SeRaMCo - Recycling Process

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GLOBAL CONTEXT

What to do?

SUMMARY OF THE PRESENTATION

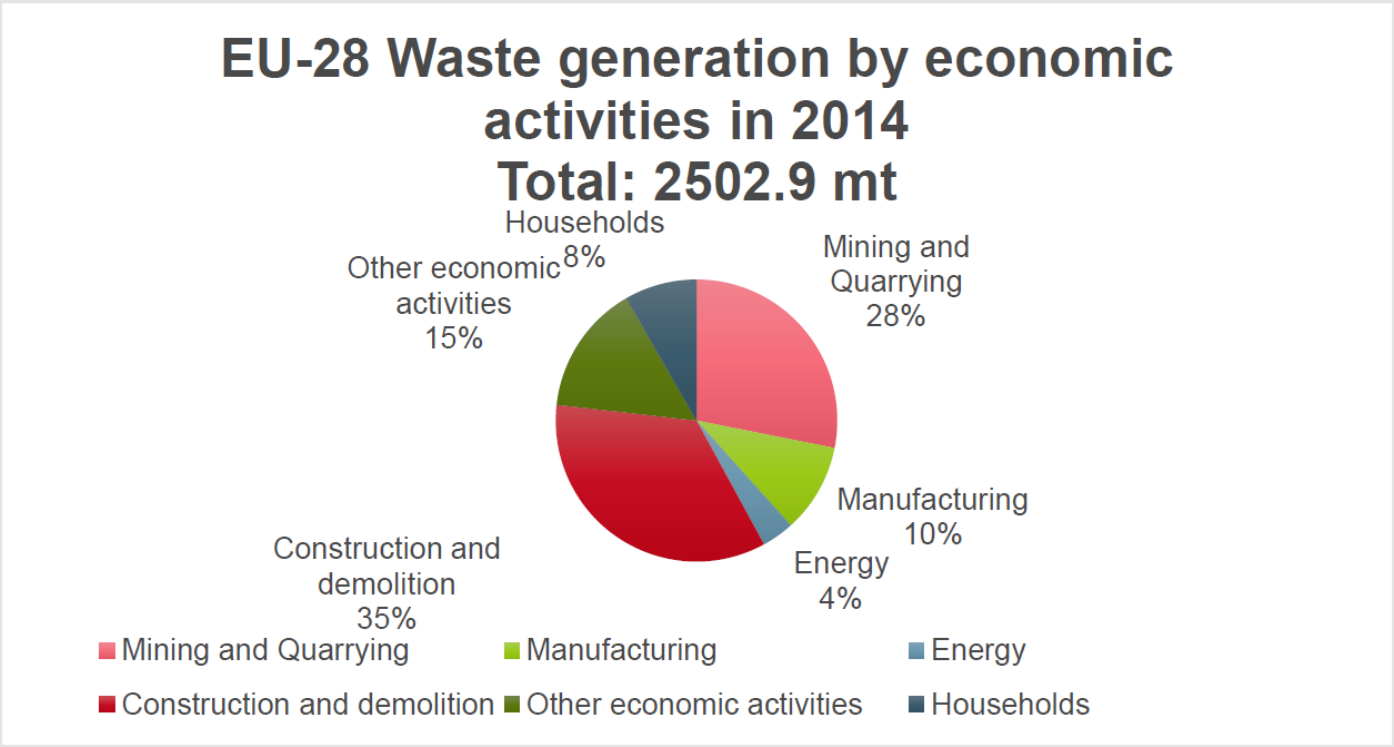
GLOBAL CONTEXT

We produce wastes

- Between **3.4 to 4 billions tons/year** or from 80 to 126 tons/second!
- Each day, human activity is contributing for more than 10 billions kg wastes
- Annual production of recycled aggregates accounted for 202 million tons in 2015
- *Construction area is producing more or less than 40% of CO_2*

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)

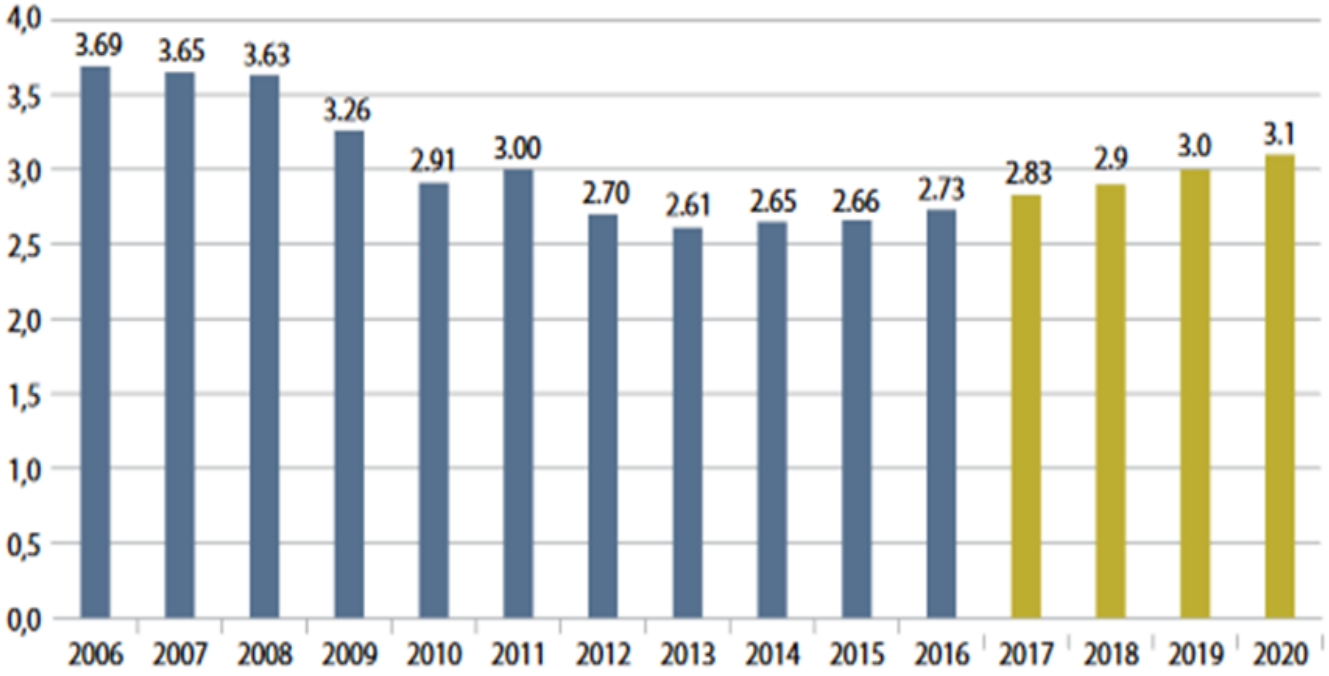
GLOBAL CONTEXT

The construction industry consumes ressources (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 CO_2 (2018): 5-8% world production

