Mechanical performance of Recycled Aggregate from CDW at long term varying gypsum content

6th International Conference on Sustainable Solid Waste

NAXOS2018

University of Córdoba
Spain

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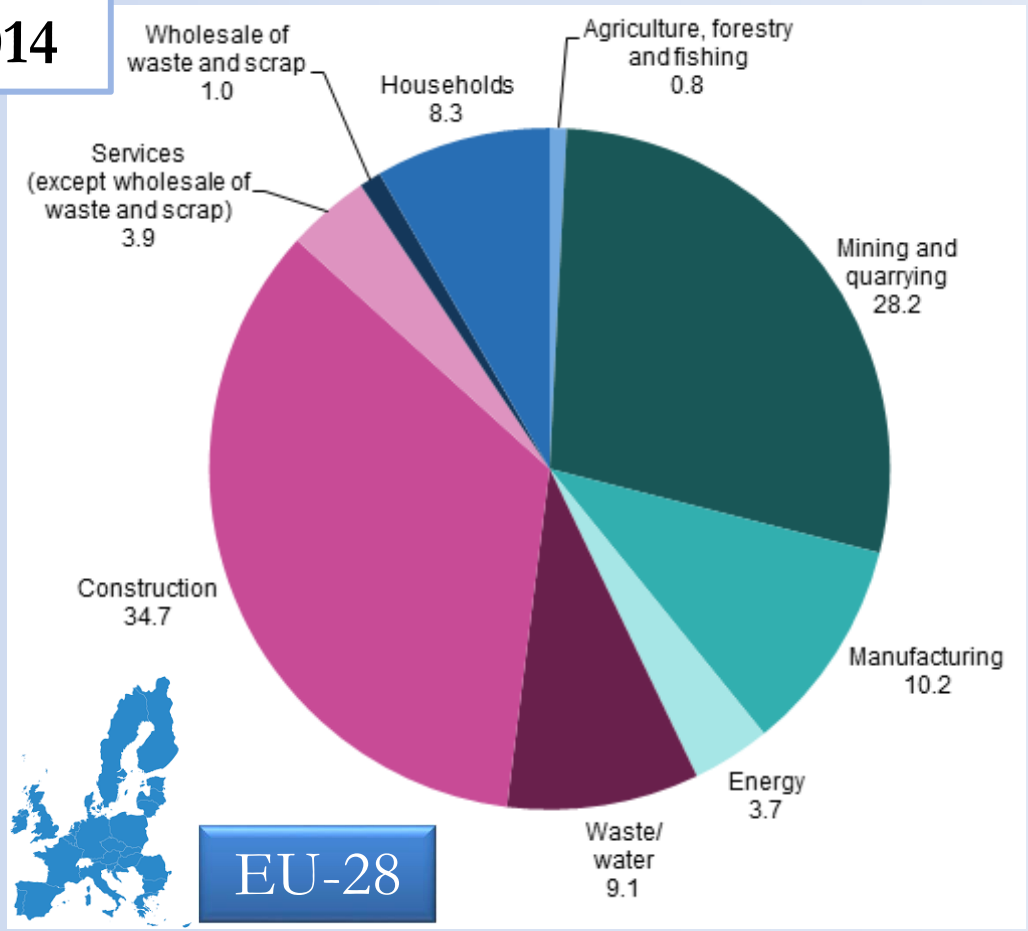
Waste generation by economic activities and households, 2014



