



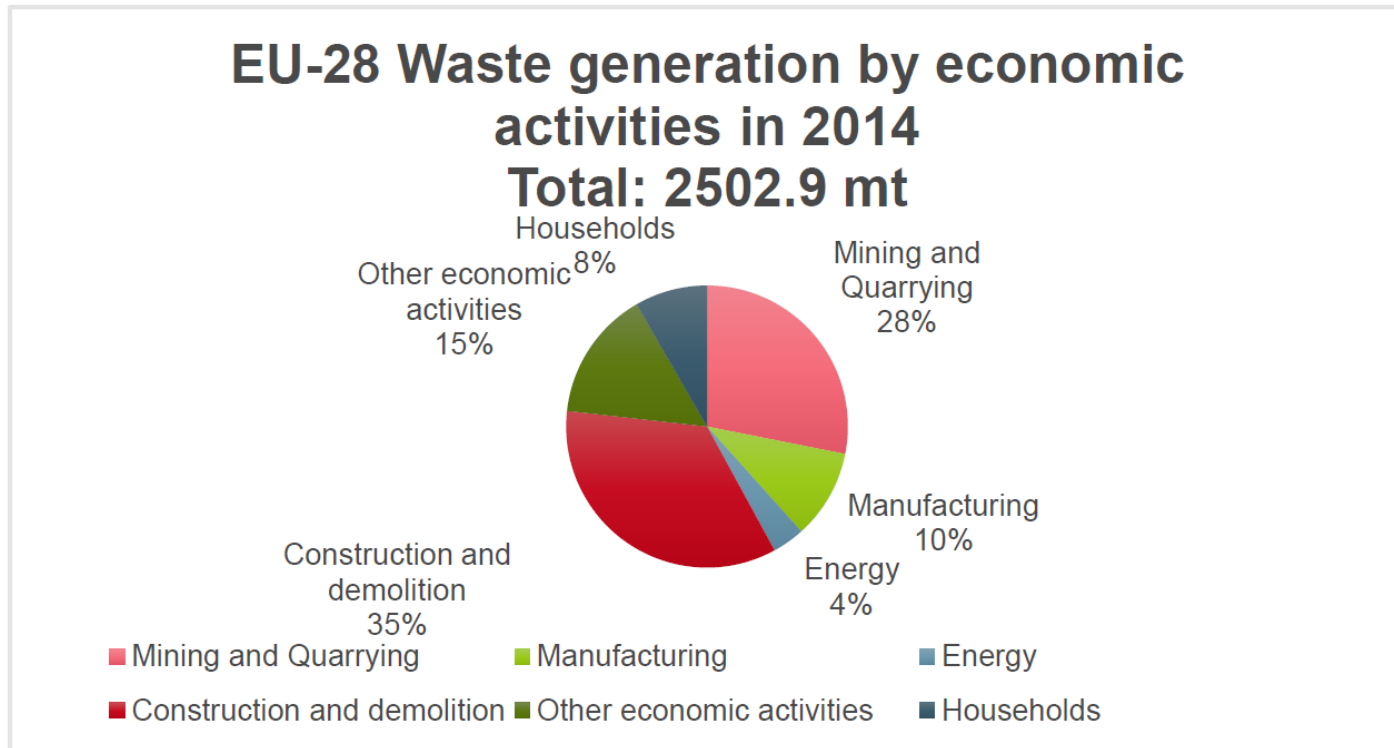


What to do?



We produce waste

- ▶ 1725 kg per inhabitant in the EU28 distributed as :

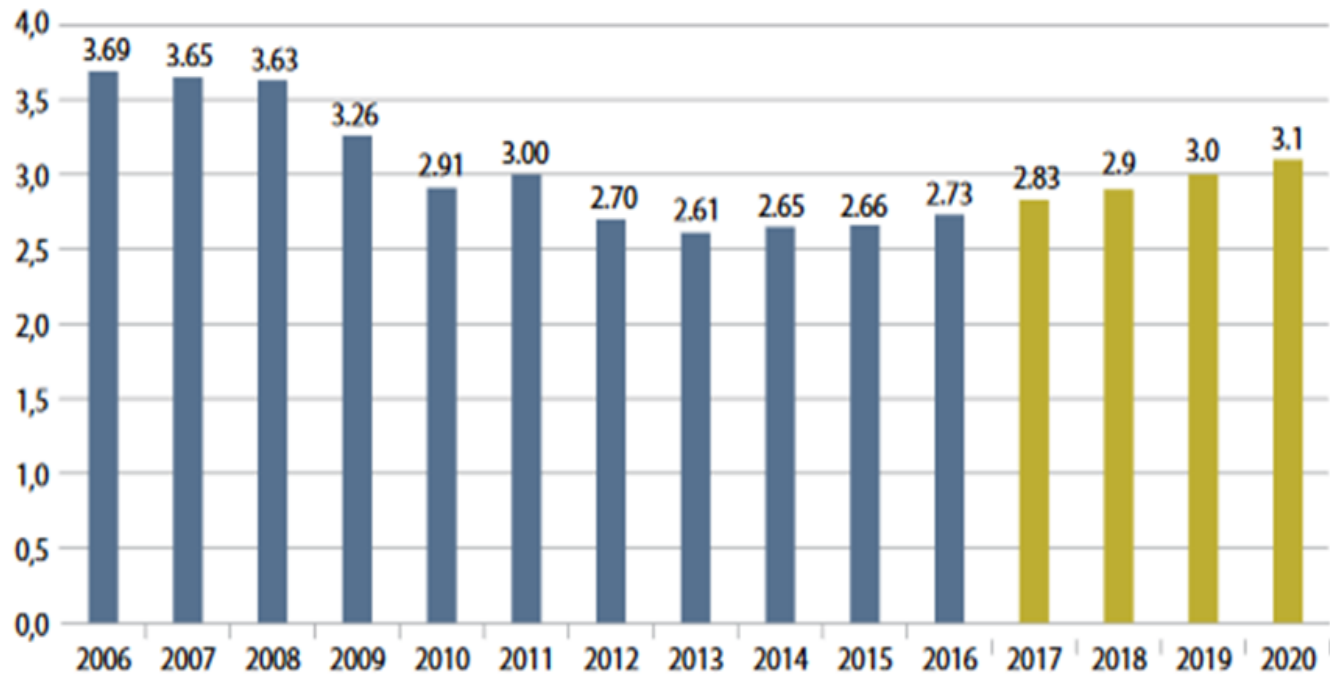


EU-28 Waste Generation by Economic Activities in 2014 (Source: EUROSTAT, 2018 b)

The construction industry consumes resources (per year)

- ▶ Sand : 2.2 billions tons
- ▶ Aggregates : 4.7 billions tons
- ▶ Cement: 4 billions tons
- ▶ Water : 800 billions liters
- ▶ Concrete: 10 billions tons
- ▶ Emission of CO₂ (2018): 5-8% world production

The construction industry consumes resources (per year)



