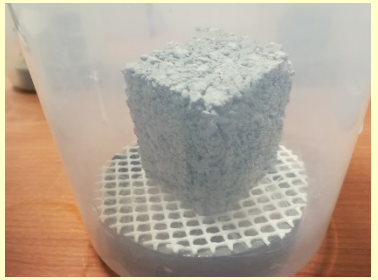
THESSALONIKI2021
www.thessaloniki2021.uest.gr

8th International Conference on Sustainable Solid Waste

LEACHING BEHAVIOUR BASED ON DIFFUSION TEST PERFORMED AT LONG-TERM ON RECYCLED CONCRETE MADE WITH PRECAST CONCRETE REJECTS





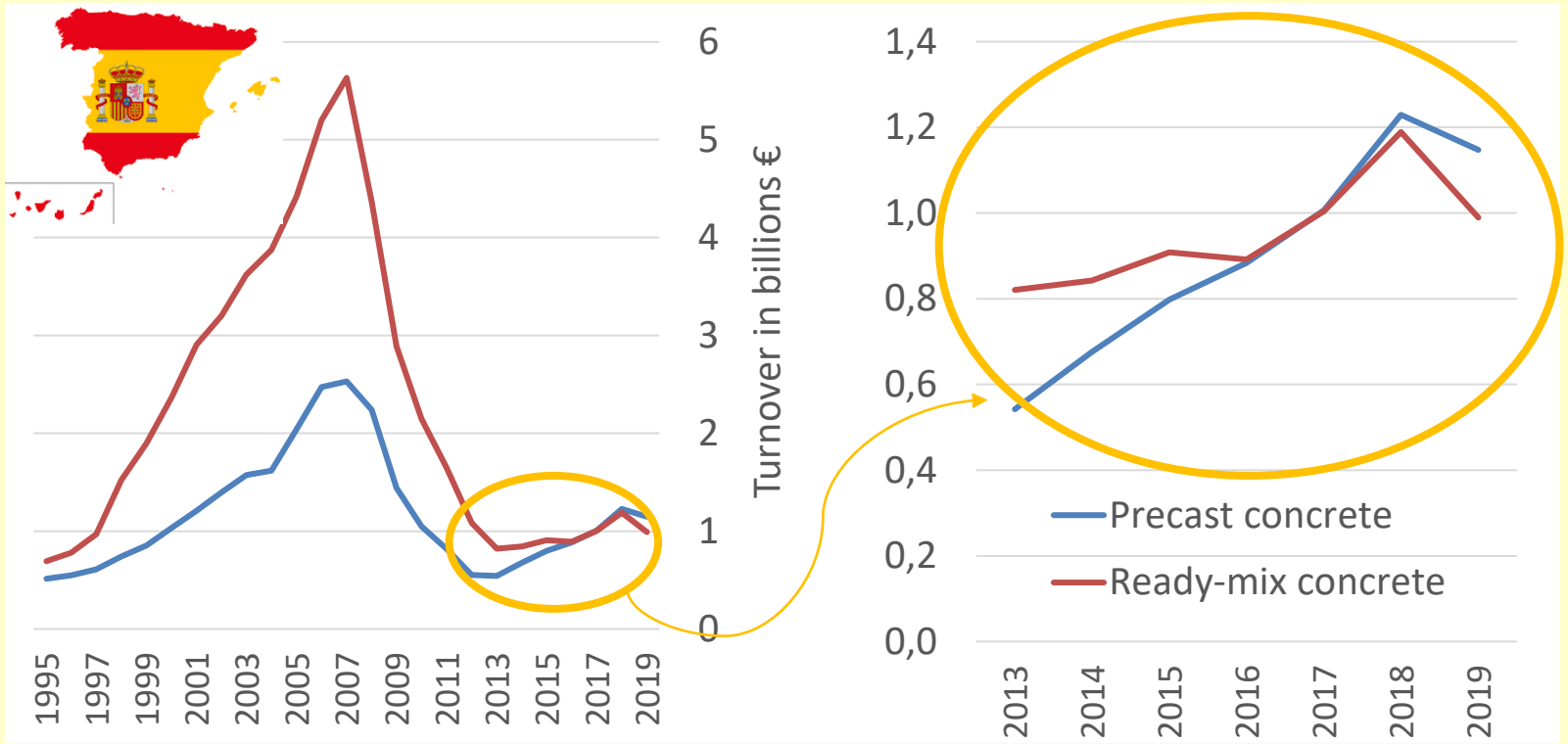

Presenting Author: Antonio López-Uceda
University of Córdoba (Spain)

