



FIBERGLASS AS AN INSULATION LAYER IN ROOF GARDENING

^a Hoorab Shoaib*, ^b Hafiz Aiman Jamshaid, ^c Hassan Sardar Cheema, ^d Umar Waqas

a: Department of Civil Engineering, University of Central Punjab, hoorabshoaib6@gmail.com
b: Department of Civil Engineering, University of Central Punjab, aiman.jamshaid@ucp.edu.pk
c: Department of Civil Engineering, University of Central Punjab umarwaqas1998@gmail.com
d: Department of Civil Engineering, University of Central Punjab,
Corresponding Author: hoorabshoaib6@gmail.com

Abstract - The purpose of this case study, document review is to create awareness among people about the benefits of fiberglass insulation and to recommend its use to reduce heat loss in summer as well as prevent heat loss in winter. A low-cost option is based on the use of a fiberglass insulation layer to ensure light barriers and insulation with reflective elements. Anyone can use it and install it on the roof of their house. The insulation layer is one of the essential layers of roof gardening. After providing insulation material to the roof building use less energy for heating and cooling. Just like in summer it prevents the building from overheating and in winter it prevents the building from getting too cold. So fiberglass insulation is the best way to protect the building from overheating. Fiberglass insulation makes building more energy-efficient. There is a lot of pollution in Pakistan cities like noise pollution, water pollution, and air pollution. Fiberglass keeps noise out of our homes. The major purpose of writing this paper is to make fiberglass more efficient and economic so that people can easily use it as insulation material in buildings to prevent heat and cold.

Keywords – Insulation layer, roof gardening, advantages of roof gardening, cost estimation.

1 INTRODUCTION

Roof gardening is simply defined as a garden on the roof of our houses. Roof gardens provide a lot of benefits. These include increment in oxygen, reducing pollution, cleaning the environment, reducing the heat of building, reducing the energy cost, and protecting our roof from moisture in the rainy season. With the increment in population, pollution is also increasing over time. People use different vehicles that produce harmful gases and these gases affect human health. Air pollution is a major problem today because it causes dangerous diseases in humans. So rooftop gardening is a great way to keep the air clean and free of hazardous gases. This study emphasizes knowledge based on journals, Various reports from research organizations, the Internet, and a visit to an Urban Landscape Architectural firm called eGarden. The visit to eGarden was essential to understand the benefits, components, materials, and alternatives (depending on the condition of a roof), and their cost. Roof gardening consists of some key components. The components include the following layers : Waterproofing, Protection layer, Lightweight fills and thermally insulating layers, Drainage, Filter layer, The soil layer, Vegetation, Irrigation, and Maintenance considerations. Roof gardening also provides fresh food, fruit, and vegetables.

Pakistan is one of the main victims of climate change. In Pakistan, the rapid population growth, and poor urban planning have resulted in an unhealthy and fragile environment in the major cities like Karachi and Lahore. Still, the Government of Pakistan does not have any specific policy provision or legislation that promotes urban agriculture or rooftop garden in particular. So roof gardening is the cheapest way to enhance gardening, reduce pollution and make the environment healthy. Roof gardening consists of different layers that protect our roof from damage. These layers involve the waterproofing layer, protection layer, insulation layer, drainage layer, and vegetation layer. Every layer has its purpose. These layers protect our roof in different ways. My aim is to discuss the insulation layer, its types, and its advantages. Insulation material is used to control the entrance of heat, cold,



and noise from entering the building. Now a day's people have a lot of options to use insulation material but the best insulation material is fiberglass.

Fiberglass is the best insulation material. It is made of special fine glass fibers. It has high tensile strength. It is used in different types of insulation materials like batts, rolls, and loose fills. It is also used in the form of rigid boards. Fiberglass can get molded into different difficult shapes. Just like we can use fiberglass in boats, roofing, and aircraft as well. We have a variety of materials that provide insulation to our home by creating small spaces, where air pockets can control the flow of heat. Fiberglass insulation does the same job. Fiberglass is made up of small, thin glass fiber that forms several air pockets that help control the flow of heat and cold [2]. So the main purpose of writing this paper is to inform people about the major benefits of fibreglass insulation which are saving of money and sound control. Installing fiberglass insulation helps you maximize your home's energy efficiency and saves your money each year by reducing your heating and cooling costs.

