



# SUSTAINABLE HOUSING: AN MATERIAL STUDY AND DESIGN IDEAS FOR ENERGY-EFFICIENT HOUSES.

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**Abstract:** This work aimed to develop an eco-friendly home. For so long studies going on how to improve house efficiency, In this paper, various sustainable material details have been shared with different techniques for improving overall house efficiency. The climate change conversation in India has picked pace. The current generation consistently rates the environment and climate change as the two issues they worry most about. All industries and sectors have now consciously been working towards reducing the carbon footprint and even the real estate sector is doing its bit. Even governments are now providing various incentives to push eco-friendly development. To put things in perspective, buildings contribute to one-third of global greenhouse gas emissions and consume 40 percent of the world's energy. In addition to this, the construction sector in India is responsible for about 22 percent of our total CO2 emissions.

So it is very important to reduce pollution from homes and make them more eco-friendly and energy-efficient, This paper will add more informative ideas and tricks to make homes more eco-friendly, In this paper, various sustainable material details have been shared, so that the least impact can be done on the environment during construction, after construction various tricks are there to reduce waste, improve indoor air quality, improve energy efficiency or many more. Those tricks are shared in this paper.

**Index Terms - Sustainable building, Eco-friendly, Construction, Environmental.**

## I. INTRODUCTION

Many works have already shown regarding sustainable materials, A sustainable home is an efficient home that's built or retrofitted in a way that respects resources, optimizes energy and water use, and will last longer with quality systems. Sustainable homes use low impact, use high-performance materials. because of the high-quality materials, systems break less and last longer, they waste less.

Various studies, it has been concluding sustainable housing includes Building materials and methods, Decorating choices, Insulation, Windows, Heat, ventilation and air-conditioning, Lighting, Appliances Plumbing fixtures, Use of smart systems, energy generation from solar and wind, and Your habits when it comes to regular maintenance and green cleaning.

In this paper, various materials have been listed based on their sustainable properties and uses. Materials are chosen from various research and test results. Most of the materials are chosen for cement brick homes because research shows that wood homes are more eco-friendly than brick homes, so this research paper focuses more on sustainable materials for brick homes. Materials like fly ash brick, recycled aggregate, M Sand, Ground-Granulated Blast-Furnace Slag, and many more are an example of sustainable materials. details about these materials will be shared in this paper.

Before you build a new home or renovate an existing one, think about investing in green energy. You can save energy and money while improving the comfort and health of your home. Consider a renewable energy system that can provide power, hot water, or space heating and cooling during the planning process. This research looked at a variety of ideas and tactics to reduce waste, increase efficiency, and ensure safe indoor air quality.

Sometimes small changes can make a big difference like choosing a light color on the exterior wall help to reduce the indoor temperature by 5-8°C. similarly, Indore plants improve air quality. This paper is to highlight the benefits of sustainable home design by reviewing the principles and their practical applications.

## Sustainable Construction Material Alternatives

### 1) Fly ash brick

Fly ash brick is a type of masonry block that uses fly ash as a building material. It is composed of Class C or Class F fly ash (a by-product of coal combustion) and water that has been burned at a temperature of about 1,000 degrees Centigrade. This type of brick is sometimes called "self-cementing" because of the high concentration of calcium oxide in Class C fly ash. Fly ash clay brick is commonly used in structural walls, pillars, and foundations.

Advantages of fly ash bricks:

- Fly ash bricks are lightweight, so suitable for multi-story buildings because as the height of the buildings increases, the stress and pressure on the foundations and structure increase. Due to the lighter bricks, this stress and constraint are multiple decrease.
- These bricks absorb less heat and they are better than clay bricks, So best for the hot climate.
- Due to the high resistance, there is practically no breakdown during transport and use. plus The compressive strength is very high and they are less porous.
- These bricks do not require soaking in water for 24 hours, sprinkling water before use is sufficient. Water leakage through bricks is reduced due to less water penetration.
- No fossil fuel is needed for the production of fly ash bricks, so no greenhouse gas emissions. So they are environmentally friendly thus allowing the individual to take a step toward sustainable development.
- Their consumption of mortar is low, their dissipation is only 1% against clay bricks which is about 10%.

