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EFFECTS OF NATURAL CONDITIONS ON BUILDING DESIGN

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ABSTRACT

Natural conditions may be referred to as physical and biological aspects of the environment that exists independently of human influence.

These includes: soil, topography, vegetation, rainfall, wildlife, humidity, temperature etc.

These conditions have caused an early deterioration or damage in most buildings in our society, hence depreciating the value of such buildings and putting the lives of the inhabitants in danger.

This research work is designed to expose the various natural conditions in our environment and portray architectural solutions to each and every one of them so as to maintain the functionality and durability of the buildings in our society.

At the end of this research work, one will be able to know how to overcome conditions like high rainfall and high temperature, sloping topography and all other natural conditions using simple design and architectural techniques.

INTRODUCTION

The earth contains thousands upon thousands of natural environments. In geography, we look at the **spatial distribution** of these environments, and how humans interact with these. The natural environment plays a crucial role in sustaining life on Earth. From

providing essential resources such as water, air, and food, to supporting biodiversity and regulating the climate, the natural environment is vital for the well-being of all living organisms. This research paper aims to explore the significance of the natural environment from various perspectives, including ecological, social, and economic. By examining the importance of preserving and conserving natural ecosystems, we can gain a deeper understanding of how human activities impact the environment and the potential consequences for future generations. Furthermore, this essay will also discuss the challenges and opportunities in promoting sustainable practices and the potential benefits of integrating conservation efforts into our daily lives. Ultimately, the objective of this essay is to raise awareness about the importance of the natural environment and to inspire individuals and communities to take action in preserving and protecting the planet for generations to come. The natural environment of a particular **location** is made of living and non-living components, and the conditions of that particular environment. The **inter-relationship** between these components produces the variety of natural environments, as well as the impact humans can have on these environments.

Living components include: Plants, Animals, Fungi and bacteria

Non-living components include:

- Landforms, such as mountains and valleys
- Water features, such as rivers
- Geological features, such as rocks and soils
- Atmospheric features, such as: sunlight and heat; rain and snow

DEFINITION OF WEATHER

Weather is the state of the atmosphere during a given time at a given place. It is affected by several different atmospheric factors and the location.

Factors Affecting Weather

There are different types of elements affecting the weather. They are:

1. Temperature

It indicates how fast air molecules and atoms are moving in the atmosphere. If the atoms are moving fast, the temperature is high, but if they are moving slow, the temperature is low. Temperature thus determines the hotness and coldness of a place, thus affecting the weather.

2. Humidity

It refers to the amount of water vapor or moisture in the air. Tropical regions have high humidity, whereas arid regions have low humidity. It is always better to balance the amount of

water vapor in the air. Humidity also determines if there is a chance of dew, fog, or precipitation and thus is often the cause of change in the weather.

3. Precipitation

There are different ways in which water returns to the Earth's surface from the atmosphere. Rain, snow, sleet, ice, hail, and drizzle are the different forms of precipitation. The temperature in the air determines the type of precipitation. For example, if the temperature is sufficiently low, water droplets will freeze and fall as hail or snow.

4. Wind

The movement of air near the Earth's surface depends on the uneven heating of the Earth. Since wind carries moisture, it is the cause of rain, and the type of wind blowing can change the weather and climate in a place.

5. Clouds

They are the primary carrier of moisture and thus the cause of precipitation. The amount of clouds often determines the amount of precipitation in a place and thus is one of the leading causes of change in the weather.

6. Atmospheric Pressure

It is the weight of the air pushing on the Earth's surface. Low-pressure systems bring clouds and precipitation, whereas high-pressure areas are usually associated with cool temperatures, dry weather, and clear skies.

Different Types of Weather Conditions

There are six main types of weather found on the Earth's surface. They are:

Different Types of Weather

1. Sunny

It is a condition where the sky is clear, and no clouds are blocking the sunlight. The temperature during such weather is warm. Sunny weather is typical in the spring and summer seasons but is also found in autumn and winter.

Sunny weather encourages outdoor activities such as playing games and sports and going on a vacation. Such condition also helps plants to produce their food.

We should use suns cream to protect our skin from sunburn and drink plenty of water to keep our body hydrated.

2. Cloudy

Such conditions happen when clouds obstruct the sunlight on its way to the Earth's surface. Cloudy days can be cold or warm, depending on the humidity, which may or may not accompany the rain. It is most common in autumn and winter but also in spring and summer. Usually, cloudy days are hot in summer and cold in winter.

We often use terms like 'partly cloudy' and 'overcast' to describe the number of clouds that covers the sky. When the condition is partly cloudy, only a few visible clouds are in the sky, partly covering the sun. However, if clouds entirely cover the sky and the sky looks gray and dark, it is an overcast condition. Such weather indicates heavy rain accompanied by lightning and thunderstorm. The World Meteorological Organization describes this weather when clouds cover at least 95% of the sky.

