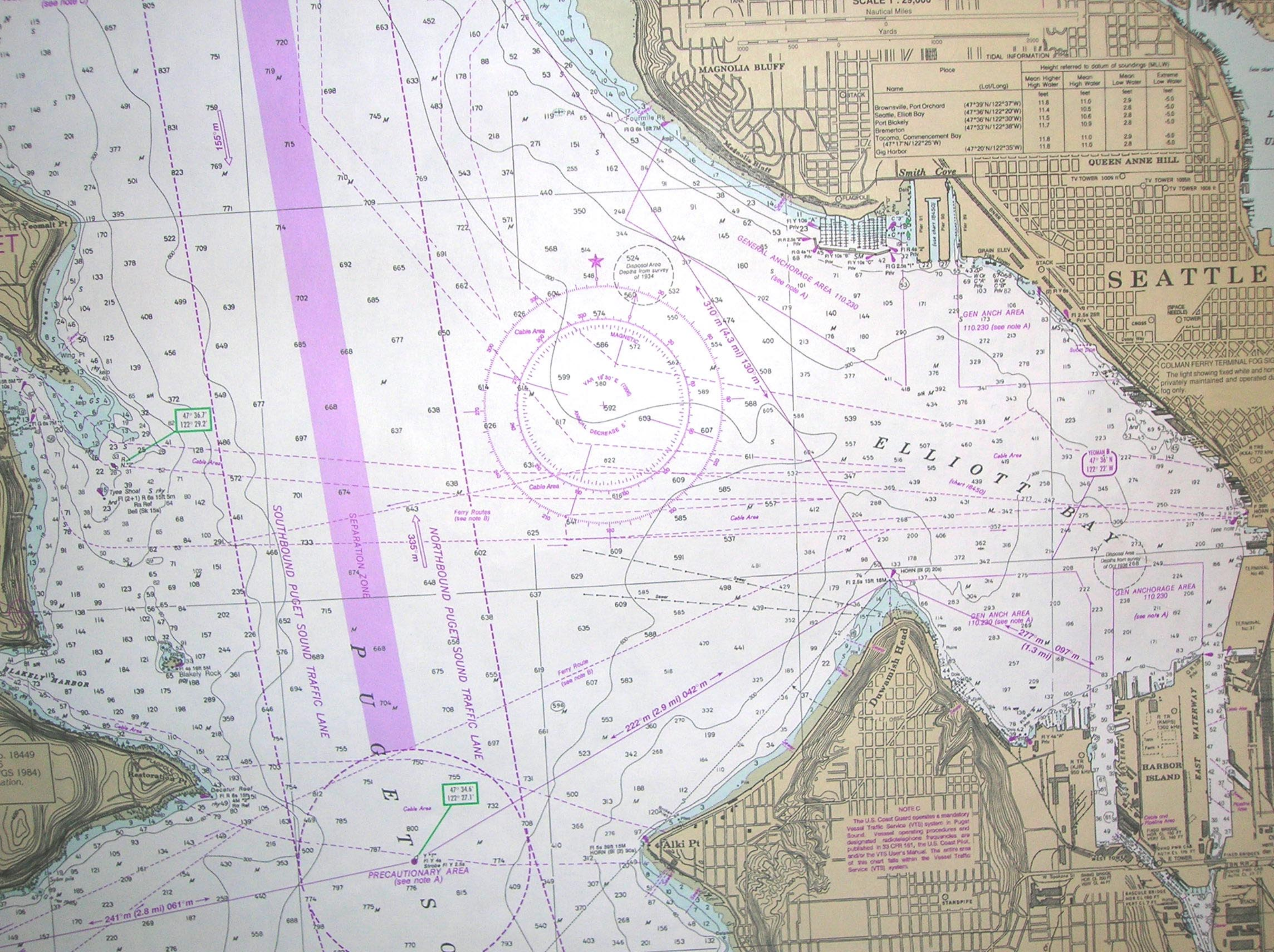

Nautical Miles
Yards
TIDAL INFORMATION
Place
Name (Lat/Long)
Height referred to datum of soundings (MLLW)
Mean Higher High Water
Mean High Water
Mean Low Water
Extreme Low Water
feet
Brownsville, Port Orchard (47°39'N/122°37'W) 11.8 11.0 2.9 -5.0
Seattle, Elliott Bay (47°36'N/122°20'W) 11.4 10.5 2.8 -5.0
Port Blakely (47°36'N/122°30'W) 11.5 10.6 2.8 -5.0
Bremerton (47°33'N/122°38'W) 11.7 10.9 2.8 -5.0
Tacoma, Commencement Bay (47°17'N/122°25'W) 11.8 11.0 2.9 -5.0
Gig Harbor (47°20'N/122°35'W) 11.8 11.0 2.8 -5.0
MAGNOLIA BLUFF
QUEEN ANNE HILL
Smith Cove
SEATTLE
ELLIOTT BAY
GENERAL ANCHORAGE AREA 110.230 (see note A)
GEN ANCH AREA 110.230 (see note A)
Disposal Area Depths from survey of 1934
Cable Area
Ferry Routes (see note B)
Ferry Route (see note B)
SOUTHBOUND PUGET SOUND TRAFFIC LANE
NORTHBOUND PUGET SOUND TRAFFIC LANE
SEPARATION ZONE
PUGET S
PRECAUTIONARY AREA (see note A)
Duwamish Head
Alki Pt
HARBOR ISLAND
Restoration Pt
Blakely Rock
BLAKELY HARBOR
Tyee Shoal
Wing Pt
Yeomalt Pt
Fourmile Rk
NOTE C
The U.S. Coast Guard operates a mandatory Vessel Traffic Service (VTS) system in Puget Sound. Vessel operating procedures and designated radiotelephone frequencies are published in 33 CFR 161, the U.S. Coast Pilot, and/or the VTS User's Manual. The entire area of this chart falls within the Vessel Traffic Service (VTS) system.
STANDPIPE
COLMAN FERRY TERMINAL FOG SIGNAL
222°m (2.9 mi) 042°m
241°m (2.8 mi) 061°m
310°m (4.3 mi) 130°m
277°m (1.3 mi) 097°m

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Materials: Aggregates

Recycled Aggregates

Construction materials are increasingly judged by their ecological characteristics. Concrete recycling gains importance because it protects natural resources and eliminates the need for disposal by using the readily available concrete as an aggregate source for new concrete or pavement subbase layers. According to a FHWA study, 38 states recycle concrete as an aggregate base; 11 recycle it into new portland cement