

Use of Pervious Concrete: A Review

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Abstract- *Pervious concrete pavement is a unique and effective means to meet growing environmental demands. By capturing rainwater and allowing it to seep into the ground, pervious concrete is helpful in recharging groundwater. In fact, the use of pervious concrete in the construction of pavement, for the hot and low rainfall places of India is seems to be significant for improving the water table. This pavement technology creates more efficient land use by eliminating the need for retention ponds, swales, and other storm water management devices.*

Pervious concrete is gaining widespread attention due to its numerous environmental benefits, including stormwater runoff control, groundwater recharge, and reduction of water and soil pollution. This sustainable solution is becoming increasingly popular globally. Composed of coarse aggregate, hydraulic cement, and other cementitious materials, Portland cement pervious concrete creates a permeable surface that allows stormwater to filter through the pavement and into the underlying soil, provided the soil is suitable for drainage.

I. INTRODUCTION

Pervious concrete offers a viable alternative to traditional paving surfaces, reducing storm water runoff and nonpoint source pollution by allowing rainfall to permeate into the ground. A well-designed pervious concrete pavement system can mitigate the environmental impacts of development, making it an attractive option for new and existing sites. By replacing conventional pavements, property owners can maintain water quality, increase base flow, decrease flooding, and preserve valuable parking areas. Portland cement pervious concrete (PCPC) has a proven track record in the Southeastern United States, but its use in areas with significant freeze-thaw cycles requires careful evaluation. Despite its benefits, including improved skid resistance and reduced pavement noise, PCPC's limited strength and durability in harsh environments have restricted its adoption. Enhancing the strength and freeze-thaw resistance of pervious concrete can expand its applications and increase its use in various regions.

Pervious concrete is an innovative pavement material designed to mitigate storm water-related environmental issues. Its unique structure features a network of interconnected voids, allowing water to filter through to the sub-base below. Research suggests that pervious concrete surfaces may exhibit higher temperatures than conventional impervious pavements, but temperatures beneath the surface are lower. This characteristic highlights the potential benefits of pervious concrete in managing storm water runoff and reducing environmental impacts.

Benefits of pervious concrete pavements

Components of Pervious Concrete

Pervious concrete typically consists of coarse aggregate, cement, and water, with optional small amounts of fine aggregate added to enhance compressive strength. Various admixtures, such as high/middle range water reducers, water retarders, viscosity modifiers, and fibers, can be used to improve performance. Additionally, fly ash may be used as a partial substitute for Portland cement, increasing the environmental sustainability of pervious concrete.

II. LITERATURE REVIEW

As per **Ozel et. al (2022)**, Pervious concrete's porous structure yields lower strength compared to conventional concrete. Optimizing pervious concrete requires balancing mechanical property enhancement with permeability preservation. Additionally, its abrasion resistance – the ability to withstand rolling, sliding, friction, and impact pressures – is crucial for its durability and performance.

Adresi et. al (2023) showed growing concerns of global warming, climate change, and human activities have led to issues like the heat island effect and flash floods. To address these problems, sustainable urban development and construction using porous concrete pavement have been proposed. Research has focused on pervious concrete's properties, including compressive strength, porosity, and permeability, as well as its durability and resistance to freeze-thaw cycles and wear. Testing methods and performance evaluation have also been investigated, along with clogging phenomena and maintenance strategies to restore permeability. Furthermore, the connection between porous pavement and sponge city concepts has been explored in the context of

sustainable development and heat island mitigation. Based on research findings, an optimal mix design has been developed that balances mechanical and hydraulic performance, meeting structural requirements and durability needs for use as a pavement material in sponge city applications.

According to **Fei et. al (2023)**, Pervious concrete's unique open-skeleton structure and high permeability effectively manage water runoff, mitigate urban heat island effects, and reduce traffic noise. However, its limitations, such as low strength and poor durability, hinder its application in pavement engineering. To address these shortcomings, vinyl ester (VE) resin, a high-strength polymer binder with excellent wear resistance, durability, and corrosion resistance, was used. By optimizing aggregate gradation and curing temperature, high-performance pervious concrete was developed. Further enhancements were achieved by adding renewable acrylated epoxidized soybean oil (AESO) and diphenylmethane diisocyanate (MDI) to increase the resin's crosslinking degree and durability. The optimal mixture, incorporating 15% AESO and 10% MDI, yielded a flexural strength of 7.72 MPa. Additionally, incorporating 50 wt% copper slag solid waste significantly improved compressive and flexural strengths to 37.72 MPa and 7.53 MPa, respectively. The pervious concrete met China's national standards for permeability (2.64 mm/s) and connected porosity (11.33%). Durability tests, including freeze-thaw, abrasion, and aging, also demonstrated satisfactory performance. This research provides a cost-efficient and sustainable approach to high-performance pervious concrete, showcasing the potential for utilizing renewable feedstocks and solid wastes in civil materials.

Li et. al (2025) modified Pervious concrete with epoxy resin (ER) and vinyl acetate ethylene (VAE) meets high-strength requirements. Optimal dosages increase compressive strength by over 30%, achieving high-strength concrete standards. The polymer emulsions' dispersing and binding properties create a dense film and network, resulting in excellent flexural strength. These findings offer valuable insights for advanced construction materials, including 3D-printed concrete.

Yuan et. al (2024) studied used fly ash (FA) and basalt fiber (BF) to improve the frost resistance of recycled pervious concrete (RAPC) made with 100% recycled concrete aggregates (RCA). The results showed that partial cement replacement with FA enhanced both strength and frost resistance. Adding BF further improved frost resistance and maintained integrity after freeze-thaw cycles. Optimal performance was achieved with 6% FA replacement and 4-6 kg/m³ BF content, yielding a maximum compressive strength of 24.3 MPa and minimal damage after 100 freeze-thaw cycles. A predictive model for freeze-thaw damage was also

established. The combined use of FA and BF offers a promising approach to sustainable and durable RAPC.

According to **Leming et al. (2007)**, pervious concrete offers unique benefits, including preserving water quality, reducing flooding, increasing base flow, and maintaining valuable parking areas. It's an ideal solution for context-sensitive construction and Low-Impact Development. The authors discussed the hydrologic behavior and design methodologies for pervious concrete pavement systems, highlighting their limitations.

Delatte et al. (2007) presented field observations and non-destructive testing results from pervious concrete pavement sites in several US states. The results showed that well-designed and constructed pervious concrete pavements performed well in freeze-thaw environments with minimal maintenance. Key findings emphasized the importance of proper drainage to prevent saturation and freezing issues. Observations also provided insights into clogging patterns and strategies for prevention.

III. DISCUSSION

Pervious concrete plays a vital role in recharging groundwater by capturing rainwater and allowing it to seep into the ground. Its unique mixture, which typically contains little to no sand, creates a high void content. Water is essential for pervious concrete, and the right amount is crucial - enough for proper cement hydration, but not so much that it clogs the pores by settling at the base of the pavement.

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