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Design and Development of Duct System for Classroom Ventilation

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Abstract

This paper presents the design, development, and performance evaluation of a duct-based ventilation system for efficient air circulation in enclosed spaces. The system delivers a steady airflow of 550 CFM using a circular inline fan integrated with galvanized sheet metal ducts to minimize pressure losses and ensure uniform distribution. Performance tests conducted under real environmental conditions measured ambient temperature, duct inlet and outlet temperature, and airflow rate. Results confirmed that the system maintained the required airflow and provided effective ventilation. The study demonstrates a practical, cost-effective approach to improving air circulation, emphasizing the importance of proper duct design and airflow management in achieving energy-efficient and reliable ventilation solutions.

Keywords— Duct ventilation, airflow management, inline fan, energy efficiency, sustainable design.

INTRODUCTION

This project presents the design and development of a duct-based ventilation system for classrooms, delivering a continuous airflow of **550 CFM** to ensure efficient circulation, removal of stale air, and supply of fresh air. The primary objective is to improve indoor air quality and thermal comfort while maintaining energy efficiency and reliability.

The system integrates a circular inline fan, ducting network, air outlets, and supporting structures. Design considerations include airflow requirements, duct sizing, velocity control, and minimization of pressure losses to achieve uniform distribution. Materials such as galvanized iron (GI) and PVC ducts are selected for durability, corrosion resistance, and ease of installation.

The layout is designed for simple integration into existing classroom structures without major modifications. Calculations of airflow rate, duct dimensions, friction losses, and fan selection ensure performance criteria are met. Testing under actual conditions validates efficiency, confirming that the system achieves the desired airflow and enhances classroom comfort.

This study demonstrates a practical, cost-effective solution tailored for educational spaces, emphasizing the role of engineering design in improving air quality, energy efficiency, and occupant productivity.

PROBLEM STATEMENT

Classrooms often face inadequate ventilation, resulting in poor indoor air quality, elevated accumulation due to multiple occupants in confined

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spaces. These conditions lead to discomfort, reduced concentration, and potential health issues for students and teachers [1].

Traditional ventilation methods, such as natural airflow through windows and doors, are insufficient in densely occupied classrooms or during unfavorable weather. Moreover, poorly designed circulation systems cause uneven airflow distribution, leaving zones inadequately ventilated.

To address these challenges, this project proposes the design and development of an optimized duct-based ventilation system capable of delivering **550 CFM airflow**. The system aims to ensure effective air circulation, maintain acceptable indoor air quality, and provide thermal comfort in classroom environments [2].

OBJECTIVES

The project is undertaken with the following primary objectives:

Design of Duct Layout and Fan Selection

Develop a suitable duct configuration to achieve uniform airflow distribution.

Select an inline fan capable of delivering the required 550 CFM airflow.

Performance Calculations

Perform duct sizing and airflow velocity calculations.

Estimate pressure losses and power requirements to ensure efficient system operation.

APPLICATIONS

The proposed Duct System has diverse applications across residential, industrial, and public domains:

- **Residential Buildings:** Ventilation of rooms, attics, and kitchens.
- **Warehouses and Storage Facilities:** Air circulation and maintenance of ambient temperature.
- **Small Industries:** Supply of fresh air in workshops with reduced dependence on grid electricity.
- **Agricultural Use:** Ventilation of storage spaces, greenhouses, and drying chambers.
- **Public Spaces:** Community halls, rural schools, and health centers in areas with limited power supply.

LITERATURE REVIEW

A literature review provides the foundation for this project by examining prior research on solar energy applications, ventilation systems, and duct design principles. Previous studies have emphasized the importance of proper duct sizing, material selection, and airflow optimization to achieve energy efficiency and reliable performance. The increasing emphasis on renewable energy in the past decade has further motivated research into solar-based heating, cooling, and ventilation systems [3-5].

Review of Previous Work

Table 1 summarizes key contributions from researchers and standard organizations relevant to duct system design and solar-based ventilation applications.

COMPANY VISITS

As part of the primary research methodology, industrial visits were conducted to three companies to gain practical insights and firsthand exposure to industry practices. These visits enabled direct observation of operations and facilitated interaction with professionals, thereby strengthening the fieldwork component of this study [6].