GLOBAL CONTEXT

The construction industry consumes ressources (per year)



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

GLOBAL CONTEXT

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

SUMMARY OF THE PRESENTATION

GLOBAL CONTEXT

RECYCLE AGGREGATES PRODUCTION

INFLUENCE OF THE WET PROCESS

INFLUENCE OF THE CRUSHING PROCESS

CONCLUSION

RECYLED AGGREGATES PRODUCTION

The goal is to transform this…

RECYCLED AGGREGATES PRODUCTION

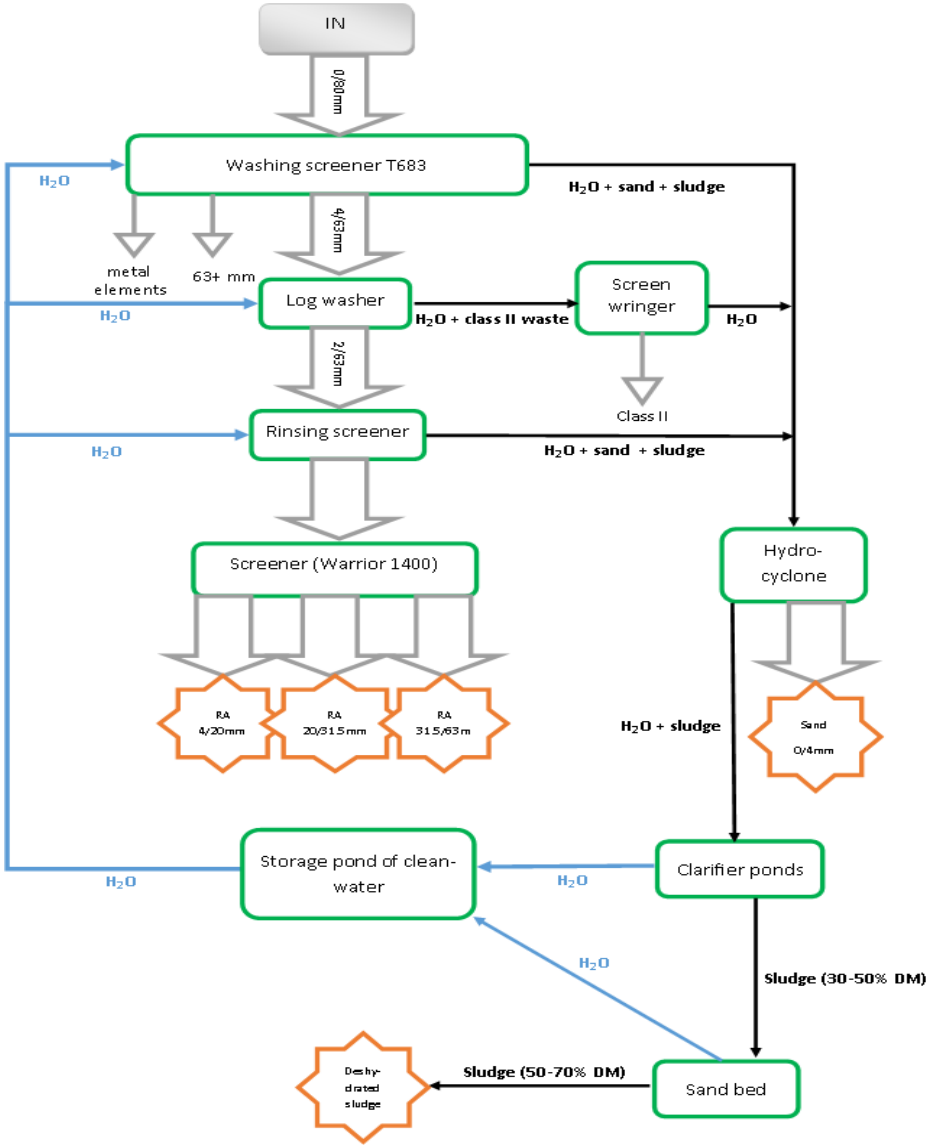
… Into secondary ressources

RECYLED AGGREGATES PRODUCTION

“SeRaMCo recycling plant” Saint-Ghislain (Tradecowall)

RECYLED AGGREGATES PRODUCTION

1st Step : Conveyor belt EDGE



RECYLED AGGREGATES PRODUCTION

2nd Step : Washing screen Terex Finlay 683

- Screening
- Overband
- Washing

Zoom

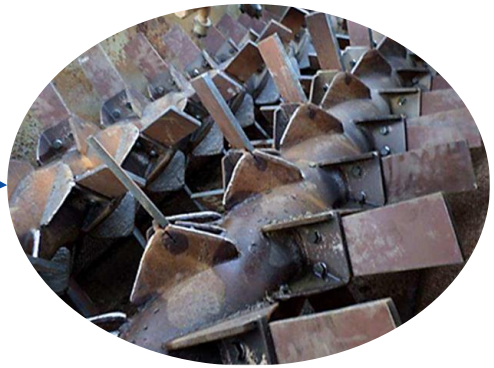
RECYLED AGGREGATES PRODUCTION

2nd Step : Washing screen Terex Finlay 683

- 1st Washing
  - 63+ mm → rejected
  - 0/63mm
- 2nd washing
  - 0/4 mm → hydrocyclones (step 7)
  - 4/63 mm → Sludge trap (step 3)

