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VENTILATION IN CLASSROOMS IN RIVERS STATE

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ABSTRACT

Ventilation is a key consideration in all architectural designs, be it natural, mechanical or hybrid but it's a very important thing to take note of in every design especially when it comes a learning environment such as a classroom. If not well put in place will lead to discomfort and lack of concentration by the learners. However, due to lack of space and poorly designed classrooms and space conversation in the country, one barely finds properly designed classrooms. Data collections were made through studies of publications and cases study. The first way to way to tackle ventilation challenge in classrooms, it starts in the design process, where spaces are designed considering the use and even if it were to be an already existing space been converted to classrooms, careful decisions should be made on the ventilation for the space. Careful and strategic openings should be done to manage inflow and out flow of air and as well how the mechanical ventilation would be positioned to serve the space.

INTRODUCTION

Ventilation in a building is part of the very primary consideration in the design of any building structure to be inhabited by humans.

Ventilation if well considered in the design process aids the thermal comfort and effective use of a space in a building.

Awbi (2003) in his article; Ventilation in buildings, stated that during the last three decades, ventilation philosophy has experienced major changes. In the first decade; considerable efforts were made towards understanding the mechanisms of air infiltration in buildings in order to reduce ventilation happening by chance and as well conserve energy. In some cases, air infiltration reduction created problems associated

with the air quality in buildings and the generic term 'sick building syndrome' came into being. The second decade encountered joint efforts in trying to understand the causes of sick buildings, which resulted in the introduction of new ventilation concepts, such as the age of air, new air quality units, and a consensus for increased outdoor air flow rates. In the third decade, emphasis on reducing energy consumption and awareness of environmental concerns has focused the minds of researchers and designers alike on the potential of natural ventilation and user control of the local environment. As a result of these changes, new ventilation standards and guidelines have been written to reflect the importance of ventilation on the quality of the indoor environment.

This paper presents ventilation in educational buildings in Rivers state, stating specifically the different ventilation types, its function and how it can serve the facility provided for. The primary goal of this study is to analyze carefully ventilation in educational building (Classrooms) and how it improves the learning conditions of the users.

The class room is a learning environment and as such, the slightest level of discomfort could lead to the idea been lost.

LITERATURE REVIEW

Yoshino and Haghighat (1992) in their article on Sustainable Built Environment said that ventilation is the process of supplying or removing air from any space. Historically, ventilation of buildings has served two purposes: to remove or dilute contaminants odors and/or moisture to ensure proper indoor air quality (IAQ), and to provide a thermally-comfortable indoor environment. Both objectives contribute to the fundamental purpose of an inhabitable space.

In warm or temperate climates, larger airflows in dwellings generally improve both IAQ and comfort. However, in regions characterized by climatic extremes, such as hot/arid, hot/humid or extreme cold, an increase in ventilation rates would usually cause an increase in energy consumption due to the necessary air-conditioning processes. In such instances, a balance is often sought between energy and environmental conservation on one hand whilst the health and wellbeing of occupants on the other. (Yoshino and Haghighat, 1992)

Proper ventilation is one of the major basics to improve thermal comfort, therefore should be heavily considered, most especially in the tropic region like Nigeria and as well limiting it to Rivers state.

Thermal comfort in an institution aids the students to concentrate as if there is no thermal comfort, concentration may not be at its peak. (Dantani, 2008).

