Properties of concrete blocks made with recycled concrete aggregates: from block wastes to new blocks

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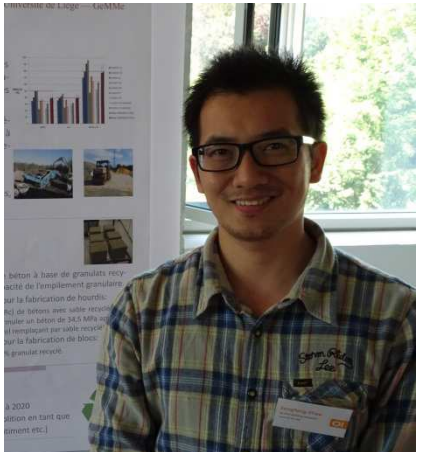


Interreg North-West Europe SeRaMCo
European Regional Development Fund

1. Introduction: Context and Challenges

Use of recycled concrete aggregates (RCA) in concrete

Use CD&W as sub-base and base material in road construction (“less noble”)

Meet Sustainable Development Goals: recovery targets to 70% of construction and demolition wastes (CD&W) by 2020 in European Union (**Directive 2008/98/EC**)

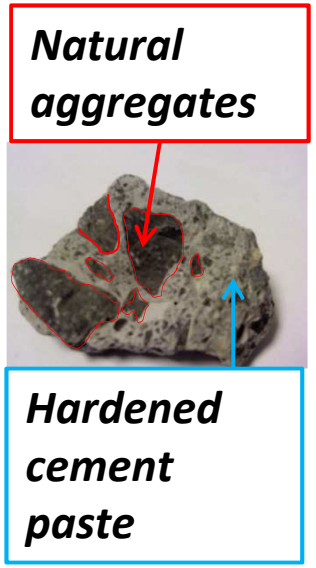
Reduced use of natural aggregates (preservation of natural resources)

1. Introduction: RCA

Two phases :

❖Natural aggregates (NA)

❖Hardened cement paste (**more porous** than NA)



Properties of RCA:

❖Depend on: proportions and properties of these two phases

❖Influenced by particle size, composition of original concrete, contaminants, crushing method…

Concrete made with RCA:

❖Coarse RCA possesses satisfying properties for the reuse as concrete aggregates

❖Fine RCA possesses a large water demand which makes it harder to recycle into concrete compared to coarser RCA

1. Introduction

PREFER company:

- ❖Concrete slab
- ❖Concrete block (6000m^3/month)
- ❖Concrete block wastes **(50m^3/month)**

Feasibility of using RCA obtained from old concrete block wastes in new concrete block

Part of Project ConRePaD

BEWARE (BEcome a WAlloon REsearcher) Fellowships Academia co-financed by the COFUND program of the European Union (FP7-Marie Curie Actions) and Walloon Government

2. Materials

RCA manufactured in laboratory

Old concrete block wastes (C8/10, from PREFER)

Crushing (jaw crusher in laboratory, opening ≈10mm)

Then dried in oven at 105°C

Separation of RCA by sieving (0/20mm)

Four granular classes:

0/2mm 2/6.3mm 6.3/14mm 14/20mm

3. Characterizations: RCA

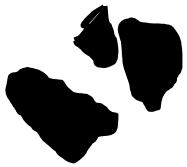
Hardened cement paste content (CPC) of RCA

Principal soluble and insoluble phases in salicylic acid and methanol dissolution

(*Zhao et al., 2013, Journal of Sustainable Cement-Based Materials, 2,186-203*)