Universidad de Córdoba

Authors: Adela P. Galvín, Antonio López-Uceda, Jesús Ayuso, Angelica Lozano-Lunar, Luis Contreras, Adolfo Peña

Concrete → The most consumed material in the world

→ Two types: Ready-mix and precast concrete



Source: https://www.nationmaster.com/nmx/timeseries/

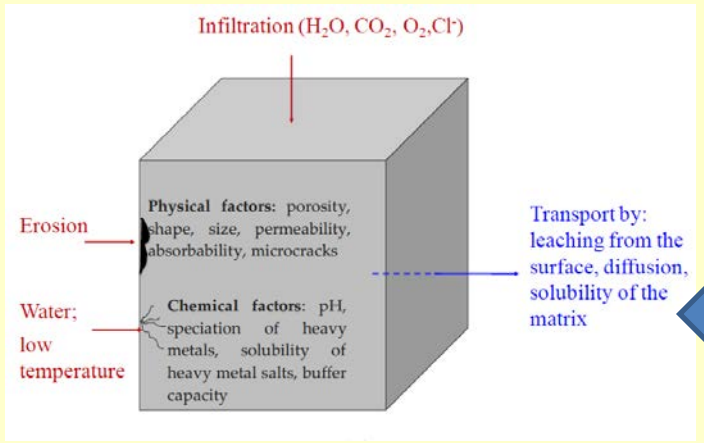
LEACHING BEHAVIOUR BASED ON DIFFUSION TEST PERFORMED AT LONG-TERM ON RECYCLED CONCRETE MADE WITH PRECAST CONCRETE REJECTS

Plant facilities/ plant process

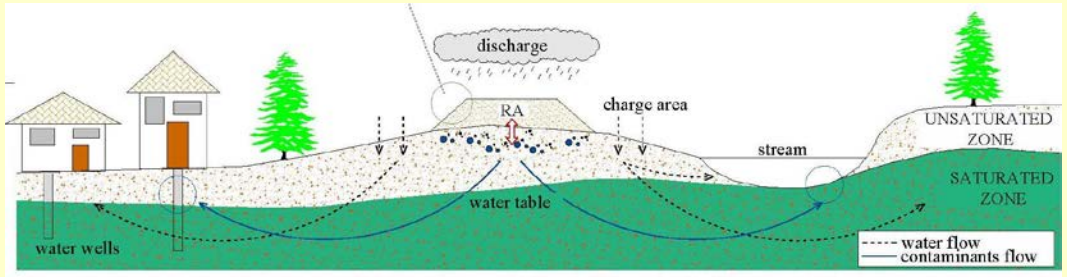
Rejected pieces (CDW) precast concrete rejects

Concrete recycled aggregates (RA)

New specimens of recycled concrete prepared in lab



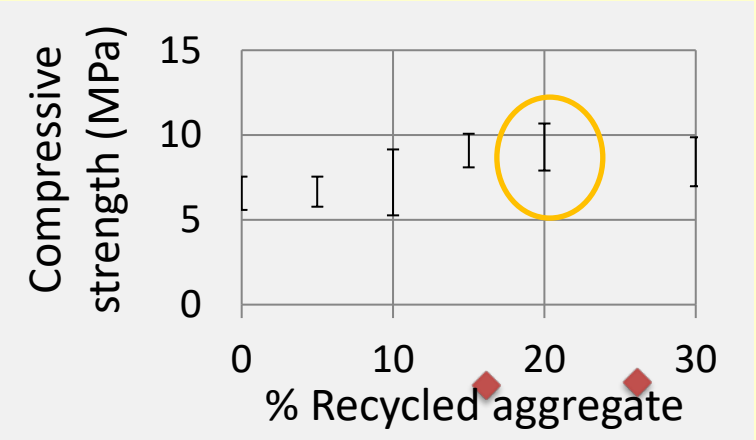
Diffusion tank leaching tests



Incorporation of RA in concrete → leaching study

Aim:

