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# Effect of temperature and ventilation on school environmental inside the classrooms

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**Abstract**

This research highlights the impact of heat and ventilation on the school environment inside the classrooms and thus develop and improve the efficiency of school buildings for the health of students and teachers and obtain sustainable and comfortable buildings. In this research, the Computational Fluid Dynamics (CFD) simulation program was used. Through the appropriate storm model and work steps within the wind simulation programs based on the best directions. A model of a school from the Ministry of Construction and Housing plans was chosen as a case study to find the wind speed inside the spaces in three different cases based on data from the nearest meteorological stations, where some climatic phenomena affecting the school environment were studied, namely the phenomenon of wind movement and heat and the extent of their impact according to the location and direction of the school building and choosing the appropriate direction to provide ventilation and a healthy environment suitable for study inside the building by analyzing these phenomena using the (CFD) program.

**Keywords:** CFD, Temperature, Ventilation

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## تأثير درجة الحرارة والتهوية على البيئة المدرسية داخل الصفوف الدراسية

**د. وئام عبد الوهاب محمد** [1]

**المستخلص**

هذا البحث يسلط الضوء على تأثير الحرارة والتهوية على البيئة المدرسية داخل الصفوف وبالتالي تطوير وتحسين كفاءة اداء المباني المدرسية من أجل صحة الطلبة والمدرسين والحصول على ابنية مستدامة ومريحة. في هذا البحث تم استخدام برنامج محاكاة ديناميكية المواقع (CFD Computational Fluid Dynamics ) ومن خلال نموذج العصف المناسب وخطوات العمل داخل برامج محاكاة الرياح بناء على أفضل الاتجاهات. تم اختيار نموذج لمدرسة من مدارس مخططات وزارة الاعمار والاسكان كحالة دراسية لإيجاد سرعة الرياح داخل الفراغات في ثلاث حالات مختلفة بناء على بيانات أقرب محطات أرصاد جوية حيث تم دراسة بعض الظواهر المناخية التي تؤثر على البيئة المدرسية وهي ظاهرة حركة الرياح والحرارة ومدى تأثيرها حسب موقع واتجاه البناية المدرسية واختيار الاتجاه المناسب لتوفير التهوية والبيئة الصحية وملائمة للدراسة داخل البناية وذلك من خلال تحليل هذه الظواهر باستخدام برنامج (CFD).

**الكلمات المفتاحية:** CFD، الحرارة، التهوية

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**معلومات البحث**

**تأريخ النشر:** تشرين الاول 2025

## Introduction

The school building is one of the most important buildings that serve the educational process and that the health and comfort of its occupants is a matter of study and analysis.

Therefore, environmental factors are taken into consideration in the selection and planning of building sites in general and school buildings in particular, so that users enjoy a healthy environment far from the risk.

The process of natural ventilation of the buildings is intended to replace the internal air of the spaces with pure air from the outside by natural means only. Providing the lowest rate of natural ventilation in buildings is essential for human life and its importance lies in its effective effect in reducing the heat stress on humans and it's also help to eliminate carbon dioxide, unpleasant odors, impurities and harmful pollutants to health.

Natural ventilation is necessary in order to reduce the temperature of walls, ceilings and floors by taking advantage of the phenomenon of thermal transfer by load currents. The study of the phenomenon of wind movement and temperature phenomena inside the school building are two of the most important phenomena that directly affect the comfort of the students inside the school where the Arab cities with their traditional cohesive texture is the best example of city planning and motion pathways in terms of width, shape, Change the direction of the basic stage to adapt to the environment Which leads to the mitigation of harsh climate effects and mitigation of effects, especially high temperatures and solar radiation and wind and thus reduce the total thermal impact on the facades of buildings, especially in areas with a hot dry climate as the study area [1].

## Location of Hilla City (Study Area)

The city of Hilla is located in the province of Babel in two galleries, 32°30 ¯ 00 ˭ and 32°32 ¯ 00 ˭ north, and within the latitudes 44°24 ¯ 00 ˭ and 44°26 ¯ 00 ˭ East, with an area of approximately 190 km². The tropical city has become a hot climate in the center of Iraq, affecting the prevailing winds and temperature [2].

## Wind Movement

Wind is defined as the movement of horizontal and parallel air to the surface of the earth due to the difference in atmospheric pressure. The movement of air from the high pressure zone towards the low pressure zone even if the difference is small. Not all moving air falls under the wind, but is required to be horizontal and parallel to the surface of the earth [3].

The energy that causes the movement of air through the building is known as the kinetic energy of the wind and is equivalent (V2 1/2 $\sigma$)

Where $\sigma$ is the density of air and V is the velocity of the air, if the movement of the air and movement within the building is the result of the gradual pressure in the air through the inner space, which is the result of two factors, the thermal force resulting from the temperature gradient between the internal air and the external air, and the other is the wind force generated by the external air currents [4, 5].

The winds movement in the city of Hilla are the Northwest winds and constitute 25.4% of the prevailing trends of wind in the city. They come from the Anatolian mountains and Armenia towards Mesopotamia. The south and south-east winds are 7.8 % warm and wet from the winter. The northeast winds contribute 3.4% accompanied by a severe fall in temperature in the winter, while the southwest wind is 2.2%, which is hot winds, dusty in the summer as shown in Figure (1).

