PRODUCTION OF RCA

The production of recycled concrete aggregate requires a simple, well defined process.

Concrete pavement recycling is a relatively simple process that involves breaking, removing and crushing hardened concrete from an acceptable source to produce recycled concrete aggregate (RCA). The formal process of RCA production typically involves an initial evaluation of the existing source concrete; pavement preparation, which may include removal of an asphalt overlay; pavement breaking, removal and transport to a processing facility; removal of any embedded steel such as dowel bars, tiebars, reinforcing bar, or wire mesh; crushing and sizing operations similar to those used for virgin aggregate production; beneficiation to improve the quality of the RCA, if necessary; and stockpiling of the freshly produced RCA. If desired, the RCA also can be produced in-place in the field. More about these topics is available in ACPA's EB043P, "*Recycling Concrete Pavements*."

The major steps in the production of recycled concrete aggregate (RCA) from concrete pavement are: evaluation of the source concrete; preparation of the slab; breaking and removing the concrete; removal of any embedded steel; crushing the concrete and sizing the RCA; beneficiation, if necessary; and stockpiling the RCA.

Evaluation of Source Concrete

The first step in producing RCA from a concrete pavement is to determine the quality and overall properties of the source concrete. Records of the original concrete components, strength and durability can be useful in determining the potential applications for the RCA produced.

Pavement Preparation

If the RCA being produced is to be considered for use in a new concrete mixture, efforts must be made to minimize the potential for introducing contaminants throughout the production process. Contaminants are generally of much less concern for RCA intended for use in subbase aggregate and fill applications. Potential contaminants in concrete pavement recycling typically include joint sealants, asphalt concrete shoulders and patching materials, reinforcing steel and dowel bars, and soils and foundation materials (NHI 1998). If possible, contaminants should be removed by an accepted method prior to the recycling process.

Concrete pavements with asphalt concrete patches and overlays can be processed to produce RCA, but it generally is recommended that the two materials be recycled separately.

Pavement Breaking and Removal

The main purpose of pavement breaking is to size the material for ease of handling and transporting to the crushing plant. The slabs are broken into pieces small enough to be lifted and transported easily. Although other breaking technologies are available, the most readily available equipment for this operation are "impact breakers", which break the pavement by dropping or hurling a heavy mass onto the pavement (Figure 1).

Front-end loaders and dump trucks can easily handle removal and transport of the broken pavement fragments to the crushing site (Figure 2).

Removal of Embedded Steel

The removal of reinforcing steel, tiebars and dowel bars can occur during several phases of the recycling process, but typically is accomplished during the breaking and removal operation or following the primary and secondary crushing operations, where electromagnets often are used to pick steel from the conveyor belts (Figure 3).

Figure 1. Trailer-mounted diesel hammer, one of the most common types of impact breakers.

Figure 2. Removal and transport of broken pavement fragments using end loader and dump truck.

Figure 3. Removal of reinforcing steel after crushing operations.

Crushing and Sizing

The same basic equipment used to process virgin aggregates also can be used to crush, size and stockpile the RCA (ECCO 1999), although some equipment modifications may permit more efficient processing of most salvaged concrete pavements.

The three main types of crushers used in concrete recycling feature "jaw", "cone" and "impact" designs, which differ in how they crush the concrete. While most concrete crushing plants are designed for high-production use by large contractors, "mini concrete crushers" (capable of being towed behind a pick-up truck) also are available for small, local projects (Figure 4).

With appropriate adjustments, concrete crushing plants can be set up to produce almost any desired gradation, although there often is an excess of fine RCA produced.

Beneficiation

Beneficiation is the treatment of any raw material to improve its physical or chemical properties prior to further processing or use. This can be a necessary step in some aggregate processing operations to prevent the inadvertent inclusion of organic material, excessive dust, and other contaminants that would cause problems in the intended application of the aggregate. The degree of beneficiation required depends upon the condition and composition of the crushed concrete, as well as the intended use of the RCA.

Stockpiling

Coarse RCA can be stockpiled using the same techniques and equipment as are used with virgin coarse aggregate materials. Fine RCA stockpiles generally need to be protected from precipitation to reduce the potential for secondary cementing due to hydration of exposed and previously unhydrated (or partially hydrated) cement grains. As with virgin fine and coarse aggregates, more than two separate stockpiles may be necessary to allow the production of aggregate blends that meet project specifications.

In-Place Concrete Recycling

When RCA is to be used in a subbase layer of the roadway and/or shoulders, production can be accomplished using an in-place concrete recycling train. Such systems are capable of separating coarse and fine RCA during recycling operations and typically utilize crushers (mounted on crawler tracks) that have been specially adapted for in-place recycling.

Figure 4. Mini concrete crushing plant.

References

ECCO 1999. "Recycling Concrete and Masonry." EV22. Environmental Council of Concrete Organizations. Skokie, IL. 1999.
NHI 1998. "Techniques for Pavement Rehabilitation: a Training Course – Participant's Manual." FHWA-HI-99-006. National Highway Institute, Federal Highway Administration. Washington, D.C.