Concrete Recycling

Concepts, Benefits and Process

Prepare by:
Civil Engineer
Ari Hasan Hussein
KEU ID: 1200 /Suleimanyah Branch

Concrete Recycling

Introduction:

Concrete recycling is becoming an increasingly popular way to utilize aggregate left behind when structures or roadways are demolished.

In the past, when structures made of concrete are demolished or renovated, the rubbles was once routinely trucked to landfills for disposal, but with more attention being paid to environmental concerns ,recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down.

Concrete aggregate collected from demolition sites is put through a crushing machine. Crushing facilities accept only uncontaminated concrete, which must be free of trash, wood, paper and other such materials. Metals such as rebar are accepted, since they can be removed with magnets and other sorting devices and melted down for recycling elsewhere. The remaining aggregate chunks are sorted by size. Larger chunks may go through the crusher again. After crushing has taken place, other particulates are filtered out through a variety of methods including hand-picking and water flotation.

Crushing at the actual construction site using portable crushers reduces construction costs and the pollution generated when compared with transporting material to and from a quarry[1].

Large road-portable plants can crush concrete and asphalt rubble at up to 600 tons per hour or more. These systems normally consist of a rubble crusher, side discharge conveyor, screening plant, and a return conveyor from the screen to the crusher inlet for reprocessing oversize materials. Compact, self-contained mini-crushers are also available that can handle up to 150 tons per hour and fit into tighter areas. With the advent of crusher attachments - those connected to various construction equipment, such as excavators - the trend towards recycling on-site with smaller volumes of material is growing rapidly. These attachments encompass volumes of 100 tons/hour and less.

[1] A **quarry** is a type of open-pit mine from which rock or minerals are extracted. Quarries are generally used for extracting building materials, such as dimension stone, construction aggregate, riprap, sand, and gravel. They are often collocated with concrete and asphalt plants due to the requirement for large amounts of aggregate in those materials. The word *quarry* can include underground quarrying for stone, such as Bath stone.

Uses of recycled concrete

- Smaller pieces of concrete can be used as gravel for new construction projects.
- Sub-base[2] gravel is laid down as the lowest layer in a road, with fresh concrete or asphalt poured over it.
- Crushed recycled concrete can also be used as the dry aggregate for brand new concrete if it is free of contaminants.
- Also, concrete pavements can be broken in place and used as a base layer for an asphalt pavement through a process called rubblization[3].
- Larger pieces of crushed concrete can be used for erosion control[4].

With proper quality control at the crushing facility, well graded and aesthetically pleasing materials can be provided as a substitute for landscaping stone or mulch.

Wire gabions[5] (cages), can be filled with crushed concrete and stacked together to provide economical retaining walls. Stacked gabions are also used to build privacy screen walls (in lieu of fencing).

[2] sub-layer material of an asphalt roadway

[3] **Rubblization** is a construction and engineering technique that involves saving time and transportation costs by reducing existing concrete into rubble at its current location rather than hauling it to another location. Rubblization has two primary applications: creating a base for new roadways and decommissioning nuclear power plants.

[4] **Erosion control** is preventing or controlling wind or water erosion in agriculture, land development and construction. Effective erosion controls are important techniques in preventing water pollution and soil loss

[5] A **gabion** (big cage) is a cage, cylinder, or box filled with rocks, concrete, or sometimes sand and soil for use in civil engineering, road building, and military applications. For erosion control, caged riprap is used. For dams or in foundation construction, cylindrical metal structures are used. In a military context, earth- or sand-filled gabions are used to protect artillery crews from enemy fire.

Description and Size of the Waste Stream:

The source of the clean aggregate is mixed and may come from tonnage received at recycle centers or sources such as foundations, curb and gutter, roads, highways, airport runways and more.

In the past decade both the American Society for Testing and Materials (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) have accepted recycled concrete as a source of aggregate into new concrete and have set the quality standards. These premier specifying agencies are confident that recycled concrete aggregate can be of high quality. Now it is the aggregate producers' responsibility to produce quality recycled concrete aggregate.

Recycled concrete aggregate:

- Is high quality - meeting or exceeding all applicable specifications
- Is an accepted source of aggregate into new concrete by ASTM and AASHTO.
- Is currently being used in concrete and asphalt products with better performance over comparable virgin aggregates.
- Provides for superior compaction and constructability.
- Is higher yield - recycled aggregates are lighter weight per unit of volume, which means less weight per cubic yard, resulting in reduced material costs, haul costs, and overall project costs.
- Weighs ten to fifteen percent (10%-15%) less than comparable virgin quarry products (concrete).
- Offers a way to reduce landfill waste streams.
- Means minimization of environmental impacts in an Urban Quarry setting.

Markets for Recycled Concrete Aggregate

1- **Aggregate base course (road base),** or the untreated aggregates used as foundation for roadway pavement, is the underlying layer (under pavement surfacing) which forms a structural foundation for paving.

A cross-section of pavement would show dirt, or subgrade, as the lowest of three levels, with aggregate base course at the center and pavement (whether concrete or asphalt) at the surface.

This is the major market and can be mastered as the simplest and easiest use of recycled concrete.

Although this site is dedicated strictly to the subject of recycled concrete aggregate, it should be mentioned here that recycled asphalt is also accepted as a usable aggregate base course or road base.

2- **Ready Mix concrete** consists of a blend of cement, sand and water. This market is in its infancy stage with few recyclers attempting this re-use strategy. Above all, the recycled

concrete aggregate producer must make a quality product and have secured a willing and progressive ready mix producer who already has something that works. The ready mix producer must then, in turn, make a quality end product.

Similarly, recycled concrete can be used in new asphalt pavement as a substitute for virgin aggregate. The additional asphalt cement required must be offset by the cost savings of the virgin aggregate.