Reference: http://ec.europa.eu/eurostat/statistics

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	Total		Mining and quarrying	Manufacturing	Energy	Construction and demolition	Other economic activities	Households
	(million tonnes)	(kg per inhabitant)			(%)			
EU-28	2 502.9	4 931	28.1	10.2	3.7	34.7	14.9	8.3
Belgium	65.6	5 838	0.1	21.7				
Bulgaria (1)	179.7	24 872	88.6	:				
Czech Republic	23.4	2 223	1.0	18.8				
Denmark	20.1	3 558	0.1	6.4				
Germany	387.5	4 785	1.9	15.8				
Estonia	21.8	16 587	36.3	20.2				
Ireland (1)	15.2	3 285	17.8	:				
Greece	69.8	6 404	67.9	7.0				
Spain	110.5	2 378	16.9	13.4	4.8	18.5	28.3	18.3
France	324.5	4 913	0.7	6.7	0.5	70.2	13.1	8.8
Croatia (1)	3.7	879	0.1	:	3.2	16.6	48.9	31.2
Italy	159.1	2 617	0.6	16.7	2.0	32.5	29.5	18.6
Cyprus (2)	2.1	2 406	:	:	:			
Latvia	2.6	1 315	0.2	9.4	27.8			
Lithuania	6.2	2 114	0.4	42.1	1.6			
Luxembourg	7.1	12 713	1.8	4.0	0.0			
Hungary	16.7	1 688	0.5	16.2	13.9			
Malta (1)	1.7	3 896	2.2	:	0.2			
Netherlands	133.2	7 901	0.1	10.1	1.3			
Austria	55.9	6 541	0.1	9.7	0.9			
Poland	179.0	4 710	42.3	17.6	12.2			
Portugal	14.6	1 402	1.9	17.9	1.2			
Romania (1)	175.6	8 820	87.0	:	4.0			
Slovenia	4.7	2 273	0.2	28.1	13.5	17.4	28.9	12.0
Slovakia (1)	8.9	1 636	3.2	:	6.1	15.6	55.4	19.6
Finland	96.0	17 572	65.4	10.7	1.5	17.0	3.7	1.7
Sweden	167.0	17 226	83.2	3.4	1.1	5.3	4.5	2.5
United Kingdom	251.0	3 885	10.5	3.2	1.3	48.0	26.0	11.0
Iceland (3)	4.5	1 651	0.0	17.6	0.3	2.1	36.1	44.0
Liechtenstein	0.6	14 919	1.7	2.0	0.1			
Norway (1)	11.7	2 283	2.8	:	1.3			
Montenegro	1.2	1 872	22.5	5.2	31.7			
Former Yugoslav Republic of Macedonia	2.2	1 058	3.4	67.9	23.3			
Serbia	49.1	6 890	84.5	1.8	9.1			
Turkey (4)	73.1	947	4.2	:	32.8			
Bosnia and Herzegovina	0.5	1 161	1.6	27.2	71.1			
Kosovo (UNSCR 1244)	1.0	574	19.3	7.0	0.0			

(1) Other economic activities includes also manufacturing.
(2) Other economic activities includes also mining, quarrying, manufacturing and energy.
(3) 2012.
(4) Other economic activities includes also manufacturing, construction and demolition.
Source: Eurostat (online data code: env_wasgen)

Waste generation by economic activities and households, 2014

EU-28

CDW Production

> 868 million tonnes

SPAIN

CDW Production

> 20 million tonnes

Reference: http://ec.europa.eu/eurostat/statistics

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Service Contract on Management of CDW (European Comission)

Directive on waste 2008/98/EC

Objective → 70% recycling rate of CDW by 2020

3.5.3. Is the 70% target achievable?

As 5 MS already achieve recycling rates of 70% or more, some of them very comfortably (with recycling rates over 80%), it would seem that this objective is feasible. However, countries with very low recycling rates (less than 40%) will certainly face a challenge in reaching this target, as it will be necessary to develop the appropriate infrastructure, as well as markets for the recycled products. For example, Spain, with a current reported recycling rate below 15% will need to put significant efforts into controlling the enforcement of existing regulation at the national level; however, some experts are optimistic as local case studies in Spain have shown that recycling rates over 90% are feasible.

