



# Economie circulaire dans la construction : introduction de granulats recyclés lavés dans les bétons préfabriqués

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# Développement durable

Nous avons besoin de matériaux

la construction au sens large consomme entre 40 et 50%  
des ressources naturelles sous forme de matériaux,  
la construction utilise et consomme 40% de l'énergie  
utilisée et produit près de 40% du CO<sub>2</sub>



# Développement durable



Nous avons besoin de matériaux

**Béton: plus de 9 milliards de tonnes ( = 30000 arches de La Défense)**

Gravier: 4,7 milliards de tonnes (670 pyramides de Chéops)

Sable: 2,2 milliards de tonnes (22 millions de wagons = train de 264000 km)

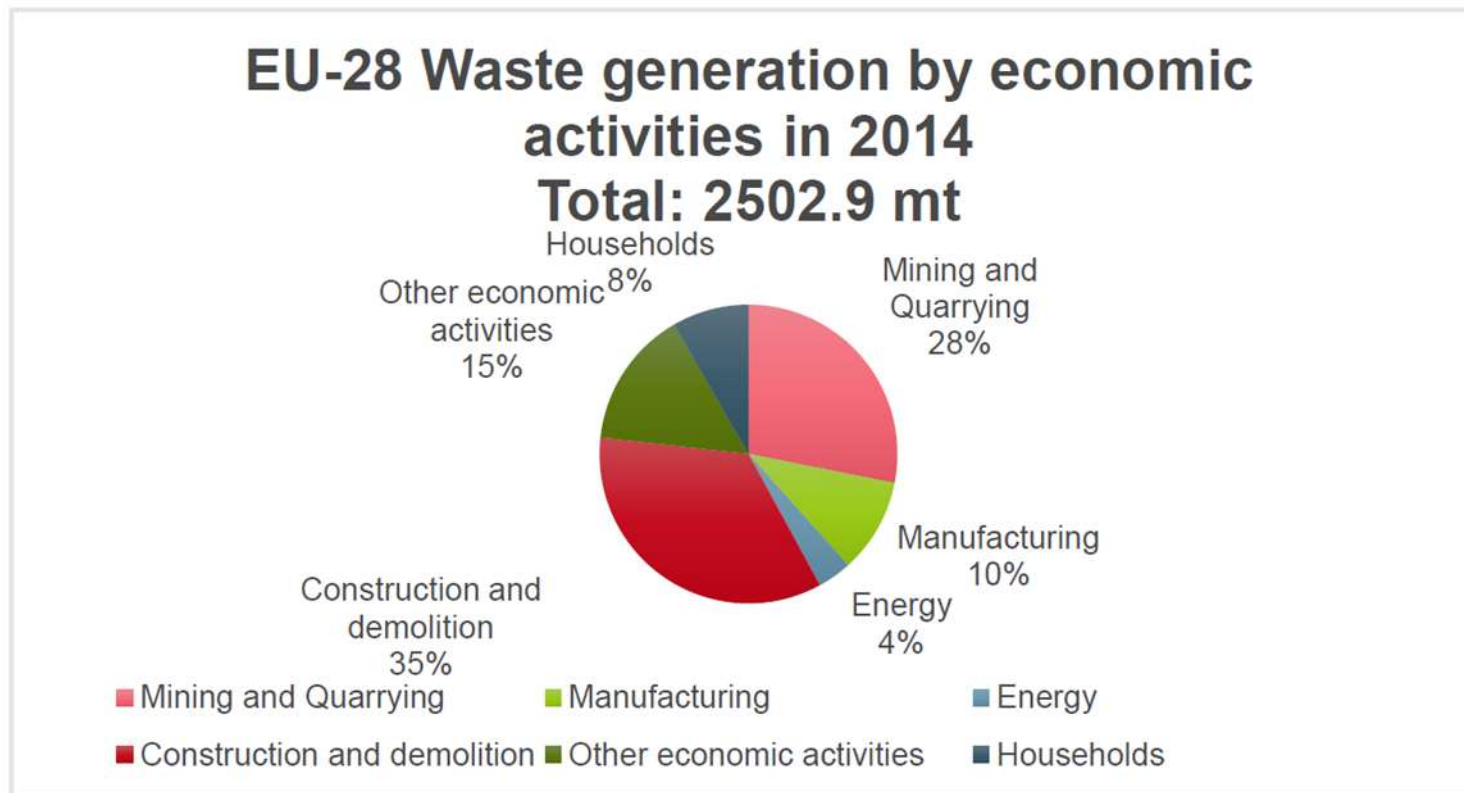
Ciment: 1,3 milliards de tonnes (17000 paquebots Norway = 2,34 milliards de tonnes de calcaire et argile)

Eau: 800 milliards de litres (23 fois le débit journalier de la Seine)

# Développement durable

Nous produisons des déchets

UE28: 1725 kg par habitant



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

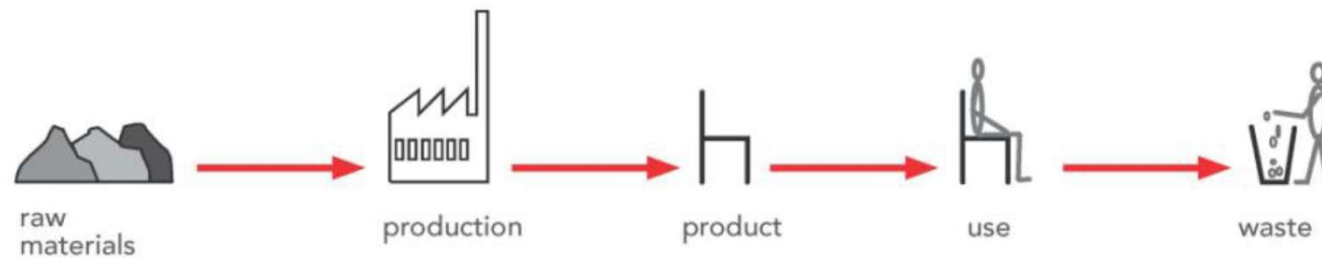
# Développement durable

Nous produisons des déchets de construction et de démolition

- Recyclés mixtes: béton, brique, céramique, pierres naturelles, tuiles etc.
- Béton recyclé composé de plus de 90% de béton.
- Bitume/asphalte recyclé provenant des voiries.

