Recycling of concrete and its contribution to sustainable construction

October 2013

Core messages

1. **Concrete can be 100 % recycled**
2. **Recycling 100 % of concrete would reduce the extraction of virgin raw materials by 25 %**
3. **Recycling is not the purpose in itself, but its impact shall be taken into account in a WLC perspective**

Introduction

The concrete sector is committed to contributing to increasing the sustainability of Europe's buildings and infrastructure. In addition to improving the energy efficiency during the use phase, it is important to reduce the impacts of the materials used. In this, an important consideration is how we deal with waste generated during construction and demolition of buildings.

Luckily, concrete is made from natural materials which are generally **abundant and locally available.** In addition, **concrete can be recycled 100% at the end of its life**, thus substituting up to 25 % of virgin raw materials These two positive attributes mean that concrete has a minimum impact on the environment.

European policy context

The issue of construction and demolition (C&D) waste and concrete recycling is more important than ever in the context of the European Commission's Roadmap to a Resource Efficient Europe, the review of the European Waste Management Targets and the upcoming Communication on Sustainable Buildings.

The **Construction Products Regulation**[1] contains 7 basic requirements for construction works. BRCW 7 is "sustainable us of natural resources". It states that the reusability or recyclability of materials and works must be ensured, the construction work must be durable, and materials must be "environmentally compatible". Concrete fulfils these requirements with ease.

European Commission's **Roadmap to a Resource Efficient Europe**[2] and the **Waste Framework Directive**[3] state that by 2020, 70% by weight of non-hazardous construction and demolition waste shall be recycled. These targets are currently being reviewed (see below).

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0005:0043:EN:PDF
[2] http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf
[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF

The upcoming Communication on Sustainable Buildings will have a focus on the resource efficiency of construction products.

Assessing the sustainability benefits of recycling

The sustainable use of natural resources in the construction context can be considered as the combination of the following elements:

- Efficient use of resources at the extraction, manufacturing, construction, use, and end of life stages
- Use of resources in such a way that has the lowest environmental, social and economic burdens over the long term
- Ensuring the availability of resources to future generations
- Use of resources appropriate to the reserves available, i.e. scarcity / abundance are critical factors which mean sustainability needs to be approached in different ways for different resources
- When applying the waste hierarchy - prevention, reduction, reuse, recycle, recovery, disposal - encouraging the options that deliver the best overall environmental, social and economic outcomes, and assessing these options on the basis of life-cycle thinking.

This last point is important. Concrete is made from abundant and local resources and therefore having a high recycling rate is not as crucial as for e.g. certain metals. Recycling is not the goal, rather one of the means to greater sustainability. It is to be encouraged where **economic**, **social** and **environmental** benefits are evident.

Recycling can be both closed-loop (reuse in the same application) and open-loop (reuse in another application). Both open-loop and closed-loop recycling can have environmental benefits: one is not necessarily better than the other when they both prevent the extraction of virgin raw materials for a given use.

Concrete fulfils policy objectives

Concrete can be 100% recycled at end of life

Crushed concrete can be reused as aggregates in new concrete, or alternatively in lower-grade applications such as in road base. Which application depends on considerations such as demand and availability, or technical suitability for structural applications, etc.

Currently, recycled course aggregates (RCA) from demolition tend to be used untreated as excavation filling, roadbeds or floor foundations.

For new non-structural concrete, good performance can be expected with quite high contents of recycled aggregates. The maximum content is set out in national standards.

For structural concrete, the maximum content of recycled aggregates is set out in national standards. These take into account requirement such as mechanical strength and resistance to aggressive environments.

Other (non-concrete) fractions from demolition waste such as crushed tiles and bricks can

also be used as aggregates in concrete.

- The difference in performance of recycled course aggregates (RCA) compared to natural aggregates (NA) is due to lower density and higher water absorption, due to the porosity of hydrated cement paste attached to the recycled aggregates.
- Fine recycled concrete aggregates can be used in place of sand in new concrete.
- Fine recycled concrete aggregates can also be used in cement or even clinker production (under study) – e.g. fired-clay ceramics, glass or unreacted cement can possess cementitious properties.

There are several research projects ongoing aiming to improve the rate or recycled concrete: an example is Recybéton[4] in France which aims at the use of all the materials of deconstructed concrete as components of new concrete or hydraulic binders.

Crushing and recycling concrete at the end of its life can contribute to a phenomenon known as **concrete carbonation**, whereby hydrated cement contained within the product reacts with CO_2 in the air. The quantity of CO_2 taken up will depend on the type of application and also its treatment after its lifetime. Uptake of CO_2 can be particularly relevant after demolition and crushing when the surface in contact with air increases very significantly.

Waste Targets – scarcity is the issue

The ECP supports the targets setting for reducing waste, but believes that the minimum target of 70% by weight for recycling of construction & demolition waste as currently set out is too simple an approach to achieve the desired environmental benefits. Targets differentiated by material type or by environmental impact, rather than simply by weight, could have a more positive effect. Such a target based on weight incentivises the recycling of heavier fractions of demolition waste in order to meet this target, even though this may not be where the greatest environmental benefit lies. Targets linked to an assessment of the environmental impact of recycling versus extraction would allow for a more rational approach.

Increasing the recycling rate in Europe

The rates of recycling of construction and demolition waste vary greatly across Europe. (As an example, in the Netherlands 95% of C&D waste is recovered, while the European average is about 30%.)

Even though concrete can be fully recycled at the end of its life, the extent of use of recycled aggregates in practice is directly attributed to making the use of such materials cost effective. Primary aggregates are widely available and of relatively low cost, and so to achieve high levels of recycling C&D waste it is necessary to make the use of such materials financially attractive. Various methods have been proven to be effective in individual MSs: these range from a ban on inorganic C&D waste going to landfill, landfill taxes, taxes on primary aggregates and financial incentives with respect to tender prices if secondary materials are used. A study of such systems would provide the evidence to support action in countries where the level of re-use of C&D waste is not meeting the target set by the Commission.

[4] http://www.pnrecybeton.fr/

Most of the political and regulatory measures needed to increase re-use of C&D waste would have to be taken at national/local level. It should be emphasised that:

- There is a need for enhanced collection, sorting, and recycling schemes and infrastructure;
- Financial incentives may be needed to achieve greater recycling rates
- However, taxation on its own could have adverse effects. ECP recommends that life-cycle and cost-benefit approaches be used in the decision making process.

CONCLUSION

INDUSTRY ENGAGEMENT

The concrete industry engages itself in applying the waste hierarchy in its value chain – from the extraction of raw materials to the end of life of concrete

- Prevention
  - improve in the factories
  - communication with users (contractors)
  - Logistics
- Reduction
  - Design
  - Concrete quality
- Reuse
  - Reclaimed concrete In RM
  - Internal reuse of precast concrete products
  - Reuse of concrete structures
- Recycling
  - Increase recycling rates at EoL

POLICY NEEDS

In view of improving the resource efficiency of the European industry, policies should be set in the C&D waste context

- Financial support, if used for fostering research and achieving an economically viable system in the medium term (2020?) – bad example of solar panels
- Prioritise by importance (scarcity), not by simplification (mass)
- Always keep the whole picture in mind (avoid compartmentation, recycling in a WLC perspective)