The present research work is focused on the leaching study of recycled concrete made with precast concrete rejects. In a previous phase of the study (0%, 5%, 10%, 15%, 20% and 30% of recycled aggregate ratio incorporation), it was determined that 20% presented the highest compressive strength. So, different leaching tests were carried out with the purpose of:



(i) identify most conflictive contaminants released in leaching tests

(ii) study of the long-term behaviour → dynamic tank leaching test

Materials

Recycled aggregate from precast plants (0-10 mm)

C-20

Sand (0-4 mm)

Fine gravel (2-6.3 mm)

Coarse gravel (4-10 mm)

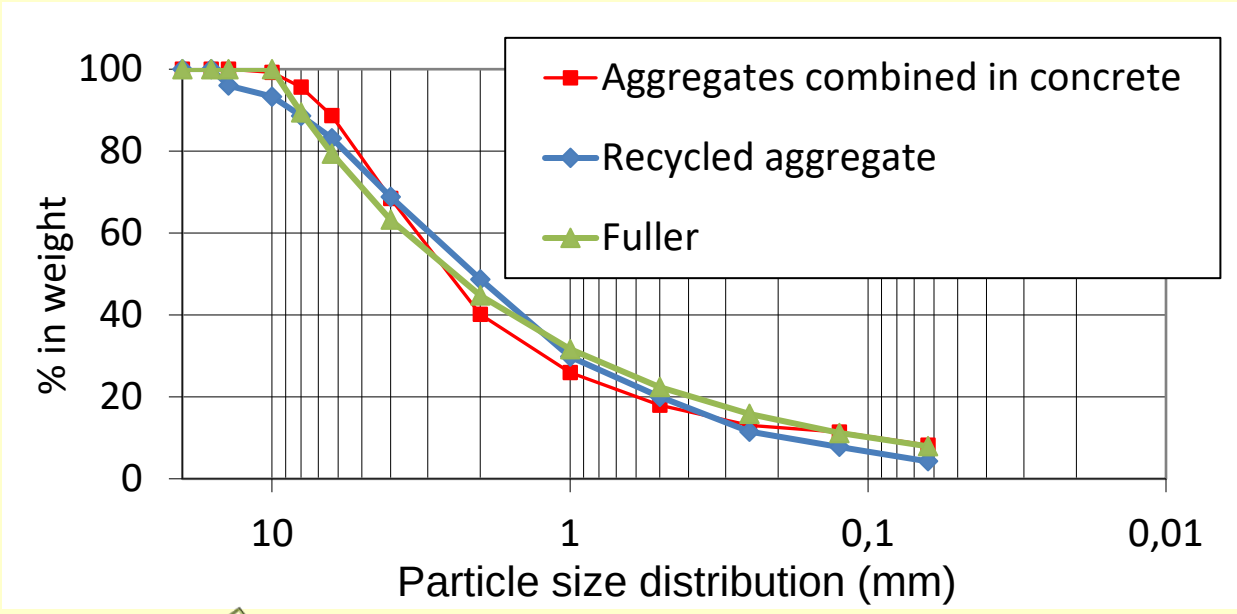
Materials

Recycled aggregate from precast plants (0-10 mm)

Sand (0-4 mm)

Fine gravel (2-6.3 mm)

Coarse gravel (4-10 mm)



	Kg/m³
WATER	69.2
SAND	748.8
FINE GRAVEL	481.2
COARSE GRAVEL	240
RECYCLED AGGREGATE	351.2
CEMENT I 52.5 R	165.6

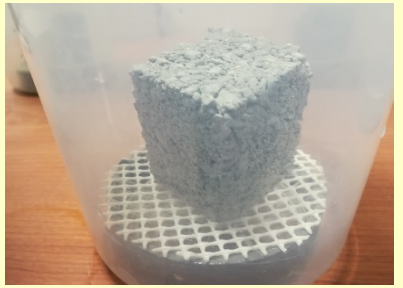
Experimental methods

1.- Compliance test UNE EN 12457-4: 2003:

Basic characterisation of release levels of pollutants

2.- Availability test (NEN 7371) and total content in C-20

Maximum levels of release and content on materials

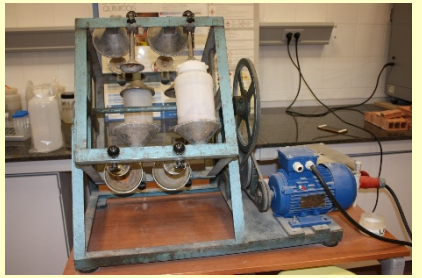


3.- Tank leaching test (NEN 7375) and one-step leaching test (CEN/TS 15862)

Release levels in monolithic state for C-20 specimens

Results 1.- Compliance test of the RA

Elements	Data from recycled aggregate	Council Decision 2003/33/CE		
	mg/kg	Inert	Non hazardous	Hazardous
Cr	0.0124	0.5	10	70
Ni	0.0017	0.4	10	40
Cu	0.0065	2	50	100
Zn	0.0393	4	50	200
As	0.0046	0.5	2	25
Se	n.d	0.1	0.5	7
Mo	0.0616	0.5	10	30
Cd	n.d	0.04	1	5
Sb	0.0611	0.06	0.7	5
Ba	0.0793	20	100	300
Hg	n.d	0.01	0.2	2
Pb	n.d	0.5	10	50
C (µS/cm)	377			
Tª (ºC)	20,6	Units → mg/kg		
pH	8,72	*Footnote: n.d. Non detected element*		

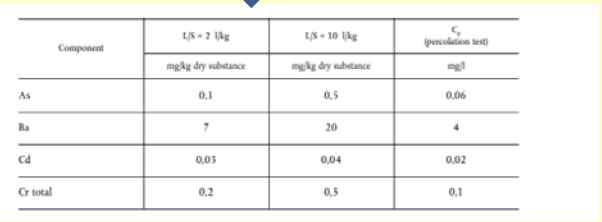


Council Decision 2003/33/CE

COUNCIL

COUNCIL DECISION
of 19 December 2002
establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC

Criteria and procedures for the acceptance of waste at landfill

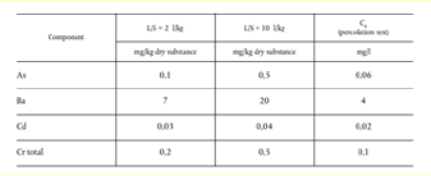


Component	L/S = 2 l/kg	L/S = 10 l/kg	C_0 (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	0,1	0,5	0,06
Ba	7	20	4
Cd	0,03	0,04	0,02
Cr total	0,2	0,5	0,1

Results 2.- One-step leaching test

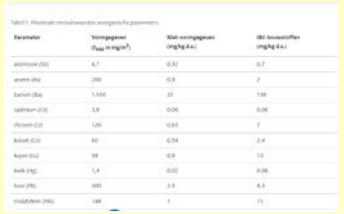
Elements	C-20	SQD	Inert
Cr	0.1032	7	0.5
Ni	0.0071	2.1	0.4
Cu	0.0200	10	2
Zn	0.0224	14	4
As	0.0004	2	0.5
Se	0.0076	3	0.1
Mo	0.0618	15	0.5
Cd	0.0000	0.06	0.04
Sb	0.0163	0.7	0.06
Ba	0.0599	100	20
Hg	0.0000	0.08	0.01
Pb	0.0007	8.3	0.5
C (µS/cm)	873		Units → mg/kg
Tª (ºC)	20.4		
pH	11,08		

Council Decision 2003/33/CE



Component	L/S = 2 l/kg	L/S = 10 l/kg	C_0 (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	0,1	0,5	0,06
Ba	7	20	4
Cd	0,03	0,04	0,02
Cr total	0,2	0,5	0,1

The Soil quality decree (SQD).
Use of mineral construction products (NL)

