Recycling Concrete Pavements and Utilizing Recycled Concrete Aggregate in New Pavement Systems

(April 3, 2020) The practice of recycling concrete pavements and using processed recycled concrete aggregate (RCA) within new pavement structures is considered a standard and essential practice by the concrete pavement industry due to numerous economic, environmental and societal (sustainability) benefits.

RCA has been used successfully and has been specified in paving concrete pavement applications in over 40 states across the U.S. and has been regularly used since the 1970s (Darter et al. 1998). The practice of recycling existing concrete pavements into new paving applications is supported by the Federal Highway Administration (FHWA 2002), which states that "reusing the material used to build the original highway system makes sound economic, environmental, and engineering sense."

The primary application of RCA has been for base/subbase layers, but it is also used as coarse aggregate in concrete and asphalt surface mixtures and has also been repurposed as fill and high-value rip-rap.

ACPA strongly encourages all agencies to allow for the use of RCA in new pavement layers as an essential local sustainable engineering practice by providing the option to contractors through standard specifications.

Benefits

Arguably, economic considerations are the most significant drivers for the practice of recycling concrete pavements for use in new pavement structures. On a broader scale, the diminishing availability of quality virgin resources and limitations on opening new quarries is impacting the availability and cost of pavement layers in the face of increasing demand for aggregate. Reusing or repurposing existing paving materials relieves that pressure and may greatly reduce aggregate transportation costs and eliminate hauling and tipping fees for the disposal of old pavement. The use of RCA may also result in faster construction and lower impacts on local traffic, particularly when on-site recycling is performed.

Concrete pavement recycling is an environmentally sustainable choice in terms of energy and other life-cycle impacts. It can reduce the mining, use, and transportation of virgin aggregate, all of which saves energy and reduces emissions. It correspondingly reduces unnecessary consumption of limited landfill or stockpiling space. In addition, RCA captures carbon dioxide from the atmosphere, further increasing the sustainability of a new pavement system.

When used in pavement foundation layers, RCA's angular, rough-textured nature can provide exceptional particle-to-particle contact, resulting in a very stable roadbed. Stability and erosion resistance may be further improved through secondary cementing mechanisms. When used appropriately, a pavement designed and constructed with RCA subbase will perform similarly to (or better than) a pavement with all virgin aggregate foundation materials.

FHWA's recent reference document, *Towards Sustainable Pavement Systems*, recognizes the benefits of the use of recycling concrete pavements as a sustainable end-of-life pavement option. This document notes that, "Clearly, the economic and environmental costs of disposal are generally quite high, and disposal is not an end-of-life option that will not often be preferred over the recycling and reuse options" (Van Dam et al. 2015).

Challenges

RCA runoff can be highly alkaline, contain contaminants, and can form deposits of suspended solids in drainage systems if not designed, specified and handled properly. Best management practices have been devised and shown to mitigate these concerns; these practices can often eliminate or minimize any related problems. Table 1 below is from the Concrete Recycling Practitioner's Reference Guide (Snyder et al. 2018) and addresses many of the environmental concerns with simple planning and design techniques. More details are available within the reference.

Table 1. Planning considerations and design techniques that protect water quality (Snyder et al. 2018; after Cavalline 2018a, National CP Tech Center).

RCA Use	Consideration	Mitigation Strategies
Unbound bases	**Contamination/pollutants from the source concrete**	• Use of concrete from known agency sources • Prequalification of source material
	High-pH leachate	• Place drainage outlets away from receiving waters • Use hardy vegetation and bioswales near drain outlets • Consider temporary use of pH adjustment products, such as pH ("shock") logs, at potentially problematic locations (after construction)
	Pollutants in leachate	• Construct drains away from receiving waters • Utilize bioswales or mechanical sediment traps
	Sediments and solid precipitate	• Use daylighted bases • Prequalify geotextile fabric per AASHTO M 319-02 • Wrap trench (rather than pipe) in geotextile fabric • Consider eliminating rodent screens • Consider blending RCA with natural aggregate • Utilize mechanical sediment trap at outlet structure • Utilize chemical coagulant products, such as "floc" logs, at local problematic locations (after construction)
Fill (beneficial reuse of fines)	**High-pH leachate**	• Construct away from receiving waters • Utilize hardy vegetation and bioswales in surrounding area
	Pollutants in leachate	• Construct away from receiving waters
New RCA concrete mixtures	**Contamination/pollutants from the source concrete**	• None required

One of the more common problems that has been solved occurs when crushing operations produce excess dust and fine material that clings to the larger coarse aggregate particles. Rainwater draining through a pavement built with the excessively dusty RCA may wash the dust from RCA base layer aggregate. The water and fine material—called leachate—may run through the drainage system. Leachate may be observed at drain outlets and may also settle on the filter fabric or drainpipes before reaching the outlets. The transport of these fines is temporary and lasts only until the material is flushed out of the system, typically within the first few months of pavement life (Sadecki et al. 1996, Snyder et al. 2018).

Proven mitigation techniques include washing the RCA, daylighting free-draining subbases, prequalifying geotextile fabrics for piped systems, and wrapping the drainage trench (rather than the pipe) with an appropriate geotextile fabric. Additionally, utilizing bioswales or mechanical sediment traps can reduce the impact of runoff/leachate on receiving waters. Appropriate drainage design allows free flow of water and fine material through a subbase to the outlet pipes and the ditch without excessive leachate. Ensuring that outlet locations are adequately separated from receiving waters will also prevent issues by allowing for further dilution of the high pH runoff. Another option is the use of chemical coagulant products, such as "floc" logs, which modify the pH of effluent. Many projects utilizing RCA have used these techniques and have been in service for years with no reported water quality or drainage issues (Cackler 2018).

Resources such as the *Recycling Concrete Pavement Materials: A Practitioner's Reference Guide* (Snyder et al. 2018) and *Recycling Concrete Pavements* (ACPA 2009) provide simple engineering strategies to address most environmental concerns with using RCA.

References and Resources

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