Summary and Abstract of “Influence of Roofing Shingles on Asphalt Concrete Mixture Properties” (Newcomb, et al., 1993)

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Reviewed by Dave Newcomb (12-27-02)

[Notes from Author: The following abstract, review and excerpts of the Newcomb 1993 report were compiled as a means to summarize this study for purposes of posting on the Minnesota Office of Environmental Assistance (OEA) shingles recycling web page: http://www.moea.state.mn.us/lc/purchasing/shingles.cfm.

The full Newcomb et al. report is currently available in PDF file format on the Minnesota Department of Transportation (Mn/DOT) web site managed by the Office of Research Services (ORS): http://www.mrr.dot.state.mn.us/research/MnROAD_Project/MnRoadOnlineReports/93-09.pdf.]

Full Citation:
Newcomb, David, Mary Stroup-Gardiner, Brian Weikle, Andrew Drescher, "Influence of Roofing Shingles on Asphalt Concrete Mixture Properties." Report MN/RC-93/09, University of Minnesota, Department of Civil and Mineral Engineering; Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota; June 1993.

Abstract from Report (Newcomb, 1993):
It is estimated that the production of new roofing shingles generates approximately 1,000,000 tons of waste annually in the US., and about 36,000 tons of this waste is in the Twin Cities Metro Area of Minnesota. With another 8.5 million tons of waste materials which are similar to those used in asphalt concrete, it seems viable that their use in hot-mix would be an attractive alternative to disposing of them in landfills.

This report presents the results of an effort to evaluate the use of roofing waste generated by manufacturers and from reconstruction projects. It was shown that up to 5%, by weight of mixture, manufacturing waste roofing shingles could be used in asphalt concrete with a minimum impact on the properties of the mixture. At a level of 7.5%, a noticeable softening of the mixture occurs, and this might be detrimental to pavement performance. The use of shingles from roof reconstruction projects resulted in the embrittlement of the mixture which may be undesirable for low temperature cracking of pavements. The manufactured shingle waste seems to work well in stone mastic asphalt mixtures.
Review from Mallick (2000):

In this paper, the authors have shown that manufactured roofing shingle waste can be incorporated successfully into hot-mix asphalt (HMA), and that roofing shingle modified mixes show less temperature susceptibility than mixes without shingles. Significant savings in the use of asphalt binder can be made since shingles are made of 40-50% asphalt binder. The use of shingles also lowered the tensile strength of mixes at 18°C, thus, improving the resistance against low temperature cracking. The properties of HMA are affected mainly because of the presence of asphalt and fiber in the shingles. The authors recommended that tensile properties of shingle modified mixes must be determined for evaluation of use of waste shingle in HMA. The authors also showed that the effect on the properties of HMA is dependent on the amount of shingles used, and the effect on tensile strength can get reversed at higher percentage of shingles.

Excerpts from Newcomb Report (1993):

Objective [Verbatim from Executive Summary]

The objective of this study was to evaluate the use of waste shingles from manufacturing and roof reconstruction projects in hot mix asphalt (HMA) mixtures. In dense-graded asphalt mixtures, it was hypothesized that the waste material might serve as an extender for the new asphalt in the mix as well a fiber reinforcement. In the stone mastic asphalt (SMA), it could serve as the binder stiffener typically used to prevent the asphalt from draining out of these types of mixtures.

Scope [Verbatim from Executive Summary]

The treatment of the two types of mixtures can be viewed as two separate experiments, because of the considerations in formulating each of them. The dense-graded mixture evaluation included two grades of asphalt cement, one aggregate gradation, three levels for roofing shingle content, and two roofing waste types [manufactured shingle scrap and “tear-off” or “reroof” or scrap]. In the SMA mixtures, one asphalt cement grade, one aggregate gradation, one level of shingle waste content, and three types of fiber additives (including two roofing waste types) were used. The control material for the SMA mixtures contained a commercial cellulose fiber. A sample of field mixed material was obtained from the Wright County Highway Department for comparison to the laboratory prepared mixtures.

Testing and Results [Excerpts from Executive Summary and Conclusions Sections]

The testing program was designed to define the properties of the materials relevant to pavement performance. The roofing waste mixtures were tested along with control mixtures in order to ascertain their characteristics relative to each other.

