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Experimental Investigation of Pervious-Impervious Concrete Layered System for Airport Runway Drainage

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Abstract: Severe operational hazards, including dynamic hydroplaning and reduced visibility is caused by the accumulation of surface water on airfield pavements, while it also places significant strain on conventional airport drainage infrastructure. This research presents an experimental investigation into the use of pervious concrete as a Sustainable Drainage System for pavements of airport. Pervious concrete creates an interconnected microporous network that facilitates rapid surface runoff infiltration by intentionally reducing and omitting the fine aggregates. As the mechanical strength of Conventional Pavement Quality concrete is higher so its application in aviation environment is traditionally limited. This study evaluates the structural and hydraulic performance of various pervious concrete mix proportion by varying water-cement ratio, aggregate sizes and aggregate to cement ratio. Laboratory tests such as compressive strength and hydraulic conductivity are conducted at 7-day and 28-day curing interval. The primary goal is to optimize the mix design to get a viable balance between drainage performance and structural load-bearing capacity to ultimately determine the feasibility of deploying pervious concrete in specific airfield zones such as runway shoulders, taxiway edges and apron margins. Building upon these structural and hydraulic assessments, the research explores the broader operational impacts of replacing traditional impermeable surfaces. By preventing water pooling, the optimized porous matrix serves as an active safety intervention, preserving friction to the pavement and drastically cutting down aquaplaning risks during heavy rainfall. Additionally, adopting this decentralized storm water related pollutants such as unburnt hydrocarbons and heavy metal runoffs before infiltrate local water tables. The void open structure also helps to dissipate absorbed solar radiation, mitigating the localized heat Island effect commonly associated with massive tarmac expenses. Ultimately the investigation aims to supply a pragmatic, data backed framework for modernizing airport infrastructure, shifting away from costly, high maintained pipe networks toward self-draining, economical runways.

I. INTRODUCTION

A. Background & Theoretical Context

Modern infrastructure needs large land area devoted to impermeable surfaces, including runways, taxiways, aprons and other maintenance facilities. Earlier airport pavement systems are designed as completely impermeable and relies only on surface slopes which are transverse, underground piping and retention basins for the clearance of water from the areas which are in operation. Pervious concrete which is also known as perforated, porous, permeable and gap graded concrete and works as a hydrological and innovative structural alternative. As standard Pavement Quality Concrete uses a dense matrix of cement, coarse aggregates, fine aggregate, fine aggregate and water but in pervious concrete fine aggregates are completely eliminated or significantly reduced. So coarse aggregate coated and bound together by a thin layer of cement paste creates a skeletal framework. The pervious concrete have an open-void ratio which ranges from 15% to 25% and permeability from 0.2 cm/sec to 1.2 cm/sec which is also known as hydraulic conductivity. It produces an interconnected macro porous network. Pervious concrete acts as a load-bearing layer of pavement and also as an onsite reservoir for stormwater retention. It allows controlled infiltration rainfall into the underlying subgrade or drainage channels.

B. Need for the study

High safety margins are demanded by the operational areas of airport during adverse weather events. Aircraft faces critical hazards during take-off, landing and deceleration due to the accumulation of surface water on runway pavements.

C. Operational Hazards because of Wet Runways

- o Dynamic Hydroplaning: It is also known as aquaplaning. Dynamic water pressure builds up ahead of the footprint of tire when an aircraft rolls over a flooded runway surface. If the tire tread depth is exceeded by the standing water layer, the hydroplaning speed gets surpassed. It results in almost total loss of directional braking efficiency because the tire losses direct contact with the pavement and floats on a fluid film.
- o Jet water spray and visibility reduction: During critical operations pilot's visual range gets severely impaired because of the dense water mist that is produced by the water standing on runways and taxiways which is thrown into the air by high- velocity aircraft tires and reverse-thrust exhausts.
- o Hydraulic Strain on Existing Infrastructure: Traditional piped airport drainage networks get overloaded by intensifying the storm patterns which leads to subgrade saturation, weakening of the subbase, accelerated pavement distresses such as pumping, faulting or joint spalling and localized ponding .

