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A Comparison of Energy Consumption between Low-E Glass and Standard Float Glass Window

Shazaliana Shamsudin[1], Mohamad Baharin Ahmed[1]*, Juliana Mohamed[2]

[1]Department of Construction Engineering Technology (Building Information Modelling), Kolej Kemahiran Tinggi MARA Sri Gading (KKTMSG), Batu 11, Jalan Kluang, 86400 Parit Raja, Johor, MALAYSIA

[2]Department of Information Technology, Center for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor MALAYSIA

*Corresponding Author Designation

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Abstract: Glass is playing more important role in architecture industry and our daily life, also it undertakes much important function. The sunshine transmittance of the common glass is very high, and the infrared reflection rate is low, so most of the sunshine passes through the building glass. As a result, the indoor temperature rises and the energy of the indoor objects radiates out through the glass, which brings out the waste of energy. For this project, here are two different types of glass and their subcategories, each with its own uses and advantages that is Float Glass VS Low-E Glass. The aim of this research is to identify does the Low-E glass reduce the energy consumption through out the year. To achieve this research, KKTM Sri Gading's library will be model by using two different material glass window and for analysing the model energy usage using software Autodesk Insight and Autodesk Green Building Studio. A literature review, study the material properties, 3D modelling, analyse and comparing the glass and eventually the drafting of the study report are all part of the project.

Keywords: Float Glass, Low-E Glass, Energy consumed, Analysis, Glass

1. Introduction

Glass is literally everywhere, and annually a minimum of 20 million TONNES of the stuff is manufactured. Different engineering practices are reflected in their ability to exhibit certain chemical, mechanical, thermal, and chemical properties. This creates variations in strength, transparency, and overall workability. For this project, here are two different types of glass each with its own uses and advantages that is Float Glass VS Low-E Glass. To test the workability of the glass, windows in KKTM

**Corresponding author: baharin@mara.gov.my*

Sri Gading Library are used to analysed whether it makes any difference on the energy consumption if different types of glass are used. According from [1], the energy use perspective, windows may also be regarded as thermal holes for a building, their loss and gain of heat may be in four ways of conduction, convection, radiation and/or air leakage. Generally, windows add to the energy bill through radiant heat gains in the summer. The need to reduce unwanted heat gain is one of the major energy-related issues in window design and selection.

In the study of this project, there are few problems that led to the study on this project made. According to [2], the insulation of the wall and roof, the air tightness and window replacement have the most impact on energy saving and allowed reducing 45% of the total annual energy consumed. Researcher from [3] reported that existing buildings with older glass (usually having lower thermal insulation and higher solar transmission) a simple retrofit solution is to attach a low-e (hard coat) coated glass internally in the building without an explicit air tight seal.

The objectives for this study are to model a KKTM Sri Gading Library with two different material of glass window which is Low-E and Standard Float Glass, to analyse the model energy usage and total energy cost per year and to identify does the Low-E glass reduce the energy consumption through out the year.

The scope of work for this study is to propose KKTM Sri Gading library with different type of window glass which is Low-E and Float Glass. It is to identify the energy usage used by two different materials and to find out which type of glass reduce the energy consumption through out the year. The energy analysis will be done by software Autodesk Insight and Autodesk Green Building Studio.

1.1 Literature review

According to [4], energy analysis or energy systems analysis is the study of energy use, energy production and energy conversion in society. It is an attempt to explain historic developments of energy use and energy production, to explore possible future developments, and to consider how such developments can be influenced.

Energy analysis is becoming an important factor to be considered in the AEC industry these days because of the worsening global warming and energy crisis. The energy analysis needs to be amalgamated into the design phase of the building with respect to the increased regulations required all over the world. Forecasting the energy usage of the building and using a suitable energy conserving measure and design for construction is a need of the hour according to [5].

Buildings consume up to 40% of the total global energy. By the year 2030, the consumption is expected to increase to 50% [6]. According to [7], energy is increasingly costly, and the condition is worsened by global warming due to greenhouse gas emission. Buildings consume more energy and waste more natural resources, which leads to more CO_2 production and environmental pollution compared to other human enterprises or industries. Researcher from [8] reported that air conditioners are shown to be the major energy users 57% in office buildings, followed by lighting 19%, lifts and pumps 18% and other equipment 6%.

Low-E, or low-emissivity, glass was created to minimize the amount of infrared and ultraviolet light that comes through your glass, without minimizing the amount of light that enters your home. Low-E glass windows have a microscopically thin coating that is transparent and reflects heat. The coating is even thinner than human hair. The Low-E coatings keep the temperature in your home consistent by reflecting the interior temperatures back inside. Low-emissivity (low-e) materials can be used to reduce energy usage in both opaque and transparent areas of a building. The main focus for low-

e materials is to reduce the heat transfer through thermal radiation. Furthermore, low-e materials will also influence on the daylight and total solar radiation energy throughput in windows according to [9].