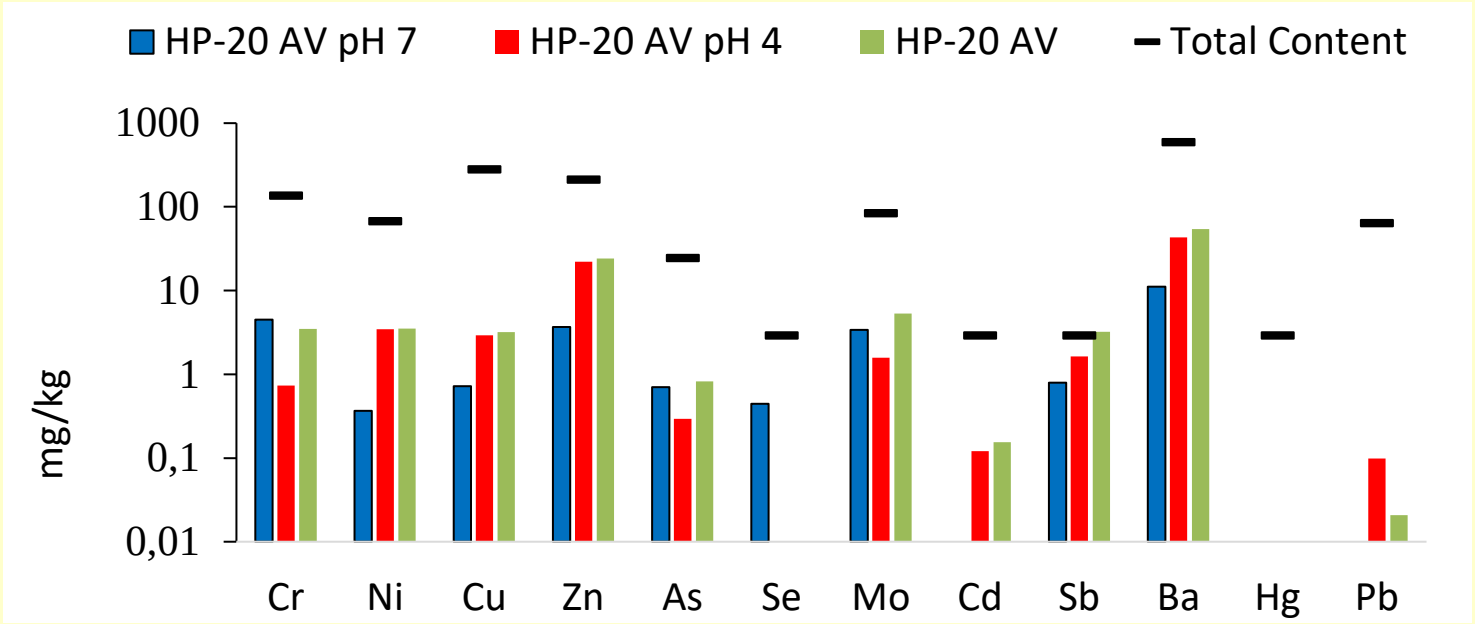


CLASSIFICATION ACCORDING TO POTENTIAL POLLUTION

Non hazardous

Inert

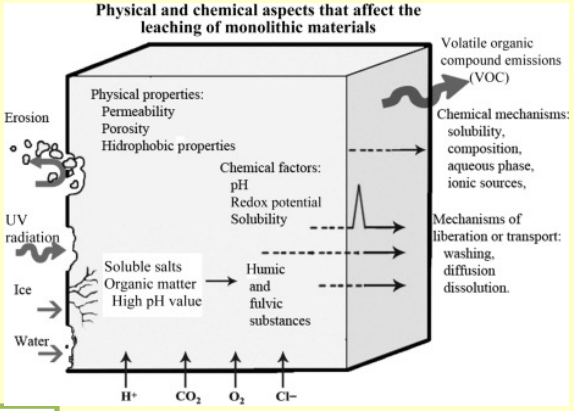
Results 2.- Availability test and total content