RECYLED AGGREGATES PRODUCTION

3rd Step : Log washer



- 3rd washing
  - Water loaded with fine particules → Dewatering screen (step 6)
  - 4/63mm → Rinsing screen (step 4)

RECYLED AGGREGATES PRODUCTION

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)

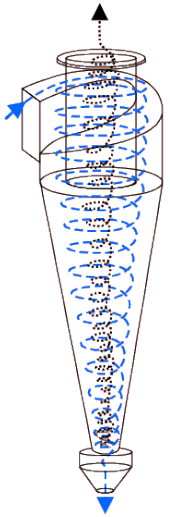
End product with 3 différents particle size:
:

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

RECYLED AGGREGATES PRODUCTION

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



RECYLED AGGREGATES PRODUCTION

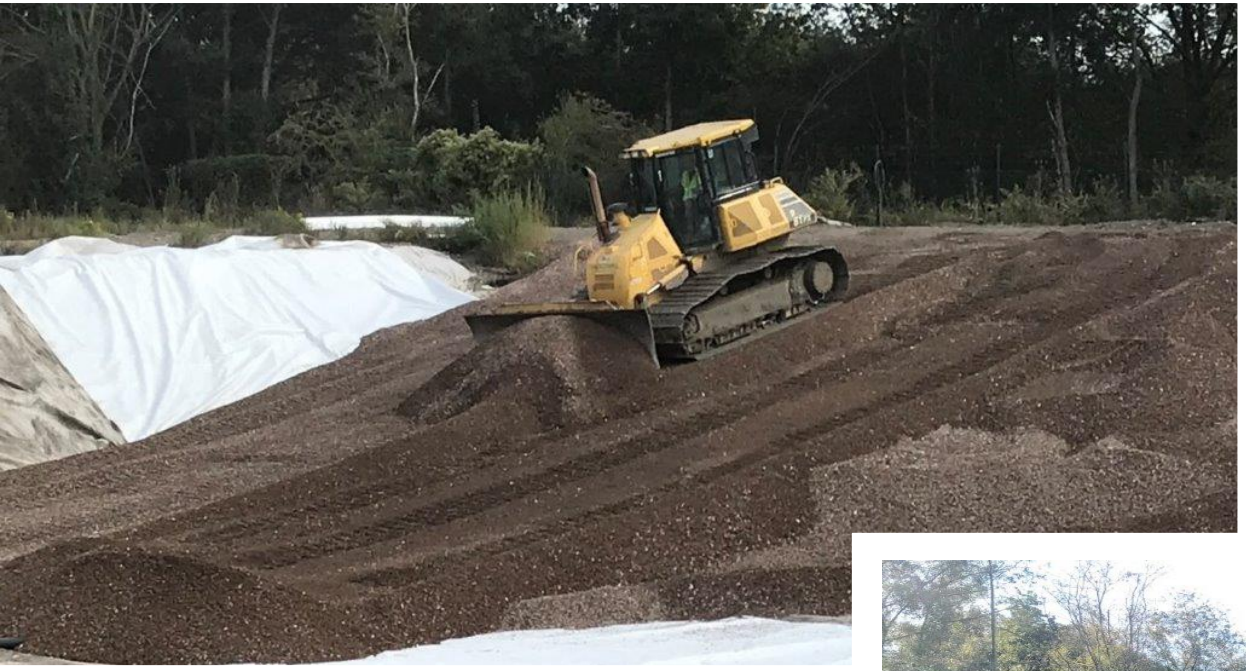
8th step : Clarifying pond

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

RECYLED AGGREGATES PRODUCTION

9th step : Sand bed and water reservoir

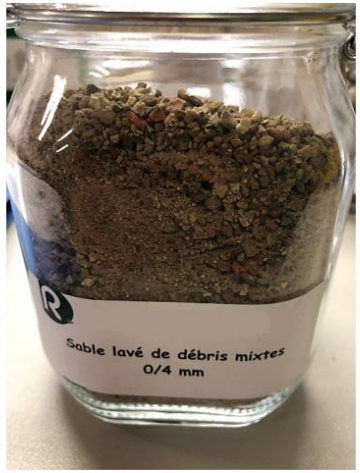
RECYLED AGGREGATES PRODUCTION



RECYLED AGGREGATES PRODUCTION

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



SUMMARY OF THE PRESENTATION

GLOBAL CONTEXT

RECYCLE AGGREGATES PRODUCTION

INFLUENCE OF THE WET PROCESS

INFLUENCE OF THE CRUSHING PROCESS

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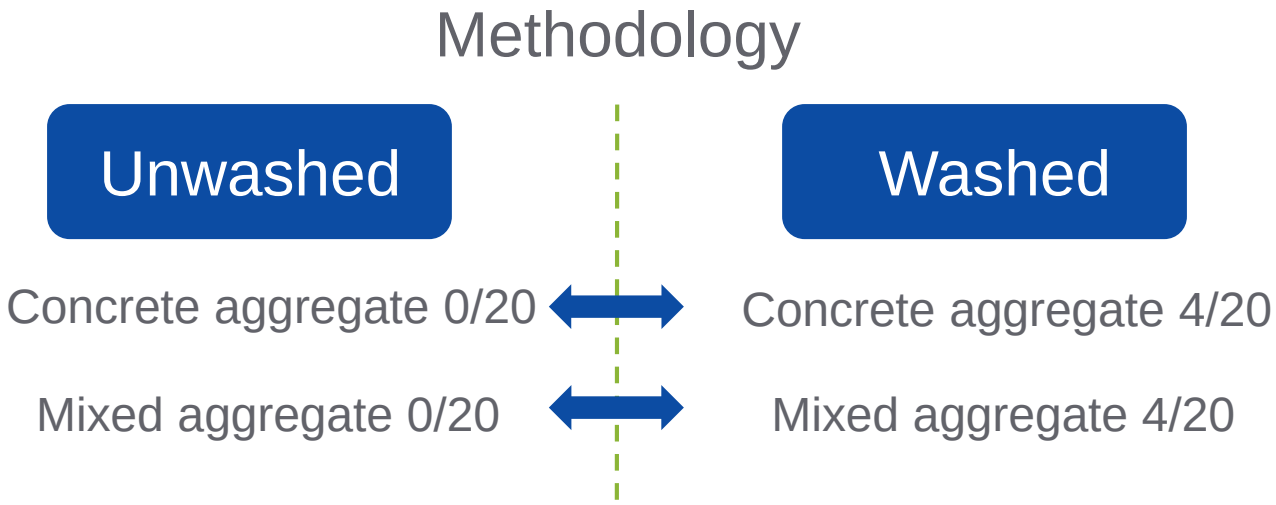
INFLUENCE OF THE WET PROCESS

