VERMONT AGENCY OF TRANSPORTATION
Research Section
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Initial Report 2019-06

Recycled Asphalt Shingles (RAS) in Town Gravel Roads-Initial Report

1. INTRODUCTION

Together, VTrans and VTANR-DEC are working to develop the use of Recycled Asphalt Shingles (RAS) as an aggregate additive to gravel roads. The idea for this project stemmed from a 2002 pilot of a RAP/RAS/Gravel used by Vermont towns in 2002 [1]. Available literature from Minnesota DOT (2014) and Iowa DOT (1997) show the beneficial use of RAS in gravel roads, providing reduced maintenance needs and decreased dust [2][3].

Vermont generates an estimated 25,000 tons of waste shingles a year [4]. Act 175 of the Vermont Legislature will increase shingle recycling, and create a supply of RAS in the state. To utilize this supply of RAS, VTrans and VTANR-DEC are advocating and testing the use of 20% RAS in town gravel roads. The proposed projects targeted using RAS that meets AASHTO MP-23, which calls for material 3/8" minus (100% of material passing a 3/8" sieve), with limited debris.

2. TEST SITE SUMMARIES

2.1. Pownal

The town of Pownal, in SW Vermont, was sent 64 tons of RAS from Myers Recycling in Colchester. The town mixed the RAS with their own gravel, at approximately 22-25% by volume, and used it to resurface 750 ft of Cedar Hill Rd, location shown in Figure 1. The roadway has a uniform width of 19 ft, 5-6% crown, a slope consistently between 10-15%, and rill erosion on the roadway edges.

Figure 1: Location of Pownal Test Section, Cedar Hill Rd.

The RAS used in the Pownal test section was not compliant with AASHTO MP-23. The RAS used had larger than 3/8" maximum aggregate size, contained a not insignificant amount of debris and particularly worrying 18 nails (two of them steel) were removed by hand from roadway after placement. Photos of the materials are available in Figure 2.

Pownal Gravel Pile

Pownal RAS Pile

Pownal 80/20 Gravel/RAS

RAS Clump

Figure 2: Pownal Materials to be used in test section

Construction of the road followed typical procedures used by the Town, with the additional step of using a finish roller to compact the material. In addition to the 750 ft RAS test section, they resurfaced and graded the adjacent roadway section with conventional gravel. Construction took place on 8-24-18. The resurfacing process can be seen in Figure 3.

Grader shaping of existing roadway materials

Truck dumped and spread material

Grader spreading

Tractor rake of surface

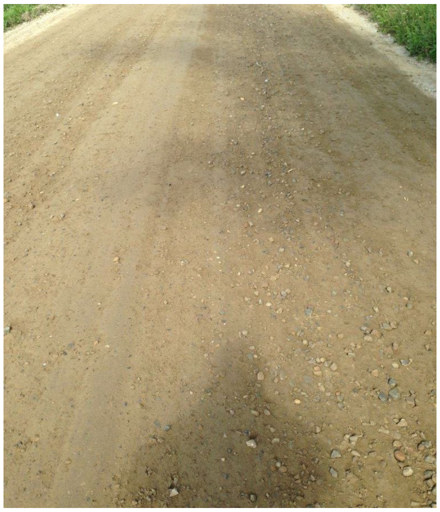
Chloride application

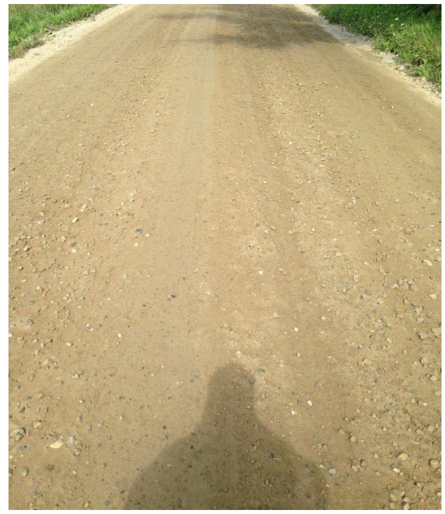
Two passes of the 2 ton roller

Figure 3: Test Section Construction

The day after construction of the RAS test section, the surface deteriorated. The roadway did not bind into a well packed surface, the large aggregate of the gravel floated to the top, forming a loose and uneven surface. Control sections made with conventional gravel did not show poor binding; instead the roadway looks well consolidated and stable (Figures 4 and 5).