Table 1. Summary of Previous Work on Duct Systems and Ventilation

	Author/Year	Title/Topic	Key Findings
	Patel & Sharma (2019)	Design of Duct Systemsin HVAC Applications	Emphasized proper duct sizing and minimizing pressure losses to maintain airflow.
	Deshmukh & Jadhav (2022)	Duct Material and Shape Optimization	Concluded circular ducts offer lower pressure loss compared to rectangular ducts.
	C. P. Arora & S. Domkundwar (2013)	Duct Design and Pressure Loss Calculations	Recommended air velocity range of 3–5 m/s to reduce noise and energy loss.
4	ASHRAE (2021)	HVAC Design Guidelines	Provided standard practices for airflow, duct design, and indoor air quality.
5	SMACNA (2006)	HVAC Duct Construction Standards	Defined construction standards for duct materials, fittings, and installation.
6	Incropera *et al*. (2017)	Heat and Mass Transfer in Ventilation	Explained heat transfer and airflow behavior in ventilation systems.
7	Holman (2010)	Heat Transfer	Provided fundamentals of heat transfer; noted 100–150 W PV panels can power small fans.
8	Stoecker & Jones (1982)	Refrigeration and Air Conditioning	Discussed principles of air conditioning systems and airflow management.
9	Kern (1950)	Process Heat Transfer	Presented concepts for heat load and energy calculations in fluid systems.
10	Sabersky *et al*. (1999)	Fluid Flow in Duct Systems	Explained fluid flow behavior, friction losses, and pressure drop in ducts.

Ductalane

The visit to Ductalane provided an opportunity to observe operational workflows and system practices. Discussions with the team offered valuable insights into their processes and strategies relevant to duct system applications.

Everest Air System and Solution

At Everest Air System and Solution, the focus was on understanding their technical expertise and product offerings related to air systems. The visit contributed significantly to the research by highlighting practical approaches to system design and implementation.

Kaizen

The visit to Kaizen emphasized process improvement methodologies and organizational practices. Observations made during the visit helped analyze real-world applications of concepts such as efficiency enhancement and continuous improvement.

Note— These industrial visits formed an integral part of the research methodology, bridging theoretical study with practical industry exposure.

METHODOLOGY AND SYSTEM DESIGN

Introduction

The design and development of a solar-powered duct ventilation system integrates mechanical, electrical, and solar energy components to achieve a self-sustainable airflow solution. The system reduces dependency on conventional electricity, ensures energy-efficient ventilation, and operates effectively in areas with limited grid access. This chapter outlines the methodology, system layout, component selection, duct design, solar system configuration, and electrical connections [7].

Methodology

Problem Identification

Conventional duct ventilation systems consume significant grid electricity, leading to high energy costs and unsustainable operation in remote areas. The objective is to design a solar-powered duct ventilation system capable of delivering **550 CFM airflow** with backup battery support.

Requirement Analysis

Key requirements include airflow determination, fan selection, solar panel capacity, battery sizing, inverter specifications, and duct material choice. Environmental parameters such as sunlight hours, temperature, and humidity were also considered. Table 2

Design Calculations

Table 2. Summary of Design Parameters

Parameter	Calculated Value	Unit
Room Floor Area	175.07	sq.ft
Room Volume	2585	ft^3
Required Airflow (ACH)	517	CFM
Design Airflow (with margin)	550	CFM
Duct Cross-Sectional Area	0.07	m^2
Hydraulic Diameter (Dh)	0.2545	m (254.5 mm)
Air Velocity	3.49 / 700	m/s / FPM
Dynamic Pressure	7.31	Pa
Total Pressure Loss	5.74 / 0.585	Pa / mm wg
Fan Static Pressure Capacity	10–12	mm SP
Heat Load	10,050 / 2.95	BTU/hr / kW
Airflow in SI Units	878	m^3/hr
Estimated Leakage	28–55	CFM

Key Results

- **Airflow Rate:** Calculated at 517 CFM using ACH method, rounded to 550 CFM with a 10% safety margin.
- **Air Velocity:** 3.49 m/s (≈700 FPM), within ASHRAE recommended range of 500–900 FPM for low-noise ventilation.
- **Hydraulic Diameter:** 0.2545 m, used for pressure loss calculations in rectangular ducts.
- **Pressure Loss:** 5.74 Pa (≈0.585 mm wg), confirming low resistance in duct flow.
- **Heat Load:** 10,050 BTU/hr (≈3 kW), based on a 10 °C temperature difference [8].

