PD-20

Recycle Materials

Goal

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials through recycling.

Sustainability Linkage

Recycling materials supports the environmental and economic principles of the triple bottom line by reducing the consumption of raw materials, reducing landfill waste, and encouraging cost savings. Some savings accrue to the traveling public because recycling pavements in place can reduce traffic disruption. However, the main benefits associated with recycling involve the avoidance of mining, processing, delivery, and disposal impacts.

Potential TBL Cost Savings*

$$ - DOTs can save 10-50 percent of their paving costs.

$ - Highway users can save travel time from reduced construction delay.

$ - Environmental impacts of mining and land filling can be avoided.

$ - Agencies set a good example and provide safety benefits.

*Order of magnitude Triple Bottom Line (TBL) dollar equivalent potential savings: $~1M, $$~10M, $$$~100M

Basis for Savings

The majority of available agency cost savings information related to the recycling of transportation facility constituents involves the use of Reclaimed Asphalt Pavement (RAP), Recycled Concrete Aggregate (RCA), and/or in-place construction recycling methods.

As the resource base for virgin materials diminishes over time, the best materials available for reconstruction are often found in existing pavements. In addition to reducing waste, recycling pavements can lead to the use of best available materials while minimizing transportation, land fill, and mining impacts.[1]

Recycling of pavement materials can result in shorter construction times and less trucking of construction materials, thus minimizing traffic disruptions and associated costs on the traveling public.[2]

Recycling pavement materials reduce the amount of construction trucking required to complete a project, thus reducing related energy use, emissions, and traffic congestion.[3] It also reduces the environmental impacts associated with the mining of virgin materials by leaving these resources available for future generations along and scarce landfill capacity.[4]

Citizens who expect their government to be sensitive to the needs of future generations are not only well served by the direct dollar savings generated by the recycling practice, but also benefit from the example and precedent set by public agencies establishing practices that encourage the wise reuse of existing resources.

Agency Experience

According to the Ohio Department of Transportation (ODOT) Cleveland Inner Belt (George V. Voinovich) Bridge INVEST Case Study, nearly all of the materials from the closed Inner Belt Bridge in Cleveland will be recycled or reused.[5]

Reclaimed Asphalt Pavement and Recycled Concrete Aggregate

RAP has been extensively used for decades in pavement construction across the country. According to a recent study jointly conducted by National Asphalt Pavement Association (NAPA) and FHWA, the 2012 construction season used more than 68.3 million tons of RAP and 1.86 million tons of Recycled Asphalt Shingles (RAS) in pavements across the U.S., saving taxpayers more than $2.2 billion.[6] Based on recent survey results, the NAPA estimated savings at $600 per ton for asphalt binder, assuming five percent liquid asphalt in RAP, is $2.04 billion. The estimated savings at $600 per ton for asphalt binder, assuming conservative asphalt content for the RAS, is $228 million.[7]

% RAP	% Savings[8 9 1011]
10	8
20	14 - 15
25	14 - 20
30	21
40	28
50	30 - 40

Savings associated with different percentages of RAP content have been reported by various researchers as a percent of total pavement cost.

Performance of RAP has also proven to be good. An FHWA survey of states found that over a 17-year period, the performance of recycled Hot Mix Asphalt (HMA), designed and controlled during production, is similar to or could even improve upon the properties of conventional HMA. In the 1970s WSDOT built two projects using 70 percent RAP that had service lives of 16 years in comparison to control sections (no RAP) that lasted 10 years.[12] Although greater usage of RAP is desirable, it must be noted that there are less obvious factors that the use of higher percentage RAP may affect. Based on available resources, environment, and site conditions, the percentage of RAP use that provides an optimal level of cost savings and performance could differ on a case-by-case basis.[13]

The American Concrete Pavement Association (ACPA) reports that RCA byproducts (e.g., crushed concrete pavement used as aggregate) varied in price from $1 to over $16 per ton, and resulted in as much as $4 per ton of savings per square-yard of Portland Cement Concrete (PCC). Some estimate savings as high as $5 million on a single project by using RCA.[14] Other technologies such as roller compacted concrete pavement (RCCP)[15] and composite pavements, particularly HMA over PCC[16] and two-lift concrete pavements,[17] can also use recycled materials and generate cost savings.

In-Place Pavement Recycling

Methods of In-Place Pavement recycling include Cold In-Place Recycling (CIR), Hot In-Place Recycling (HIR), and Full Depth Reclamation (FDR). In-place pavement methods can substantially reduce transportation costs associated with hauling aggregate by using the material already in place. FHWA reports initial savings for CIR in lieu of conventional construction methods of 6 to 67 percent; 20 to 30 percent range savings were most commonly reported by state DOTs.[18] Similarly, FHWA research suggests that the use of HIR methods can generate cost savings over conventional construction methods in a range of 17 to 50 percent, with the 15 to 25 percent range of savings being most commonly reported by state DOTs.[19] With Full Depth Reclamation (FDR) costs are typically reduced by 25 to 50 percent and waste production is minimal compared to conventional treatments.[20]

Recycling Minor Structural Elements

Anecdotal information suggests that at least 90 percent of the minor structural highway elements including existing luminaries, signal poles, and sign structures can be relocated, reused, or recycled at considerable savings. For instance, North Park Road, Jackson Lake Lodge to Leek's Marina Project relocated and reused over 90 percent of minor structural elements.[21] However, documented research on agencies experience recycling minor structural elements is lacking due to its "business as usual" nature.

Notes on Valuation

In general the savings to be realized through recycling of materials will depend on:

- ✓ Availability of virgin materials
- ✓ Local markets
- ✓ Available technologies

Individual Assessments

States are encouraged to access the following references and to consult the FHWA Invest Subject Matter Expert, Gina.Ahlstrom@dot.gov for additional working materials in assessing their own unique situations and/or if they have information that could assist others on this topic.

References

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