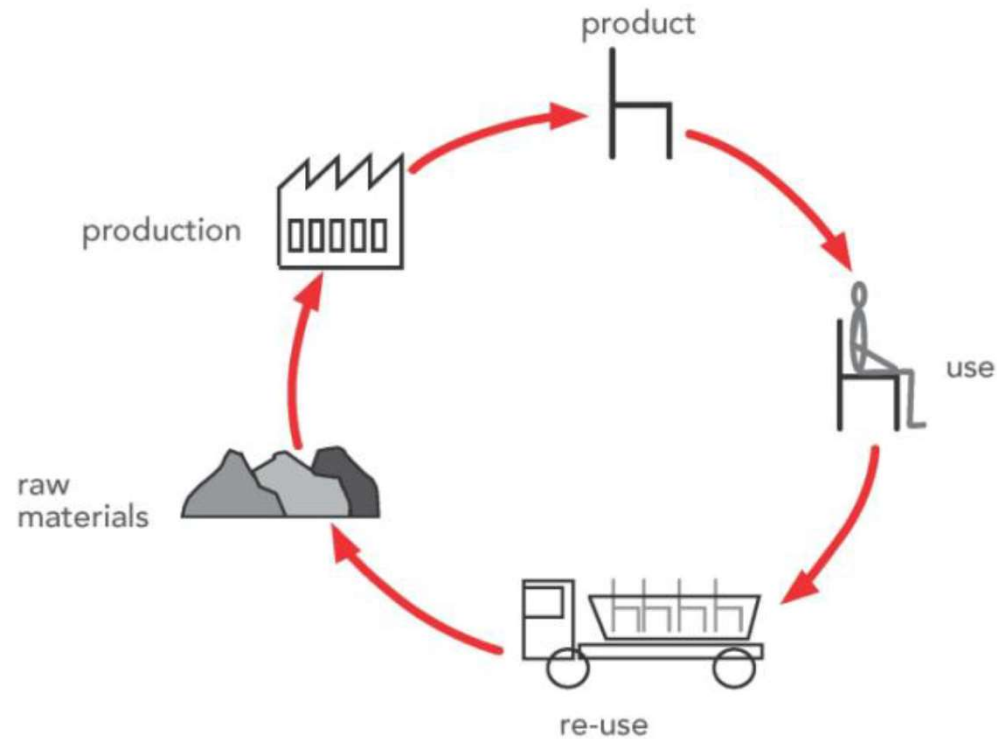


# Développement durable



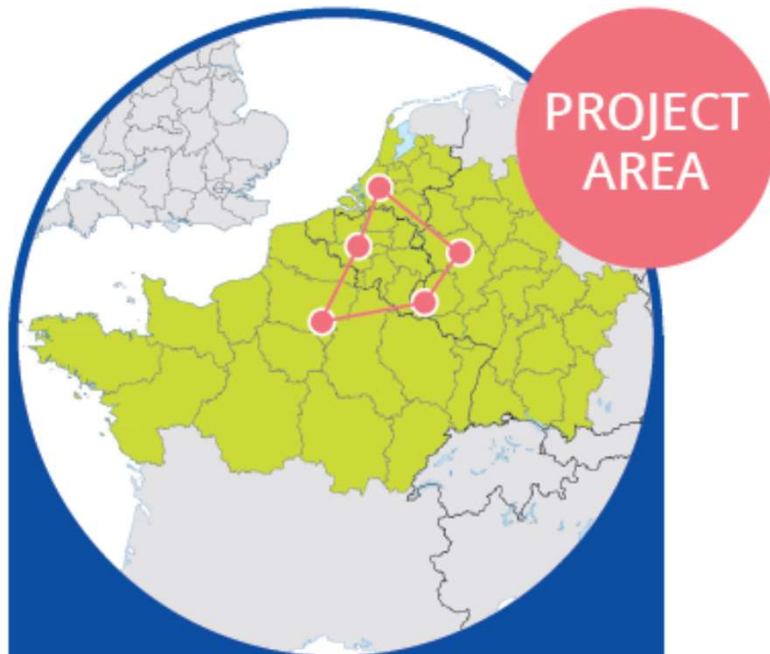
**OLD LINEAR ECONOMY - is about ownership**

# Développement durable



## C2C - TECHNICAL NUTRIENT CYCLE

SOURCE: S. BECKERS (d'après M. BRAUNGART -EPEA, Cradle to Cradle)



**Duration**

March 2017 - September 2020

**Budget**

Total: € 7.28 million

EU funding: € 4.37 million

**Partnership:**

11 Partners

3 Sub-Partners

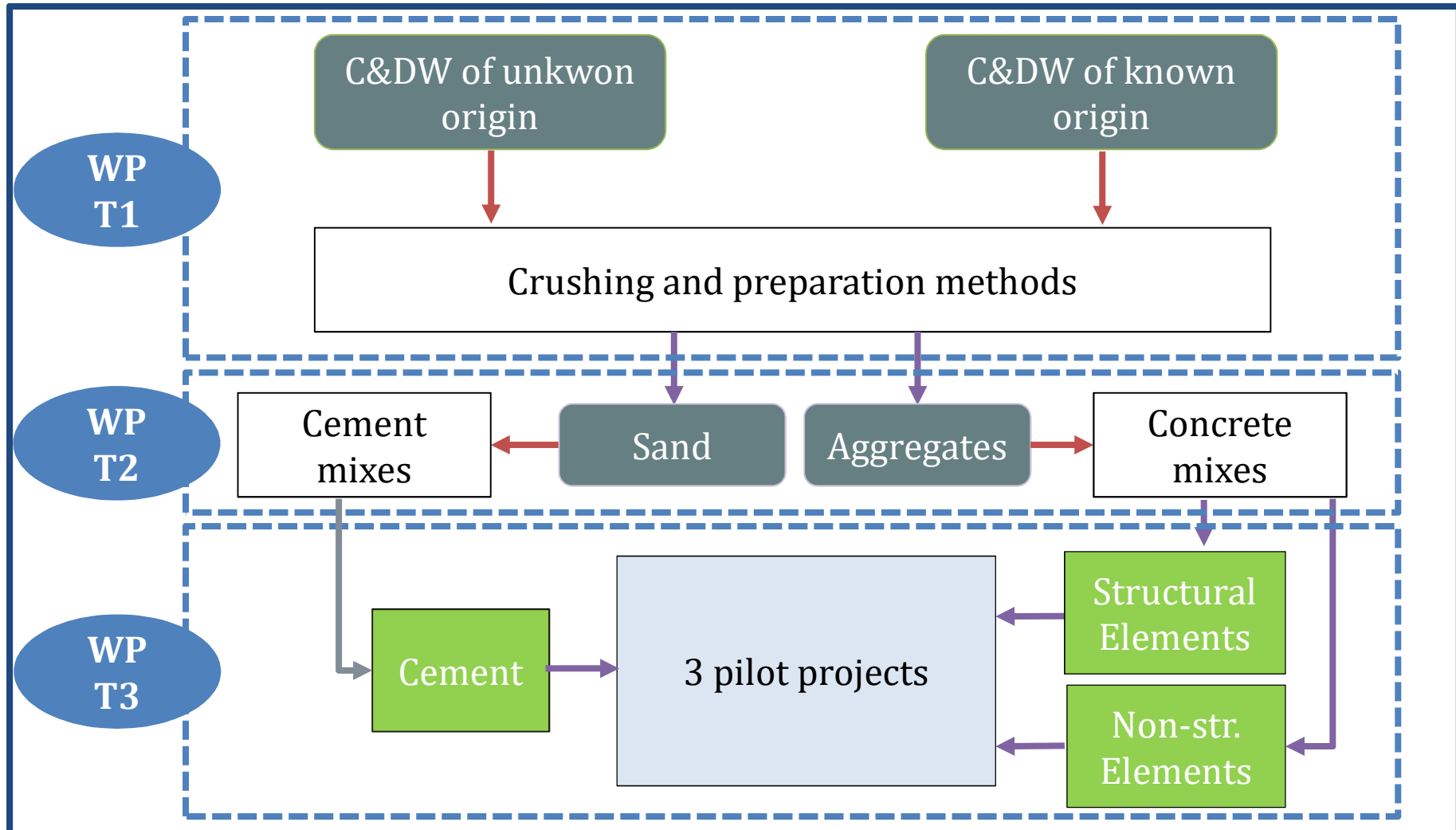
3 Associated Partners

17 Partners from 5 EU countries (Germany, France, Netherlands, Belgium, Luxemburg)





**Project core Idea**



# Recyclage des C&DW

## ➤ Recyclage de déchets de construction/démolition

De ceci...