concrete. The states that do use recycled concrete aggregate in new concrete report that concrete with recycled concrete aggregate performs equal to concrete with natural aggregates. Most agencies specify using the material directly in the project that is being reconstructed. For a summary of the findings, click here.

Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. See ACI 555 (2001) for more information on processing old concrete into recycled concrete aggregates. The quality of concrete with recycled concrete aggregates is very dependent on the quality of the recycled material used. Reinforcing steel and other embedded items, if any, must be removed, and care must be taken to prevent contamination by other materials, such as: asphalt, soil and clay balls, chlorides, glass, gypsum board, sealants, paper, plaster, wood, and roofing materials which can be troublesome.

Applications

In general, applications without any processing include:

1. many types of general bulk fills
2. bank protection
3. base or fill for drainage structures
4. road construction
5. noise barriers and embankments

Most of the unprocessed crushed concrete aggregate is sold as 37.5 mm (1½ in.) or 50 mm (2 in.) fraction for pavement subbases.

After removal of contaminants through selective demolition, screening, and /or air separation and size reduction in a crusher to aggregate sizes, crushed concrete can be used as:

1. new concrete for pavements, shoulders, median barriers, sidewalks, curbs and gutters, and bridge foundations
2. structural grade concrete
3. soil-cement pavement bases
4. lean-concrete or econo-crete bases and
5. bituminous concrete

Recycled Aggregate Chararacteristics

The crushing characteristics of hardened concrete are similar to those of natural rock and are not significantly affected by the grade or quality of the original concrete.

Recycled aggregates produced from all but the poorest quality original concrete can be expected to pass the same tests required of conventional aggregates.