RAS Test Section





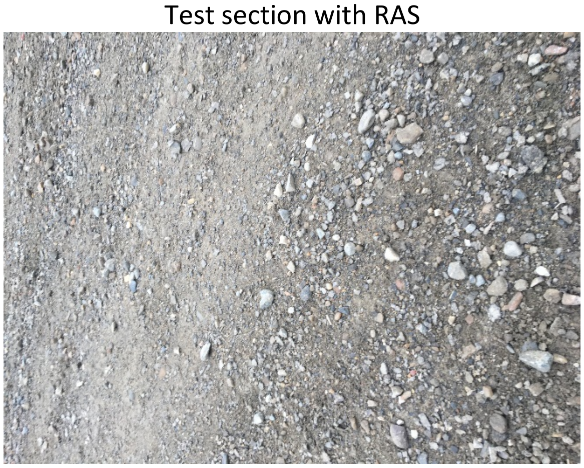
Gravel Control Section

Figure 4: Failure of the RAS Test Section compared to the All-Gravel Control Section

Washboards quickly developed as a result, and performance was very poor. Investigation of the roadway during VTrans' visit on 9-7-18 showed segregation of materials and that below the coarse surface, a compact and well graded aggregate existed.

Test section with RAS

Segregation of material



Control section with conventional gravel

Dimensions of displaced aggregate

Figure 5: More Failure Photos, September 2018

Upon discussion between VTrans, VTANR-DEC, and town staff, the larger stones were raked off of the surface, and the roadway was regraded and rolled with a larger roller in early September. Town staff report good performance of the roadway in the following days until a rain event caused the large aggregate and RAS to again float to the surface. Observations indicate that the second failure was not as severe as the first.

RAS Test Section - Hill

RAS Test Section

RAS Test Section – Flat

Loose Shoulder Material

Figure 6: October 10th, 2018 Pownal Visit

Sieve analysis showing the breakdown of the various materials can be seen in Table 1 and the distribution in Figure 7. Samples of the new gravel used in reconstruction show a higher proportion of material above ¾". The RAS sampled was found to be above the 3/8" minus targeted for the project, as shown in Table 1, where 21% of the material is retained on the 3/8 sieve. The combined gravel with RAS has a larger gradation than the virgin aggregate, and is a potential cause of the surface instability.

Table 1: Pownal Sieve Analysis

Sieve Size	Sieve Size	Sieve Size	Percent Passing (by mass)			
(mm)	(in)	(#)	Existing Gravel	New Gravel	Gravel with RAS	3/8 Plus RAS
25	1		99	100	99	100
19	3/4		97	88	87	100
12.5	1/2		88	71	68	93
9.5	3/8		81	63	59	79
4.75	0.187	#4	65	49	41	29
2	0.0787	#10	53	36	30	18
0.841	0.0331	#20	42	25	20	11
0.42	0.0165	#40	31	19	16	7
0.25	0.0098	#60	24	17	13	2
0.149	0.0059	#100	18	14	11	2
0.074	0.0029	#200	11	10	7.4	1