Trend in total EU + EFTA Tonnages (in billions of tonnes) for the production of aggregates

Construction and demolition waste

- ▶ Mixed waste : concrete, brick, ceramic, natural stone, etc. ;
- ▶ Concrete waste : composed of at least 90% concrete ;
- ▶ Bituminous waste : asphalt and road surfaces ;



Technical barriers and challenges

- ▶ The most common requirements are (EN 12620:2013 (Aggregates for concrete)):
 - ▶ *grading criteria (d, D or category)*
 - ▶ *flakiness index*
 - ▶ *fine content*
 - ▶ *resistance to fragmentation (Los-Angeles)*
 - ▶ *bulk density*
 - ▶ *water-/acid-soluble sulfate content*
 - ▶ *water absorption*
- ▶ Higher value markets
 - ▶ *constant production*
 - ▶ *constant quality*
- ▶ Down cycling → upcycling

**Natural
aggregates**



**Adherent
hardened
cement
paste**

GLOBAL CONTEXT

RECYCLED AGGREGATES PRODUCTION

INFLUENCE OF THE WET PROCESS

INFLUENCE OF THE CRUSHING PROCESS

CONCLUSION

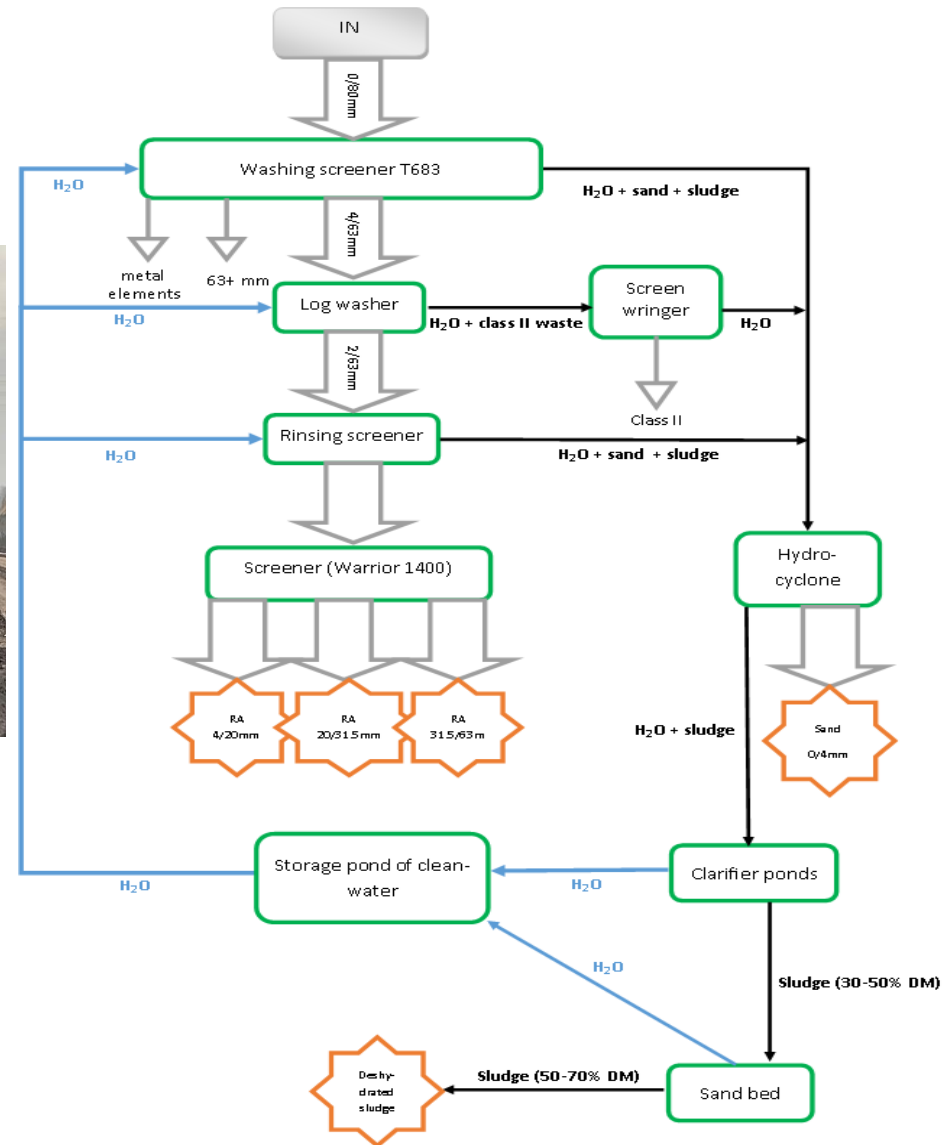
The goal is to transform this...



... Into secondary resources



“SeRaMCo recycling plant” Saint-Ghislain (Tradecowall)

1st Step : Conveyor belt EDGE

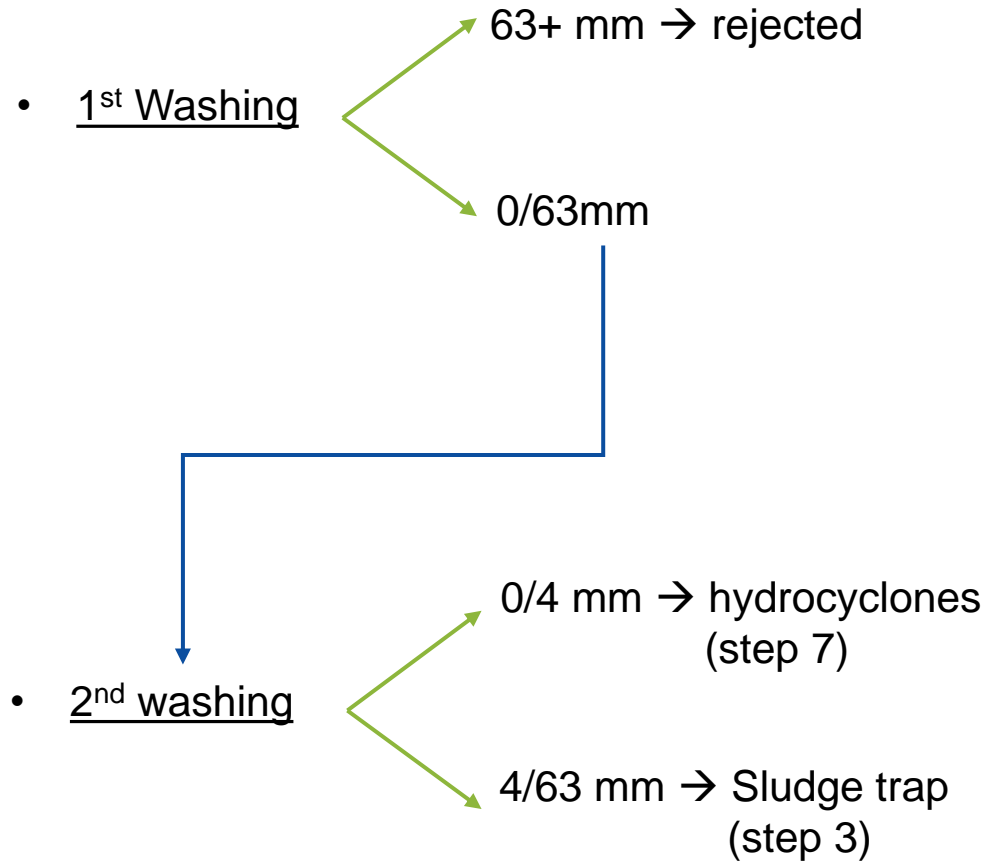
2nd Step : Washing screen Terex Finlay 683