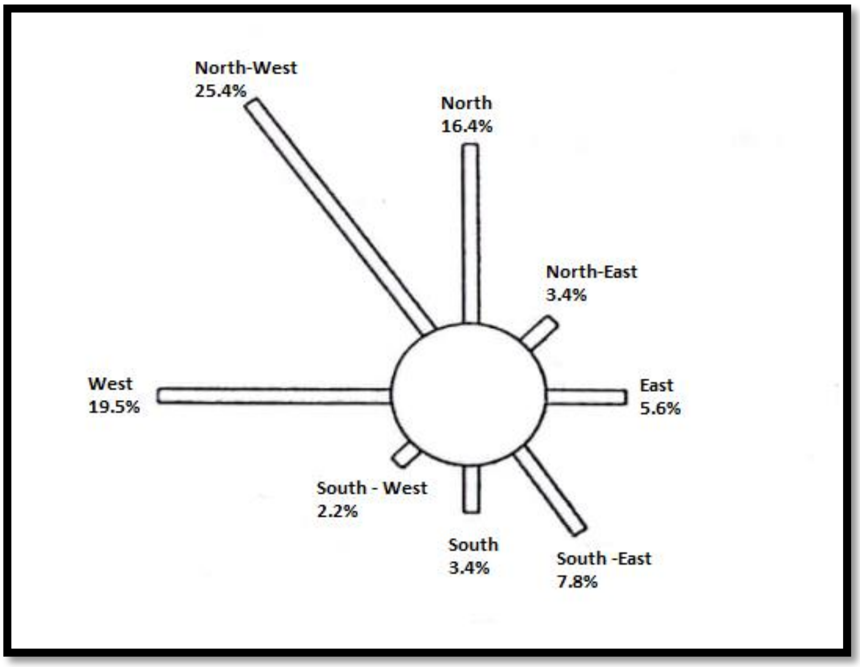


**Figure (1): State the General Organization for Aeronautical and Seismic monitoring, climate department, unpublished data=¯**

The data for 2019 showed that the month of June and July witnessed the highest rates of wind speed of 2.1 m/s, higher than the annual average of 1.6 m /s while the wind speed starts to decline gradually starting in November by 0.7 m/s until January 1.7 m/s as shown in Table (1) and Figure (2).

**Table (1): State the Monthly rates of wind speed (m/s) in Hilla Station (2019)**

| | |
|---|---|
| **January** | **1.7** |
| **February** | **1.8** |
| **March** | **1.7** |
| **April** | **1.7** |
| **May** | **1.6** |
| **June** | **2.1** |
| **July** | **2.0** |
| **August** | **1.1** |
| **September** | **1.2** |
| **October** | **1.0** |
| **November** | **0.7** |
| **December** | **1.2** |

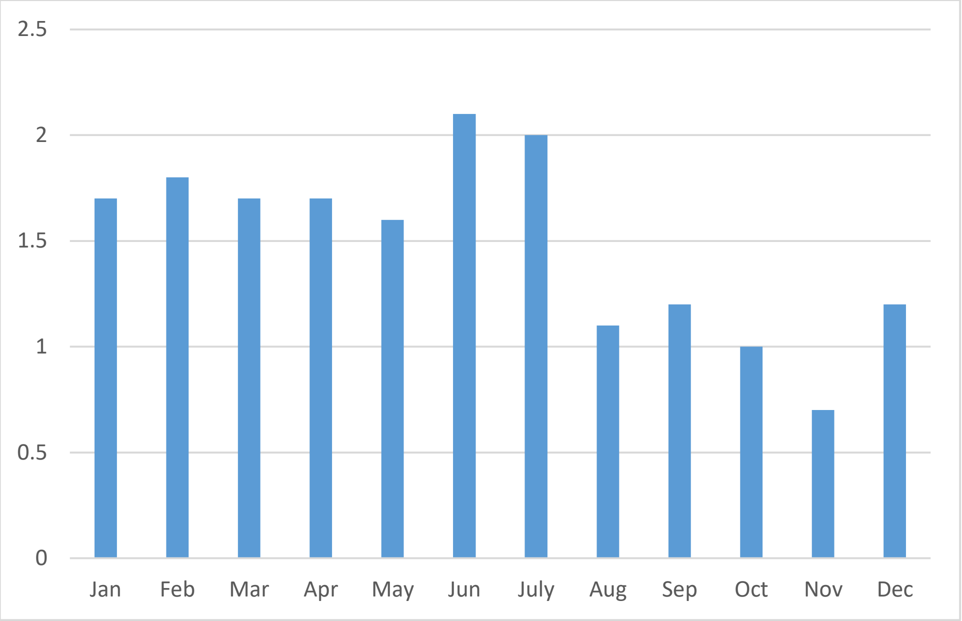


**Figure (2): State the monthly rates of wind speed (m/s) in Hilla station (2019)**

**Temperature**

The temperature of the warm elements and important phenomena that have a significant impact on the environment through the extreme heating of the earth's temperature in the day and the associated heating of the air and wind, which leads to the movements of the upward up ward active work to spread pollutants vertically while the result of the night cooling of the surface of the earth .The control of air landing movements results in the concentration of most air pollutants close to the earth's surface, thus increasing the density of contaminants [6].The average annual temperature in the city of Hilla 26 ° with a large annual temperature range of 37.5° and through. Table (2) showing that the temperature rates in the city of Hilla begin to increase from June and increase rates to reach 46° in August While the temperature range is falling from November to early April as shown in Figure (3).

**Table (2): State the Monthly rates of high and low temperature (Celsius) in Hilla Station (2019)**

| months | Low temperature rate | High temperature rate | Average temperature rate |
|---|---|---|---|
| January | 7.9 | 21.2 | 14.6 |
| February | 10 | 22.0 | 16.5 |
| March | 13.5 | 27.6 | 20.6 |
| April | 17.3 | 30.6 | 24 |
| May | 23 | 37.5 | 30.3 |
| June | 26.7 | 42.5 | 34.6 |
| July | 27.6 | 45 | 36.3 |
| August | 29 | 46 | 37.5 |

| | | | |
|---|---|---|---|
| **September** | **25.3** | **41.9** | **33.6** |
| **October** | **20.1** | **35.4** | **27.8** |
| **November** | **11** | **27.8** | **19.4** |
| **December** | **10.8** | **21.4** | **16.1** |