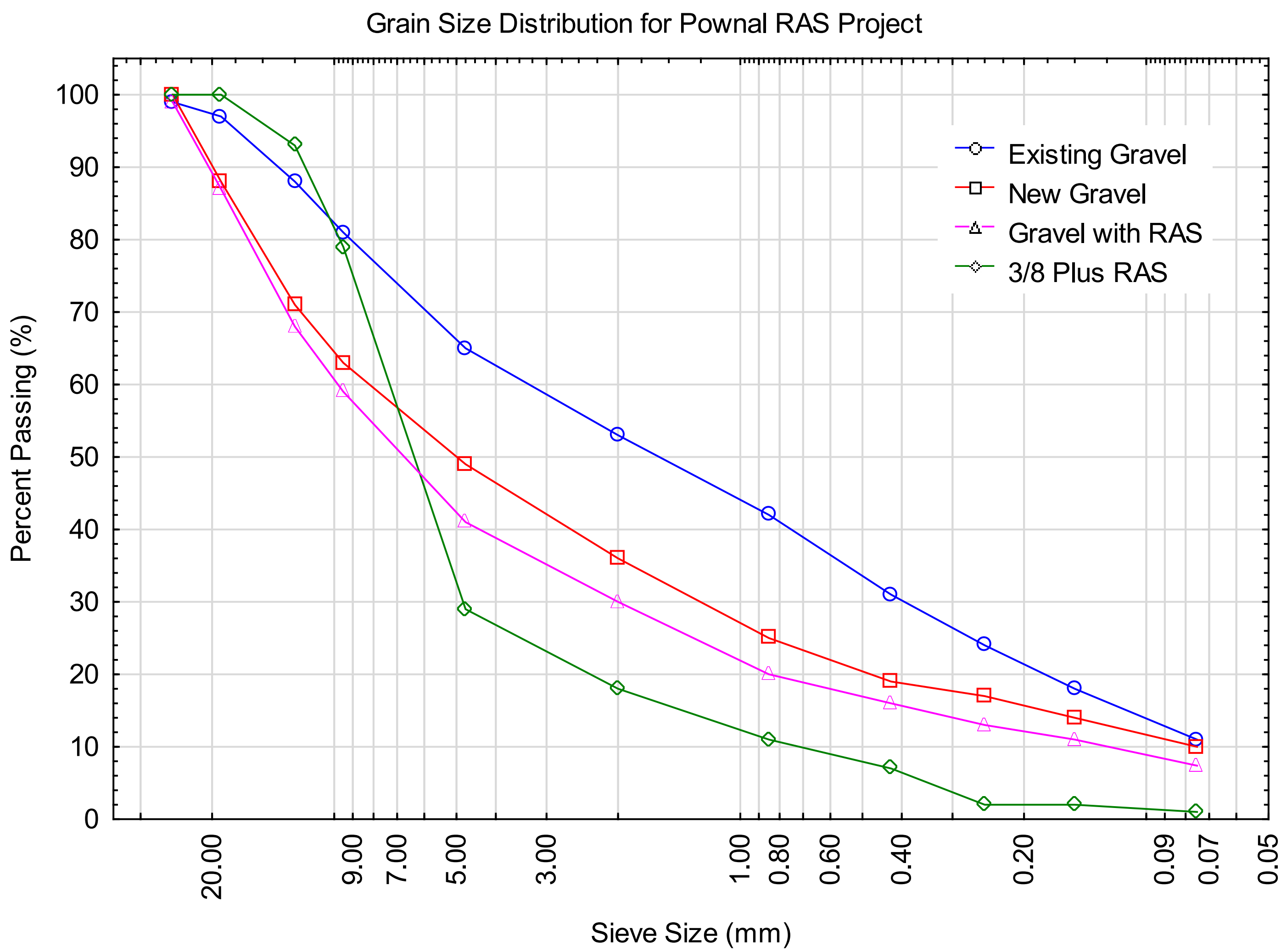


Figure 7: Pownal Grain Size Distribution

2.2. Shaftsbury

The town of Shaftsbury, in SW Vermont, was sent 64 tons of RAS from Myers Recycling in Colchester. The RAS was mixed at 20% by mass with gravel from William E. Dailey, Inc. (Peckham Industries Subsidiary). The RAS used was approximately comprised of 50% RAS at minus 3/8", and 50% RAS not passing 3/8". The test section (Figure 8), located on Myers Rd (unrelated to Myers Recycling) is approximately 1000ft long, with a 600ft section of between 6-7% grade, and a flat 400ft section. The roadway is uniformly 20ft wide. The existing roadway had a 3-4% crown, with several sections being noticeably flatter. Precondition of the roadway can be seen in Figure 7.