Results 3.- Leaching tank test

$$\varepsilon_{64} = \sqrt{64}\left\{\prod_{i=a}^{b}\frac{E_i^*}{\sqrt{t_i}-\sqrt{t_{i-1}}}\right\}^{\frac{1}{1+b-a}}$$

$$D_e = \left(\frac{\varepsilon_{64}}{2653\times\rho\times U_{avail}}\right)^2 \times f$$



Element	Derived cumulative leaching over 64 days	Diffusion coefficient	Mobility
	ε_{64}	D_e	pDe=-log De
	(mg/m²)	(m²/s)	
Cr	12.64	$8.17\cdot10^{-11}$	High
Cu	1.06	$6.87\cdot10^{-13}$	Average
Mo	5.96	$7.89\cdot10^{-12}$	Average
Ba	8.40	$1.50\cdot10^{-13}$	Low
Zn	1.98	$4.20\cdot10^{-14}$	Low

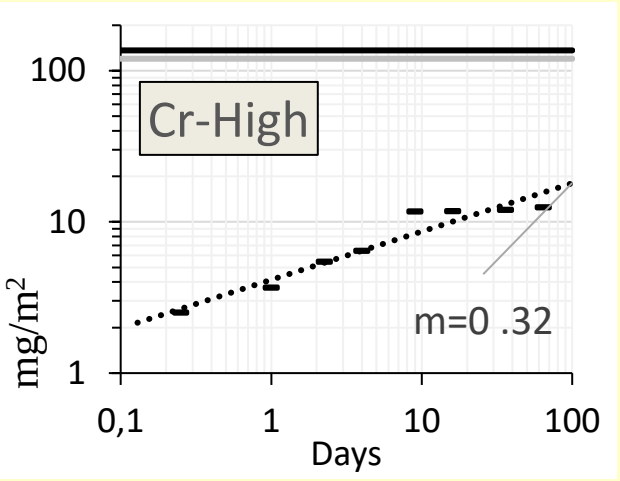
Mobility criteria:

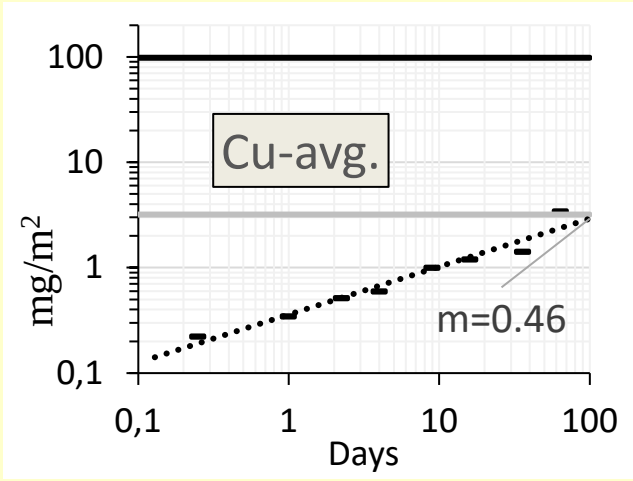
Low
$pD_e > 12.5$

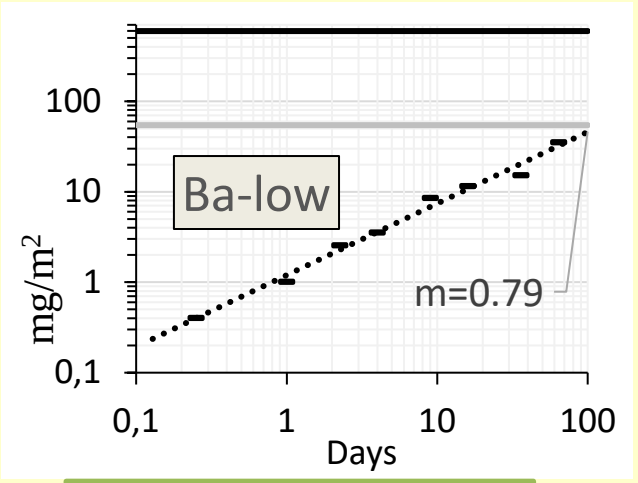
Average
$11 < pD_e < 12.5$

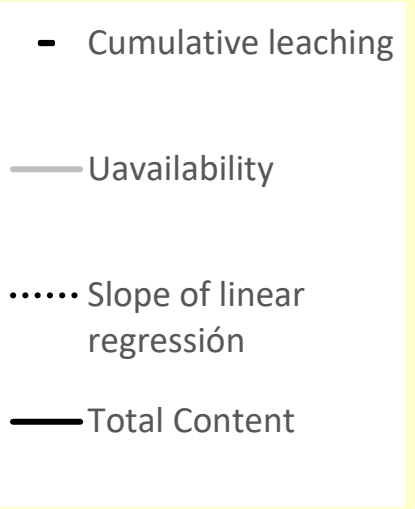
High
$pD_e < 11$

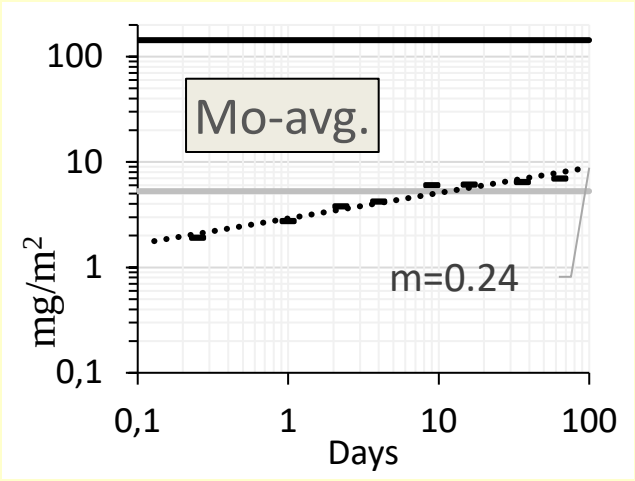
Results 3.- Leaching tank test

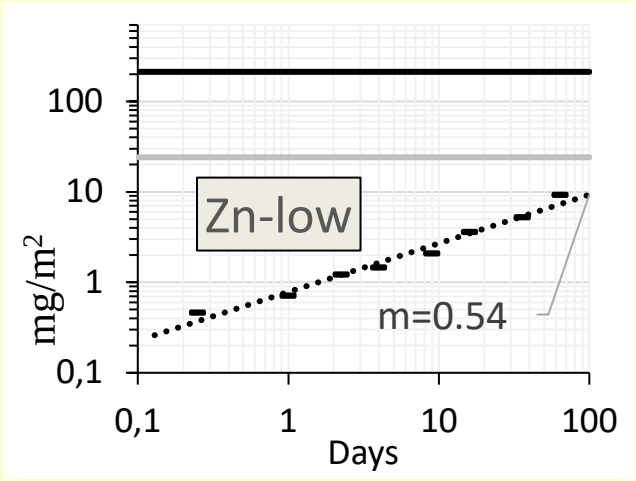












Mechanism criteria:

Surface dissolution
$m > 0.65$

diffusion
$0.35 < m < 0.65$

Initial wash-off
$m < 0.35$

Conclusions

- Release levels from monolithics samples were lower to the legal limits clasifying the tested materials as inert materials.
- From the study about the mobility Cr showed a high mobility consistent with previous studies on RA from CDW. Cu and Mo → average mobility and Ba and Zn →low mobility
- The identified mechanism were: Initial wash-off for Mo and Cr, diffusion for Cu and Zn and surface dissolution for Ba

The research deeps into the perfomance of leaching behaviour in recycled concrete produced in a similar way to a precast concrete plant observing (according to legal limits) low release levels of heavy metals, which allows to confirm the environmental safe/feasibility of RA from precast rejected pieces for a second life cycle.

Thank you very much for your attention

Antonio López-Uceda
p62louca@uco.es
University of Cordoba, Spain

Innolivar Project, - Public Purchase of Innovation in its modality of Pre-commercial Public Purchase, in agreement with the former inistry of Economy, Industry and Competitiveness (current Ministry of Science, Innovation) and the University of Córdoba, co-financed in 80% by ERDF funds, within the Pluriregional Operational Program of Spain 2014-2020.