2 LITERATURE REVIEW

Below are the common types of insulation material,

2.1 Cellulose insulation

It is the oldest form of insulation that people can use in their houses. It is in form of loose-fill or blow-in insulation. Both these forms can be used in both old and new houses. Cellulose is fiber insulation. It is used in enclosed existing walls and unfinished floors. Now a day's mostly companies make cellulose insulation. It is primarily made from recycled newsprint. Mostly 75-85% of cellulose insulation is made by recycling paper [3].

2.2 Polyurethane foam

Polyurethane foam insulation is a new and effective method of insulation for buildings. Labour applies it by spraying, in this way it reaches the smallest of gaps. Its perfect installation is an important step. It provides the damage-resistant insulation of a house. It also improves living comfort and reduces bills.

2.3 Mineral wool

Mineral wool is also known as mineral fiber and mineral cotton. It is made of fibrous material which is formed by spinning molten mineral or rock material like slag and ceramics. It is used for soundproofing. Most people avoid it because it is an expensive type of Insulation. The high cost of mineral wool is its major drawback

2.4 Fiberglass

Fiberglass is the best insulation material. It is made of special fine glass fibers. It is used in different types of insulation materials like batts, rolls, and loose fills. It is also used in the form of rigid boards. Now a day's mostly manufacturers made medium and high-density fiberglass batt insulation because these have a higher R-Value than simple and low-density fiberglass batts, according to the U.S Department of Energy [2]. Most people use batt because it is a common type of batt. These batts are available in different thicknesses mostly in the range of 3 to 6 inches. Fiberglass is primarily used in all types of buildings to prevent or slow down the transfer of heat in summer and cold in winter. Fiberglass is a great option for homeowners who want to save money cheaply. The properties of fiberglass are as follows,

- Less in weight
- High strength
- Less brittle

Gel-coat with colored pigment

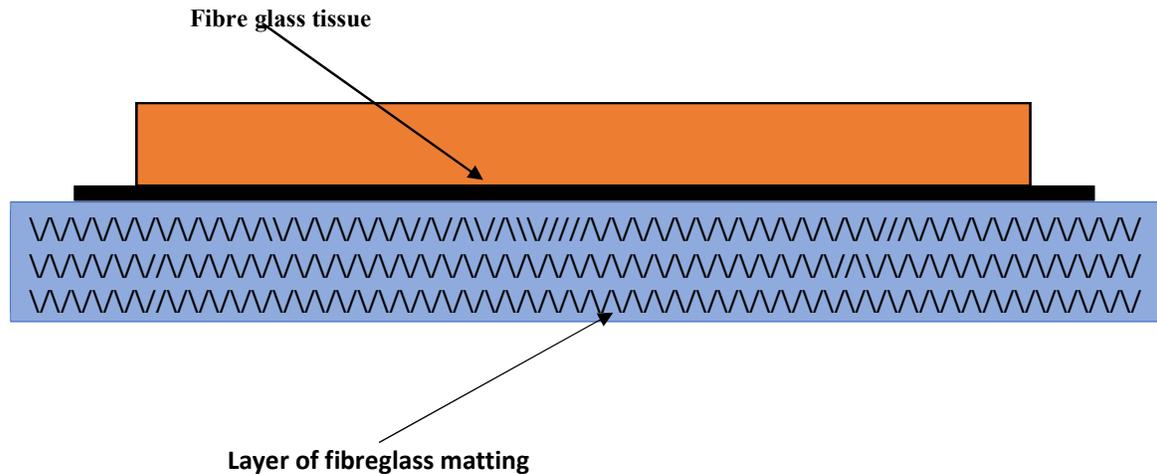


Figure 1 : Fibreglass insulation diagram

2.4.1 Types of fiber insulations

Nowadays manufacturers are making several different types of Fibreglass insulation. We've to carefully choose it according to our house area like if we're only looking to install insulation in the roof so it is different from wall insulation. There are three main types of Fibreglass insulation which are as follows:

2.4.2 Batt insulation

This is the most common insulation type used to insulate walls and ceilings. The insulation batts are long having circular shapes like rolls. These batts are made of a very fine layer of fine glass stands. It is a very thick blanket. Batt insulation can also be made from cotton or stone wool.

