

# Use of recycled aggregates from Construction and demolition waste (CDW)

Definition – Generation – Composition  
Managing – Recycling - Policies and Standards

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## Introduction

The European Union (EU) has among its objectives **to protect, preserve and improve the environment for present and future generations** and is moving towards a **recycling society**

Concept such as **Sustainable Development** offers a vision of progress that integrates immediate and longer-term objectives, local and global action, and regards social, economic and environmental issues as inseparable and interdependent components of human progress

In the past 30 years the EU has adopted a substantial and diverse range of **environmental measures (Policies – laws - plans and a framework of legislation)** aimed at improving the quality of the environment for European citizens and providing them with a high quality of life.



### Contact

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# Introduction

As **engineers** must be present concepts such as

**Sustainable development**  
Urban environment

**Water** – Marine pollution / Drinking water

**Soil** – Erosion / Soil contamination

**Waste** – Recycling / Hazardous waste

**Nature and biodiversity**  
Nature conservation / Biological diversity

**Eco-innovation**  
Eco-friendly technology

**Air** – Air quality / Kyoto protocol

**Chemicals** – Dangerous substances / Plant protection products

As European society has grown wealthier it has created **more and more waste**.

Each year in the European Union alone we throw away 3 billion tonnes of waste - some 90 million tonnes of it hazardous. This amounts to about 6 tonnes of solid waste for every man, woman and child, according to [Eurostat statistics](#).

It is clear that treating and disposing of all this material - without harming the environment - becomes a major headache.

The EU is aiming for a significant cut in the amount of rubbish generated, through new waste prevention initiatives, better use of resources, and encouraging a shift to more sustainable consumption patterns.

## Framework Directive 2008/98/CE

The revision of the **Waste Framework Directive (1)** brings a modernised approach to waste management, marking a shift away from thinking about waste as an unwanted burden to seeing it as a valued resource.

**The Directive** focuses on **waste prevention** and puts in place new targets which will help the EU move towards its goal of becoming a **recycling society**. It includes targets for EU Member States to recycle 50% of their municipal waste and **70% of construction and demolition waste by 2020**.

**Brochure:** <http://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf>

## Waste Framework Directive 2008/98/CE

The Directive introduces a **five-step** waste hierarchy where **prevention** is the best option, followed by **re-use**, **recycling** and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy.

### Moving up the waste hierarchy



**Brochure:** <http://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf>



## Definition CDW

**Construction and demolition waste (CDW)** is one of the heaviest and most voluminous waste streams generated in the EU. It accounts for approximately **25% - 30% of all waste** generated in the EU and consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil, many of which can be recycled.

**CDW** is the “umbrella” term for a very wide range of materials which are generated by all construction activities

(i) Waste arising from the construction of buildings, civil infrastructure and/or roads



Surplus material (excess supplies), damage or broken material, cut-off pieces, ...

## Definition CDW

**CDW** is the “umbrella” term for very wide range of materials which are generated by all construction activities

(II) Waste arising from the maintenance of buildings, civil infrastructure and/or roads

(III) Waste arising from the total or partial demolition of buildings, civil infrastructure and/or roads



(IV) Soil and rocks arising from land levelling, civil works and/or general foundations

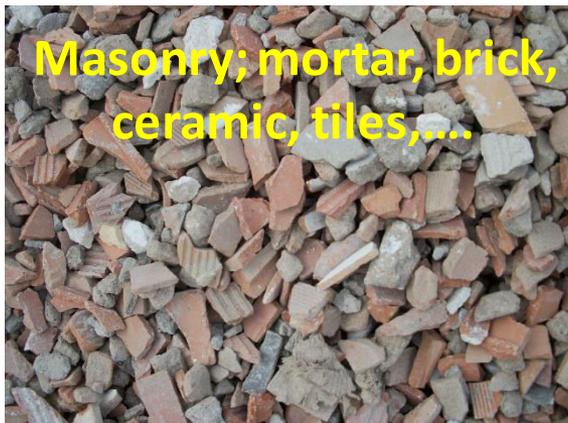


## Composition of CDW

The composition of CDW varies significantly between countries:



Wood, metal,  
gypsum,  
plastics,  
miscellaneous...



