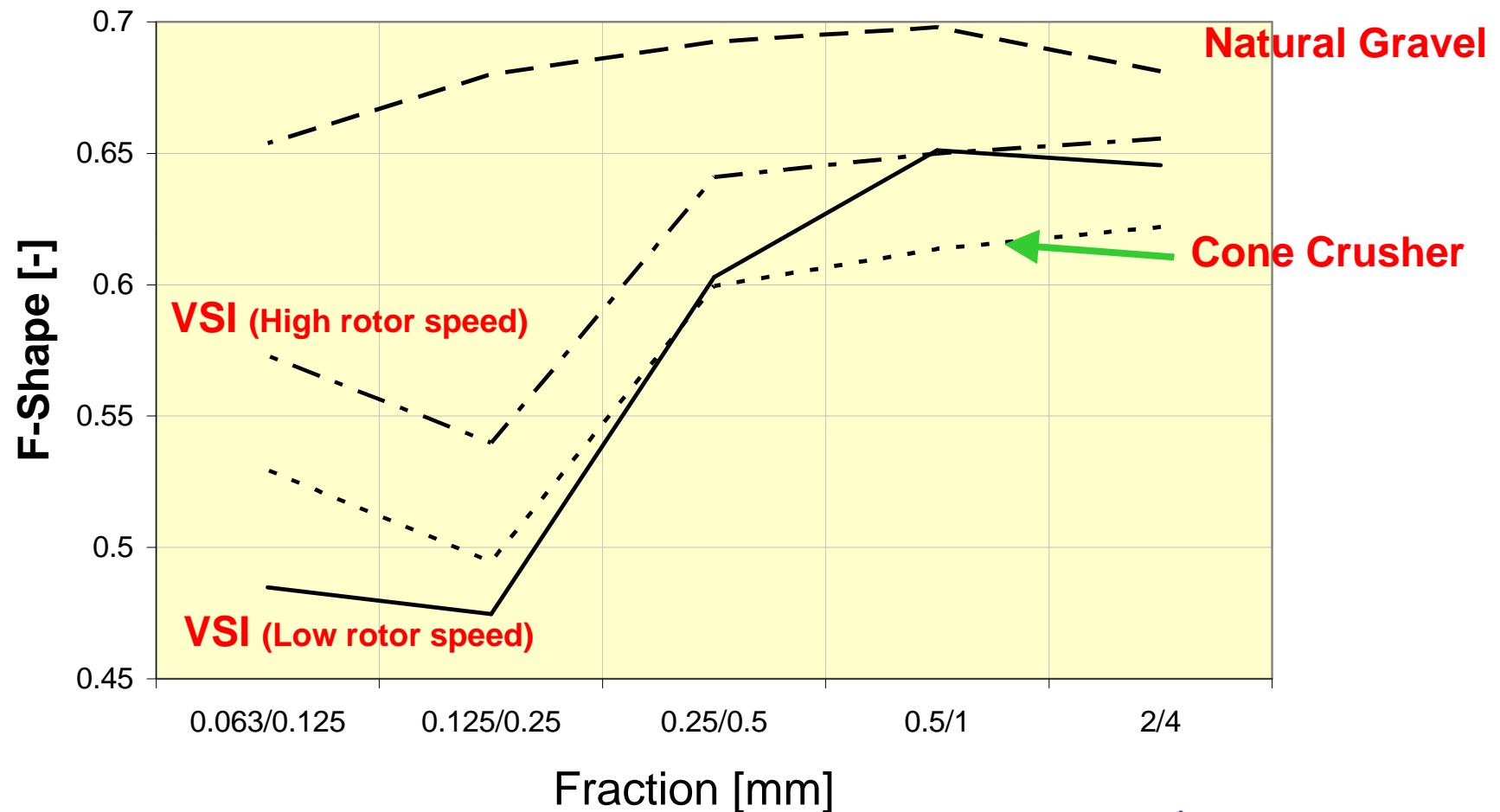
F-Shape
## Optical Microscope
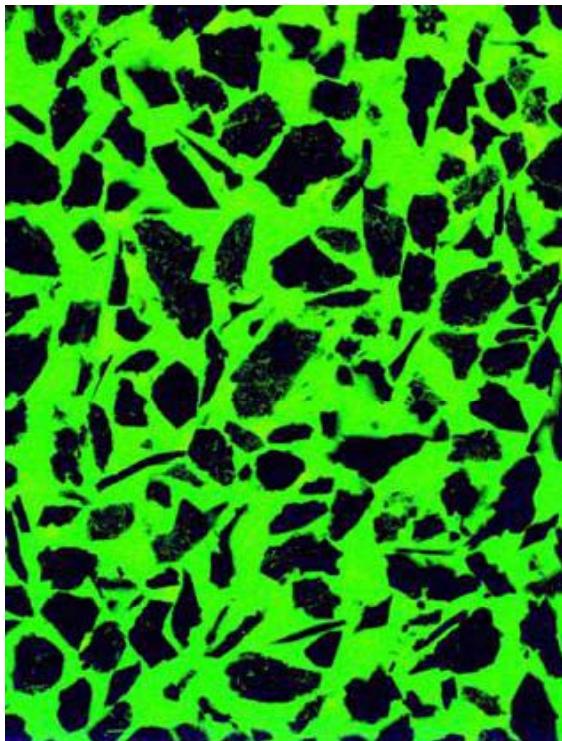
+250-500 microns