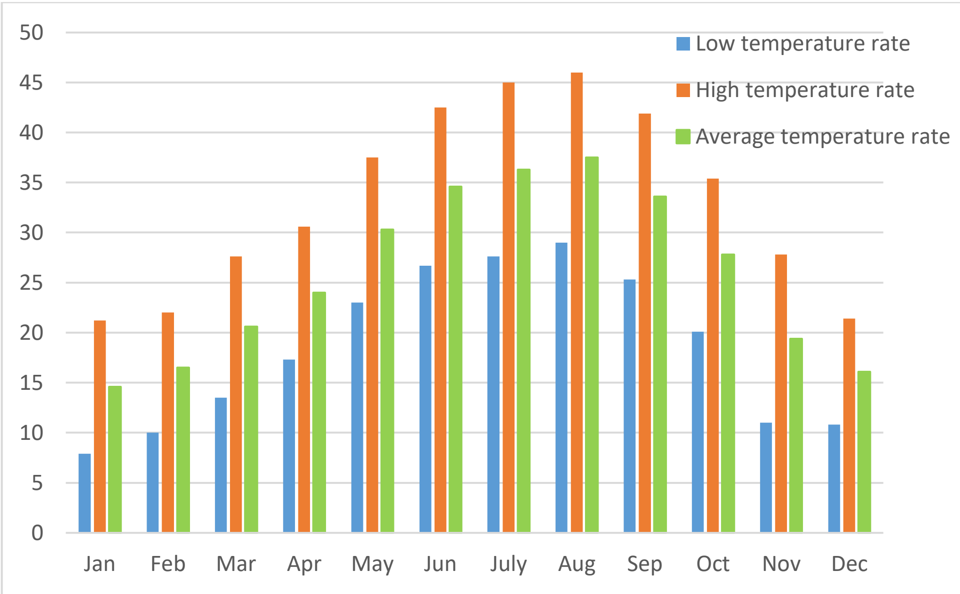


**Figure (3): State the monthly rates of high and low temperature (Celsius) in Hilla station (2019)**

**Computational Fluid Dynamics and Phonics Software Modeling**

Computational Fluid Dynamics (CFD) is a discipline within the field of numerical modeling that has been specifically designed to address challenges related to fluid flow phenomena. This encompasses various applications that pertain to the interaction between fluids and solids, such as the dynamics of water flow in natural river systems or the behavior of fluids around and over hydraulic structures. Hydraulic engineers have expressed significant interest in investigating the potential of (CFD) for simulating fluid flow in hydro-electric generating facilities. Despite the considerable computational time required, (CFD) offers the ability to analyze three-dimensional flow fields surrounding curved objects, along with other intricate flow characteristics that are not attainable with simplified one or two-dimensional models. Although (CFD) is widely employed for modeling flow in various sections of a power plant, this research specifically examines the application of CFD in simulating the water flow via the surface drainage system of a roadway.

A thermal model was developed using (CFD) techniques to represent the studied area. Subsequently, simulations were conducted utilizing the boundary conditions that were specifically recorded throughout the monitoring time. The (CFD) tool PHOENICS (2009) was employed to conduct the simulations. The standard k-ε model was employed to simulate the impact of turbulence. The boundary conditions provide essential data regarding the temperature and wind characteristics of the fluid upon its entry. The boundary conditions for surface temperatures were incorporated into the PHOENICS software, and subsequent simulations were conducted to model the distributions of ambient temperature and wind speed. Wind, simulation software based on (CFD), has gained significant popularity in recent years. This can be attributed to its user-friendly interface, high level of accuracy, and advancements in computer technology [7], [8], [9].

In this study, a model for a school building (schools of the Ministry of Housing and Construction) is made up of six class. The school building is exposed to winds of 2.1 m/s and 46° temperature degrees for three directions.

**Case Study**

**Case A**

The first case when the school is titled at 45° from the direction of the north (clockwise), which ensures the flow of wind at a speed of (2.1) m/s on the side of the school is the highest wind speed obtained from the meteorological data. The results show that the velocity of wind graded from (1.14, 0.9, 0.7 to 0.63) m/s inside the classroom as shown in the Figure (4. a, b, c, d) and Figure (5. a, b, c).

