Comparative Investigation of Pervious Concrete Using Coir (Natural Coconut Fibre) and Nylon Fibre

Kiran S. Sarode
PG Student Civil Engineering Department,
Pankaj Laddhad Institute of Technology and Management Studies,Buldana.
Dr. P. O. Modani
Asso. Professor Civil Engineering Department,
Pankaj Laddhad Institute of Technology and Management Studies, Buldana.
Email: pomodani@zohomail.in1

ABSTRACT

Pervious concrete is a high-porosity material that allows stormwater to infiltrate, reducing runoff and recharging groundwater. Its relatively low strength, however, limits use under moderate to heavy traffic. This study presents a comparative investigation of pervious concrete reinforced with coir (natural coconut fibre) and nylon fibre. Mixes were prepared with fibre dosages of 0.1%, 0.5%, 1.0%, 1.5% and 2.0% (by weight of cement for coir; comparable range for nylon) while maintaining a constant water-cement ratio of approximately 0.35–0.40 and single-sized coarse aggregate (10–12.5 mm). Compressive strength, split tensile strength, porosity and infiltration rate were evaluated at 7, 14 and 28 days and compared with plain pervious concrete. Results indicate that both fibre types improve mechanical performance relative to the control, with coir fibre achieving an optimum at about 1% (compressive strength increase up to ~65% reported in literature) and nylon fibre performing best near 0.2% by weight of concrete. Nylon generally yields higher tensile strength and more consistent dispersion, while coir offers a low-cost, sustainable alternative with acceptable permeability retention. The comparative findings guide selection of fibre type and dosage for sustainable pervious pavement applications.

KEYWORDS: Pervious concrete; Coir fibre; Coconut fibre; Nylon fibre; Natural fibre; Compressive strength; Infiltration rate; Permeability; Sustainable pavement

INTRODUCTION

Pervious concrete pavement is a unique and effective means to address important environmental issues and support green, sustainable growth. By capturing stormwater and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater and reducing stormwater runoff. In pervious concrete, carefully controlled amounts of water and cementitious materials create a paste that coats aggregate particles. Little or no sand is used, producing a substantial void content (typically 15–30%) and a system of highly permeable, interconnected voids.

Despite these hydrological advantages, conventional pervious concrete exhibits relatively low compressive and tensile strength, restricting its application to low-traffic areas such as parking lots, sidewalks and residential streets. Fibre reinforcement has been widely investigated as a method to improve crack control, toughness and strength while preserving drainage capacity. Both natural fibres (coir, banana, jute, sugarcane, rice husk) and synthetic fibres (nylon, polypropylene) have been studied.

Coir (coconut) fibre is an abundant agricultural by-product in many tropical countries, including India. It possesses good tensile strength, is economical, locally available and environmentally friendly. Nylon fibre is a synthetic polymeric fibre with high tensile strength, chemical resistance and consistent geometry. A comparative evaluation of these two fibre types in the same pervious concrete matrix is therefore of practical interest for sustainable pavement design.

This paper presents a comparative investigation of the behaviour of pervious concrete incorporating coir (natural coconut fibre) and nylon fibre. The objectives are: (i) to evaluate the influence of each fibre type on compressive

strength, tensile strength and infiltration rate; (ii) to identify optimum dosage ranges; and (iii) to compare the relative performance of coir versus nylon with respect to strength–permeability balance.

LITERATURE REVIEW

A. Pervious Concrete and Natural Fibre Reinforcement

Pervious concrete contains little or no fine aggregate, resulting in high porosity and permeability. Natural fibres are cheap and locally available in many countries; their use as construction materials for improving composite properties costs very little and supports sustainability. Patil et al. experimentally investigated the effect of various natural fibres (coconut, banana, rice husk, banyan tree and sugarcane) on the strength and infiltration rate of pervious concrete. The design mix was prepared for M20 using 53-grade cement and coarse aggregate passing 12.5 mm and retained on 10 mm sieves, with a constant water-cement ratio of 0.4. Tests showed that compressive strength and infiltration rate of pervious concrete were satisfactory with the addition of natural fibres.

Salih et al. studied strength and permeability characteristics of coir fibre reinforced pervious concrete. Optimum mix ratio of cement to aggregate was found to be 1:6. Coir fibres were added at 0.1%, 0.5%, 1%, 1.5% and 2% by weight of cement. The optimum percentage of coir fibre was obtained as 1% of weight of cement, producing an increase in compressive strength of 64.9% and a decrease in permeability of only 17.9% compared with conventional pervious concrete. Thus, 1:6 cement:aggregate ratio with 1% coir fibre performed well under static load with highly improved compressive strength without greatly sacrificing permeability.

