Reducing the Rate of Carbon Dioxide Emissions for Social Housing Units in New 6th of October City

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Abstract:

When creating new cities, it is necessary to take into account the environmental dimensions of not harming the climate and designing buildings so that they contribute to reducing carbon dioxide emissions in light of the increasing global crises resulting from climate challenges, which are no longer have a small impact on the contemporary world and with the increasing demands for different solutions to solve the housing crisis. The provision of housing units appropriate to the needs and requirements of the users and from this point of view decisions have been taken to implement the social housing initiative for the low-income people by the Egyptian state and are working to provide economic support for residential units, and the main objective of this research paper was to reduce the rate of carbon dioxide emissions for social housing units in the New Sixth of October City, by treating the Building Envelope, using thermal insulation for walls and choosing a low-e double glazing type that works to reduce carbon dioxide emissions, and that was through an applied study using computer simulation in the Design Builder 6.0 program for a model of social housing units in the 6th of October City, Giza Governorate, and taking into account the design determinants and variables such as direction and type of the used glass, and the building materials used in the Building Envelope. The results indicate that treating the Building Envelope using polystyrene thermal insulation with a thickness of 6 cm in the walls and a heat insulation polystyrene 8 cm in the Roof and a wall thickness of 25 cm Red brick can reduce the rate of carbon dioxide emissions by more than 50% on the condition of the foundation, these results are among the good indicators that illustrate the importance of choosing the materials and thickness of the building materials in the Building Envelope of the building in reducing the rate of carbon dioxide emissions in the buildings of social housing units in the new Sixth of October city in Egypt.

1- Introduction:

When creating new cities, it is necessary to take into account the environmental dimensions of not harming the climate and designing buildings in such a way that they contribute to reducing carbon dioxide emissions in light of the increasing global crises resulting from climate challenges that no longer have a small impact on the contemporary world (1), usually conditions of Housing in substandard social housing units, which is often associated with high exposure to indoor pollutants, and thus negative health effects (2), (3), (4) and

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with the increasing demands for different solutions to solve the housing crisis and provide housing units that are appropriate to the needs and requirements of users; I have taken decisions to implement a social housing initiative for low-income people on the part of the Egyptian state and are working to provide economic support for residential units, and with the increase in awareness and global trend towards constructing buildings that are more environmentally friendly and reduce carbon dioxide emissions and achieve the quality of the internal environment, it was necessary to construct friendly residential buildings (5), (6), and preserve the environment; Starting from its treatment of the outer covering and applying the requirements of the energy code for residential buildings (7), until the desired result is achieved in contributing to the reduction of carbon dioxide emissions. These issues have become of particular relevance in the context of climate changes and the achievement of carbon emissions targets in addition to the impact that short-term weather changes can have on thermal comfort in current social housing (12)

2- Literature review

Numerous studies indicated that the prevailing trend in the world and the unprecedented levels of rural-to-urban mobility led to the presence of large numbers of social housing buildings in cities all over the world. (1) As of 2014, about 54% of the world's population lives in urban areas (14), and this growth has led to an increase in housing demand in or near urban centers, which has often resulted in housing unaffordability. To address this, governments have invested in social housing, which consists of subsidized units available to low-income residents. This has resulted in large numbers of social housing buildings all over the world. According to housing statistics prepared by the Dutch Ministry of the Interior, there were more than 1.3 million social housing households in Europe in 2008. (16) In Canada, Statistics of Canada reported that there were more than half a million subsidized housing tenants as of 2011. The United States Census Bureau reported that there were more than one million public housing units in the United States in 2015. (17) These figures are only a fraction of the total number of low-income households, and IEQ conditions are usually difficult in social housing that is exposed to air pollutants or lack of thermal comfort or health effects associated with living in these units as that Residents of social housing may be exposed disproportionately to high levels of pollution due to limited economic conditions and the absence of prosperity. Another study indicates that rich families produce a greater share of emissions per capita than poor families through their direct energy consumption and higher spending on goods and services that they use. Energy as an intermediate input. (15) Environmental concerns are considered in light of climate change on the housing sector as one of the main sectors that consume energy and produce carbon dioxide and the policy of expanding it to meet the needs of the population. The most important policy to combat this problem is to apply the energy code for residential buildings, which the sector must adhere to Social housing in compliance with these standards. (18) Through studies, we find that attention must be paid to environmental remedies and thus to reduce GH emissions rates. As for carbon dioxide, to obtain the quality of the internal environment for the social housing buildings in the new 6th of October City. The Design Builder 6.0 program was used in this study to verify and explore the results as many studies used this program because of its accuracy in showing simulation results when compared to the actual results. The results

of a study indicated that Design Builder 6.0 achieved the same actual results by comparing them with Depreciation bills while QUEST had a 7% deviation in results. (13)

3- Research problem:

Increasing the rate of carbon dioxide emissions for social housing units in high quantities due to the inefficiency of the buildings of Building Envelope and the failure to apply the energy code for residential buildings (8).