Disadvantages of fly ash bricks:

- Some fly ash bricks from a power plant are usually suitable for concrete, so it is very important to use only high-quality fly ash to avoid negative effects on the structure of the building.
- The strength of the mechanical bond is low but can be corrected using marble waste.

### 2) Recycled aggregate

Recycled aggregate might be utilised as an alternative. One of the consequences of the construction boom is the increased use of natural aggregates. Simultaneously, the building industry's ongoing expansion produces significant amounts of construction trash, This has a detrimental impact on the environment and leads to social problems in the surrounding area. Today's construction sites generate a massive amount of waste. The data reveal that waste levels are high and that the majority of potentially helpful demolition debris, such as concrete waste, is discarded without being effectively utilised. The availability of rubbish as a recycling source allows for sustained yield since recovered aggregates may be employed as a waste management solution. for example, a country like India will produce 2.3 billion tons of construction and demolition waste by 2026, according to the World Bank's 2012 report. India has a limited area and the second-highest population in the world, so cannot afford the waste of natural resources. So India needs to start recycling and reusing C&D waste to protect the environment and natural resources.

The advantages of utilising recycled aggregates The following are the advantages and disadvantages of utilising recycled aggregates.

- 1) Industrial and economic benefits: Recycled aggregates can help reduce the cost of materials used in concrete manufacturing, cutting construction material prices and improving profitability for businesses. Furthermore, the emergence of new recycling enterprises as a consequence of the manufacture of recovered aggregates from waste will result in the creation of new jobs for the people.
- 2) Recovery and protection of the environment and natural resources:- The loss of ecosystems, which serve as natural habitats for flora and fauna, is a major concern. In addition, dust pollution from quarries has become a societal problem in nearby communities. The use of recycled aggregates can help to reduce the industry's dependency on natural aggregates while simultaneously ensuring aggregate safety and long-term growth. Recycling has the ability to minimise the quantity of building and demolition trash dumped in landfills, hence extending the landfill's usable life. Landfills.
- 3) Potential savings: Recycling construction and demolition trash to produce recycled aggregates may help you save a lot of money. Recycled aggregate is significantly less costly than natural aggregate. The price of aggregates has continued to grow due to the depletion of natural aggregates. The availability of recycled aggregates as a substitute can help market stability and regulation. The use of recycled aggregates can assist save money on construction expenditures over the life of a project. Recycling reduces transportation costs, waste transport costs, and fines or penalties for depositing rubbish in landfills, all of which save money on trash disposal. Furthermore, recycling aggregates lowers the cost of importation.

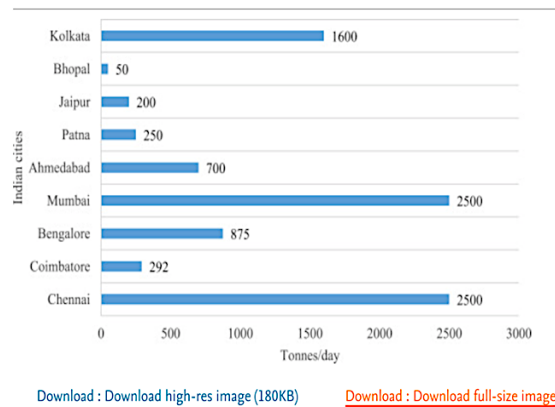


Fig. 1. C & D waste generation in various Indian cities (tonnes per day) (BMTPC, 2018, CPCB, 2017).

Figure 1: Construction waste in various Indian cities.

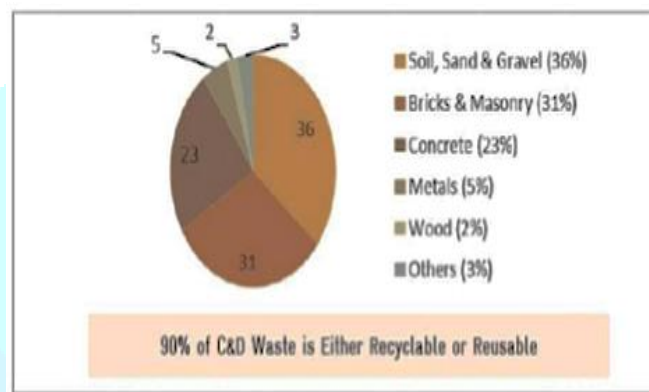


Figure 2: Percentage waste which is recyclable

### 3) Ground-Granulated Blast-Furnace Slag

GGBFS (Ground-Granulated Blast-Furnace Slag) is a by-product of iron blast furnaces that may be used to make mortar and concrete.

