Recycled Concrete in Subbases: A Sustainable Choice

Concrete pavements are 100% recyclable and the inclusion of recycled concrete in subbases in new concrete pavement structures is an environmentally friendly decision.

Concrete, being 100% recyclable, is often crushed and reused in new concrete structures, such as new concrete pavements or engineered subbases. The benefits of using recycled concrete aggregate in a new subbase are typically realized in the form of improved performance, cost savings, and reduction of wastes. Because some of the cement matrix from the existing concrete will be included in the recycled concrete aggregate, recycled concrete aggregate have special requirements for some design considerations such as gradation and water demand of the aggregate. This publication details some of these concepts and more on the topic of recycled concrete aggregate used in subbases is available in ACPA's **EB204P**, "*Subgrades and Subbases for Concrete Pavements*."

Why Use Recycled Concrete in a Subbase?

Using recycled concrete as unstabilized subbase or in a cement-stabilized or lean concrete subbase is common practice. There are many benefits to using recycled concrete in new concrete pavement structures, most of which fall into the area of sustainability, including:

- ***Performance:*** The angularity of recycled concrete aggregate, coupled with potential residual cementation, provides a strong and durable platform for construction and improves load carrying capacity over the life of the pavement. Furthermore, the crushing and sizing operations can be modified to accommodate any desired aggregate gradation.
- ***Economics:*** Savings are realized in the cost of transporting new aggregates, and in the cost of hauling and disposing of the old pavement.
- ***Resource Conservation:*** Reusing existing material is helpful where quality aggregate supplies are scarce. Also, using recycled concrete aggregates in either a subbase or in the concrete mixture conserves virgin aggregates.
- ***Environmental Considerations:*** Recycling existing pavement materials as an aggregate subbase reduces dumping and disposal in landfills. Using valuable landfill space for disposal of concrete would be questionable when it can easily be recycled. Also, recycling existing pavement materials reduces pollution from mining, processing, and transporting of virgin aggregates.

The cost of using recycled aggregates for subbase material includes only the cost of crushing operations. The costs for breaking, removal, steel separation, and transport are incidental to any reconstruction project.

Although the construction processes used for unstabilized and stabilized subbases do not change when including a recycled concrete aggregate, there are some special considerations with respect to the aggregate properties that must be addressed.

Paradigm in-place concrete recycling equipment in operation in Oklahoma (photo courtesy of Duit Construction).

Aggregate Characteristics

Research and experience has established the various physical properties of coarse and fine aggregates resulting from recycling in-place concrete pavements. The properties have also been verified through agency testing where recycled concrete aggregates have been specified for reuse. Generally, the tests performed on materials made from recycled concrete pavements are the same as for virgin aggregates, with only a few exceptions.

A contractor can produce nearly any desired gradation using crushed, recycled concrete. Table 1 provides typical recycled unstabilized subbase layer gradations. A lower yield of recycled coarse material will result when the target gradation requires smaller top-size material. Coarse aggregates are those particles which are at least 3/8 in. (9.5 mm) at their narrowest width. The gradation of the fine aggregate portion depends upon the type of crushing operation employed. The material will be very angular, requiring somewhat more effort to place than virgin-based unstabilized (granular) material.

A small amount of fine particles cling to coarse aggregates during crushing and sizing operations. Studies of this condition conclude that, for most cases, the aggregates do not need washing to remove this fine material. However, some agencies require washing to reduce the potential of leaching calcium carbonate or calcium oxide when the aggregate is used for unstabilized subbase.

Recycled aggregates produced from all but the poorest quality material should be able to meet the L.A. Abrasion Test (AASHTO T96 or ASTM C131) requirement of 50% or less for subbase materials. Regardless, abrasion resistance typically is not considered a crucial property for a subbase layer because it is never exposed to traffic.

Normally, on a highway project that employs recycled concrete into the subbase, the source material is the old pavement at the project site, which is processed without any contaminants or inclusions. In urban areas, the concrete that is to be recycled may be from a variety of sources and can include materials such as plaster, soil, wood, gypsum, plastic and vinyl, or rubber. Tests for contaminants are particularly important for generally recycled source materials. Agencies should apply the contamination percentage limits normally permitted for virgin coarse aggregates as a means to control the volume of these contaminants in recycled concrete subbase material.

Table 1. Typical Recycled Unstabilized Subbase Gradations.

Sieve Size	Percent Passing	
2 in. (50 mm)	100	100
1 in. (25 mm)	–	–
3/8 in. (9.5 mm)	40-75	–
No. 4 (4.8 mm)	25-60	35-75
No. 10 (2.0 mm)	–	–
No. 40 (425 µm)	15-45	–
No. 200 (75 µm)	3-12	3-10

Special Precautions

As mentioned, crushing and sizing operations may produce dust and fine material that clings to the larger aggregate particles. In a free-draining subbase, water that seeps through the recycled concrete particles may wash the dust off the large aggregates over time. The water and fine material sometimes drains through the layer and, if an edge drainage system exists along the pavement, the fines may be expelled from it. Some agencies report observing leachate at drain outlets due to this action. The fine material may also settle on filter fabric or drain pipes before reaching the outlets.

Over time, the leachate can clog edge drain pipes and blind filter fabrics, if they surround the pipe trench. To prevent this from occurring, it is important to use a daylighted drainage design or to ensure that the filter fabric for the edge drain pipe does not completely surround the trench. In either case, there is no potential obstruction to the free flow of water and fine material, which allows it to flow through the subbase to the outlet pipes or side ditches.

Although the leachate from a recycled concrete aggregate subbase is initially extremely alkaline (high pH due to high concentration of hydroxyl ions in solution), it is not harmful to the environment. In the event that the effluent from the pavement system is of a high enough pH to be of any concern, it is usually filtered and diluted by the time it reaches the drainage outlets, restricting environmental concerns to small regions surrounding the outlets. Furthermore, some states (including Minnesota, Virginia, California and Texas) have taken a proactive stance by lowering regulatory burdens on recycled concrete aggregates to effectively promote their use. These states realize that the environmental benefits of not having the expired concrete pavement placed in a landfill and the subsequent conservation of virgin aggregates outweigh the potential concerns related to the leachate alkalinity.

References

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