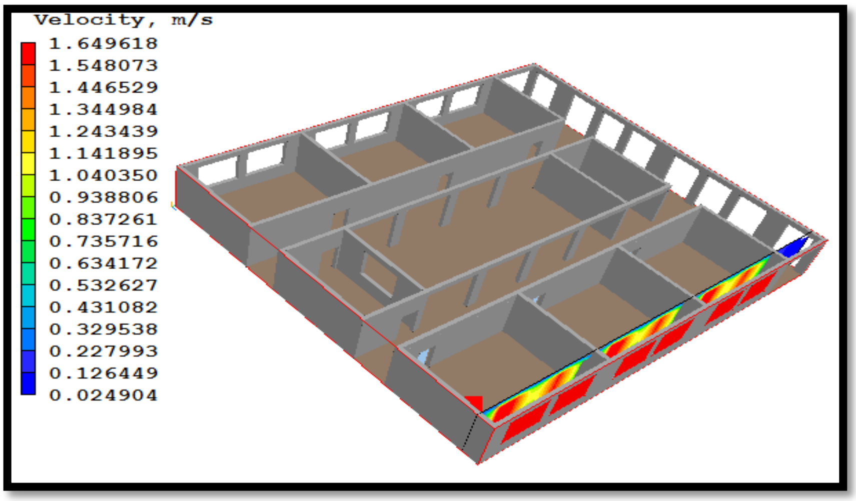


**Figure (4.a): State the velocity wind simulated on the side at first part of the school**

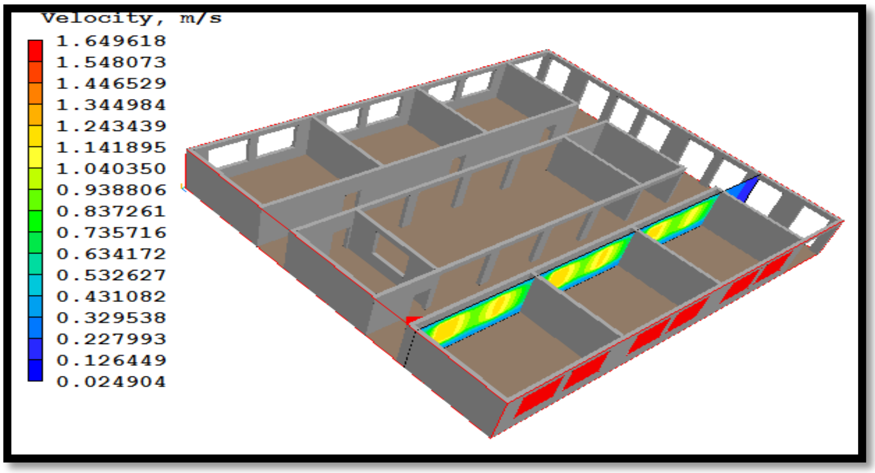


**Figure (4.b): State the velocity wind simulated on the side at second part of the school**

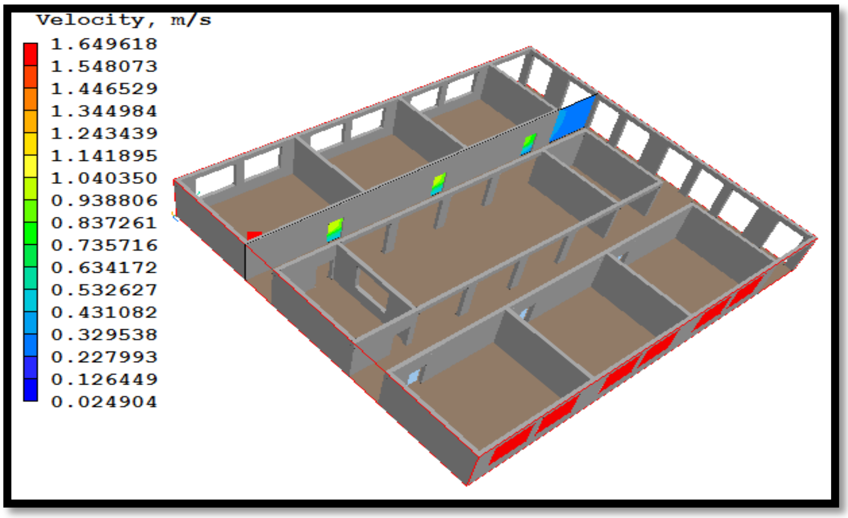


**Figure (4.c): State the velocity wind simulated on the side at third part of the school**

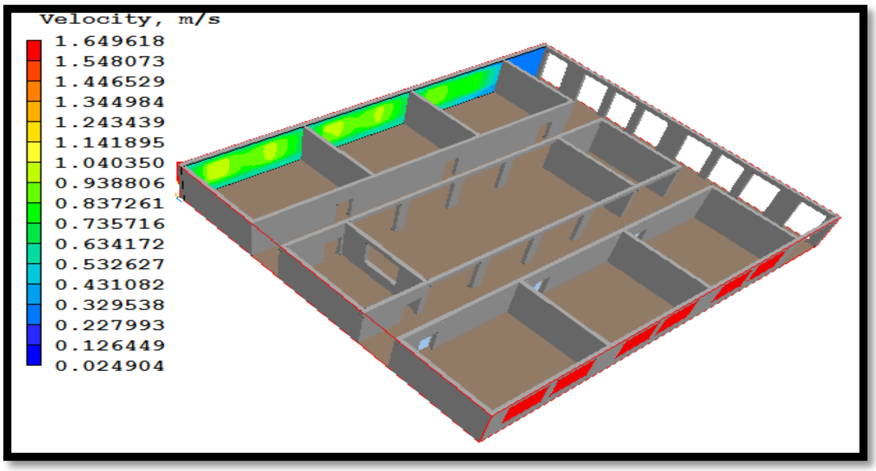


**Figure (4.d): State the velocity wind simulated on the side at fourth part of the school**

Also the results showed that the temperature decreased from 46° to 38°as shown in the Figure (5. A, b, c).

