Simulation for Heat Gain Rate through Window Glazing in Hyderabad, Pakistan

Waqar Nisar[1], Rizwan Ahmed Memon[1], Abdul Manan[1], Abedalaziz Ibrahem Ahmad Ali[1], Loay Yousef Khalil Amro[1], Khawar Ali Khan[1]

[1]*Department of Mechanical Engineering, Mehran UET-Jamshoro, Sindh, Pakistan*

***Abstract*: Building design plays pivotal role in energy consumption. Buildings in Pakistan consume over 40% of the entire electricity produced. Significant energy reserves are attained in buildings if they are appropriately planned, built and functioned. The objective of this research is to analyze the impact of type, medium and thickness of glass on transfer of heat flux through building envelope and cost estimation of optimized window glazing for a building in Hyderabad, Pakistan. For this purpose, different types of glazing with window-to-wall ratio of 25% has been analyzed. A simulation software EnergyPlus has been used to determine zone windows total heat gain rate per area of non-air-conditioned room. The result shows that zone windows total heat gain rate per area by double low-e (pyrolytic coating) clear 6mm/13mm air is lower as compared to other glazing considered in research, which means it has tendency to reduce zone air temperature. In cost study, it has been estimated that double low-e (pyrolytic coating) clear 6mm/13mm air is cost effective than other glazing.**

***Keywords*: Energy efficient building, Window glazing, Window-to-Wall Ratio, Energy Plus.**

I. INTRODUCTION

Buildings are the basic need of the human beings. Buildings are considered one of the biggest electricity consuming segment inside the world. With increasing population demands, there is constant noticeable need for energy supply. According to estimation of ENERCON energy efficient building design can reduce electricity bills by 20% and this can be increased to 50% when electrical appliances works efficiently. [1] Consistent with conservative estimate, homes in Pakistan consume over forty percent of the total power produced. Pakistan is highly energy deficient country. The demand of building is growing on the price of almost 14% in keeping with annum, the best amongst all different sectors. The main causes of increased demand in building sector are considered to subsequent construction of buildings and increasing standards of living. [2] Population development, more time consumed indoors, and global climate change has increased energy consumption in buildings. Energy in buildings use presently accounts for more than 40% of general primary power consumption inside the United States of America and Europe. [3] Buildings experienced enough warmness advantage otherwise shift by window, then this disturb the thermal comfort of building inhabitants. [4] Energy consumption in the building sector includes energy used for heating, cooling and lighting. Innovations in the prevailing building design will help in reducing the energy crises. Our concern is to analyze the impact of type, medium and thickness of glass on transfer of heat flux through building envelope and cost estimation of optimized window glazing for a building in Hyderabad, Pakistan. Glazing is a layer of transparent material positioned between sky and sun and the interior of building envelope. The glass is extensively used in building construction for a long time. In buildings, glass is used as non-load bearing wall and used to partition the rooms in the building. Window glazing highly affect the heating and cooling load of the building. Window glazing improves the building energy consumption performance and result as reduction in heating and cooling load.

II. METHODOLOGY

1. Literature will be reviewed as a first step to collect the data of different types of glasses with their properties
2. The market is survey to check the availability of glasses with their cost
3. The building envelope is design using SketchUp
4. EnergyPlus has used for simulation of building envelope
5. The IDF is create using IDF-Editor in EnergyPlus. In IDF, we provide details of construction material, type of window glazing, medium and other parameters of building envelope
6. The IDF and weather data file in EPW is provide to EnergyPlus for simulation
7. The benefits of optimized window glazing are analyzed by comparing zone windows total heat gain rate per area in building envelope for each glazing type based on simulation results
8. The cost of each type of glass with thickness is survey in markets of Hyderabad, Pakistan and international markets also taken into consideration for those glazing type which are not available in local markets

A. EnergyPlus Simulation

EnergyPlus calculate the heat gain rate through building envelope necessary to keep warm air regulator setpoints in addition to various extra simulation that remain needed to confirm that simulation is acting as the genuine building could. EnergyPlus weather file containing the weather data of building location and IDF comprising the data telling the building envelope, is simulate in EnergyPlus. IDF-Editor provide service for creating and editing EnergyPlus input data files.