# Recyclage des C&DW

## ➤ Recyclage de déchets de construction/démolition

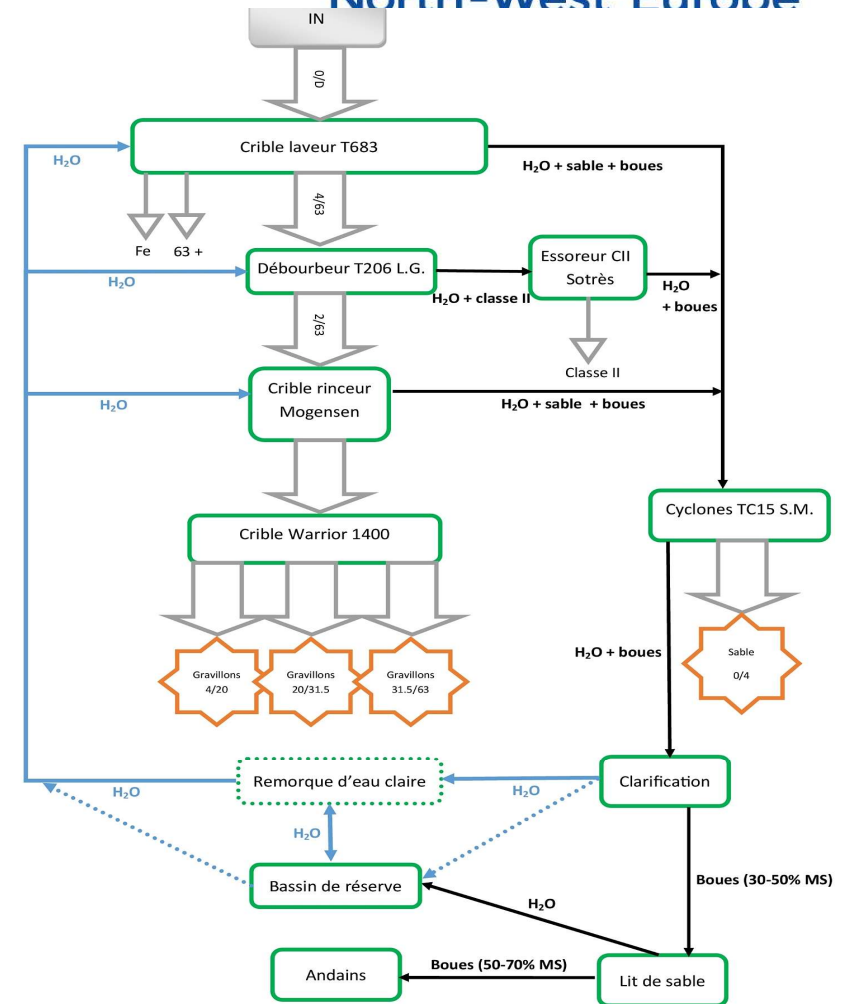
A ceci !



# Recyclage des C&DW

## Processus par voie humide

- Etape 1: Bande transporteuse EDGE



# Recyclage des C&DW

## ➤ Etape 2: Crible laveur Terex Finlay 683

3 rôles:

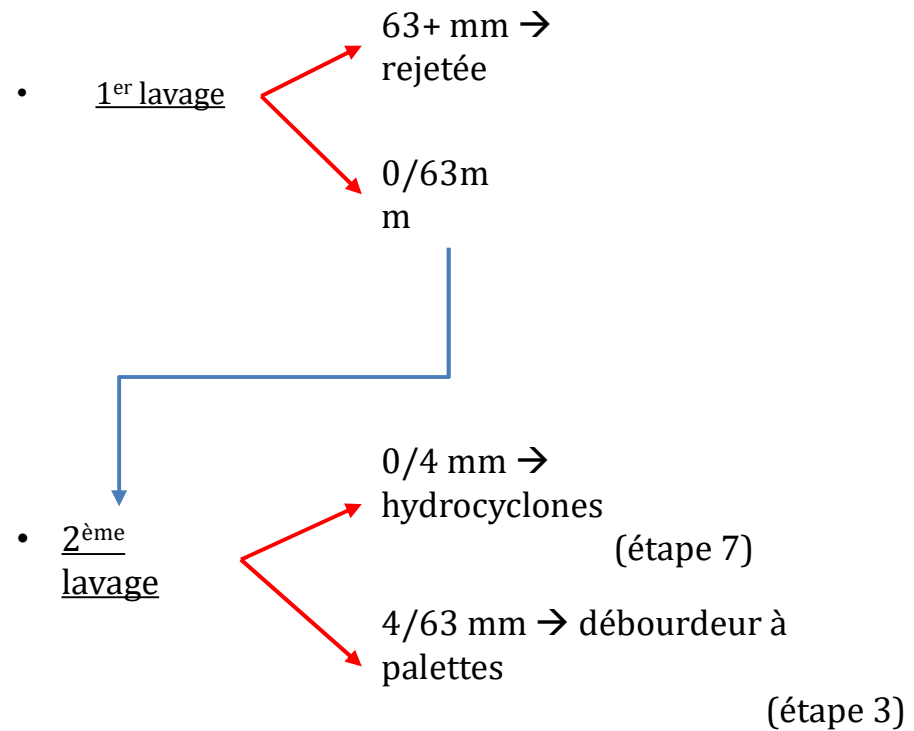
- Partie crible
- Overband
- Partie laveuse



ZOOM

# Recyclage des C&DW

## ➤ Etape 2: Crible laveur Terex Finlay 683 (suite)



# Recyclage des C&DW

## ➤ Etape 3: Débourdeur à palettes: Logwasher 206 Terex Finlay



- 3<sup>ème</sup>  
lavage

Eaux de lavage  
chargées en  
boue

→ Cribleessoreur Sotrès  
(étape 6)

4/63mm → Crible rinceur Mogensen  
(étape 4)



# Recyclage des C&DW

## ➤ Etape 4: Crible rinceur Mogensen

- 4<sup>ème</sup>  
lavage
  - 0/4mm → hydrocyclones (étape 7)
  - 4/63mm → crible warrior (étape 5)



## ➤ Etape 5: Crible Warrior 1400

3 granulométries différentes en sortie:

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



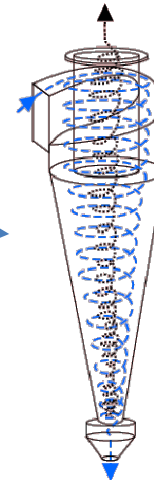
# Recyclage des C&DW

## ➤ Etape 6: Crible essoreur Sotrès

- Eaux de lavage
  - ➔ Matière flottante → Valorisée dans filière adaptée
  - ➔ Matière précipitante → hydrocyclones (étape 7)

## ➤ Etape 7: Hydrocyclones Sand master Terrex C15

- Fraction 0/4mm + eaux de lavage
  - ➔ Boues → bassin collecteur (étape 8)
  - ➔ Sables → Crible essoreur haute fréquence



# Recyclage des C&DW

## ➤ Etape 8: Containers de clarification

- Eaux boueuses
- Particules floculées → lit de sable
- Eau claire → bassin de réserve



# Recyclage des C&DW

➤ Etape 9: Lit de sable et bassin de réserve



# Recyclage des C&DW



# Recyclage des C&DW



# Recyclage des C&DW

## ➤ Produits finis

### Sables :

- 0/4 mm mixte
- 0/4 mm béton



### Granulats:

- 4/6 mm mixte
- 4/6 mm béton
- 6/14 mm mixte
- 6/14 mm béton
- 14/20 mm mixte
- 14/20 mm béton