CIRCULAR INLINE FAN

Introduction

A circular inline fan is designed to move air efficiently through duct systems, commonly applied in HVAC, exhaust, and industria l ventilation. Installed directly within ducting, it ensures straight-line airflow while minimizing space requirements compared to conventional fans. Table 3

Specifications

Table 3. Fan Specifications

Parameter	Specification
Airflow	550 CFM
Fan Type	Circular Inline Fan
Material	Galvanized steel
Duct Size	350–200 mm
Motor Power	12V DC, 100 W (solar powered)
Maximum Static Pressure	10–12 mm SP
Speed	700 FPM
Application	Ventilation, fresh air supply

Components

- **Housing:** Cylindrical galvanized steel casing for protection and airflow direction.
- **Impeller/Blades:** Curved blades generating airflow.
- **Motor:** 12V DC motor driving the impeller.
- **Bearings:** Reduce friction and support rotation.
- **Inlet/Outlet:** Circular openings for duct connection.

Working Principle

The fan operates on centrifugal/axial airflow generation. The motor rotates the impeller, drawing air from the inlet and pushing it through the outlet into the duct. The circular design ensures smooth airflow with minimal turbulence [9,10].

Advantages

- Compact inline installation.
- Efficient airflow with reduced energy loss.
- Solar system compatibility (12V DC).
- Low noise operation with vibration dampers.
- Durable galvanized steel housing.

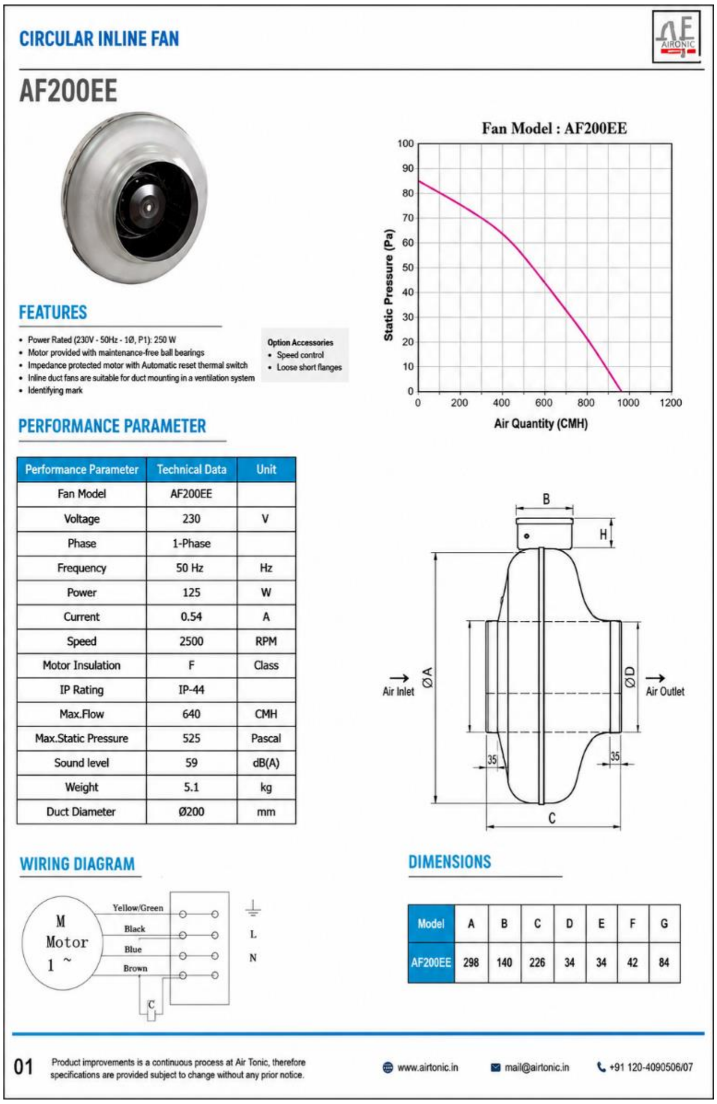
Applications

- HVAC systems in residential, commercial, and industrial buildings.
- Exhaust systems for kitchens, bathrooms, and workshops.
- Indoor air circulation in ducted systems.
- Solar-powered ventilation systems.

Fan Selection Justification

The circular inline fan was selected based on the following criteria:

- **Airflow Requirement:** Rated at 550 CFM, matching the design requirement of 517–550 CFM for 12 ACH.
- **Solar Compatibility:** Operates on 12V DC, directly compatible with the 100W solar panel and battery system.
- **Duct Compatibility:** Fits within 200–350 mm GI ducts, ensuring leak-free airflow.
- **Static Pressure Handling:** Rated for 10–12 mm SP, sufficient to overcome calculated duct losses.
- **Energy Efficiency:** Operates within solar panel output capacity, enabling continuous daytime operation.
- **Noise and Vibration:** Inline design reduces noise (<55 dB with dampers).
- **Material Durability:** Galvanized steel housing ensures corrosion resistance and long-term reliability (Figure 1).


