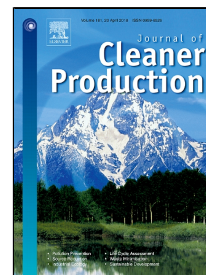


# Accepted Manuscript

The engineering, economic, and environmental performance of terminal blend rubberized asphalt binders with wax-based warm mix additives



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13

#### 14 **ABSTRACT**

15 Produced with fine crumb rubber (CR) particles and at demanding conditions, *Terminal*  
16 *Blend (TB)* asphalt binder is an alternative approach to incorporating CR from scrap  
17 tires into asphalt binders. It offers the advantages of convenient transportation, storage,  
18 and usage at asphalt mixture plants. In the study as presented in this paper, Sasobit<sup>®</sup>  
19 and Polyethylene (PE) wax were used as warm-mix additives to further modify the  
20 properties of TB asphalt binders. These additives are anticipated to reduce the  
21 production temperatures of TB asphalt mixtures, hence reducing fuel consumption and  
22 greenhouse gas (GHG) emissions in mixture production and reducing asphalt fumes in  
23 construction. It is also anticipated that the engineering performance of TB asphalt  
24 binders modified with such additives are not adversely affected. To gain a  
25 comprehensive understanding of TB asphalt binders modified with the two additives, a  
26 variety of laboratory tests were conducted, including storage stability, high temperature  
27 performance, low temperature performance, fatigue, and other basic rheological  
28 properties. The costs of producing TB asphalt mixtures with or without the additives  
29 were compared, using the conventional hot-mix asphalt mixtures as a reference. Energy  
30 consumptions and GHG emissions generated in mixture production were also evaluated.  
31 Actual field construction was performed using TB asphalt mixtures with Sasobit<sup>®</sup> and  
32 using conventional asphalt mixtures. Both aerosol and volatile organic compounds  
33 (VOCs) samples were collected at zones close to the loose mixtures and were analyzed.  
34 The two wax-based additives were found to enhance the storage stability and  
35 workability of the TB binders. The other engineering properties related to the use of  
36 wax-based additives are mixed. The selection of right type of additive depends on local  
37 climate conditions. While the costs of using the TB binders (with or without additives)  
38 are higher than the costs of using the base (neat) asphalt binder. Energy consumptions

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