There are 3 types of ventilation: Natural, mechanical and the Hybrid ventilation

Natural Ventilation: Natural ventilation is the term used to describe the air flow to or from a building through specific openings in the building envelope, such as openable windows, (Awbi, 2003). The interactions between wind and urban as well as natural environment produce energy exchanges between the static and dynamic components of the Bernoulli equation. The magnitude of the pressure differences is affected by several factors such as wind speed, wind direction, local topography and building shape. Openings in a building's envelope tend to act as short-circuits, relieving pressure differences between air masses near the building façades. The energy available near a building's windward façade is the sum of the static and dynamic pressure. The energy near the leeward façade is the static pressure, while the kinetic energy in the jet of air exiting at the leeward opening represents an energy loss, which is dissipated downstream. This is the basic mechanism behind cross-ventilation. Similarly, leeward-facing wind stacks are often designed as exhausts, harnessing the induction effect of the wind caused solely by the differences in static pressure. Ventilation due to buoyant effect temperature differences between two air masses produce differences in air density, which in turn produces differences in pressure. When an indoor space is heated, the outside pressure near the lower part of the building is generally greater than the indoor pressure, whereas the outside pressure near the upper part of the building is generally lower. This difference in pressure causes airflow spanning across the building envelope, a phenomenon often referred to as the stack effect. The level where the pressure difference is zero is called the neutral zone. Below the neutral zone, the outdoor air enters the space, while above the neural zone the indoor air exits the space. The airflow increases as the temperature differences become larger. (Yoshino and Haghighat, 1992).

Mechanical Ventilation: This is the ventilation achieved through mechanical devices, such as fans and air conditioners. Fans are often used for ventilation in a building. Yoshino and Haghighat, (1992) cited that indoor pressure increases when the ventilation fan is operated to supply outdoor air. On the other hand, indoor pressure

decreases when the ventilation fan is operated to exhaust indoor air. When ventilation fans are used both to supply outdoor air and exhaust indoor air, the indoor pressure depends on differences in power between the supply and the exhaust fan. Three types of mechanical ventilation systems when indoor pressure is positive, indoor moisture may penetrate into the wall, producing condensation within the envelope. It is therefore better to keep the indoor pressure slightly negative. However, this may cause contaminants contained in the wall to be emitted into the room.

Hybrid Ventilation: This ventilation type places concern on the combination of both natural and artificial ventilation systems. The mechanical and natural components may be used at the same time, or at different times of day, or in different seasons of the year. Since natural ventilation flow depends on environmental conditions, it may not always provide an appropriate amount of ventilation. In this case, mechanical systems may be used to supplement or regulate the naturally driven flow. (De Gids and Jicha, 2010)

In tropical areas like Nigeria especially Rivers state it is very important to consider ventilation thoroughly, this is because it'll affect the thermal comfort in the building envelope, and as well improve the learning process. One of the very first ventilation types to consider in the designing process is natural ventilation. This is because of the state of the country and the power challenge that it faces, thereby relying solely on mechanical ventilation will be inappropriate.

Considering the climatic condition of the locality of study, it will be appropriate to adopt the hybrid system in the design of classroom spaces to enhance the ventilation system to make it very effective. This however, should have a greater percentage of natural ventilation and then been appended with mechanical ventilation. In order to take advantage of the best ventilation, east west orientation is advisable to adopt too.

Awbi, (2003) in his article stresses that, recently, ventilation occupies an important position in the building design process since building occupants expect good standards of indoor air quality and comfort. People have become more aware of the effect of the indoor environment on health as a result of media publicity surrounding building related sickness. Appended to this, it is argued that some problems have been intensified as a result of a global reduction in the infiltration of air and general ventilation rates in order to achieve energy conservation.

Charles Munonye and Yingchun Ji (2021) explained that the characteristics of any building in terms of the materials used in the construction of the walls and the floors, including the type of doors, windows and ceiling installed, determine the thermal condition of that building. To a large extent, these parameters determine the thermal perception of building occupants.

The walls of the case study classrooms used in this study are made of sandcrete blocks, a product from the mixture of cement, sand and water. Sandcrete block is the most common material used for the construction of external building walls in Nigeria,

Location and Climate

The location for this specific study is in River's state, Port Harcourt to be precise.