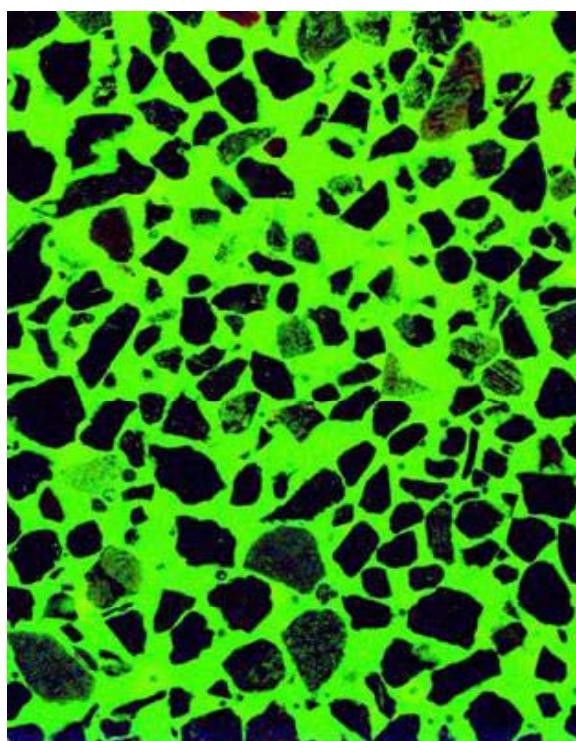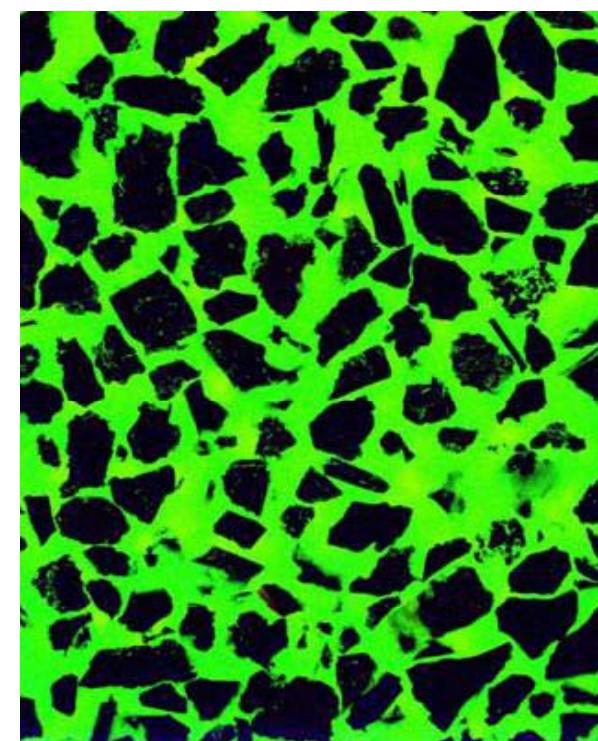
**Cone crusher**   **Natural gravel**   **VSI**