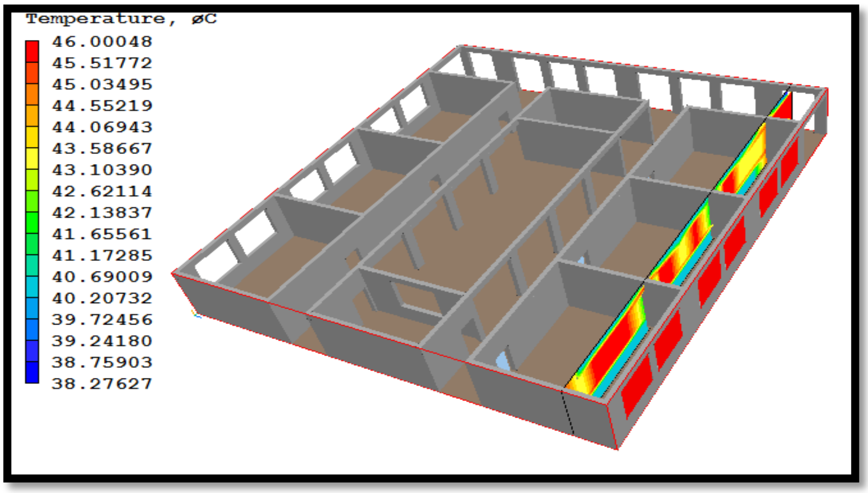


**Figure (5.a): State the temperature simulated on the side at first part of the school**

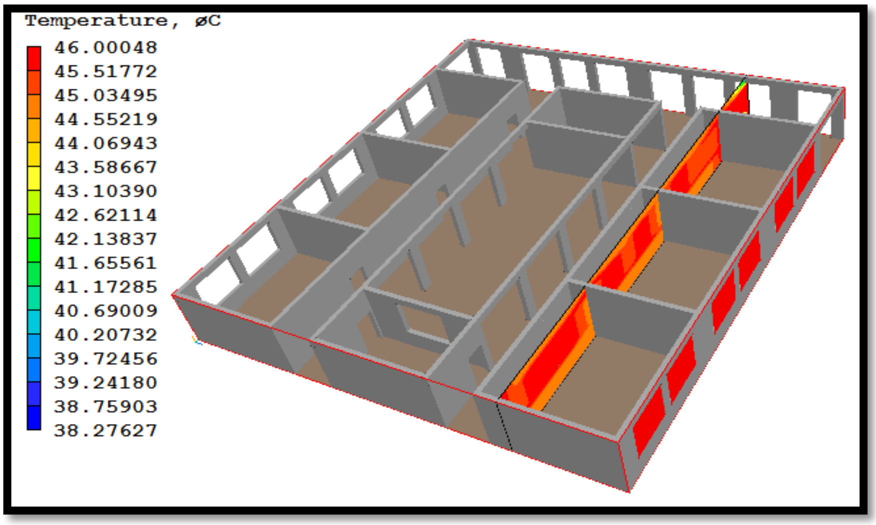


**Figure (5.b): State the temperature simulated on the side at second part of the school**

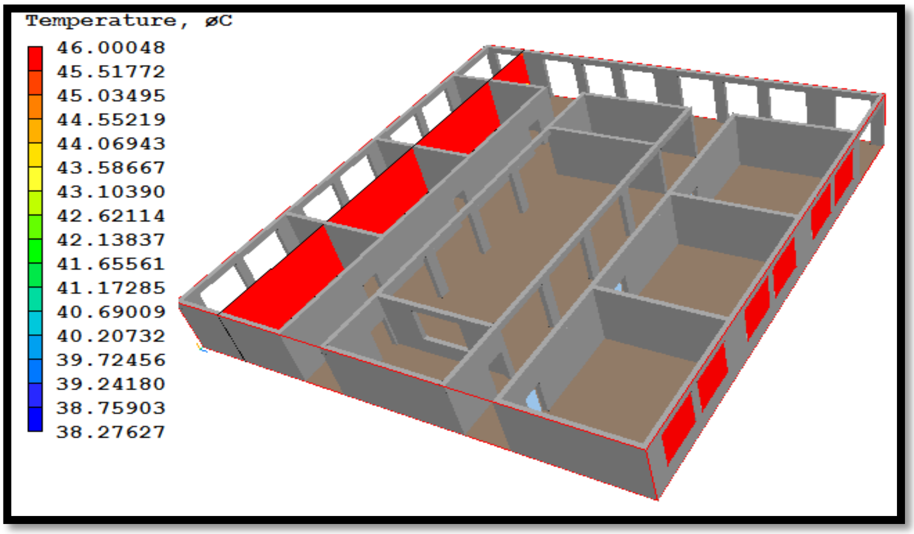


**Figure (5.c): State the temperature simulated on the side at third part of the school**

**Case B**

The second case when the school is tilted at 45° from the direction of the north (Counterclockwise), which ensures the flow of wind at a speed of (2.1) m/s on the front of the school is the highest wind speed obtained from the meteorological data. The results show that the velocity of wind graded from (0.8, 0.44, 0.4 to 0.001) m/s inside the classroom as shown in the Figure (6.a, b, c, d). (7. a, b, c).

