Investigation into Sustainable and Environmentally Friendly Pavement Solutions for Heavy Traffic Urban Roads

[1]Prof. Tinu M. Khandale, [2]Vaishnavi T. Walthare, [3]Rohan R. Sharma, [4]Rahul S. Dharmik, [5]Omkar R. Yampalwar.

[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student.
[1]Civil Engineering Department,
[1]J D College of Engineering and Management Nagpur, India.

ABSTRACT

Numerous issues with pavement in heavy traffic urban road have been observed. Engineers and employees can only make educated guesses and prediction based on their experience and knowledge, they cannot determine if the construction and maintenance was properly or not.

This project entails an exhaustive analysis of extant pavement design methodologies and materials employed in high-traffic urban thoroughness, with a special emphasis on discerning critical factors impacting pavement performance. The study will additionally scrutinize traffic load patterns and environmental conditions specific to the chosen urban road. The investigation will delve into sustainable and recycled materials suitable for pavement construction, meticulously evaluating their mechanical properties. Moreover, a life cycle assessment will be conducted to juxtapose the environmental footprints of traditional and sustainable pavement designs. Lastly, the findings will inform the proposition of maintenance approaches and rehabilitation methodologies aimed at prolonging the operational lifespan of urban road pavements, all while considering sustainability and environmental facets.

1.INTRODUCTION

As one of the most important transportation infrastructures, roads perform an essential role in a wide range of anthropogenic activities. Rigid pavements are those which posse flexural strength or flexural rigidity. In rigid pavement the stresses are not transferred from the grain to grain to the lower layers. Development efforts to involve infrastructure have resulted in an unlimited demand for cement and thus global production has increased at lightning speed, with an annual increment of 2.5%. The cement industry is energy-consuming and a source of carbon dioxide CO_2 emissions, which increases greenhouse gases that harms the environmental through global and climate change.

From literature, it is evident that construction practices are responsible for air quality deterioration and they have a significant impact on human health and natural environment over time. According to the World Bank, the transport sector accounts for nearly 14% of global GHG emissions and approximately the 72% of these ones are due to construction, rehabilitation, maintenance and usages of roads. To provide a right answer to the rising demand of construction and rehabilitation of roads, it is necessary to integrate sustainable practice in the construction processes by reducing the consumption of resources and minimizing the impact on environment. An effective approach in this view is that of considering environmental issues along with social and economic factors in the decision-making process at a stages even before the design is conceptualized (Chang et al., 2015).

Global warming increases the frequency and the magnitude of extreme rainfall events. Existing urban drainage systems were constructed on the previous meteorological observation data and might not be suitable for nowadays or future climatic condition. By lowering air pollution and carbon emissions, eco-friendly transportation can aid in environmental preservation. By reducing the number of private automobiles on the road, improved public transportation systems can also lessen air and noise pollution.

The careful evaluation of heavy traffic urban roads estimation of correlated environmental procedures and practices and the estimation of the correlated environmental burdens are of crucial importance for identifying the criticalities and put in act strategies and measures able to make the whole process of roads construction more sustainable. In practice, it is fundamental to deep analyse the construction processes, considering the various factors and methodologies, their duration and location along the road infrastructure with the aim of an Investigation into Sustainable and Environmentally Friendly Pavement Solution for Heavy Traffic Urban Roads. In this study we will discuss about the problems generated due to the transportation system and transportation infrastructures. This study aims to provide a solutions for Heavy Traffic Urban Roads by considering the various factors of Environment.

2. MATERIAL AND METHODS

2.1. Materials

2.1.1. Glass Powder

Glass powder is a finely ground form of glass, typically created by crushing or milling glass objects into tiny particles. It can be used in various applications, such as in the manufacturing of ceramics, as a raw material in the production of glass, in construction materials like concrete, and even in artistic endeavours like glass art.

2.1.2. Fly Ash

ASTM C618 (ASTM 2012a) defines FA as the finely distributed sediment collected from the crushed or powder coal burning.

2.1.3. Reclaimed Asphalt Pavement

Reclaimed Asphalt Pavement (RAP) is the term used to describe old asphalt pavement material that has been removed from existing roads and then processed to be reused in the construction of new roads or as a component in asphalt mixes. When roads are resurfaced or repaired, the old asphalt is typically milled or crushed, and the resulting RAP material can be recycled. This practice is environmentally friendly because it reduces the need for new aggregates and the energy required to produce new asphalt. RAP is commonly mixed with new asphalt binder and aggregates to create a mix that meets the required specifications for road construction. The amount of RAP that can be used in an asphalt mix depends on factors like its quality, the specific project, and local regulations. Using RAP can help save resources and reduce costs while maintaining road quality.

