Elastiko®
Engineered Crumb Rubber Technology
www.asphaltplus.com

ASPHALT PLUS LLC
Elastiko®

TB – 003

USE OF RUBBER-MODIFIED ASPHALT PAVEMENTS IN HIGHER ALTITUDE AND THERMAL CRACKING ENVIRONMENTS

INTRODUCTION

Rubber modification of asphalt pavements offers a number of benefits that help improve road performance, reduce maintenance costs and extend road life. Roads modified with rubber from scrap tires are more resistant to binder aging, rutting and cracking, and rubber-modified roads offer better traction in wet weather events and a quieter ride. Rubber pavements are in use across the globe in a wide range of environments, including higher altitude locations in the US (CA, NV, TX, CO) and in the EU (Switzerland, Turkey). Crumb rubber from scrap tires can be added through binder modification (the wet process) and through mix modification (dry process Engineered Crumb Rubber, or ECR). Although the rubber addition processes and the modification effects are different, these pavements perform similarly in all environments. In higher elevation applications, pavements can be exposed to multiple environmental and operational stresses, including:

- Heavy truck traffic (rutting, reflective and fatigue cracking)
- Extreme cold (promotes thermal cracking)
- Extreme heat (promotes rutting)
- High freeze-thaw activity (accelerated crack propagation)
- High UV radiation (promotes pavement bleaching and rapid surface cracking)

The use of Engineered Crumb Rubber (ECR) can help manage these pavement stressors.

THE IMPACT OF RUBBER ADDITIONS ON HIGH ALTITUDE PAVEMENT STRESSORS

Regardless of location and environment, all road owners face similar questions: how do I manage my roads cost-effectively, and how can I effectively extend road life? Use of ECR in asphalt mix designs can help answer some of those questions in high altitude and cold weather environment paving. In the US and overseas, multiple independent studies have explored the relationship between rubber and the stressors listed above.

HEAVY TRUCK TRAFFIC

In the Chicago, Illinois area, interstate toll highways not only experience high freeze-thaw frequency, extreme cold (periodic -35 C winter surface temperatures), they also support heavy truck traffic (E pavements). Multiple comparisons of polymer modified, wet process rubber-modified and dry process rubber-modified pavements have been evaluated in that operating environment, and both pavement types perform comparably (1, 2)). The Georgia DOT placed a dry process ECR pavement (porous European mix) alongside a polymer-modified pavement on their one of the most trafficked interstates (I-75 south of Atlanta). In a heavy traffic, high rainfall and high temperature environment, ECR and polymer-modified pavements performed comparably. In early paving efforts, ECR pavements exceeded expectations for road life by ten years (2). These pavement comparisons span almost 20 years of service life. California interstate highways in the Sierras also use rubber-modified asphalt in their operations up to 3,000 feet in elevation (snow chains degrade rubber pavements at higher elevations) (4).

EXTREME COLD

Some of the coldest temperatures in the continental US occur in the northern central US. As noted earlier, rubber pavements performed well on interstate roads in northern Illinois during severe cold events (1). In addition, work by Michigan Tech researchers demonstrated excellent ECR pavement performance in pavement temperature environments that approach -40 C ().

EXTREME HEAT

Wet Process and Dry Process ECR pavements have been placed throughout the SW US, including both high and low desert. In these areas, temperatures above 45 C are common. In a project comparing polymer and ECR, TXDOT noted that ECR pavements were more rut-resistant than the polymer pavement (6). These researchers also noted that the bleaching rate of the ECR pavement was substantially slower than the bleaching seen in unmodified asphalt pavements. TXDOT also noted that the ECR pavement evaluated (a dense-graded, thin overlay or "TOMs mix") substantially outlasted the standard hot mix pavements used in the same area.

HIGH FREEZE-THAW ACTIVITY

The same roads referenced in studies (3) and (5) are in very high freeze-thaw regions of the US and very heavy snowfall areas (up to 9 feet in depth). In both cases, the ECR roads have held up well, comparable to or better than polymer modified roads.