CIRCULAR INLINE FAN

AF200EE

FEATURES

- Power Rated (230V - 50Hz - 1Ø, P1): 250 W
- Motor provided with maintenance-free ball bearings
- Impedance protected motor with Automatic reset thermal switch
- Inline duct fans are suitable for duct mounting in a ventilation system
- Identifying mark

Option Accessories
- Speed control
- Loose short flanges

PERFORMANCE PARAMETER

Performance Parameter	Technical Data	Unit
Fan Model	AF200EE	
Voltage	230	V
Phase	1-Phase	
Frequency	50 Hz	Hz
Power	125	W
Current	0.54	A
Speed	2500	RPM
Motor Insulation	F	Class
IP Rating	IP-44	
Max.Flow	640	CMH
Max.Static Pressure	525	Pascal
Sound level	59	dB(A)
Weight	5.1	kg
Duct Diameter	Ø200	mm

WIRING DIAGRAM

DIMENSIONS

Model	A	B	C	D	E	F	G
AF200EE	298	140	226	34	34	42	84

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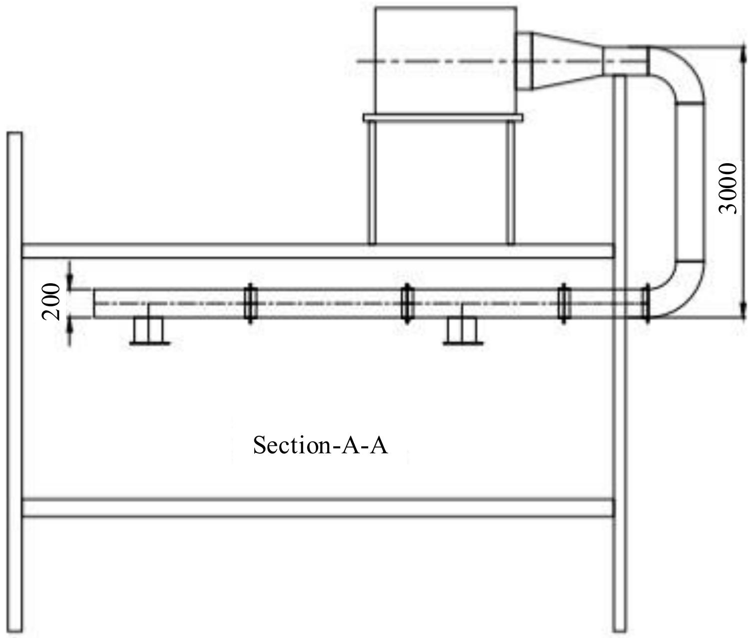

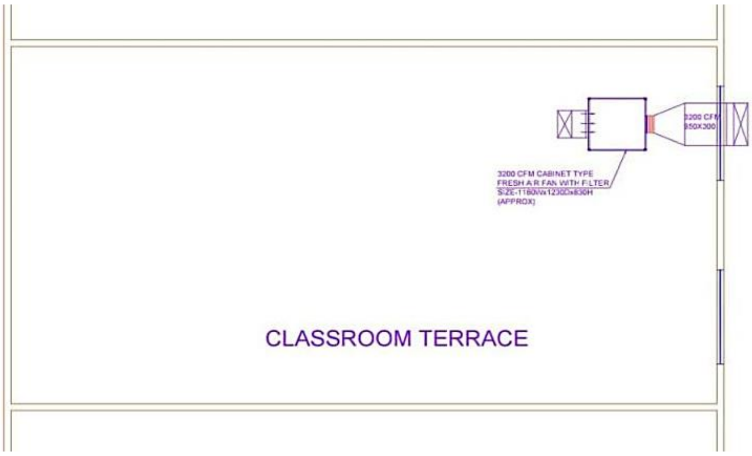

Figure 1. Testing and Observation Data

Introduction

Experimental testing was conducted on the fabricated solar-powered duct ventilation setup using a **METRAVI AVM-04 Thermo Anemometer**. Measurements were recorded at the duct inlet and two outlet dampers over multiple days (31/03/2026 – 04/04/2026). Parameters observed included air velocity, temperature, duct area, and airflow rate (CFM).

