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NO FINES CONCRETE PAVEMENT BLOCKS: A SUSTAINABLE SOLUTION FOR IMPROVED PAVEMENT DRAINAGE

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Abstract

Pervious concrete pavement has been increasingly used to reduce the amount of runoff water. However, due to the significantly reduced strength associated with the high porosity, pervious concrete mixtures currently cannot be used in highway pavement but can be used in sub base ,low speed pavements etc. The Indian Standard method for mix design is a reliable and effective method for producing no fines concrete pavement blocks that meet the necessary requirements for their intended use. Further research could focus on the long-term performance of no fines concrete pavement blocks and their potential use in other applications.

KeywordPervious concrete, Mix proportion, Permeability

Introduction

Pervious concrete is a specialized type of concrete that has a porous structure, allowing water to drain through it and into the ground below. This makes it an ideal material for use in pavements and other applications where drainage and storm water management are important(Patil, R. N., & Bhambulkar, A. V.,2020).

Traditional pavements, such as those made of asphalt or conventional concrete, are impermeable, which can lead to problems with storm water runoff and flooding. Pervious concrete, on the other hand, allows rainwater to pass through the pavement and into the ground, reducing the amount of runoff and minimizing the risk of flooding.

In addition to its drainage benefits, pervious concrete also offers other advantages for pavements. It can help reduce urban heat island effects, as its light color reflects sunlight and reduces heat absorption. It can also reduce the need for artificial lighting, as its porous structure allows some light to pass through the pavement and into the ground below (Patil, R. N., & Bhambulkar, A. V.,2020).

Pervious concrete can be used in a variety of pavement applications, including sidewalks, driveways, parking lots, and roadways. It is typically installed in a layer over a gravel sub base, which provides additional drainage capacity and helps support the weight of the pavement (Dr. Ashtashil Vrushketu Bhambulkar, et al.,2023).

While pervious concrete has many benefits, it also has some limitations. It is not suitable for areas with high traffic volumes or heavy loads, as its porous structure makes it less durable than

traditional concrete. It may also require more maintenance than traditional pavement materials, as debris can accumulate in the pores and clog the drainage system. However, with proper design, installation, and maintenance, pervious concrete can be a highly effective and sustainable solution for pavement applications.