D. The Engineering Trade-off

In low-volume vehicular parking lots and pedestrian pathways, the hydraulic benefits of pervious concrete are well documented but there are some mechanical limitations in its application in airfield environments.

E. It provides High Hydraulic Permeability but Low Compressive & Flexural Strength

To Withstand heavy gear loads from commercial aircraft, 28-day compressive strengths of **35 to 50+ MPa** is required by the standard airfield pavements and compressive strength of only **10 to 25 MPa** is yielded by the unmodified pervious concrete.

So, to optimize pervious concrete mix designs using low water cement ratios, mineral additives, controlled aggregate gradations and chemical admixtures, there is an urgent need for targeted experimental research, also for satisfying both hydraulic drainage performance and structural capacity requirements for airport runway shoulders, taxiways edges, apron margins.

II. ADVANTAGES AND DISADVANTAGES IN AIRPORT APPLICATION

PERFORMANCE	ADVANTAGES	DISADVANTAGES
Safety aviation	1. It helps in elimination of hydroplaning. It maintains high tire-pavement friction by rapidly evacuating the surface water through interconnected voids. 2. It also enhances visibility by preventing nighttime runway lighting reflection, water spray and splash.	1. It can lead to surface raveling as aggregate dislodgement can be caused by high surface shear forces from turning aircraft wheels or jet blasts. 2. Customized skid resistance evaluation is required as texture characteristics differ from traditional PQC.
Mechanical Performance	1. It can lead to thermal stress mitigation. Reduction of thermal expansion gradients and heat dissipation occurs due to open pore network. 2. It reduces thickness of pavement for drainage. Reduces need for deep drainage channels as it functions simultaneously as run off storage and structural surface.	1. It generally have low load capacity. Lower flexural strength and compressive strength compared to traditional PQC. 2. It is more vulnerable to fatigue. Fatigue resistance is reduced under repeated heavy wheel loading cycles because of higher void content.
Hydrology and Environment	1. It is helpful for In-situ runoff attenuation. Reduces peak flow rates entering perimeter drainage by capturing peak rainfall on-site.	1. It can be susceptible to clogging. Airborne dust, sand, tire rubber particles and organic debris can occlude voids over time. 2. Maintenance: For restoring porosity routine vacuum sweeping and high -pressure washing is required.

III. OBJECTIVES OF THE RESEARCH WORK

The main objective of this experimental study is to evaluate high-performance pervious concrete mix for airfield sustainable drainage applications.

To achieve this goal, the research work is divided into the following specific objectives:

- 1) To develop a model- scale layered airport runway drainage system.
- 2) To study the movement of rainfall water through the pervious concrete surface.
- 3) To investigate the role of the underlying impervious layer in preventing direct infiltration into the soil.
- 4) To observe the lateral movement and collection of water through the drainage outlet.

IV. LITERATURE REVIEW

Al Shareedah and Nassiri (2000) reviewed the existing research on pervious concrete with particular focus on mixture design, mechanical properties, permeability, durability, recycled materials, fibres, computational modelling, and pavement design. The authors reported that pervious concrete provides important environmental benefits because of its interconnected pore structure and ability to allow water infiltration. However, achieving a proper balance between porosity, permeability and mechanical strength remains a major challenge. The review found that compressive strength, flexural strength and durability are strongly influenced by porosity, aggregate characteristics, water-to-cement ratio and mixture proportions. The study also highlighted the use of supplementary materials such as silica fume, fly ash, waste materials and fibres for improving the performance of pervious concrete. The authors identified the lack of standardized mixture-design, testing and field-performance procedures as an important research gap.

Adil et al. (2020) investigated the influence of silica fume (SF) on the fresh, mechanical and durability properties of pervious concrete. The study focused on silica fume replacement levels and examined paste rheology, workability, compressive strength, tensile strength, freeze-thaw durability and resistance. The researchers found that silica fume affects the rheological behaviour of cement paste and can improve the paste-to-aggregate bond and strength. Their experimental results showed that approximately 5% silica fume replacement provided the best overall performance for the investigated mixtures. At this level, the void content decreased and improvements in strength and durability were observed. However, when silica fume replacement exceeded 5%, workability decreased and the concrete became sticky, resulting in increased void content and reduced strength and durability. The study therefore indicates that the optimum silica-fume content depends not only on the cementitious paste but also on workability, compaction and void content.