Figure 8: Shaftsbury Resurfacing location

Figure 9: Shaftsbury precondition, and 3/8 Plus RAS stockpile

Prior to regrading and adding new gravel with RAS, ditch clearing maintenance was performed. Roadway surface construction took place on 10-2-18. Construction of the road followed typical Town procedures, with the additional step of using a roller to compact the material. The existing roadway was regraded to shape, adding crown to achieve 6-7%. Effort was made to ensure the roadway width did not creep out into the ditches, and ensure that surface material was maintained on the 20ft travel section. The gravel was dumped in successive loads onto the center of the roadway, and spread with a grader until a thickness of 2-3 inches was achieved. Large clumps of RAS were observed in the material bring spread on the roadway. These clumps are the result of RAS stockpiling, and self-consolidation when stored for extended periods of time. Compaction was done with a 13.75 ton smooth vibratory roller, with at least 2 passes over each section. During construction, research staff found 10 nails in the new surface material.

Figure 10: Shaftsbury Resurfacing

A follow up site visit on October 9th, showed that the roadway is well consolidated, and tightly packed. Feedback from the local road foreman following the reconstruction have been positive, with no maintenance needed as of February 2019.

Figure 11: Shaftsbury post resurfacing condition

Sieve analysis showing the breakdown of the various materials can be seen in Table 2 and the distribution in Figure 13. Samples of the new gravel to be used show similar gradation to existing roadway. The larger RAS sampled was found to be above the 3/8" minus that was intended for the project. A sample of the finer RAS had only 8% above the 3/8" screen, much closer to the proposed material target. The combined gravel and RAS has a larger gradation than the virgin aggregate, but does not yet appear to substantively change its performance.

Table 2: Shaftsbury Sieve Analysis

Sieve Size	Sieve Size	Sieve Size	Percent Passing (by mass)				
(mm)	(in)	(#)	Existing Gravel	New Gravel	RAS and Gravel	3/8 plus RAS	3/8 minus RAS
25	1		96	100	100	100	100
19	3/4		96	100	100	97	100
12.5	1/2		83	91	93	91	100
9.5	3/8		74	78	78	78	92
4.75	0.187	#4	57	53	48	33	73
2	0.0787	#10	40	33	30	23	53
0.841	0.0331	#20	32	25	20	13	24
0.42	0.0165	#40	27	21	16	8	11
0.25	0.0098	#60	24	19	14	4	2
0.149	0.0059	#100	22	18	12	2	1
0.074	0.0029	#200	17	15	10	0.3	0.4

