



TECHNICAL ADVISORY

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Recycled Concrete Aggregates Make Cents

In today's environment of skyrocketing material and transportation costs encountered in road construction, recycled concrete aggregates (RCA) provide substantial savings to TxDOT and taxpayers. Natural resources are conserved, waste disposal is reduced, and air quality is improved due to reduced haul distances and reduced energy consumption. In many cases, allowing the use of RCA can be the most cost effective choice for an aggregate source. This is especially true for those districts that do not have good, native aggregate sources. Using RCA can reduce time and expense of importing aggregates from other parts of the state.

TxDOT has researched and used RCA with good success for about 15 years. In just the last two years alone, TxDOT saved approximately 1.8 million tons of virgin aggregates by incorporating RCA in cement treated base, flexible base, continuously reinforced concrete pavement (CRCP), filter dams, gabion walls, concrete traffic barriers, flowable fill and select backfill for mechanically stabilized earth walls. This equates to an estimated savings of \$12.6 million from reduced or eliminated landfill and virgin aggregate associated costs. Savings from using RCA has the potential to increase tenfold based on current availability of RCA.

➔ ENGINEERING PROPERTIES

Compared to virgin aggregates, RCA typically have a higher percentage of material passing the No. 200 sieve, lower specific gravity, higher water absorption, higher sulfate soundness loss and higher Los Angeles Abrasion loss. The minus No. 4 fraction typically has a low plasticity index and high alkalinity. Item 6, "Control of Materials," of the Department's 2004 *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* requires that it be certified as a nonhazardous recyclable material (NRM) in order to be used on TxDOT projects. The RCA producer must meet the requirements of departmental material specification DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines."

➔ ITEM 247, FLEXIBLE BASE

RCA can be used on TxDOT projects when specified on the plans as Type D under Item 247, "Flexible Base," of the Department's 2004 *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*. In addition to the requirements specified in DMS-11000, Item 247 requires contractor-furnished RCA to be free from reinforcing steel and other objectionable material. It can have a maximum of 1.5% deleterious material and 3000 ppm of soluble sulfates. The Engineer may also require separate dedicated stockpiles. RCA typically increases the optimum moisture requirement when used as a flexible base. Because of its high absorption properties, it can potentially lose strength if not protected from moisture. When allowing Type D as an option, it is recommended that strength and wet ball mill requirements be specified (such as in Grade 1). An alternative is to specify Item 276, "Cement Treatment (Plant-Mixed)," to reduce or eliminate the potential for loss of strength and water absorption of RCA.

➔ ITEM 421, HYDRAULIC CEMENT CONCRETE

RCA can also be used as a coarse aggregate in Item 421, "Hydraulic Cement Concrete," as long as it meets the specification requirements. CRCP constructed with RCA has a long history of good performance. Positive effects for pavements are higher creep values and lower modulus of elasticity. Although RCA can cause the final concrete to have a higher magnesium sulfate soundness loss due to the attached old mortar, experience has eliminated this as a concern and magnesium sulfate soundness requirements

are waived when RCA is used as a coarse aggregate in CRCP. Lower strengths, increased water demand and diminished workability, particularly in hot weather, are also concerns, but these can be compensated for during mix design and construction. Moisture control is critical and it is extremely important to sprinkle the aggregate stockpiles in order to maintain consistent moisture content. Recycled fine aggregate has an adverse effect on flexural strength and currently not allowed in concrete applications. Additionally, unlike pavements, the higher creep properties caused by RCA has a negative impact on structural concrete, thus the Department no longer allows RCA in structural concrete.

➔ **ITEM 423, RETAINING WALLS**

RCA can also be used as select backfill in Item 423, "Retaining Walls." RCA generally provides adequate gradation, compaction, shear strength and pullout properties, but has a lower hydraulic conductivity. When allowing RCA backfill for MSE walls, the gradation must meet the Type A or D requirements under Item 423 and the walls should not be subject to inundation. For walls constructed with RCA, incorporate adequate drainage elements following the guidelines on the RW (MSE) standard sheet. RCA from concrete structures that have suffered chloride or sulfate attack should not be used as retaining wall backfill. Resistivity and pH requirements should be waived but the RCA should still be tested for chloride ion concentrations and soundness. RCA material to be used as retaining wall backfill should be tested for soundness and meet the minimum requirements in Item 423.

➔ **TESTING AND INSPECTION**

Because RCA is a recycled product, a great deal of variability can exist not only from one stockpile to the next, but also even within a stockpile. This variation can be caused by a variety of factors, including the quality of the original concrete, crushing method, type of concrete crushed, clays and soils introduced during the transportation process, and rebar not completely removed during demolition. RCA obtained for salvage from TxDOT highway projects are reasonably free of contaminants if care has been taken to segregate it from underlying asphalt, base and subgrade. Because TxDOT is unaware of the chain of custody of RCA obtained from non-TxDOT projects, take additional care to ensure that other contaminants such as gypsum, glass, tile, etc. are not present in unacceptable levels prior to use. Individual stockpiles should be built, sampled and tested to ensure quality and consistency. Do not allow completed stockpiles to have material added to them after they have been sampled.

➔ **SUMMARY**

RCA is a valuable resource that represents significant savings and environmental benefits to TxDOT and the public. Districts should encourage using RCA in flexible and cement treated base, all non-structural concrete and MSE backfill as long as engineering and specification requirements are met. The RCA must be certified as an NRM in accordance with DMS-11000. Mix designs should be performed to maximize material properties. Special care should be taken to ensure stockpiled material is free from contaminants and of uniform quality. When used in concrete, stockpile moisture content is critical.

➔ **CONTACT INFORMATION**

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