In Port Harcourt, the wet season is warm and overcast, the dry season is hot and mostly cloudy, and it is oppressive year-round. Over the course of the year, the temperature typically varies from *71°F* to *87°F* and is rarely below *64°F* or above *90°F*. Also, the temperature in Port Harcourt varies so little throughout the year that one can't discuss best, hot and cold seasons. (https://weatherspark.com, 2022)

Port Harcourt is 9m above sea level. it has a tropical climate. Rainfall is significant most months of the year, and the short dry season has little effect. The average annual temperature is 26.0 °C | 78.8 °F in Port Harcourt. Precipitation here is about 2719 mm | 107.0 inch per year. The driest month is January, with 58 mm | 2.3 inches of rainfall. Most of the precipitation here falls in June, averaging 347 mm | 13.7 inches. (Akubueze Chibuzor, 2021)

METHODOLOGY

The case study approach and also a systematic analysis of relevant literatures was adopted in order to achieve this study. This study intends to analyze the ventilation of classroom spaces using the Faculty of Environmental Sciences, Department of Architecture classroom Rivers State University as a case study.

Rivers State University (RIVSU or RSU), is a university located in Port Harcourt, Rivers State, Nigeria. Rivers it is one of Nigeria's warmest areas, it has an average daily high temperature of 31 degrees Celsius. Low humidity and high temperatures cool the weather at times, but it is still tropical hot and humid. From June to October, the majority of precipitation decreases. Air temperature and relative humidity were calculated as indoor environmental variables. The thermal properties of the building surfaces were identical in all of the classrooms; materials used for the building include concrete, steel, ceramic and glass.

Fig 1. Rivers State University Campus, Faculty of Environmental Sciences

Fig 2. View of Environmental Sciences block

The classroom blocks were designed to take advantage of natural ventilation even though some mechanical ventilation systems were provided to support the natural ventilation. The design made provision for cross ventilation for every single classroom space to ensure the ventilation is at its best. Also, this was considered as well most especially because the classroom spaces also double as a studio workshop for some departments such as: architecture and urban and regional planning where some materials used in the studios/classrooms are having some toxic scent so, sponging the smell it brings quickly has to be considered.