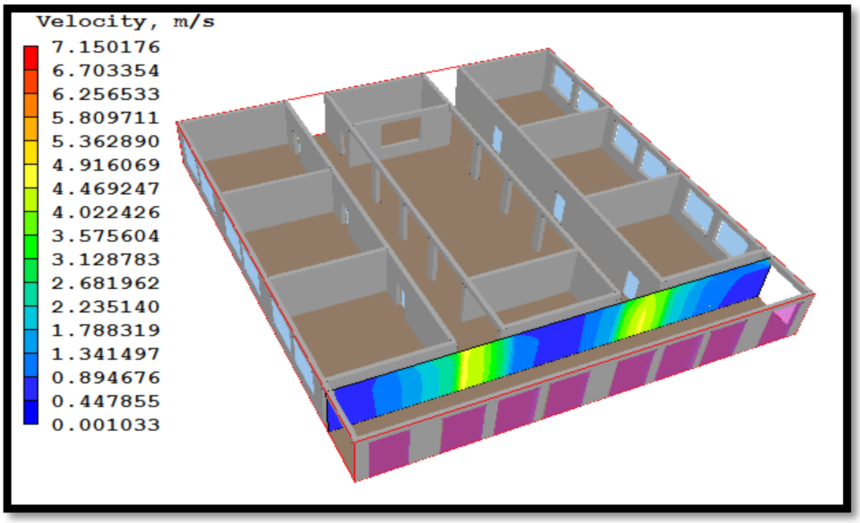


**Figure (6.a): State the velocity wind simulated on the front at first part of the school**

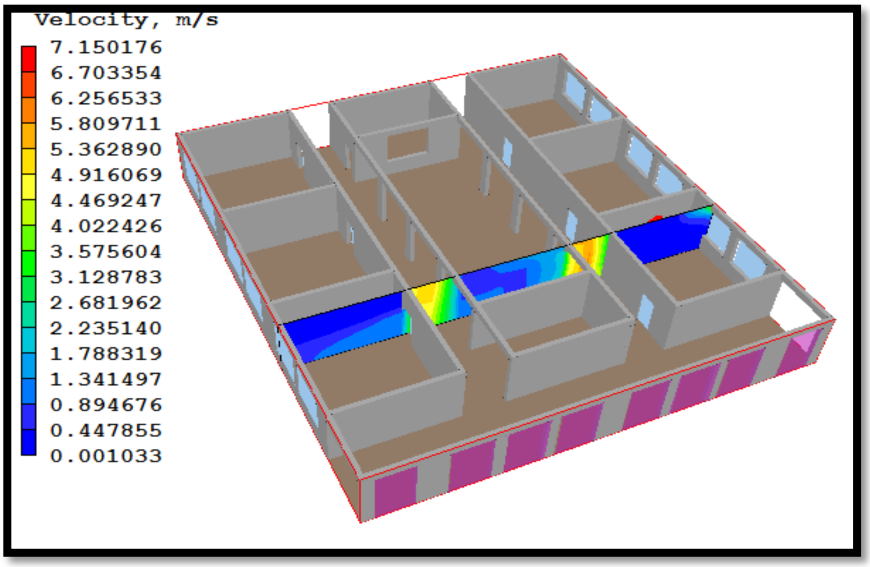


**Figure (6.b): State the velocity wind simulated on the front at second part of the school**

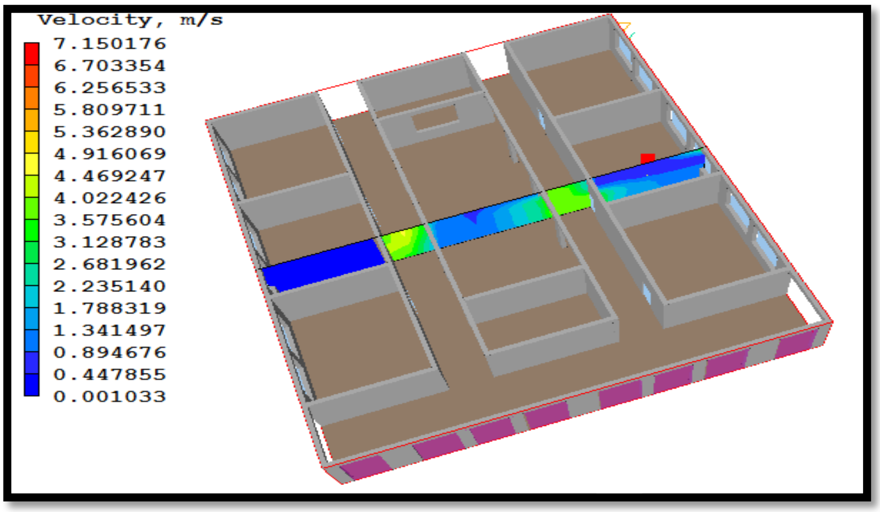


**Figure (6.c): State the velocity wind simulated on the front at third part of the school**

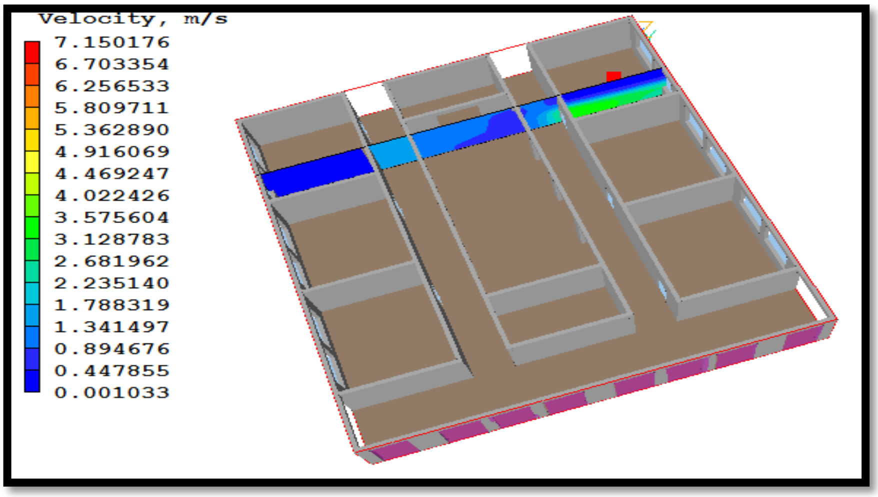


**Figure (6.d): State the velocity wind simulated on the front at fourth part of the school**

Also the results showed that the temperature decreased from 46° to 42° as shown in the Figure (7.a, b, c).

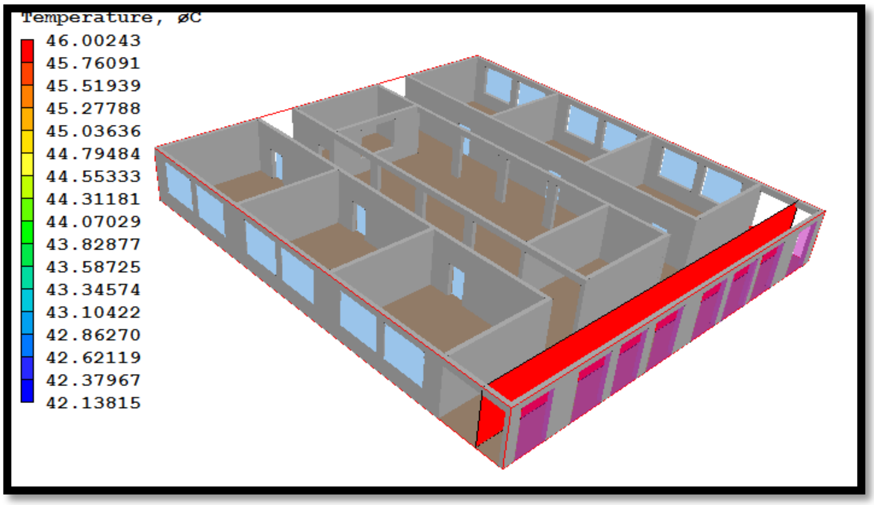


**Figure (7.a): State the temperature simulated on the front at first part of the school**

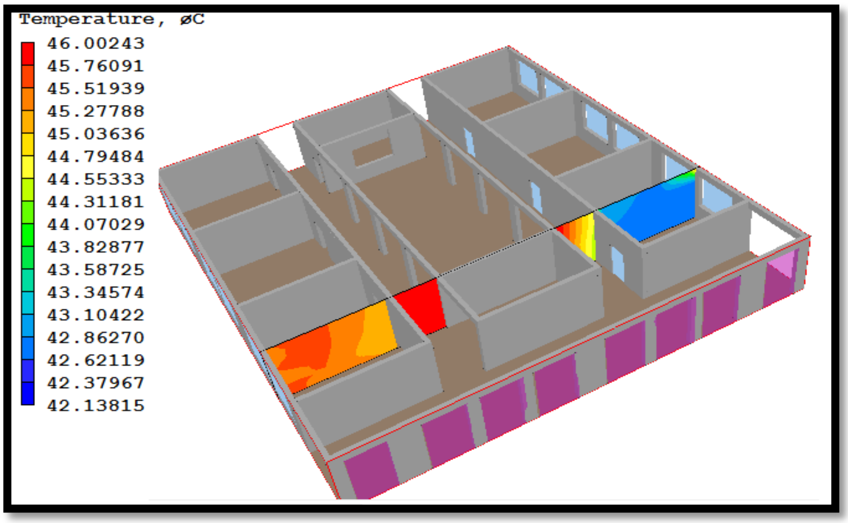


**Figure (7.b): State the temperature simulated on the front at second part of the school**

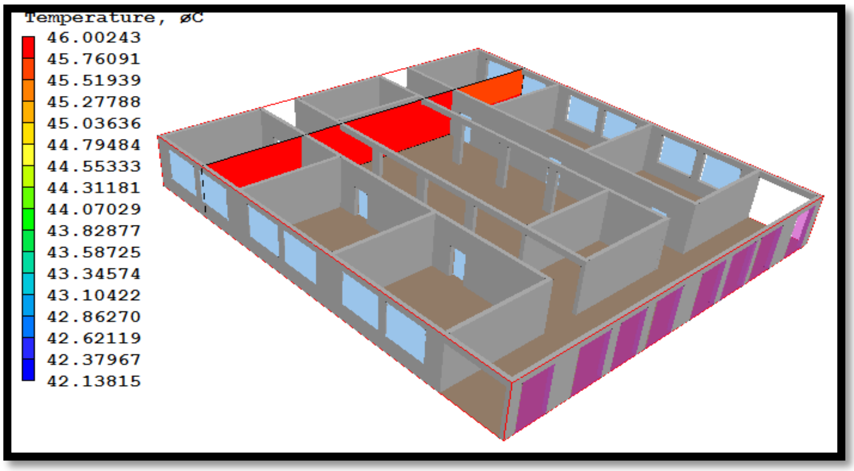


**Figure (7.c): State the temperature simulated on the front at third part of the school**

**Case C**

The third case when the school is tilted at 135° from the direction of the north (clockwise), which ensures the flow of wind at a speed of (2.1) m/son the back of the school is the highest wind speed obtained from the meteorological data. The results show that the velocity of wind was (1.332e-4) m/s inside the classroom as shown in the Figure (8.a, b, c, d).