2.1.4. Demolished Concrete

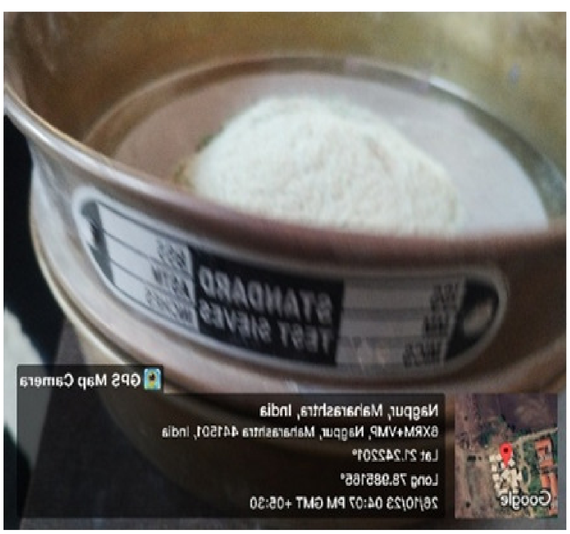
Demolished concrete refers to concrete structures, such as buildings, bridges, or pavement, that have been intentionally broken down or demolished for various reasons, such as renovation, reconstruction, or removal of deteriorated structures. This process involves breaking concrete into smaller pieces or rubble using heavy machinery like bulldozers, excavators, or jackhammers. Once the concrete is demolished, the resulting debris can be repurposed or disposed of in different ways. It is common to recycle demolished concrete by crushing it into smaller pieces to create recycled concrete aggregates (RCA), which can then be used in construction as a sustainable alternative to natural aggregates. Recycling demolished concrete reduces the need for new raw materials and can be more environmentally friendly.

2.2. Test

The various testing has been performed over a Waste Glass Powder and Fly Ash as this materials used for partial replacement of cement in construction work which were utilised as cement hence the test which are going to perform over material will be same as cement. Reclaimed Asphalt Pavement and Demolished Concrete were used as a aggregate in construction work the test are like aggregate.

2.2.1. Fineness Test

A fineness test for waste glass powder typically measures the particle size distribution of the material. This test helps determine how fine or coarse the particles are, which is important for



various applications. Common methods to perform this test include using a sieve analysis or laser particle size analyser. The results can be used to assess the suitability of waste glass powder for specific uses, such as in construction materials, concrete, or as a pozzolanic material in cement production.

2.2.2. Consistency Test

Refers to a procedure or examination aimed at determining the uniformity, reliability, or stability of a material or a process. In various contexts, consistency tests can be used to assess the reliability and repeatability of measurements, the uniformity of a substance’s properties, or the stability of a system or process over time. The specific definition and purpose of a consistency test can vary depending on the field or industry in which it is applied.

The partial replacement of glass powder according to the IS 4031 part 4 consistency test give the value between 5 to 7 which resulted that Waste Glass Powder and Fly Ash provide the proper consistency hence we can use the glass powder and fly Ash as a partial replacement of cement in construction work.

2.3. DATA COLLECTION

Till the date the following materials are used to obtained sustainable and Environmentally Friendly pavement for Heavy Traffic Urban Roads

1. Reclaimed asphalt pavement (RAP)

2. Construction and demolition waste (C&DW)

3. Lignin (a by-product of 2nd generation bioethanol processing)

4. Bio-binder from vegetable oil

In addition to these materials, there are many other eco-friendly materials that can be used in various construction applications. Some examples include:

1. Recycled concrete

2. Bamboo

3. Cork

4. Recycled plastic

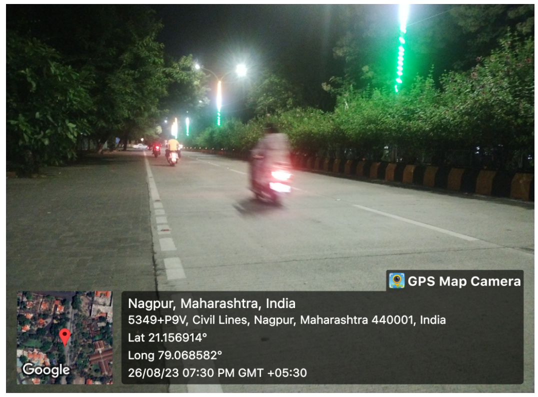
5. Fly ash (a by-product of coal combustion)