F-Shape
## Optical Microscope

+250-500 microns
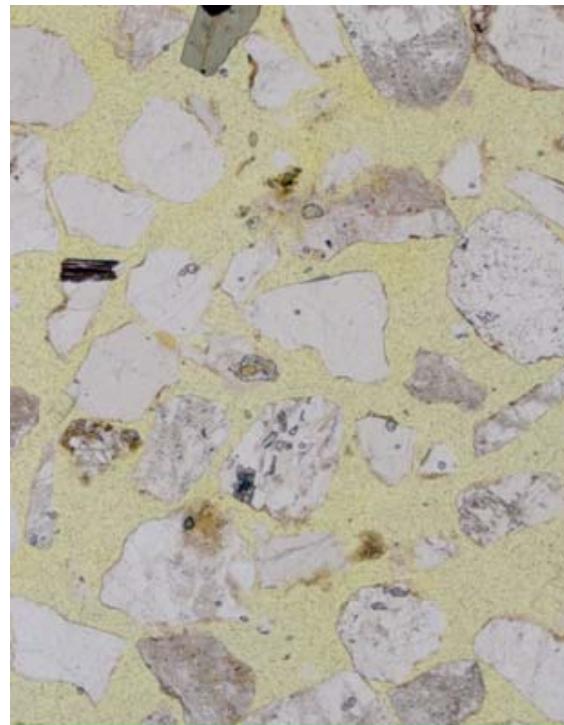
**Cone crusher**   **Natural gravel**   **VSI**

No cubicity Plant

Production 0 – 16 mm

NF

Deck 2
Sep 16 mm

Why ?

11-16   8-11   4-8   2-4   0-2
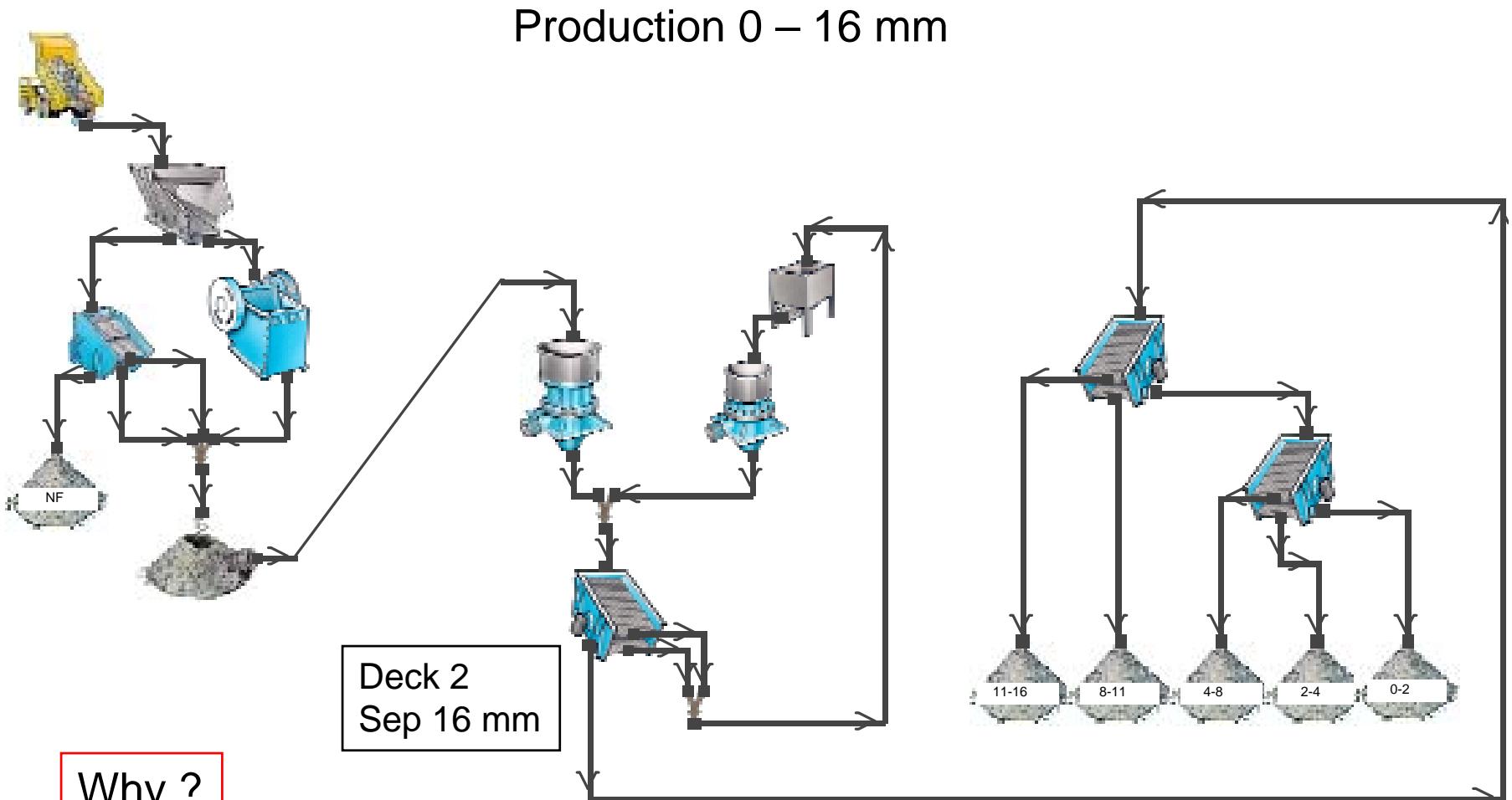
Upgraded cubicity Plant