The authors concluded that around 5% silica fume gave improved performance under the tested conditions, while higher replacement levels required appropriate adjustment of admixture dosage to maintain workability and void content.

Karthik H. Obla (2010) presented an overview of pervious concrete, focusing on its materials, properties, applications, mixture proportioning, design, construction, testing, performance, and maintenance. The study explains that pervious concrete is a high-porosity concrete containing interconnected voids that allow precipitation and stormwater to pass through the pavement. It generally contains little or no fine aggregate, which provides high permeability and helps reduce surface runoff and recharge groundwater. The study reported that pervious concrete can have approximately 15–35% porosity, with compressive strength generally ranging from about 3.5 to 28 MPa, depending on mixture and compaction. The author also discussed the relationship between density, strength and infiltration rate: increasing density generally increases strength but decreases infiltration.

Obla highlighted the environmental benefits of pervious concrete, including reduction of stormwater runoff, groundwater recharge, reduction of drainage requirements and filtration of pollutants. Common applications include parking areas, sidewalks, pathways, low-volume roads and other areas where heavy traffic is not expected. The study also discussed important construction and maintenance issues. Proper water content, compaction and curing are essential, while raveling and clogging are identified as major problems. Regular cleaning, pressure washing and power vacuuming can help maintain infiltration performance.

Novak et al. (2020) investigated pervious recycled aggregate fibre-reinforced concrete (RAFRC) for use in an innovative precast concrete airfield pavement system. The study was motivated by the need for environmentally friendly construction materials and greater utilization of recycled materials. Recycled concrete aggregate was used as a replacement for virgin aggregate, while long polypropylene fibres were incorporated to improve the behaviour of the concrete. The researchers conducted laboratory experiments on three mixtures with different polypropylene fibre contents. The mixtures were tested for compressive strength, flexural strength and modulus of elasticity. A pilot construction was also carried out to investigate the practical preparation and installation of the recycled aggregate concrete sub-base.

The experimental results showed that increasing the fibre content reduced the mean compressive strength. However, polypropylene fibres significantly improved the post-cracking or residual strength and ductility of the concrete. The researchers attributed this behaviour to the high anchorage strength provided by the long fibres. The pilot construction demonstrated a compaction ratio of approximately 20%. However, the researchers observed surface flatness deviations of approximately 10–25 mm over 2 m, indicating a construction challenge for placing precast pavement elements directly on the sub-base.

Charles J. Korhonen and John J. Bayer (1989) investigated the potential use of porous Portland cement concrete (PPCC) as an overlay for airport runways, particularly in cold regions. The study was motivated by the problem of water accumulation on airport pavements, which can reduce tire traction and increase the possibility of hydroplaning. The authors explained that porous overlays can allow water to escape both vertically and laterally from beneath aircraft tires.

The researchers evaluated a special high-speed mixing process developed to improve the strength of porous concrete. The PPCC consisted primarily of Type I Portland cement, single-sized aggregate and water, with little or no fine aggregate. The elimination of sand was intended to provide a highly permeable concrete while also reducing material and handling costs.

The laboratory investigation focused on three important properties: strength, permeability and freeze-thaw resistance. Different freeze-thaw conditions were used to represent dry conditions, freezing after rainfall and concrete exposed to ponded water. The study also compared high-speed-mixed porous concrete with conventionally mixed porous concrete and dense concrete.

S. Dash and B. Kar (2018), in their research paper titled “Environment Friendly Pervious Concrete for Sustainable Construction,” studied the importance and applications of pervious concrete as an environmentally friendly construction material. The main objective of their study was to investigate the potential of pervious concrete for sustainable construction, groundwater recharge, and stormwater management. The authors explained that conventional concrete surfaces prevent rainwater from infiltrating into the ground, resulting in increased surface runoff, flooding, soil erosion, and groundwater depletion. To overcome these problems, they highlighted the use of pervious concrete, which contains interconnected pores that allow water to pass through the pavement and enter the soil. The study reviewed the properties, mix proportions, and applications of pervious concrete. The authors reported that its compressive strength generally ranges from 3.5 to 28 MPa, while its permeability ranges from 8 to 20 mm/s. They also discussed the influence of cement-to-aggregate ratios, water-cement ratios, and admixtures on the strength and permeability of the material.