6. Recycled Waste glass Powder

It is important to note that the use of eco-friendly materials should be evaluated on a case-by-case basis, taking into account factors such as performance, cost, and availability. To conduct a comprehensive investigation into sustainable and environmentally friendly pavement solutions for heavy traffic urban roads, collect data on traffic patterns at the specified locations and times. Here's a basic outline data collection:

1. Location Details:

    a. Ravibhavan

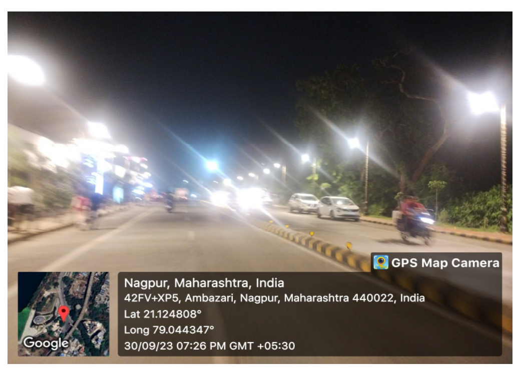


    b. Ramjhula

c. Bardi Market

d. Dharmpeth Road

e. Futala Lake Route



2. Time Intervals:
    a. 7 am
    b. 9 am
    c. 2 pm
    d. 4 pm
    e. 7 pm

3. Traffic Data:
    a. Number of vehicles passing through each location at the specified times.
    b. Vehicle types (e.g., cars, trucks, motorcycles).
    c. Average speed of traffic.
    d. Peak traffic hours.

4. Sustainability Measures:
    a. Identify if there are any existing environmentally friendly pavement solutions.
    b. Note any sustainable practices in place.

2.3. RESULT TRAFFIC ANALYSIS

2.3.1. Daily Volume

Reference: Traffic Data Computation (Publication No. FHWA-PL-18-027)

Day	Daily Volume (veh/day)	Daily Factors	Weighted Volume
Day 1	4410	0.11	4410 × 0.11 = 490
Day 2	5135	0.12	5135 × 0.12 = 614
Day 3	5270	0.13	5270 × 0.13 = 676
Day 4	5114	0.15	5114 × 0.15 = 743
Day 5	5980	0.16	5980 × 0.16 = 971
Day 6	4295	0.16	4295 × 0.16 = 697
Day 7	2890	0.17	2890 × 0.17 = 494
		ADT (Sum) =	4686 (Veh/day)

On the basis of above survey able to determine the traffic loads on the basis of Traffic Data Computation (Publication No FHWA-PL-18-027)

2.4. CONCLUSION

In conclusion, the investigation into sustainable and environmentally friendly pavement solutions for heavy traffic urban roads has revealed the importance of addressing the environmental impacts of road infrastructure. Sustainable pavement solutions, such as the use of recycled materials, permeable surfaces, and advanced construction techniques, offer promising alternatives to conventional road construction. These solutions not only reduce the carbon footprint of road projects but also mitigate the adverse effects on local ecosystems, water resources, and air quality. Moreover, they contribute to the overall sustainability of urban environments by promoting responsible resource management. To ensure the successful implementation of such solutions, collaboration among government agencies, construction firms, and environmental organizations is essential. As cities continue to grow and traffic congestion increases, it is imperative that we prioritize sustainable and environmentally friendly pavement solutions to create greener, healthier, and more urban spaces.

2.6. CONCLUDING REMARKS

Dust and Gases generation Control	**Engineering Control**
Cover dump trucks that transport excavated materials.	Use of dustproof cover, net or screens
Control of driving speed	Dust collection system
Control during loading operations	Wet dust suppression system
Implementing appropriate material stacking and stockpiling heights	Wheel washing of vehicles
Change of worker behaviour	Dilution using fresh air
Change of construction methods	Using windbreaks/ hedges
Ground surface hardening	Use of local exhaust ventilation
Provision of sealed roads within construction sites.	Use of chemical agents

2.5. ACKNOWLEDGEMENT

This project will provide valuable knowledge about Sustainable pavement material which contribute to the development of more resilient and Eco-friendly infrastructure solutions for the future. It will provide recommendations for the adoption of sustainable pavement solutions in heavy traffic urban roads based on the project's finding.

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