Sustainable development of road infrastructure using recycled waste aggregates

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The global issue of waste management calls for innovative solutions that not only reduce environmental pollution but also promote sustainable development. Accordingly, this research focuses on utilizing two types of waste materials, namely recycled construction and demolition (C&D) waste, and mine waste overburden soil, along with fly ash, in road pavement applications. By exploring these alternatives, we aim to address the environmental challenges posed by waste generation and provide cost-effective solutions for the construction industry.

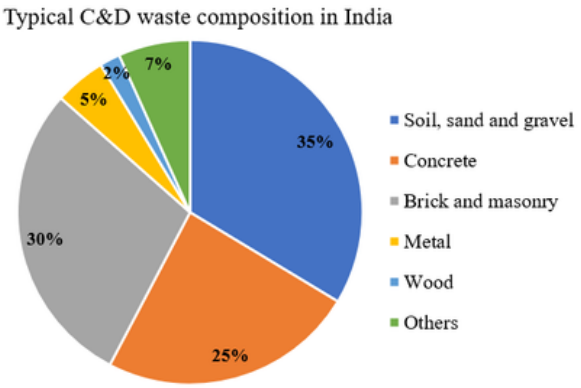

Fig. 1. Typical C&D waste composition in India as per the data published by Central Pollution Control Board

Utilization of Recycled Construction and Demolition Waste: Construction and demolition activities generate a significant amount of waste each year. Statistics indicate that an enormous volume of waste is produced through the construction and demolition of old infrastructure.

The generated C&D waste are typically dumped into the landfill, causing severe threat to the environment due to the leaching of harmful pollutants. On the other hand, generated C&D wastes can be recycled in recycling plants to produce recycled aggregates. Fig. 1. shows the typical composition of generated C&D waste in India.

Road construction activities are growing rapidly around the world and require a large volume of natural aggregates for their construction. Recycled C&D waste aggregates can be used as a sustainable alternative to natural aggregates in road pavement construction, thus reducing the burden on landfills and decreasing the demand for natural resources. Additionally, the use of recycled materials may provide economic and environmental benefits by reducing the costs associated with sourcing and transporting conventional aggregates and reduction in transportation-related emissions. Fig. 2. shows the Ramky C&D waste recycling plant located in Hyderabad, India.

Fig. 2: Ramky C&D waste recycling plant in Hyderabad and recycled aggregates derived from construction and demolition wastes

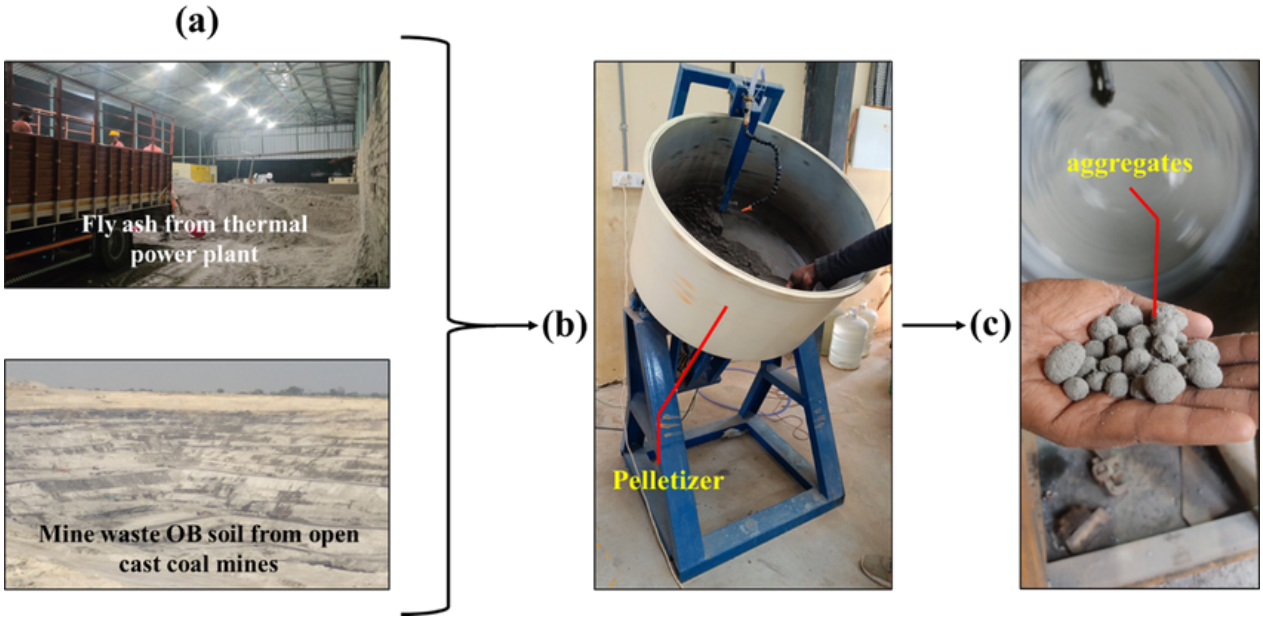

Fig. 3: Manufacturing aggregates from mine waste and fly ash: (a) material collection, (b) pelletization, and (c) pelletized aggregates

Utilization of Mine Waste Overburden Soil and Fly Ash: Mining operations, particularly open-cast mining, generate substantial amounts of waste rock and soil, known as mine waste overburden. This waste poses significant environmental challenges, including air pollution, unproductive land use, and potential ecological damage.

Moreover, the thermal power industry generates substantial quantities of fly ash, which is a by-product with limited utilization. In this research, we propose utilizing mine waste overburdened soil, and fly ash as alternative materials for pavement construction.

By integrating these waste materials into the construction industry, artificial aggregates from the mine wastes may be generated (refer to Fig. 3).

The availability of coal reserves worldwide, coupled with the extensive reliance on thermal power generation, necessitates efficient and sustainable management of these waste materials. By converting them into valuable resources of aggregates for pavement applications, we promote a circular economy and contribute to the reduction of greenhouse gas emissions.

Conclusion: The utilization of waste materials in road construction offers a promising avenue for solid waste management, sustainable development, and environmental conservation. By recycling construction and demolition wastes and, or incorporating mine waste overburden soil and fly ash in road construction, we can reduce environmental pollution, minimize landfill load, and provide cost-effective alternatives for sustainable road construction.

This research not only contributes to mitigating the environmental challenges associated with large volumes of waste generated but also offers a valuable and sustainable solution for addressing the scarcity of natural aggregates. By adopting these sustainable practices, we pave the way for a greener future, where waste is transformed into a valuable resource, benefiting both the construction industry and the environment.

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