Expectations of washing aggregates:

- Constrain grain size distribution
- Decrease fine content
- Decrease the quantity of unwished components (floating, clay, plaster...)
- Increase resistance to fragmentation

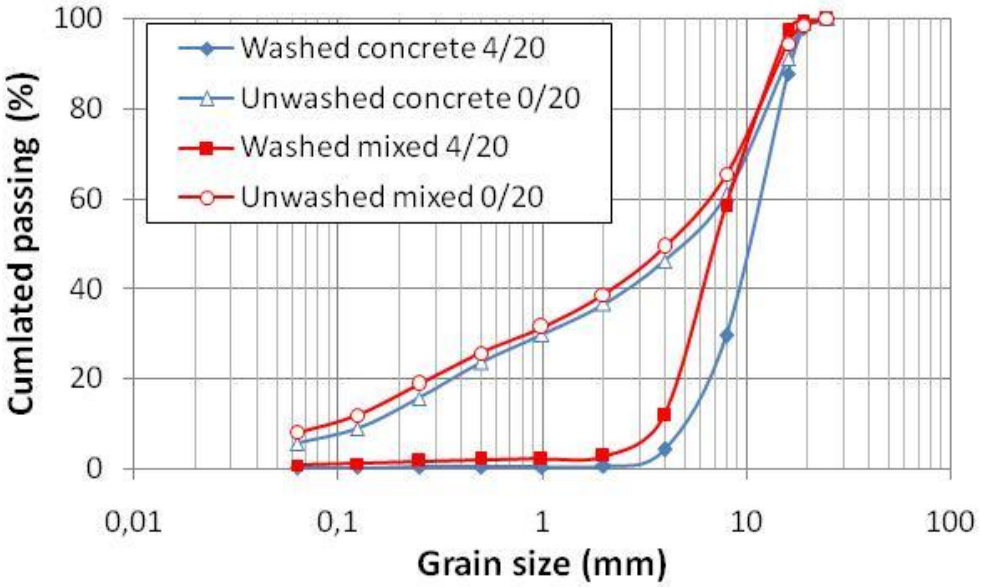


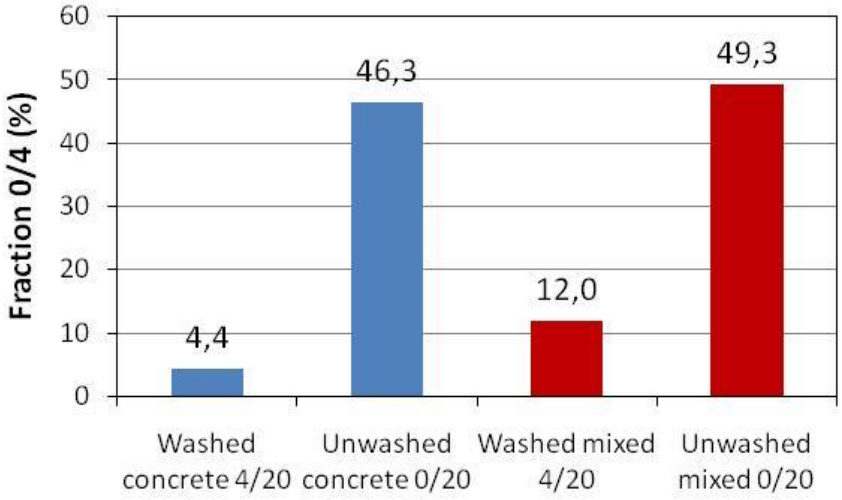
GRAIN SIZE DISTRIBUTION