Composition is the most common parameter for the  
**classification of CDW**

# Composition of CDW

## Material composition of CDW for some European countries

Country	Netherlands	Flanders	Denmark	Estonia	Finland	Czech Republic	Ireland	Spain	Germany
Year	2001	2000	2003	2006	2006	2006	1996	2005	2007
Concrete	40%	41%	32%	17%	33%	33%	80%	12%	70%
Masonry	25%	43%	8%			35%		54%	
Other mineral waste	2%	-	0%	0%	-	-	0%	9%	-
<b>Total mineral waste</b>	<b>67%</b>	<b>84%</b>	<b>40%</b>	<b>17%</b>	<b>33%</b>	<b>68%</b>	<b>80%</b>	<b>75%</b>	<b>70%</b>
Asphalt	26%	12%	24%	9%	-	-	4%	5%	27%
Wood	2%	2%	-	-	41%	-	-	4%	-
Metal	1%	0,20%	-	40%	14%	-	4%	3%	-
Gypsum	-	0,30%	-	-	-	-	-	0,2%	0,4%
Plastics	-	0,10%	-	-	-	-	-	2%	-
Miscellaneous	7%	2%	36%	34%	12%	32%	12%	12%	3%

**Source:** European Commission (DG ENV). Final Report Task-2. Management of CDW. France. 2011. Available from: [http://ec.europa.eu/environment/waste/pdf/2011\\_CDW\\_Report.pdf](http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf)

## Composition of CDW

if not separated at source, it can contain small amounts of **hazardous wastes**, the mixture of which can pose particular risks to the environment and can hamper recycling

- Asbestos-based construction materials
- Lead Based Paints (LBP)
- Phenols
- Polychlorinated Biphenyls (PCB)
- Polycyclic Aromatic Hydrocarbons (PAH)



## Composition of CDW

CDW are all wastes mentioned in Chapter 17 of the European Waste Catalogue (EWC)

EWC code	
17 01 00	Predominantly inert concrete, bricks, tiles and ceramic materials
	17 01 01 Concrete 17 01 02 Bricks 17 01 03 Tiles 17 01 04 Mixture of concrete, bricks, tiles
17 02 00	Wood, glass, plastics materials
	17 02 01 Wood 17 02 02 Glass 17 02 03 Plastics
17 03 00	Asphalt, tar and tarred products
17 04 00	Metals (including their alloys)
17 05 00	Soil and dredged spoil
17 06 00	Insulation materials
17 07 00	Mixed construction and demolition waste

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## Generation of CDW in EU-27

Several recent sources provide estimates of CDW waste arising in Europe

Source	Total C&D waste arising (million tonnes)	C&D waste per capita <sup>3</sup>
[WBCSD 2009] (2002 data)	510	1.1
[ETC/RWM 2009](2004 data)	866	1.8
[EUROSTAT 2010] (2006 data)	970	2.0

WBCSD: World Business Council for Sustainable Development

ETC/RWM: European Topic Centre on Resource and Waste Management

EUROSTAT Statistics

### **The CDW arising per capita show important differences between Member States (MS):**

- Six countries (Denmark, Finland, France, Germany, Ireland and Luxembourg) report high quantities of CDW generation (over 2 tonnes per year per capita)
- Seven countries (Bulgaria, Greece, Hungary, Latvia, Lithuania, Poland and Slovakia) report very low levels of CDW generation (below 500 kg per year per capita)

## Generation of CDW in EU-27

### Why are there these differences between Member States ?

- **Economic reasons** (rate of new constructions)
- **Architectural and Engineer habits** (the type of materials used; e.g. in some regions bricks is the main constructions material, whereas in others concrete represents the majority; wood is a major construction material in northern countries like Finland or Sweden)
- **Cultural issues** (e.g. demolition is sometimes seen as a failure in countries such as France, whereas it is regarded in a more positive way in other countries)
- **Technical issues** (the quality of the materials used in old construction influences the rate of demolition, e.g. more demolition is expected in new Member States because of the low quality of the concrete used in old construction).
- **Inclusion of excavated materials:** Countries with high generation per capita included high amount of excavated material (soil and stones).

## Generation of CDW in Europe

### Exclusion of excavated materials

- Natural soil and stones, generated during construction activities (mostly in public works activities) are not to be included in the calculation of the generation and recycling rates
- **Excavated material is not included** in the definition of CDW for the purpose of the **70% target set by the Waste Framework Directive**

### New estimations of total CDW arising in EU-27

Excluding excavated materials, an estimate of **0.94 tonnes per capita of CDW** is made. This amounted to a total of approximately **461 million tonnes** in 2005, and the following ranges can be estimated:

	Low estimate	High estimate
Generation of C&D waste per capita (tonnes, Table 2)	0.63	1.42
Generation of CD&E waste per capita (tonnes, Table 2)	2.74	5.9
Total generation of C&D waste (million tonnes) – 2005	309	697
Total generation of CD&E waste (million tonnes) - 2005	1,346	2,898

