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Evaluation system for CO_2 emission of hot asphalt mixture

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ABSTRACT

The highway construction industry plays an important role in economic and development, but is also a primary source of carbon emission. Accordingly, with the global climate change, energy conservation and reduction of carbon emissions have become critical issues in the highway construction industry. However, to date, a model for the highway construction industry has not been established. Hence, to implement a low-carbon construction model for highways, this study divided asphalt pavement construction into aggregate stacking, aggregate supply, and other stages, and compiled a list of energy consumption investigation. An appropriate calculation model of CO_2 emission was then built. Based on the carbon emission calculation model, the proportion of carbon emissions in each stage was analyzed. The analytic hierarchy process was used to establish the system of asphalt pavement construction with a judgment matrix, thereby enabling calculation of the weight coefficient of each link. In addition, the stages of aggregate heating, asphalt heating, and asphalt mixture mixing were defined as key stages of asphalt pavement construction. Carbon emissions at these stages accounted for approximately 90% of the total carbon emissions. Carbon emissions at each stage and their impact on the environment were quantified and compared. The energy saving construction schemes as well as the environmental and socioeconomic benefits were then proposed. Through these schemes, significant reductions in carbon emissions and costs can be achieved. The results indicate that carbon emissions reduce by 32.30% and 35.93%, whereas costs reduce by 18.58% and 6.03%. The proposed energy-saving and emission reduction scheme can provide a theoretical basis and technical support for the development of low-carbon highway construction.

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1. Introduction

The greenhouse effect has a serious impact on the national system and social economy. The traffic industry is an important source of greenhouse gas and air pollution emissions. Hence, It has become one of the key industries in the development of alternation for low-carbon emissions, as explicitly proposed by Ministry of Environmental Protection to speed up highway construction. Generally, traditional hot mix asphalt is used in pavement construction, which emits large quantities of CO_2, CH_4, and N_2O (Deng and Cheng, 2002; Wang et al., 2003; Yan, 2011). This material is part of the high-carbon emission model, and is considered as an element of the carbon emissions disaster area of the highway industry, which is unfavorable to the development of a low-carbon economy. The International Energy Agency (IEA) reported that CO_2 emissions from the transport industry account for approximately 25% of global emissions (IEA, 2009). Pollutants and greenhouse gas emissions from transport accounted for 8% of the total emission in China (Cai et al., 2001), a country that also has large energy consumption. Hence, efforts are currently focused on building mechanisms for the energy-saving emission reduction. Annually, approximately 350 million tons of raw materials are used in the construction and maintenance of national highways annually (Nicholas, 2009) and roughly 7×10^6 MJ energy is required to build a 1 km standard two-lane asphalt road (Lee et al., 2010). In Denmark, the transport sector generates CO_2 emissions that account for approximately one third of the total CO_2 emissions of domestic industries, with approximately 95% of the emissions directly caused by traffic infrastructure construction and operation (Schmidt and Dyre, 2012).

Numerous studies on the influence of carbon emissions from the highway transport industry have been conducted by scholars both locally and abroad. Cass and Mukherjee (2010) analyzed and compared the design of pavement materials based on emission inventories, and provided a calculation method based on the process of carbon emissions, with a concrete pavement reconstruction project to illustrate the method. After establishing a calculation model of carbon emissions with the application of life cycle analysis method, Pan (2011) integrated energy consumption and emission inventory. The study also introduced energy-saving and emission reduction measures for highways. However, the models found in domestic and international researches on the study of carbon emissions mainly focused on building life cycle carbon emissions. Studies on the environmental pollution caused by asphalt pavement construction have not

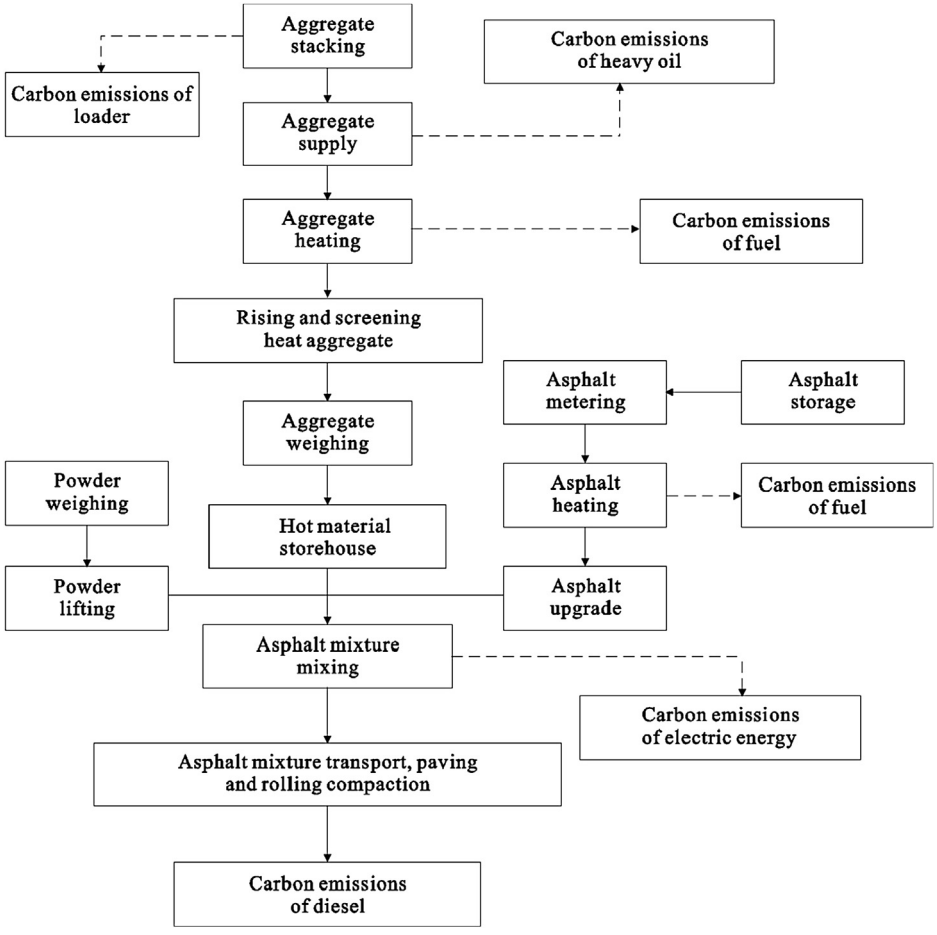

Fig. 1 – Production and construction process of asphalt mixture.