http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf

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CDW

RA used

From crushing concrete and well graded size range of 32-0 mm

CDW treatment plant

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CDW composition

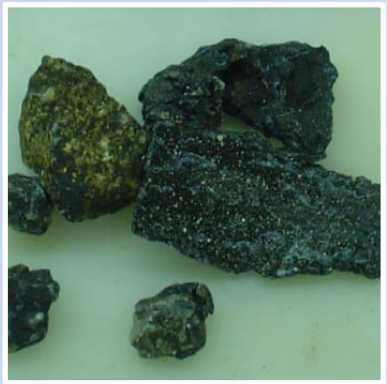
Ceramic Particles

Natural aggregates

Gypsum elements

Concrete and mortar

Asphalt



Wood, glass, paper,…

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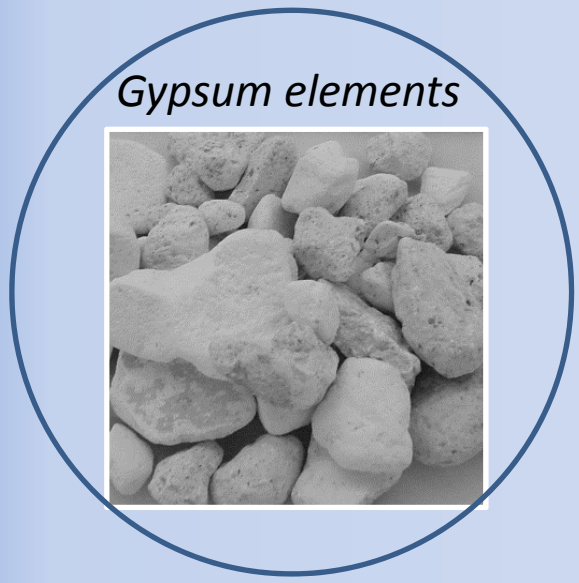

- The RA usually contains a higher sulphate content than natural aggregates.
- The solubility, hardness and density of gypsum has a negative effect on the quality of the aggregate.
- Barbudo et al. (2012) stablished good correlations between the percentage of gypsum in RA and sulphate content, and not with other parameters such as concrete and mortar and ceramic particles.

In Spain, restrictions in RA regarding to its use to form road base layers are severe. The maximum sulphur content is 1%, and the acid-soluble sulphate content is 0.8%.

The aim:

The aim of this research was to analyze the effect on mechanical properties at long term of gypsum content in RA. For this purpose,

- Different RA samples were prepared by adding different percentages of gypsum (0%, 2% and 4%) previously hydrated and crushed.
- California bearing ratio (CBR) was conducted on the samples prepared without cement addition, and compressive strength was conducted on the samples prepared with a 3% cement addition. Both tests were conducted at different ages, up to one year of curing.

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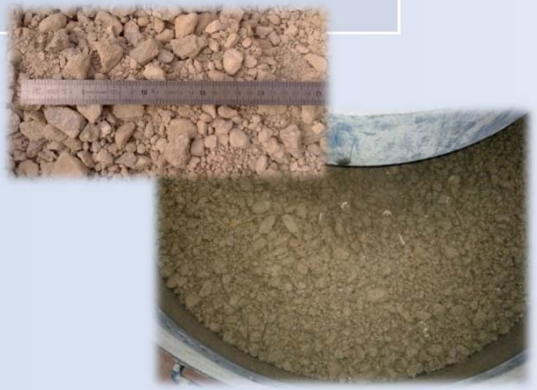
Materials and methods:

Samples	Cement (CEM II BL 32.5 N) addition	Gypsum addition	Methods
	(%)	(%)	
RA+0%	0	0	CBR (UNE 103502:1995)
RA+2%	0	2	
RA+4%	0	4	
CT-RA+0%	3	0	Compressive strength (UNE-EN 13286-41:2003)
CT-RA+2%	3	2	
CT-RA+4%	3	4	

RA→ Unbound Recycled Aggregate

CT-RA→ Cement treated Recycled aggregate



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RA

CT-RA

Barbudo et al. (2012)