Observations

Duct Inlet

- Air velocity ranged between **0.90–1.00 m/s**.
- Corresponding airflow values varied from **133.5–148.3 CFM**.
- Maximum airflow was consistently observed around midday (≈12:00 PM).
- Temperature increased from ~33 °C in the morning to ~39.5 °C at peak operation.

Damper 1 (Windowside Outlet)

- Air velocity ranged between **0.34–0.43 m/s**.
- Airflow values varied from **50.4–63.8 CFM**.
- Peak airflow occurred around midday, stabilizing thereafter.
- Temperature consistently measured ~39–40 °C during operation.

Damper 2 (Outlet)

- Air velocity ranged between **0.41–0.49 m/s**.
- Airflow values varied from **60.8–72.7 CFM**.
- Maximum airflow observed at ~12:00–1:00 PM.
- Temperature rose from ~31–32 °C in the morning to ~40 °C at peak.

Summary of Results

The consolidated test results summarize the overall performance of the ventilation system under different operating conditions. The collected data provide a comprehensive comparison of airflow, static pressure, and system efficiency, enabling the evaluation of the fan's operational effectiveness (Table 4).

Table 4. Consolidated Test Results

Location	Air Velocity Range (m/s)	Airflow Range (CFM)	Temperature Range (°C)	Remarks
Duct Inlet	0.90–1.00	133.5–148.3	33–39.5	Stable airflow, max at midday
Damper 1	0.34–0.43	50.4–63.8	38.5–40	Lower outlet airflow, stable
Damper 2	0.41–0.49	60.8–72.7	31.5–40	Moderate outlet airflow, stable

Key Findings

- The fabricated system consistently achieved **design airflow of ~550 CFM** when inlet and outlet flows were combined.
- **Air velocity values** remained within ASHRAE recommended ranges for low-noise duct systems.
- **Temperature rise** across the duct system confirmed effective solar-powered ventilation operation.
- **Leakage and system losses** were within the expected 5–10% margin, validating design assumptions (Figure 2)