Ground-granulated blast-furnace slag is made by soaking molten iron slag in water or steam to create a vitreous granular product, which is then dried and ground into a fine powder. This slag is regularly tapped as a molten liquid, and it must be promptly soaked in enormous amounts of water if it is to be employed in the production of GGBS. Quenching increases cementitious properties and produces coarse sand-like particles. After drying, the "granulated" slag is crushed into a fine powder.

Typical chemical composition:

Calcium oxide = 40%

Silica = 35%

Alumina = 13%

Magnesia = 8%

Typical physical properties:

White color

Specific Gravity: 2.9

Apparent density 1200 Kg/m

Fineness: 350 m/kg

Uses of GGBS

The main use of GGBS is in ready-mixed concrete, and it is used in a third of all ready-to-mix deliveries in the UK. Specifiers are well aware of the technical advantages that GGBS confers on concrete, including:

- Better ease of work, manufacture of placement locker, and compaction.
- Lower increase in temperature at an early age, reducing the risk of thermal cracking in large castings. Elimination of the possibility of harmful internal responses like ASR
- High resistance to chloride inlet, reducing the risk of reinforcing corrosion
- High resistance to attack by sulfates and other chemicals
- Significant sustainability benefits.

On a weight-for-weight basis, GGBS is utilized as a straight replacement for Portland cement. Replacement levels for GGBS range from 30% to up to 85%. Typically 40-50% is used in most cases. For concrete structures on the ground with higher early strength requirements, the replacement rate would usually be 20-30%. For underground concrete structures with average strength required, the replacement rate would typically be 30-50%. The replacement rate for solid concrete or concrete structures with rigorous temperature rise criteria is generally 50-65 percent. For special concrete structures with higher durability requirements, i.e. corrosion resistance for marine structures, sewerage treatment plants, etc. the replacement rate would usually be 50-70%.

### **The Electrical Wire Used At Home**

Green cables and wires are now possible thanks to modern manufacturing processes. There are two options for accomplishing this. One is to concentrate on the material, while the other is to concentrate on the production process. The majority of the materials used in manufacture are ecologically friendly. Biodegradable and cutting-edge materials, such as a halogen-free envelope, are used. Presentation suggestions to help you choose the right wires/cables for your house:-

#### 1. Select the high-quality material

In electrical lines and cables, aluminium and copper are often utilised. Only copper wires should be utilised in your residence when it comes to cables. Use multi-stranded threads instead of single-stranded threads. Above all, the electrical wire must be ISI certified, which indicates that it is of good quality. Quality wires will be safe and long-lasting, allowing you to protect your property while saving money. Use red, yellow, and blue insulation for all three phases. The ground wire is threaded in green, whereas the neutral wire is threaded in black. Neutral wires are normally grey or white, whereas three-phase wires are usually black, red, and blue. The green wire also functions as a grounding line.

#### 2. Examine the insulation of the wires

The finest solution is a three-layer electrical wire. The first layer is water-resistant, the second layer is heat or high-temperature resistant, and the third layer is flame retardant. The non-melting insulation must also be able to endure a temperature of +100o C. This component is essential for guaranteeing the electrical safety and security of your house.

#### 3. Select the appropriate cable size

The choice of cable size is influenced by three things. First and foremost, there is voltage control. Second, there's the short circuit rating, and then there's the current load capacity. Before selecting a cable size, consider the following criteria! Short circuit rating and voltage control are frequently overlooked. This viewpoint may endanger your property and cause damage to the cable.

### **Solar Panel System**

Solar panels, solar electrical panels, photovoltaic modules Solar panels, photovoltaic modules in the frame to be safe. Solar panels use daylight as a measure to generate direct current. In a normal house the monthly electricity consumption is 1000 kWh which can achieve thorough of 26 to 30 solar panels (320 watts per solar panel). Although the service life of solar panels is limited. Its longevity is 25 to 30 years,

The solar panels are divided into two.