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



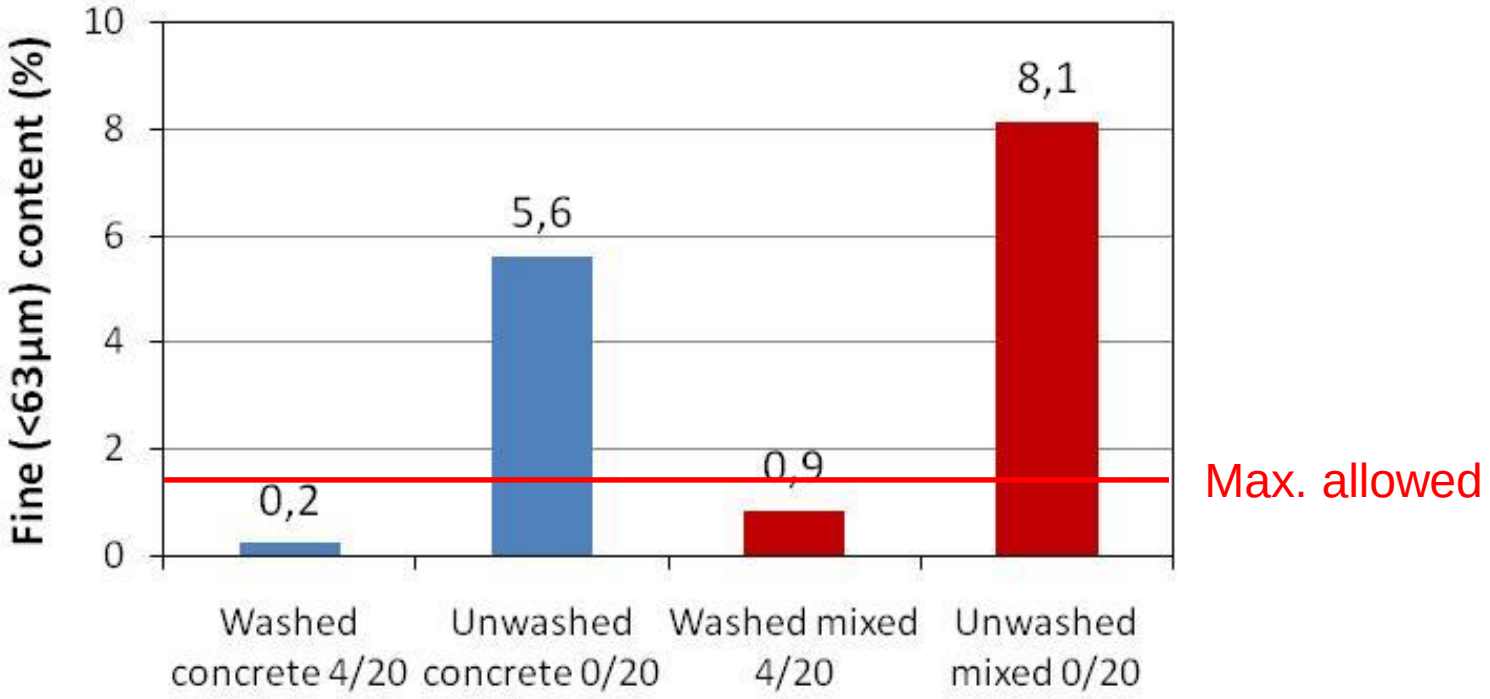


FINE CONTENT

Fine content (< 63µm) 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

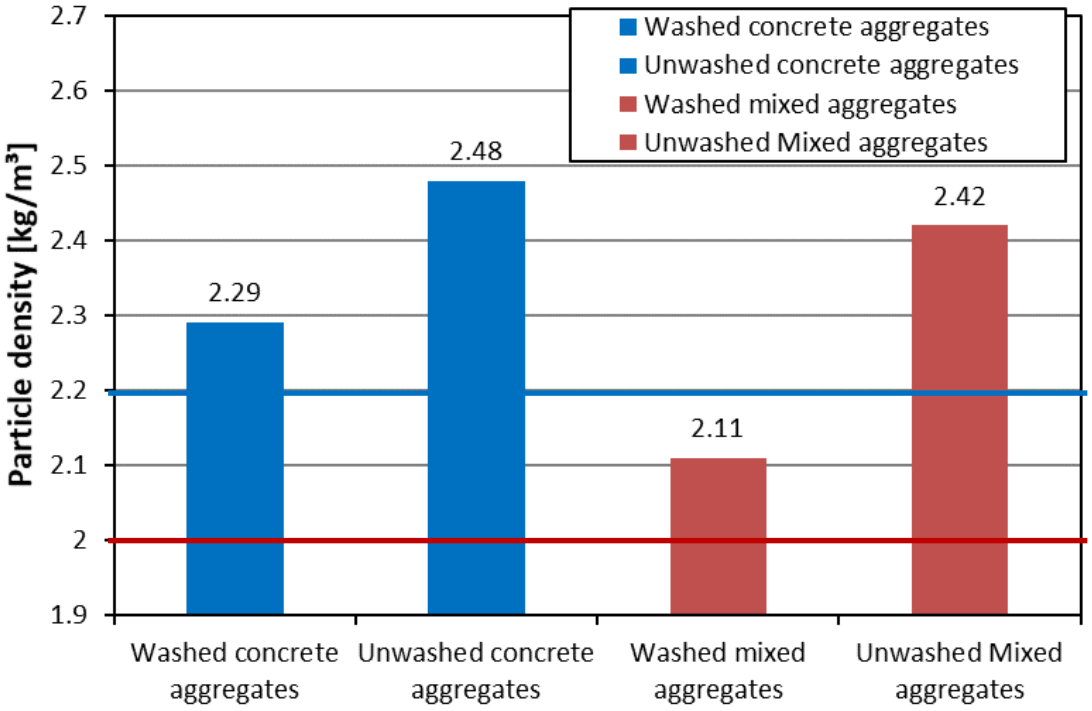
Floating elements reduced by 50% after washing and reach suitable values for standards (max. 2 cm³/kg)

