World Academy of Science, Engineering and Technology
International Journal of Transport and Vehicle Engineering
Vol:17, No:07, 2023

Assessing the Effect of Waste-based Geopolymer on Asphalt Binders

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Abstract : Asphalt cement concrete is a very commonly used material in the construction of roads. It has many advantages, such as being easy to use as well as providing high user satisfaction in terms of comfortability and safety on the road. However, there are some problems that come with asphalt cement concrete, such as its high carbon footprint, which makes it environmentally unfriendly. In addition, pavements require frequent maintenance, which could be very costly and uneconomic. The aim of this research is to study the effect of mixing waste-based geopolymers with asphalt binders. Geopolymer mixes were prepared by combining alumino-silicate sources such as fly ash, silica fumes, and metakaolin with alkali activators. The purpose of mixing geopolymers with the asphalt binder is to enhance the rheological and microstructural properties of asphalt. This was done through two phases, where the first phase was developing an optimum mix design of the geopolymer additive itself. The following phase was testing the geopolymer-modified asphalt binder after the addition of the optimum geopolymer mix design to it. The testing of the modified binder is performed according to the Superpave testing procedures, which include the dynamic shear rheometer to measure parameters such as rutting and fatigue cracking, and the rotational viscometer to measure workability. In addition, the microstructural properties of the modified binder is studied using the environmental scanning electron microscopy test (ESEM). In the testing phase, the aim is to observe whether the addition of different geopolymer percentages to the asphalt binder will enhance the properties of the binder and yield desirable results. Furthermore, the tests on the geopolymer-modified binder were carried out at fixed time intervals, therefore, the curing time was the main parameter being tested in this research. It was observed that the addition of geopolymers to asphalt binder has shown an increased performance of asphalt binder with time. It is worth mentioning that carbon emissions are expected to be reduced since geopolymers are environmentally friendly materials that minimize carbon emissions and lead to a more sustainable environment. Additionally, the use of industrial by-products such as fly ash and silica fumes is beneficial in the sense that they are recycled into producing geopolymers instead of being accumulated in landfills and therefore wasting space.

Keywords : geopolymer, rutting, superpave, fatigue cracking, sustainability, waste
Conference Title : ICTEA 2023 : International Conference on Transport Engineering and Applications
Conference Location : Toronto, Canada
Conference Dates : July 10-11, 2023