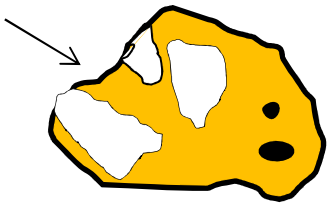
Natural aggregates

Adherent hardened cement paste



NA

Quartz, Dolomite, Calcite
Insoluble in salicylic acid



Cement paste

C_2S, C_3S, $Ca(OH)_2$, C-S-H, Ettringite
Soluble in salicylic acid

Insoluble in salicylic acid
C_4AF, AFm ⟶ CEM I

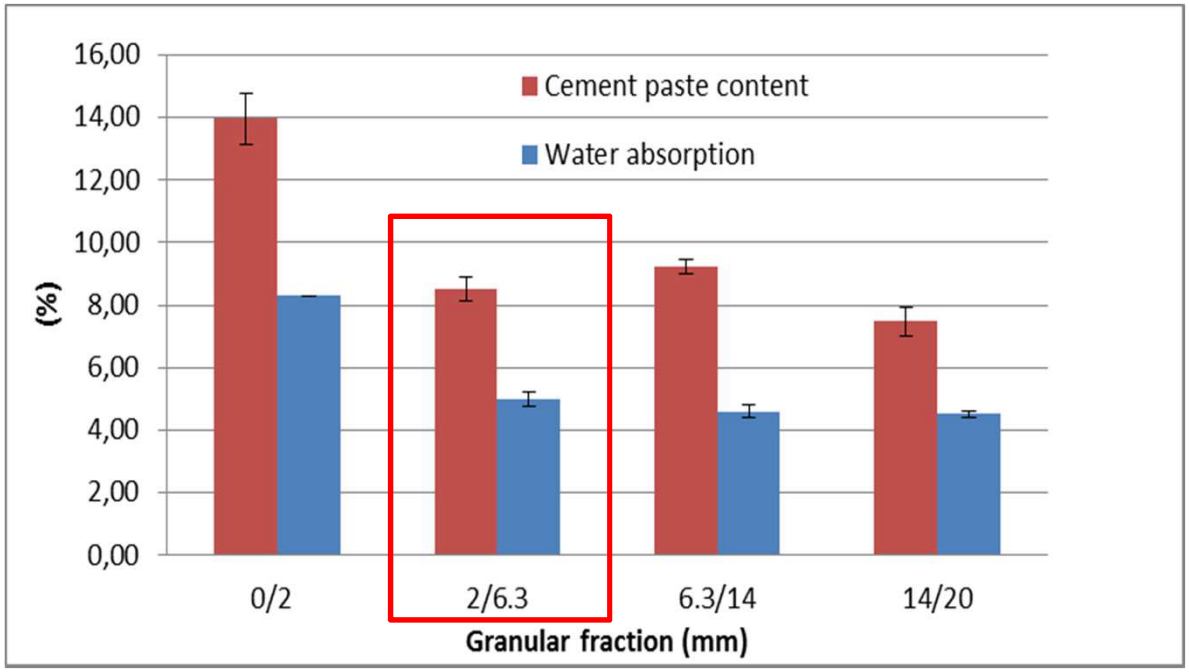
Calcite, Slag… ⟶ CEM II, III

3. Characterizations: RCA

Hardened cement paste content (CPC) of RCA

Salicylic acid and methanol dissolution

Water absorption (WA) (EN 1097-6)



(*Zhao et al., 2017, European Journal of Environmental and Civil Engineering, 1-11*)

CPC and WA of 0/2mm fraction larger than three coarse fractions

Recycled sand possesses higher CPC and WA than CRCA

3. Characterizations: Compositions

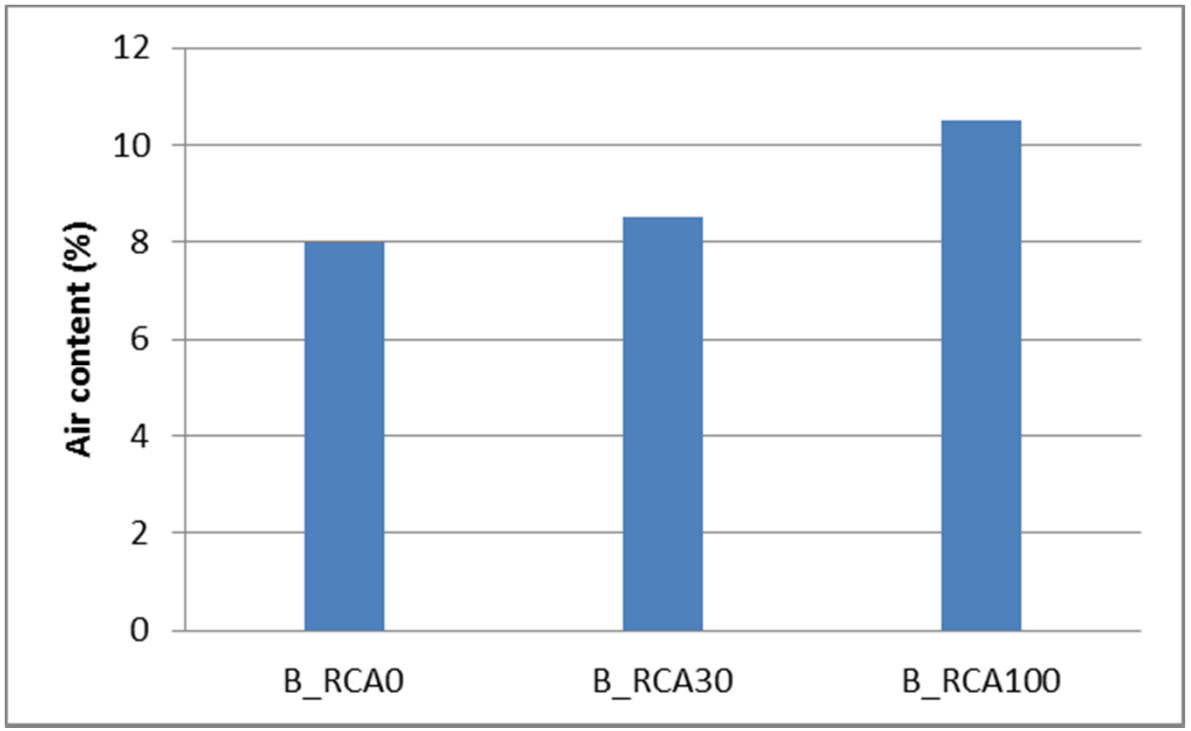
Compositions of concrete blocks (1 m^3)