B. Room Specification

The single room is designed on SketchUp. It is naturally ventilated room with three windows and one door. The details of single room are specified in the table.

Table 1: Room Specification

S. No.	Field	Unit	Size
1	Longitude	Degree	68.35
2	Latitude	Degree	25.39
3	Ceiling Height	m	3
4	Length	m	5
5	Width	m	5
6	Window Length	m	2.5
7	Window Height	m	1.5
8	Window Area	m^2	3.75
9	Weather file	-	Hyderabad, Pakistan

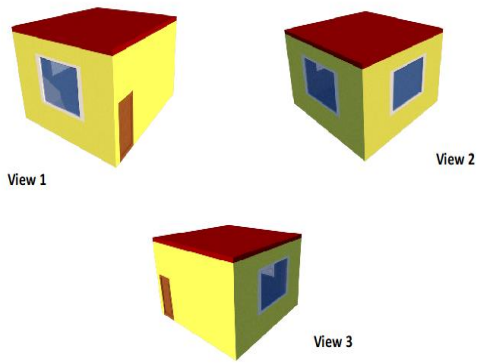

Fig. 1: Single Room

C. Material Used in Building Envelope

There are different materials used in building envelope. Some of them, we have used in our research are common brick for walls. The common brick is used as an intermediate layer of the wall. The bonding material which is used for common brick is cement plaster of different thickness as an inside and outside layer on the wall. The three walls of building envelope (north, south and west walls) having windows of different glazing are single clear 6mm, single green 6mm, single low-e (pyrolytic coating) clear 6mm, double low-e (pyrolytic coating) clear 6mm/13mm air and triple clear 3mm/6mm air. The one wall of building envelope (east wall) having door of wood. Simulation is carried for each glazing type while other material of building envelope is same. In single low-e (pyrolytic coating) clear 6mm and double low-e (pyrolytic coating) clear 6mm/13mm air, Pyrolytic coating is used on surface 2, which is inside zone that is why emissivity of glazing is 0.2.

III. RESULTS

The simulation has been done to evaluate performance of different glazing based on parameter, the parameter is zone windows total heat gain rate per area. According to weather data file, the hottest month of the year is May. For this reason, we have compared zone windows total heat gain rate per area during the hottest month: May.

A. Comparison of Average Zone Windows Total Heat Gain Rate per Area

The average zone windows total heat gain rate per area obtained during the month: May for single clear 6mm glass, single green 6mm glass, single low-e (pyrolytic coating) clear 6mm, double low-e (pyrolytic coating) clear 6mm/13mm air and triple clear 3mm glass/6mm air are 26.52 W/m^2, 22.80 W/m^2, 20.55 W/m^2, 17.46 W/m^2 and 18.36 W/m^2 respectively. Fig. 2 represents comparison of average zone windows total heat gain rate per area during the month: May.