4.4% max. of gypsum to comply with leached sulphates limitations

0%

2%

4%

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RA

CT-RA

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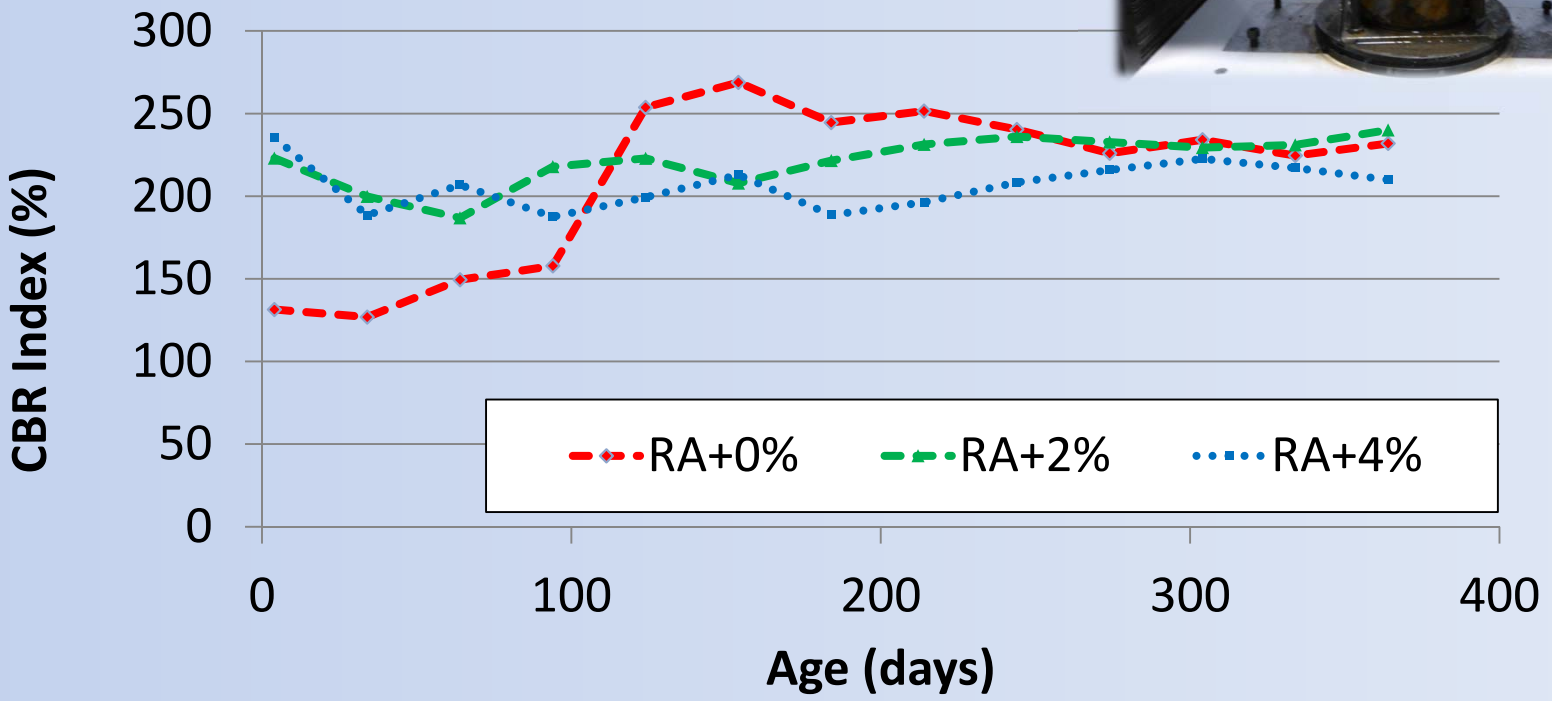
Results and discussion:

CBR (UNE 103502:1995)



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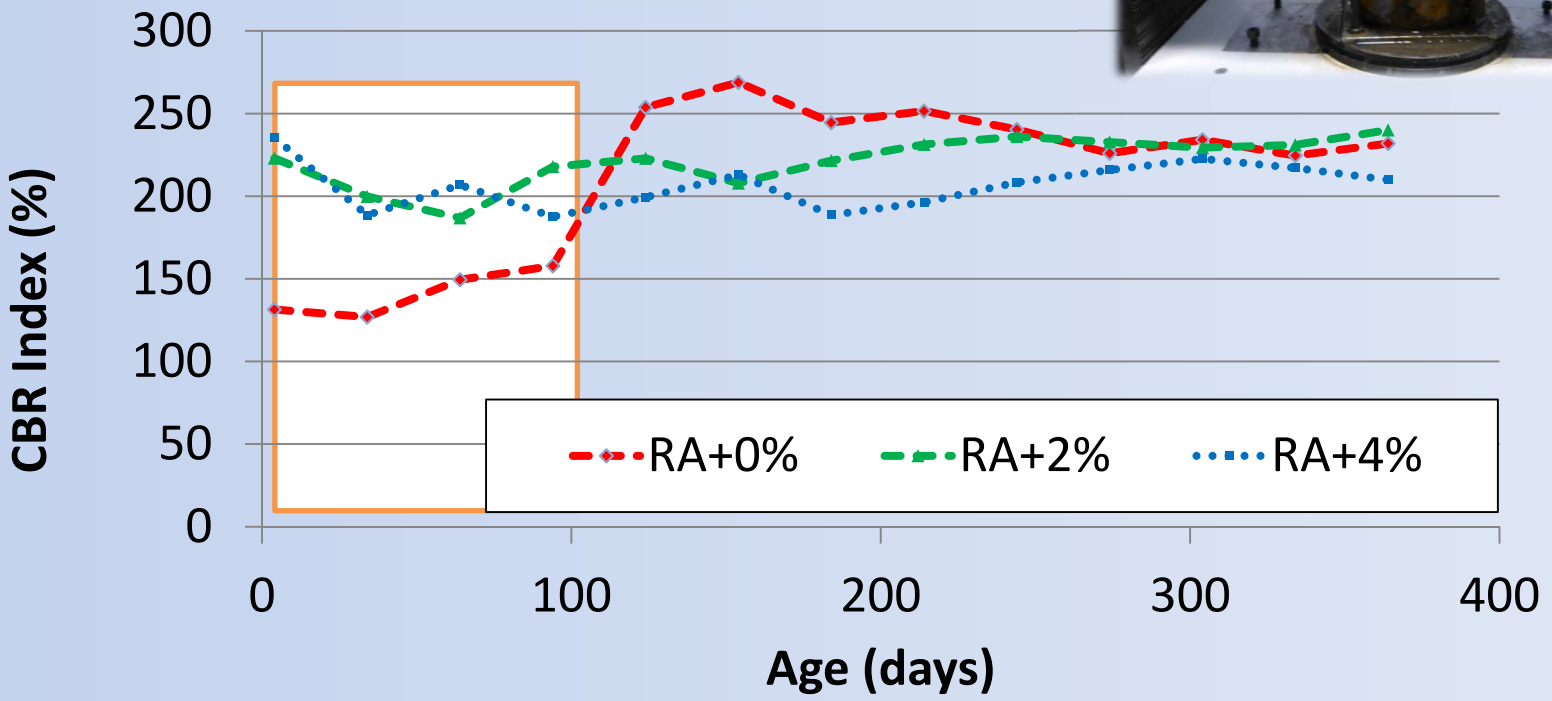