Recycled concrete can be batched, mixed, transported, placed and compacted in the same manner as conventional concrete. Special care is necessary when using recycled fine aggregate. Only up to 10% to 20% recycled fine aggregate is beneficial. The aggregate should be tested at several substitution rates to determine the optimal rate.

Higher porosity of recycled aggregate compared to natural aggregate leads to a higher absorption. It is recommended that recycled aggregates be batched in a prewetted and close to a saturated surface dry condition. To achieve the same workability, slump, and water-cement ratio as in conventional concrete, the paste content, or amount of water reducer have to be increased.

Mix Design

It is generally accepted that when natural sand is used, up to 30% of natural crushed coarse aggregate can be replaced with coarse recycled aggregate without significantly affecting any of the mechanical properties of the concrete. Replacing higher amounts will results in increased drying shrinkage, while strength and freeze-thaw resistance are not significantly affected. For more information, click here.

Often recycled aggregate is combined with virgin aggregate when used in new concrete. An example of a mix design using recycled aggregates in a pavement application is shown following table.

Example mix designs for recycled concrete pavements

Concrete Ingredients	Minnesota DOT lb per cu yd	Wisconsin DOT lb per cu yd	Grand Forks, ND Int'l Airport lb per cu yd	Wyoming DOT lb per cu yd
Cement (Type I)	472	480	400	488
Fly Ash (Type C)	83	110	130	133
Water	255	265	230	258
Recycled CA	1630	1815	1650	1349
Natural CA	—	—	—	601
Recycled FA	—	—	—	253
Natural FA	1200	1315	1260	882
Admixtures:	—	—	—	—
Air entrained	yes	yes	yes	yes
Water reducer	no	no	yes	yes

Source: ECCO, Recycling Concrete and Masonry, 1999

Sustainability

The **LEED** Green Building Rating System recognizes recycled concrete in its point system. Credit 4 (Materials and Resources) states, “specify a minimum of 25% of building materials that contain in aggregate a minimum weighted average of 20% post-consumer recycled content material, OR, a minimum weighted average of 40% post-industrial recycled content material.” Using recycled aggregates instead of extracted aggregates would qualify as post-consumer. Because concrete is an assembly, its recycled content should be calculated as a percentage of recycled material on a mass basis.

Credit can also be obtained for Construction Waste Management. It is awarded based on diverting at least 50% by mass of construction, demolition, and land clearing waste from landfill disposal. Concrete is a relatively heavy construction material and is frequently recycled into aggregate for road bases or construction fill. See *Building Green with Concrete: Points for Concrete in LEED* for more information on the LEED rating system.

Reference:
ACI Committee 555, *Removal and Reuse of Hardened Concrete*, ACI 555R-01, ACI Committee 555 Report, American Concrete Institute, Farmington Hills, Michigan, 2001, 26 pages.

http://www.cement.org/tech/cct_aggregates_recycled.asp

An Advanced Concrete Recycling Technology and its Applicability Assessment by the Input-Output Analysis
Hirokazu Shima, Hisashi Tateyashiki, Ryuji Matsuhashi and Yoshikuni Yoshida
Journal of Advanced Concrete Technology, 3(1) 53-67, 2005

While at present mostly recycled into road subbase, the amount of demolished concrete in Japan is expected to increase rapidly and exceed the demand of road subbase in the near future. To promote the recycling of concrete, a technology to produce high-quality recycled aggregate has been developed. This technology employs the heating and rubbing method. In order to investigate a future concrete recycling system, first of all, a specific model considering indices of economic activity is established to forecast the amount of demolished concrete in the future. Furthermore, an input-output table is extended by a detailed description of concrete-related industries such as construction, aggregate, cement, and ready-mixed concrete, and several concrete recycling processes have been added.The linear programming model connected to the input-output table assumes that the technology to be introduced in 2020. A subsidy for the high-quality recycled aggregate and a carbon tax are found to be effective to the early introduction of the technology.