- Increasing the content of roofing shingles reduced the mixtures’ demand for new asphalt. [The amount of reduction in demand for virgin asphalt is dependent on the type and amount of shingle scrap. E.g., the study found that at five percent fiberglass manufactured scrap shingles, there was a 10 percent reduction in demand for virgin asphalt.]
- Compactability of mixtures generally increased with roofing waste content.
• Use of manufactured shingle waste resulted in a less temperature susceptible asphalt mixture. The mixture stiffnesses were adversely decreased when the shingle content exceeded five percent by weight of the aggregate. The roofing waste mixtures for the SMA experiment had similar stiffnesses to that found for the \textit{commercial} cellulose fiber control mixture.

• Use of manufactured shingle waste did not significantly change the moisture susceptibility of the conventional dense-graded mixtures.

• Samples containing reroof material had increased susceptibility to moisture damage.

• Manufactured roofing waste seemed to actually improve the resistance to water damage in the SMA mixtures.

• Tensile strengths at low temperatures decreased with increasing roofing waste content.

• Mixtures made with the reroof material showed a decrease in strain capacity with increased shingle content, implying that this material will be more brittle at cold temperatures.

• (Cold temperature cracking) behavior of the roofing waste modified mixtures in SMA mixtures was about the same as that of the control mixture containing \textit{commercial} cellulose fibers.

• The field mixture obtained from Wright County behaved similarly to the laboratory mixture containing five percent, felt-backed shingle waste from the manufacturing process.

\textbf{Recommendations [Verbatim from Executive Summary, plus author notes]}

1. The Minnesota Department of Transportation should produce a permissive specification which allows up to five percent manufactured roofing shingle waste to be used in hot mix asphalt base courses on high-volume roads and in all hot mix asphalt layers on low volume roads. The use of this waste material should be dictated by economics which will be influence by the transportation and processing costs. Contractors might be encouraged to try the material if they are allowed a bid premium for using it.

\textit{[Author’s note: Such a specification was adopted by Mn/DOT in 1995 and published in 1996. The specifications are available on Mn/DOT’s web site under “Plant Mixed Bituminous Pavement (Mn/DOT specification 2331.3, Allowable Salvaged Material for Recycling in Plant Mixed Bituminous Pavement), \texttt{http://www.dot.state.mn.us/tecsup/spec/2d2/k2331.pdf} and under “Plant Mixed Asphalt Pavement Quality Control/Quality Assurance” (Mn/DOT specification 2350.2E, Scrap Shingles), \texttt{http://www.dot.state.mn.us/tecsup/spec/2d2/index.html}.]}

2. There are currently [in 1993] no facilities which process reroof [or “tear-off”] scrap material in Minnesota. An economic incentive, such as the availability of low interest loans, might be used to encourage the development of such facilities. Another alternative would be to wait until the cost of placing this material in a landfill becomes higher than the cost of processing and reusing it. If this material becomes available, a thorough
evaluation of the material should be conducted to ascertain whether it is more suitable than the reroof material used in this study. Care would need to be taken to assess the potential for asbestos dust when dealing with reroof scrap material.

[Author’s notes: There still are no permitted facilities in Minnesota that process tear-off shingle scrap. There are plans to demonstrate recycling and use of tear-off scrap in Minnesota in 2003, including research and development of end-use applications. Three dust sampling events at the shingle recycling processing plant have been conducted. Results indicate dust and fiber levels well below OSHA permissible exposure levels. Krivit, et al., in preparation.]

3. The performance of projects built with processed shingle waste should be monitored through the Minnesota Department of Transportation’s pavement management system to see if they differ from conventional materials.

4. A field trial should be constructed in which manufactured shingle waste is used in a stone mastic asphalt (SMA) mixture. The performance and cost of this material should be compared against more conventional approaches to SMA. Based upon the laboratory results from this study, the shingle waste SMA should have a performance comparable to the conventional SMA.

[Author’s note: There are two SMA projects under development at Mn/DOT and will be let for bid in the spring of 2003. These do not specify, but also do not prohibit, alternative bids for testing of the use of manufactured shingle scrap in the SMA mixtures.]

5. Improved means of processing shingle waste should be developed to reduce the amount of moisture in the material. It was not proven conclusively in this study that the moisture in the material is harmful to the final product. However, from the standpoints of hot-mix plant efficiency and the assurance of the final product quality, it would be best to attempt to reduce the amount of water present in the shingle waste.

Other References Cited:

Roofing Shingles into Roads

Recycling Asphalt Shingles

An asphalt shingle contains the same basic ingredients as hot-mix asphalt – aggregate, asphalt cement and mineral filler.