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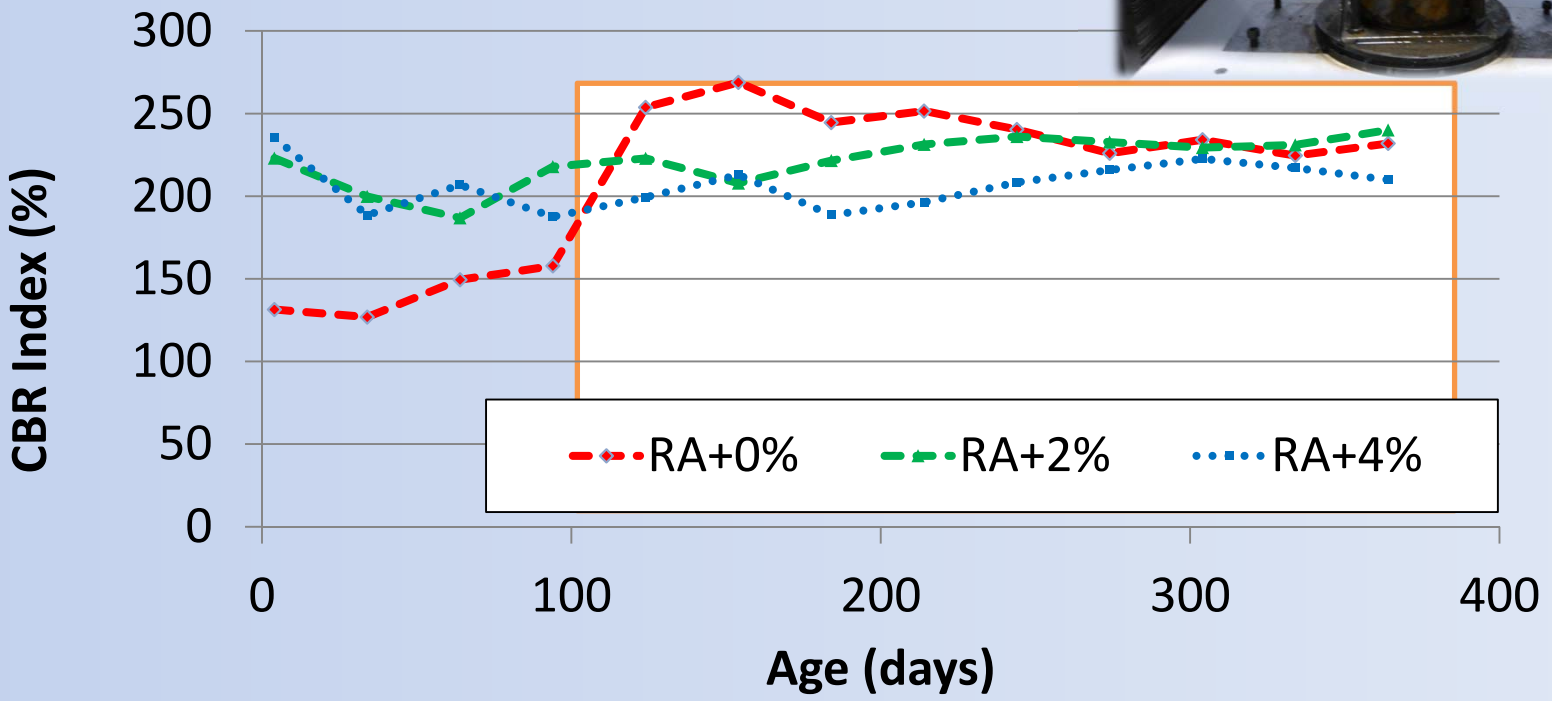

