BUILDING San Diego County BETTER ROADS

GUIDANCE DOCUMENT S-3

RECLAIMED ASPHALT SHINGLE (RAS) USE IN HMA

May 2025
Version 1.0

www.sandiegocoutny.gov/bbr

RECLAIMED ASPHALT SHINGLES (RAS)

ABSTRACT

This guidance document will detail the benefits of local agencies utilizing RAS pellets in asphalt .

Environmental, policy, and economic considerations support the increased use of recycled content in pavement. While recent focus has largely been on increasing the use of recycled asphalt pavement (RAP), asphalt shingles are a widely available resource that can increase recycled content and displace high-cost virgin asphalt in pavement. The components of asphalt shingles include asphalt binder, aggregates, and fiberglass fibers. Each of these materials is either necessary to or has benefits in hot mix asphalt production, yet California's state and local specifications do not allow inclusion of RAS in pavement. More than half of states allow RAS in at least some mixes, but experiences with RAS use since the 1990's have been varied. There is a need for solutions that enable the effective recycling of RAS in pavement while ensuring pavement performance is maintained. The demonstration and evaluation of newer pre-treatment technology for RAS in San Diego County is a key step in meeting this need.

PROBLEM STATEMENT

Addressing the challenges of integrating Recycled Asphalt Shingles (RAS) into pavement materials to enhance sustainability while mitigating premature cracking and handling issues.

The use of RAS in pavement as a binder replacement was pioneered and grew in popularity in the 1990's. The traditional use of RAS in pavement involves receiving pre- or post-consumer shingle waste, grinding it to 3/8 inches or less, then introducing the ground shingles to the hot mix. RAS is typically used up to 5% by weight of the mixture, conservatively replacing up to 20% of the total binder. Binder from RAS differs from virgin paving binder in important ways. The binder used in shingles is stiffer than paving grade binder. It is additionally stiffened during aging of the shingles. When untreated RAS is added to hot mix, it may not melt and blend entirely at typical hot mix temperatures, resulting in less contribution of available bitumen. These factors – if not properly addressed – can result in a more brittle mixture that is prone to premature cracking. While the stiffening impacts of RAP exist to some degree, some sources state that the binder in RAS has approximately twice the stiffening impact on the HMA binder than a similar quantity of RAP[1].

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Around 2014, these issues were identified by the Federal Highway Administration and others as having contributed to increased instances of premature cracking of RAS-containing pavements[2]. Some agencies reduced RAS or ceased RAS use because of concerns about cracking, while others have continued. As it stands today, most state departments of transportation allow RAS in at least some mixes. Some states have amended specifications to limit the total quantity of RAS by weight, limit the percent binder replacement, require the use of softer virgin binder to compensate for stiffer binder from RAS, allow recycling agents, or require an assumption of less effective binder contribution from RAS. Overall, the use of RAS in pavement in the U.S. has declined from an estimated 2 million tons in 2014 to 670,000 in 2021[3].

In addition to the above concerns regarding cracking, some handling challenges have also presented a barrier to broader adoption of RAS use by pavement contractors. Storage of ground RAS is complicated by the fact that stockpiles standing for more than a few weeks reagglomerate, requiring re-processing or risking clumping in the mix. Consistently feeding ground RAS into the mix can also be challenging due to the ground RAS agglomerating during and within the feed equipment.

Environmental Drivers – Recycled Content in Pavement

Using RAS in pavement diverts waste from disposal and increases recycled content in roads. Shingle waste is generated in large quantities and is nearly always disposed in landfills. The U.S. EPA's estimate is that 15 million tons of shingle waste is generated in the U.S. annually, and 13 million tons of that is disposed in landfills[4]. Shingles make up about 2.5% of construction and demolition (C&D) material generated, but about 9% of C&D material disposed[5]. Comparison with other, more frequently discussed material streams reveals the magnitude of this issue; more asphalt shingles are landfilled annually than plastic packaging, for example[6]. Asphalt shingles are also disposed in much greater quantities than asphalt concrete, despite the fact that asphalt pavement generation is over seven times that of asphalt shingles[7]. California is no exception to this, with over 540,000 tons of asphalt roofing disposed in California landfills in 2021[8]. Existing landfill capacity is finite, and constructing new landfills is complicated by environmental regulation, local land use, community opposition, and environmental justice issues.