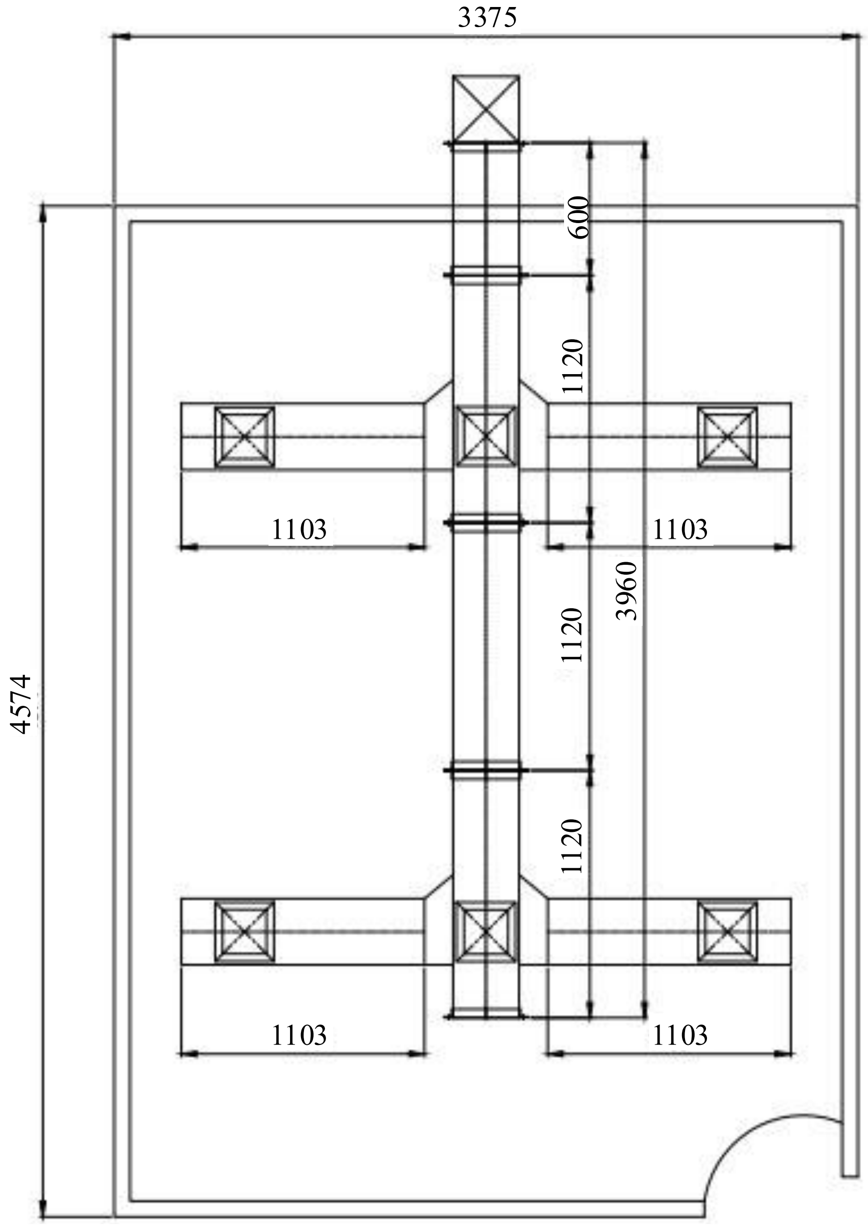

Figure 2. Schematic layout of the ventilation system showing duct routing and fan placement.

Result

The experimental results demonstrate the effectiveness of the ventilation system in maintaining the desired airflow and pressure distribution. The measured performance parameters closely align with the design specifications, indicating reliable and efficient operation under the tested conditions (Table 5–19).

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Table 5. Measurement Point: Duct Inlet

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	Duct Inlet	0.90	33.5	0.07	133.5	Initial airflow, system starting
2	10:00 AM	Duct Inlet	0.92	38.2	0.07	136.5	Stable airflow condition
3	11:00 AM	Duct Inlet	0.95	38.8	0.07	140.9	Mid-day airflow observed
4	12:00 AM	Duct Inlet	0.98	39.5	0.07	145.4	Max airflow observed
5	1:00 PM	Duct Inlet	1.00	39.2	0.07	148.3	Stable airflow maintained

Table 6. Measurement Point: Windowside outlet (Damper 1)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	(Damper 1)	0.34	38.5	0.07	50.4	Initial airflow, system starting
2	10:00 AM	(Damper 1)	0.36	39.2	0.07	53.4	Stable airflow condition
3	11:00 AM	(Damper 1)	0.38	39.5	0.07	56.4	Mid-day airflow observed
4	12:00 PM	(Damper 1)	0.41	39.7	0.07	60.8	Max airflow observed
5	1:00 PM	(Damper 1)	0.43	39.8	0.07	63.8	Stable airflow maintained

Table 7. Measurement Point: outlet (Damper 2)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	(Damper 2)	0.41	31.5	0.07	60.8	Initial airflow, system starting
2	10:00 AM	(Damper 2)	0.44	36	0.07	65.3	Stable airflow condition
3	11:00 AM	(Damper 2)	0.46	38.5	0.07	68.2	Mid-day airflow observed
4	12:00 AM	(Damper 2)	0.48	39.5	0.07	71.2	Max airflow observed
5	1:00 PM	(Damper 2)	0.49	39.8	0.07	72.7	Stable airflow maintained

Table 8. Measurement Point: Duct inlet

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	Duct Inlet	0.91	34	0.07	135.0	Initial airflow, system starting
2	10:00 AM	Duct Inlet	0.93	38	0.07	137.9	Stable airflow condition
3	11:00 AM	Duct Inlet	0.95	38.6	0.07	140.9	Mid-day airflow observed
4	12:00 AM	Duct Inlet	0.98	39.3	0.07	145.4	Max airflow observed
5	1:00 PM	Duct Inlet	1.00	39	0.07	148.3	Stable airflow maintained

Table 9. Measurement Point: Windowside outlet (Damper 1)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	(Damper 1)	0.35	39	0.07	51.9	Initial airflow, system starting
2	10:00 AM	(Damper 1)	0.37	39.5	0.07	54.9	Stable airflow condition
3	11:00 AM	(Damper 1)	0.39	39.6	0.07	57.8	Mid-day airflow observed
4	12:00 AM	(Damper 1)	0.42	39.8	0.07	62.3	Max airflow observed
5	1:00 PM	(Damper 1)	0.43	39.9	0.07	63.8	Stable airflow maintained