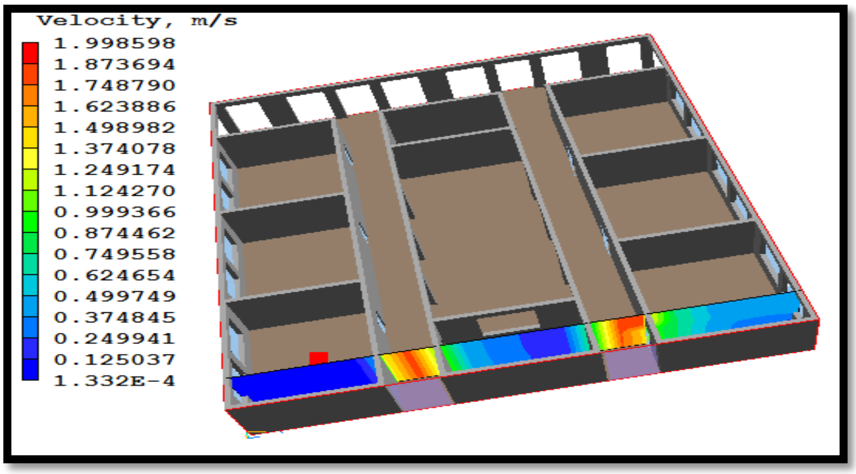


**Figure (8.a): State the velocity wind simulated on the back at first part of the school**

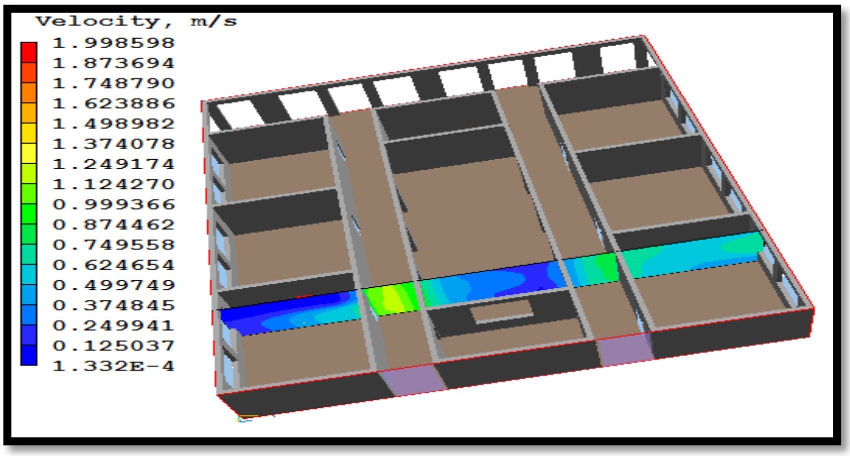


**Figure (8.b): State the velocity wind simulated on the back at second part of the school**

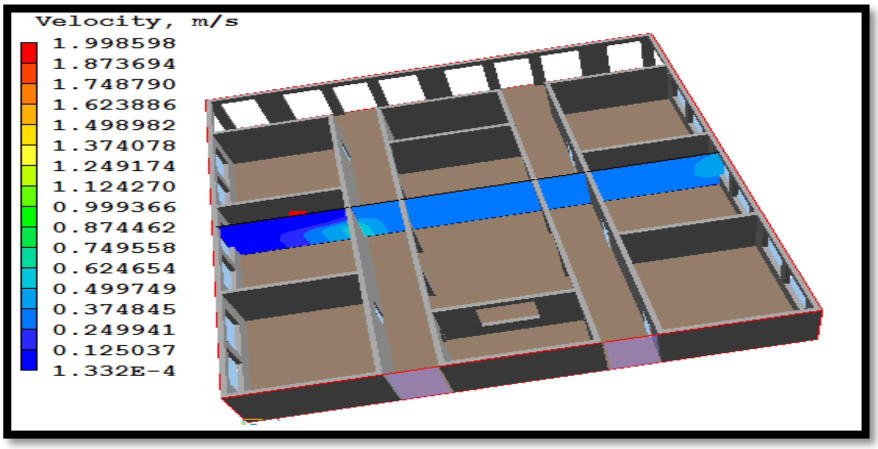


**Figure (8.c): State the velocity wind simulated on the back at third part of the school**

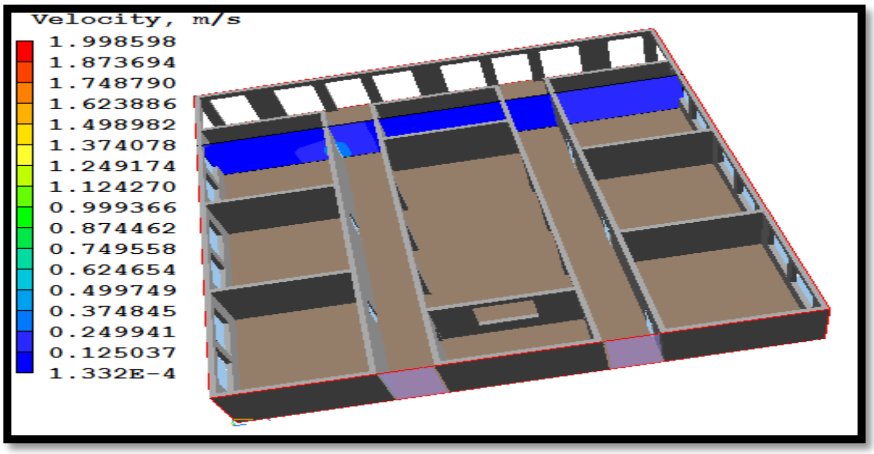


**Figure (8.d): State the velocity wind simulated on the back at fourth part of the school**

Also the results showed that the temperature decreased from 46° to 43° as shown in Figure (9. A, b, c)