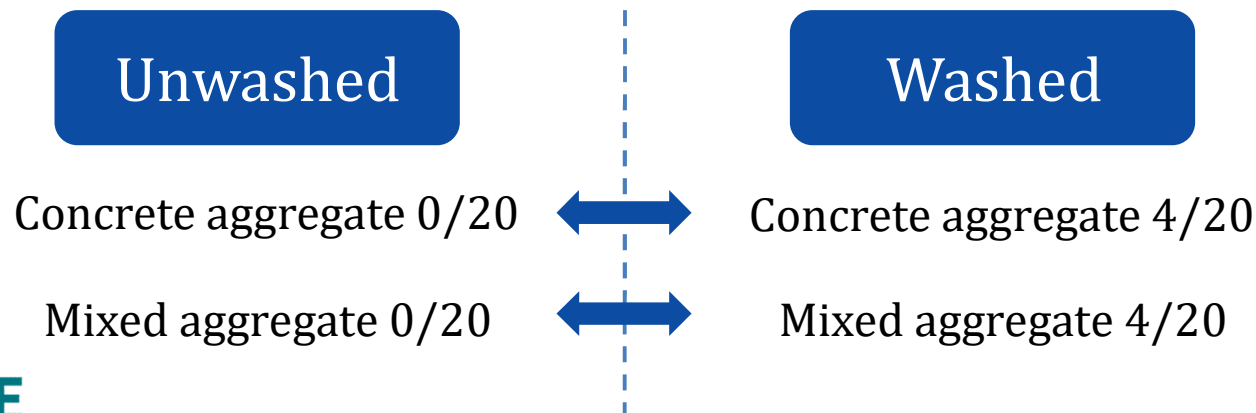


# Effect of washing on aggregates quality

## Expectations of washing aggregates:

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

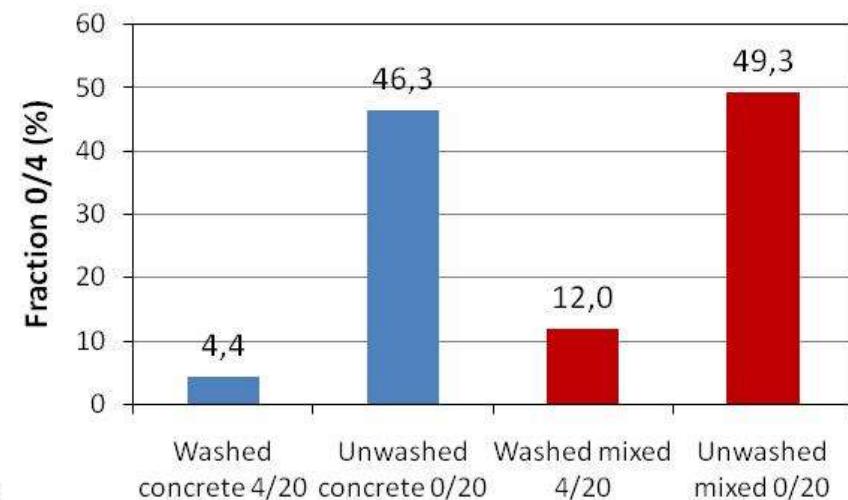
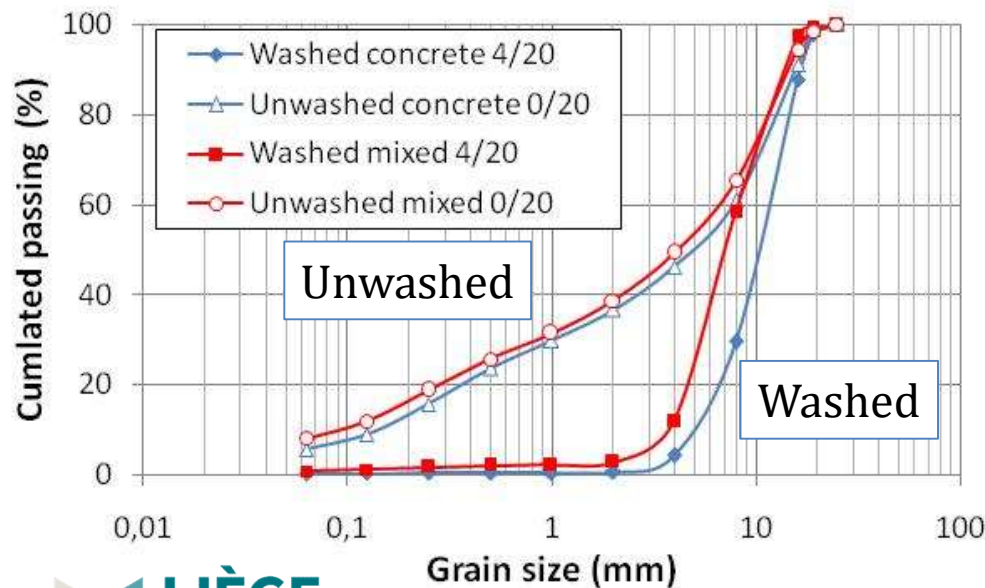
## Methodology





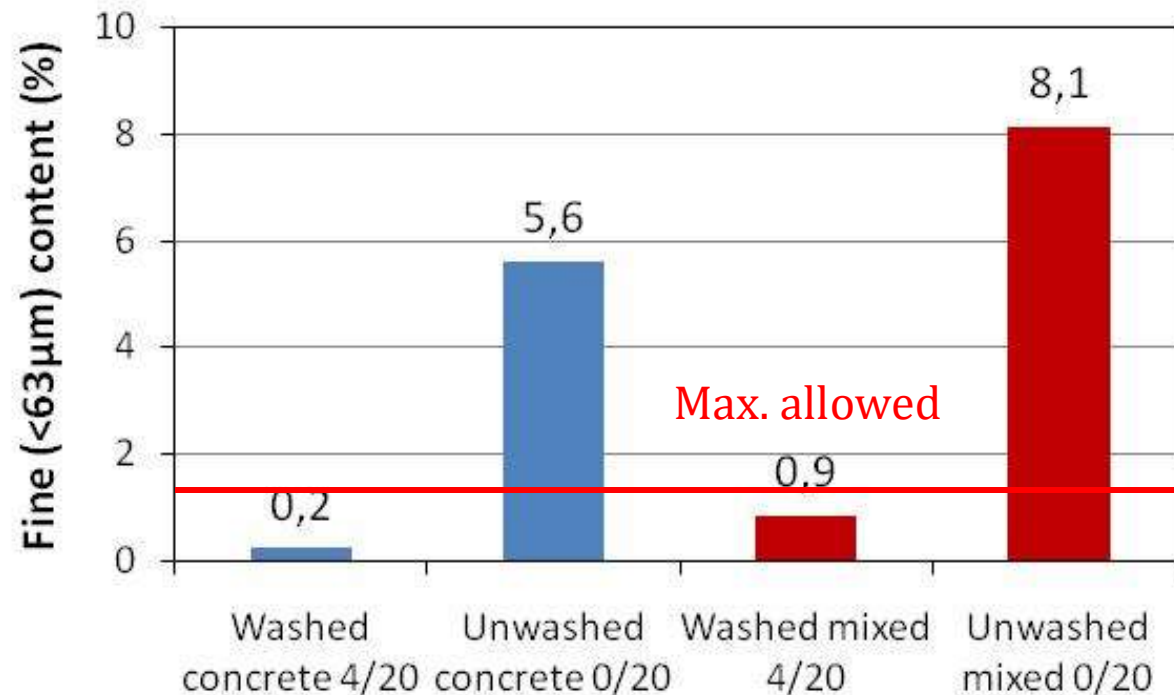
# Grain size distribution - aggregates

- 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



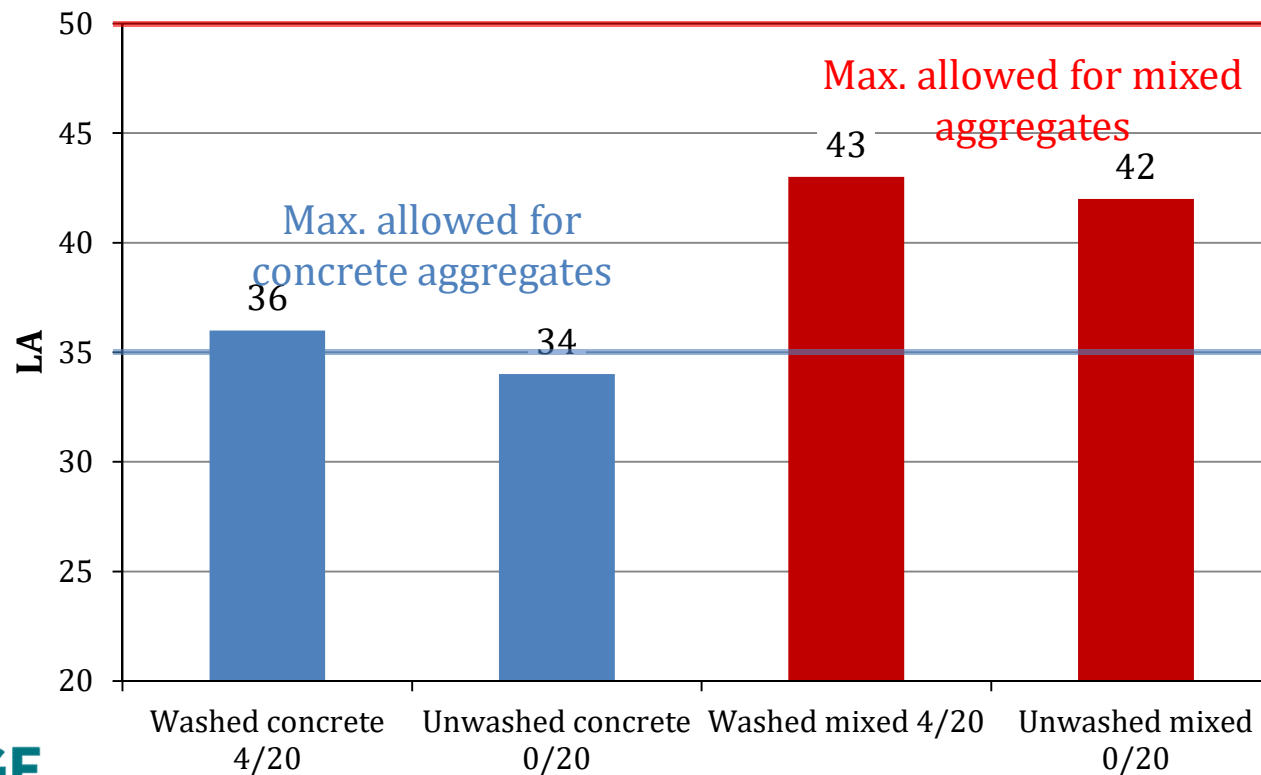
# Grain size distribution - aggregates

- 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



# Resistance to fragmentation

- Concrete recycled aggregates have better resistance to fragmentation
- No effect of washing



