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Comparison Between Bitumen Road and Concrete Paver Block Road

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Abstract: ***In this paper, the comparative study between bituminous roads (asphalt roads) and concrete paver block roads is presented here with the material composition, durability, cost, maintenance, environment and comfort as the main considerations. Bituminous roads consist of bitumen, sand, and aggregates. They are usually faster and less expensive to build and involve a clean surface to walk or drive on. However, such signs have higher maintenance needs (they tend to have shorter lives, particularly in areas with heavy traffic or extreme weather) and are usually more expensive.***

Interlocking concrete paver block roads have a high initial construction cost and installation time for this type of road are greater. Another, they last longer meaning less maintenance, they are more cost effective long term. Ecological is that, bituminous road construction emits less carbon than cement road construction, which creates a rise in temperature on the surface of the road which is often referred to as the heat island effect for animals, humans in the urban area.

In comparison, concrete paver block roads, while having a carbon footprint that is more than double that of tar in production, reflects more sunlight and are cooler at all times. Choice between bituminous paver block road and concrete paver block road we make taking into consideration many a specific factors like budget, climatic conditions, traffic conditions, level of flexibility desired, and lifespan of road that we want to achieve. An objective comparison of these aspects facilitates the selection of the appropriate road type for sustainable infrastructure planning.

Keywords: DurabilityandLongevity, Environmental Impact,Comfortand Noise, Climate Suitability.

I. INTRODUCTION

The development and maintenance of road infrastructure is vital for the economic progress, connectivity and overall socio-economic development of any region. Two of the most popular materials for road construction are concrete bricks and bitumen (or asphalt). All of them have certain benefits that are very specific, and the best one for you is determined by your situation, traffic and budget. Considering the accelerated urbanization and the demand for efficient, affordable and sustainable infrastructure, the benefits and limitations of each type of road construction have to be compared.

Paver brick roads are made using interlocking bricks or precast concrete bricks.

More typically than not, these roadways are understood for being strong, strong, and with adequate strength to act as a surface for bring even the heaviest loads for long stretches. Additionally, concrete blocks present an attractive face to the end user and as such the blocks are often used in urban design or wherever durability is not so much cost driven issue. They require less frequent care and are resistant from reactions to extreme weather, making it ideal to place in hot or rainy zones.

On the other hand, bitumen roads, or asphalt roads, are used in different part of the world as one of the most commonly used types of roads and are being widely used due to relatively low construction costs, smooth and quiet surface, as well as relatively simple maintenance. Bitumen, a product of crude oil, is highly flexible, and can accommodate minor ground movements without fracturing; such pavements are appropriate for places with temperate climates and variable soil types. However they could wear down relatively quickly in extreme weather or where heavy traffic causes it if not maintained well. The aim of this comparison is to provide an extensive analysis of concrete brick road and bitumen road under many aspects, such as costs, service lives, maintenance requirements, shaking, temperature, vehicle traffic capacity, environment impact, friction, economic benefit for in long term.

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1) Concrete Paver Block :-Higher strength grades over 60 MPa are used in industrial applications. Complies to ASTM C936 or IS 15658. Flexural strength is usually between 3.5 and 5 MPa. If correctly produced, it is resistant to the weather, chemicals, oil and UV. This resistance can be enhanced further by adding magnesia materials (e.g., silica fume or fly ash) and by using surface treatments.



Fig. 1.1 Concrete Paver Block

2) Bitumen road:-The durability, safety and cost-effectiveness of bitumen (asphalt) roads depend on their performance. Aggregate particles are held together by a binder, such as bitumen, and form a flexible pavement structure. On contrary, high stability combined with the appropriate flow is necessary. Bitumen road pavement layers are able to move or deform slightly without cracking. Water can strip bitumen off aggregate, causing potholes and ravelling.

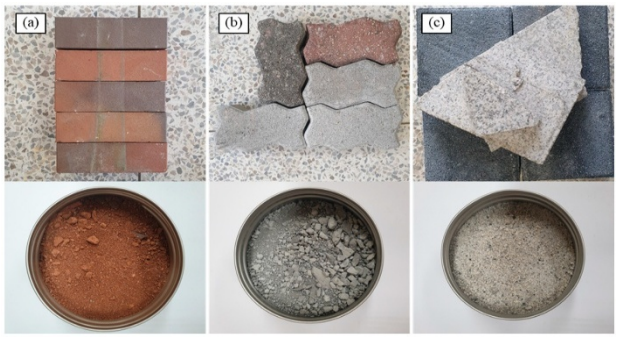


Fig. 1.2 Bitumen

II. LITERATURE REVIEW

Extensive literature review to compare concrete paver block pavement with bitumen (asphalt) road reveled about unique advantages and disadvantages of each type with special reference to mechanical properties, economical & ecological aspect and suitability.