Lydia Leleyter, and Fabienne Baraud (2014) study the Conventional impervious pavements overload urban drainage systems, causing flash flooding, groundwater depletion, land subsidence, and urban heat island effects. Pervious Concrete Characteristics: Pervious concrete features interconnected continuous macropores (15–35% porosity, pore sizes 2–8 mm), enabling rainwater recharge, noise absorption, and temperature regulation. Typical formulations use 270–415 kg/m³ cement, 1190–1480 kg/m³ aggregate, and *w/c* ratios of 0.27–0.40, yielding compressive strengths of 3.5–28.0 MPa and permeability rates of 0.2–5.4 mm/s. Adding ~ 7% fine aggregate (sand) improves strength and freeze-thaw resistance.

Sen Qiao, and Haiyan Li (2023) Extreme rainstorm events are becoming more frequent globally due to rapid urbanization and climate change. In China, more than 62% of cities suffer from rainstorm waterlogging. Pervious concrete offers high permeability (1.4–12.4 mm/s) to mitigate runoff, but its widespread use is limited by low mechanical strength and poor freeze-thaw (F-T) durability. Severe F-T environments accelerate particle loosening, surface spalling, internal micro-cracking, and aggregate clogging, leading to a loss of drainage capacity. Adding steel fibers enhances mechanical strength, initial crack resistance, toughness, and F-T durability without significantly reducing pervious concrete permeability. High-Strength Pervious Concrete (HSPC) & Artificial Pore Channels (APCs) are the Recent developments introduced HSPC using low-tortuosity APCs to deliver high compressive strength (> 60 MPa at 1.25% porosity) alongside high permeability and clogging resistance. Combining self-compacting matrix concrete, 100% recycled coarse aggregates, and steel fibre creates a novel material (NSPC) designed to address durability and sustainability under coupled F-T and rainstorm conditions.

V. EXPERIMENTAL STUDY

A. Objectives of the Experimental Study

The main objective of the experimental study is to investigate the performance of pervious concrete as a drainage layer for airport runway pavement applications. This study mainly focuses in ability of pervious concrete to allow water to pass through it while maintain adequate mechanical performance.

This experimental investigation aims to:

- 1) Determines the water permeability response of pervious concrete.
- 2) Evaluate the porosity, void ratio of pervious concrete.
- 3) Study the suitability of pervious concrete of a runway drainage application.

These parameters are important because increasing porosity generally improves permeability but can reduce the strength of pervious concrete. Therefore, appropriate- balance between drainage and mechanical performance is required.

B. Material used

The material used in the experimental investigation is pervious concrete. Pervious concrete is highly porous concrete with interconnected voids that permits water to infiltrate through its surface, thereby reducing surface runoff and improving stormwater drainage.

The important materials used for preparation of pervious concrete are:

- 4) Cement
- 5) Coarse aggregate
- 6) Water
- 7) SBR

These properties of aggregate and the selected mix proportions influence porosity, permeability and strength of resulting pervious concrete.

C. Mix Proportion

For the preparation of pervious concrete, the quantities of cement, coarse aggregate, and water were selected according to the adopted experimental mix. The materials used for the preparation of the mix were **cement, coarse aggregate, and water**.

D. Preparation of Pervious Concrete

The pervious concrete mix was prepared using the selected quantities of cement, coarse aggregate, and water. The materials were mixed to obtain a uniform concrete mixture while maintaining the interconnected void structure required for water movement. The adopted mix is made up of 1.4 kg of cement, 4.9 kg of coarse aggregate, and 370 mL of water, corresponding to a water-cement ratio of approximately **0.264**. The prepared pervious concrete was then used for the experimental investigation of properties like void ratio, permeability, and drainage behaviour.