Cloudy weather prevents us from outer outdoor activities. We are not encouraged to go outdoors during cloudy weather as thunderstorms and lightning often accompany it.

3. Windy

Wind can be defined as air in motion. It happens when there is a pressure imbalance between two regions. Air moves from a high-pressure region to a low-pressure region. We experience the motion of air as wind.

Windy weather is often accompanied by lightning and thunderstorm, destroying lives and properties such as agricultural fields, roads, and transport.

Windy condition is commonly seen in the mountains, where the weather becomes hot during the day compared to the plains. This temperature change causes the warm air to rise, and the cool air from the plains rushes to take its place, causing the wind to blow. This phenomenon reverses at night, causing the wind to blow in the opposite direction.

We must stay indoors as much as possible during windy weather for our safety.

4. Rainy

This type of weather happens when the sky is covered with clouds. Thus, cloudy weather (either partial or overcast) can become rainy weather when the clouds are large, causing much precipitation.

There are certain hilly regions where one can see a rainy day continuously throughout a week or even months. At the same time, in some other parts, such as deserts, one can hardly encounter rain throughout the year.

Rain is beneficial for plants since they get water to produce their food. One must wear a raincoat or carry an umbrella outdoors during a rainy season.

5. Snowy

They are usually seen in winters when the precipitation in the clouds freezes and becomes snowflakes due to low temperature. The precipitation finally falls as snow instead of rain.

Snowy weather is cold but allows many fun activities such as ice-skating, sledding, throwing snowballs, and making a snowman.

We must wear woolen clothes such as jackets, socks, and gloves to protect ourselves from the cold.

6. Foggy

Although not very common, they can happen anywhere, anytime. Fog develops when water vapor condenses and stays in the air, forming clouds close to the ground.

They are found to occur commonly in the late autumn, winter, and early spring. Fog reduces visibility; thus, vehicle drivers are advised not to drive in such conditions. Also, fog increases the humidity level and thus causes more problems for humans.

Types of Severe Weather

Apart from the six main types of weather conditions, sometimes the weather can become more dangerous and cause natural disasters costing the lives of millions. They are:

- Thunderstorms are often the result of overcast conditions. Thunderstorms include rain, hail, storm, thunder, and lightning. They can be partly or very severe.
- Tornadoes develop from thunderstorms when warm air collides with cold air, creating a narrow, rotating column of air. Similar to thunderstorms, tornadoes also vary in severity.
- Hurricanes and Typhoons are high-speed spiraling storms that are long-lasting. Such storms develop over water and can produce winds of 200 mph. Storms from the north of the Pacific Ocean are called typhoons, while storms from the north of the Atlantic Ocean are called hurricanes.
- Winter Storm occurs in cold temperatures, causing rain to freeze and create snow and ice. Winter storms form after much snowfall.
- Sand Storms happen when the strong wind moves dust and sand, taking them to another place.
- Blizzards are a type of harsh snowstorm that occurs for long periods. Blizzards also accompany strong winds, heavy snowfall, and sub-zero temperatures.
- Flood occurs due to heavy rain over a long time period.
- Droughts are long periods without rain or precipitation and can happen worldwide. Droughts can last for months to years and can cause forest fires and famines.

The Impact of Weather Conditions on Construction Projects

Weather conditions play a significant role in construction projects, influencing project timelines, work efficiency, and overall project outcomes. From extreme temperatures and precipitation to high winds and storms, various weather elements can significantly impact construction activities. This article explores the impact of weather conditions on construction projects, highlighting the importance of planning, mitigation strategies, and adapting to weather challenges to ensure successful project execution.

Delays in Construction Timelines:

Unfavorable weather conditions can cause delays in construction timelines. Extreme temperatures, heavy rain, snowfall, or storms can impede progress, restrict access to the site, and affect the productivity of construction crews. Proactive planning, including factoring in potential weather-related delays in project schedules, allows for appropriate adjustments and helps manage client expectations.

Safety Risks for Workers:

Adverse weather conditions pose safety risks to construction workers. High winds, lightning, icy surfaces, or extreme heat can jeopardize worker safety. Implementing robust safety protocols and providing appropriate personal protective equipment (PPE) is essential to minimize the risks associated with weather conditions. Regular monitoring of weather forecasts and implementing temporary work stoppages during severe weather events help ensure worker well-being.

Effect on Material Storage and Quality:

Weather conditions can affect the storage and quality of construction materials. Exposure to moisture, extreme temperatures, or prolonged sunlight can cause damage to materials, such as wood, cement, or steel. Proper storage measures, including covering materials, providing insulation, or utilizing climate-controlled storage facilities, help maintain material integrity and prevent deterioration.