HIGH UV RADIATION

In the desert SW US, roadways are subjected to very intense UV radiation, which tends to accelerate oxidation of paved asphalt surfaces. A comparison of west Texas and Arizona UV levels with Colorado mountain UV levels shows that UV intensities are about the same (7). Processed ECR pavements include additions of antioxidants from the tire crumb that act to impede binder oxidation (8).

PERFORMANCE SUMMARY AND ECONOMICS

Rubber-modified roads perform well in both high and low altitude locations. Their ability to withstand the impacts of environmental extremes found at high elevations makes them well-suited for paving in those regions as long as they are not exposed to studded tires or chains. Comparisons of various types of modified pavements clearly indicates that polymer modified, wet process rubber modified and dry process ECR modified asphalt pavements perform comparably in all environments.

Economic evaluation presented by Federal Highways Administration (FHWA) shows that adoption of dry process modification requires significantly less investment compared to terminal blends (wet process) (. California reports that extensive use of wet process rubber is somewhat more expensive than polymer modification (about $1-$2 per mix ton, depending on mix design) (4). Depending on the mix design, ECR is typically $2-$5 per mix ton cheaper than either polymer or wet process rubber modification. Because they can use ECR at will in operations and because it is less expensive, contractors generally prefer ECR as their primary modification option where available and permitted.

REFERENCES

1. Punyaslok Rath, Joshua E. Love , William G. Buttlar and Henrique Reis (2019)
Performance Analysis of Asphalt Mixtures Modified with Ground Tire Rubber Modifiers and Recycled Materials. Sustainability, MDPI.

2. Punyaslok Rath, H. Majidifard, B. Jahangiri, W. Buttlar (2021). Laboratory and Field Evaluation of Pretreated Dry-Process Rubber Modified Asphalt Binders and Dense-Graded Mixtures. Transportation Research Record.

3. Zhaoxing Xiea & Junan Shenb (2015) Performance of porous European mix (PEM) pavements added with crumb rubbers in dry process. International Journal of Pavement Engineering

4. Caltrans (2020) 2018 Crumb Rubber (Asphalt) Report: https://dot.ca.gov/-/media/dot-media/programs/maintenance/documents/office-of-pavement-programming/2018-crumb-rubber-report-approved-version-for-web-posting-without-issue-memokaa11y.pdf

5. Zhanping You, Dongdong Ge, Siyu Chen (2022): Using Rubberized Asphalt to Maintain High Volume Traffic Roads in Dickinson County
Sponsored by: Michigan Department of Environment, Great Lakes, and Energy (EGLE)
And Dickinson County Road Commission

6. Zhou, F. and Scullion, T (2008) Mix Design, Construction, and Performance of a Thin HMA Overlay on Pumphrey Drive, Fort Worth, TX. Texas DOT and Texas Transportation Institute. Report : FHWA/TX-09/5-5123-01-2.

7. Map of US UV Levels: https://www.bing.com/images/search?view=detailV2&ccid=4bLs02PP&id=FE16976E3801B58AAC519256

AEEB1BF48EDE0726&thid=OIP.4bLs02PPpBrfv03mv4KZVQHaDZ&mediaurl=https%3a%2f%2fvitamindwiki.com%2fdl3175%3fdisplay%26x%3d800%26y%3d367&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.e1b2ecd363cfa41adfbf4de6bf829955%3frik%3dJgfejvQb665Wkg%26pid%3dImgRaw%26r%3d0&exph=367&expw=800&q=US+UV+Radiation+Map&simid=608011402286024599&FORM=IRPRST&ck=6472F570E0A1E58E01D9B6C694D8E81D&selectedIndex=16&ajaxhist=0&ajaxserp=0

8. Hoffmann, P & Potgieter, C 2007, 'Bitumen rubber chip and spray seals in South Africa', Southern African transport conference, 26th, Pretoria, University of Pretoria, South Africa.

9. Gaylon Baumgardner, Adam Hand, Timothy Aschenbrener (2021). Recycled Tire Rubber – Hybrid GTR Binders and Dry Added GTR – How to use them in Asphalt Pavement Mixtures. Federal Highways Administration.