4- Research and practical study objectives:

This study aims to reduce carbon dioxide emissions for social housing units in the New Sixth of October City, taking into account the appropriate directive for residential units, treatment of the Building Envelope, the use of thermal insulation for walls, and the choice of a double glass 6 mm Low-E glass that works to reduce carbon dioxide emissions for housing units Social.

5- Research questions:

A- How to achieve the reduction of carbon dioxide emissions for social housing units in the Greater Cairo Region? (2).

B- How to reduce the carbon dioxide emissions of social housing units by treating the Building Envelope?

6- Research hypothesis:

The use of thermal insulation and double glazing of 6mm Low-E Glass in the Building Envelope of social housing units works to reduce the carbon dioxide emissions of social housing units.

7- Methodology used:

To achieve the objectives of the research, a theoretical approach is followed based on a review of previous studies of what has been achieved and its impact on the current study, and an analytical approach, which is a basic case study of a housing unit model from the social housing units in the 6th of October City, Giza Governorate, which follows the Greater Cairo Region, and an applied approach using Computer simulation by means of the Design Builder 6.0 simulation tool, studying the environmental aspects and the rate of carbon dioxide emissions, by changing the orientation, changing the thickness and type of walls in the Building Envelope, changing the type of glass, and then coming up with the simulation results for each case separately.

Then, clarify the results and compare them, and thus achieve the research objectives.

7-1- The main steps of the simulation were as follows:

1. Evaluate the environmental performance of the proposed model using the Design Builder 6.0 simulation program:

Climate data analysis. Solar radiation analysis.

2. Identify the rate of carbon dioxide emissions of social housing units, depending on:

- The orientation, the type of glass used, the thickness of the building materials used and the thermal insulation of 6 cm in the walls and 8 cm in the Roof in the Building Envelope of the social housing units.

7-2- Basis for selecting the case study:

New 6th of October City is located in Giza Governorate and follows the Greater Cairo region, where it is considered one of the regions with a hot and dry climate and the buildings of social housing units were not treated as environmental remedies that resulted in the failure to provide thermal comfort within the spaces in the social housing units, which negatively affected the user and to achieve the goal of the study, the following must be taken into account:

 The existence of this case study for a specific climatic region, which is the Greater Cairo Region.

 Provide the required information to prepare it for the simulation and evaluation phases.

7-3- The technical method for collecting and documenting data for the model under study:

The following methods were followed in collecting information on study cases:

Research and previous studies that dealt with the study cases.

Field visits and photographic documentation.

Architectural and aerial maps of case studies.

7-4- Applied study methodology: -

A- Analysis of climatic data for the study area.

B- Analytical description of the social housing units under study, (architectural description, description of current building materials, occupancy rate, openings ratio, and orientation).

C- Evaluating the basic situation using simulations, for the models of the social housing units under study using the Simulation 6.0 Design Builder program, and then evaluating them.

D- Development of alternatives by testing the proposed methodology for the case studies using appropriate treatments. The orientation, materials, and glass type of openings were studied to obtain the best results by using a simulation program to analyze the rate of carbon dioxide emissions of social housing units.

E- Compare and discuss results.

In this way, different alternatives and materials alternatives can be evaluated in order to choose the best solutions that contribute to achieving comfort requirements, providing a good environment and reducing the rate of carbon dioxide emissions for social housing units.

This simulation aims to:

A- Study the effect of building materials on the rate of carbon dioxide emissions of social housing units.

B- Estimating the rate of saving of carbon dioxide emissions for social housing units by using different alternatives, whether design or materials alternatives.

7-5- Analyzing social housing units' models: The analysis is done through:

A- Climatic data analysis for the study area, Greater Cairo Region.

Climatic data for the Greater Cairo region were used using a 6.0 climate consultant program.

-Data of a housing unit model for social housing:

Architectural design data:

The aim of studying a housing unit model for social housing before and after modifying building materials is to find the effect of materials, orientation, and glass type of openings with different architectural dimensions on the rate of carbon dioxide emissions of social housing units. A comparison will be made between the current situation of the social housing unit and the amendment after setting the alternatives. The comparison will deal with the most important design elements such as (horizontal projections - walls - building materials used in each element).

Figure (3) shows a model of a residential building - social housing of 800 acres - New 6th of October City - Giza.

7-6- Evaluating a model of a social housing unit using simulation: This is done through:

A- Simulation methodology:

The specifications and dimensions of the building are entered into the program and create a model and a simulated model that simulates the reality of the building, so that this model simulates the rate of carbon dioxide emissions of the social housing units in the building as it appears in the following model taken from the Design Builder 6.0 program, it is a program that analyzes the inputs in the case fully scholastic.