1. Electric solar panels
2. Solar hot water board.

Photovoltaic panels:-

Photovoltaic panels are converted into electrical energy per day. Photovoltaic (PV) is directly converted from sunlight to electricity. The terms "light" and "volts" are each related to light and electricity. Photovoltaic cells are made of daylight-absorbing semiconductor materials, and often crystalline urns. Photovoltaic cells have been obtained in clocks, watches, calculators, and other machinery. This can be the same as the communication lamp. Solar energy with advanced home and public grid photovoltaics are also tied. Its electricity providers available energy utility grids also.

PV batteries are often combined into about 40 battery module panels. Photovoltaic workbench panels are grouped, into about 10 modules.

Installation:-

In the northern hemisphere, many photovoltaic panels are placed in the south of the sun house, while in the southern hemisphere, many photovoltaic panels are placed on the northern solar house. It can be placed on the pole floor, although the municipal law homeowner's union is forbidden.

Solar power generation is only generated when the sun is shining, so consumers still tie solar energy to the public grid, solar panel production is insufficient when the grid gives additional power. it called solar system grid system.

Solar panels (materials):-

- Monocrystalline solar panels.
- Polycrystalline solar panels.
- Thin-film solar panels (amorphous).

Table 1: Monocrystalline solar panels and polycrystalline solar panels

Parameters	Monocrystalline	Polycrystalline
Efficiency	High	Low
Appearance	Black color panels	Bluish color panels
Temperature Coefficient	High	Low
Lifespan	Up to 25 years	Up to 25 year

#### Off-Grid vs. Grid-Tied Systems:-

The cost of solar power generation is still determined by being connected to the grid and off the grid. Off-grid photovoltaic power plants would have cost between \$45,000 and \$85,000 per kWh. With energy-saving meters, photovoltaic panels are especially easy to use with other equipment, which is more cost-effective, so it is more humble than later, solar energy is the basis of the original construction of the house. Off-grid systems require batteries to store electricity, and a charge regulator to protect batteries that are undercharged and charged without charge.

Details and varieties of off-grid systems:

- Small, special solar energy is often used in RV energy, illuminated, cabin, equipped with the portable power system. Fully self-sufficient solar systems make it possible for fossil fuels and power companies to be free.
- In the whole system of the punishment, two inverters are used to ensure that the air conditioner and the like must be supplied with power, and when an inverter is not used or must be held, an inverter can supply power.
- This system requires a large battery storage capacity, so the evil gas is solar energy, and electricity can be obtained.
- The cost of household batteries, between \$80 per kWh and \$200, makes it an expensive component of autonomous solar systems.

Off-grid pros:

1. No electricity charges.
2. Utility network self-sufficiency also.
3. Where there are no power lines, it will be cost effective.

Off-grid cons:

1. The initial investment is higher than the network connection system (Grid-tied system)
2. High Cost of maintaince system components such as battery and charge regulators.

Grid-tied pros:

1. If the solar system cannot generate enough electricity, it is provided with a backup power supply
2. If the solar energy is generated by electricity or the net amount of capital.
3. less Initial investment than off grid system

Grid-tied cons:

1. Certain incentives require contractors to show adequate certification and competency in areas related to grid-tied installation.
2. Some reliance on the power grid
3. In the case of a grid power outage, you may not be able to utilise your solar system.

#### Green Wall or Vertical Garden

The Hanging Gardens of Babylon, one of the ancient world's seven wonders, introduced the notion of the green wall in approximately 600 BC. The Romans used to drag vines, on garden trellises and on the walls of the villa, climbing roses were the symbols of secret gardens

Advantages of the Green Wall:

- 1) Economic advantages  
Plants placed around buildings can help to improve their structural integrity by mitigating the effects of harsh weather. Green walls reduce the effects of climate change on building facades while simultaneously increasing the useful life of the structure. It also aids in the reduction of UV (ultraviolet) light degeneration of structures. One of the financial benefits of green walls is that it lowers the cost of paint supplies. In warmer climes, it has been stated that the energy consumed to cool a building can be lowered by 28%. Greenery may help a home's value rise.
- 2) Aesthetic advantages  
The green wall is frequently utilised to improve the visual value of a city. The visual contrast and respite provided by vegetation can help to break up the monotony of a densely built metropolitan landscape. In the city's unforgiving concrete jungle, the plants also provide city inhabitants a sense of connectedness to Mother Nature. Aside from that, the natural landscape adds components of natural size and aesthetic attractiveness to buildings and streets, as well as a seasonal indication. Furthermore, the softness of the flora, as opposed to the firm concrete surface, can offer visual relief to smooth walls. Green walls and plants may hide unsightly building barriers.
- 3) Improving the thermal efficiency of the structure  
Plants may offer cooling in the city through two processes: direct shade and evaporative transpiration. The plants used in green walls provide shade to the building, and the amount of shade provided is determined by the density of the plants in

the green walls. The temperature in and around the building is reduced when the building is shaded. By insulating the structure, green walls ensure that daytime fluctuations are kept to a minimum. Green walls have been shown to lower building surface temperatures by up to 15.2 degrees Celsius.

4) Better health and happiness

Visual and bodily interaction with plants has been shown to provide immediate health advantages. A green wall can have calming benefits, resulting in less stress, faster recuperation for patients, and increased disease resistance. Vertical gardens absorb noxious gases and volatile chemicals released by contemporary conveniences, lowering the risk of cancer, stroke, depression, heart disease, and respiratory illness.

5) Improving the quality of indoor air

Plants have long been thought to be efficient extractors of gaseous and particle pollution from the urban environment's atmosphere. By filtering airborne particles in their leaves and branches and absorbing gaseous pollutants through photosynthesis, they help enhance air quality. They use their leaves and branches to filter airborne particles and absorb gaseous contaminants. VOCs, or volatile organic compounds, are absorbed by both plants and the planting media through biofiltration.

Other advantages of the green wall include:

- Reduce the internal ambient temperature by 5 to 10 degrees in summer by installing them from the outside.
- Plants are far from soil-borne diseases.
- More plants within a limited space
- Helps save water.
- Helps hide less attractive parts of the landscape.
- Provides excellent air circulation for plants.
- Can provide privacy and disguise unattractive points of view.
- In a vertical garden, the most usually utilised plants are: For full sun, use Lavendula, Thymus, Rosmarinus, or Salvia; for gloomy areas, use Begonia, Arum, Davallia, Asplenium, or Fuchsia.

The green wall consists:

- i. Plant material: Plant selections are site-specific and determined by light availability, location, size, color, texture, and growth patterns.
- ii. Planting matrix: A way for plants to take root and anchor on a vertical surface. These can be in the form of organic matter, such as soil, or inorganics such as plastics or synthetic fibers.
- iii. Irrigation system: To provide plants with water and nutrients for good growth.
- iv. Waterproof barrier: To keep moisture away from the building's exterior.
- v. Structural support: For the support, the structural load of the vertical garden system on the façade of the building.
- vi. Lighting: Provide plants with sufficient lighting for photosynthesis and promote natural growth habits. Lighting can be provided by a natural (sun) or artificial source (metal halide, high-pressure sodium and LED lights).
- vii. Plants suited for vertical garden choices should be determined by local climatic conditions.
- viii. Plants should have a compact growth port that can produce a dense, thick cover. Plants having a short life cycle and a shallow fibrous root system should have a short growth port. Depending on the region, plants should be able to tolerate full sun or partial shade.



Figure 3: Vertical Garden

## Energy Efficiency

Sustainable roofs increase the energy efficiency of the building envelope and reduce a building's energy demand on space conditioning and therefore greenhouse gas emissions, thanks to direct roof shading, evapotranspiration, and enhanced insulating properties.

Sustainable roofs are particularly effective in reducing the entry of heat into the building in summer. The roof is shaded and cooled by plants. The insulation value is both in the plant and the growing medium. The water in the plants and growth media evaporates, cooling the roof even further. The growth medium also serves as a thermal mass, storing and releasing solar energy throughout the day. Green roofs are less effective in preventing heat from leaving the building in winter due to the limitations of the same thermal mechanisms.