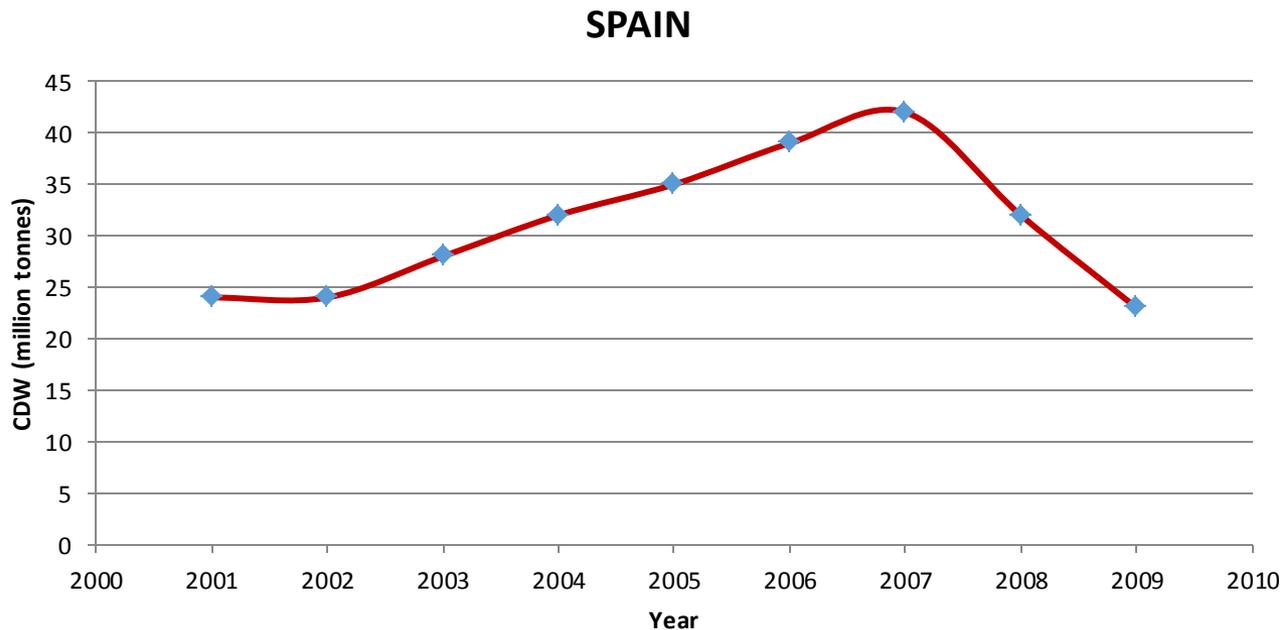
**SPAIN: 0.74 tonnes per capita.**

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## Generation of CDW in SPAIN

The rise of the construction industry in Spain over the past decade has substantially increased the production of CDW. Nevertheless, the fall of the construction sector in Spain, over 50% in the last two years because of the economic crisis has produced a considerable reduction in the production of CDW



Source: Spanish Ministry of Environmental

## Problems of CDW disposal

-In countries and regions in which CDW reuse or recycling is not practised, this waste is usually **deposited in landfills** with the environmental problems associated: degradation of the area and the destruction of the natural topography and vegetation, landfills can be full of hazardous or toxic substances, landfills can also attract undesirable animals and insects that can cause serious health problems to the surrounding population.

- CDW is an enormous quantity of Municipal Waste that has to be managed in some way or other



# Problems of CDW disposal

## Problem associated with the disposal of CDW

-The major environmental impact of landfilling comes from the use of space for storage of inert CDW. This is particularly relevant in countries where land is scarce and disposal costs are expensive.



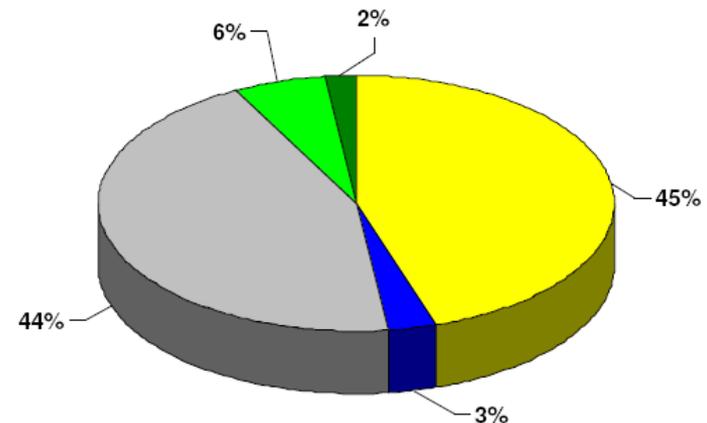
## Problem associated with the disposal of CDW