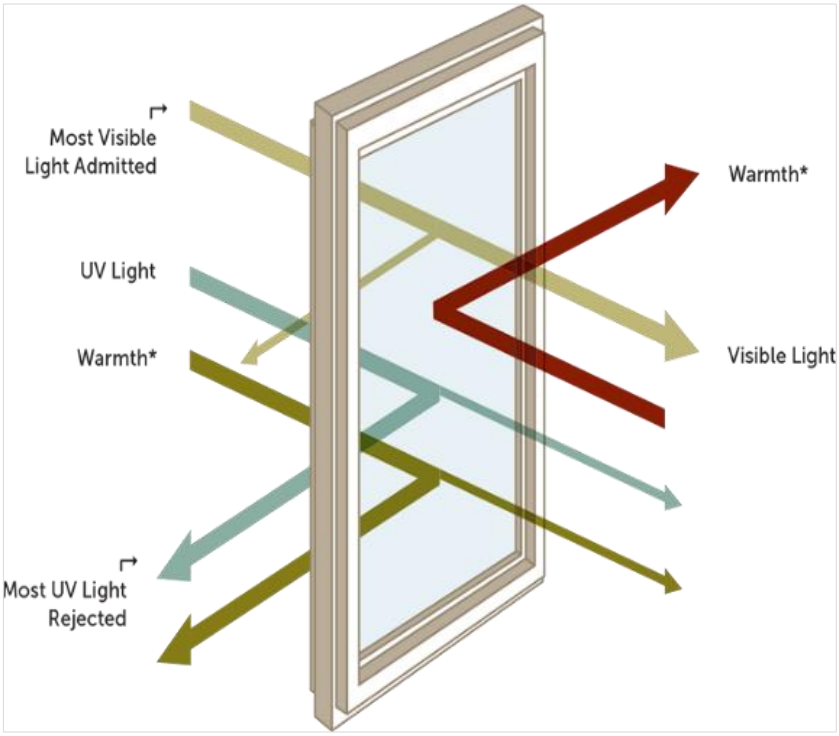

Figure 1: How low-E glass works

Figure 1 shows the concept of how low -E glass works towards different type of lights. Float glass is a sheet of glass made by floating molten glass on a bed of molten metal, typically tin, although lead and other various low-melting-point alloys were used in the past. This method gives the sheet uniform thickness and very flat surfaces. Modern windows are made from float glass. Most float glass is soda-lime glass, although relatively minor quantities of specialty borosilicate and flat panel display glass are also produced using the float glass process [10].

1.1.1 Comparison Between Low-E and Standard Float Glass

Researcher from [11] reported different type of window glass may have various features, which not only affect the amount of heat gain or loss through the windows by either solar radiation or conduction heat transfer, but also the effectiveness of using daylighting.

Table 1: The window glass types

Glass Types		U-value (W/m^2K)	Shading Coefficient	Solar reflectance	Visible Transmittance
Single	Clear	6.17	0.95	0.07	0.88
	Tinted	6.17	0.71	0.06	0.75
	Reflective	5.11	0.29	0.27	0.14
	Low-e	4.27	0.84	0.09	0.81
Double	Clear	2.79	0.89	0.13	0.81
	Tinted	2.79	0.71	0.09	0.74

Reflective	2.35	0.20	0.27	0.13
Low-e	1.99	0.85	0.15	0.74

For this study, a total of eight types of glass are chosen from **Table 1**. It can be seen that each type may be characterised by four indices of U–value, shading coefficient, solar reflectance and visible transmittance. It is noted that the term of "Clear" means there are no impurities added to the glass mix, while the "Tinted" means that the outer pane is tinted with inorganic materials to increase light absorption. "Reflective" means a metallic coating is applied to one surface of a pane in order to increase solar reflection, while "Low-e" indicates a metallic coating is applied in order to increase thermal infrared reflectance. In parallel, the "Single" is referred to as single pane of glass with thickness of the pane being 6 mm, while the "Double" is referred to as the double panes of glass with 12.7mm of air gap between and the thickness of a glass pane is 3mm.