Washing required for mixed aggregates

AGGREGATES DENSITY

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

Density higher for recycled concrete aggregate than mixed aggregate



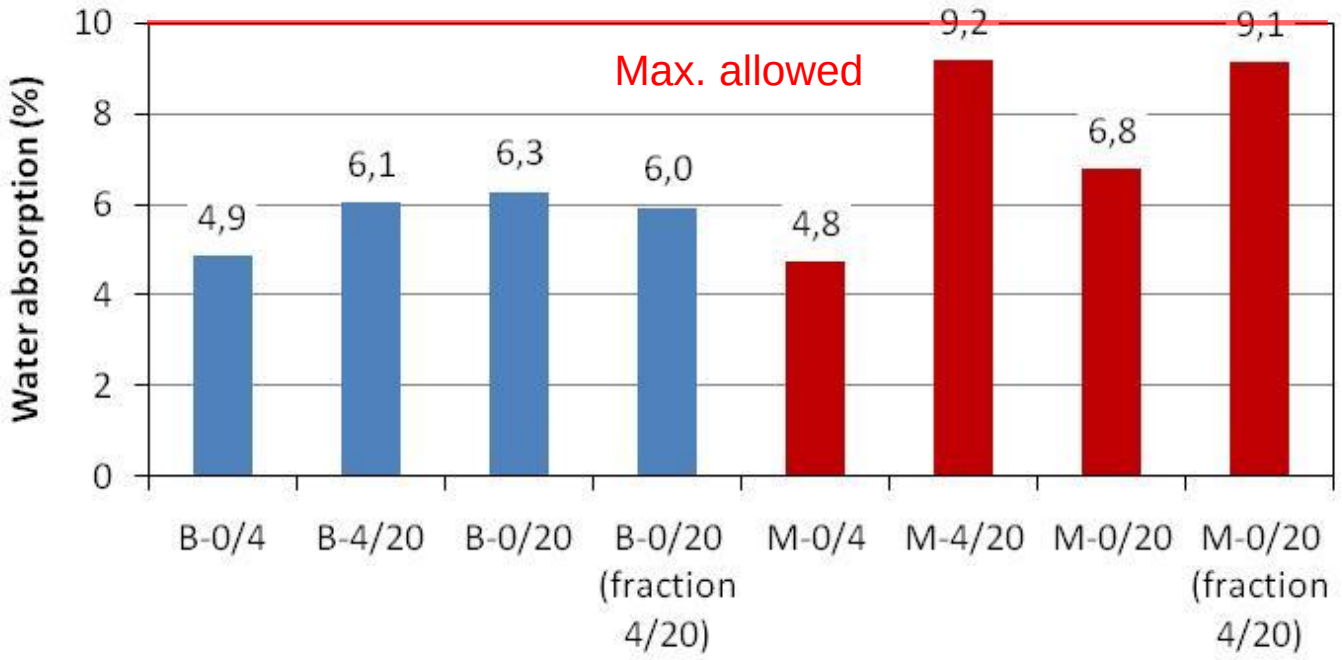
Min allowed for concrete aggregates

Min allowed for mixed aggregates

WATER ABSORPTION

Water absorption is higher for mixed aggregates

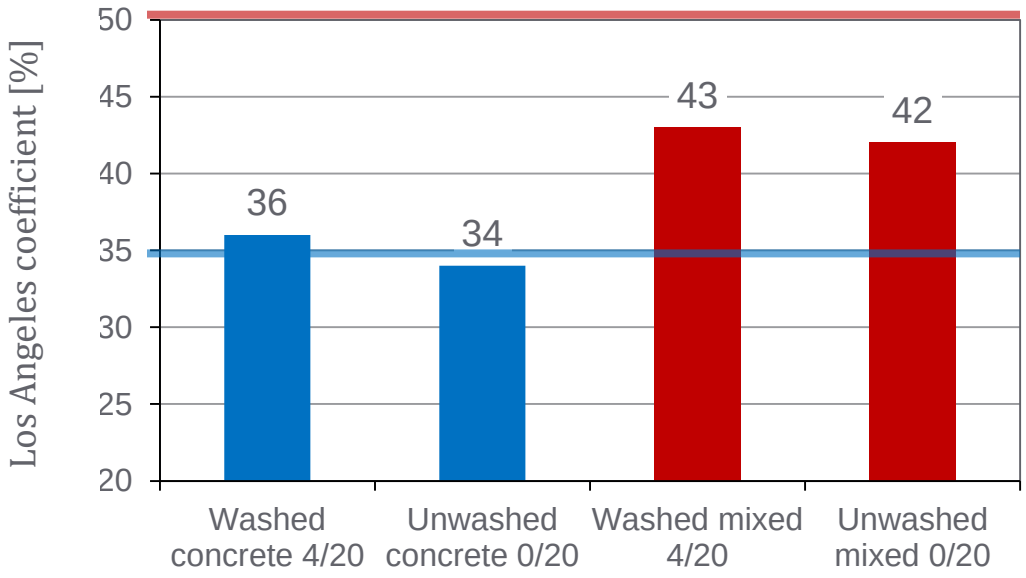
Both washed and unwashed aggregated respect the requirements



RESISTANCE TO FRAGMENTATION

Concrete recycled aggregates have better resistance to fragmentation

No effect of the washing process



Max. for mixed aggregates

Max. for concrete aggregates

CONCLUSIONS

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

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INFLUENCE OF THE CRUSHING PROCESS

CONCLUSIONS

INFLUENCE OF THE CRUSHING METHOD

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

INFLUENCE OF THE CRUSHING METHOD

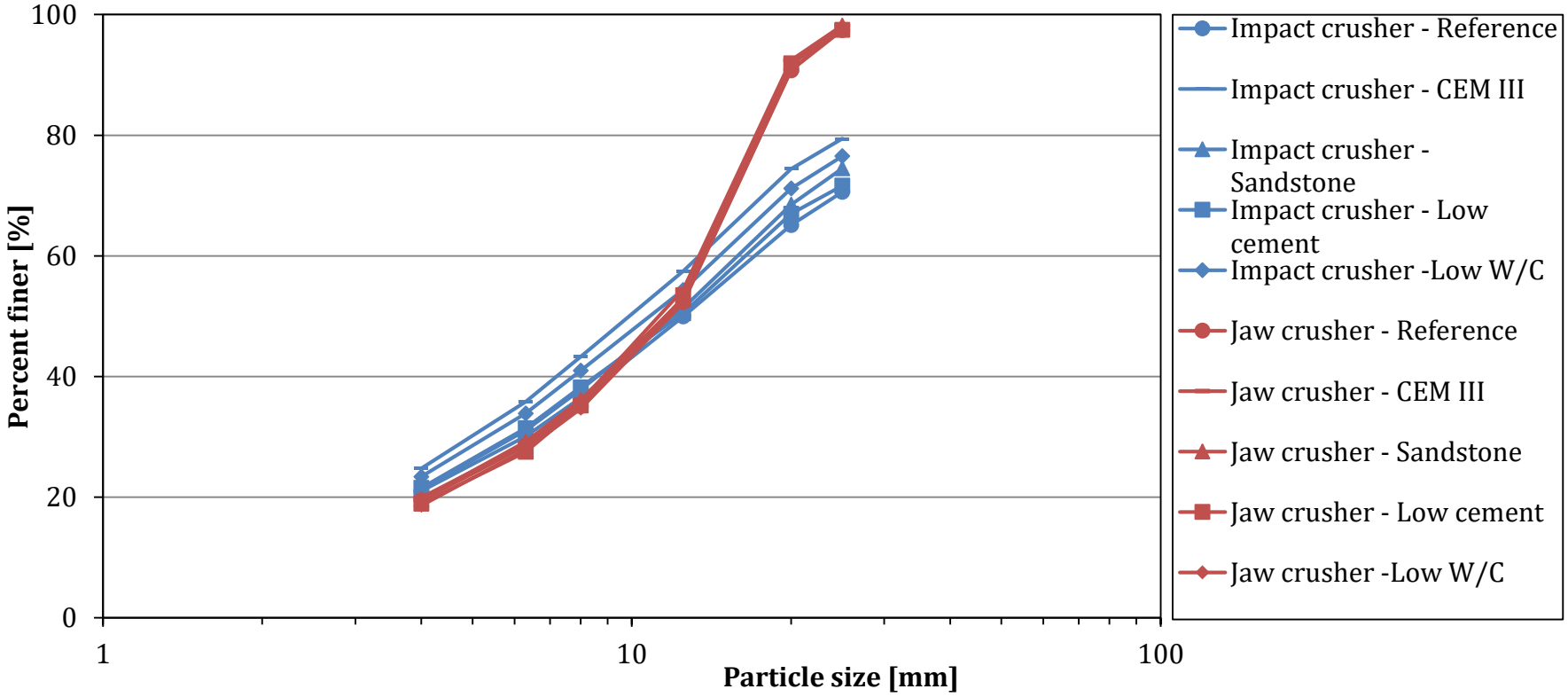
Lab produced concrete to obtain recycled aggregates of known origin