Production 0 – 16 mm

Deck 1
Sep 16 mm

Deck 2
Sep 25 mm

11-16   8-11   4-8   2-4   0-2

NF

Why ?

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Cubicity Plant

Production 0 – 16 mm

Deck 1
Sep 16 mm

Deck 2
Sep 4 mm

Why ?
Alternative?

NF

11-16   8-11   4-8   2-4   0-2
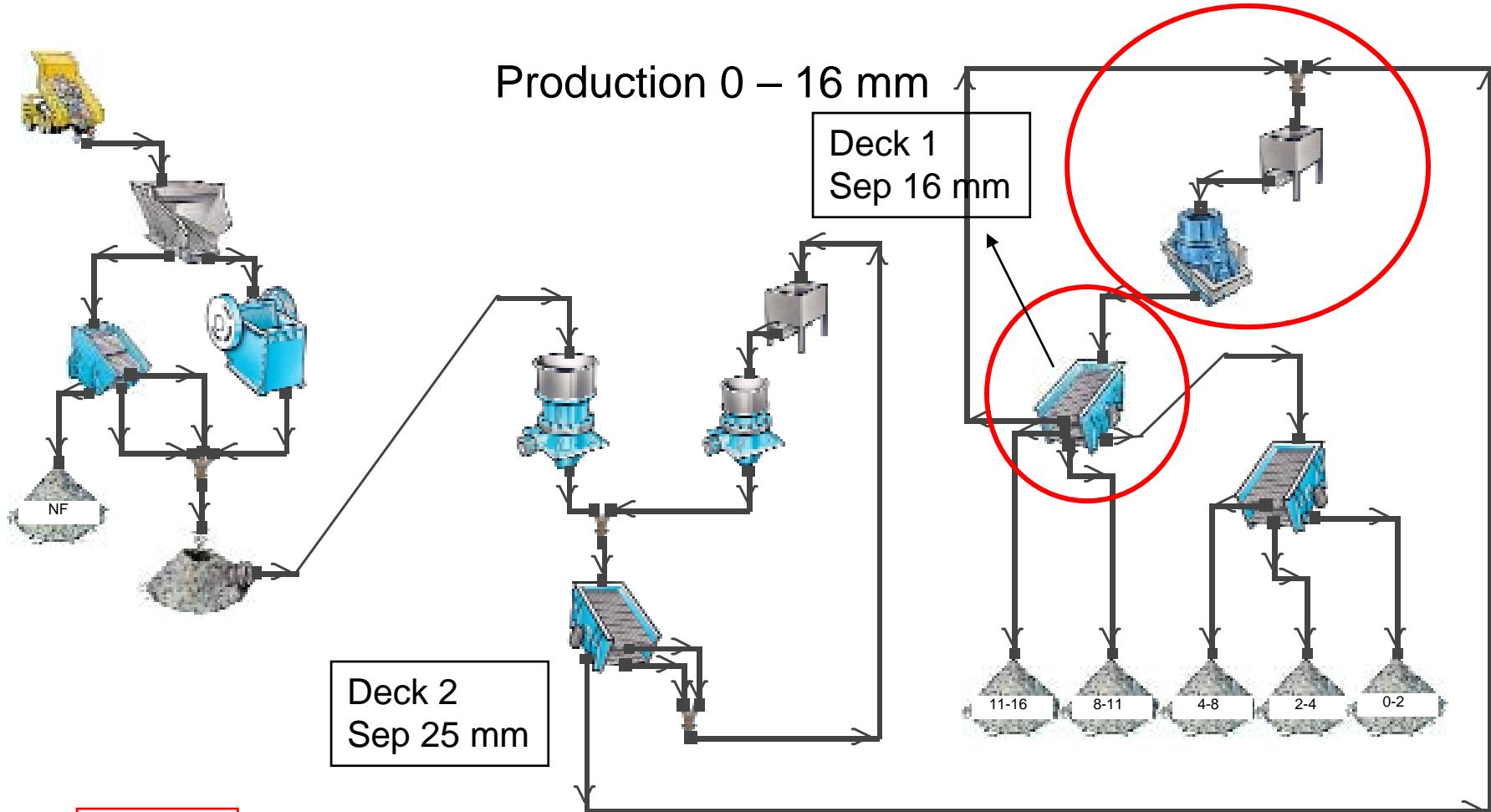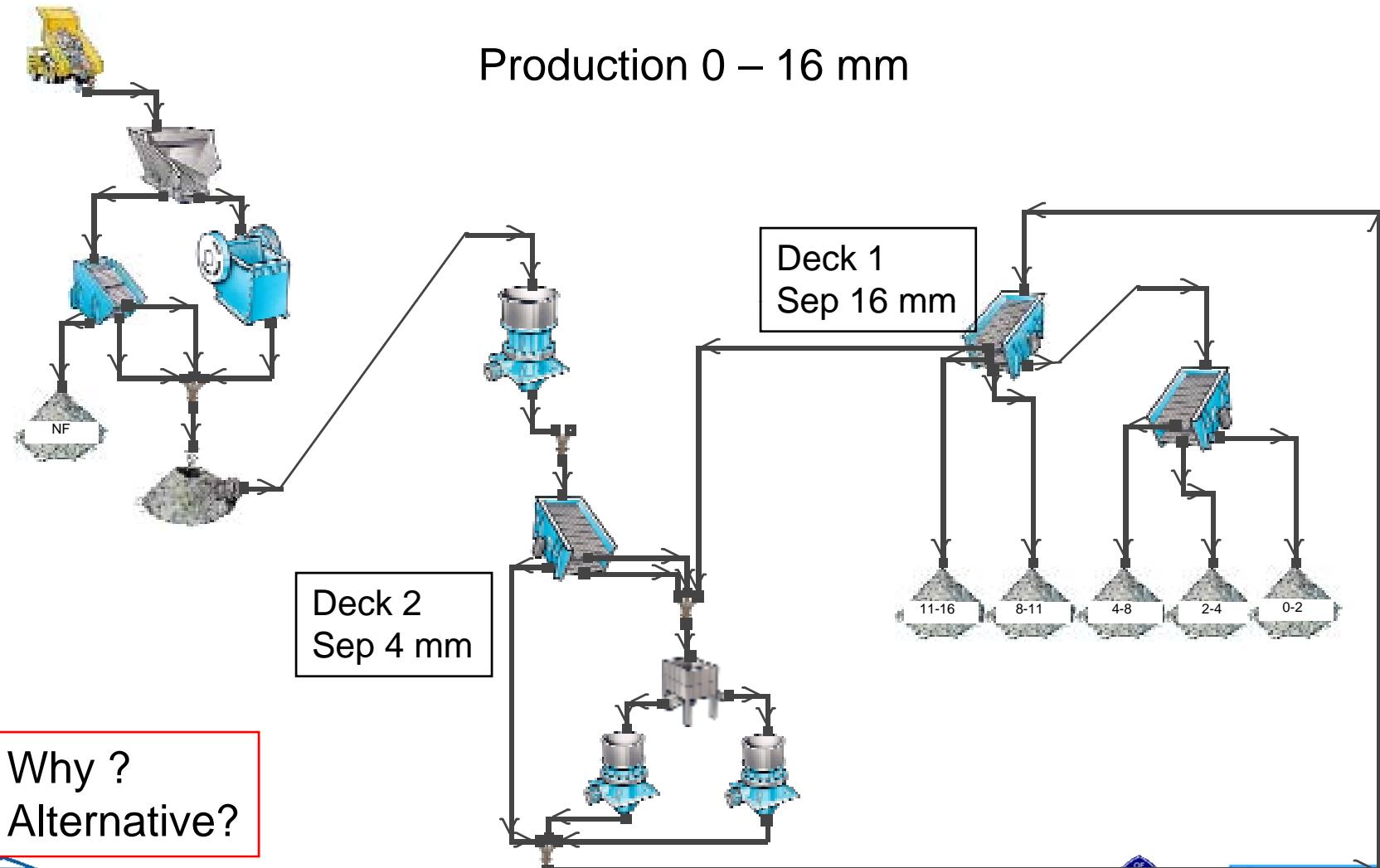
One example