The Way Concrete Recycling Should Be
Fuminori Tomosawa, Takafumi Noguchi and Masaki Tamura
Journal of Advanced Concrete Technology, 3(1) 3-16, 2005

Providing excellent performances as a structural material, concrete has long been deemed essential for modern civilization and recognized as a material that will continue to

maintain and support the development of human society. It is now being seen in a new light, as recycling of concrete in a completely closed loop has become technically feasible. This paper reviews the background to this development referring to the changes in the social systems and introduction of new technologies. In view of considerations for the global environment to be required in the future at every step of the production of concrete and concrete structures, this paper then overviews the method of identifying social needs for concrete structures, the way the production systems of structures should meet such social needs, lifecycle design techniques for structures, and techniques for expressing the environmental performance of structures with the background reasoning, as well as the importance of such techniques.The authors finally discuss what true recycling and truly recycling-oriented society are, based on the above-mentioned discussions.

http://www.j-act.org/4-7.html

King County Environmental Purchasing Program

Aggregate, Recycled Concrete

- Introduction
- Usage History and Experience
- Bid and Contract Specifications
  - King County contract provisions and specifications
  - Crushed-Stone Surfacing: Houghton Landfill
  - Crushed-Stone Surfacing: Puyallup/Kit Corner Landfill
  - Backfill, Recycling and Waste Management: Regional Justice Center Project
  - Fill, Vashon Transfer/Recycling Station
  - Rubblizing - Road Project
- WSDOT 2002 Standard Specifications - Recycled Concrete Aggregate
- Product Experience
  - Recycled Concrete Aggregate as Crushed Stone Surfacing at the Puyallup/Kit Corner Custodial Landfill
  - Recycled Concrete Aggregate as Crushed Stone Surfacing at the Houghton Custodial Landfill
  - Recycled Concrete Aggregate at the Regional Justice Center
- For More Information
- Vendor Information

Introduction

Portland cement concrete can be reclaimed during demolition operations and crushed into a coarse granular material that can be used as a substitute for crushed virgin rock. Aggregate processors are beginning to accept reclaimed concrete for a "tipping fee" significantly lower than the cost of landfilling the material and to supply recycled concrete aggregate of sufficient quality for many applications.

As landfill costs for Construction, Demolition, and Landclearing debris (CDL) continue to rise and the landfills become more heavily regulated, it makes economic sense to seek alternative means of disposal of concrete from construction and demolition operations. More disposal sites are opening up and contractors are incorporating recycling into their operations to decrease disposal costs.

Recycled concrete aggregate is increasingly available and is often an economical alternative to new aggregate. Project managers can ensure that their contractors are aware of opportunities to recycle this material and can require the use of recycled material in construction.

Users of recycled concrete aggregate should take customary precautions to ensure that the material is suitable for the intended application.

Usage History and Experience

Recycled concrete aggregate has been used in various King County projects over the past twelve years. Last year, the Roads Operations Section purchased 3,850 yards of recycled concrete (and asphalt), at a cost of $31,000, for use in small maintenance projects. Using recycled material in place of increasingly scarce and expensive native rock aggregate saves money, as well as diverting material from the waste-stream.

Bid and Contract Specifications

King County agencies purchase recycled concrete aggregate for use as a temporary road surface through a term-contract with local vendors. The Cedar Hills landfill (Solid Waste Division), save money by using this material in place of increasingly scarce and expensive native rock aggregate.

King County Supply Contract

The King County supply contract includes:
6-8" minus ballast
4-6" Minus Ballast
2-4" Ballast & Borrow
1-1/2" minus base course
Technical Specifications:
Material shall be composed of recycled asphalt, concrete and brick. It may not be contaminated with glass, metal or other foreign material.
Native rock may not be substituted or mixed with recycled material.
All material shall conform to the applicable requirements of the State of Washington, Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.
In the event there is a question regarding the quality of the material, King County will be the final authority.
Source of material shall be located within a 25 mile radius of the Cedar Hills Landfill.
Reporting Requirement
The supplier shall report the total amount of recycled concrete aggregate supplied to each County department during each calendar quarter. This information shall be furnished to the Recycled Product Procurement Coordinator, in the Purchasing Agency, during the month following the end of each completed quarter. The amount shall be stated in both units and dollars.