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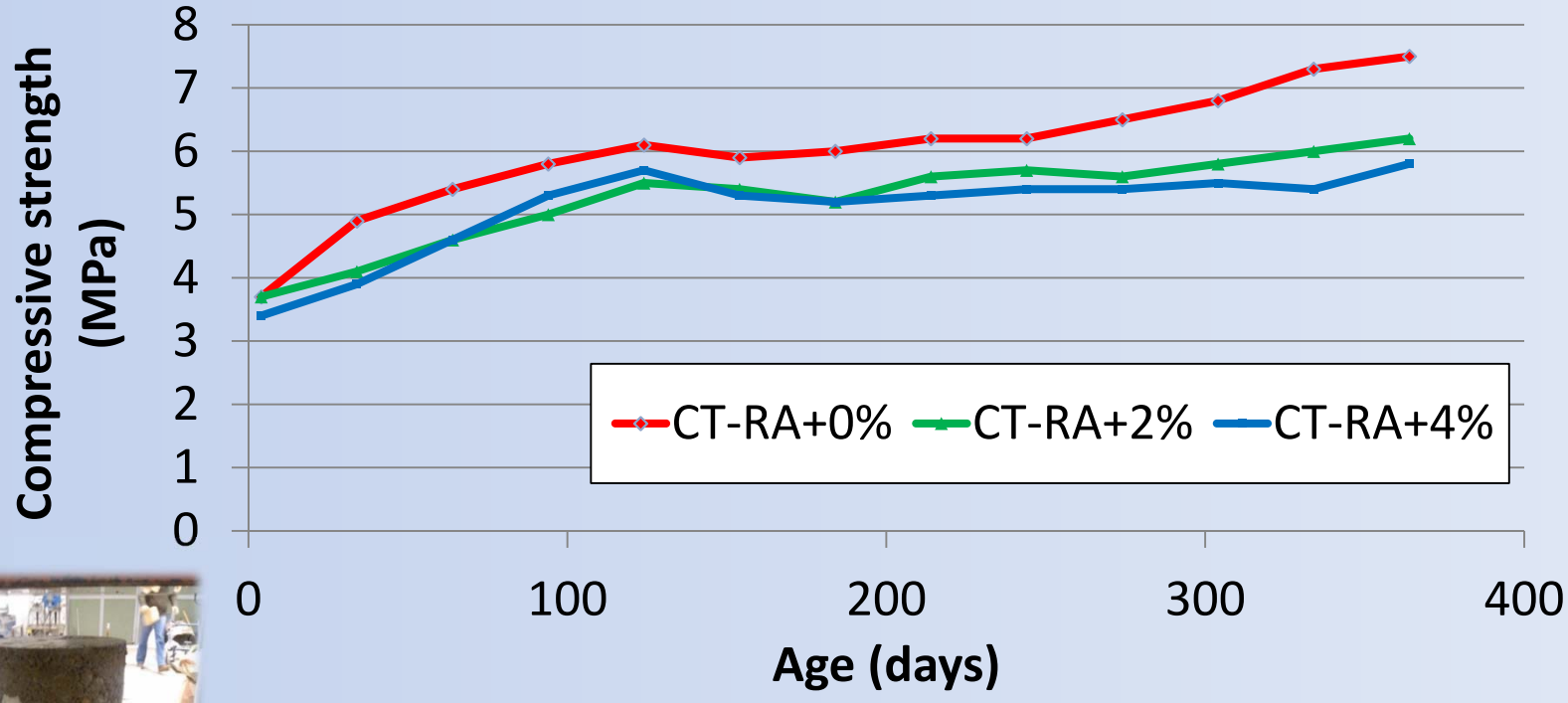