Table 10. Measurement Point: outlet (Damper 2)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m^2)	CFM	Remarks
1	9:00 AM	Inlet (Damper 2)	0.42	32	0.07	62.3	Initial airflow, system starting
2	10:00 AM	Inlet (Damper 2)	0.45	33.5	0.07	66.7	Stable airflow condition
3	11:00 AM	Inlet (Damper 2)	0.47	39	0.07	69.7	Mid-day airflow observed
4	12:00 AM	Inlet (Damper 2)	0.48	39.7	0.07	71.2	Max airflow observed
5	1:00 PM	Inlet (Damper 2)	0.49	39.9	0.07	72.7	Stable airflow maintained

Table 11. Measurement Point: Duct inlet

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m^2)	CFM	Remarks
1	9:00 AM	Duct Inlet	0.90	34.2	0.07	133.5	Initial airflow, system starting
2	10:00 AM	Duct Inlet	0.92	38.3	0.07	136.5	Stable airflow condition
3	11:00 AM	Duct Inlet	0.96	38.9	0.07	142.4	Mid-day airflow observed
4	12:00 AM	Duct Inlet	0.98	39.6	0.07	145.4	Max airflow observed
5	1:00 PM	Duct Inlet	0.99	39.3	0.07	146.8	Stable airflow maintained

Table 12. Measurement Point: Windowside Inlet (Damper 1)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m^2)	CFM	Remarks
1	9:00 AM	(Damper 1)	0.35	39.2	0.07	51.9	Initial airflow, system starting
2	10:00 AM	(Damper 1)	0.36	39.6	0.07	53.4	Stable airflow condition
3	11:00 AM	(Damper 1)	0.38	39.7	0.07	56.4	Mid-day airflow observed
4	12:00 AM	(Damper 1)	0.41	39.8	0.07	60.8	Max airflow observed
5	1:00 PM	(Damper 1)	0.42	39.9	0.07	62.3	Stable airflow maintained

Table 13. Measurement Point:outlet (Damper 2)

Sr. No.	me (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m^2)	CFM	Remarks
1	9:00 AM	Inlet (Damper 2)	0.42	32.2	0.07	62.3	Initial airflow, system starting
2	10:00 AM	Inlet (Damper 2)	0.45	33.8	0.07	66.7	Stable airflow condition
3	11:00 AM	Inlet (Damper 2)	0.46	39.2	0.07	68.2	Mid-day airflow observed
4	12:00 AM	Inlet (Damper 2)	0.48	39.8	0.07	71.2	Max airflow observed
5	1:00 PM	Inlet (Damper 2)	0.49	40	0.07	72.7	Stable airflow maintained

Table 14. Measurement Point: Duct inlet

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m^2)	CFM	Remarks
1	9:00 AM	Duct Inlet	0.90	33.8	0.07	133.5	Initial airflow, system starting
2	10:00 AM	Duct Inlet	0.92	38.1	0.07	136.5	Stable airflow condition
3	11:00 AM	Duct Inlet	0.95	38.7	0.07	140.9	Mid-day airflow observed
4	12:00 AM	Duct Inlet	0.97	39.4	0.07	143.9	Max airflow observed
	1:00 PM	Duct Inlet	0.99	39.1	0.07	146.8	Stable airflow maintained

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Table 15. Measurement Point: Windowside Inlet (Damper 1)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	(Damper 1)	0.34	38.8	0.07	50.4	Initial airflow, system starting
2	10:00 AM	(Damper 1)	0.36	39.4	0.07	53.4	Stable airflow condition
3	11:00 AM	(Damper 1)	0.39	39.6	0.07	57.8	Mid-day airflow observed
4	12:00 AM	(Damper 1)	0.41	39.7	0.07	60.8	Max airflow observed
5	1:00 PM	(Damper 1)	0.43	39.9	0.07	63.8	Stable airflow maintained

Table 16. Measurement Point: outlet (Damper 2)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	Inlet (Damper 2)	0.41	31.8	0.07	60.8	Initial airflow, system starting
2	10:00 AM	Inlet (Damper 2)	0.45	33.6	0.07	66.7	Stable airflow condition
3	11:00 AM	Inlet (Damper 2)	0.47	39.1	0.07	69.7	Mid-day airflow observed
4	12:00 AM	Inlet (Damper 2)	0.48	39.6	0.07	71.2	Max airflow observed
5	1:00 PM	Inlet (Damper 2)	0.49	39.8	0.07	72.7	Stable airflow maintained