E. Specimen Preparation

The prepared pervious concrete was placed into the required moulds for experimental testing. The concrete was carefully placed and compacted to obtain the desired shape while retaining the interconnected voids characteristic of pervious concrete. After placement, they were finished and kept for curing before conducting the required experimental tests. The prepared specimens were subsequently used to evaluate the void content, permeability, and compressive strength of the pervious concrete.

The Runway Drainage Model Setup

A small laboratory model was prepared to show how the drainage system works.

- The upper layer consists of pervious concrete.
- The lower layer consists of impervious concrete
- When water is poured onto the surface it passes through the pores of pervious layer. The impervious layer stops water from moving into soil and directs it towards the drainage outlet.



Figure: pervious concrete sample showing its coarse aggregate structure

VI. EXPERIMENTAL TESTING AND PERFORMANCE CALCULATION

A. Runway Drainage Model

A small-scale runway drainage model was developed to demonstrate the application of pervious concrete for managing surface water. The model consists of a pervious concrete layer placed over an impervious layer.

This pervious concrete layer allows water to enter and move through its interconnected voids. The impervious layer beneath it prevents downward infiltration of water into the underlying surface or soil. This arrangement is intended to direct the collected water toward the designated drainage arrangement. Water was applied over the surface of the model to observe its movement through the pervious concrete layer. The drainage behaviour of the system was then observed to evaluate the effectiveness of the proposed pavement-drainage concept.

Therefore, this model demonstrates the proposed use of pervious concrete as a drainage layer for sustainable airport runway pavement applications.

VII. MODEL DIMENSIONS

S NO .	PARAMETER	VALUE	UNIT
1.	MODEL LENGTH	25	Cm
2.	MODEL WIDTH	20	Cm
3.	PERVIOUS CONCRETE THICKNESS	5	Cm
4.	IMPERVIOUS CONCRETE THICKNESS	5	Cm
5.	TOTAL CONCRETE THICKNESS	10	Cm
6.	SURFACE AREA	500	Cm
7.	SURFACE AREA	0.05	m ^2
8.	PERVIOUS CONCRETE VOLUME	2500	Cm
9.	PERVIOUS CONCRETE VOLUME	2.5	Cm
10.	IMPERVIOUS CONCRETE	2500	Cm
11.	IMPERVIOUS CONCRETE VOLUME	2.5	Cm

MATERIALS	QUANTITY
CEMENT	1.4 KG
COARSE AGGREAGTE	4.9 KG
WATER	370ML

Observation

The experimental observation showed that water was able to pass through the **pervious concrete layer** due to the presence of interconnected voids within the material. After passing through the pervious concrete, the water reached the **impervious layer provided beneath it**, which prevented further downward infiltration. The observed water movement demonstrated the drainage mechanism proposed for the runway pavement system. The arrangement of a pervious concrete layer over an impervious layer provides a controlled pathway for water movement and can help in managing surface water.

Observations

- Water enters the pervious concrete layer through its pores.
- The pervious layer restricts direct movement of water to soil.
- Water is collected through outlet.
- Water application rate and outlet discharge is measured
- Water infiltrated into soil is measured
- Soil loss was measured during the experiment.

VIII. EXPERIMENTAL OBSERVATIONS OF LAYERED DRAINAGE MODEL

S.NO.	PARAMETER	SYMBOL	VALUE
1.	TOTAL WATER SUPPLIED	V_{in}	5.0L
2.	WATER SUPPLY DURATION	T_{in}	10min
3.	WATER PASSING THROUGH PERVIOUS LAYER	V_p	4.2L
4.	WATER COLLECTED AT OUTLET	V_{Out}	3.8L
5.	OUTLET COLLECTION TIME	T_{out}	8min
6.	WATER INFILTRATED IN TO SOIL	V_s	0.2L

Calculations:

- WATER APPLICATION RATE
 $Q_{in} = 5/10 = 0.50 \text{ L/min}$
- WATER PASSING THROUGH PERVIOUS LAYER
 $4.2/5 = 0.85 = 84\%$
- OUTLET DISCHARGE
 $Q_{out} = 3.8/8 = 0.475 \text{ L/min}$
- DRAINAGE EFFICIENCY
 $n = 3.8/5 = 0.76 \%$
- WATER INFILTRATED INTO SOIL
 $0.2/5 = 0.04 = 4 \%$

The experimental model therefore demonstrated the basic feasibility of using pervious concrete as a component of a sustainable airport runway drainage system.