# Aggregates washing conclusion

## Expectations of washing aggregates:

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

# Influence of the crushing method

## Methodology

Production of 0/25

### Impact crusher



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

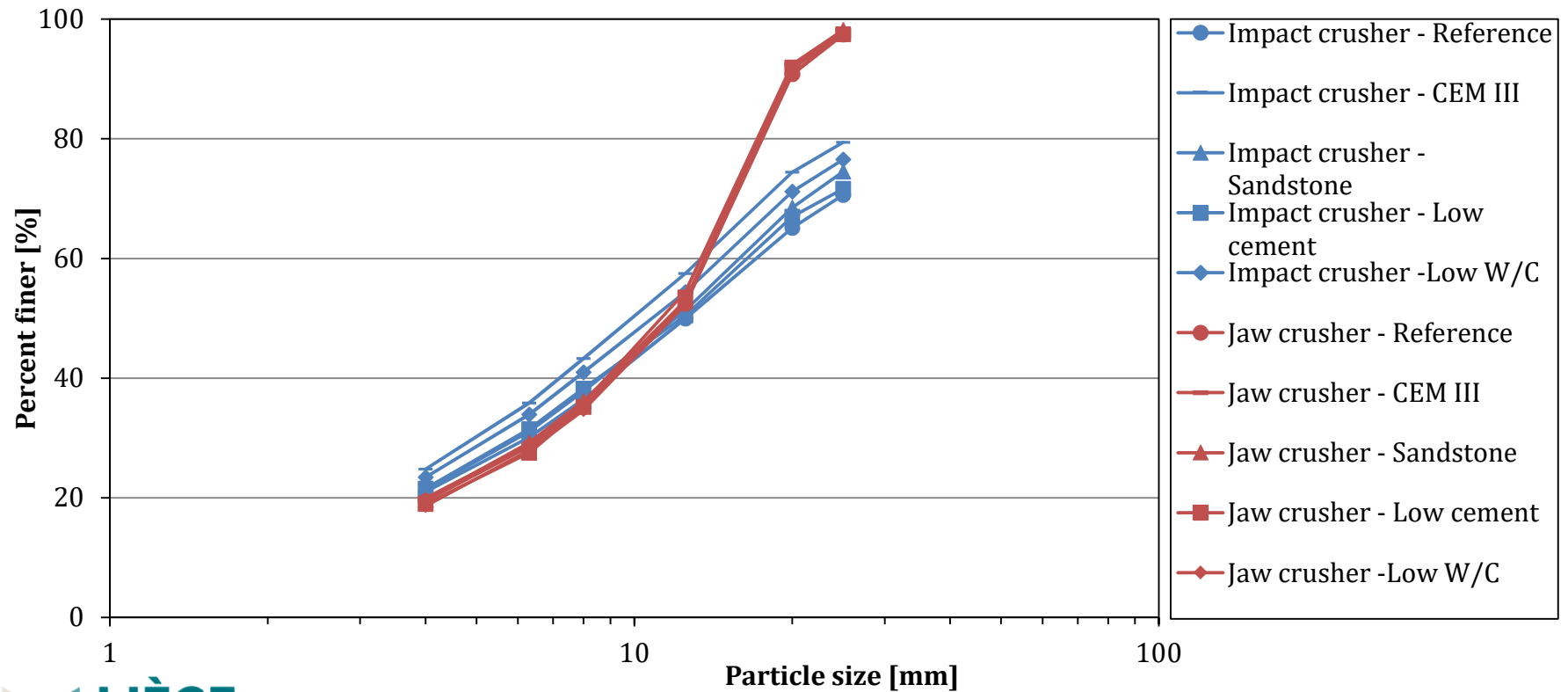
### Jaw crusher



Jaw crusher set at a 22 mm opening

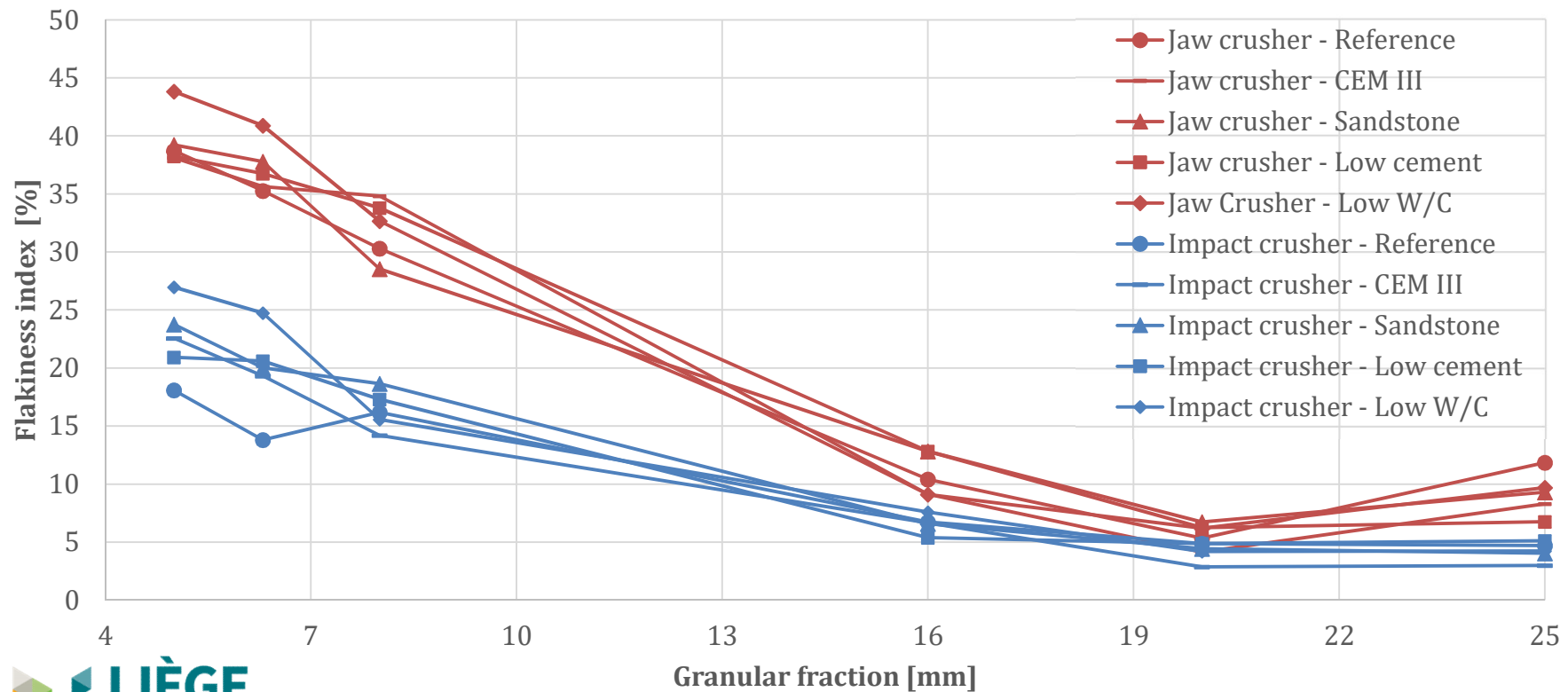
# Grain size distribution

- 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



# Crushing energy consumption analysis

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



# Concrete for paving blocks

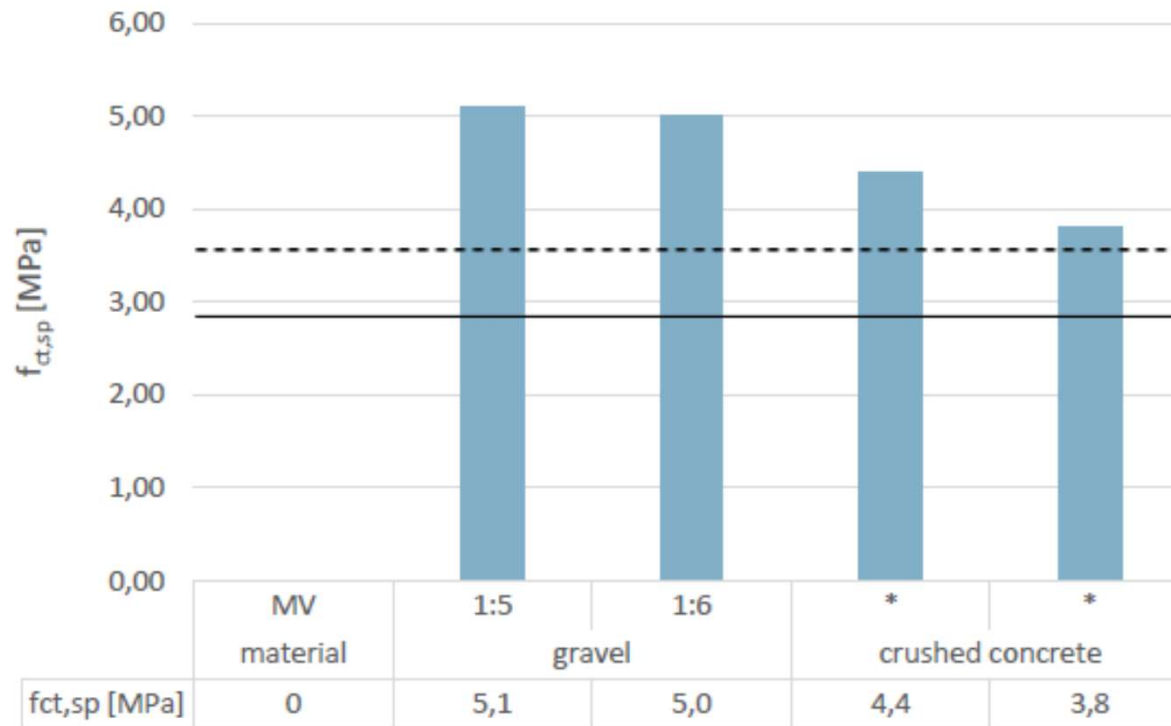
- Requirements
  - Slump 0 (earth-moist concrete)
  - High early age strength