-Disposing of CDW and at the same time producing new materials and components for the construction industry contributes to the depletion of natural resources and increases environmental damage by generating noise, air pollutions, higher energy consumption, CO2 emissions and other negative impacts



*Each ton of recycled aggregates saves approximately one ton of natural resources*

Production of aggregates in Europe: 3.000 Mt  
7 tons of aggregates per inhabitant



Reference: UEPG annual report 2005

# Managing of CDW

## 1º.- Selective demolition & On Site Sorting

To increase the recycling rate of CDW, **the foreign material** such as wood, paper, cardboard, plastic and metal, **must be segregated**. Many of these materials are lightweight and degrade with time, compared to brick and concrete and hence are highly visible even at low levels.

### How should segregation be carried out?

Segregation can be carried out at source – **during demolition or construction activities** - or can be achieved by processing the mixed material to remove the foreign materials.

**Segregation at source is most efficient in terms of energy utilisation, economics and time.**



DECONSTRUCTION

# Managing of CDW

## 1<sup>o</sup>.- Selective demolition & On Site Sorting

For demolition sites, it is important to strip out the 'soft' materials - wood, glass, and cabling, plastic, plasterboard and so on - before demolition in order to produce recycled aggregate of good quality.



## Managing of CDW

### 2<sup>o</sup>.- Processing of CDW in Plant: Phases

**The aim of the Plants** is to transform CDW in recycled aggregates with defined particle size distribution and quality.

Processing in mobile plants  $\longrightarrow$

Processing in stationary plants  $\downarrow$



# Managing of CDW

## 2<sup>o</sup>.- Processing of CDW in Plant: Phases

### Crushing



- Reduction of particle size



### Sieving



- Generation of fractions with defined upper and lower particle size: 0/10; 10/40; > 40 mm