Laboratory and field testing by researchers at the University of Minnesota and the Minnesota Department of Transportation (Mn/DOT) showed that scrap from asphalt shingle manufacturers could be used successfully in hot-mix asphalt. Based on this success, Mn/DOT has issued specifications that allow for the use of up to 5 percent manufacturers' shingle scrap in hot-mix asphalt.

Including shingle scrap in bituminous mixtures offers equal performance compared to other mixes, potential cost savings, and measurable benefits to the environment by reducing disposal of shingle scrap.

Asphalt Shingle Recycling Forum :: April 13-14, 2003

Evidence demonstrates that these materials can be recycled into a variety of products, including hot-mix asphalt. :: shinglerecycling.org
Please plan to join us for this informative forum to discuss future strategies for improving asphalt shingle recycling. This forum has been developed to address the needs of shingle recyclers, transportation and materials engineers, highway construction contractors, hot-mix asphalt producers, and environmental/OSHA regulators.

It will provide an opportunity to present the latest research findings and will include discussion on future strategies for improving asphalt shingle recycling. The forum will include both national and regional speakers and will address the both manufacturers shingle scrap and used roofing shingles (or tear-off scrap). There will be an emphasis on "hands-on, real-world" applications of lessons learned and technology advancements. A vendor exposition and video tour of an active shingle recycling operation are both scheduled to be included.

This forum is part of a larger research project, **Overcoming the Barriers to Recycling of Asphalt Shingle Scrap**, funded in part by the Recycled Materials Resource Center (RMRC) and sponsored by Mn/DOT and the Minnesota Office of Environmental Assistance (OEA). Forum co-sponsors include the Construction Materials Recycling Association (CMRA) and the U.S. Environmental Protection Agency, Region 5.
For more information

Contacts

Use these contacts for more assistance on the use of shingle scrap in paving applications.

- Improving Recycling of Shingles in Minnesota project:  
  James Klessig < jim.klessig@dot.state.mn.us >,
Mn/DOT Office of Research Services, 651-282-2472

- Technical assistance on mix-design approvals involving shingle byproducts in Minnesota:
  Roger Olson < roger.olson@dot.state.mn.us >, Mn/DOT Office of Materials and Road Research, 651-779-5517

- Consultant technical assistance in Minnesota:
  Dan Krivit < dkrivit@bitstream.net >, Dan Krivit and Associates, 651-489-4990

- Shingle recycling and product development operations in Minnesota:
  Kent Peterson < petersonk@bitroads.com >, Bituminous Roadways, Inc., 651-686-7001

Literature and online resources

- Influence of Roofing Shingles on Asphalt Concrete Mixture Properties (Newcomb, et al., 1993).
  [PDF] Summary & Abstract (4 pages, 38Kb) | [PDF] Full report (108 pages, 9Mb)

  The production of new roofing shingles generates approximately 1 million tons of waste annually in the U.S., around 36,000 tons of which comes from the Twin Cities Metro Area. This report presents the results of an effort to evaluate the use of roofing waste generated by manufacturers and from reconstruction projects. Research showed that up to 5%, by weight of mixture, manufacturing waste roofing shingles could be used in asphalt concrete with a minimum impact on the properties of the mixture.

- Minnesota's Experience With Scrap Shingles in Bituminous Pavements (Janisch & Turgeon, October 1996), Office of Research Services, Mn/DOT.
This laboratory study by researchers at the Worcester Polytechnic Institute and UMass Dartmouth showed that the properties of hot mix asphalt with 3, 5 and 7 percent shingles are not significantly different from the properties of conventional hot mix asphalt used for surface courses.

Online resources

- www.shinglerecycling.org || An online resource for those interested in recycling asphalt shingles. Developed by the University of Florida in collaboration with the CMRA, the National Roofing Contractors Association (NRCA) and U.S. EPA, Region 5.

- Recycled Materials Resource Center || www.rmrc.unh.edu
  The RMRC is a national center at the University of New Hampshire created to promote the use of recycled materials (pavements, secondary waste, by-product materials) in the highway environment. They focus particularly on the long-term physical and environmental performance of recycled materials. The RMRC has a unique role in the growing area of recycled materials use in highway construction and will serve as a principal outreach and evaluator of information for the Federal Highway Administration (FHWA) and be the principal point of contact for information about recycling in the highway environment.

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