# OPTIMIZING ENERGY EFFICIENCY: A COMPARATIVE ANALYSIS OF MATERIALS FOR TUBULAR SKYLIGHTS"


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## ABSTRACT

This research paper investigates the selection of the optimal material for tubular skylights, with a focus on the factors that influence this decision. Three common materials - acrylic, glass, and polycarbonate - are evaluated based on their heating demand, lighting output, and economic considerations. The study found that acrylic skylights have the lowest heating demand, making them the best option for achieving optimal energy efficiency. Additionally, the economic analysis revealed that installing a permanent skylight can provide significant cost savings in the long run, with a payback period of 10 years. The results of this study demonstrate the importance of considering multiple factors when selecting the most suitable material for tubular skylights and highlight the potential benefits of using permanent skylights for lighting and energy efficiency in buildings.


## INTRODUCTION

The use of tubular skylights has become increasingly popular in modern architecture, providing natural daylighting to interior spaces, reducing energy consumption and costs, and creating a more sustainable and comfortable living environment. However, selecting the appropriate material for these skylights is crucial to achieving optimal lighting output and energy efficiency. This requires a comprehensive analysis of various factors, including the heating demands, lighting output, and economic considerations of each material option, such as acrylic, glass, and polycarbonate. In this context, this report provides a comparative analysis of these materials and aims to determine the most suitable material for tubular skylights based on these criteria.

## METHODOLOGY

Choosing between acrylic, glass, and polycarbonate for use in tubular skylights will depend on factors such as the maximum Lumen each material can provide to the room (watts).

So:

- The First step:

The first step involves collecting data for each material.

- The Second step:

This step's purpose is to provide the heating and cooling demand analysis for the room.

- The Third step:

Do an economic analysis (payback period)

- The last step:

The final step comprises of determining the optimal material, factoring in the findings obtained from the comparative analysis.

## RESULTS AND DISCUSSION

We have the Room Parameters:

- The surface of this room that we are working on is: 3*3=9m2
- The material of the house is :

| | |
|---|---|
| *Limestone* | |
| *Thickness* | *150 mm* |
| *Thermal Conductivity* | *0.04 W/ (m.k)* |
| *The thermal resistivity* | 3.75 m²K/W |

| *Parameter* | *Value* |
|---|---|
| *ACH* | *1* |
| *Interior Temperature Ti* | *20 C* |
| *Exterior Temperature* | *-5 C* |
| *Mass flow of Infiltration, mi* | *0.012 kg/s* |
| *Mass flow of Ventilation, mv* | *0.72 kg/s* |
| *Specific heat of air, Cp* | *1000 J/kgk* |
| *The Volume of the room* | *36 3* |

The three materials that we will be comparing along with their respective dimensions are as follows:

- Acrylic tube skylights:

Acrylic skylights typically allow around 92% of light to pass through. This type can provide up to 700 watts for a surface of 0,5m * 0,1m.

- Glass tube skylights:

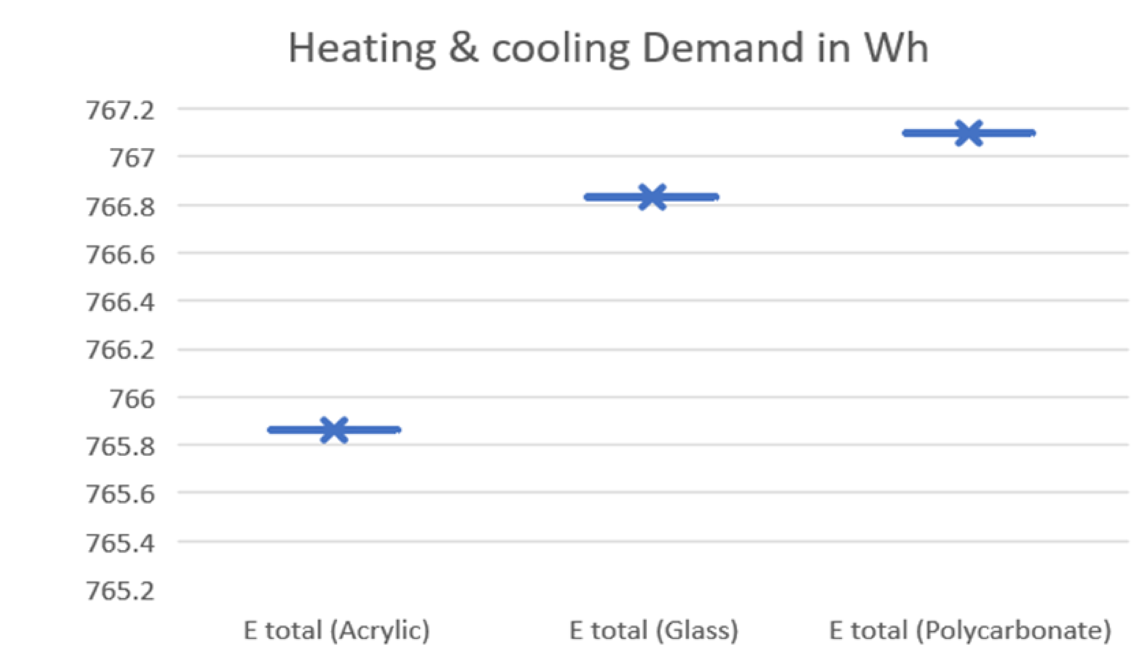
In general, glass skylights allow around 80-90% of light to pass through. For this type, the luminous intensity of 6500 lumens is comparable to that of 325 watts for a surface of 0.35m * 0.1m.

- Polycarbonate skylights:

Polycarbonate skylights typically allow around 85-90% of light to pass through. This type can provide up to 300 watts for a surface of 0.31 * 0,1m.

### DISCUSSION

Based on the heating demand, the acrylic tube skylights are still the best choice as they require the lowest heating demand of 765.8 Wh compared to both the glass tube skylights which require a heating demand of 766.8 Wh and the polycarbonate tube skylights which require a heating demand of 767 Wh.




For The Economic part :

To calculate the payback period, we need to compare the cost of the permanent skylight to the cost of using a normal electric lamp. a 10-20 year lifespan for the permanent skylight and an annual electricity cost of $100 for the electric lamp, we calculate the payback period as follows: Initial Cost = $1000, Annual Savings = $100, Payback Period = 10 years.

Therefore, the payback period for the permanent skylight would be 10 years. After 10 years, the cost savings from using the skylight instead of the electric lamp would have fully covered the initial cost of the skylight.

## CONCLUSION

In conclusion, after comparing the heating demands of acrylic, glass, and polycarbonate tube skylights, it was found that acrylic skylights have the lowest heating demand, making them the best choice. Additionally, the payback period for a permanent skylight was calculated based on the cost savings from using the skylight instead of an electric lamp.

The use of tubular skylights has become increasingly popular in modern architecture, providing natural daylighting to interior spaces, reducing energy consumption and costs, and creating a more sustainable and comfortable living environment.

In general, these results demonstrate the importance of considering multiple factors when choosing the most suitable material for tubular skylights, in order to achieve optimal lighting and energy efficiency while minimizing costs.

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