The hugest advantage of batt insulation is its lowest price. It is the least expensive way that we can use for our home insulation. So most people have to prefer this insulation for their houses. People can save their electricity bills most cheaply. Secondly, it is so easy to install. We can also install it in our houses by ourselves and in this way, we can reduce labor costs as well.

2.4.3 Loose-fill insulation

Loose fill is made of cellulose, fiberglass, and mineral wool. All these materials are produced by recycling the waste materials. It consists of small particles of fiber and foam. So we can easily conform them to any place in our house.

It gives us the following advantages

1. We can install it in any roof shape
2. It can provide better insulation by up to 22% [2]
3. We can achieve a higher R-value starting with a loose fill
4. Not too much expensive/cheap
5. Only 2 persons can install it easily

2.4.4 Rigid fiberboard insulation

It is mainly made of fiberglass or mineral wool material. It is mostly used for insulating air ducts in homes. It is also used in places where the temperature is high. Its range is 1 – 2.5 inches. It gives us the following advantages:



1. High R-value
2. It can control moisture
3. We can use it on both sides of the wall or ceiling
4. It prevents air leakage

3 METHODOLOGY

This study emphasizes knowledge based on journals, Various reports from research organizations, the Internet, and a visit to an Urban Landscape Architectural firm called eGarden. The visit to eGarden was essential to understand the benefits, components, materials, and alternatives (depending on the condition of a roof), and their cost. The thickness of the glass wool insulation has a great influence on the audile and thermal insulation value. The thickness of fiberglass insulation starts at 60 mm and increases to 20 mm (80, 120, 140, 160, 180,...)[6]. A minimum thickness of 160 mm is recommended to insulate a pitched roof. You can also work with two alternating layers to make sure there are no seams[6]. Insulation values and properties of blankets and fiberglass batts are;

1. High storage capacity : 800 J/kgK
2. Lamda value : 0.032 to 0.040 W/mL-K
3. Density : 25kg/m³
4. Diffusion resistance : 1

The important point about fiberglass insulation is its R-value and its thickness. The R-value tells us about the efficiency of insulation material. The greater the R-value shows the more efficiency of insulation material. Simply the R-value tells us about the resistance of heat transfer through the 2D barrier. These barriers can be a layer of insulation, a window, or a complete wall or ceiling. If you want to know about the perfect type of fiberglass insulation so it depends on the thickness of the batt. According to the US Department of Energy reports that if you want to use 3.5-inch thick fiberglass batt so it will offer an R-value of R-15 at (68 -80 Rupee)[1]. If you want to use 8-inch thick batt so it'll offer an R-value of R- 25 at (74 -90 Rupee) per square foot [1].

TYPES OF INSULATION	R-VALUE
BATTS	3.1 – 3.4 per inch of thickness
LOOSE FILL (WALL)	3.7 - 4.3 per inch of thickness
RIGID FIBROUS	4 – 5 per inch of thickness

Now if we talk about the synthesis of fiberglass, it is made of limestone, soda ash, feldspar, nepheline syenite, and silica sand. Silica sand is commonly used as a precursor to glass in fiberglass. The limestone and soda ash are used to help reduce melting temperatures. We need to carefully add all the ingredients to make the perfect quantity and quality of fiberglass. During the formation of Fibreglass insulation, all the materials are sampled at various steps in the process of formation just to maintain the quality. One of these steps is the batch of raw materials is fed into the melter then the glass fiber leaves the machine and last, the final cured fiberglass insulation product appears from the end of the production line. Most manufacturers of fiberglass insulation follow different ASTM testing procedures to adjust, measure and optimize the product's sound barrier performance and noise absorption. Manufacturers efficiently control their physical properties by adjusting the manufacturing variables like binder content, bulk density, fiber diameter, and the thickness of fiberglass insulation.