Crushed-stone Surfacing: Houghton Landfill Project

This project involved installation of a gas-extraction system at the Houghton Custodial Landfill. The project used recycled concrete aggregate as a crushed surfacing material.
Project Title
Houghton Custodial Landfill: Gas Extraction Facilities North Perimeter Gas Extraction System (Completed Summer 1994) John Komorita, Project Manager, King County Solid Waste Division
Technical Specifications
Recycled Concrete Aggregate, Crushed-Stone Pavement
2.05 CRUSHED-STONE PAVEMENT
2-05.2(2) Aggregate
Aggregate shall consist of recycled concrete rubble in accordance with Section 9-03.11 of the 1994 Standard Specifications for Road, Bridge and Municipal construction.
The aggregate shall meet the following test requirements:
Los Angeles Wear, 500 revolution 35% maximum degradation factor 25% minimum.
Aggregate shall meet the following gradation:

Sieve Size	Percent Passing By Weight
1-1/2" square	100
3/4" square	55-90
No. 4	25-60
No. 50	5-25
No.200	3-12

The gradation shall be determined in accordance with ASTM D-422 testing procedures.
The portion passing the No. 40 sieve shall be non-plastic.
The moisture content of the aggregate immediately prior to placement shall be within 2% of the optimum moisture content as determined by ASTM D-1557 test method.
Summary:
1900 tons of recycled concrete aggregate was used, purchased at $7.05 ton compared to $10.50 ton for raw aggregate. This project also used recycled glass as pipe-bedding

Crushed-Stone Surfacing: Puyallup/Kit Corner Landfill

This project involved installation of a gas-extraction system at the Puyallup/Kit Corner Custodial Landfill. The project used recycled concrete aggregate as a crushed surfacing material for road surface and for "equipment pads".
Project Title
Puyallup/Kit Corner Custodial Landfill
Landfill Gas Extraction System
South Landfill Perimeter
Prepared by Applied Geotechnology Inc and CH2M HILL
John Komorita, Project Manager, King County Solid Waste Division

Technical Specifications
Division 9 MATERIALS
Section 9-03 AGGREGATES
9-03.5 Granular Material

Granular material, where specified on Drawings, shall be recycled concrete rubble meeting the gradation, sand equivalent, and fracture requirements of Section 9-03.9(3) Crushed Surfacing - Top Course and Keystone.

Test results for recycled concrete rubble shall be submitted for LA Wear and Degradation Factor. The Contractor shall certify that the recycled material is neither hazardous or toxic. This certification shall address the toxicity characteristics prescribed in WAC 173-303-090(8) under sampling and testing according to WAC 172-303-110. Sampling and testing shall be one per 10,000 tons from any single source and not less than one sample from any single source. Acceptance of the recycled concrete rubble aggregate for hazardous and toxic requirements shall be by Manufacturer's Certificate of Compliance with accompanying test reports.

If recycled concrete rubble meeting the above requirements cannot be found, regular Top Course and Keystone material shall be substituted.

Summary:
644 tons of recycled aggregate was used for equipment pads and as crushed rock for roadway surfacing. It was purchased at $10.00 ton, compared to $13.00 ton for raw aggregate. This project also used recycled glass as pipe-bedding

Backfill, Recycling and Waste Management: Regional Justice Center Project

This project involved the development of a new regional justice center, including courthouse and detention facilities. The project manager required that materials be recycled on the project site and used in place of new material.

The project used recycled concrete aggregate from the demolition for backfill, general fill, pipe-bedding and as aggregate base course for pavement construction in new construction.

The paragraphs below are excerpted from contract documents related to this project.

Project Title
Metropolitan King County
Regional Justice Center Project
Demolition and Construction
Recycling and Waste Management Specifications
Section 01010 Summary of Work
F. Ownership and Disposal of Materials
1. The County wants to recycle as much material as possible during demolition and the demolition schedule has been planned to maximize the amount of recycling, reuse, and salvage that can be achieved during demolition.
1.04 Base Contract Work Includes:
4. Demolish building and foundations. Crush and stockpile concrete rubble and dispose of all rebar. Do not mix asphalt with concrete in stockpile.
5. Remove drives, parking areas, walks and pads. Segregate different material types (concrete and asphalt) load, haul, crush, consolidate and stockpile material on site.
7. Backfill pits, holes and excavations with clean recycled crushed concrete. Backfill to surrounding grades.