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**

GRAIN SIZE DISTRIBUTION

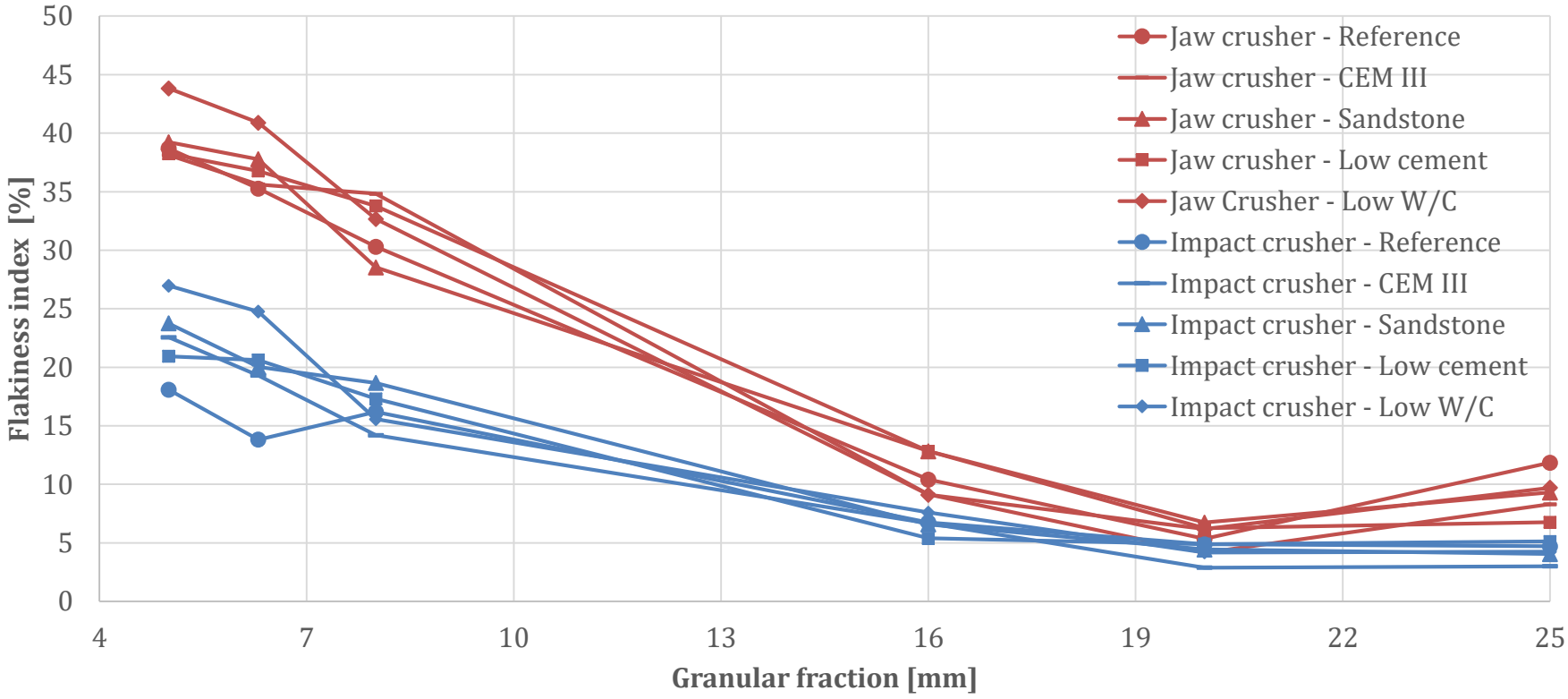
The jaw crusher produces aggregates with a more constrained grain size range (for all the tested composition)



