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information

Recycling Concrete Saves Resources, Eliminates Dumping

Construction and demolition (C&D) waste comprises 23% to 33% of municipal solid wastes. Some estimates put concrete, asphalt, and rubble at about 50% of the C&D waste by weight.

To slow the flow of waste to landfills, local governments have raised tipping fees. With landfill space at a premium and the costs of hauling and dumping increasing, recycling old concrete into new aggregate makes sense. And with new technologies old concrete—no matter how heavily reinforced—can be recycled.

Recycling concrete requires the breaking, removing, and crushing of concrete to a specified size. A subcontractor usually brings the recycling equipment on-site, although stationary recycling plants are also common in heavily developed areas. Recycling plants can produce any desired gradation. After processing, the crushed concrete makes an acceptable aggregate for use in new concrete, road base material, or other uses.

Market for recycled concrete is wide

Agencies have specified recycled aggregate for all types of concrete pavement, including jointed plain, jointed reinforced, and continuously reinforced, with both regular and epoxy-coated rebar. Though concrete properties differ when using recycled aggregate, no special construction techniques are necessary for paving new concrete made with recycled concrete aggregate.

In addition to roadways, designers use recycled aggregate for sidewalks, curbs, bridge substructures and superstructures, concrete shoulders, median barriers, residential driveways, erosion control, and general and structural fills. It can also be used in subbases and can support layers such as cement-treated bases, unstabilized bases, and permeable bases. Oversized material can be used at entrances of construction sites to help remove mud from truck tires.

Fine aggregate from the crushing operation also makes good fill for subgrade corrections. These recycled fines even act as a drying agent when mixed with subgrade soil (to correct weak subgrades), taking advantage of the fines' high water absorption capacity.

In some areas of the country, aggregate must be shipped over 200 miles. Reusing existing material makes a great deal of sense in such cases where a high quality aggregate is scarce.

Recycling concrete is on the rise

From Chicago's Edens Expressway to Oklahoma's I-40, highways of all types and capacities have accommodated the recycling process. In one of the earliest large-scale recycling projects, the Wisconsin Department of Transportation recycled and reconstructed 29 miles of I-90/94 from Madison to Portage, Wis. The existing pavement represented 140 acre-feet of material, which would have cost a great deal to dump.

The Wyoming Highway Department recycled I-80, a four-lane divided highway near Pine Bluffs that had severe alkali-reactive aggregate. The existing 8-inch-thick plain jointed concrete pavement was recycled into a new 10-inch-thick pavement with concrete shoulders. The builders overcame the alkali reactive aggregate problem by using a Type II low-alkali cement and Class F fly ash.

A recycling project in Portland, Ore., demonstrated one way that non-pavement concrete can be usefully recycled as well. An abandoned Sears department store was recycled, diverting 77% of its waste material from the landfill. More than 7,000 tons of brick, concrete, sand, and dirt were processed into on-site and off-site fill. Some was used as a clean capping

The Environmental Council of Concrete Organizations is a coalition dedicated to promoting the environmental benefits of concrete and its role in safe and sustainable construction.

ECCO members are companies, organizations, and individuals affiliated with the concrete industry. Together, they are committed to developing and disseminating information on the environmental benefits of concrete and concrete products.

layer for a closed landfill. The dumping costs were much lower than if the entire building's waste was landfilled.

Standards for recycled aggregate

As with all construction materials, testing of aggregate and fines made from recycled concrete determines how it will perform. As long as the recycled aggregate can meet the requirements of ASTM Standard C 33 for new aggregate, it can be used in concrete.

Most of the same tests performed on virgin aggregate are necessary for recycled concrete aggregate, including gradation, Los Angeles abrasion, freeze-thaw durability, and alkali reactivity. Many of these tests have shown recycled aggregate to be of better quality than some virgin material, though specific characteristics must always be considered.

Recycled aggregate often does not require a sulfate soundness test. Typical values for recycled concrete aggregate are 3 or less, far below the maximum loss allowed by ASTM Standard C 88. Many recycled-aggregate concretes also provide better freeze-thaw durability than concrete made with all virgin materials.

Using 100% recycled coarse aggregate produces acceptable quality concrete. Use of recycled fines, however, in a new mix requires close examination. Usually replacement of only 10% to 20% virgin sand is acceptable. Recycled fine aggregate is angular, with a high absorption rate and low specific gravity.

Concrete produced with recycled aggregate has 80% to 90% of the strength of a comparable natural aggregate concrete. Using recycled fines further reduces strength compared with virgin sand, so its use in new concrete mixes should be carefully controlled.

Recycled coarse aggregate water absorption values are typically slightly higher than virgin aggregate, due to old cement mortar attached to the recycled aggregate. The values range from 2% to 6%, and increase as particle size decreases. Mix designers will likely increase typical water batch weights. Guidelines for designing concrete mixes using recycled aggregate are contained in RILEM's *Recycling of Demolished Concrete and Masonry*.

Contaminants and other problems

Contamination is usually not a problem when recycling rural highways or airport pavements. Urban recycling, though, requires more concern for contaminants such as plaster, soil, wood, gypsum, asphalt, plastic, vinyl, or rubber. While contaminants are usually not a concern for recycled aggregates used as a base course, strict control must be used for recycled aggregates in concrete to ensure that there are no more contaminants than are allowed for virgin coarse aggregate.

If concrete has alkali-silica reactivity problems or D-cracking, the severity of those problems may govern reuse or place limitations on use of the old concrete.

The Minnesota, North Dakota, and Oklahoma highway departments all conducted studies before trying to recycle D-cracked pavements. Each state found that the maximum size of the aggregate has a critical effect on D-cracking. Reducing the size of susceptible aggregate to a maximum size of 3/4 inch reduces the probability of D-cracking recurring.

Each state also added fly ash to the mix with recycled D-cracked concrete aggregate. Minnesota and Oklahoma replaced 15% of the portland cement in the mix with 20% fly ash by weight. North Dakota replaced 15% of the cement with 15% fly ash by weight.

For recycled concrete aggregate containing asphalt, records in Austria have suggested a method of paving designed as a bottom slab of recycled aggregates and a top slab (at least 1 inch thick) of virgin material. One is slipformed over the other while both courses are still plastic or before initial set of first course. After consolidation and curing, they become a monolithic slab.

A small amount of fine particles remain on the coarse aggregates during recycling sizing operations. Studies of this condition found that for most uses, these aggregates do not need washing to remove this fine material. When the aggregate is used for an unstabilized base course, though, some agencies require washing to reduce the potential of leaching calcium carbonate or calcium oxide.

Savings

The cost of recycling can be up to $4.00 per ton to crush, as well as other expenses. But by eliminating the cost of removing the old concrete and factoring in savings on disposal costs, potential use of recycled fines, and potential road damage from transport of virgin or waste materials, some states have estimated savings of up to 50% to 60% from using recycled aggregates versus buying new aggregate.

For concrete recyclers the most difficult part of the business is obtaining a permit; they need to have a site plan, demonstrate an end market, and provide a list of equipment, process capacity, general operations, and what contaminants are received.

Recycling concrete, though, makes sense—for the cost benefits, the conservation of resources, and for the redirection of material that would otherwise be waste.