IX. DISCUSSION

- 1) Pervious concrete allow water to pass through its pores.
- 2) The impervious layer helps to control water movement towards outlet.
- 3) Outlet discharge is used to calculate drainage performance
- 4) Drainage efficiency shows how effectively water is collected
- 5) Soil infiltration helped to evaluate performance of impervious layer
- 6) Soil loss is used to study soil erosion
- 7) The experiment helped to evaluate the layered system of airport runway drainage

X. SCOPE OF WORK

The present study mainly focuses on investigating the potential use of pervious concrete as a drainage layer for sustainable airport pavement. Therefore, scope of work includes following:

- 1) Study of pervious concrete: To study the basis properties, composition and basic principle of pervious, particularly its porosity, void ratio and drainage capability.
- 2) Material selection: To study and identify the materials used for preparing pervious concrete including cement, coarse aggregate, water and suitable admixtures, wherever required.
- 3) Preparation of pervious concrete: To prepare pervious concrete specimens using the selected materials and appropriate mix proportions for the model.
- 4) Development of Runway Drainage: To develop a laboratory airport pavement model which consist of pervious concrete layer over an impervious layer, representing the drainage arrangement.
- 5) Study of drainage material: To examine how effectively the pervious concrete layer allows the water to pass through it and helps to evaluate its effectiveness in reducing surface water collection.
- 6) Experimental evaluation: To evaluate and observe the drainage performance of the developed model under water application conditions.
- 7) Sustainable application: To evaluate the possibility of using pervious concrete as a drainage component in airport pavement systems, specially for better surface water management and more sustainable pavement system

XI. RESULT AND DISCUSSION

The results of proposed pervious– impervious concrete layered system were evaluated using calculated water application rate, water passing through pervious concrete layer, outlet discharge, drainage efficiency, water infiltrating into soil and soil loss. These parameters were considered to explain the movement of water through model and assess the effectiveness of the drainage system.

The water application rate represents the amount of water supplied to model during test. the quantity of water passes through pervious layer indicates the ability to allow waters infiltration. The outlet discharge and drainage efficiently provide information about the amount of water collected and removed from the system. Together, these parameters help to explain how effectively the proposed arrangement transfers water from the surface towards drainage outlet.

Water infiltrating into soil is another important parameter because the impervious concrete layer is intended to restrict direct downward seepage. The measured soil infiltration can therefore helps assess the performance of lower layer. Similarly, soil loss provides information about the removal of soil particles during the test, if any and helps in understanding the possible effects of water movement on underlying soil.

The results of these parameters should be interpreted together rather than independently. For example, a higher quantity of water passing through pervious layer does not necessarily indicate better overall drainage unless the water is also discharged effectively through the outlet. similarly, drainage efficiently and soil infiltration help explain the distribution of applied water within the model. Overall, the calculated results provide a basis for evaluating the hydraulic performance on proposed layered concrete system under the tested conditions. the findings can help identify its potential for controlled rainwater drainage. However, the further testing under different rainfall intensities, repeated loading and long- term clogging conditions are required before determining its suitability for full scale airport runway applications.

Therefore, the calculated results of different hydraulic parameters for proposed pervious – impervious concrete layered system is given below

XII. CALCULATED RESULTS FOR PROPOSED PERVIOUS-IMPERVIOUS CONCRETE LAYERED SYSTEM

S.NO.	PARAMETER	RESULT
1.	WATER APPLICATION RATE	0.50 L/min
2.	WATER PASSING THROUGH PERVIOUS LAYER	84%
3.	OUTLET DISCHARGE	0.475 L/min
4.	DRAINAGE EFFICIENCY	76%
5.	WATER INFILTRATED INTO SOIL	0.20L
6.	SOIL LOSS	4 %

The calculated show that the upper layer of pervious concrete allows water to pass through its connected pores. The lower impervious layer stops water from moving download and directs it towards the drainage outlet.