- ▶ Screening
- ▶ Overband
- ▶ Washing

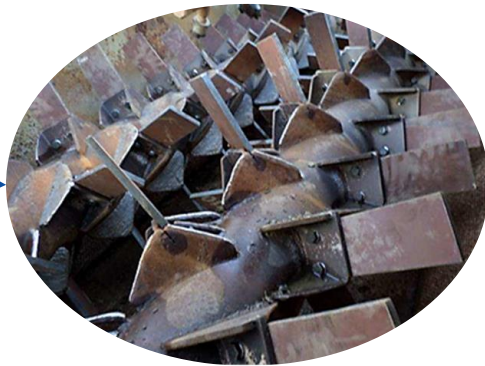


Zoom

2nd Step : Washing screen Terex Finlay 683



3rd Step : Log washer



- 3rd washing

Water loaded with fine particles
→ Dewatering screen (step 6)

4/63mm → Rinsing screen
(step 4)

4th and 5th Steps : Rinsing screen Mogensen and Screen Warrior 1400



- 4th washing
 - 0/4mm → hydrocyclones (step 7)
 - 4/63mm → Screen Warrior 1400 (step 5)

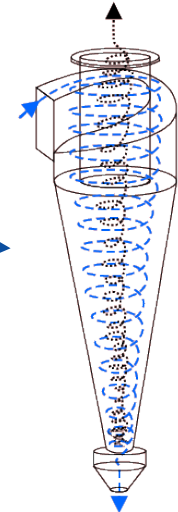


End product with 3 différents particle size:

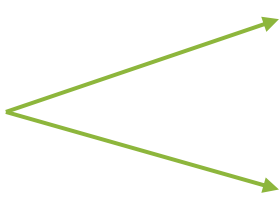
- :
- 4/20mm
- 20/31,5mm
- 31,5/63mm

6th and 7th Steps : Wringing screen SOTRÈS and hydrocyclones

- Wastewater
 - Floating particles → valorization
 - Precipitating particles → hydrocyclones (step 7)
- 0/4mm + wastewater
 - Sludges → settling tank (step8)
 - Sand → Dewatering screen



8th step : Clarifying pond

- Waste water 
 - Precipitated particles → sand bed
 - Clean water → water reservoir



9th step : Sand bed and water reservoir



End product

- ▶ **Sand :**
 - 0/4 mixed
 - 0/4 concrete
- ▶ **Aggregates :**
 - 4/6 mixed
 - 4/6 concrete
 - 6/14 mixed
 - 6/14 concrete
 - 14/20 mixed
 - 14/20 concrete



GLOBAL CONTEXT

RECYCLED AGGREGATES PRODUCTION

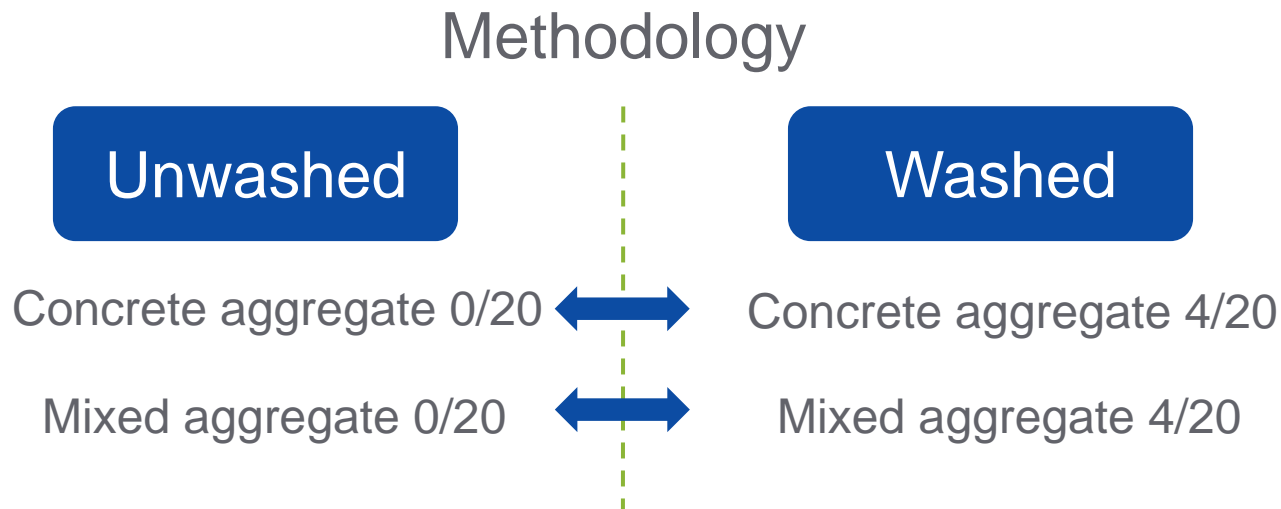
INFLUENCE OF THE WET PROCESS

INFLUENCE OF THE CRUSHING PROCESS

CONCLUSION

Expectations of washing aggregates:

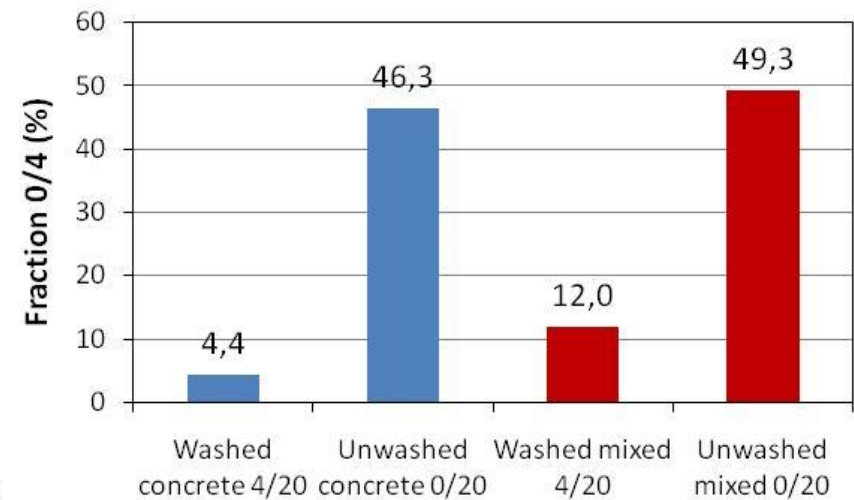
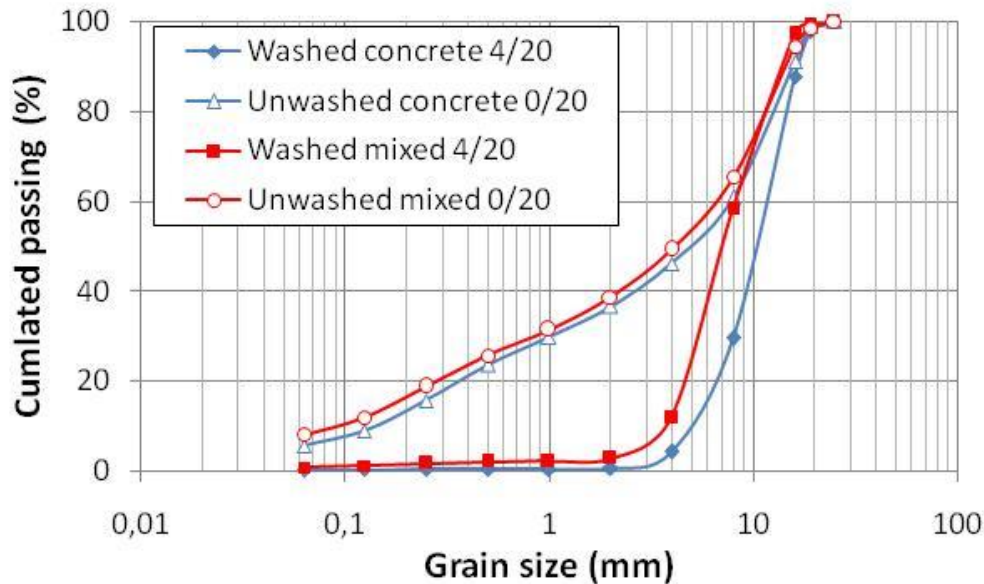
- ▶ Constrain grain size distribution
- ▶ Decrease fine content
- ▶ Decrease the quantity of unwanted components (clay, plaster, wood, etc.)
- ▶ Increase resistance to fragmentation



0/4 fraction comprises nearly 50% of the unwashed aggregates composition

0/4 fraction a bit higher in mixed aggregates

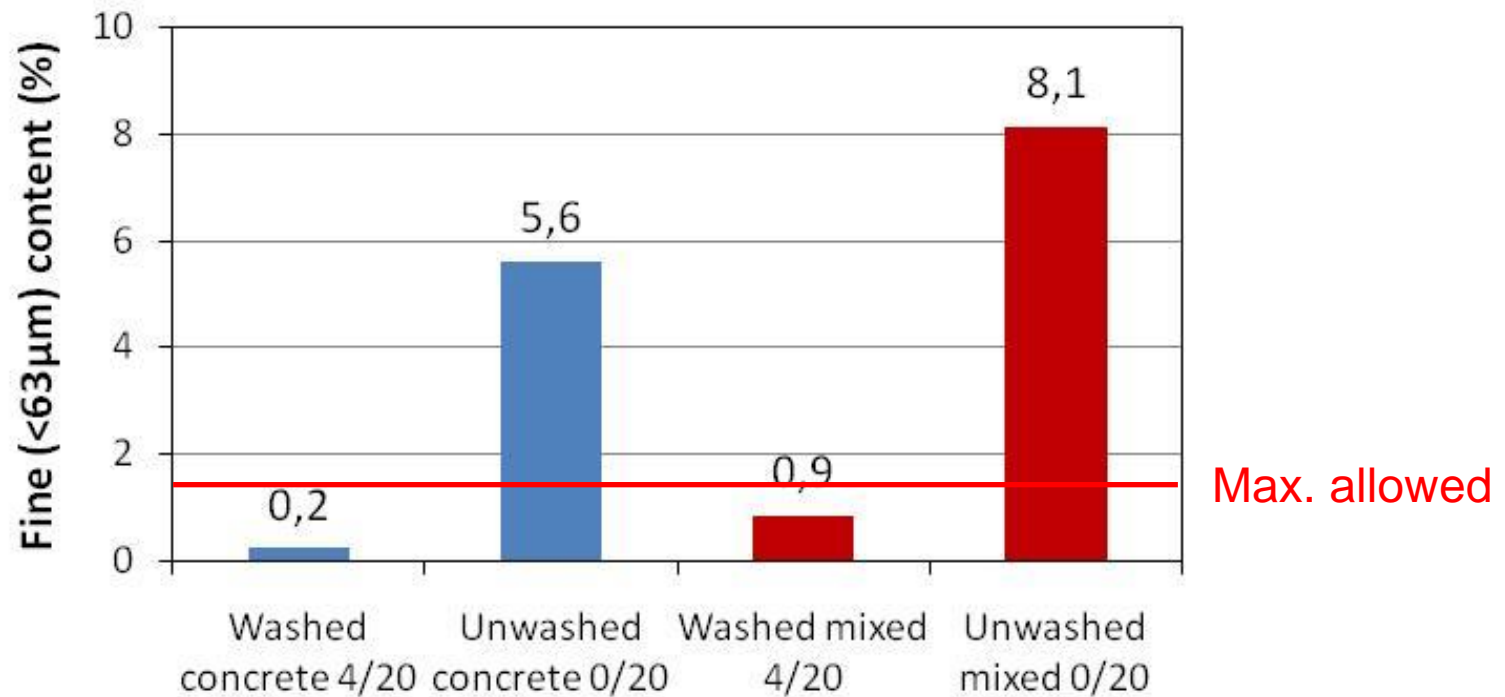
Washing significantly reduces the sand fraction of the aggregates



Fine content ($< 63\mu\text{m}$) higher in mixed aggregates and significantly reduced by washing