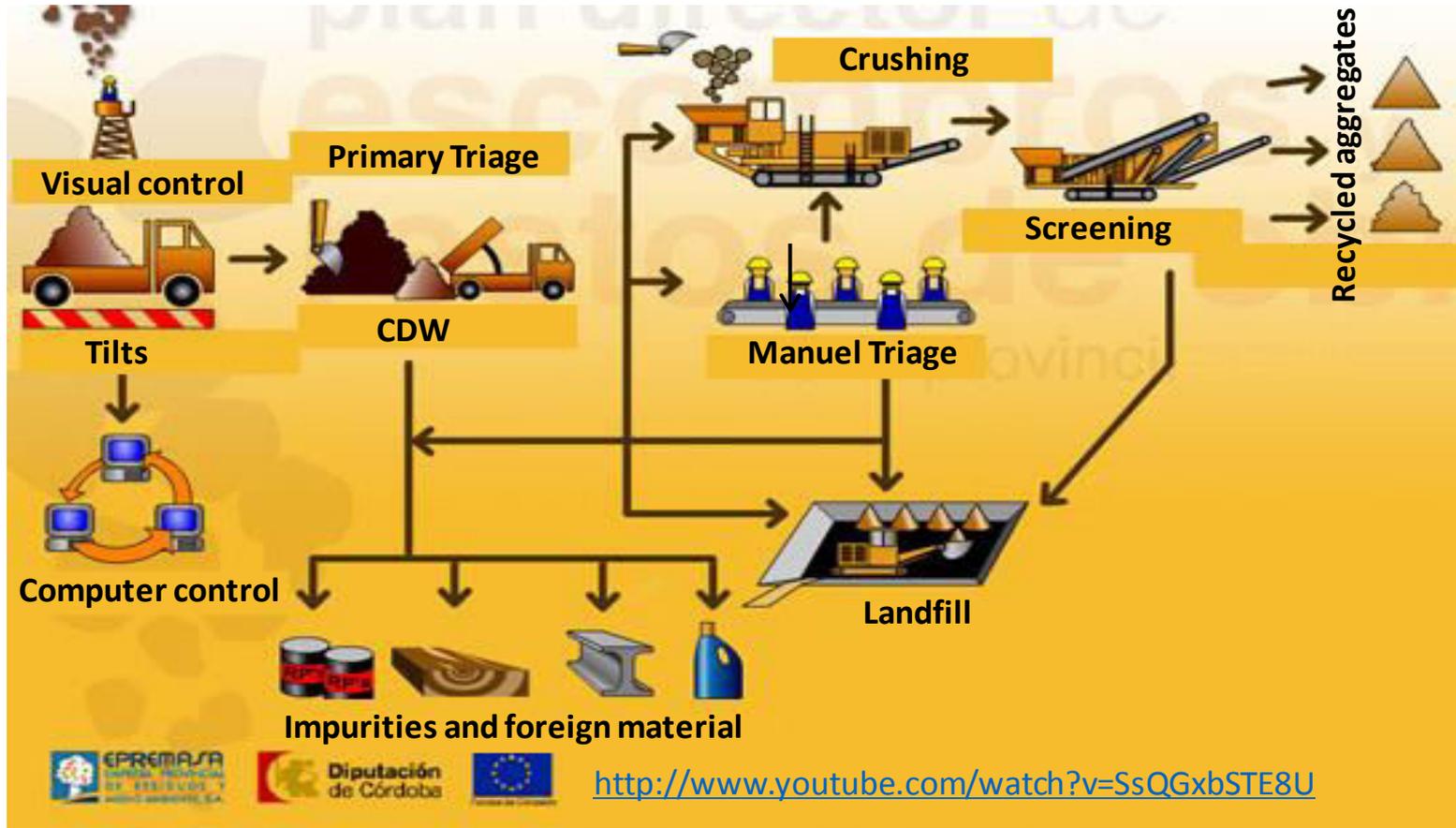
### Sorting



- Removal of hazardous substances
- Separation of impurities

## Managing of CDW

Stationary recycling plant: PUBLIC COMPANY EPREMASA located in Cordoba (Spain)



# Recycling of CDW in the EU

## Recovery and recycling of CDW in the EU

There is a high potential for recycling and re-use of CDW, since some of its components have a high resource value. In particular, there is a re-use market for aggregates derived from CDW waste in roads, drainage and other construction projects.

However, the level of recycling and re-use of CDW waste varies greatly (between less than 10% and over 90%) across the Union:



Although, It is very difficult to calculate recycling rates for CWD in the Member States.

[http://ec.europa.eu/environment/waste/construction\\_demolition.htm](http://ec.europa.eu/environment/waste/construction_demolition.htm)

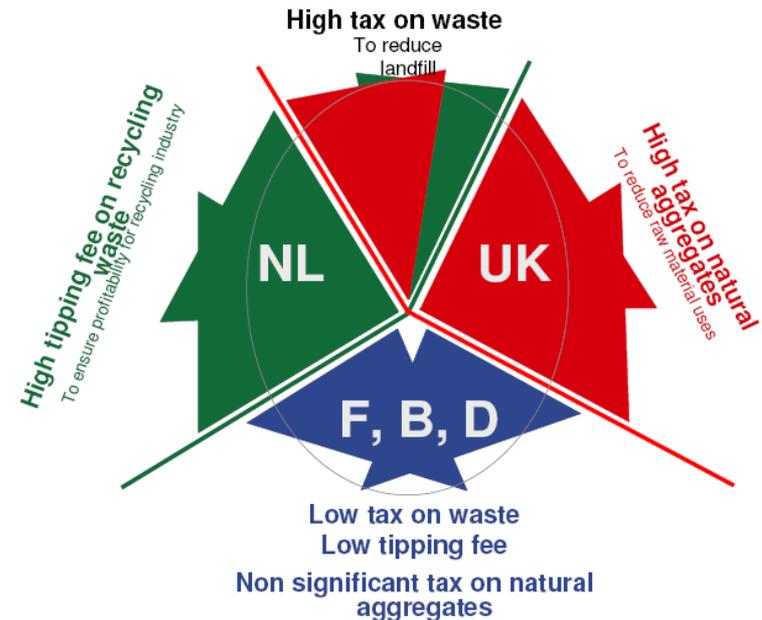
# Recycling of CDW in the EU

## Recovery and recycling of CDW in the EU

According with the recent data (European Commission – DG ENV), countries such as the **Netherlands (98%)**, Denmark (94%), Estonia (92%), Germany (86%), Ireland (80%) and UK (75%), have the highest recycling rates in the EU, while, countries like Cyprus (1%), Greece (5%), Portugal (5%) and **Spain (15%)** has the lower recycling rates.

