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# Evaluation of asphalt mixture containing coal ash

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**Abstract**

As the first time in Korea, bottom ash which is by-product of coal ash in power plant was recycled as fine aggregates in hot mix asphalt (HMA) mixtures. The bottom ash was used to replace the fine aggregate of HMA by various portions of fine aggregate which is passing 4.75mm sieve, at the ratio of 10%, 20%, and 30%. Leaching test was performed to measure the concentration of toxicity in the bottom ash. The optimum asphalt content was measured for each portion of bottom ash used as fine aggregate using by Marshall mix design method. Stability, flow value, and mixture volumetric properties were compared to verify the applicability of bottom ash as fine aggregate in HMA. The moisture susceptibility and fatigue cracking resistance of asphalt mixture containing bottom ash and fly ash was investigated. It is concluded that coal ash can be efficiently used as fine aggregates in asphalt mixture.


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*Keywords:* coal ash; leaching test; moisture susceptibility; fatigue cracking

## 1. Introduction

Bottom ash (BA) is produced as a granular material and removed from the bottom of dry boilers. It is much coarser than fly ash and formed during the combustion of coal. Several studies (Long and Floyd (1982); Chesner et al. (1997)) have been carried out on the use of BA in asphalt mixture. BA is highly absorptive materials, due to it

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lightweight and porous structure. Consequently, a higher amount of asphalt binder is needed for using it as aggregate substitutes in asphalt mixtures in order to achieve a full coverage and good bonding of aggregates.

Colonna et al. (2012) investigated the use of bottom ash as part of bituminous mixes for binder course. The experiments show that the bottom ash improves the stability while reducing the wearing resistance, however, the reduction can be compensated with an increase in the asphalt content in the mixture. BA can be used in the asphalt mixtures for flexible pavements without risk of the release of dangerous substances into the environment indicated by a leaching test.

Asphalt mixtures containing BA have been proved to show lower moisture resistance and lower rutting resistance compared to conventional ones. Moreover, BA had a high content of heavy metal and high level of toxicity, however, after being mixed with asphalt binder, the heavy metal was undetectable and the toxicity was reduced (Chen et al. (2008)). In previous studies (Chen et al. (2008); Hassan (2005)), the authors suggested that the use of BA substituting mineral aggregates in asphalt mixture range from 10 to 15 percent for surface or stone matrix asphalt courses and around 20% for base courses of pavement to ensure the pavement performance.

This paper aims to evaluate the possibility of using bottom ash as fine aggregate replacement in asphalt mixture. The leaching characteristics of BA were investigated through Synthetic Precipitation Leaching Procedure (SPLP) batch tests. The BA was used at 10, 20 and 30% by weight of fine aggregate. The Marshall mix design method was conducted to determine the optimum asphalt binder content for each percentage of BA replacement. Indirect tensile test and repeated indirect tensile test were conducted to evaluate moisture susceptibility and fatigue cracking resistance, respectively.

## 2. Materials

HMA is a mixture of mineral aggregate and bituminous binder. Asphalt binder PG58-22 was used in the study as it is the most widely used in Korea. The aggregate with the particle size distribution has bulk specific gravities, $G_{sb}$, of 2.680 determined according to AASHTO T 85-10 (2010) and AASHTO T 84-10 (2010) tests.

Bottom ash (BA) used in this study was supplied by Gunsan Combined Cycle Gas Turbine (CCGT) Power Plant, Korea. It was screened to particle size passing sieve #4 (4.75mm) and the gradation is shown in Fig. 1. BA was used in substitution of 10%, 20%, and 30% fine aggregate (passing sieve #4) by weight in asphalt mixture, according to the previous studies (Chen et al. (2008); Hassan (2005)) and preliminary trials. Fig. 1 indicates that aggregate gradation tends to become slightly coarser with the higher amount of BA.

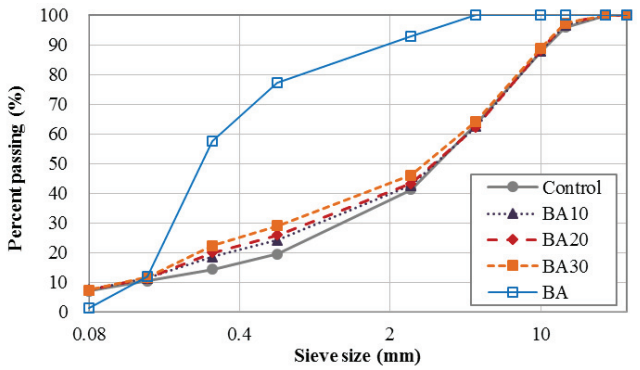


Fig. 1. BA gradation and Aggregate gradation with the combination of 10%, 20%, and 30% BA.