Uses to date are: residential slab and foundation; walk and curb; residential street and alley; commercial slab and foundation; and concrete paving per aggregate approval.

3- **Soil Stabilization** is the incorporation of recycled aggregate, lime, or fly ash into marginal quality subgrade material used to enhance the load bearing capacity of that subgrade. The process changes the water susceptibility of subgrade thereby stabilizing the soil/subgrade. Many times concrete aggregate can be found and reused on the same project for this purpose.

4- **Pipe bedding**: Recycled concrete can serve as a stable bed or firm foundation in which to lay underground utilities. In this scenario, recycled concrete aggregate serves as a replacement of virgin aggregate.

5- **Landscape Materials**: Recycled concrete can be used in various landscape settings. Sized concrete rubble can serve as landscape feature; an attractive support that offers different architectural texture and color. To date, recycled concrete aggregate has been used as boulder/stacked rock walls, underpass abutment structures, erosion structures, water features, retaining walls, and more.

Benefits Summary:

There are a variety of benefits in recycling concrete rather than dumping it or burying it in a landfill.

- Keeping concrete debris out of landfills saves landfill space.
- Using recycled material as gravel reduces the need for gravel mining.
- Using recycled concrete as the base material for roadways reduces the pollution involved in trucking material.

Value Engineering Benefits:

- Produce specification sized recycled aggregates at your location
- Avoid haul-off costs and landfill disposal fees
- Eliminate the expense of aggregate material imports and exports
- Increase project efficiency and improve job cost - recycled concrete aggregates yield more volume by weight (up to 15%)
- Minimize impact to community infrastructure by reducing import and export trucking

Lead paint contamination

There have been concerns about the recycling of painted concrete due to possible lead content. The Army Corps of Engineers' Construction Engineering Research Laboratory (CERL) and others have conducted studies to see if lead-based paint in crushed concrete actually poses a hazard. Results concluded that concrete with lead-based paint would be able to be used as clean fill without impervious cover but with some type of soil cover.

How Concrete is Recycled

Products (aside from base course) are high quality aggregate, processed in steps with time and effort involved in crushing, pre-sizing, sorting, screening and contaminant elimination. The denominator is to start with clean; quality rubble in order to meet design criteria easily and ultimately yield a quality product that will go into end use.

Crushing and screening systems start with primary jaws, cones and/or large impactors taking rubble from 30 inches to 4 feet. A secondary cone or impactor may or may not need to be run, and then primary and secondary screens may or may not be used, depending upon the project, the equipment used and the final product desired. A scalping screen will remove dirt and foreign particles. A fine harp deck screen will remove fine material from coarse aggregate.

Further cleaning is necessary to ensure the recycled concrete product is free of dirt, clay, wood, plastic and organic materials. This is done by water floatation, hand picking, air separators, and electromagnetic separators.

Occasionally asphalt overlay or patch is found. A mixture of asphalt and concrete is not recommended but small patches are not detrimental.

The more care that is put into the quality, the better product you will receive. With sound quality control and screening you can produce material without having to wash it as with virgin aggregate which may be landed with clay and silt.

Recycle Plants Type:

The choice of one or several types of these recycle plants will be determined by the project. For example, is the project a redevelopment? Is there demolition onsite? Is the site a recycle center? Rest assured there is a recycle plant to fit the project.

Mobile Recycling Plants

This type of recycling plant can be moved to various locations economically. Track-mounted plants allow superior on-site mobility.

Portable Recycling Plants:

Choosing the right crusher for a particular concrete recycling project depends on several factors to be successful/ profitable. What goes into the crusher, what is used to feed it (loader or hoe) and what specification final product is needed determines the size, type, and capacity of the unit / units.

1. **Preparation** - How much are you willing spend to prepare the material before it is ready to crush? This will determine the maximum feed size the crusher will be fed and how much steel/rebar/wood/dirt needs to be removed prior to crushing. This is typically done with hammers, hydraulic crunchers, and pre-screening. Magnets may be used to remove the loose steel.

2. Most Popular Types of crushers

- **Jaw Crushers** - Jaws compress the concrete between a stationary and moveable plate. Concrete is reduced in size as it travels down the length of the wedge between the two plates. Jaws are used as primary crushers and typically produce a 4" to 8" minus product usually used as fill.

- **Impact Crushers** - Impactors have a spinning rotor with bars or hammers that fling the concrete into a solid plate, several plates, or rods. Impactors can be used as primary, secondary, and even tertiary crushers and produce a product typically 2" minus used as base material in some parts of the country.

- **Cone Crushers** - Cones are also compression type machines with the concrete being compressed between two cone shaped plates. Concrete feed to a cone is typically 6" minus as they are used mostly as secondary crushers behind a Jaw or Impact Primary. Cones typically produce products of 1-1/2" minus.

All of the above crusher types are available in Portable, Mobile, and Stationary configurations.

- **Portable crushers** are mounted on rubber tired chassis and towed to the site by truck. On site they are moved by loaders or tugs.

- **Mobile crushers** are carried to the site by truck and trailer and have their own onboard drive system typically track driven. These units move easily on sites where several moves are required.

- **Stationary crushers** are just that they are permanently fixed to the ground. Typically used in a recycling yard where all material is trucked to the site.

Most recycling projects require the operator to produce a sized or specified end product with gradations that need to be met. The example below may help.

References

- Wikipedia, the free encyclopedia Website (www.wikipedia.org)
- ConcreteRecycling.org.
- Frederick G. Wright, Jr, "FHWA Recycled Materials Policy", *Federal Highway Administration*, November 20, 2006. Retrieved 2010-04-05.