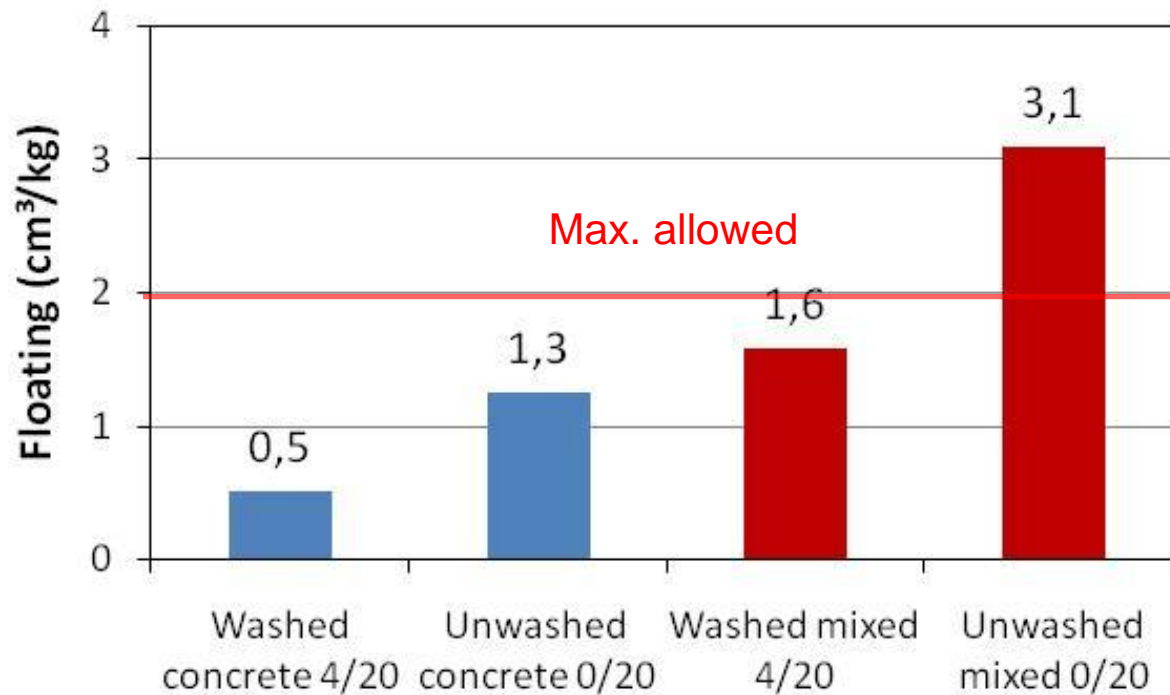
Fine fraction higher in mixed aggregates

Washed aggregates respect regulations in all considered countries



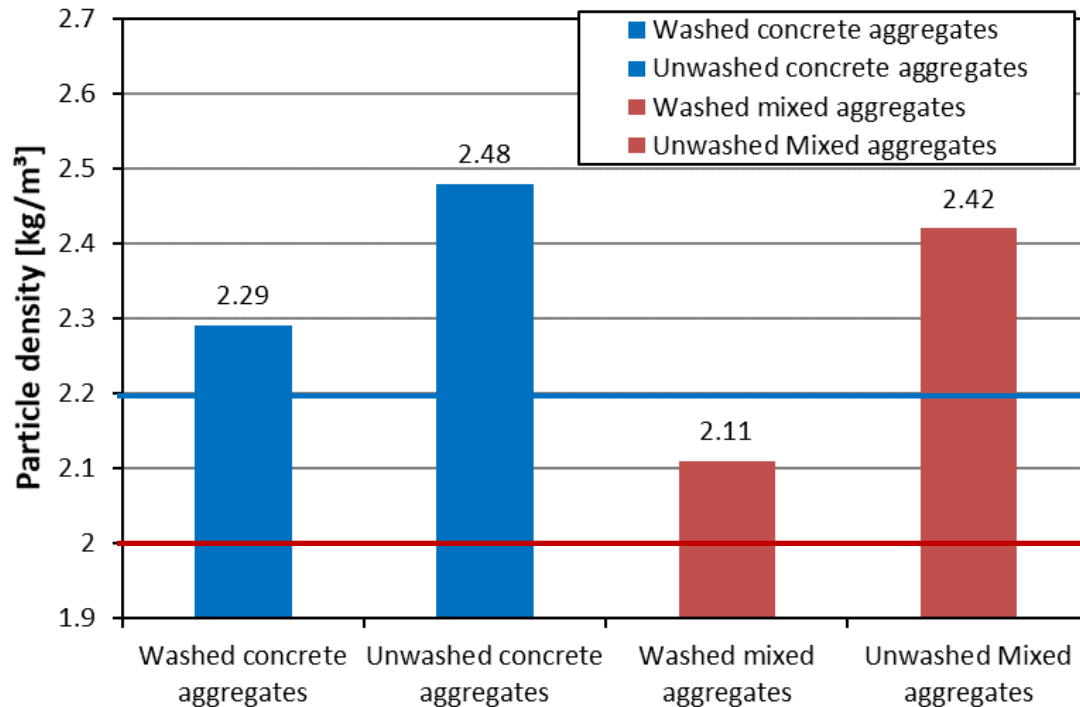
Floating elements reduced by 50% after washing and reach suitable values for standards (max. 2 cm³/kg)

Washing required for mixed aggregates



Density decreases with washing due to smaller particles removal but does still fulfill the requirements