Roofs with a high thermal mass and a moderate insulation value are considered durable. These combined properties significantly reduce daytime temperatures at the boundary between the green roof and the building structure (The daily maximum and lowest temperature range are referred to as daylight temperature).

The daytime temperature range for a conventionally built hot-roofed waterproof layer can be very large; for example, On a hot summer day, a typical coating of waterproof bitumen may reach temperatures of over 50°C, while dropping to slightly about 0°C at night. A roof with a low level of insulation under the waterproof layer will allow the space below to heat up quickly in hot, sunny weather. The increase in internal temperatures on the floor under the roof helps to make the interior environment of the building uncomfortable for the occupants of the building.

Overheating can lead to increased use of air conditioning, which will lead to an increase in energy consumption. In cold weather, the reverse effect occurs, resulting in an increase in energy consumption due to an increased need for underfloor heating right beneath the roof. The energy used for heating and cooling has a financial and environmental impact.

The green roof has the same energy suppliers as a conventional roof, but it has the additional energy consumers of evapotranspiration and photosynthesis. Plants absorb solar radiation for photosynthesis, Plants have a higher albedo (reflectivity of solar radiation) than many standard roof surfaces.

Unlike a conventional roof, the green roof is a living system that reacts to the environment in several important ways:

Water is stored in the substrate and is used in evapotranspiration by the vegetation layer; this process uses a considerable proportion of the incoming solar radiation compared to a non-green roof the green roof has a large thermal mass, which stores energy and delays the transfer of heat to or from the building fabric Heat trapped inside urban canyons can be avoided from source areas by turbulent transfer. However, these heat losses on the streets can be reduced when it is possible to obstruct wind circulation in urban areas. In this case, ventilation in urban open spaces is of great importance. Most of the solar radiation was intercepted and captured by the dense foliage of the plants, except a very small part transformed Vertical Gardening: 531 into chemical energy by photosynthesis is a new concept from the modern era. The absorbed solar radiation is then modified into latent heat that converts water from the liquid into gas, resulting in a low leaf temperature, a lower surrounding air temperature, and higher humidity through the evapoperspiration process. In other words, CIP can be mitigated by these mechanisms. Plants can adjust the climate through their unique processes of shading, windbreak, evapotranspiration, and photosynthesis.

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As the air travels over the plants on green roofs, small pollutants floating in the air are filtered. The surface areas of plants tend to catch airborne pollutants. It is washed away in the growth media below by the rain. Photosynthesis allows plants to absorb gaseous contaminants, which they then sequester in their leaves (later become humus). According to studies, metropolitan roadways with trees contain 10 to 15% fewer dust particles than identical routes without trees.

A treeless street in Frankfurt, Germany, for example, had an air pollution count of 10 to 20,000 dirt particles per liter of air, whereas a tree-lined street in the same neighbourhood had less than a third of that quantity. According to tree research, a grass roof with 2,000 m<sup>2</sup> of undisturbed grass (100 m<sup>2</sup> of leaf area per m<sup>2</sup> of the roof) could remove 4,000 kg of dirt from the air each year (2 kg per m<sup>2</sup> of the roof). Because the bottom half of the grass layer is too dense to be in direct touch with air, this estimate is likely excessive. Even if the quantity was a tenth of what the trees could remove, 10 m<sup>2</sup> of grass roof could still remove 2 kilograms of soil each year, which is a substantial amount.

### Temperature regulation tricks:

Because modernization does not always succeed, it is best to plan ahead of time.

- As a natural screen against the heat, use leaves and plants on the balcony or outside the window.
- When deciding where to put the windows, consider the direction of the wind.
- Paint the roof with lime or another heat-resistant substance to decrease heat transmission from the exterior and avoid cool air loss.

- Ventilation begins late at night, not early in the morning. By closing the windows and blinds, air can be used to chill the premises under the rule of ventilation.
- Outside the home, provide shade with hanging garments.