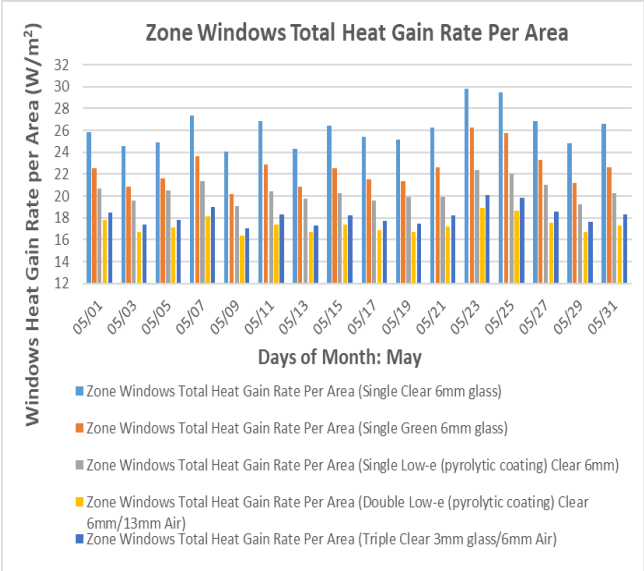

Fig. 2: Comparison of Zone Windows Total Heat Gain Rate Per Area

Cost of Window Glazing

For cost estimation of different glazing, local markets of Hyderabad, Pakistan are surveyed. The cost estimation of glazing which are not available in Hyderabad, Pakistan than international markets are taken into consideration. Table 2 shows cost of different glazing which are available in Hyderabad, Pakistan and international markets. In cost estimation, it is obtained that double low-e (pyrolytic coating) clear 6mm/13mm air is found more cost effective than other glazing types because it is not available in local markets of Hyderabad, Pakistan. The cost of double low-e (pyrolytic coating) clear 6mm/13mm air is estimated according to U.S. markets. [5] Whereas single clear 6mm glass is found less cost effective than other glazing types because it is widely used and easily available in local markets of Hyderabad, Pakistan.

Table 2: Cost of Window Glazing

S. No.	Glazing	Cost (Rs.)
1	Single Clear 6mm	4070
2	Single Green 6mm	5570
3	Single Low-e (pyrolytic coating) Clear 6mm	21200
4	Double Low-e (pyrolytic coating) Clear 6mm/13mm Air	42400
5	Triple Clear 3mm/6mm Air	6100

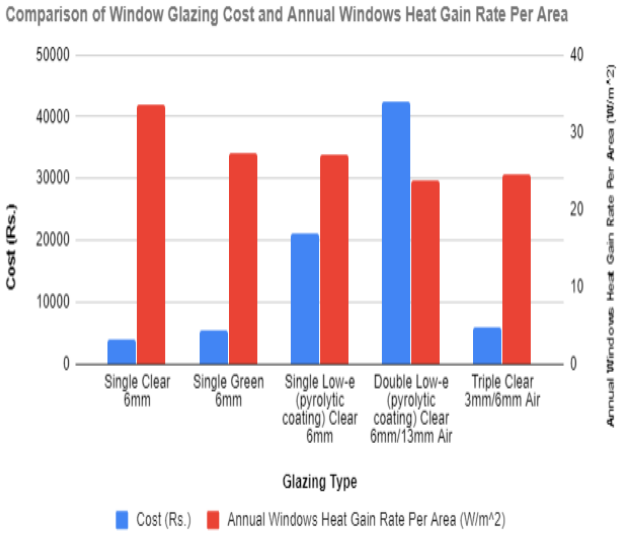

Fig. 3: Comparison of Window Glazing Cost and Annual Zone Windows Heat Gain Rate Per Area

IV. CONCLUSIONS

In this research, a simulation software Energy Plus has been used to analyze the impact of type, medium and thickness of glass on transfer of heat flux through building envelope. The cost has been estimated of optimized window glazing for a building in Hyderabad, Pakistan and compared with other glazing types. From results and comparison, it can be concluded that double low-e (pyrolytic coating) clear 6mm/13mm air and triple clear 3mm glass/6mm air are suitable, because zone windows total heat gain rate per area of these glazing types are low throughout the hottest month of the year. Therefore, zone windows total heat gain rate per area through double low-e (pyrolytic coating) clear 6mm/13mm air and triple clear 3mm glass/6mm air are not much as compared to single clear 6mm glass, single green 6mm glass and single low-e (pyrolytic coating) clear 6mm. While single clear 6mm glass and single green 6mm glass are not effective at reducing zone windows total heat gain rate per area and are not suitable for energy-efficient building. The cost of double low-e (pyrolytic coating) clear 6mm/13mm air is more than single clear 6mm glass, single green 6mm glass, single low-e (pyrolytic coating) clear 6mm and triple clear 3mm/6mm air. Whereas single clear 6mm glass is found less cost effective than other glazing types. Simultaneously, single green 6mm glass has more cost than single clear 6mm glass but less cost than single low-e (pyrolytic coating) clear 6mm, double low-e (pyrolytic coating) clear 6mm/13mm air and triple clear 3mm glass/6mm air. Hence, among these five glazing types double low-e (pyrolytic coating) clear 6mm/13mm air appears an optimal option which reduce zone windows total heat gain rate per area and zone air temperature. It also reduces the cooling energy requirements of building envelope and ultimately save the cost of electricity consumption in the building.

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