  - Resulting concrete fulfilling standards of EN 1338



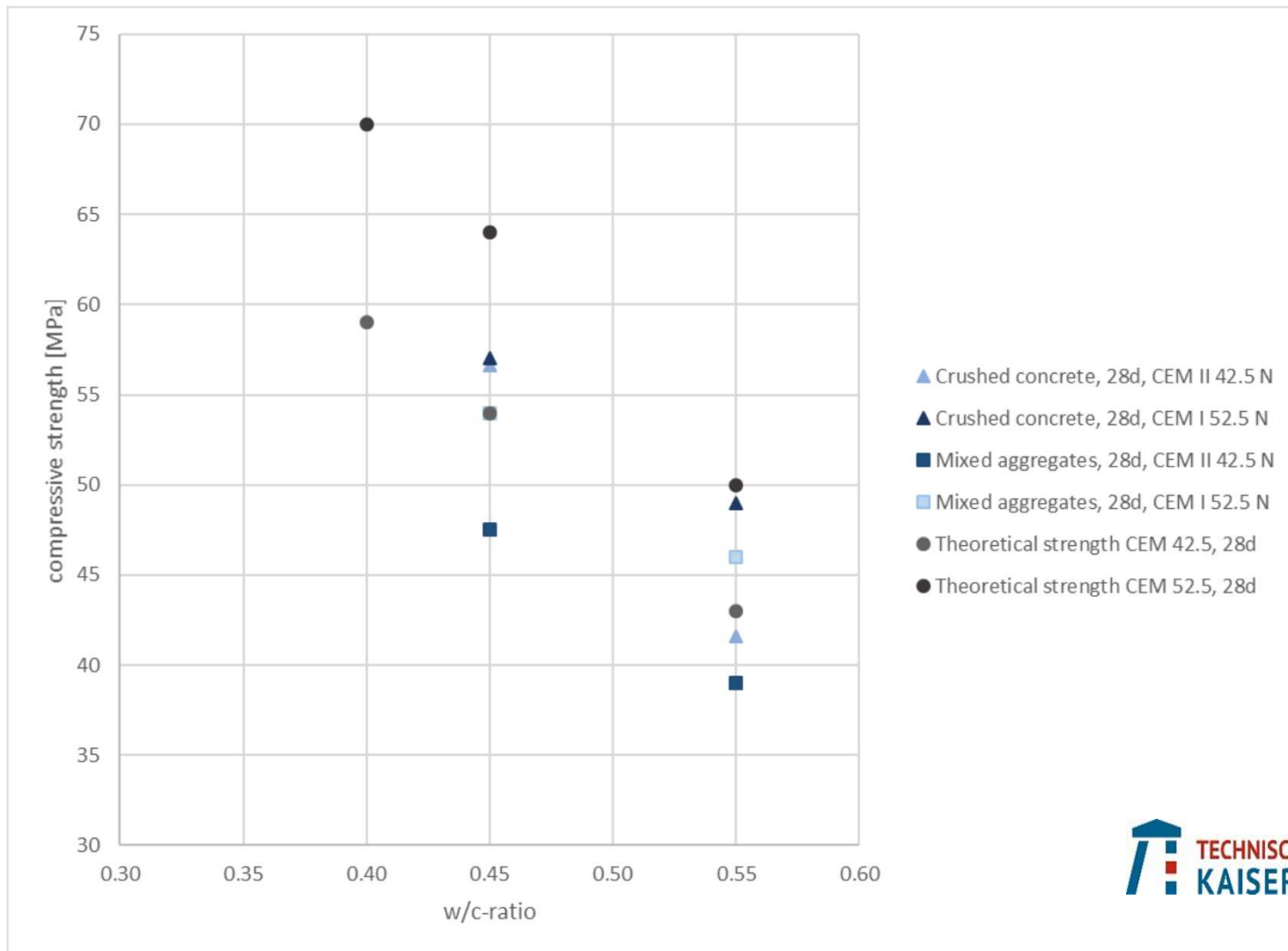
# Concrete for paving blocks

Parameter	Influence
Water content	Most important
Concrete composition	Increasing with increasing cement content and specific surface
Grading curve of aggregates	Minor influence
Admixtures/additives	Depends on individual case (mixing ratio, added amount)
Compaction energy	Important

# Concrete for paving blocks



# Concrete for structural design



# 10 Product designs

1. Hollow Core Floor Slab
2. Urban SeRaMCo Elements
3. Sound Absorbing L-Wall
4. Façade Cladding
5. Salty Concrete
6. Rammed Concrete
7. Energy Sound Barrier
8. Foam Concrete Insulated Wall
9. Cooling Wall
10. Energy Bench