Meanwhile, there are important environmental drivers to increase recycled content of road materials. Over 94% of U.S. roads are paved with asphalt, and

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over 420 million tons of asphalt mix was produced in the U.S. in 2020. The magnitude of this production makes it important in broader efforts to reduce raw material use and environmental impacts of the transportation sector. The federal government has identified asphalt pavement as one of the highest contributors to greenhouse gas emissions among construction materials[9]. A recent greenhouse gas emissions inventory found that the production of asphalt pavement in the U.S. generated 21.7 MMT CO2e in 2019[10]. Increasing recycled content in asphalt pavement has been identified as an important method of reducing embodied greenhouse gas emissions of roads[11]. The current use of RAS and RAP was estimated to reduce the emissions associated with U.S. asphalt pavement production by 3.0 MMT CO2e in 2019, a reduction of 12%. Increases in recycled content in the future were cited as a key strategy to further reduce embodied emissions of pavement[12]. Another study by the National Asphalt Pavement Association evaluated potential scenarios of RAS use and found that mixes with 2% and 5% RAS contents would reduce cradle-to-gate (A1-A3) GHG emissions by 4% and 10%, respectively[13]. Inclusion of RAS in pavement is also constituent with efforts to create a circular economy, since end-of-life pavement including RAS can in turn be recycled as RAP.

Policy Drivers

The policy atmosphere is rapidly evolving to prioritize embodied carbon and recycled content in construction materials, including road pavements. The federal government initiated a Buy Clean program, identifying asphalt as one of four priority materials. Subsequently, over $2 billion was allocated to the General Services Administration through the Inflation Reduction Act (IRA) for the purchase of low embodied carbon construction materials, and embodied carbon limits were established for asphalt as part of that program[14]. The U.S. EPA is developing a low-embodied carbon labeling program for construction materials, including asphalt. Finally, the Federal Highway Administration received $2 billion under the IRA to allocate to state and other agencies to fund low carbon materials, in addition to its existing Climate Challenge program[15].

California has created an incentive program to encourage the development of environmental product declarations (EPDs) in the asphalt and concrete industries by reimbursing certain costs for EPDs for materials used on Caltrans projects[16]. California law requires at least 65% of construction and demolition

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material from certain job sites to be recycled, and local governments may adopt more stringent standards[17]. Under 2017 legislation, California's Road Maintenance and Rehabilitation Program requires cities and counties receiving state funds to use material recycling techniques that reduce costs and greenhouse gas emissions[18]. Recent legislation emphasizes the use of recycled materials in road construction, requiring local governments to allow the use of recycled materials to at least the same extent as Caltrans' standard specifications[19]. CalRecycle continues to strive toward higher levels of waste diversion and recycled content use generally, and is currently in the process of developing a Zero Waste Plan for the state[20].

Within San Diego County, the Climate Action Plan adopted in September 2024 calls several waste diversion actions, including establishing an 80% waste diversion target by 2030 and 90% diversion target by 2045[21].

Approach in California

RAS is not currently used in California. CalTrans standard specifications do not allow for RAS, nor do the Greenbook specifications referenced by many local governments in California[22]. CalTrans' Pavement Materials Partnering Committee created a scoping document to use up to 3% RAS in HMA, and in 2023 published the results of pilot projects using RAS[23]. As of 2024, CalTrans is reviewing the results of the pilot projects and developing a new scope of work to govern the ultimate creation of a high RAP and RAS standard special provision.

