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Review

Pervious concrete as a sustainable pavement material – Research findings and future prospects: A state-of-the-art review

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HIGHLIGHTS

- Presented current state-of-the-art regarding pervious concrete pavements.
- Reviewed durability issues associated with pervious concrete mixtures.
- Documented past studies related to field performance of pervious concrete mixes.
- Discussed environmental and economical aspects of pervious concrete materials.
- Pervious concrete found to be a very promising candidate in pavement applications.

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ABSTRACT

In the last few years, the use of pervious concrete as a pavement material in low-volume road applications has gained importance due to its positive environmental aspects. This paper reviews the developments and state-of-the-art pertinent to pervious concrete research and practices. The investigations on mechanical-hydrological-durability properties of pervious concrete performed in various studies have been reviewed. The storm water purification efficiency of pervious concrete has been documented. The field investigations of few test sections and in-service pervious concrete pavements have been discussed. A review has been made on rehabilitation techniques to increase the hydraulic efficiency of pervious concrete pavements. A note has been mentioned on the life cycle cost analysis of pervious concrete. Due to an increased use of pervious concrete in the pavement industry due to its multitudinous benefits, there exists an expansive scope for further research to understand the material better, which will make it a promising sustainable roadway material in future.

Contents

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1. Introduction

High-impact development in the areas of transportation infrastructure by the construction of conventional pavements is transforming the natural pervious ground into an impervious land cover [1–4]. The construction of conventional impervious pavement systems has caused two major shifts in the local environment, including: (1) changes in the hydrological aspects, and (2) variations in the surrounding thermal ambience [2,4–7].

The impervious nature of the conventional pavement systems has resulted in increased stormwater runoff quantity that has stemmed in a large volume of first flush containing unacceptable level of pollutants, and unwarranted flash floods [3,8–12]. Moreover, the treatment of first flush requires large detention basins and purification plants before it is discharged into the natural water bodies [3,10]. In addition, problems such as decreased groundwater recharge, hydroplaning surfaces, and non-skid-resistant wearing courses is virtuous of the impervious pavement systems [2,9]. Further, unfavorable changes in the surrounding thermal ambience such as the creation of a difference in the temperature between urban and the surrounding rural areas are also known to be caused due to the impervious urban fabric. The impervious pavement systems which act as heat storage media release the heat back to the atmosphere during night times [13]. This phenomenon commonly called Urban Heat Islands (UHI) has led to thermal discomfort for urban dwellers, which has prompted the consumption of additional electricity for cooling purposes and increased CO_2 emissions [6,14,15].

In order to decrease the effect of high-impact development, several transportation organizations have focused on research and implementation of sustainable materials and eco-friendly strategies that result in low-impact development [10]. Conventionally, most of the urban planners and developers have adopted detention and retention basins as strategies to reduce runoff from the urban areas. However, water from such basins will require engineered treatment before discharging it into natural water bodies, thus making the solution uneconomical [16,12].

Among various strategies for low-impact development in pavements, pervious concrete pavement system has become a suitable candidate due to its structural, economical, and road user benefits [12,17]. Pervious concrete is a unique concrete pavement type mainly composed of rationally graded coarse aggregate and cementing materials which provide the mix with an interconnected macro-pore internal structure [18–21]. The limited quantity or absence of fines in pervious concrete creates highly curvaceous pores that help store stormwater within them, and reduce runoff quantity in a scientific manner. Further, the porous nature is found to reduce the UHI effect, and helps maintain conducive surrounding ambience.

The score of benefits has undoubtedly bolstered the use of pervious concrete in pavement applications in the various regions of the world over the last several years [19]. However, the implementation of pervious concrete as a pavement material in many countries especially emerging countries is still not practiced due to lack of a standard technique in material preparation and testing as well as construction practices. Concurrently, there is a need to compile literature of pervious concrete material in pavement applications

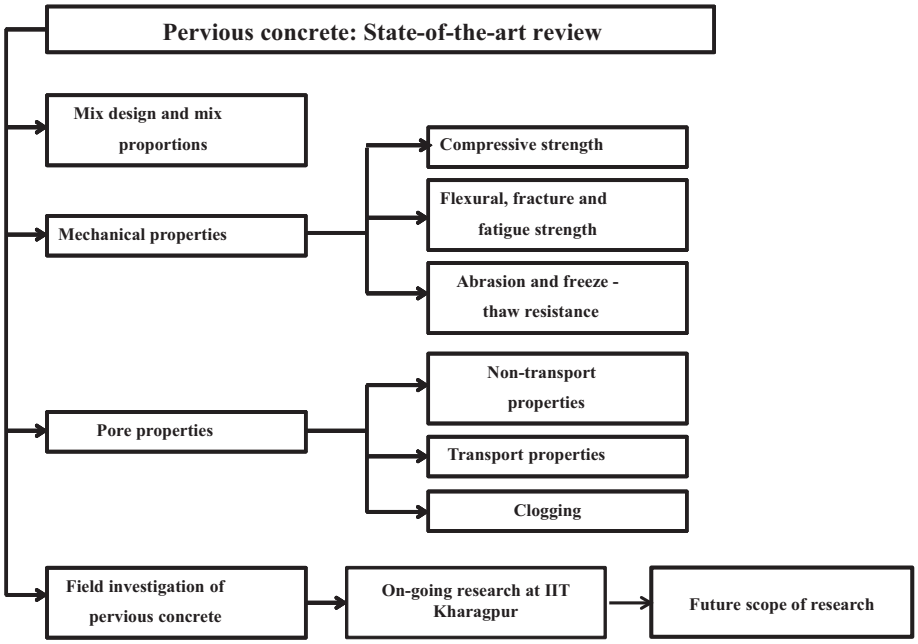

Fig. 1. Research review outline.