Sources: UBA 2009 & ETC/RWM 2009

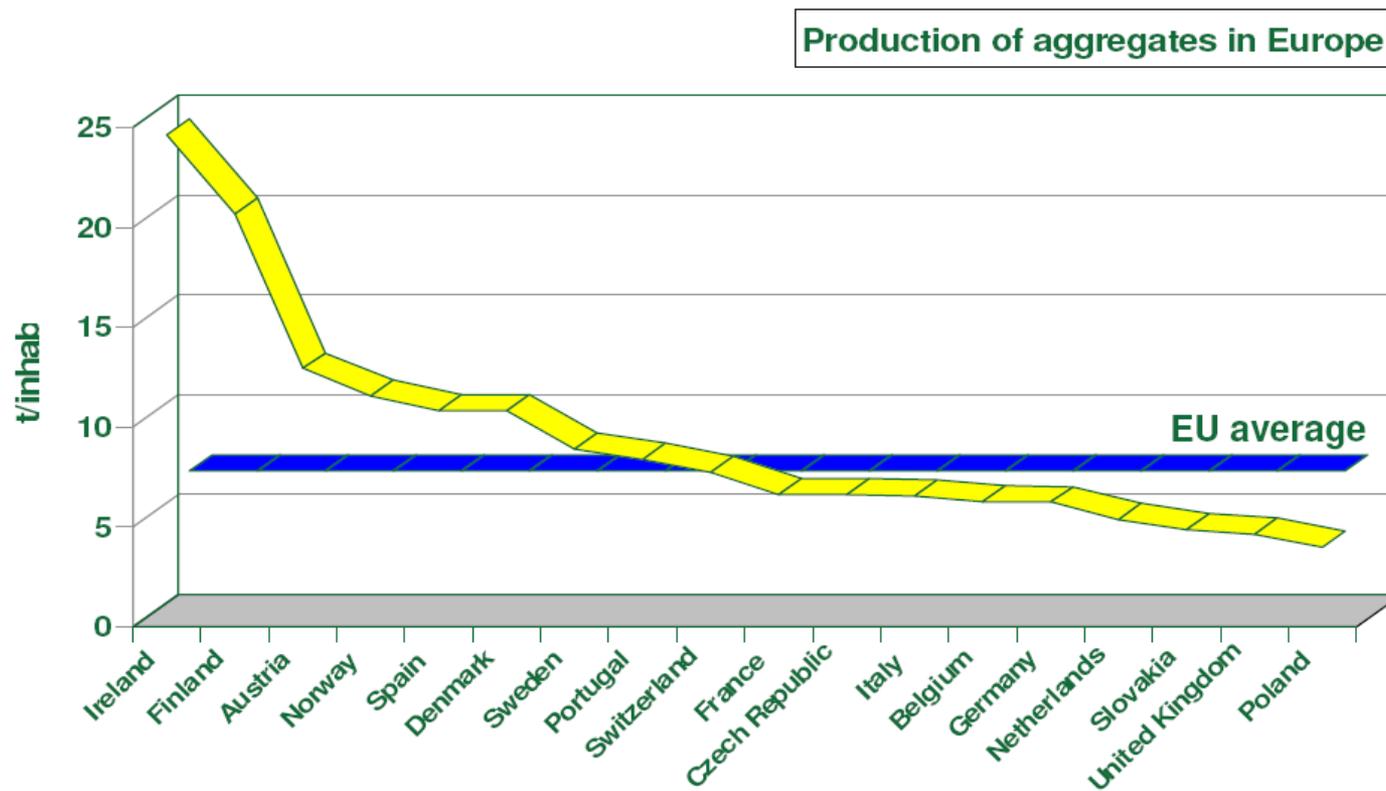
National Policies and Standards influence in the recycling rate