8. Recycled crushed materials of differing material types are not to be mixed. Segregate concrete and asphalt stockpiles. Concrete which has been overlaid with asphalt shall be kept separate from other stockpiles.

Section 01595
1.03 Requirements:
A. The County requires the Contractor to recycle, reuse, and salvage as much material as possible. The demolition schedule was planned to allow for selective removal and sorting of materials.
B. The County requires the Contractor to submit a waste handling plan detailing how the waste streams will be separated and managed.
E. The Contractor is responsible for removing and reusing, recycling, or salvaging all other materials associated with the demolition of the buildings, pavement, vegetation, utilities, and any other site improvements.

Section 02235 Recycled Crushed Materials
Part 1-GENERAL
A. Concrete including concrete and cement shall be crushed on site. Crushed concrete shall be stockpiled separately on site. Crushed concrete shall be used as backfill as specified in Section 02200, Earthwork.
B. Asphalt and Concrete Asphalt mixtures shall be crushed on site. No asphalt or combination of asphalt products shall be used as fill by the Demolition Contractor.
C. Crushed asphalt shall not be mixed with crushed concrete.
1.02 Description of Work
This section pertains to work involving recycled crushed concrete, crushed asphalt, and crushed concrete/asphalt materials produced on site during demolition operations. Potential sources of recycled crushed materials on site include (but are not limited to) existing foundations, floor slabs, reinforced concrete walls, and pavements. Mixed crushed recycled concrete/asphalt may occur as a result of demolishing concrete slab areas overlain by asphalt surfacing. All reinforcing steel shall be removed from concrete elements prior to crushing, and exported from the site.

Recycled crushed concrete may be used on site as backfill in the parking garage over excavation zone identified on the project plans, or as general backfill to fill depressions produced during demolition or within low areas. Recycled crushed concrete will also be stockpiled on site for use during future site work, as backfill in future footing over excavation zones, as general fill, pipe-bedding or backfill, and as aggregate base course for pavement construction. Recycled crushed asphalt or mixed asphalt/concrete will be stockpiled on site for use during future site work, as general fill or aggregate base beneath paved areas. Brick, masonry, and CMU elements will be demolished as part of this Contract. These materials will not be reused on site, but should be demolished and exported from the site.

1.03 Description of Site Conditions:
A. Reuse, recycle and salvage as much material as possible.
B. Stockpile the various types of crushed recycled materials in separate, secure areas as directed by the County.
C. Do not mix recycled materials with soil, and do not mix crushed recycled concrete with asphalt.

Part 2 - PRODUCTS
2.01 Crushed Recycled Concrete:
A. Crushed recycled concrete materials shall conform to the following gradation specification:

Sieve Size U.S. Standard Percent Passing By Weight

1-1/2" square	100
3/4" square	40-75
1/4 inch	25-50
No. 40	5-20
No.200	10 max

B. Recycled concrete materials used or stockpiled on site shall be uniform in quality and free from wood, steel, roots, bark or other extraneous material. In addition, the recycled concrete materials shall meet the following requirements:

Los Angeles Abrasion, 500 rev. 35%max
Sand Equivalent 30 min
2.02 Crushed Recycled Asphalt Pavement:
A. Existing asphalt concrete pavement on site shall be pulverized by a method that limits damage or dislodging of the material below the pavement. The pulverized material shall conform to the following gradation:

Sieve Size U.S. Standard	**Percent Passing By Weight**
1-1/2" inch	100
3/4" inch	40 min

