EUPAVE
EUROPEAN CONCRETE PAVING ASSOCIATION

FACT SHEET
100% Recycling

Concrete roads are made with local raw materials, offer a long service life and are 100% recyclable

Concrete pavement recycling – motorway E17, De Pinte, Belgium, 2011 © L. Rens / FEBELCEM

Concrete is made with **local raw materials** and is **100% recyclable**. Concrete having reached the end of its life can be crushed to provide aggregates – sand and stones – for use in new concrete or in other cement-bound or unbound applications such as road bases. In all cases **natural resources are saved**.

Concrete mixes for road construction can accommodate **low carbon cement** types using secondary materials (fly ash, slag) recycled from other industries, resulting in **equal performances**.

A selective demolition and recycling allows to separate the high quality recycled concrete aggregates (RCA), e.g. coming from pavements, from the normal RCA (e.g. coming from foundations and buildings).

High quality RCA can be reused in concrete for new pavements, other infrastructure or buildings. Thanks to research and technical developments, the number of applications is growing, both for pavements and for kerbs, gutters and safety barriers.

The normal quality RCA are mostly used to produce high performing base layers, which are indispensable for long-life pavements, both asphalt and concrete. This is a good example of open loop recycling and it is often the most sustainable way to reuse these aggregates.

RCA can reabsorb from the atmosphere up to 20% CO_2 of the originally emitted CO_2 during the cement manufacturing. This is called (re)carbonation. It improves the quality of the RCA, making them even more suitable for reuse in new concrete.

The research project "Fastcarb" studies how this process can be accelerated.

Finally, new techniques of "smart crushing" allow for a better separation of aggregates and hardened cement paste in crushed concrete. This results in a better quality of the stones and allows reuse of the recycled cement, either in the cement manufacturing process or directly in the concrete mix.

SOME MORE INFORMATION

RECYCLABILITY

About 450-500 million tonnes of construction and demolition waste (C&DW) is generated every year in Europe, at least a third of which is concrete. Fortunately for concrete, recycling is not technically difficult. Concrete can be 100% recycled after demolition!

Recycling concrete offers two main benefits: it saves primary raw materials and reduces the amount of waste sent to landfill. There are two main ways in which recycled concrete is reused:

- As a recycled aggregate in new concrete
- As a recycled aggregate in road bases and earthworks. The base layers can be either unbound aggregates or cement-bound (cement-treated base, lean concrete…).

It is clear that concrete production generates higher requirements on the recycled materials than e.g. unbound base layers. That is why recycled concrete aggregates (RCA) of high quality, e.g. coming from old concrete pavements, are used for replacing virgin aggregates in new concrete. Most of the applications so far consisted of the use of RCA (mostly 60%, sometimes up to 100% of the coarse aggregates) in the bottom layer of a

Motorway construction in two-layer jointed plain concrete in Austria © Smart Minerals GmbH two-layer jointed concrete pavement. This is typically the Austrian motorway construction practice since 1990. Nowadays, thanks to further research and technical developments, the number of applications is also growing in one-layer pavements, as well as in kerbs, gutters and safety barriers.

RCA of normal quality, coming from CDW (other than pavements) can possibly contain higher amounts of brick, glass or other materials. Their use is only allowed for certain types of concrete of lower strength classes. They can also be used to produce high performing unbound or cement-bound base layers, which are indispensable for long-life pavements, both asphalt and concrete. This is a good example of open loop recycling and it is often the most sustainable way to reuse these aggregates.

It also shows the importance of a high performing selective demolition and recycling strategy in order to separate the high quality RCA from the normal quality.

Another essential parameter is transport distance. Due to the large share of coarse aggregates in concrete, LCA results are influenced to a relatively large extent by changes in transport distance of the aggregates. Local availability is therefore indispensable.

As a conclusion, the choice of application should be based on the optimum balance of sustainability, local availability and long-term technical performance.

RECARBONATION

Cement recarbonation refers to the process where CO_2 is re-absorbed by the hardened concrete. Carbonation is a slow process that occurs in concrete where lime (calcium hydroxide) in the cement paste reacts with carbon dioxide from the air and forms calcium carbonate. For pavements, this is a very slow process during their service life because of the high quality of that concrete. The amount of absorbed CO_2 is only about 0.5 to 1 kg/m^2 of pavement.

At the end of their useful life, buildings and infrastructure (reinforced concrete structures) are demolished. If the concrete is then crushed, its exposed surface area increases and this increases the recarbonation rate. The amount of recarbonation is even greater if stockpiles of crushed concrete are left exposed to the air prior to reuse. In order to benefit from the CO_2 trapping potential, crushed concrete should be exposed to atmospheric CO_2 for a period of several months before its reuse. This needs to be taken into account in the way construction waste is dealt with. Up to 20% of the originally emitted CO_2 during the cement manufacturing can be reabsorbed, when proper recycling practices are applied.

The FastCarb research project (www.fastcarb.fr 2018-2020) aims at accelerating the carbonation process by using CO_2 at higher temperature and pressure. It consists of an experimental approach in the laboratory and an implementation at industrial scale.

In addition carbonation has another advantage: it improves the quality of the treated aggregates by plugging the porosity, making them even more suitable for reuse in new concrete.

SMART CRUSHING

Recycling methods have been investigated which allow separating the hardened cement paste from the original aggregates. By eliminating that hardened cement paste, RCA gets the same characteristics as virgin aggregate with similar impact on concrete characteristics such as strength, E-modulus, shrinkage and creep. One of the methods to separate the cement paste was developed in the Netherlands. It is a "smart crusher" with crushing jaws moving in two directions. In that way the crushed concrete is separated in different fractions of powder, sand and stones. As a result the obtained new aggregates are much cleaner and can perfectly be reused in new concrete.

In addition the fine particles obtained can be used as a secondary raw material in clinker production, as a resource for blended cements or as a filler directly in the concrete mix.

Crushing and sieving installation at motorway N49, Zwijndrecht, Belgium, 2007 © AWV, Flemish Agency for Roads and Traffic

More environmental benefits from concrete roads can be found on EUPAVE's infographic "Concrete Pavements Make Roads More Sustainable" (2019), https://www.eupave.eu/resources-files/infographic

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EUPAVE
EUROPEAN CONCRETE PAVING ASSOCIATION

Published by: EUPAVE
European Concrete Paving Association
Vorstlaan 68 Boulevard du Souverain, B13
1170 Brussels

T + 32 2 645 52 31
F + 32 2 640 06 70
info@eupave.eu
www.eupave.eu

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