# Recycling of CDW in the EU

## Environmental benefits of recycling

Using recycled aggregates conserves natural resources

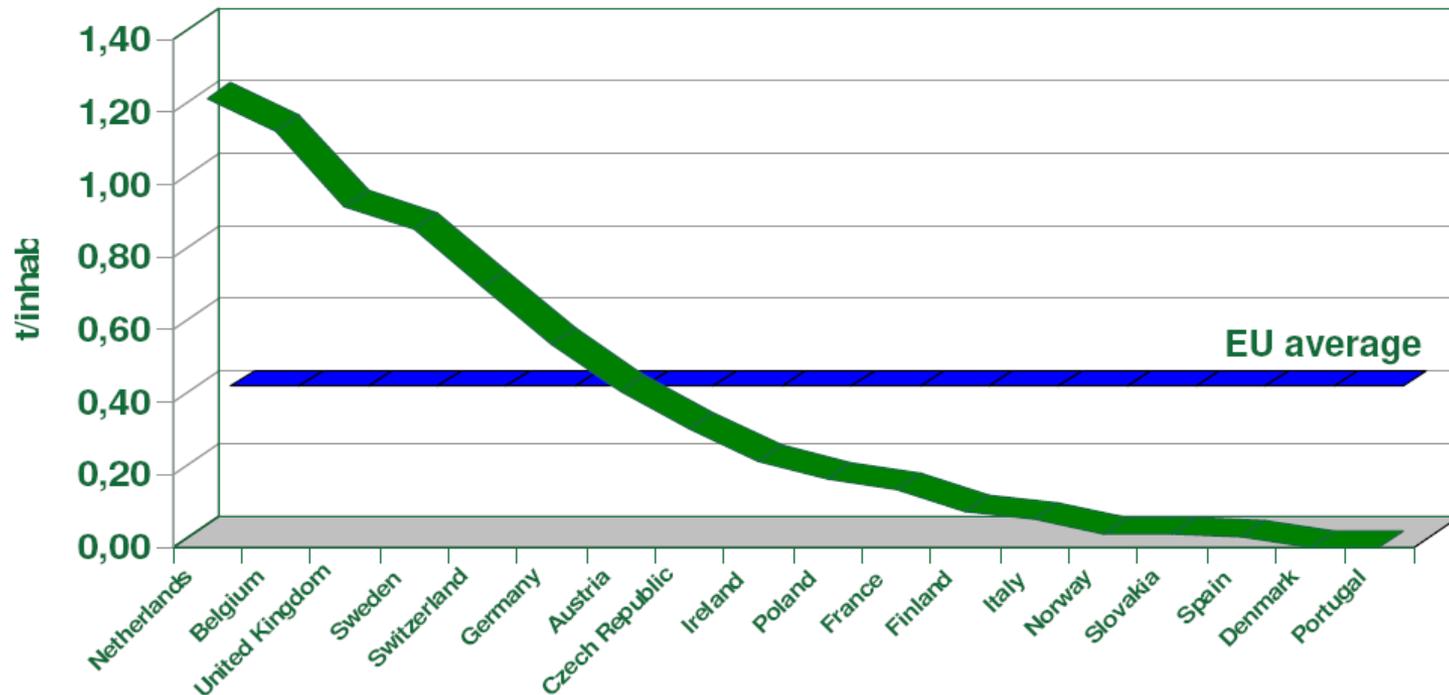


# Recycling of CDW in the EU

## Environmental benefits of recycling

Using recycled aggregates conserves natural resources

Production of recycled aggregates in Europe



# Recycling of CDW in SPAIN

## WHY SPAIN HAS A LOW RECYCLING RATE OF CDW?

- The low cost of dumping CDW in landfills
- The high transportation and processing cost of the waste
- The low value of recycled aggregates
- High raw materials resources
- Heterogeneous nature of the RA.
- Lack of **specific technical standards** that allow use of recycled aggregate



*From a purely economic point of view:*

***The recycling of CDW is only attractive when the recycled product is competitive with the natural resources in relation to cost and quality***

# Recycling of CDW in SPAIN

## POLICES AND STANDARDS IN SPAIN

To increase the recycling rate, the Spanish Government recently have approved the next polices and standards:

1.- **Law 22/2011 of 28 July, waste** and contaminated soils.



In accordance with the **Waste Framework Directive 2008/98/CE**

### Objectives

- 100% of all hazardous materials contained in CDW should be properly environmentally managed by 2010
- Recycling rate of 25% for 2012
- Recycling rate of 35% for 2015

2.- **National Integrate Plan for Waste 2008-2015** (PNIR).  
Spain's Ministry of Environment (MoE)

# Recycling of CDW in SPAIN

## POLICES AND STANDARDS IN SPAIN

3.- **Royal Decree 105/2008**, regulating the production and management of CDW, establishes the responsibilities of the waste producers, holders, and managers, without setting any quantitative targets.

However, this Decree requires that CDW plans have to be established for every construction project; in addition information on hazardous wastes has to be included in demolition projects. A deposit will have to be paid to the authorities, which be returned when proof of lawful disposal/recycling of CDW is provided.