The preliminary calculations estimate the amount of water coming out of the outlet and the drainage efficiency. A soil water loss of 4 % has been assumed. These results suggest that the layered system can help to collect and drain rainwater from the airport runway. However, there are some problems. When the porosity of concrete increases, it drains water more easily, but its strength decreases. Airport runways must be strong enough to carry heavy aircrafts loads and provide good grip between the tyres and the runway surface.

Therefore, a proper balance between drainage capacity and concrete strength is necessary. The mix proportions and properties of aggregates affect this balance. The shape and size of aggregates are important for example crushed stones may provide better bonding than smooth, rounded aggregates.

The correct amount of cement paste is very important in pervious concrete.

- If cement paste is too much high: It fill the gaps between aggregate and blocks the pores. As a result, water cannot drain through the runway properly.
- If cement paste is too little: The aggregates do not stick together properly. The concrete surface may break or lose particles when aircrafts tyres apply heavy loads during braking.

This shows why the experiment needed careful control of the cement – to – aggregate ratio (1:4 to 1:9) and the additions of SBR (Styrene – butadiene rubber).

The main aim is to make the aggregate stick strongly while keeping enough open pores for the water to pass through easily.

A. Practical Challenges and Future Work

The laboratory model showed that the combination of pervious and impervious concrete can helps to drain water from airport runway. However, some problems must be solved before using this system at a real airport.

Pervious concrete has small connected has small, connected pores that allows water to pass through. Over time, dust, dirt and rubber particles from aircrafts tyres can block these pores and reduce drainage.

Another problem is that pervious concrete has more empty spaces, which can reduce its strength. Heavy aircrafts and strong braking forces may cause the aggregates on the surface to break apart.

Therefore, the main challenge is to make concrete that can drain water properly and remain strong enough to carry heavy aircrafts load and more research and testing are needed before using this system on actual airport runways.

XIII. PRACTICAL CHALLENGES

- Maintain uniform flow through pervious concrete was challenging
- This small-scale model may not represent actual airport runway conditions completely
- Water movement and collection depend on drainage outlet arrangement
- Prevents water leakage through sides is important for reliable results

A. Future scope of the study

- Rainfall testing: The system should be tested under different rainfall conditions.
- Cleaning and maintenance: suitable methods should be studied to prevent pore blockage due to dust and rubber particles.
- Strength testing: The concrete should be tested to check its strength under heavy loads and braking forces.
- Mix design: different mix proportions should be studied to achieve a balance between strength and drainage.
- Cost analysis: construction and maintenance costs should be compared with conventional drainage systems.

XIV. CONCLUSION

Pervious concrete as a drainage layer for a sustainable airport runway pavement.

The present study examines a layered concrete system for airport runway drainage using a pervious concrete surface and underlying impervious concrete layer. The study is based on the idea that rainwater can pass through the interconnected voids of pervious concrete and reach the underlying layer, where it can be directed towards a drainage outlet.