Density higher for recycled concrete aggregate than mixed aggregate

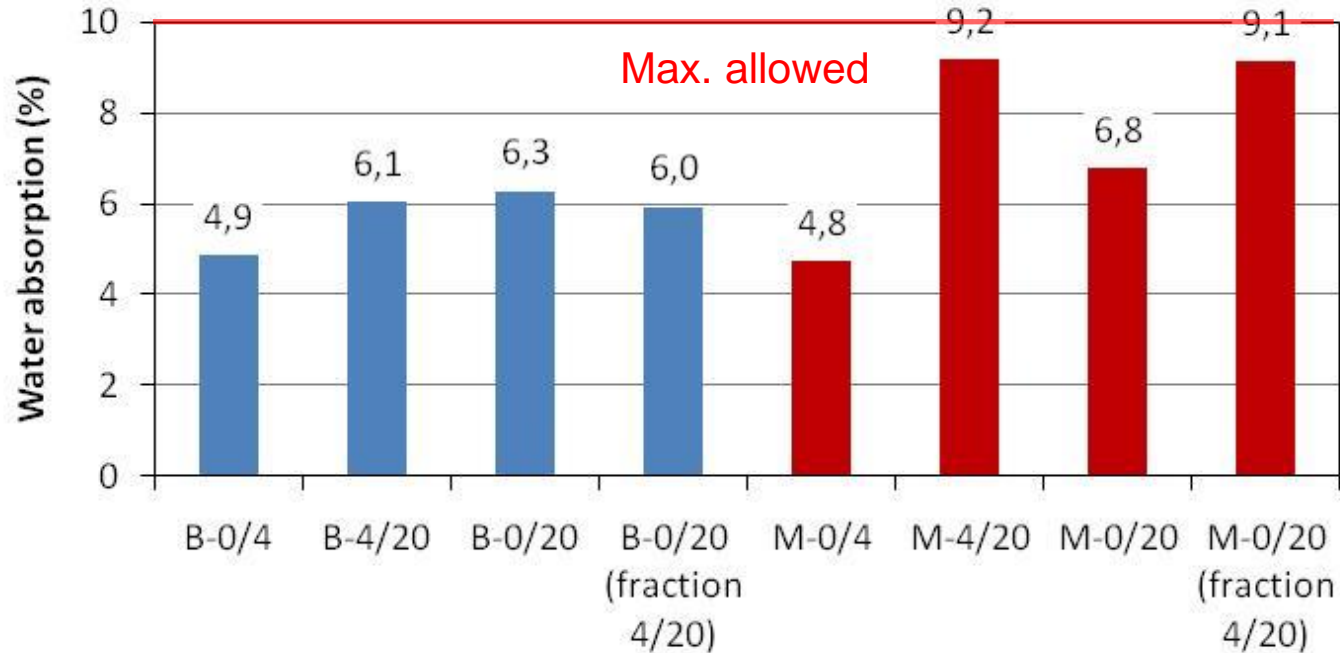


Min allowed
for concrete
aggregates

Min allowed
for mixed
aggregates

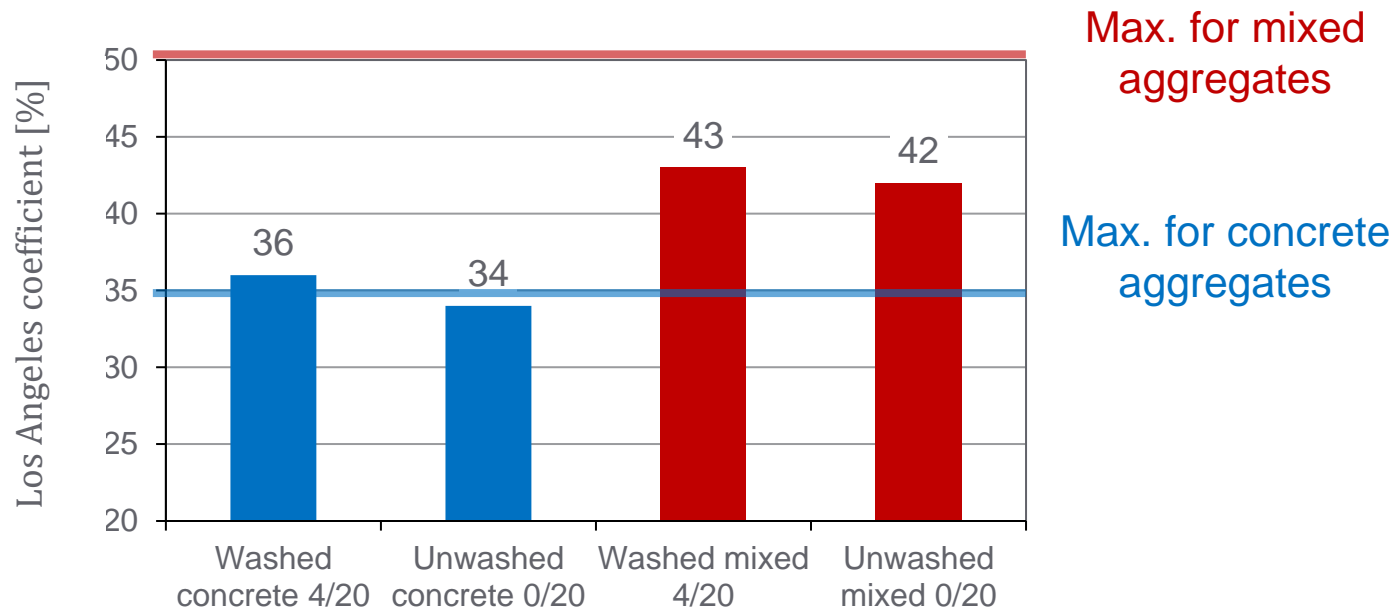
Water absorption is higher for mixed aggregates

Both washed and unwashed aggregated respect the requirements



Concrete recycled aggregates have better resistance to fragmentation

No effect of the washing process



Expected improvement :

- ▶ More constrained grain size distribution
- ▶ Decrease in fine content
- ▶ Decrease in the quantity of unwanted elements (clay, plaster,etc.)
- ▶ Increased resistance to fragmentation

Other effects :

- ▶ No effect on the water absorption
- ▶ Decrease in aggregates density

GLOBAL CONTEXT

RECYCLED AGGREGATES PRODUCTION

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CONCLUSIONS

Methodology

Production of 0/25

Impact crusher



Set at 6,5 kW (40% of maximum power)

Jaw crusher

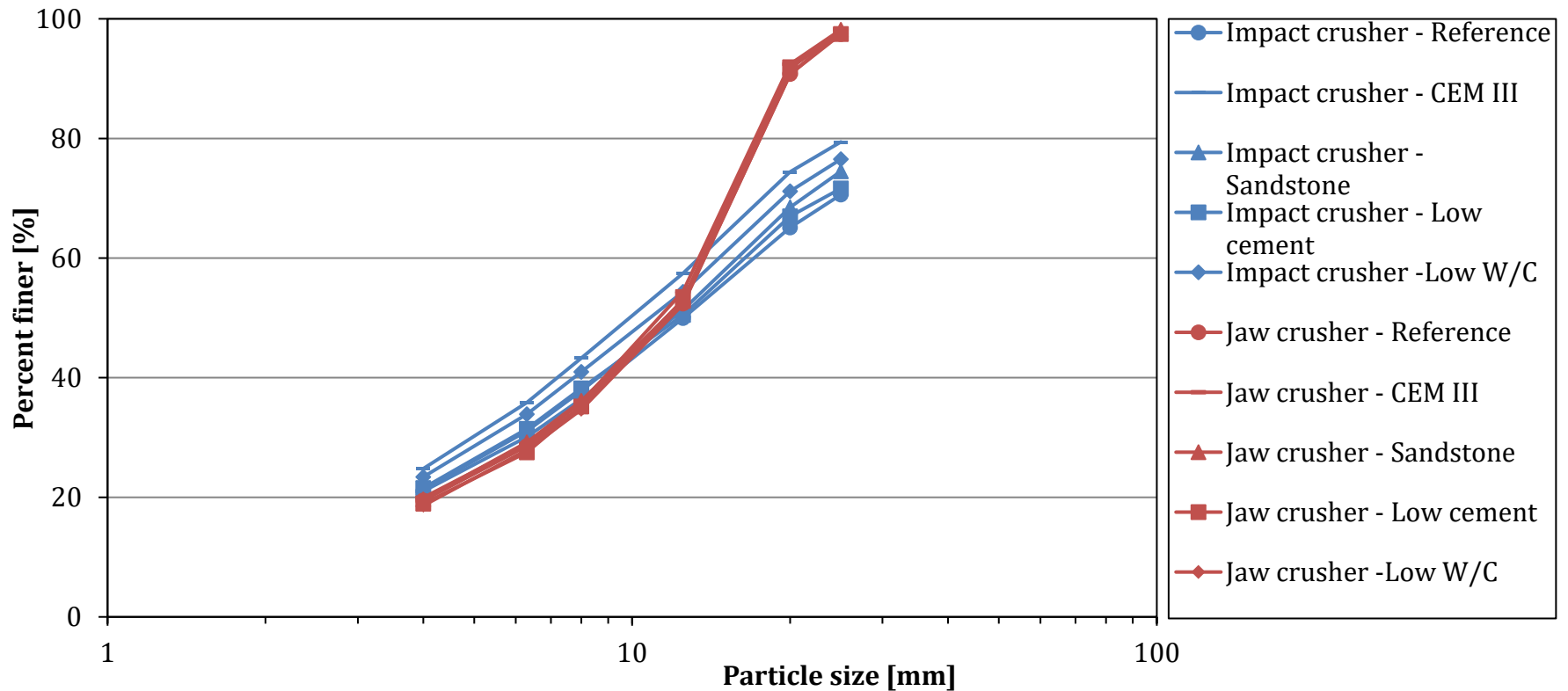


Jaw crusher set at a 22 mm opening

Lab produced concrete to obtain recycled aggregates of known origin
5 concrete mixes to study influence of key parameters

