Procedia Engineering

Volume 143, 2016, Pages 1–9

Advances in Transportation Geotechnics 3 . The 3rd International Conference on Transportation Geotechnics (ICTG 2016)

An Application of Pulsed Power Technology and Subcritical Water to the Recycling of Asphalt Concrete

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Abstract

In order to resolve the issues related to the recycling of asphalt concrete, this study focuses on the application of pulsed power technology and subcritical water to the recovery of asphalt from asphalt concrete lumps. At the result, the recycled aggregate over 5mm with asphalt content of approximately 0.99% was produced using pulsed power technology. Furthermore, the application of subcritical water to recover asphalt from the residues of pulsed power discharge inside of asphalt concrete lumps resulted in an about 91% pure asphalt recovery rate and recycled fine aggregate with pure asphalt content of less than 0.5%.

Keywords: Asphalt, asphalt concrete recycling, pulsed power technology, subcritical water, recycled aggregate

1 Introduction

After a given time in service, the deteriorated asphalt concrete pavement is removed by milling or excavation from roads to become asphalt concrete waste (Cheung, 2003). Next, asphalt concrete waste has to be deprived from any other unwanted type of waste. The reprocessed asphalt concrete wastes become the reclaimed asphalt pavement (RAP). The reprocessing consists in crushing and screening the asphalt concrete waste collected.

RAP can be recycled by adding it to new asphalt mixes. Owing to the fact that CO_2 emission and energy consumption regarding virgin binder production represent more than 80 % and 70 % respectively of the whole virgin mixture manufacturing process, the higher the RAP content of the recycled asphalt pavement, the higher the amount of reduced CO_2 emission and energy savings compared to producing virgin mixtures (Lee, 2011; Horvath, 1998). Hendricks, et al. demonstrated that the recycling of RAP can save approximately 37.9 liters of asphalt per ton of recycled mix

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Selection and peer-review under responsibility of the Scientific Programme Committee of ICTG 2016

doi:10.1016/j.proeng.2016.06.001

(Hendricks, 2005). However, not only could the RAP have a high moisture content compromising the cold-in-place recycling process (Horvath, 1998) but also it could be contaminated by salt and oil residues (Tam, 2006). Owing to its high stiffness and variability in aggregate gradation, RAP influences the volumetric and low temperatures properties of hot-mix asphalt (Santucci, 2007; Horvath, 1998), and decreases the recycled asphalt pavement cracking resistance (Huang, 2011). As regards polymer modified asphalt (JMAA, 2007); a mixture of virgin asphalt and a polymer modifier, it is resistant to the existing recycling and treatments methods due to the lack of accurate knowledge of the behavior of recycled modified asphalt binder in the recycled mix and requires the implementation of appropriate recycling methods that match its properties (Watson, 2011; Kubo, 2009).

As a result, asphalt recovery from asphalt concrete wastes would improve the quality of recycled mixes, minimize the need for virgin mineral aggregate and the expenses associated with foreign crude oil exportation especially in the case of Japan that is well-known as a developed country without significant natural resources (Hesham, 2012). For this reason, pulsed power was discharged into straight and modified asphalt concrete specimens with asphalt content of 5% underwater. As a result, the recycled aggregate with asphalt content of approximately 1% originating from the asphalt concrete control specimens was produced using pulsed power technology (Amoussou, 2015).

In line with previous studies where authors proposed an ideal asphalt concrete recycling to resolve the issues related to modified asphalt concrete recycling (Amoussou, 2015), this research work set as goals to:

- separate asphalt concrete lumps into recycled aggregate and the residues containing asphalt using pulsed power technology;
- assess the applicability of pulsed power technology to separate recycled aggregate from asphalt concrete lumps;
- recover asphalt from the above-mentioned residues with the aid of subcritical water;
- evaluate the properties of the recovered asphalt.

This paper explains how to reproduce the aggregate from asphalt concrete lumps with the aid of pulsed power technology and subcritical water.

2 Material and Methods

Asphalt and aggregate were separated from asphalt concrete lumps using pulsed power discharge and subcritical water as described in Figure 1.

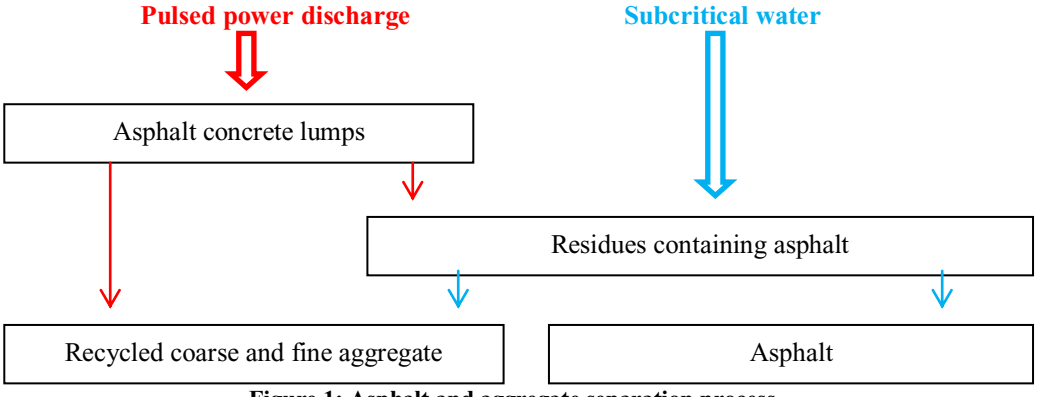

Figure 1: Asphalt and aggregate separation process