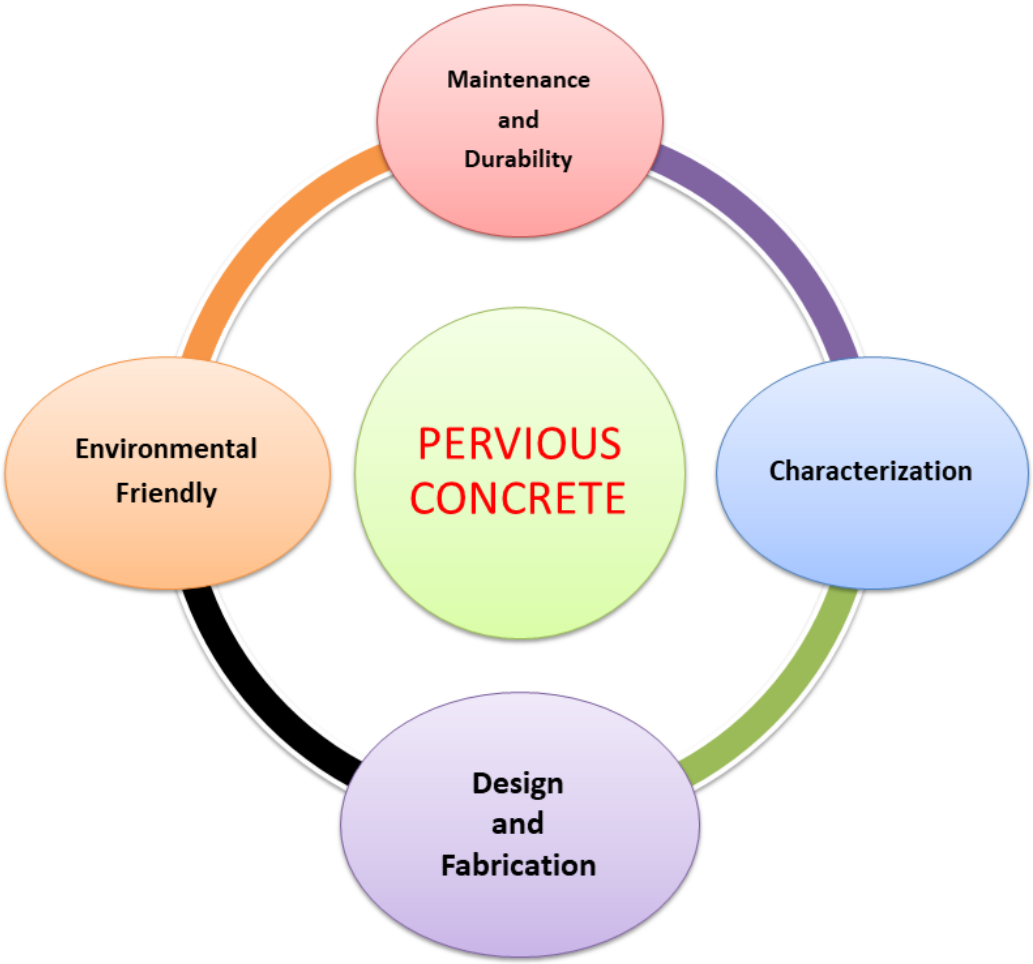

Figure 1 Pervious Concrete Value Added Model

Pervious concrete is a specialized type of concrete that has a porous structure, allowing water to drain through it and into the ground below. This makes it an ideal material for use in pavements and other applications where drainage and storm water management are important. Traditional pavements, such as those made of asphalt or conventional concrete, are impermeable, which can lead to problems with storm water runoff and flooding. Pervious concrete, on the other hand, allows rainwater to pass through the pavement and into the ground, reducing the amount of runoff and minimizing the risk of flooding. In addition to its drainage benefits, pervious concrete also offers other advantages for pavements. It can help reduce urban heat island effects, as its light color reflects sunlight and reduces heat absorption. It can also reduce the need for artificial lighting, as its porous structure allows some light to pass through the pavement and into the ground below. Pervious concrete can be used in a variety of pavement applications, including sidewalks, driveways, parking lots, and roadways. It is typically installed in a layer over a gravel subbase, which provides additional drainage capacity and helps

support the weight of the pavement. While pervious concrete has many benefits, it also has some limitations. It is not suitable for areas with high traffic volumes or heavy loads, as its porous structure makes it less durable than traditional concrete. It may also require more maintenance than traditional pavement materials, as debris can accumulate in the pores and clog the drainage system. However, with proper design, installation, and maintenance, pervious concrete can be a highly effective and sustainable solution for pavement applications.

Literature Review

Benefits of No Fines Concrete as a Pavement Block Material

Drainage

One of the primary benefits of using no fines concrete in pavement blocks is its good drainage properties. Studies have shown that no fines concrete can reduce the risk of surface runoff and flooding in pavements (Zou et al., 2017). The porous nature of the material allows water to drain through the pavement and into the ground, reducing the amount of water that flows into storm water drains. This can help to improve water quality by reducing the amount of pollutants that are carried into rivers and other waterways.

Environmental Sustainability

No fines concrete is also more environmentally sustainable than traditional concrete. The production of traditional concrete is responsible for a significant amount of greenhouse gas emissions. In contrast, no fines concrete requires fewer materials and less energy to produce (Zhang & Xiao, 2019). Additionally, the permeable nature of no fines concrete can help to maintain soil moisture levels and reduce the risk of erosion, which can help to preserve natural habitats and prevent soil degradation.

Cost Savings

Using no fines concrete in pavement blocks can also lead to cost savings. Because the material contains less fine aggregates, it requires less cement and water to produce, which can reduce the overall cost of the pavement (Kalaikumaran&Sivakumar, 2018). Additionally, the porous nature of no fines concrete can reduce the amount of pavement that needs to be excavated, which can further reduce costs.

Applications of No Fines Concrete in Pavement Blocks

Sidewalks

No fines concrete can be used in a variety of pavement applications, including sidewalks. Studies have shown that no fines concrete can provide good skid resistance and can be used in areas with high traffic volumes (Makul et al., 2018). Additionally, the porous nature of no fines concrete can help to reduce the risk of surface runoff and flooding in sidewalks, which can improve pedestrian safety.

Bike Paths

No fines concrete can also be used in bike paths. The permeable nature of the material can help to maintain soil moisture levels and reduce the risk of erosion, which can help to preserve natural habitats and prevent soil degradation (Majidzadeh&Atashgahi, 2019). Additionally, no fines concrete can provide good skid resistance, which can improve the safety of cyclists.