Atul Thakur et al. (2017) have studied the impact of partial replacement of cement with RHA on the performance of paver blocks for compressive strength, water absorption, and abrasion resistance. Cement was partially replaced by volume as 0, 15, 20, 25, 30, 35 and 45%. The compressive strength was determined (28, 56 and 7days) and tests for both water absorption and abrasion resistance were performed after 28days [1].

B. Kaviya (2016) studied the production of pavement blocks from crusher dust. The properties of crusher dust were obtained and compared with sand. The results shows that there is a reduction 0% of weight for crusher dust compared with sand. Since the availability of sand is reducing now a days using of crusher dust is a good replacement for sand stone in to good quality of concrete this paper presents feasibility of artificial sand in concrete for the purpose of experimentation concrete 20%, 30% and 40% by weight.[2].

Deshpande B. C. and P. Darade M. M. (2015) investigate the impact of using fly ash as a partial substitute for cement and dust as a partial substitute for fine aggregate on the properties of pavement blocks.

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Their study focuses on an M30 mix that incorporates fly ash as a replacement by weight of cement. Experiments were conducted to evaluate the compressive strength, flexural strengthand abrasion resistance of the concrete paving blocks[3].

Ellie H. Fini and colleagues (2015) describe bitumen according to the European standard as a viscous, almost solid adhesive and waterproofing agent derived from crude oil or found in natural asphalt, which is entirely soluble in toluene. It is widely recognized that the original properties of bitumen are significantly influenced by its production and processing methods, as well as the characteristics of the crude oil from which it is derived. Typically, heavier petroleum oils yield greater amounts of bitumen. Thus, gaining a comprehensive understanding of bitumen's characteristics from different perspectives is essential[4].

Michele Porto et al. (2019) compiled data for their study by thoroughly reviewing the most recent literature on modified bituminous materials, technologies, and advancements. The report is structured into two primary sections for this reason. The first section analyzes bitumen in terms of its molecular composition and microstructural features. The second section focuses on the modification of bitumen from various angles in order to assess the effectiveness of added additives and polymers in enhancing the technical properties of bitumen for both paving and industrial uses. The results of this study highlight the importance of the chemical composition of bitumen as a basis for modification. While certain polymers and compounds can improve specific characteristics of pure bitumen, they may also lead to compatibility challenges during production and storage. In this context, various studies have shown that waxes are effective in enhancing polymer compatibility with bitumen and offer benefits related to the production of warm mix asphalt (WMA)[5].

III. OBJECTIVE OF STUDY

The primary objective of this study is to present the performance investigation and comparison such as cost, sustainability and applicability of bitumen roads as well as concrete paver block pavements. The two types of surfacing are commonly employed in either urban or rural areas, with distinct advantages and disadvantages for each. With the growing emphasis on sustainable and cost-effective building, there is a need to understand the relative benefits of these options. In this study, the construction process, the cost and cost of maintenance, structural life, loading behavior, the earth pressure, maintenance simplicity, weather resistance, and aesthetic appearance as regards the environmental effect factors are investigated for one by means of each other is compared. Asphalt roads tend to be black, bitumen is a smooth sticky texture, and they are both favored as they give a relatively quick build, they are most used on inner city roads and highways as they are for high traffic areas. On the other hand, concrete paver blocks are gaining popularity due to their modular pattern, ease of maintenance and ability to allow surface water infiltration, thus aiding groundwater recharge. The applicability of both surfaces in various climatic zones, especially zones of high precipitation, temperature fluctuation and traffic load, will also be studied. By comparison of the life cycle performance of each pavement type, the goal of this study is to find out the most cost-effective and environmentally sustainable choice under some conditions.

IV. METHODOLOGY

1) Material testing: Concrete paver blocks is essential to ensure they meet the quality standards for strength, durability, and usability in construction. Various tests are performed both in the laboratory and on-site.