Insight empowers architects and engineers to design more energy-efficient buildings with advanced simulation engines and building performance analysis data integrated in Revit [12]. Insight features like better building performance, whole building energy and daylighting analysis helps the study about building analysis. These tools were used to study the thermal and energy performance of a well-insulated test cell and to study the impact of a change of thermal mass and insulation thickness to figure out the advantages and disadvantages of each tool [13]. It was concluded that these BIM tools enabled the designers to easily experiment different design alternatives for the entire life cycle of the project, before they start implementing the final design solutions, saving time and money, while contributing for the achievement of more energy efficient buildings.

2. Methodology

To fulfil the objectives of the project, this part will explain how to manage the project with do arrangement and planned properly in the methodology. This part will discuss about the energy consumption between low-E glass and standard float glass window method and testing. This project will describe how to produce the energy consumption and energy cost result also to identify does the Low-E glass reduce the energy consumption through out the year. The software used for this project includes Autodesk Revit, Autodesk Insight and Autodesk Green Building Studio. As according to the review of the literature , it is important for these study to be conducted with the necessary methods. **Figure 2** depicted the methodologies'flow of these study.

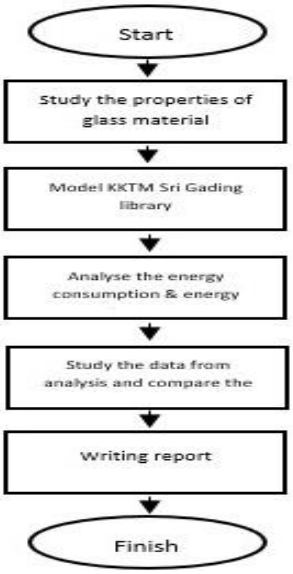

Figure 2: Methodology Flow Chart

2.1 Start of The Project

This study use the concept of green technology that is very important in ensuring the environment in a good condition which also the main point of this project is to compare the energy consumption between two types of glasses and identify does the Low-E glass reduce the energy consumption throughout the year.

2.2 Study The Properties of Glass Material

Low-E glass stands for low emissivity. Low-E glass is clear glass that has been treated with a metallic oxide coating that is nearly invisible to the naked eye. Though the coating is thin (1/100th the thickness of a human hair), it is extremely durable and creates a surface that reflects heat and blocks UV rays, while allowing visible light to pass through.

Annealed glass, also commonly known as float glass, is the basic flat glass product that is the first result of the glass manufacturing process. Annealed glass is cooled slowly under controlled conditions during production. This annealing procedure removes internal stresses from the glass. Annealed glass (also known as float glass) is the minimum standard for glass in the home.

2.3 Model Kolej Kemahiran Tinggi MARA Sri Gading's Library

In order to analyse the consumed energy, two different types of glass which is low-E and standard float glass is required to model KKTM Sri Gading library and the glass material will be inserted on the window then the data analysis can be done. The house will be designed and modelled in 3D by using Autodesk Revit.

(a) **(b)**

Figure 3: 3D view model of KKTM Sri Gading library on Revit software, (a) main entrance and (b) front area

2.4 Analyse The Energy Consumption & Energy Cost for the Library.

The software that will be used for this analysis is Autodesk Insight and Autodesk Green Building Studio. This software will analyse the energy usage and energy cost through out the year and the result will be shown on the software. Figure 4 depicted to the example of analysis study.

Figure 4: Example of energy analysis data

2.5 Study The Data from Analysis and Compare the Result

The data from the analysis will be observed and compare to find out the difference between Low-E glass and Standard Float Glass. Percentage of the difference will be calculated to find out how much does it save the cost through out the year when the Standard Float Glass was changed to the Low-E Glass.

Report will be made after calculations and analysis of the glass have been made. The purpose for this report is to explain about the whole thing in this project. The report will be inserted the result and conclusion for this project.

3. Discussion and Result

The result were obtained from the analysis that has been captured using software Autodesk Insight and Autodesk Green Building Studio. This section also discuss and evaluate the data that had been gathered. The data will be compared to identify which type of glass reduce the energy consumption through out the year.

3.1 Data of Analysing Standard Float Glass

Figure 5 shows data obtained by the Autodesk Insight shows the Energy Cost Mean of the standard float glass is 25.3 USD/m2/yr. While the **Figure 6** shows the result of how much energy was used through out the year. The total energy by standard float glass was 278 Kwh/m2/yr.