# 10 Product designs

1. Hollow Core Floor Slab

2. U

3. S

4. F

5. S

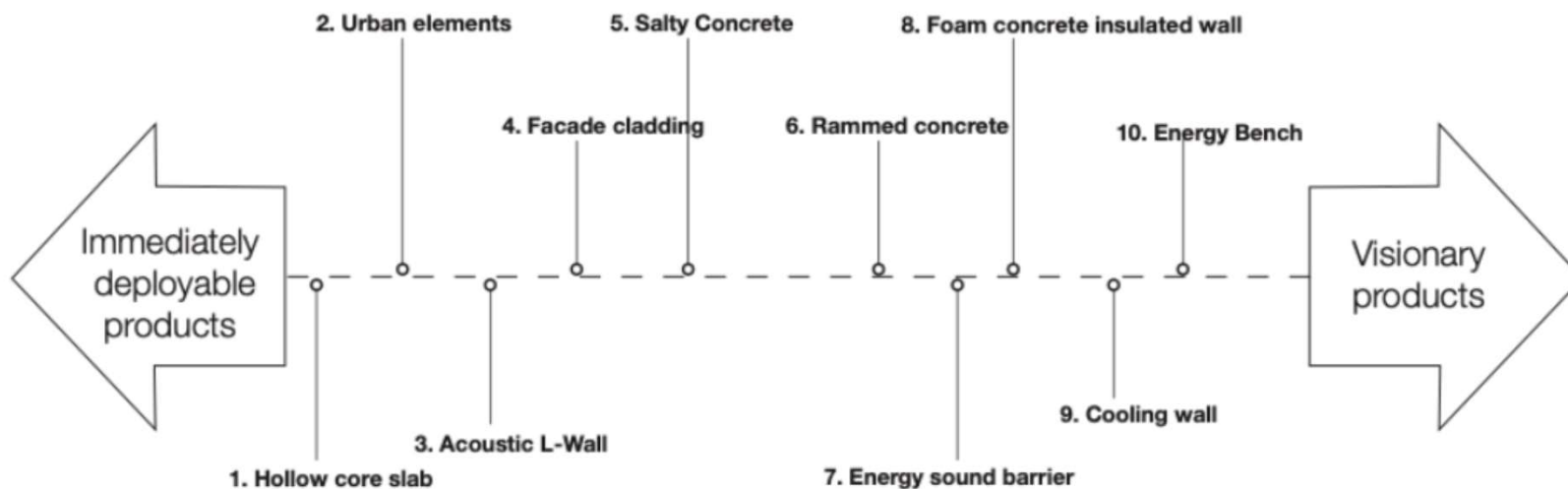
6. R

7. E

8. F

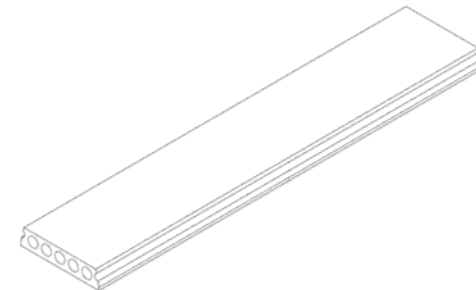
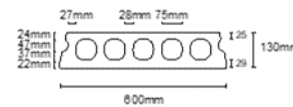
9. Cooling wall

10. Energy Bench



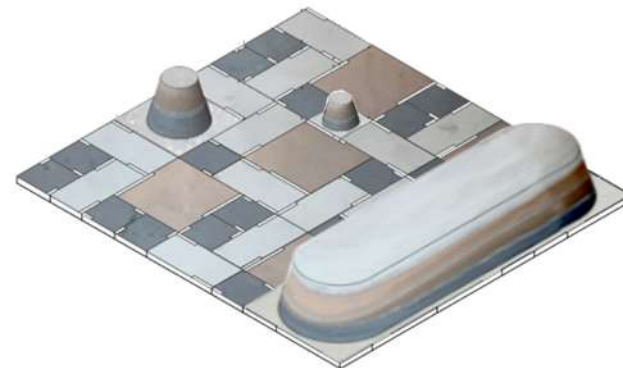
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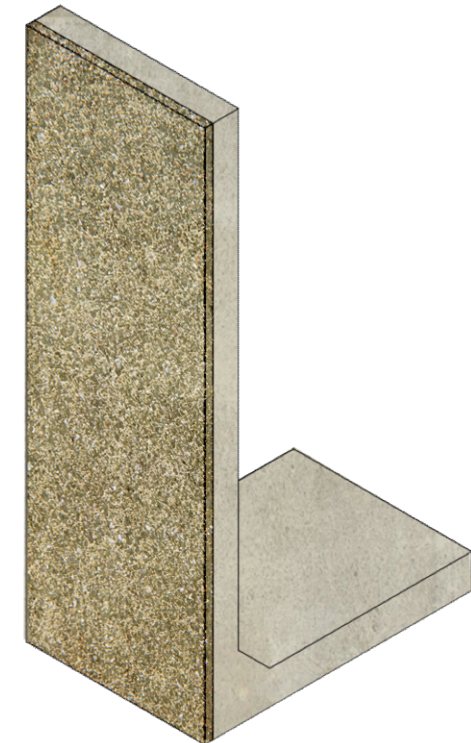
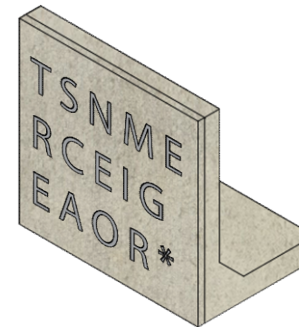
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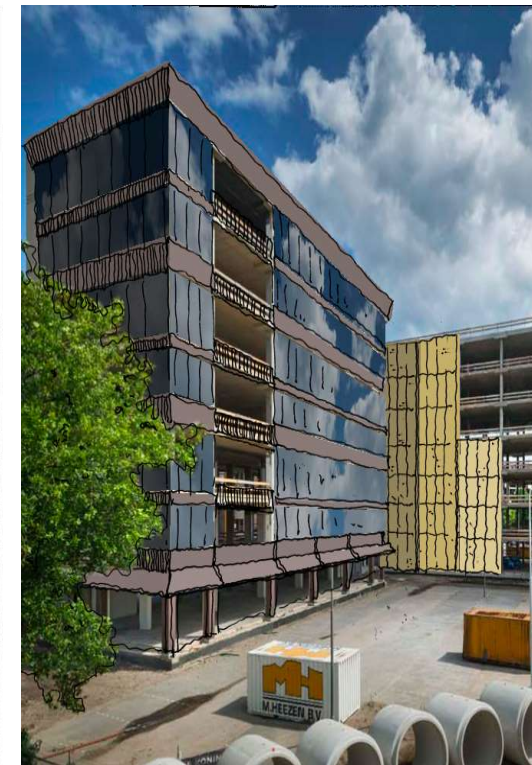
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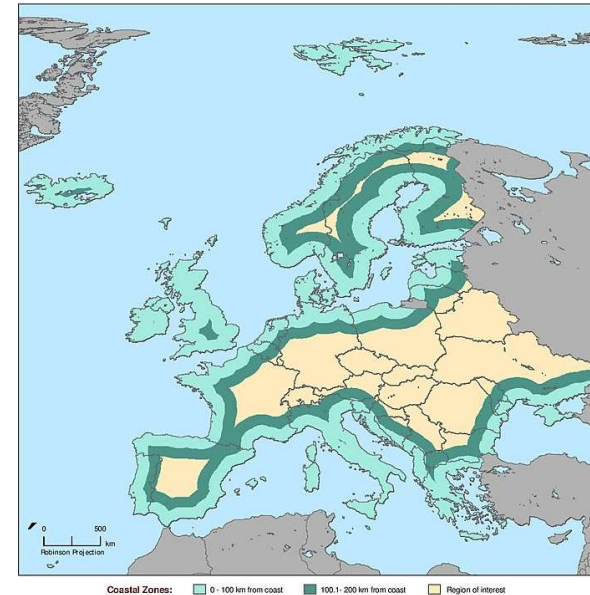
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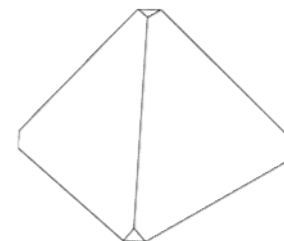
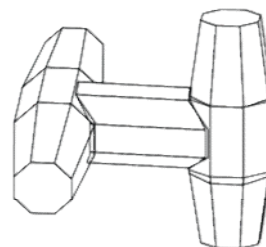
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< 100km from coast ca. 35% of total EU area