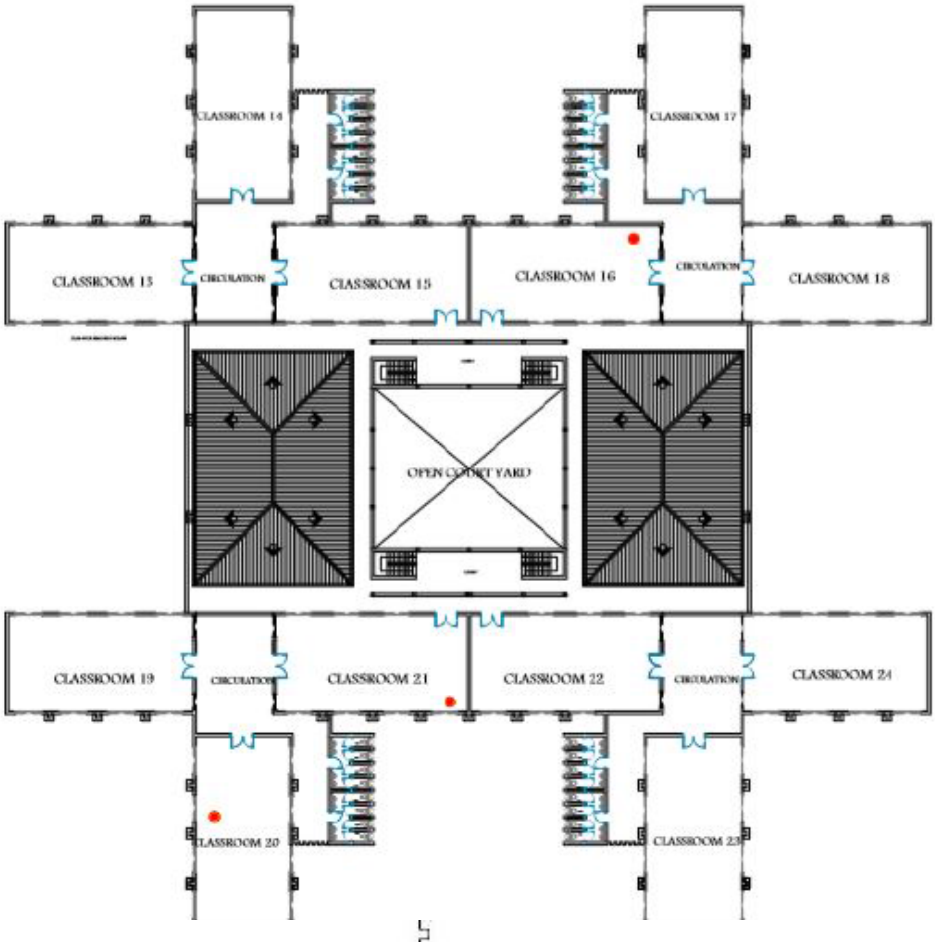

Fig 3. Second floor plan

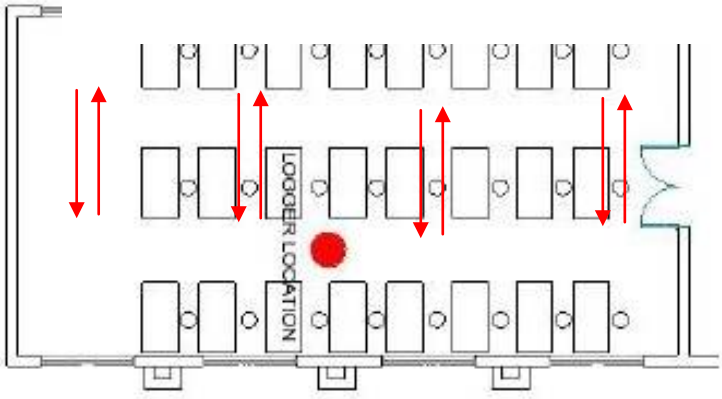

Fig4. Typical classroom/studio layout

The window sizes were 1,500mm/3000mm broken down into three panels. The window specification used for the building are sliding windows where there is an open able space of approximately two meters for every single window opening in the classroom.

Yoshino and Haghighat, (1992) explained that the primary consideration of making calculation for ventilation design is straightforward. Ventilation design can be preceded as follows:

1. Calculate the ventilation airflow volume required for each room
2. Fix the ventilation airflow path
3. Choose the ventilation system
4. Select ventilation appliances

When the aim is to eliminate a specific pollutant, the ventilation airflow volume can be calculated on the basis of the emission rate and the acceptable concentration of the pollutant. Or, when the purpose of ventilation is to remove heat from a space, the ventilation airflow rate can be calculated based on the acceptable maximum temperature and the heat generation rate. Usually, the ventilation airflow volume can be calculated for the purpose of pollutant removal: in this case, heat can be considered as pollutant. However, information on both the emission rate and the acceptable concentration is available for a limited number of pollutants. The acceptable concentrations of several pollutants are available in regulations and guidebooks of several countries, such as *ASHRAE Standard 62-1999* and *SHASE Japan Standard 106-1996.* Yoshino and Haghighat, (1992) explaining Murakami 1998. As the information on emission rate is limited, it is difficult to calculate the ventilation airflow volume for each pollutant. One solution is to use carbon dioxide as an indoor air pollution index. The airflow volume is therefore

calculated based on the acceptable concentration of carbon dioxide, i.e., 1000 ppm Yoshino and Haghighat, (1992) explaining from Haghighat and Donnini, 1992. The ventilation requirement per person becomes 20 to 30 m^3/h. However, in the case of housing, general ventilation rates are often prescribed independently of specific pollutants and emission rates, such as the 0.5 air change rate per hour prescribed in the criteria for energy conservation of residential buildings in Japan (1999).

CONCLUSION

A classroom is a primary learning environment and ventilation in it has to be carefully designed so its users can be comfortable in the classroom space. For a tropical country like Nigeria, and a State like Rivers, mechanical ventilation should never be wholly depended on because of the power challenge in the country. Classroom spaces need as much natural ventilation as possible but can also adopt the hybrid ventilation system to enhance the air circulation and movement around the space.

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