	B_RCA0	*B_RCA30*	*B_RCA100*
NA 2/7 (kg)	1080	754	0
RCA 2/6.3 (kg)	0	302	1008
NS 0/2 (kg)	825	825	825
Cement (kg)	150	150	150
Efficient water (kg)	105	105	105
Absorbed water (kg)	13.12	26.00	56.20
W_{eff}/C	0.70	0.70	0.70

- Different substitutions of NA 2/7 by the same volume RCA 2/6.3 (0, 30, 100%), same W_{eff}/C ratio, cement CEM III/A 42.5
- Water absorption of all aggregates measured according to EN 1097-6
- All aggregates (air dried condition), pre-saturated in the mixer 5 min before the addition of cement by half of total water

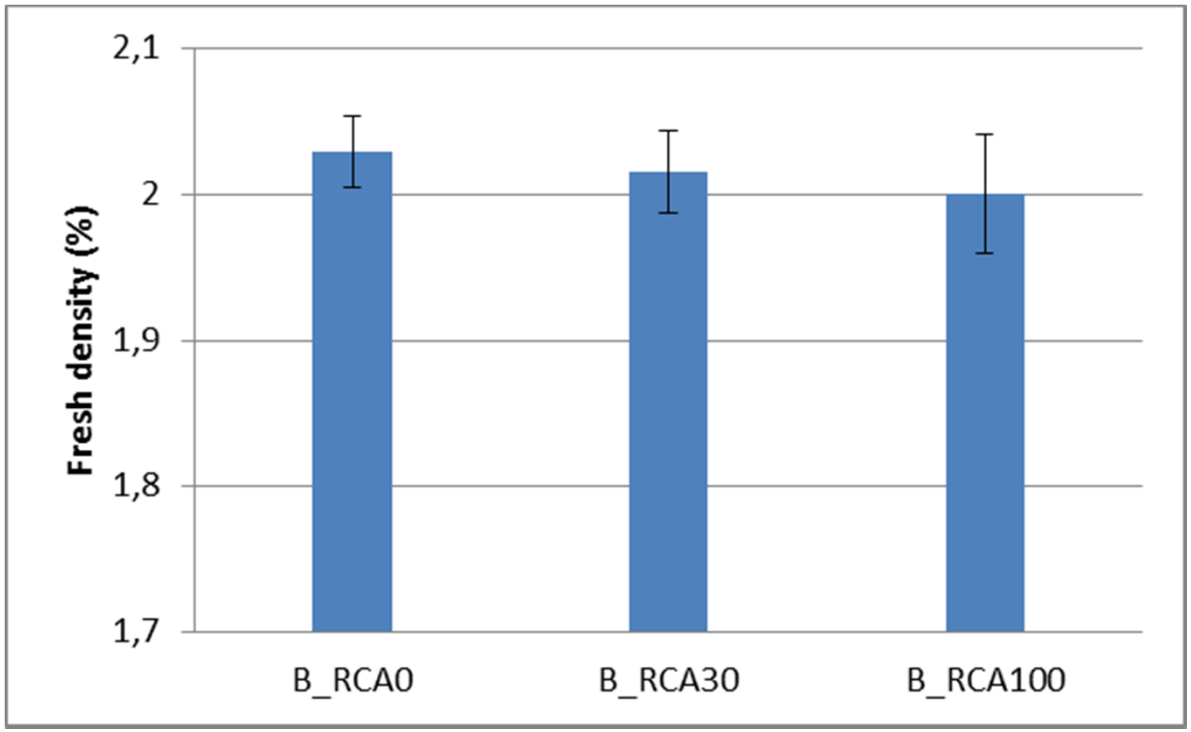
3. Characterizations: Fresh properties of concrete