< 200km from coast ca. 60% of total EU area



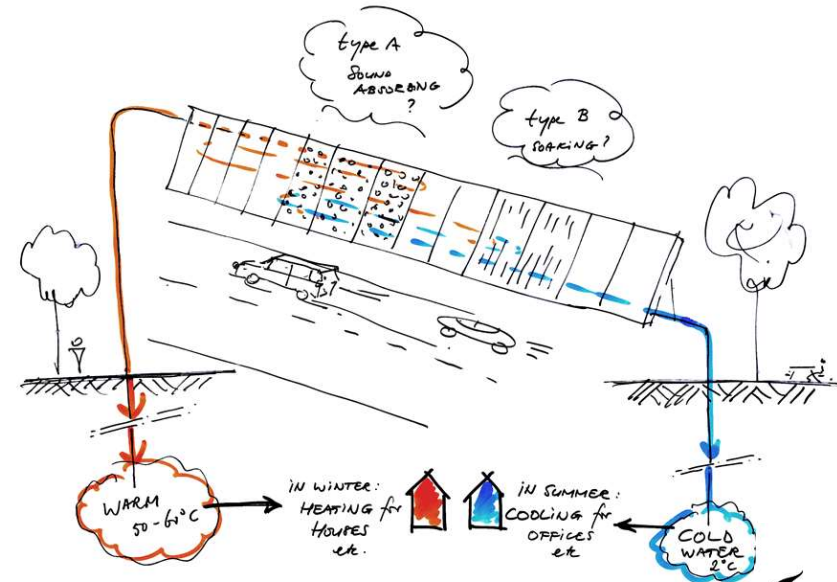
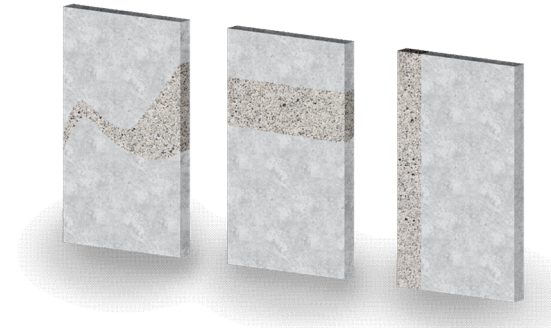
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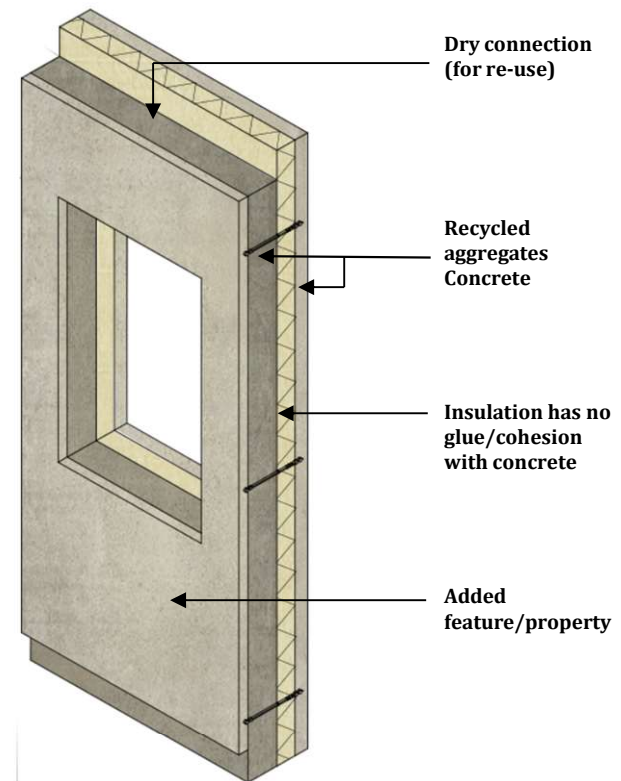
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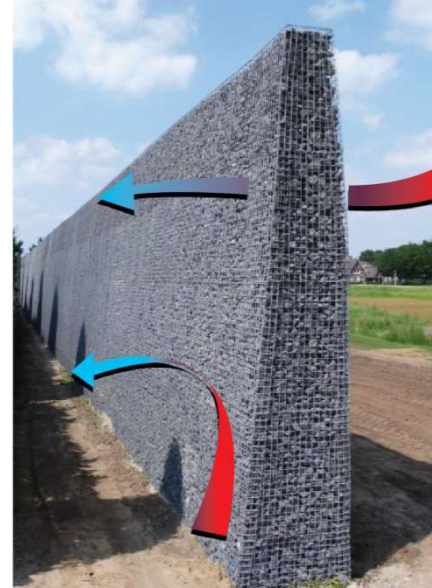
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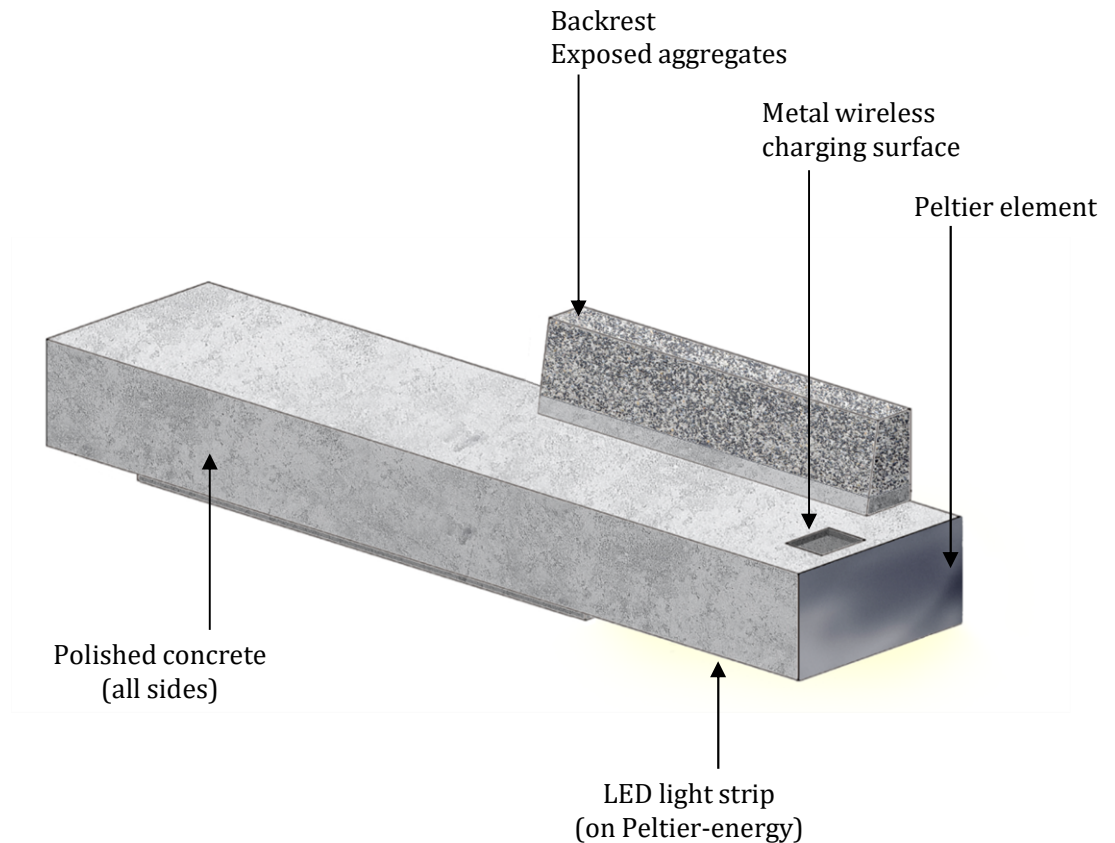
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# Parkour Park – Parc des Marêts



# Parkour Park – Parc des Marêts





*Projet soutenu par l'Union Européenne dans le cadre de Interreg NWE SeRaMCo*