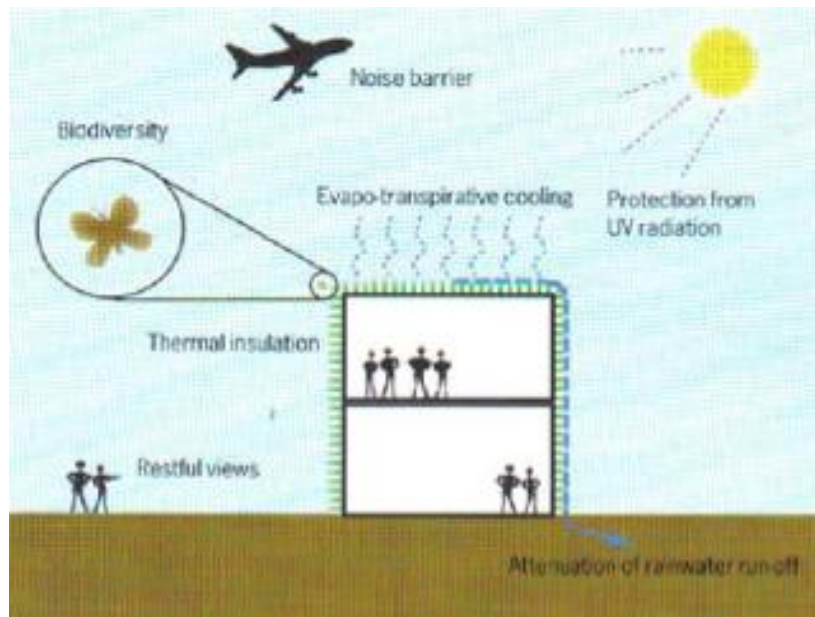


Figure 4: Eco - roof benefits

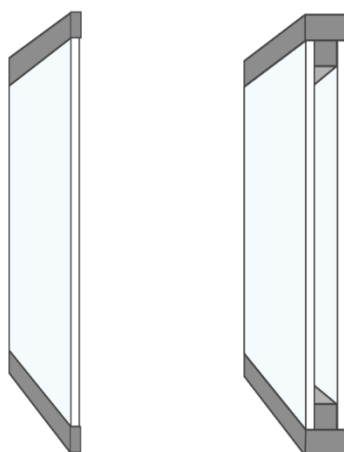
#### Window and glass variation for maximum sunlight and energy efficiency

##### Single glazed windows:

A single pane of glass refers to a window with a single layer of glass or a single pane of glass inside the window; most of the windows in a standard house are single glaze. Simple glazed windows can be in a variety of glass types, including annealed glass, tempered glass, or weak. If you live in a cooling climate, such as Queensland, then the optimal type of glass or window configuration for energy efficiency is Simple glass windows with tinted glass - or super tinted - on the outside of the window.

##### Double glazed windows:

Double-glazed windows use two separate pieces of glass that are separated by a central gap, usually filled with argon gas. The argon layer acts as an insulating barrier and reduces the conductive properties of each piece of glass (the ease with which cold air, sunlight, or moisture can pass through the glass). If you live in a heating climate, such as Victoria or Tasmania, then the best type of glass or window specification for energy efficiency is: Double glazed windows with low glass e configured on side three of the insulated glass unit.



Single Glazed Window

Double Glazed Window

Figure 5: Single and double Glazed window



### The 3 Rs of Waste Management

Many have heard of Reduce, Reuse, and Recycle, but not everyone cares enough about integrating them into everyday life while some are absolutely not initiated into the golden rules/guidelines for proper waste disposal. The golden rule is that the less you buy, the less there is to dispose of.

3 Rs Waste Cure:-

Everyone hears less, uses it, and reaps it, and non-human beings are enough to worry about it, or they will use the law of gold/the law to deal with it well. This is not exhausted. In the golden law, the less you buys, the less it is disposed of.

Tips to get started.

Reduce:

- Avoid disposable products such as paper trays, razors, paper towels, gloves, etc. On the contrary, it is necessary to buy durable items that do not need to be repurchased.
- Carry on shopping bags or jute bags to avoid plastic bags.
- Bulk minimum/minimum There are recyclables to dispose of less.
- Switch several news, not subject to flyers, with fewer laptop card coins.
- Switch to organic diapers and sanitary napkins.