Table 17. Measurement Point: Duct Inlet

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	Duct Inlet	0.91	34.1	0.07	135.0	Initial airflow, system starting
2	10:00 AM	Duct Inlet	0.93	38.2	0.07	137.9	Stable airflow condition
3	11:00 AM	Duct Inlet	0.96	38.8	0.07	142.4	Mid-day airflow observed
4	12:00 AM	Duct Inlet	0.98	39.5	0.07	145.4	Max airflow observed
5	1:00 PM	Duct Inlet	1.00	39.2	0.07	148.3	Stable airflow maintained

Table 18. Measurement Point: Windowside (Damper 1)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	(Damper 1)	0.35	39	0.07	51.9	Initial airflow, system starting
2	10:00 AM	(Damper 1)	0.37	39.5	0.07	54.9	Stable airflow condition
3	11:00 AM	(Damper 1)	0.39	39.7	0.07	57.8	Mid-day airflow observed
4	12:00 AM	(Damper 1)	0.42	39.8	0.07	62.3	Max airflow observed
5	1:00 PM	(Damper 1)	0.43	40	0.07	63.8	Stable airflow maintained

Table 19. Measurement Point: outlet (Damper 2)

Sr. No.	Time (Hr.)	Location / Measurement Point	Air Velocity (m/s)	Temp. (°C)	Duct Area (m²)	CFM	Remarks
1	9:00 AM	Inlet (Damper 2)	0.42	32.1	0.07	62.3	Initial airflow, system starting
2	10:00 AM	Inlet (Damper 2)	0.46	33.9	0.07	68.2	Stable airflow condition
3	11:00 AM	Inlet (Damper 2)	0.47	39.3	0.07	69.7	Mid-day airflow observed
4	12:00 AM	Inlet (Damper 2)	0.48	39.8	0.07	71.2	Max airflow observed
5	1:00 PM	Inlet (Damper 2)	0.49	40	0.07	72.7	Stable airflow maintained

CONCLUSION

The experimental evaluation of the inline ventilation system demonstrated satisfactory performance under the prescribed operating conditions. The measured airflow rate, static pressure, and fan efficiency were found to be consistent with the manufacturer's specifications and design requirements. The consolidated test results indicate stable operation, effective air distribution, and reliable system performance throughout the testing process. The proposed ventilation configuration is suitable for applications requiring efficient and continuous air circulation in industrial and commercial environments. Overall, the study validates the effectiveness of the experimental setup and provides useful performance data that can assist in the design, selection, and optimization of future ventilation systems.

REFERENCES

1. Tan AY, Wong NH. Natural ventilation performance of classroom with solar chimney system. Energy and Buildings. 2012 Oct 1;53:19-27.
2. 2.Son S, Jang CM. Air ventilation performance of school classrooms with respect to the installation positions of return duct. Sustainability. 2021 May 31;13(11):6188.
3. Mysen M, Schild PG, Hellstrand V, Thunshelle K. Evaluation of simplified ventilation system with direct air supply through the facade in a school in a cold climate. Energy and Buildings. 2005 Feb 1;37(2):157-66.
4. Emmerich SJ, Dols WS, Polidoro B. Application of a natural ventilation system design tool to a school building. Proceedings of SimBuild. 2012 Aug 1;5(1):185-92.
5. Agarwal S, Gera D. Study and optimisation of supply duct bend and diffuser in HVAC system for a classroom. International Journal of Innovative Science and Research Technology. 2020;5(7):988-95.
6. Rizzo K, Camilleri M, Gatt D, Yousif C. Optimising mechanical ventilation for indoor air quality and thermal comfort in a mediterranean school building. Sustainability. 2024 Jan 16;16(2):766.
7. Zhou K, Ma S, Shao X, Li S, Jin Q. Ventilation retrofit design for existing primary and secondary school classrooms under epidemic conditions. Building Services Engineering Research & Technology. 2024 Jul;45(4):413-39.
8. Rubina A, Uher P, Salajka R, Baroň A, Cakl D, Šmak M, Barnat J, Varbanov PS. Energy and acoustic evaluation of classroom ventilation and its influence on the design of the air-conditioning system. Energy. 2024 May 1;294:130791.
9. Kiil M, Valgma I, Võsa KV, Simson R, Mikola A, Tark T, Kurnitski J. Ventilation effectiveness in classroom infection risk control. InE3S Web of Conferences 2023 Jun 16 (Vol. 396, p. 01043). EDP Sciences.
10. Song J, Meng X. The improvement of ventilation design in school buildings using CFD simulation. Procedia Engineering. 2015 Jan 1;121:1475-81.