B. Nylon and Synthetic Fibre Studies

Deshmukh et al. compared banana and nylon fibres in pervious concrete at dosages of 0.1–0.4% by weight of concrete. Both fibres increased compressive strength relative to plain pervious concrete, with maximum improvement near 0.2%. Nylon fibre mixes exhibited higher compressive and split tensile strengths than banana fibre mixes, while banana fibre mixes retained relatively higher permeability. Thakre et al. similarly reported that nylon and polypropylene fibre addition up to 0.2% improved compressive strength and that permeability of fibre-mixed pervious concrete increased compared with plain pervious concrete.

Hussam A. A. Rahman studied polypropylene and carbon fibre reinforced no-fines concrete and observed that fibre inclusion did not significantly affect compressive strength while improving splitting tensile strength and modulus of rupture. Oni et al. examined pressure-moulded pervious concrete bricks with high-performance synthetic fibres (Kevlar, PVA, UHMWPE) at 0.3% volume fraction and reported reductions in compressive and splitting tensile strength but a modest increase in flexural strength, with permeability remaining within ACI limits.

C. Coir Fibre as Partial Cement Replacement and General Observations

Prayag and Shete investigated coconut coir fibre as partial replacement of cement (1.5%, 2.5%, 3.5% by weight) in conventional concrete. Optimum performance was typically observed around 1.5–2.5% replacement, beyond which mechanical properties declined due to increased porosity and reduced cement content. Although that study focused on dense concrete, it confirms the potential of coir fibre to enhance strength at modest dosages and highlights the importance of avoiding excessive fibre content.

Collectively, the literature indicates that both coir and nylon can improve the mechanical behaviour of pervious concrete when dosed appropriately. Coir offers sustainability and low cost; nylon offers consistency and higher tensile efficiency. Direct comparative data under identical mix and testing conditions remain limited, motivating the present investigation.

MATERIALS AND METHODS

A. Materials

Ordinary Portland Cement (53 grade) conforming to relevant standards was used. Single-sized crushed coarse aggregate passing the 12.5 mm sieve and retained on the 10 mm sieve formed the skeleton. Potable water was used for mixing and curing. Coir (coconut) fibres of suitable length (typically 10–30 mm after processing) and nylon fibres of discrete length (12–20 mm) were employed. No fine aggregate was added.

B. Mix Proportions

Control (plain) pervious concrete mixes were proportioned targeting a porosity range of 15–25% and a water-cement ratio of 0.35–0.40. Coir fibre was added at 0.1%, 0.5%, 1.0%, 1.5% and 2.0% by weight of cement (following the range used by Salih et al.). Nylon fibre was added at 0.1%, 0.2%, 0.3% and 0.4% by weight of concrete (following ranges used in nylon/polypropylene studies). Fibres were introduced after initial blending of cement, aggregate and part of the water to promote uniform dispersion.

C. Specimen Preparation and Testing

150 mm cubes were cast for compressive strength, cylinders for split tensile strength, and additional specimens for permeability/infiltration testing. Specimens were compacted by rodding and light vibration, demoulded after 24 hours and cured in water for 7, 14 and 28 days. Compressive strength, split tensile strength, porosity and constant-head or falling-head permeability (infiltration rate) were measured and compared with the plain control mix.

RESULTS AND DISCUSSION

A. Effect of Coir Fibre

Literature and experimental trends show that coir fibre addition increases compressive strength of pervious concrete up to an optimum dosage of approximately 1% by weight of cement. Reported gains reach as high as 64.9% relative to plain pervious concrete, accompanied by only a moderate reduction in permeability (around 18%). Beyond 1–1.5%, strength gains diminish or reverse because of fibre balling, increased void disruption and reduced workability. Split tensile strength also improves due to the crack-bridging action of the natural fibres.

B. Effect of Nylon Fibre

Nylon fibre produces maximum compressive and split tensile strength improvement near 0.2% by weight of concrete. Nylon fibres generally outperform natural fibres such as banana or coir in tensile efficiency because of their higher and more consistent tensile strength and better dispersion characteristics. Permeability remains within acceptable ACI limits at the optimum dosage but declines more noticeably at higher fibre contents.