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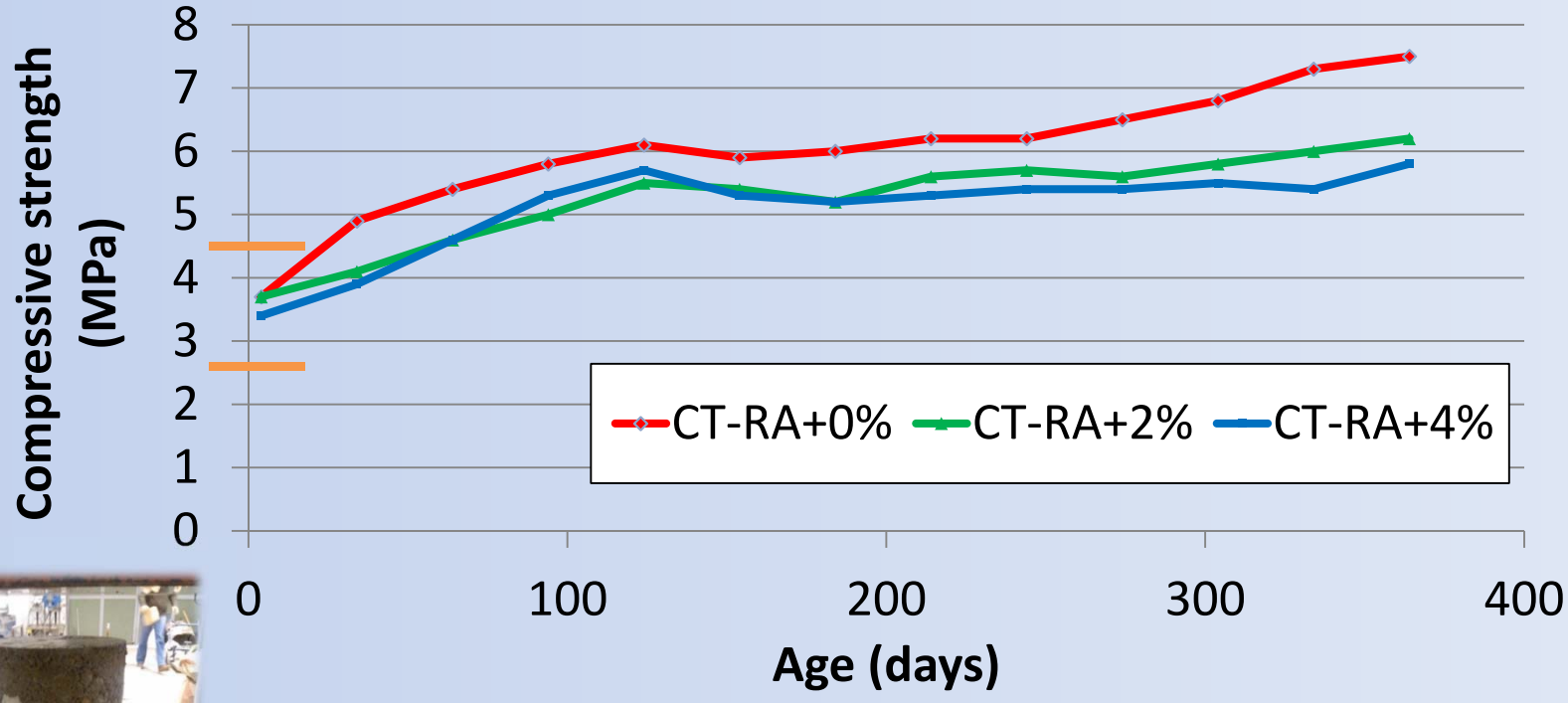
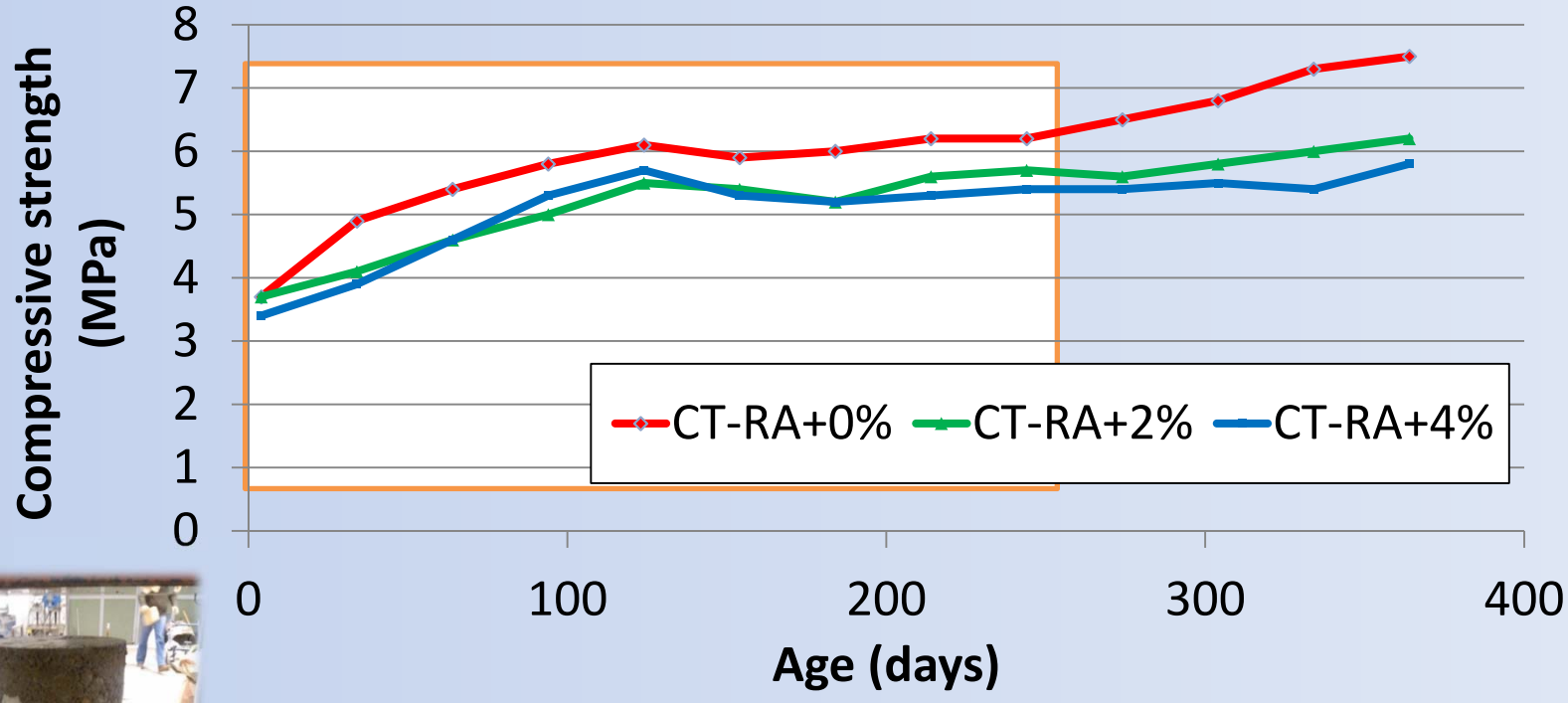


Mechanical performance of Recycled Aggregate from CDW at long term varying gypsum content

Results and discussion:

Compressive strength
(UNE-EN 13286-41:2003)



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Conclusion:

Regarding to the **CBR performance** with different gypsum content:

- Samples with gypsum addition had a good performance at early ages, and at long term, no difference was found respect to sample without gypsum addition.

In relation to the **compressive strength performance** with 3% cement addition and different gypsum content:

- The gypsum presence present a slightly decrease the compressive strength values respect to that without gypsum addition, but not significantly.

This research supports that sulphate content limits could be restudied → to widen the use of RA to form base layers in roads.

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Thank you for your attention

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Acknowledgements

The authors would like to thank the European Regional Development´s Fund (ERDF) of the European Union for financial support via the project "Applications of recycled aggregates from CDW for the sustainable development of road infrastructure in central areas of Andalusia".