FLAKINESS INDEX

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

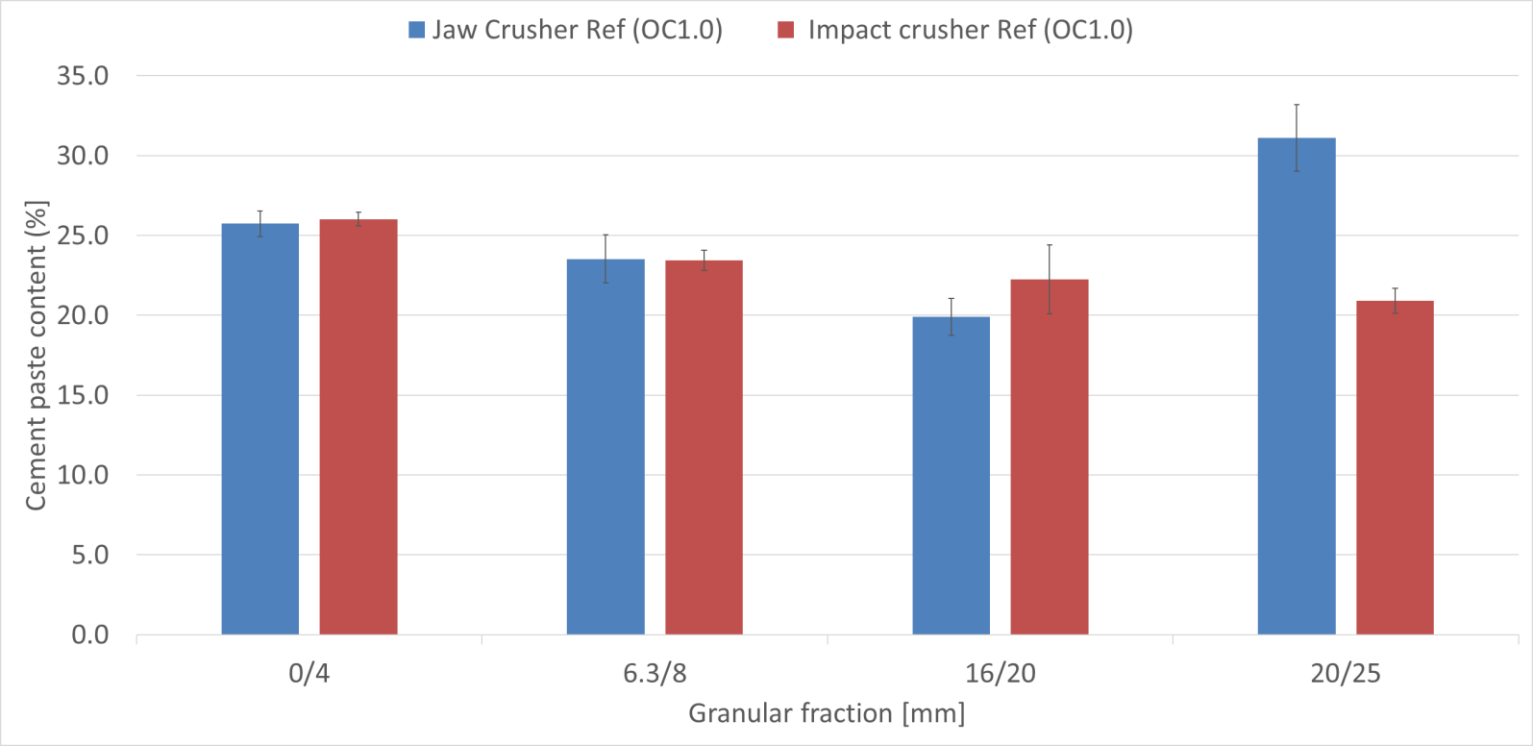
No influence of the concrete composition



CEMENT PASTE CONTENT

Decrease in cement paste content with increasing granular fraction

No influence of the crushing method

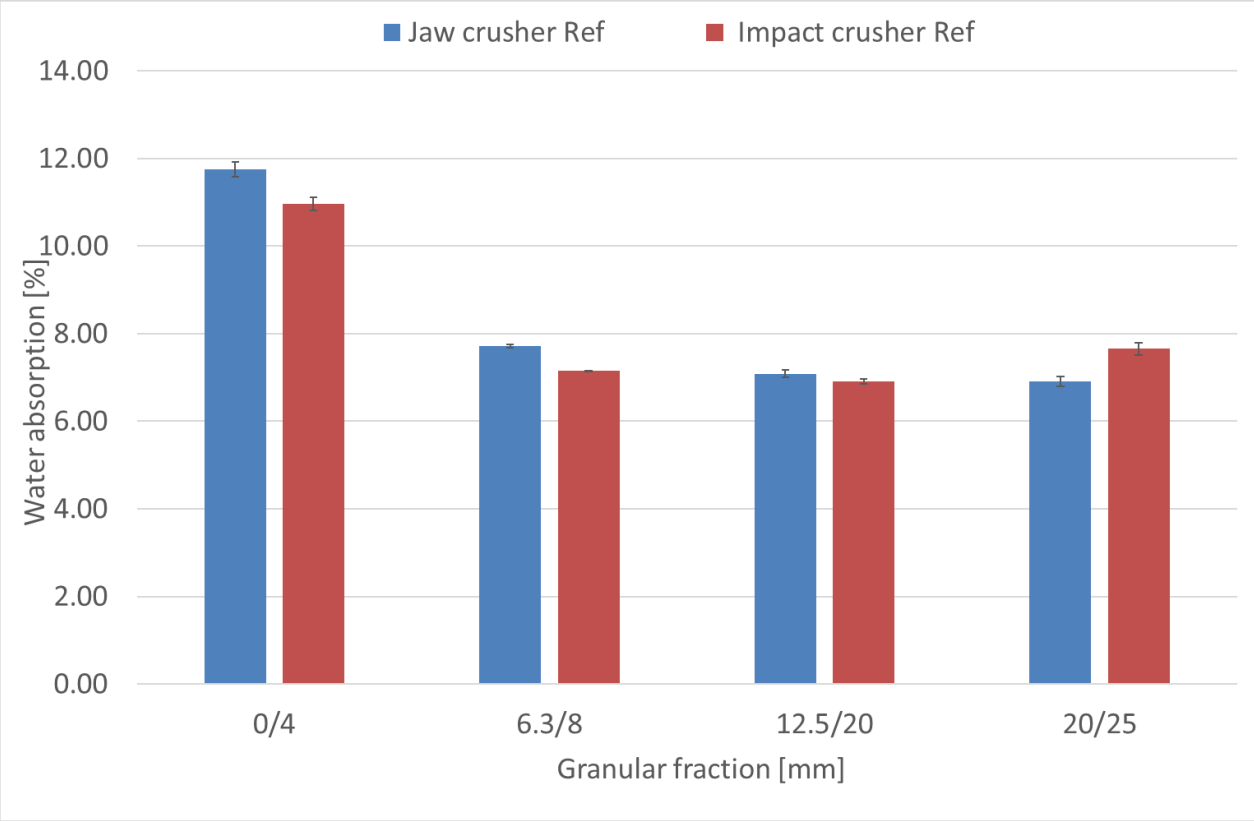


Exception : fraction 20/25 with the jaw crusher (abnormal results)

WATER ABSORPTION

Decrease in water absorption with increasing granular fraction

No influence of the crushing method



Good correlation with cement paste content

WATER ABSORPTION

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

CONCLUSIONS

	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	-	+

RECOMMANDATIONS

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.

CONTACT

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