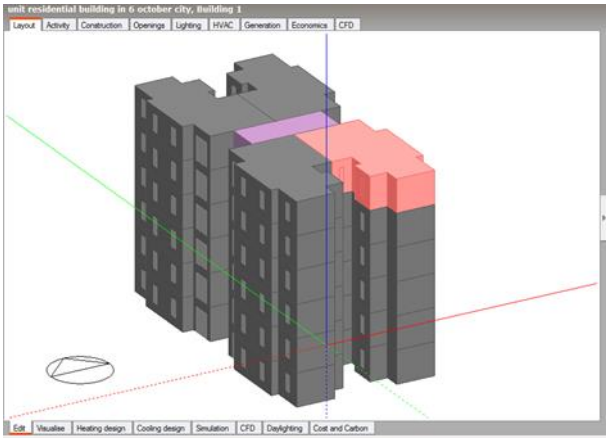

Figure (5) shows the case study in the 6.0 Design Builder program, source:
https://designbuilder.co.uk/(11)

7-7- The simulation results:

The simulation results show that the highest rate of co_2 gas emissions for the social housing unit model in **the first case**, which is the wall thickness of the Building Envelope 12 cm red bricks and transparent single 3 mm glass, and without applying the energy code by applying thermal insulation on the roof and on the walls, the rate of CO_2 gas emissions was 61.258 tons per meter ^{2} / year. **The results of the second** case, which is the wall thickness of Building Envelope, indicate 25 cm red bricks and transparent single 3 mm glass, the rate of co_2 emissions decreased to 40.691 tons per square meter / year, at a rate of 20.567 tons per square meter / year, by 34% from the base case. **The results of the third** case indicate that in the case of adding a thermal insulation of 8 cm to the Roof and a wall thickness of 25 cm red bricks and heat insulation of 6 cm on the walls and a single 3 mm clear glass, the rate of co_2 gas emissions decreased to 33.28 tons per square meter / year at a rate of 27.978 tons per square meter / year by 46% for the case. The basis, **and the results of the fourth** case indicate that in the case of adding an 8 cm thermal insulation to the Roof and a wall thickness of 25 cm red bricks and 6 cm thermal insulation on the walls and 6 mm double reflective glass, the rate of co_2 gas emissions decreased to 29.6 tons per square meter / year, at a rate of 31.658 tons per meter ^{2} / year, 52% of the base case.

8- Conclusion:

The use of simulation programs for social housing units is an important factor for assessing and identifying the rate of carbon dioxide emissions for social housing units, and thus working to improve their condition by treating the Building Envelope and choosing the appropriate direction.

The possibility of applying the results of research and simulation studies to the models of social housing units that are built by the competent authorities in those areas to achieve thermal comfort and reduce the rate of carbon dioxide emissions, and it is clear to us that both the architectural dimensions, the wall thickness and the thermal insulation are 6 cm thick in the walls and 8 cm thick in the Roof It greatly affects the carbon dioxide emission rate of social housing units, and if architects take these dimensions into consideration during

the design process, the reduction of carbon dioxide emissions of social housing units will be achieved.

- The rate of carbon dioxide emissions for social housing units is a result of design decisions. In the research, four architectural dimensions were studied and analyzed, namely (orientation, building materials, thickness of building materials, and the type of glass in openings). These dimensions were tested due to their importance and impact on the rate of energy consumption. For social housing units, and in summary, the results showed the effect of architectural dimensions and dimensions of building materials, and their effects on thermal comfort and CO^2 emissions rate through treatment of the Building Envelope.

- The use of simulation programs for social housing units is an important factor for assessing and identifying the rate of carbon dioxide emissions for social housing units and thus working to improve their condition by treating the building envelope and choosing the appropriate direction, which is the orientation of (North) where the lowest rate of carbon dioxide emissions.

The possibility of applying the results of the research and simulation studies to models of social housing units that are built by the competent authorities in those areas to achieve thermal comfort and reduce the rate of carbon dioxide emissions, and it is clear to us that both the architectural dimensions, when the wall thickness and the thermal insulation are 6 cm thick in the walls and 8 cm thick in the roof, it greatly affects the rate of carbon dioxide emissions of social housing units, and if architects take these dimensions into consideration during the design process, the rate of carbon dioxide emissions of social housing units will be reduced.

The rate of carbon dioxide emissions for social housing units is a result of the design decisions. In the research, four architectural dimensions were studied and analyzed, namely (orientation, building materials, thickness of building materials, and the type of glass in openings). These dimensions were tested due to their importance and impact on the rate of energy consumption of Social housing units, and in summary, the results showed the effect of architectural dimensions and dimensions of building materials, and their effects on thermal comfort and the rate of carbon dioxide emissions through treatment of the outer envelope and thus prove the validity of the hypothesis that is the use of thermal insulation and double glazing 6 mm Low-E glass in the building envelope of social housing units, works to reduce carbon dioxide emissions for social housing units, thus responding to the problem and achieving the research goal, which is to reduce carbon dioxide emissions for social housing units in the New Sixth of October City, taking into account the appropriate directions for residential units and treating the building envelope.

9- Recommendations:

In this research we presented the simulation result of the treatment method required for social housing units in the Greater Cairo region to reduce carbon dioxide emissions, which is the selection of the appropriate direction, which is the (North) directive, where the lowest rate of carbon dioxide emissions must be applied to the energy code for residential buildings and work to treat the Building Envelope for social housing units, using a wall thickness of at least 25 cm, red brick with 6 cm thermal insulation, with the use of double low-e glass

((SHGC) = 0.43), ((LT) = 0.634), ((UV) = 0.233)) with insulation Surface and thermal thickness of at least 8 cm for the last round in order to improve the energy performance of social housing units in the Greater Cairo Region.

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