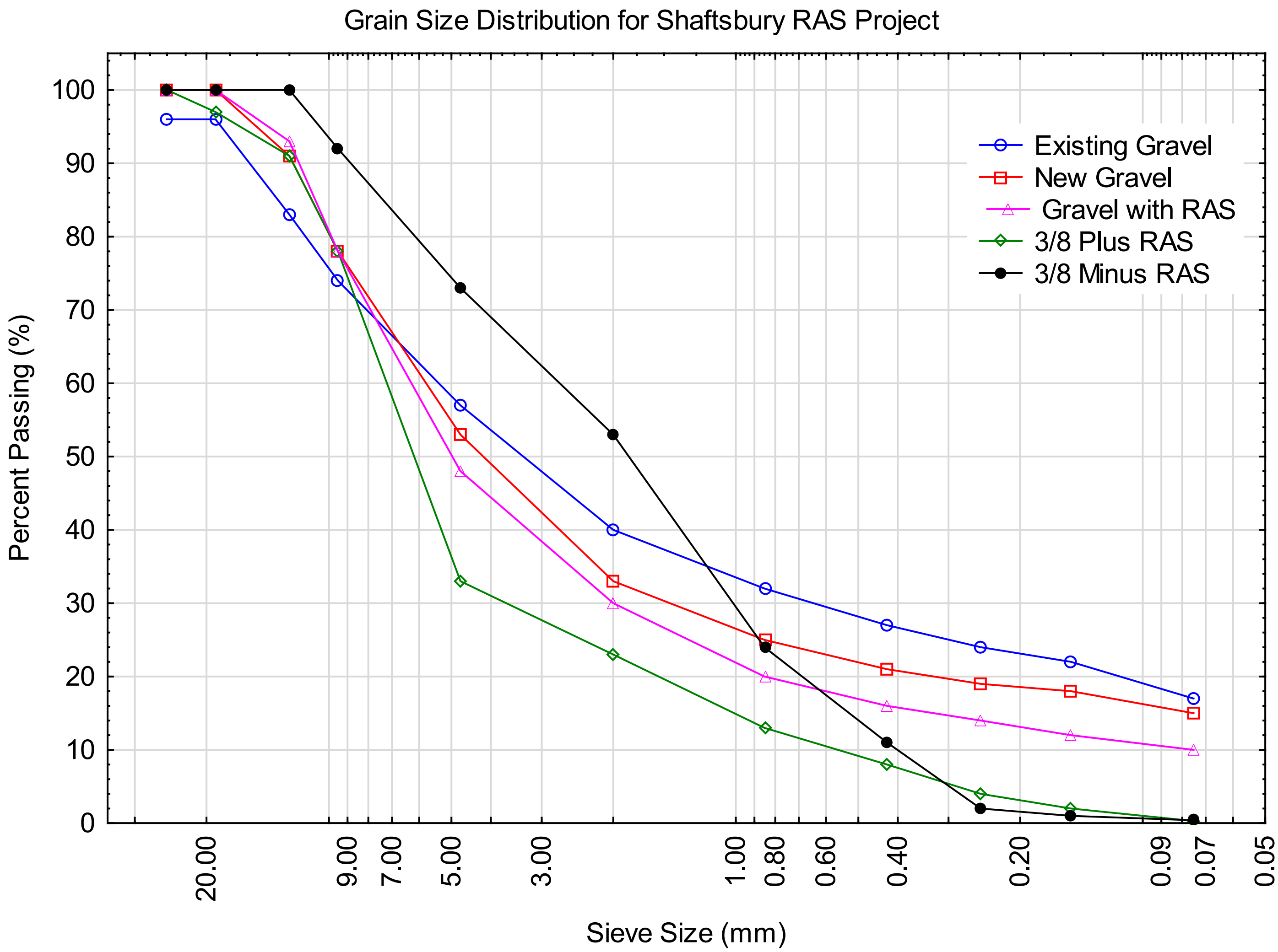


Figure 12: Shaftsbury Grain Size Distribution

3. INSTALLATION CONCLUSIONS

Construction of the two RAS and Gravel road test sections follow conventional techniques and methods as a normal gravel road. The RAS used in both cases was outside of the targeted aggregate size, with Pownal using exclusively larger material, and Shaftsbury using a 50/50 blend of RAS gradations. Nails were found on both projects, likely because of the non-screened RAS used.

The Pownal site showed significant deterioration immediately after construction, likely because the larger aggregates in the gravel were prevented from binding because of the RAS content. Eventually, the large aggregates were removed from the material, and a stable compacted surface formed. A rain event again caused segregation of large aggregates and large RAS material, and the surface stabilized again once traffic compacted the remaining material. The Shaftsbury site shows no issues with the surface. The material is performing well and formed a firm stable surface. Further inspections will take place in early spring to determine the surface condition in Pownal and Shaftsbury after one winter of exposure.

4. REFERENCES

[1] Grodinsky, C., Plunkett, N., and Surwilo, J., *Performance of Recycled Asphalt Shingles for Road Applications,* Final Report, State of Vermont Agency of Natural Resources, 2012. <https://p2infohouse.org/ref/23/22746.pdf>

[2] Wood, Thomas J., Eddie N. Johnson, and Melissa K. Cole. *Research Using Waste Shingles for Stabilization or Dust Control for Gravel Roads and Shoulders*. No. MN/RC 2014-06. Department of Transportation, Research Services & Library, 2014. <https://www.dot.state.mn.us/research/TS/2014/201406.pdf>

[3] Marks, V.J. and G. Petermeier. *Let me shingle your roadway*, Interim Report for Iowa DOT Research Project HR-2079, Iowa Department of Transportation, 1997. <http://publications.iowa.gov/19901/1/IADOT_hr_2079interim_Let_Me_Shingle_Your_Roadway_1997.pdf>

[4] *Policy on Recycling Asphalt Roofing Shingles in Vermont.* State of Vermont Agency of Natural Resources, 2015. <https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/FINALShingleMgtPolicy4.pdf>