Figure 1:RenuCore™ RAS Pellets

Key Issues:

- The binder in RAS is stiffer than virgin binder, leading to premature cracking.
- RAS helps divert 13 million tons of shingle waste from landfills annually, and its inclusion in asphalt reduced CO2 emissions by 3.0 million metric tons in 2019.
- California aims for 80% waste diversion by 2030, with federal programs providing over $2 billion for low-carbon construction materials, including asphalt.

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THE SOLUTION

RAS Pellets: The Sustainable Solution for Smarter, Stronger Asphalt Mixes..

New, pre-treatment technology can address the past challenges with RAS use, unlocking the economic and environmental benefits of this source of recycled content. The RenuCore by CertainTeed™ pelletizing technology is a pre-treatment process that enables RAS to be used more effectively and consistently in asphalt mixes. In the RenuCore™ process, pre- or post-consumer asphalt shingles (or a mixture of both) are ground to the industry standard 3/8" minus. The ground shingles are then pelletized with a recycling agent and a water-resistant coating. This allows the recycling agent to target the shingles specifically and soften the stiff asphalt before the RAS is ever added to the mix. The RAS pellets are then added to the hot mix, where they melt and blend entirely in the mix. Up to 5% RAS pellets (by weight) may be included in the mix. By pelletizing the RAS, the storage and feed issues are also resolved. The pellets can be utilized shortly after production, or stored for up to 12 months.

Testing to Date

RenuCore Pelletizing Technology has been in use for several years in Washington and Oregon, and has been subject to testing as described below.

PG Grading

PG grading of the asphalt cement extracted from RAS pellets treated with the RenuCore process demonstrates the process's effectiveness in creating a quality binder appropriate for pavement applications.

As discussed above, because of the stiffer binder typically used for asphalt shingles and aging during the use of the shingle, the asphalt cement extracted from untreated RAS is typically much stiffer and has a higher temperature grade than pavement grade asphalt. In contrast, the PG of asphalt cement from RAS pellets treated with the RenuCore process was 84 -46 (Figure 1). This demonstrates that by pretreating the RAS, a product with quality, pavement grade binder can be created before the RAS is ever added to the mix.

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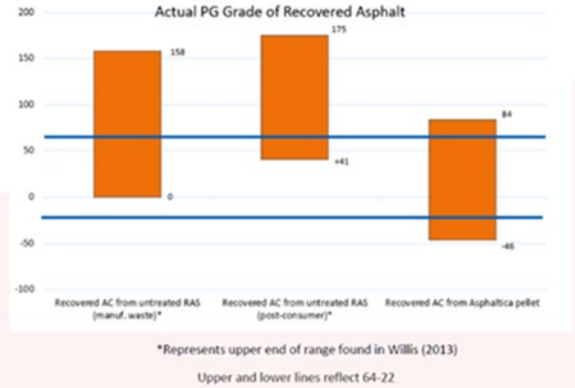

Figure 1: PG Grade of Recovered Asphalt from RAS

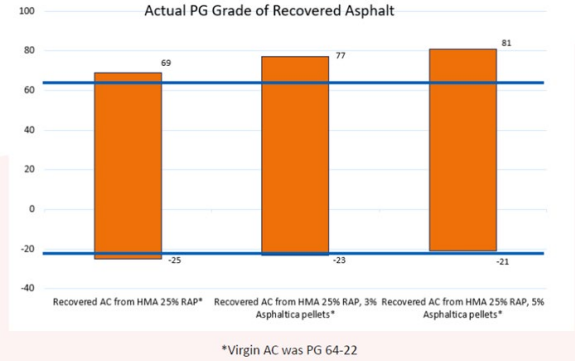

Figure 2: PG Grade of Recovered Asphalt from Mixes with and without RAS

PG grading of the asphalt cement extracted from mixes with and without RAS pellets further demonstrates this effect. As shown in Figure 2 above, addition of RAS pellets to HMA mixes containing 25% RAP improved the top end performance (providing protection against rutting and shoving), with minimum impact on the bottom end.

IDEAL-CT Testing

Because the typical concern with the addition of RAS is with premature cracking, IDEAL-CT testing was performed to evaluate cracking resistance of mixes with pre-treated RAS pellets.