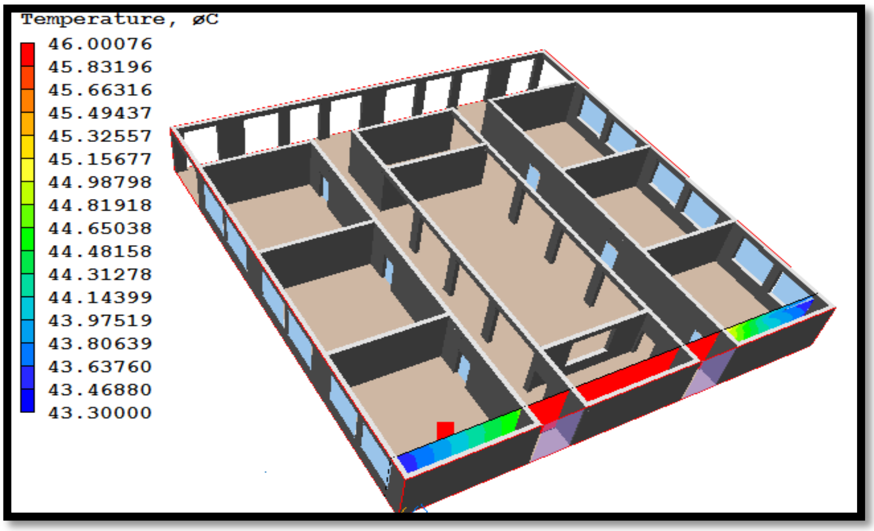


**Figure (9.a): State the temperature simulated on the back at first part of the school**

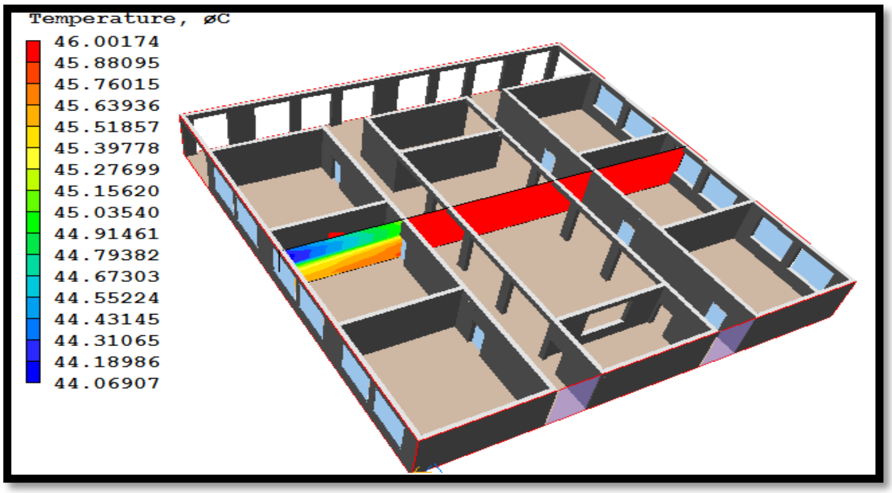


**Figure (9.b): State the temperature simulated on the back at second part of the school**

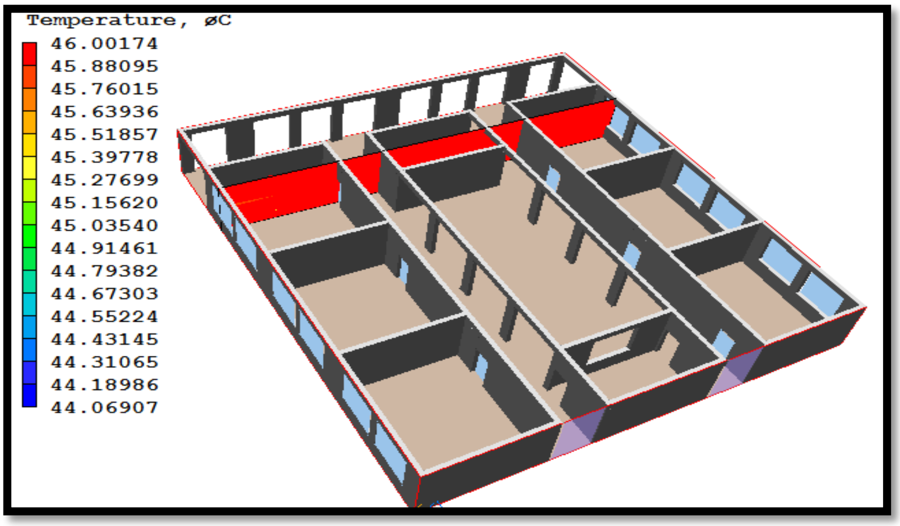


**Figure (9.c): State the temperature simulated on the back at third part of the school**

## Conclusions

- The data of General Organization for Aeronautical and Seismic Monitoring, Climate department of Babylon Governorate for 2019 explain that the strongest wind speed is 2.1 m /s in the North West direction with rate 25.4% in the sixth month and the highest temperature is 46 ° in the eighth month.
- The results showed that the first case provides the highest flow of wind in the classroom (1.14,0.9,0.7,0.6) m/s when the front of the school is tilted at 45° from the direction of the north (clockwise), Which provides the airflow coming from the north-west direction, which is better than the case B and C as it provides high flow of air inside the building, and as a result of a significant reduction in temperature within the room Starting from the beginning of air entry from the window to the opposite side of the class ,and thus help in compensating the industrial ventilation approved by fans and air conditioners and as a result helps to reduce the problems of overcrowding in the classroom

and the accompanying problems of environmental pollution.

- The results showed that the first case provides decrease in temperature from 46° to 38° when the front of the school is tilted at 45 degrees from the direction of the north (clockwise), which is better than the case B provide decrease in temperature from 46° to 42°, while case C provide decrease in temperature from 46 ° to 43 ° and this greatly affects the thermal comfortable inside the building.
- The results demonstrate the importance of using simulation technology in general and the Computational Fluid Dynamics (CFD) program in particular because of its significant impact to help make decisions that directly affect building efficiency, the health and comfort of occupants and the application of environmental sustainability principles.

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