2) Concrete paver block road – production & installation

a) *Production of Paver Blocks*

- Material Preparation: Cement, sand, stone chips/aggregates, water, and colouring additives.
- Mixing: Cement, sand, and aggregates are dry mixed; then water is added for a semi-dry mixture.
- Moulding: The mixture is placed into moulds (either manually or with a hydraulic press) and then vibrated/compacted.
- Curing: Blocks are removed from moulds and placed in water tanks or curing rooms for a duration of 14–28 days to enhance strength.
- Finishing & Storage: A surface finish is applied (either textured or smooth), and blocks are stored to dry.

b) *Installation of Paver Block Road*

- Sub-grade Preparation: The ground is compacted and levelled .
- Sub-base Layer: Typically made of compacted sand or granular sub-base (GSB).
- Base Layer (Optional): A cement-treated base or dry lean concrete may be utilized.
- Bedding Layer: A layer of sand, 20–30 mm thick, is laid and evened out.
- Block Laying: Paver blocks are manually arranged in desired patterns with small gaps in between.

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- Compaction: The surface of the blocks is compacted using a plate compactor.
- Joint Filling: Dry sand is swept into the joints and compacted again.

c) Bitumen (Asphalt) Road – Production & Installation Process

- *Material Preparation*
  - Aggregates: Crushed stone, gravel, or sand graded according to design specifications.
  - Bitumen Binder: Penetration grade or modified bitumen heated to a temperature of 150–170°C.

- *Hot Mix Asphalt (HMA) Preparation*
  - Drying & Heating: Aggregates are dried and heated in a drum mixer.
  - Mixing: Heated aggregates are blended with hot bitumen in the appropriate proportions.
  - Transport: Hot mix is delivered to the construction site using insulated trucks.

- *Road Installation*
  - Sub-grade & Sub-base Preparation:Natural ground is prepared through earthwork and compaction; a granular sub-base is applied.
  - Base Course: Water Bound Macadam (WBM) or Wet Mix Macadam (WMM) is compacted.
  - Tack Coat: A thin layer of bitumen is sprayed onto the base to ensure the asphalt layer adheres.
  - Bituminous Layer Laying: The hot mix is applied using a paver machine at a thickness of 50–100 mm (depending on design).
  - Compaction: It is immediately rolled with tandem/vibratory rollers for effective compaction.
  - Curing: The road is allowed to cool and settle; traffic is permitted after several hours.

d) Material Test and I.S. Code

Table 4.4 Material Test and I.S. Code

Sr.NO.	Test	I.S. Code		Range	
		Paver block brick	Bitumen road	Paver block brick	Bitumen road
1.	Compressive strength	IS : 15658-2021	IRC: SP: 53-2010	(30-50) MPa	(5-6) MPa
2.	Impact value of aggregate	IS : 2386 (Part IV)	IS:456-1598(1977)	Not exceed 20%	(30-40) %
3.	Water absorption	IS : 15658-2021	IS : 2386(Part III)	(6-7) %	(0-2) %

V. RESULT& DISCUSSION

Table (v). comparison between bitumen and concrete paver road test

Sr.No.	Tests	Paver block brick	Bitumen road
1.	Compressive strength	29.5 N/mm^2	14 KN/mm^2
2.	Impact value of aggregate	Fine aggregate (small particles)	15.13mm
3.	Water absorption	1.9%	0.15%
4.	Cost estimation (1 sq mt)	₹900 – ₹1300	₹800 – ₹1200

Here's we gives the brief descriptions of above table of comparison in tests:

1) The compressive strength of concrete paver block is29.5N/mm^2, On the others bitumen road is 14 KN/mm^2which gives the more durable load on bitumen road.

2) Impact value of aggregate using to prepare the paver block road is small particles and 15.14mm of aggregate used to preparing the bitumen road which gives the bitumen may not be deformed.
3) Concrete paver block road reserves 1.9% water whereas it absorbs 0.15% of water absorption value.
4) It cost the Rs(300-400) to build the one square meter of concrete paver block road and it cost Rs200-250) the bitumen road.