- Workability of three concretes is low (zero slump)



- The air content of concrete increases when the substitution of recycled aggregates increases

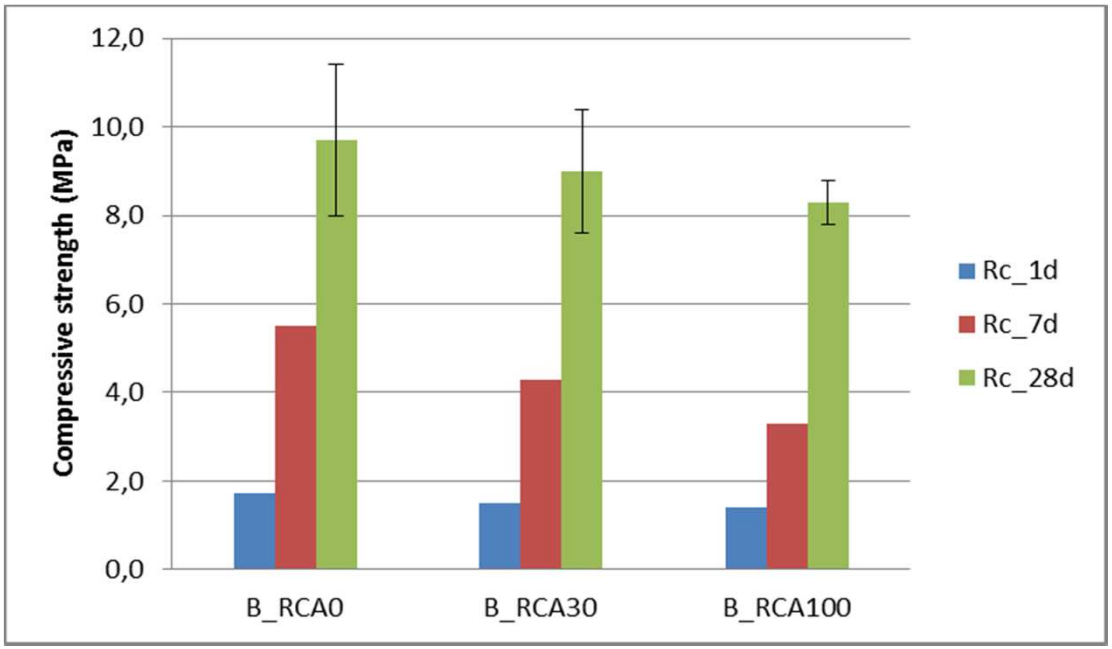
3. Characterizations: Fresh properties of concrete



- The fresh density of concrete slightly decreases when the substitution of RCA increases

3. Characterizations:

Compressive strength of concrete



- Compressive strengths of concretes with RCA are slightly lower than those of concrete with natural aggregate
- Compressive strength of concrete made with 100% RCA at 28 days decreases 14.4% comparing with the reference concrete (8 MPa), while Rc of B_RCA 30 decreases 7.2%
- This behavior may be due to the poor properties of RCA (adherent cement paste leads to a higher porosity)

4. Conclusions et perspectives

Feasibility of using RCA obtained from old concrete block wastes in the new concrete blocks

⇒ Recycled sand possesses significantly higher cement paste content and higher water absorption than coarse RCA

⇒ Compressive strength of concrete blocks slightly decreases as the substitution of RCA increases; Rc of B_RCA100 could reach 8 MPa after 28 days without increasing the cement content of the concrete mix

⇒ Use of RCA obtained from old concrete block wastes can be envisaged depending on their class of exposure and the concrete grade requirement

⇒ Assessment of durability of new concrete blocks made with RCA (now)

⇒ Industrial application of new concrete block made with RCA will be realized in PREFER Company in September 2017

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