3 COST ESTIMATION

However, fiberglass insulation is not too much expensive. Most house owners can easily install this in their houses. The average cost to install fiberglass insulation starts at (175 – 320 Rupees) per square foot [5]. Installing fiberglass insulation in our houses reduces our electricity bills and saves our money. Its cost also depends on its installation method.



5 RESULT

Make rooftop gardening a trend in Pakistan as its every layer offers many benefits. In this paper I have only explained the insulation layer and its benefits. If we talk about other layers then each layer is providing individual benefits. The biggest advantage of these layers is that you can use them individually on the roof of your homes. Now if you talk about insulation layer then following are the results that people will get after installing it.

5.1 Energy Efficient and saves the bills

Normally fiberglass insulation can reduce our electricity bills by up to 40-50%. It can also reduce noise pollution. Fiberglass insulation reduces heat in the summer and cools your roof.

5.2 Environment friendly and flexible

30 % Fiberglass is made from recycling waste material. This factor makes it environment-friendly. People can easily install it on their roofs because it is flexible. Its flexible nature reduces its cost.



Figure 2 : Installation of fibreglass insulation in the walls and ceilings [9]

5.3 Easily available and less expensive

Fiberglass insulation is easily available in the market. Manufacturers mostly made batts and these are available at low prices in the market. The low cost of fiberglass insulation makes it the most useable insulation material.

5.4 Incombustibility

Fiberglass is a mineral material, it is incombustible in nature. It does not support a flame. It does not emit smoke or toxic products when exposed to heat.

5.4 Practical implementation



In this paragraph I've briefly explain the practical implementations of fibreglass as an insulation material. The best thermal barrier for industrial gaskets is a high temperature insulating material. Because fiberglass is enduring, safe and offers superior insulation, fiberglass is one of the widely preferred materials in industrial gaskets. It also provides safety of machinery and professional manpower. Its biggest practical use is to wrap pipes and tanks because it can protect cold and hot surfaces from -60°F to 650°F. Fiberglass grating is used in bottling lines and wineries. Due to the salt water of the sea, the docks rust and fiberglass is used to protect it[8].

6 CONCLUSION

Fiberglass insulation is one of the cheapest types of insulation. Now the weather is very hot in summer and very cold in winter. People use air conditioners to reduce the heat from their homes in summer and this increases their electricity bills. So the best solution to this problem is to install fiberglass insulation in homes. It resists heat waves in summer and keeps our homes cool. It also reduces electricity bills by up to 50%. Plus, it's easy to install and less expensive. Nowadays, with the increase in population, noise pollution is increasing day by day. The atmosphere is getting hot and humid. Therefore, the installation of fiberglass insulation in your home also reduces noise pollution.

ACKNOWLEDGEMENT

The authors would like to thank every person/department who helped thorough the research work, particularly the CE department. The careful review and constructive suggestions by the anonymous reviewers are gratefully acknowledged.

REFERENCES

- [1] <https://www.attainablehome.com/the-r-value-of-fiberglass->
- [2] <https://www.forbes.com/advisor/home-improvement/what-is-fiberglass-insulation/>
- [3] https://en.wikipedia.org/wiki/Cellulose_insulation
- [4] <https://www.buildwithrise.com/stories/fiberglass-insulation>
- [5] <https://www.homeadvisor.com/cost/insulation/>
- [6] <https://www.insulation-info.co.uk/insulation-material/fibreglass-insulation>
- [7] <https://blog.gltproducts.com/blog/the-value-of-mineral-wool-in-fabricated-pipe-insulation-0-0-0-0>
- [8] <https://phelpsgaskets.com/blog/fiberglass--types-properties-and-applications-across-industries>
- [9] <https://blog.certainteed.com/2021/09/benefits-of-fiberglass-insulation/>