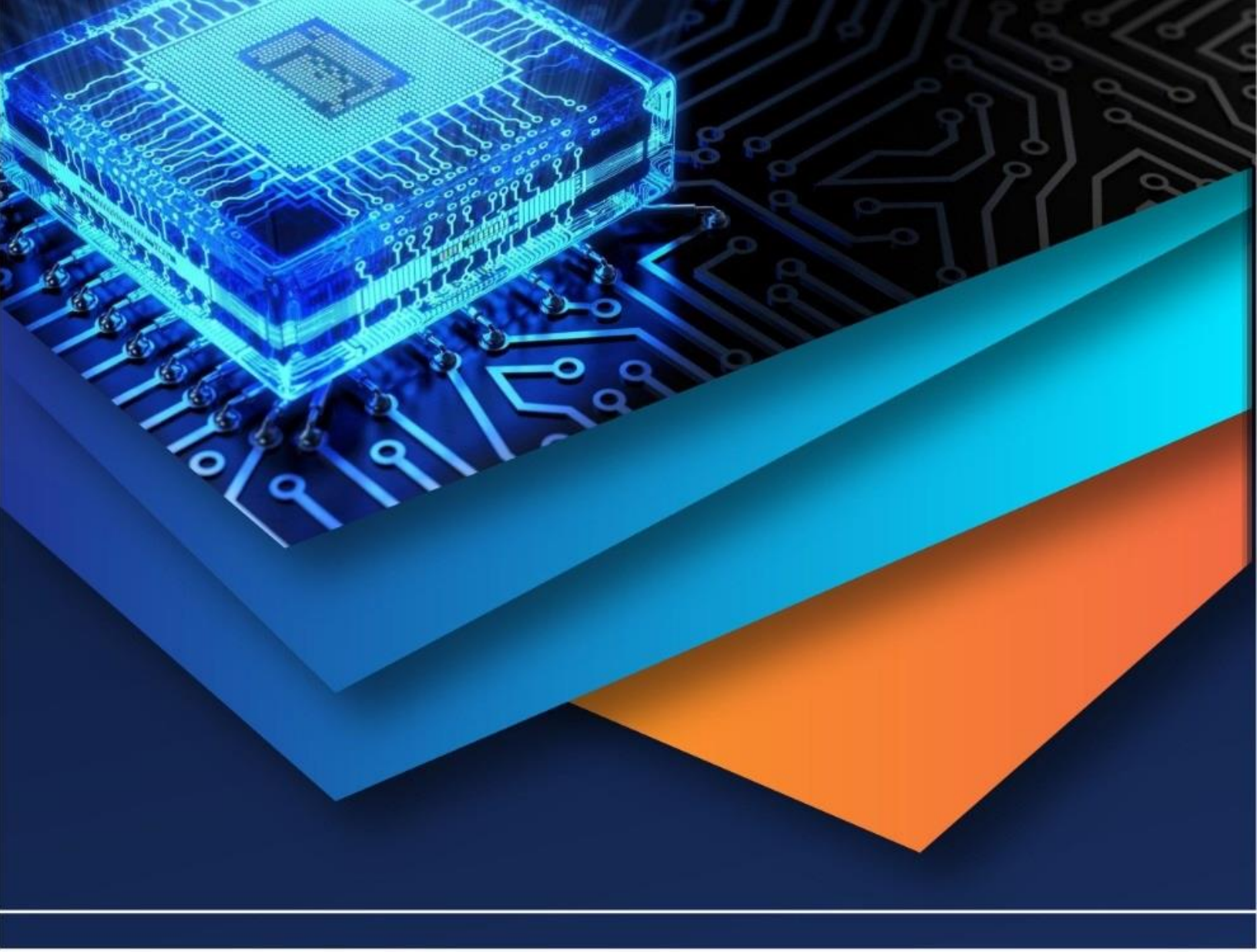
VI. CONCLUSION

The paver block sector is experiencing notable expansion driven by several elements, such as increased construction activities, improved living standards, and changing consumer preferences These elements have resulted in heightened demand for paver blocks from both the residential and commercial markets. Notably, India stands out as one of the fastest-expanding economies globally, and as such, the nation is expected to make a substantial contribution to the overall growth of the paver block market. This concludes our overview of paver blocks. In response to the high demand for these products, numerous construction firms worldwide have begun to invest in machinery for making paver blocks to produce high-quality products. This investment enables them to access a broader audience and generate considerable revenue. Given the popularity and characteristics of paver blocks, those interested in manufacturing them should choose the most suitable paver block making machine.

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