Hydrocone 3800, SI (L/T > 3)		
Feed (mm)	4 – 8 mm	Note
4 – 32	15 %	MF, ecc 29 mm ASR
32 – 63	31 %	MF, ecc 29 mm ASR
4 – 63	22 %	MF, ecc 29 mm ASR

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Kornform i fin ballast
Reologitest

- **Ursprung:** New Zeeland standard *3111:1986*

- **Mäter** *massflöde*

- **Ett antal smala fraktioner är provade**

Reologitest
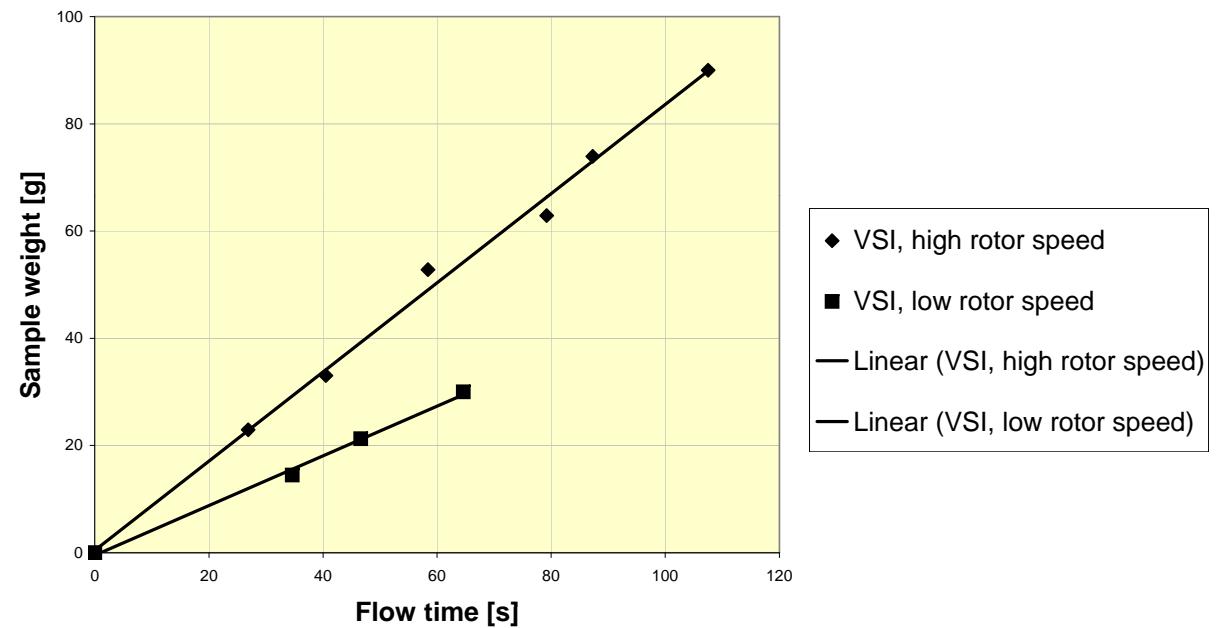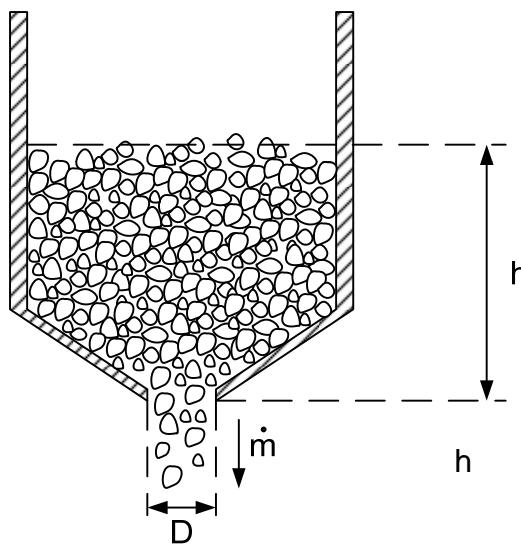
$$\dot{m} = C \cdot \rho_b \cdot \sqrt{g} \cdot \left(D - k \cdot d\right)^{5/2}$$

Jämförelse mellan reologitest och F-Shape