WHY RECYCLE CONCRETE PAVEMENTS?

Recycling concrete pavements into a new concrete pavement structure provides economic, sustainable and performance benefits.

The cost of aggregates typically is between 20 and 30% of the cost of materials and supplies, or 10 to 15% of the total construction cost of a roadway section. Many of the high-quality, conveniently located virgin aggregate resources are being depleted rapidly, causing the haul distances and costs associated with the use of virgin aggregates to increase. Recycled concrete aggregate (RCA) – a substitute for virgin aggregates in applications such as bases/subbases, concrete and asphalt paving layers, high-value "rip-rap," and general fill and embankment (see TS043.4P for more details about the many uses of RCA) – can be produced from existing concrete pavements or other acceptable concrete sources. This publication details many of the sustainable and performance benefits associated with the use of RCA in lieu of virgin aggregate. More details about these topics are available in ACPA's EB043P, "*Recycling Concrete Pavements*."

While virgin aggregate sources are vast, they also are finite; many high-quality, conveniently located virgin aggregate sources are being depleted rapidly. In addition, environmental regulations, land use policies and urban/suburban construction and expansion are further limiting access to many virgin aggregate resources. Virgin aggregate costs can be expected to rise with scarcity of supply and increasing haul distances.

Concrete pavement recycling is a relatively simple process that involves breaking, removing and crushing hardened concrete from an acceptable concrete pavement source to produce RCA. **Concrete pavements are 100% recyclable** (ACPA 2006). Concrete recycling has been used extensively in Europe since the 1940's and in the U.S. since the 1970's (NHI 1998). The primary applications of RCA have been base and subbase materials, but it also has been used in concrete and asphalt paving layers, high-value "rip-rap," general fill and embankment, and other applications.

Concrete recycling for paving applications is now performed in at least 41 states (Figure 1) and has the support of the Federal Highway Administration (FHWA), which states that "reusing the material used to build the original highway system…makes sound economic, environmental, and engineering sense." (FHWA 2007, FHWA 2002).

Economics of Concrete Pavement Recycling

Aggregate costs constitute one of the greatest costs of highway construction, comprising between 20 and 30% of the cost of materials and supplies, or 10 to 15% of total construction costs (excluding engineering and right-of-way acquisition) (Halm 1980).

Virgin aggregate costs are increasing rapidly in many areas as sources of high-quality virgin aggregate material are depleted and new sources cannot easily be extracted. As available sources become increasingly scarce, haul distances increase, resulting in additional supply costs. In some urban areas, conventional aggregates must be hauled from sources that are up to 200 miles (320 km) from the project site (ECCO 1999). These haul distances and associated costs can be expected to continue to increase as sources become scarcer.

The cost of producing RCA can be considered to be limited to the costs of crushing the demolished concrete and screening and backhauling the RCA. The costs of concrete demolition, removal and hauling are required whether the pavement is recycled or simply discarded. RCA production costs may be offset by savings in hauling and disposal costs, especially if the RCA is produced on site.

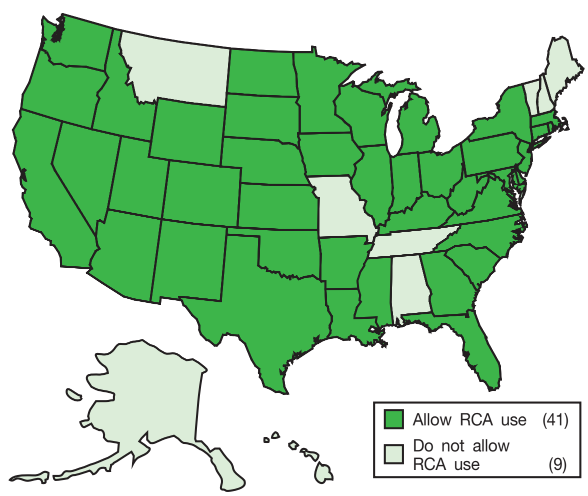

Figure 1. States that currently allow the use of recycled concrete aggregate (RCA) in pavement or other applications (FHWA 2004).

> **"Reusing the material used to build the original highway system…makes sound economic, environmental, and engineering sense."**
> - FHWA

Sustainability Benefits

Every pavement construction or rehabilitation effort draws on a finite reserve of virgin aggregate resources. Concrete recycling conserves aggregate and other resources, reduces unnecessary consumption of limited landfill space, saves energy, reduces greenhouse gas emissions, and actually removes CO_2 from the air.

Conservation of Virgin Aggregate Resources

Replacing the slabs in one lane-mile (1.61 lane-km) of a 10-in. (250-mm) thick concrete pavement requires about 3,000 tons (2,700 metric tons) of coarse and fine aggregate. Because concrete is 100% recyclable, this existing lane-mile of paving slabs can be recycled to produce about 4,000 tons (3,600 metric tons) of coarse and fine RCA – enough to supply the aggregate required to replace all of the slabs in that mile, with additional material left for other applications.

Landfill Reduction

Placing demolished concrete slabs in landfills is becoming increasingly expensive as available landfill space becomes scarcer and more restricted. Concrete pavement recycling eliminates the need to dispose of concrete in landfills, resulting in both cost savings and an extension of landfill usefulness for materials not as easily recycled as concrete.

Energy Savings

The production and use of virgin aggregate involves the consumption of a great deal of energy at each step, including: mining/extraction of the aggregate; crushing, screening and washing; stockpiling and/or transport; and removal and disposal of the material (if it is not recycled) at the end of its period of use. Concrete recycling can greatly reduce the need for mining or extraction, and can reduce haul distances and fuel consumption associated with both supply and disposal.

Reduced Emission of Greenhouse Gasses (GHGs) and Other Pollutants

Each activity that consumes fuel or requires electrical power in the production and use of virgin aggregate also is responsible for the generation of GHGs and other pollutants. Concrete recycling helps to reduce the environmental impact of pavement reconstruction activities while helping to ensure the maintenance of our transportation infrastructure.

Carbon Sequestration Through RCA Carbonation

Research at the University of New Hampshire has shown that RCA has significant value as a sink for carbon dioxide (CO_2), a primary greenhouse gas, through the mechanism of spontaneous carbonation, in which atmospheric CO_2 reacts with calcium hydroxide ($Ca(OH)_2$), a by-product of the cement hydration, in the concrete mortar to produce calcium carbonate (RMRC 2006). The potential for carbon dioxide sequestration is equal to all of the CO_2 that originally evolved from the raw materials used in producing the portland cement.

Pavement Performance Improvements

Pavement reconstruction with either new or recycled aggregates offers the opportunity to correct pavement subgrade or subbase deficiencies to better ensure the performance of the new concrete pavement structure. Such corrections are not possible with typical rehabilitation and overlay options. Reconstruction also allows an opportunity for any existing concerns with pavement geometry, drainage and roadway safety to be addressed. Reconstruction using RCA also can provide additional performance benefits through improved foundation strength and stability and increased concrete strength.

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