New Approach on Modified Asphalt Concrete Recycling using Pulsed Power Technology

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1. Introduction

In Japan, large volume of construction waste consists of ordinary and asphalt concrete. The application of the 3Rs (Reduce-Reuse-Recycle) to asphalt concrete waste helps avoid its dumping in landfill sites as regards its disposal [l]. However, recycled asphalt mixture becomes less durable and unpredictable due to the difficulty of mix design and the quality control by reusing of modified asphalt waste. Therefore, it is imperative to implement high level asphalt concrete recycling methods to enhance the quality of recycled asphalt mixture by reducing the impact of deteriorated asphalt and modified asphalt binders.

As the first part of our proposed ideal modified asphalt concrete recycling (**Fig.1**), this study aims: (1) to release asphalt binder from asphalt concrete by pulsed power technology, (2) to evaluate the quality of the pulsed power recycled asphalt concrete aggregate, (3) to assess the performance of pulsed power at separating bitumen from asphalt concrete in terms of energy consumption.

2. Methods

Pulsed power was discharged into soft straight asphalt concrete sample A, brittle modified asphalt concrete sample B, and hard modified asphalt sample C. The pulsed power parameters were set as follows 30 and 40 kV as voltage and 8μF as total capacitor. Here, 720, 1080, and 1446.4 kJ were discharged to specimens A. In addition, 1152 and 1260 kJ were discharged to modified asphalt concrete specimens B and C in the pulsed power reactor (**Fig.2**) [2].

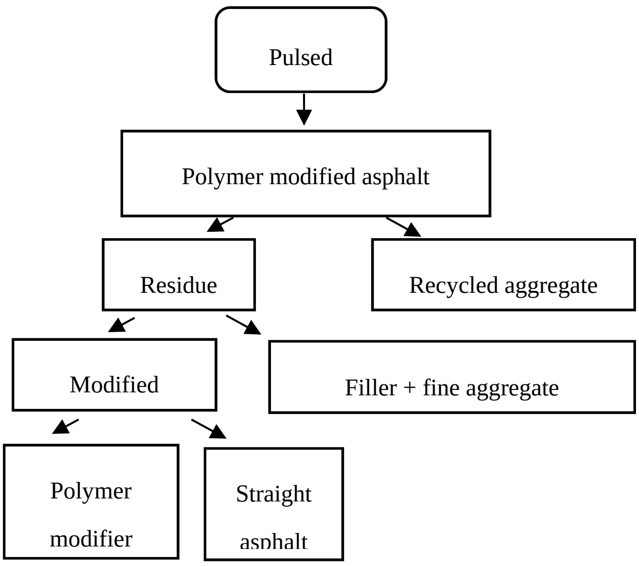

Fig 1. Proposed polymer modified asphalt concrete recycling

The pulsed power discharge products were collected in the following sieves 5mm, 2.5 mm, and 1.2 m. To recover the original aggregate, asphalt was extracted automatically from the pulsed power discharge products thanks to the automatic asphalt extraction apparatus Model ANI-700-3 Iwata CO., Ltd.

Furthermore, oven-dry density and asphalt content tests were conducted on the asphalt concrete products, residues, and recovered aggregate.

3. Results and Discussion

3.1 Asphalt content

Sample A under 2.5 mm residues contain the highest asphalt content (**Fig.3**). In contrast, in Fig.3 over 5 and 2.5 mm contain the lower asphalt contents. In addition, the asphalt content, in the case of sample A, decreases when the pulsed discharge energy increases.

On the contrary, in the case of the modified asphalt concrete B and C (**Fig.4**) the asphalt content increases slightly when the pulsed discharge increases. The results demonstrate that the releasing of modified asphalt is not as easy as that of ordinary asphalt and requires more pulsed power discharge energy. Furthermore, the finer the pulsed power product is, the higher the asphalt content becomes.

3.2 Oven-dry density

The oven-dry density of over 5 mm products from all types of asphalt concrete is close to that of their corresponding recovered aggregate (**Fig.5** and **Fig.6**). Furthermore, it seems like the increase in pulsed power discharge energy improves the oven-dry density of asphalt concrete recycled aggregate.