Figure 5: Data show cost of energy usage by library using standard float glass

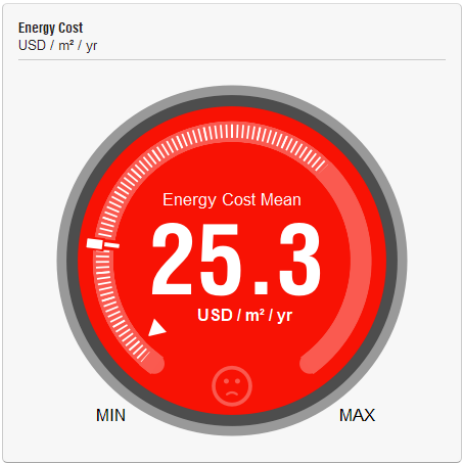

Figure 6: Data of energy usage by library using standard float glass

3.2 Data of Analysing Low-E Glass

Figure 7 shows data obtained by the Autodesk Insight shows the Energy Cost Mean of the Low-E glass is 25.0 USD/m2/yr which the value decrease 0.3 USD compared to the standard float glass. While the figure 8 shows the result of how much energy was used through out the year. The total energy by Low-E glass was 278 Kwh/m2/yr which the value was decrease by 4 Kwh compare to the standard float glass .

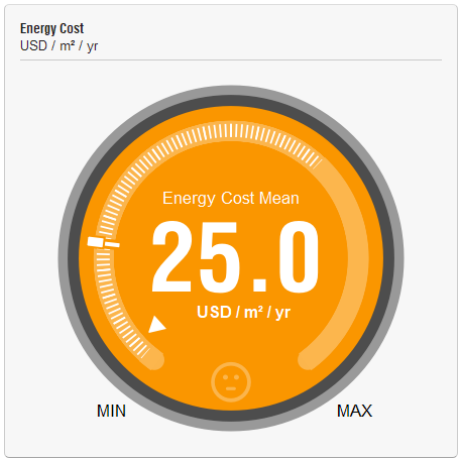

Figure 7: Data show cost of energy usage by library using Low-E Glass

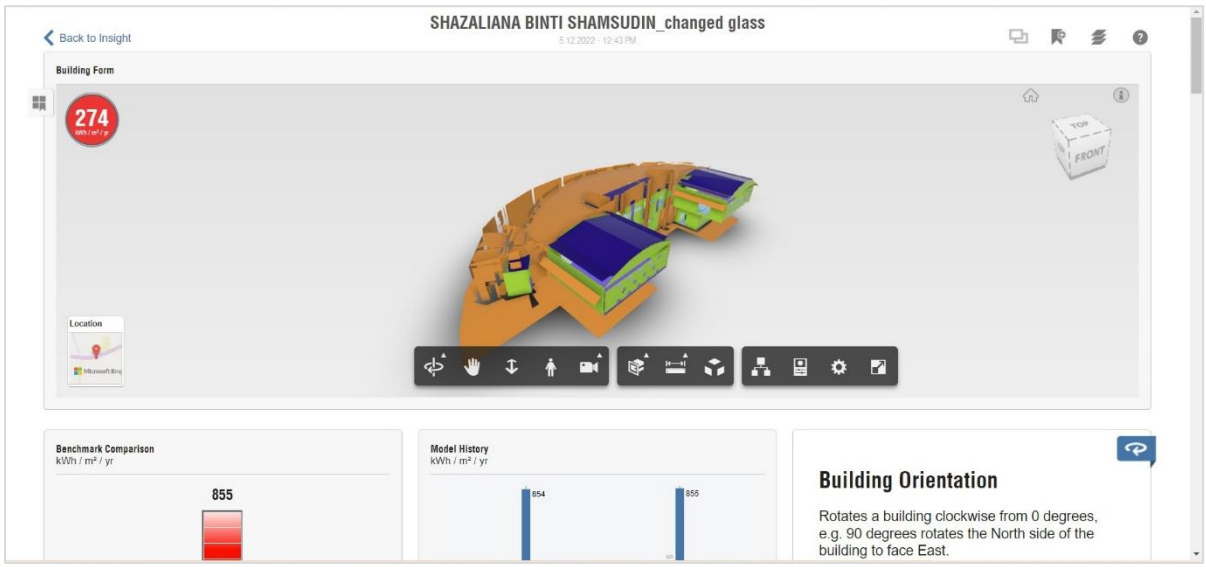

Figure 8: Data of energy usage by library using Low-E Glass

4. Conclusion and Recommendations

For the conclusion, all objectives are achieved and knowledge about the energy consumption was gained. For the analysis, comparison was made and the difference from the result was not significant. Changing the standard float glass to Low-E reducing the energy usage but not giving too many impact. For the recommendation, KKTM Sri Gading library's window can apply window film such as Heat Control Window Film as an improvement to reduce the reliance on air conditioning. Next, student can try another energy analysis software such as BIM Energy and IES Virtual Environment. Moreover, student can do energy analysis on different building on Kolej Kemahiran Tinggi MARA Sri Gading such as Dormitary or Academic Building.

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