B. Acceptance of the gradation will be based on visual inspection by Hong West, King County's Representative.
2.03 Mixed Crushed Concrete/Asphalt
A. Any mixed crushed concrete/asphalt shall conform to the gradation specified above in Section 2.02.
Part 3 - EXECUTION
A. The Contractor shall crush, haul and stockpile the crushed materials to a stockpile area on site designated by King County. Crushed recycled materials shall not be placed higher than Elevation 33 within the parking garage excavation, as shown on the project plans.
B. Where used as backfill in the parking garage over excavation zones, the recycled concrete shall be placed on properly-prepared subgrade. Where very soft, wet subgrade conditions are encountered, use a geotextile separator between subgrade soils and the recycled concrete. Evaluation of conditions requiring use of a geotextile separator, and monitoring of geotextile placement, shall be performed in the field by Hong West, King County's Representative.
C. Where placed as compacted fill, recycled concrete materials shall be moisture conditioned to within 3 percent of the optimum moisture content, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at least 95 percent maximum dry density, determined using ASTM D 1557. Where used as general backfill in areas to be reloaded, the recycled concrete shall be compacted to at least 90 percent maximum dry density, and using the same criteria.
PART 4 - QUALITY CONTROL
A. The Contractor is responsible for the quality of the work and for complying with the specifications. Testing will be conducted by Hong West and King County.
B. The following laboratory tests will be performed on the recycled concrete:
L.A. Abrasion Testing for determination of aggregate durability, using ASTM C 131.
Sand Equivalent Testing, using ASTM C 2419.
Sieve analysis for acceptance of aggregate gradation, using ASTM D 422.

C. Other tests may be performed as necessary based on field conditions, to verify the suitability of the crushed recycled materials for the intended purpose.
PART 5 - MEASUREMENT AND PAYMENT
A. Crushing, placement, and stockpiling of crushed recycled materials shall be measured by lump sum as part of the base bid.
B. Crushed recycled materials that do no meet gradation or other criteria specified herein shall be removed from the site and disposed of at the Contractor's expense.
C. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions, or beyond that level required for normal clearing and grubbing operations or removal of structural elements, without specific direction of King County. Unauthorized excavations within footing over excavation zones shall be backfilled in accordance with these specifications, at the Contractor's expense. Any unauthorized excavations in other areas of the site shall be backfilled as directed by Hong West.
D. Any additional testing required due to recycled crushed materials failing laboratory or field density test specifications shall be at the Contractor's expense. In addition, testing related to backfilling of unauthorized excavations shall be at the Contractor's expense.
E. No payment will be made for materials which has become mixed with other material or misplaced by the Contractor's action, or lack of action. Crushed recycled material which is contaminated by the Contractor by spills or mixing with other site soils, or by any other means, shall be tested, removed, and disposed of by the Contractor at the Contractor's expense.
2.03 BACKFILLING (Supplemental)
G. 5. The Contractor shall backfill the portion of the excavation above the lean concrete using recycled crushed concrete and/or structural fill, in accordance with applicable sections of the Specifications.
For product experience summaries on this project, please see
Recycled Concrete Aggregate at the Regional Justice Center and
Recycled Asphalt Road Base

Fill, Vashon Transfer/Recycling Station

A. Recycled Portland cement concrete rubble shall meet the requirements of WSDOT Section 9-03.11. Recycled Portland cement concrete rubble is specified for its use for specific fill materials in this Section.

F. Structural Fill beneath Structures: Clean, free draining 90% recycled Portland cement concrete rubble and 10% glass cullet meeting the requirement of WSDOT Section 9.03.14 (1). If construction is in wet weather or wet conditions, the maximum passing the US Standard No. 200 sieve shall be 5 percent.

G. Fill: On-site material finely divided and free of debris and organic material. The fill material shall contain no masses of moist stiff clay. The maximum particle size shall be 4 inches, with a maximum of 5 percent passing the US Standard No. 200 sieve.

H. Backfill for Walls: Clean, free draining material meeting the requirements of WSDOT 9.03.12 (2). Backfill shall be 90% recycled Portland cement concrete rubble and 10% glass cullet.

I. Crushed Surfacing Top Course and Base Course: Crushed surfacing shall meet the requirement of WSDOT Section 9-03.9 (3). Crushed surfacing shall be 90% recycled Portland cement concrete rubble and 10% glass cullet.

K. Pipe Bedding and Backfill for Rigid Pipe: Clean, material meeting the requirements of WSDOT Section 9-03.12 (3) except the maximum passing the US Standard No. 200 sieve shall be 5 percent. Material shall be 90% recycled Portland cement concrete rubble and 10% glass cullet.

L. Pipe Bedding and Backfill for Flexible Pipe: Clean, 90% Portland cement concrete rubble and 10% glass cullet meeting the requirements of WSDOT Section 9-03.16.