Figure 3 below shows the results of 2023 testing of three mixes containing 30% RAP. One mix containing no RAS was compared with mixes containing 3 and 5% RAS pellets treated with the RenuCore process. The addition of the RAS pellets increased the average CT index, indicating that the process results in improved cracking resistance.

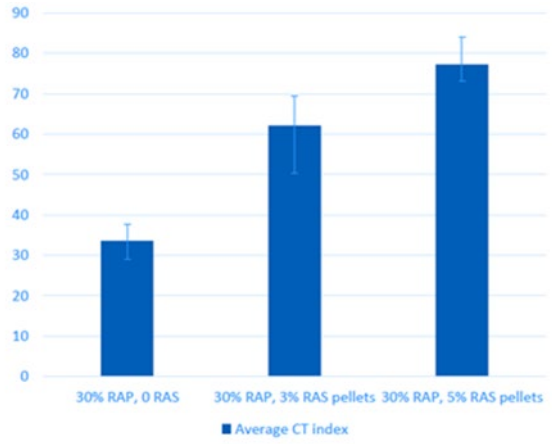

Figure 3: CT_{Index} for Asphalt Mixes With and Without RAS Pellets

In-Situ Pavement Performance

A 2024 white paper written by a third party consultant evaluated the performance of five pavement locations in Washington with and without RAS pellets. While the nature of the study as a comparison of cores taken from existing pavements limited the ability to achieve exact

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consistency in paving dates and air voids of the cores tested, the white paper concluded that the addition of RAS Pellets had no discernable effect on moisture-induced damage, rutting, or cracking resistance. All pavements surveyed, which were paved between 2020 and 2022, were free from visually apparent environmental or load-related defects and met generally applicable standards for tensile strength ratio, Hamburg rut depth, and CT index.

Potential Cost Impacts

While the specifics will vary based on the production volume and transportation distances for the shingles, the RenuCore process is anticipated to reduce costs of pavement production. A pelletizing plant may be located either at a recycler (e.g. Construction and Demolition debris recycling facility) or at a HMA plant. The establishment of the pelletizing plant involves some up-front capital equipment costs. There is the operational costs of the plant. However, the facility creating the RenuCore pellets typically can collect a tipping fee for shingles, which otherwise roofing manufacturers or roofing installers would need to pay to dispose. The HMA producer will also benefit from a reduction in costs for virgin asphalt as a result of the RAS displacing virgin asphalt. For example, for RAS with 20% asphalt cement content and a mixture with 5.5% binder, inclusion of 5% RAS pellets would replace approximately 18% of the binder.

Key Takeaways:

- RAS pellets create a pavement-grade binder with a PG rating of 84-46, ensuring superior mix performance.
- IDEAL-CT testing shows that RAS pellets improve cracking resistance in asphalt mixes.
- RAS pellets replace up to 18% of binder with recycled shingles, cutting costs and reducing waste.

CONCLUSION

RAS Pellets: Paving the Way for Sustainable, High-Performance Asphalt.

Environmental and economic factors are driving the increased inclusion of recycled content in asphalt, with asphalt shingles presenting a significant, yet underutilized, opportunity. Currently, the use of recycled asphalt shingles (RAS) is not permitted on California roads due to concerns over premature cracking, primarily caused by

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the stiffer binder found in shingles. However, newer pre-treatment technologies like the RenuCore Pelletizing Technology address these challenges by creating pellets that improve binder quality and enhance the mix's performance. Testing has shown that RenuCore-treated RAS pellets not only provide a pavement-grade binder but also improve cracking resistance. To explore the potential benefits, it is recommended that San Diego County conduct a pilot paving project incorporating RAS pellets treated with the RenuCore process. The results from this pilot should be thoroughly evaluated to determine the feasibility of allowing pre-treated RAS pellets in future pavement specifications. A detailed workplan for the pilot project is included in the Appendix.