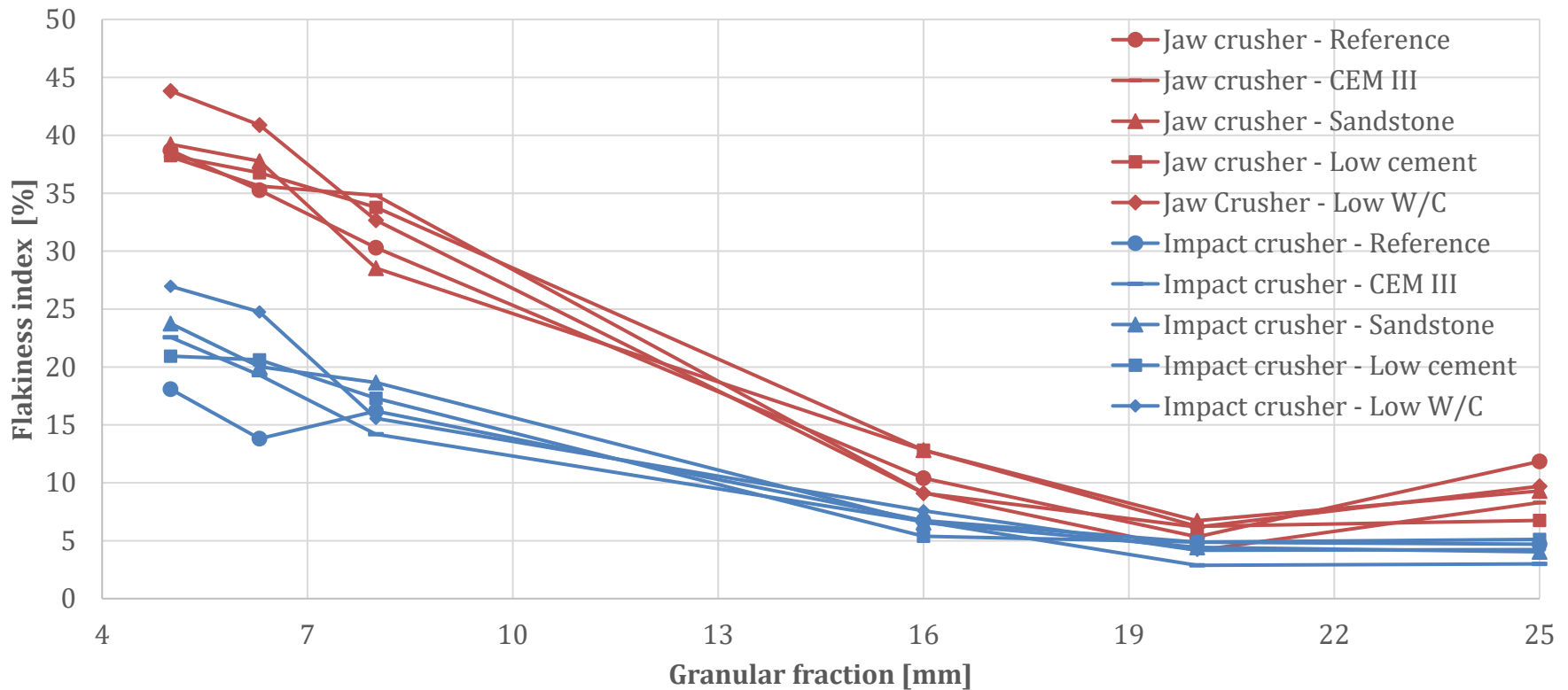
	1.0	1.1	1.2	2	3
Name	Reference	CEMIII	Sandstone	Low Cement	Low W/C
Aggregates type	Limestone	Limestone	Sandstone	Limestone	Limestone
Cement type	CEMI 52.5	CEMIII 52.5	CEMI 52.5	CEMI 52.5	CEMI 52.5
Cement quantity (kg/m ³)	400	400	400	320	452
Cement paste volume (dm ³ /m ³)	351	358	351	282	351
W/C	0.56	0.56	0.56	0.56	0.46

The jaw crusher produces aggregates with a more constrained grain size range (for all the tested composition)



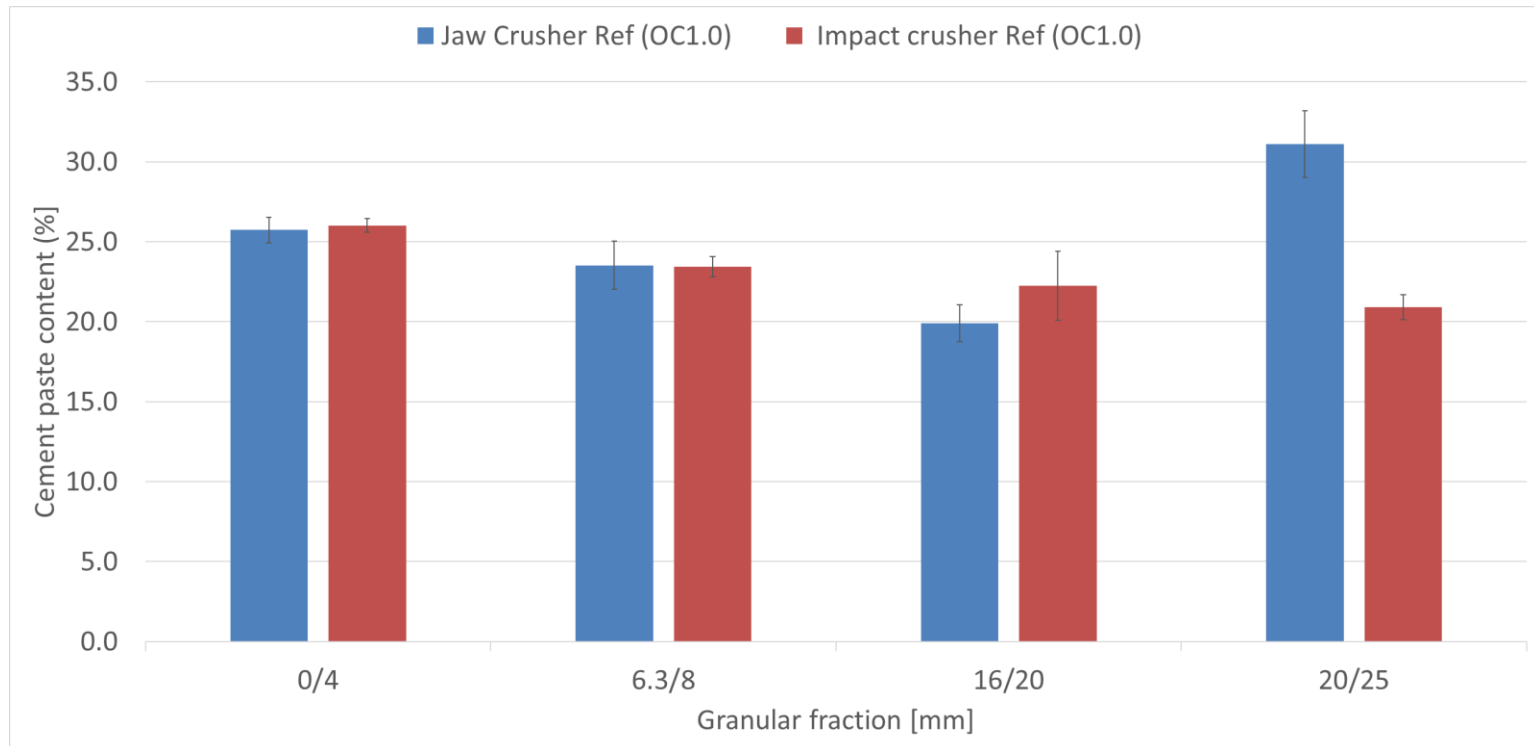
The flakiness index decreases with increasing granular fraction and the jaw crusher produces flakier aggregates