# Recycling of CDW in SPAIN

## POLICES AND STANDARDS IN SPAIN

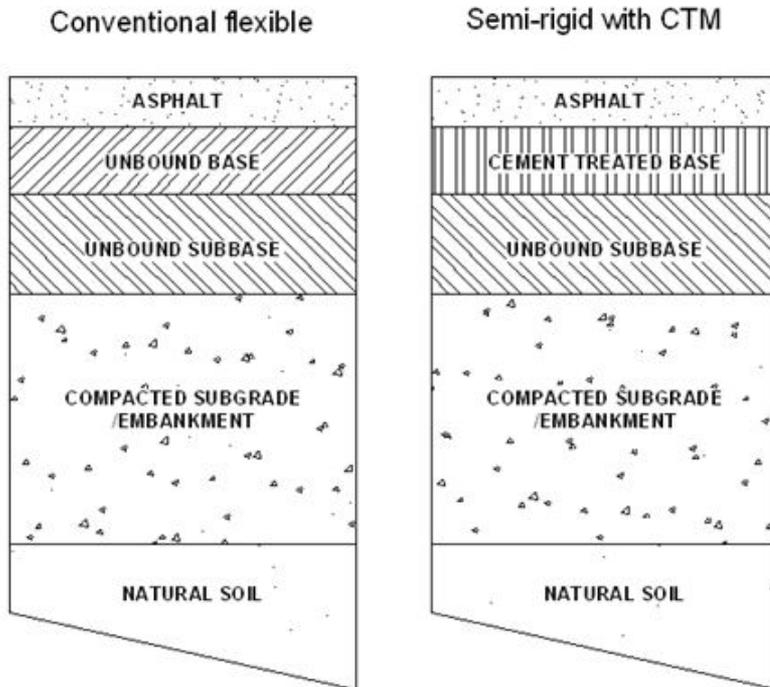
4.- **Spanish Structural Concrete Code EHE-08**, allows up to 20% of coarse natural aggregate to be replaced by recycled concrete aggregate in structural concrete. It's necessary characterize the RCA with the following battery of test: particle size distribution, sand equivalent, fines content, flakiness index, particle density, water absorption, Los Angeles coefficient, and the chemical analysis of chlorides, water-soluble sulphates, total sulphur compounds and organic matter.



**But the limits set by the Standards were proposed by natural aggregates and they are not adapted to the reality of RA from CDW generated in Spain**

# Recycling of CDW in SPAIN

-The Spanish General Technical Specification for Road Constructions (**PG-3**), **allows the use of recycled aggregates as materials for road structural layers:**



RA as granular materials for roadbed or embankment (Art 330)

RA as granular materials for unbound road bases or sub-bases (Art 510)

RA as cement treated materials (Art 513)

The problem is that the limits of this Technical Specification are designed for natural aggregates and not for recycled aggregates

In Spain there is no specific regulations on the use of recycled aggregates as material for road construction

# Recycling of CDW in SPAIN

## POLICES AND STANDARDS IN SPAIN

In Summary:

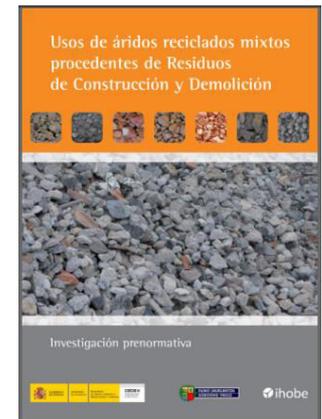
**To increase the recycling rate, it's necessary an specific regulations, and sets new limits and uses more according with physico-mechanical and chemical properties of RA from CDW**

Two Autonomous Communities have researched the use of RCA and MD as materials in road construction and have published both recommendations. This is the first step to a specific regulations of RA from CDW according with its physico-mechanical and chemical properties

### Andalusian



### Basque Country

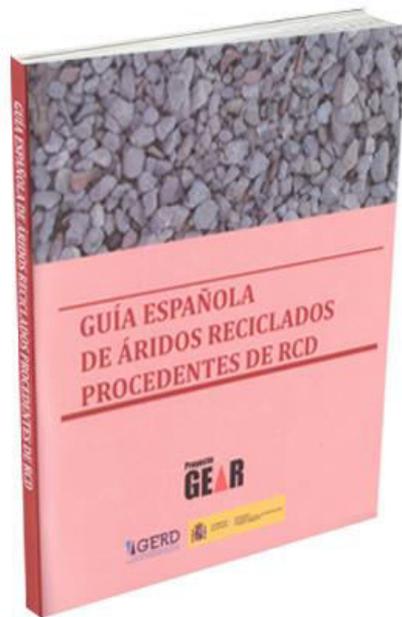


# Recycling of CDW in SPAIN

## POLICES AND STANDARDS IN SPAIN

Recently has been published **The Spanish Guide of RA from CDW** as a result of a research Project carried out between the Polytechnic School of Catalonia and the Spanish Guild of Demolition Waste Recycling Entities

**The Research Group TEP-227 “Construction Engineering” from the University of Córdoba** is developing a research Project (2012-2013) funded by the Andalusian Government and FEDER

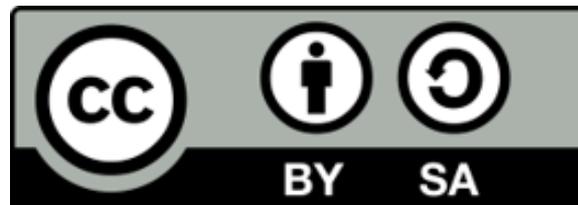


Available in: <http://www.aridosrcdandalucia.es/rcd/>

## THANK YOU FOR YOUR ATTENTION

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