Key Takeaways:

- Asphalt shingles present a significant opportunity for recycled content in pavement, yet their inclusion is currently restricted in California due to concerns over premature cracking. RPAs cut virgin binder use, boost RAP allowances, and support carbon neutrality goals.
- Agencies are encouraged to conduct a pilot paving project with RenuCore-treated RAS pellets to evaluate their effectiveness and consider changes to pavement specification

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REFERENCES

[1] Federal Highway Administration, *Techbrief: State of the Knowledge for the Use of Asphalt Mixtures with Reclaimed Binder Content* (Sept. 2018), https://www.fhwa.dot.gov/pavement/pubs/hif18059.pdf
[2] *See, e.g.* Federal Highway Administration Memo, "Recycled Materials in Asphalt Pavements" (October 20, 2014), available at https://www.fhwa.dot.gov/pavement/recycling/141020.cfm
[3] NAPA, Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage 2022.
[4] EPA, *Advancing Sustainable Materials Management: 2018 Fact Sheet,* p. 23 (Dec. 2020), https://www.epa.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf
[5] Id at pp. 20, 23.
[6] Id at p. 4.
7[1] Id. at pp. 20, 23.
[8] CalRecycle, *2021 Disposal-Facility-Based Characterization of Solid Waste in California* p. 24 (June 2024), https://www2.calrecycle.ca.gov/Publications/Details/1738
[9] The White House, FACT SHEET: Biden-Harris Administration Announces New Buy Clean Actions to Ensure American Manufacturing Leads in the 21st Century (Sept. 15, 2022) https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/15/fact-sheet-biden-harris-administration-announces-new-buy-clean-actions-to-ensure-american-manufacturing-leads-in-the-21st-century/
[10]NAPA, GHG Emissions Inventory for Asphalt Mix Production in the United States, pp. 8, 11 (June 2022), https://www.asphaltpavement.org/uploads/documents/Sustainability/SIP-106_GHG_Emissions_Inventory_for_Asphalt_Mix_Production_in_the_US_%E2%80%93_NAPA_June_2022.pdf
[11] Id.
[12] Id at p. 11.
[13] NAPA, *The Carbon Footprint of Asphalt Pavements,* p.29 (March 2024), https://www.asphaltpavement.org/uploads/documents/Climate/NAPA-SIP109-TheCarbonFootprintOfAsphaltPavements-March2024.pdf
[14] GSA, Low-embodied carbon program details, https://www.gsa.gov/real-estate/gsa-properties/inflation-reduction-act/lec-program-details
[15] FHWA, Low-Carbon Transportation Materials Grants Program, https://www.fhwa.dot.gov/lowcarbon/
[16] CalTrans, FHWA Climate Challenge, https://dot.ca.gov/programs/engineering-services/fhwa-climate-challenge
[17] CalGreen §5-408.1.
[18] 2017 Senate Bill 1 (Beall).
[19] 2022 Assembly Bill 2953 (Salas).

[20] 2023 SB 101 (Budget Act of 2023).
[21] San Diego County, Climate Action Plan Update, https://www.sandiegocounty.gov/content/sdc/sustainability/climateactionplan/
[22] CalTrans, Standard Specification 2023 Edition, https://dot.ca.gov/-/media/dot-media/programs/design/documents/2023_stdspecs-a11y.pdf; Greenbook 2024 Greenbook: Standard Specifications for Public Works Construction.
[23] CalTrans Pavement & Materials Partnering Committee, Work Product Scoping Document, Use of Recycled Asphalt Shingles (RAS) in Hot Mix Asphalt, https://dot.ca.gov/-/media/dot-media/programs/maintenance/documents/pmpc/atg/pmpc-atg-sd-up-to-three-percent-ras-a11y.pdf; CalTrans, RAP and RAS in HMA Pilot Project on ELD 49 (Jan 2023), https://dot.ca.gov/-/media/dot-media/programs/maintenance/documents/office-of-asphalt-pavements/rap-and-ras-in-hma-pilot-project-on-eld49-a11y.pdf