No influence of the concrete composition



Decrease in cement paste content with increasing granular fraction

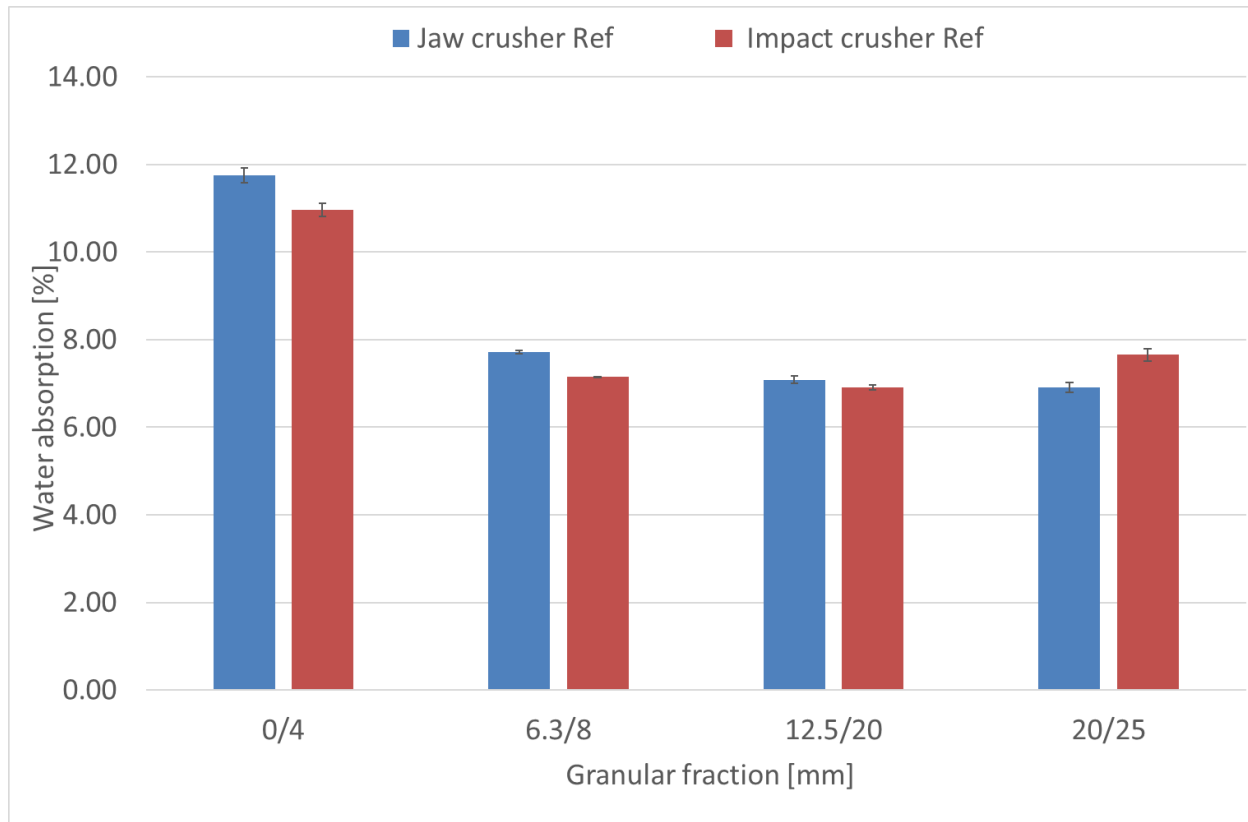
No influence of the crushing method



Exception : fraction 20/25 with the jaw crusher (abnormal results)

Decrease in water absorption with increasing granular fraction

No influence of the crushing method



Good correlation with cement paste content

Jaw crusher less energy consuming because of its lower running power

	Jaw crusher	Impact crusher
(a) Running power (kW)	1,8-2,0	6,5-6,6
(b) Mean net power (kW)	1,9-2,1	0,5-0,8
(c) Mean crushing duration (s)	200	252
(d) Crushed mass of material per hour (t/h)	2,0-2,3	1,6-1,7
(e) Net specific energy consumption (kWh/t) (b/d)	0,9-1,0	0,30-0,50
(f) Total specific energy consumption (kWh/t) ((a+b)/d)	1,8-1,9	4,1-4,5
(g) Percentage of energy consumed for crushing (=b/(a+b))	~50	~10

	Impact crusher	Jaw crusher
Aggregates geometry	+	-
Grain size distribution	-	+
Fine content	-	+
Cement paste content	No influence	No influence
Water absorption	No influence	No influence
Energy consumption	-	+
Crushing duration	-	+

Enhance public procurement through the introduction of **mandatory percentages** of recycled aggregates in large civil engineering projects;

Develop reuse/reclaimed products programme of **support and promotion** (e.g. reuse percentage target);

Introduce end-of-waste **criteria** for recycled products;

Develop **standards for recycled materials** for various utilization for waste that did not meet end-of-waste criteria;

Facilitate material content **traceability**;

Introduce **applications** for recycled non-aggregates;

Encourage the construction products and **materials supply chain** to have much greater provision for taking back and incorporating recycled materials into new products;

Deploy **financial incentive** to use recycled aggregates.

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THANK YOU FOR YOUR ATTENTION