N. Trench Backfill in Unpaved Areas: On-site material finely divided and free of debris and organic material. The fill material shall contain no masses of moist stiff clay. The maximum particle size shall be 4 inches, with the maximum of 5 percent passing the US Standard No. 200 sieve.

Rubblizing

In 1998, The King County Roads Division tested a process in which deteriorated concrete roadways are rehabilitated by crushing this concrete surface into rubble and using this as a base for a new asphalt road surface. This process is about one-fourth the cost of other techniques, because it avoids the expense of landfill disposal and of new aggregate for the roadbed. The Roads Division used this method for a 2,500 linear feet of roadway this year, avoiding disposal of approximately 1,100 cubic yards of concrete, **saving roughly $90,000** on avoided disposal cost and the purchase of virgin aggregate. The ultimate cost of the project was about $30,000.

WSDOT - 2002 Standard Specifications

AGGREGATES
9-03.9 Aggregates for Ballast and Crushed Surfacing
9-03.9(3) Crushed Surfacing
Crushed surfacing shall be manufactured from ledge rock, talus, or gravel in accordance with the provisions of Section 3-01. The materials shall be uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following test requirements:

Los Angeles Wear, 500 Rev 35% max.
Degradation Factor -- Top Course 25% min.
Degradation Factor -- Base Course 15% min.

Crushed surfacing of the various classes shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Base Course Percent Passing	Top Course and Keystone Percent Passing
1-1/4" square	100	
1" square	80-100	
3/4" square		100

5/8" square	50-80	
1/2" square		90-100
U.S. No. 4	25-45	46-66
U.S. No. 40	3-18	8-24
U.S. No. 200	7.5 max.	10.0 max.
% Fracture	75 min.	75 min.
Sand Equivalent	32 min.	32 min.

All percentages are by weight.

The fracture requirement shall be at least one fractured face and will apply to material retained on each sieve size U.S. No. 10 and above if that sieve retains more than 5 percent of the total sample.

The portion of crushed surfacing retained on a U.S. No. 4 sieve shall not contain more than 0.15 percent wood waste.

9-03.11 Recycled Portland Cement Concrete Rubble

Recycled Portland cement concrete rubble may be used as, or blended with: ballast; shoulder ballast; crushed surfacing base and top course; maintenance rock; gravel backfill for foundation, walls, and pipe bedding material; gravel borrow; and foundation material.

A preliminary sample of the recycled concrete, and native material if any, used for ballast, shoulder ballast, crushed surfacing base and top course, maintenance rock, and gravel backfill for foundation Class A shall be submitted for testing for LA Wear and Degradation Factor. In addition, the source of any native material that may be blended with the recycled Portland cement concrete rubble shall also meet the specifications for LA Wear and Degradation Factor for the type aggregate being used.

A maximum of 20 percent by weight of recycled asphalt concrete pavement may be used in the blended product. The asphalt concrete content is calculated as the amount of asphalt particles retained on all screens U.S. No. 4 and above.

The recycled aggregates shall be stockpiled in such a manner that each certified test report will identify a single stockpile of not more than 10,000 tons.

The Contractor shall certify that the recycled material is neither hazardous or toxic. This certification shall address the toxicity characteristics prescribed in WAC 173-303-090(8) under sampling and testing according to WAC 173-303-110. Sampling and testing shall be one per 10,000 tons from any single source and not less than one sample from any single source.

Acceptance of the recycled concrete rubble aggregate for hazardous and toxic requirements shall be by Manufacturer's Certificate of Compliance with accompanying test reports.

Gradation, sand equivalent, and fracture requirements will be per the specific product outlined in these specifications.

For More Information

Further information may be available through the following main menu selections:

King County Recycled Content Supply Contracts
Resources for Buyers
Standard Paragraphs for Contracts

Vendor Information

Renton Concrete Recyclers, (425)481-9101 Bothell, WA
Cadman Sand and Gravel, (425)794-4100 Monroe, WA
Stoneway Rock and Recycling, (425)226-1000 Renton, WA

E-mail

Return to Environmental Purchasing Menu

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