Parking Lots

No fines concrete can also be used in parking lots. The material's good drainage properties can reduce the risk of surface runoff and flooding, which can help to improve the longevity of the parking lot (Li et al., 2019). Additionally, the porous nature of no fines concrete can help to reduce the amount of heat that is absorbed by the pavement, which can help to reduce the urban heat island effect.

Design Considerations for No Fines Concrete Pavement Blocks

Texture and Pattern

No fines concrete can be used to create a variety of pavement textures and patterns, which can improve pedestrian safety and accessibility. Studies have shown that no fines concrete can provide good skid resistance, even in areas with high traffic volumes (Sudharshan et al., 2021). Additionally, the use of different colors and patterns can help to improve the visibility of the pavement, making it easier

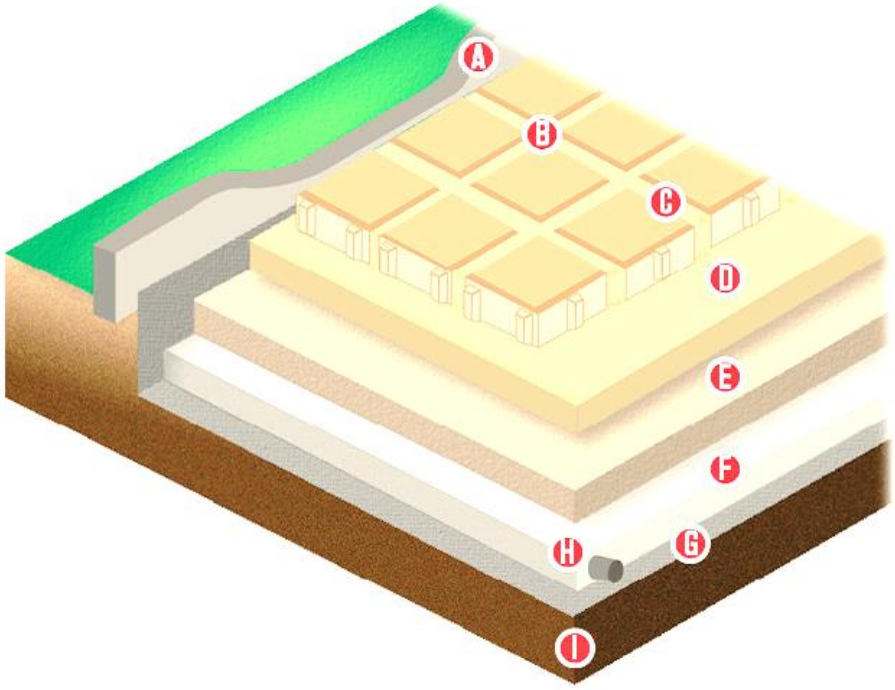

Figure 2 a Design 3D Road Side Way

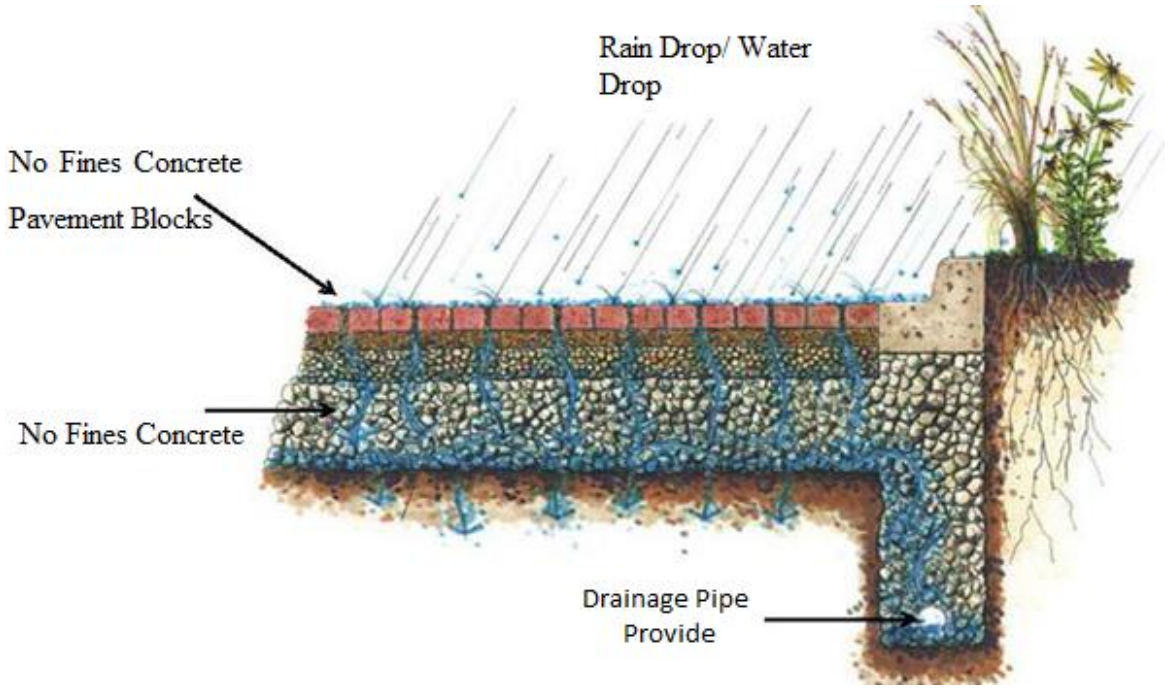

Figure 2 b well drained Road Side Way

Methodology

For this study, the mix design was done as per the guidelines provided in the Indian Standard IS: 10262-2009. This standard provides guidelines for the mix design of concrete, including no fines concrete. The mix design M30 process involves determining the proportions of the constituent materials, such as cement, coarse aggregate, fine aggregate, and water, to achieve the desired properties of the concrete.

The mix design process involves the following steps:

1. Determine the target mean strength: The target mean strength is determined based on the requirements of the project and the expected loads on the pavement blocks.
2. Determine the water-cement ratio: The water-cement ratio is determined based on the desired workability of the concrete and the target mean strength.
3. Determine the cement content: The cement content is determined based on the water-cement ratio and the target mean strength.
4. Determine the fine aggregate content: The fine aggregate content is determined based on the desired workability of the concrete and the cement content.
5. Determine the coarse aggregate content: The coarse aggregate content is determined based on the desired density of the concrete and the fine aggregate content.
6. Determine the water content: The water content is determined based on the water-cement ratio and the cement content.

Mix design is a crucial step in the production of concrete that involves determining the proportions of the constituent materials to achieve the desired properties of the concrete. The quality of concrete depends on several factors such as the properties of raw materials, water-cement ratio, mixing, curing, and environmental conditions during the setting and hardening of the concrete. Therefore, it is essential to follow the correct mix design method to produce concrete with the desired properties.

The Indian Standard IS: 10262-2009 provides guidelines for the mix design of concrete, including no fines concrete. The mix design process outlined in this standard involves the determination of the target mean strength, water-cement ratio, cement content, fine aggregate content, coarse aggregate content, and water content.