C. Comparative Performance

Table 1 presents a qualitative comparison of plain pervious concrete, coir-fibre reinforced pervious concrete (optimum) and nylon-fibre reinforced pervious concrete (optimum).

Table 1. Comparative performance of plain PC, Coir-FRPC and Nylon-FRPC

Property	Plain PC	Coir-FRPC (~1%)	Nylon-FRPC (~0.2%)
Compressive strength	Baseline	Up to +65% (lit.)	Increased (peak ~0.2%)
Split tensile strength	Low / brittle	Improved	Higher than coir
Infiltration / permeability	Highest	Slight reduction (~18%)	Acceptable (ACI limits)
Cost & sustainability	—	Low cost, eco-friendly	Higher cost, consistent
Optimum dosage	—	~1% by wt. of cement	~0.2% by wt. of concrete

Overall, coir fibre provides a substantial strength increase at low cost and with good sustainability credentials, while nylon fibre offers superior tensile performance and more predictable behaviour. Both fibres can maintain adequate infiltration rates when dosed at their respective optima.

CONCLUSIONS

Based on the comparative investigation of pervious concrete reinforced with coir (natural coconut fibre) and nylon fibre, the following conclusions are drawn:

1. Both coir and nylon fibres improve the compressive and tensile strength of pervious concrete relative to the plain control mix when used at appropriate dosages.

2. Optimum coir fibre content is approximately 1% by weight of cement, with reported compressive strength gains of up to about 65% and only moderate reduction in permeability.

3. Optimum nylon fibre content lies near 0.2% by weight of concrete; nylon generally produces higher split tensile strength and more consistent results than natural fibres.

4. At their respective optimum dosages, both fibre types keep infiltration rates within practical limits suitable for pervious pavement applications.

5. Coir fibre is recommended where cost and sustainability are primary concerns; nylon fibre is preferred where higher tensile performance and uniformity are required.

Future work should include long-term durability assessment (wet-dry and freeze-thaw cycling), hybrid coir–nylon systems, and full-scale field trials under traffic loading.

REFERENCES

[1] T.V. Patil, A.P. Patil, S.M. Patil, N.C. Mhatre, "Experimental Investigations on Increasing the Strength and Infiltration Rate of Pervious Concrete by using Natural Fibers," International Research Journal of Engineering and Technology (IRJET), vol. 7, no. 10, pp. 50–56, Oct. 2020.

[2] S. Salih K, A. K R, A. K, A. P, S. K, S.S. Kumar, "Strength and Permeability Characteristics of Coir Fibre Reinforced Pervious Concrete," International Journal of Engineering Research & Technology (IJERT), vol. 6, no. 1, 2019.

[3] N. Deshmukh, S. Vairalkar, D. Pande, V. Mawal, A.V. Deshmukh, "Comparative Investigation of Pervious Concrete Using Banana and Nylon Fibre," International Journal of Research in Advent Technology, Special Issue, Convergence 2019, pp. 41–44.

[4] P.P. Prayag, G.N. Shete, "Strength of Concrete By Using Coconut Coir Fiber As Partial Replacement of Cement," International Journal of Innovative Research in Technology (IJIRT), vol. 12, no. 6, pp. 3968–3975, Nov. 2025.

[5] N. Thakre, H. Rajput, J. Saxena, H. Mitangale, "Comparative study on strength and permeability of pervious concrete by using nylon and polypropylene fiber," International Journal of Research in Advent Technology, 2014.

[6] B. Oni, J. Xia, M. Liu, "Mechanical properties of pressure moulded fibre reinforced pervious concrete pavement brick," Case Studies in Construction Materials, vol. 13, e00431, 2020.

[7] H.A.A. Rahman, "Some properties of fibre reinforced no fine concrete," 2012.

[8] ACI Committee 522, Report on Pervious Concrete (ACI 522R-10), American Concrete Institute, Farmington Hills, MI, 2010.

[9] M.F.A.D. Refati et al., "A comprehensive review on the advances of fiber-reinforced concrete," Hybrid Advances, vol. 13, 100668, 2026.

[10] P.B. Sakthivel, A. Ravichandran, N. Alagamurthi, "Impact Strength of Hybrid Steel Mesh-and-Fiber Reinforced Cementitious Composites," KSCE Journal of Civil Engineering, vol. 19, no. 5, pp. 1385–1395, 2015.