Reuse:

- Reuse has broken furniture and makes new DIY items from bottles such as trays, hangers, and toilet racks.
- Heavy damage to the sac, Maundy coat cushion cover.
- Reuse fruit peel as a mask wet tea powder for faces.
- Reuse old utensils, cloth bags, gold containers, and box storage.
- Compost organic waste infill and sell it for community gardening

Recycle:

- When buying, please find the recycling symbol on the bag, indicating whether the product is recycled from the recycled material.
- Its scrap collector/recirculation provider. Monthly distributor, the company collects dry paper and newspaper plastic waste.
- Its recipient option is the electronics store to dry battery electronics.
- Use eco-friendly options such as biodegradable ornaments, food utensils, and gifts.

### Summary and Conclusion

This work was aimed at developing an ecological house. For so long, ongoing studies on how to improve the efficiency of the house, and various durable material details have been shared with different techniques to improve the overall efficiency of the house. The conversation about climate change in India has gained momentum. The current generation constantly considers the environment and climate change as the two issues that concern them the most. All industries and sectors have now consciously worked to reduce the carbon footprint and even the real estate sector is doing its part. Even governments are now offering various incentives to promote environmentally friendly development. To put things in perspective, buildings contribute to a third of global greenhouse gas emissions and consume 40 percent of the world's energy. In addition, the construction sector in India is responsible for about 22% of our total CO<sub>2</sub> emissions.

It is therefore very important to reduce the pollution of houses and make them more ecological and energy-efficient, In this document, various details of sustainable materials have been shared, so that the least impact can be made on the environment during construction, after construction, various tricks are there to reduce waste, improve indoor air quality, improve energy efficiency or many others. Many works have already shown when it comes to sustainable materials, A sustainable home is an efficient home that is built or modernized in a way that respects resources, optimizes the use of energy and water, and will last longer with quality systems. Sustainable homes use low-impact, high-performance materials. due to high-quality materials, systems break less and last longer, they waste less.

He concluded that sustainable housing includes building materials and methods, decorating choices, insulation, windows, heat, ventilation and air conditioning, lighting, plumbing fixtures, use of smart systems, solar and wind power generation, and habits for regular maintenance and green cleaning.

Materials like fly ash can be used in many ways such as in bricks and tiles. this material is environmentally friendly, cheap, durable, and strong in force. de same, porotherm smart bricks, it is also a very environmentally friendly and sustainable material. aggregates play an important role in concrete and mortar, so recycled aggregates are a very environmentally friendly choice for construction. It also helps reduce construction waste. River sand has been a very integrated part of the construction industry, but it destroys the ecosystem, M sand which a quite sustainable option for modern construction.

GGBS (Blast Furnace Dairy Granulated Grinded) is a very useful alternative for cement. It can solve many problems like the cement plant population, GGBS also needs less water for an obligation compared to cement. In reinforced concrete, steel plays an important role, so here is aluminum, it needs more research before use, but scientists have tested aluminum as a reinforcement in concrete. Bamboo is a durable material for constriction, bamboo can be used in tiles, roofs, walls, and furniture, there are endless uses for this golden plant.

Paint is a very vital part of any home, it shows the final product, but it also affects people's health. There are eco-friendly options for murals that are harmless to humans and the environment. There are important things solar panels, vertical gardening, rooftop gardening, smart window, and electricity-saving appliances are a part that makes your home smart, help reduce energy consumption make a home more eco-friendly and sustainable.

Waste management is a very important thing in this modern world, things like reuse and reduction play an important role in reducing waste, and decomposition is also a good idea for waste management. things like water collection and organic plants are a bit complicated but can solve many problems. so considering them in a house is a good idea.

Before designing a new home or remodelling the existing one, consider investing in energy efficiency. energy and money can be saved, and your home will be more comfortable and durable. The planning process is also time to look at a renewable energy system that can provide electricity, water heating, or space heating and cooling. You may also want to explore your options for financing an energy-efficient home and other details about it. In an existing home, the first step is to conduct a home energy survey to find out how your home uses energy and determine the best ways to reduce energy consumption and costs. Sometimes small changes can make a big difference like choosing a light color on the outer wall helps reduce the indoor temperature by 5-8°C. Similarly, the Indore plant improves the air quality.

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