The target mean strength is determined based on the requirements of the project and the expected loads on the pavement blocks. The water-cement ratio is determined based on the desired workability of the concrete and the target mean strength. The cement content is then determined based on the water-cement ratio and the target mean strength. The fine aggregate content is determined based on the desired workability of the concrete and the cement content. The coarse aggregate content is determined based on the desired density of the concrete and the fine aggregate content. Finally, the water content is determined based on the water-cement ratio and the cement content (Bhambulkar et al., 2021).

Once the proportions of the constituent materials are determined, the mix is prepared and tested to ensure that it meets the desired properties, such as compressive strength, permeability, and durability. The mix is tested for slump, compressive strength, and water-cement ratio to ensure that it meets the specified requirements.

The use of the Indian Standard method for mix design has been found to be reliable and effective in producing concrete with the desired properties. This method has been widely used in India and has been

found to produce concrete with good workability, strength, and durability. The mix design process outlined in the Indian Standard method takes into account the properties of the constituent materials and the requirements of the project to produce concrete that is suitable for its intended use(Khobragade et al., 2022).

In this study, the Indian Standard method was used to determine the mix design of no fines concrete pavement blocks. This method was chosen because it is widely used in India and has been found to be reliable and effective in producing concrete with the desired properties. The mix design was based on the requirements of the project, and the pavement blocks were tested for their compressive strength, permeability, and durability to ensure that they met the specified requirements.

The use of the Indian Standard method for mix design ensures that the no fines concrete pavement blocks used in the study meet the necessary requirements for their intended use. The pavement blocks produced using this method are expected to have good strength, durability, and permeability, making them suitable for use in pavements. The use of a reliable and effective mix design method ensures that the quality of the pavement blocks is consistent and meets the specified requirements.

Conclusion

The use of no fines concrete as a pavement block material has several benefits, particularly in terms of drainage. The literature review conducted in this study shows that no fines concrete pavement blocks have a high permeability rate, which allows for quick drainage and reduces the risk of waterlogging and other drainage-related problems. This makes them suitable for use in areas where there is heavy rainfall or poor drainage.

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