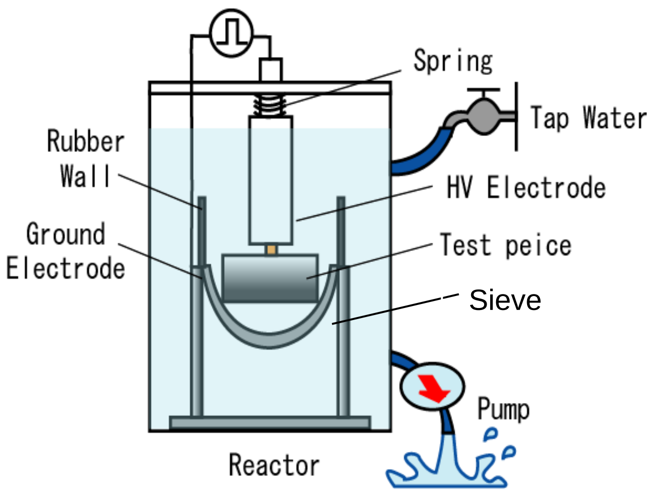

Fig. 2. Pulse power discharge apparatus

4. Conclusions

To evaluate the performance of pulsed power technology at asphalt concrete recycling, pulsed power was discharged into the above-mentioned ordinary and modified asphalt concrete samples. Consequently, asphalt binder was released successfully from asphalt concrete waste as part of the under 2.5 mm and 1.2 mm residues. The Oven-dry density of pulsed power asphalt concrete recycled aggregate is close to that of the recovered aggregate and increases when pulsed power energy increases. In terms of pulsed power energy, at least 720 kJ were discharged to separate the asphalt binder from ordinary asphalt concrete. In addition, at least 1152 and 1260 kJ required to release asphalt binder from brittle and hard modified asphalt concrete specimens respectively. Future work should focus on the implementation of environmentally friendly methods to recover modified asphalt from the residues and separate it into polymer modifier and straight asphalt.

Acknowledgements

I am grateful to my academic supervisor Assoc. Prof. Mitsuhiro Shigeishi for his guidance on my study. I would like to thank Mr. Daizou Fukuoka, president of (Kabushiki Kaisha) Fukuoka Kensetsu-Gouzai, Dr.Shinya Iizasa, Ms. Eva Arifi. and the other members of Shigeishi`s Laboratory.

References

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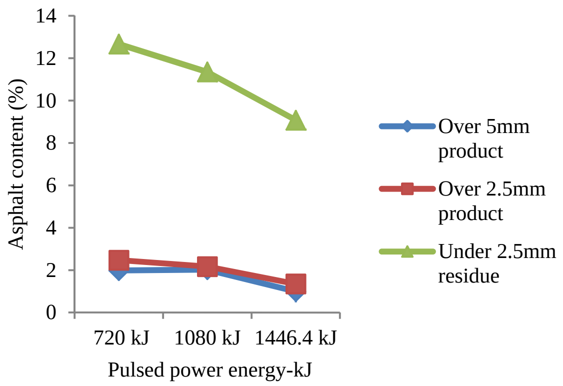

Fig. 3. Asphalt content of sample A products and residues

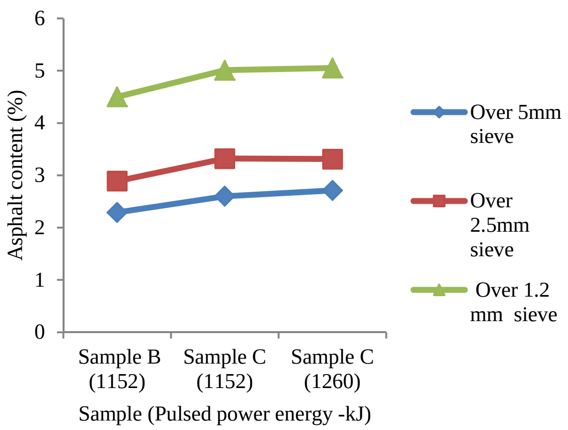

Fig. 4. Asphalt content of samples B and C products, and residues

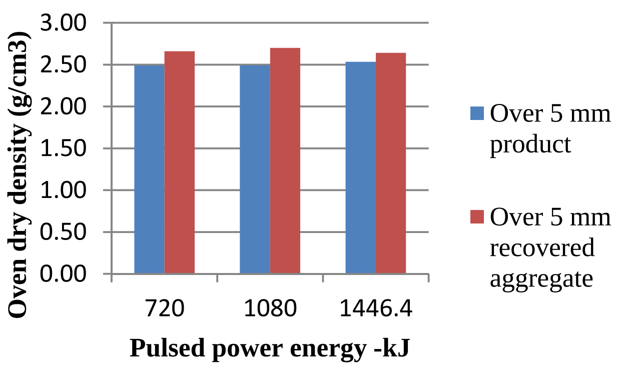

Fig. 5. Oven-dry density of sample A over 5mm products and recovered aggregate

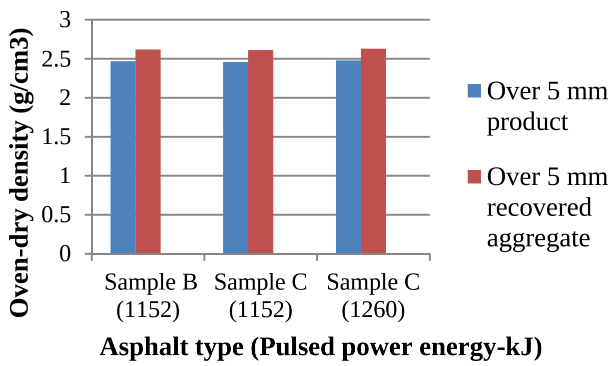

Fig. 6. Oven-dry density of samples B and C over 5 mm products and recovered aggregate