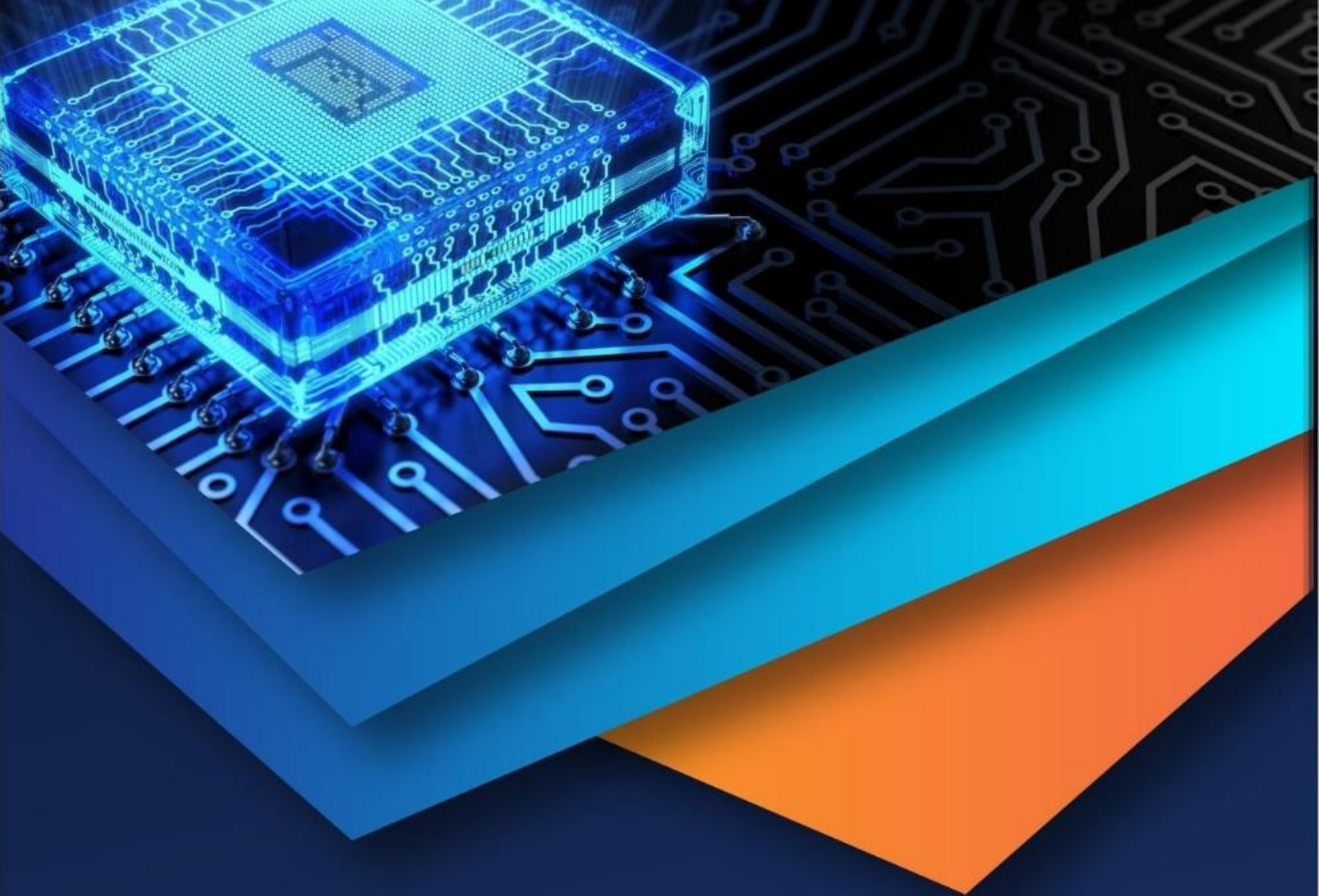
This study highlights the importance of permeability, porosity, drainage, strength and durability in the application of pervious concrete to pavement systems. This study examined its use in airport pavement drainage and other pavement applications. Building on this work, the present study focuses on a layered arrangement in which the impervious layer is intended to limit direct downward movement of water into soil and guide it laterally towards the outlet. The model provides a practical way to observe the movement of water through the proposed arrangement under simulated rainfall conditions. Its performance can be assessed using experimental observations and calculations based on the volume of water supplied, the volume collected at collected at outlet and time taken for drainage. These measurements can help explain how effectively the model directs water towards the outlet and whether any water remains within the system or moves into the soil. In present model, the objectives is to collect water passing through the pervious surface and redirect it laterally through the underlying impervious layer. This approach may be useful for investigating controlled stormwater collection and drainage beneath a permeable surface.

“The study investigates the potential of a layered pervious – impervious concrete system to collect water passing through the pervious surface and redirect it towards a drainage outlet.”

Overall, the study presents a model- scale approach to investigating controlled drainage through a combination of pervious and impervious concrete layer. The findings from the actual experiments will determine the drainage performance of the proposed arrangement. Further studies involving repeated rainfall tests, different slopes, material strength and larger – scale models would be required before drawing conclusions about its long – term performance or suitability for operational airports runways.

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