Impact on Equipment and Machinery:

Weather conditions can impact the performance and longevity of construction equipment and machinery. Extreme temperatures, humidity, or exposure to water can affect the functionality of electrical components, engines, or hydraulic systems. Regular maintenance, protection from adverse weather, and implementing preventive measures help mitigate potential equipment breakdowns and prolong their lifespan.

Soil and Foundation Challenges:

Weather conditions, especially heavy rain or freeze-thaw cycles, can pose challenges to soil stability and foundation integrity. Excessive rainfall can lead to soil erosion, soil compaction issues, or slope instability. Freeze-thaw cycles can cause soil expansion and contraction, affecting foundation structures. Implementing proper drainage systems, soil stabilization techniques, and

utilizing suitable foundation designs help mitigate weather-related soil and foundation challenges.

Mitigation Strategies:

Mitigating the impact of weather conditions on construction projects requires proactive planning and implementation of strategies. This includes closely monitoring weather forecasts, incorporating weather contingency plans into project schedules, and allocating additional resources to expedite construction during favorable weather windows. Flexibility in scheduling and utilizing weather-resistant construction techniques can help minimize the effects of adverse weather.

Adapting to Weather Challenges:

Adapting construction techniques to weather challenges is crucial for project success. For example, in regions prone to high winds, utilizing modular construction methods or incorporating wind-resistant design features can help maintain construction progress. In extreme cold climates, employing insulated forms or utilizing winter construction methods allows work to continue efficiently. Adapting to weather challenges ensures that construction projects can proceed even in adverse conditions.

5 Ways That Climate Affects Building Design

1. Windy Climates Can Cause Up-Lift and Racking

Climates in cold regions, plains, and some coasts receive more days of windy conditions and faster winds. Buildings have to withstand constant pressure and be resistant to weathering over the years from grainy debris. Two types of winds that building designers accommodate are up-lift and racking.

Up-lift is when the high-pressure wind strikes a pocket of low-pressure on the leeward sides of walls and roofs. This wind causes the building's interior to compensate for its pressure outward. Responsive building designers will adjust how roofs attach to the house walls on these low-pressure sides. Hurricane and tornado-prone areas need this the most.

Racking happens when powerful winds strike a building at an uneven angle. These winds destroy roofs, doors, frames, and sidings. While this occurs in tornado and hurricane-prone regions, it also affects exposed, cold climates. Buildings in these areas need higher quality construction and more maintenance.

2. Rainy Climates Threaten Water Damage and Flooding

Buildings in rainy climates are at additional risk of water damage through poor connections between walls and roofs. These areas are usually chimneys and plumbing outlets where the caulking fails or the foundation where the soil quits absorbing excess moisture.

Most sealants like caulking expand, desiccate, and erode with time, creating gaps for rain damage. So, these areas need frequent repairs or designs that don't use sealants. Rain-heavy climates threaten foundations and flood buildings once the soil gets saturated. Sometimes the

foundation can even shift. In these environments, builders test the soil type and compensate with materials and angles that help move water around the building.

Compensating for Rainy Climates Affecting Building Design

Moderate regions that become wetter will have to develop similar designs as regions with more experience with the conditions. They'll need to give more care to chimneys, vents, and the stability of the foundation. Some older buildings lack steel support in the foundation, and soil saturation lets enough water into the concrete for the foundation to crack and shift.

3. Snowy Climates Affect Roofing and Heating

Light snowfall can weigh as much as 15 pounds (6.80 kg) per cubic foot, and heavy snow can weigh 50 pounds (22.68 kg) per cubic foot. Regions like high elevations and latitudes expect snow every year and build according to that added wet weight. After all, with enough feet on top of a roof, hundreds of pounds can stack over each square foot. Roofs can otherwise sag and collapse. These regions tend to have steeper roofs to both distribute the snow's weight and to discourage it from collecting too much in the first place. The plus side is that buildings require less heating because snow provides insulation along the walls.

Compensating for Snowy Climates Affecting Building Design

Like the shift of racking winds coming from meridional atmospheric flows, locations farther south can face more snow than they've experienced in many decades. When this happens, roofs collapse, and the locality fails to deal with the damage or the people suffering. Plumbing and utilities will also be more vulnerable. Building designers will have to be more thoughtful toward roofs and plumbing insulation.

4. Hot and Sunny Climates Require Certain Building Materials

Overly dry buildings can age faster than buildings subjected to a better balance of conditions. Roofs wear down in hot climates more than in the cold. Attic fans and vents help circulate otherwise trapped air under the roof. The circulation helps wood from drying out. It also moderates the temperature elsewhere in the building. Colors also matter in hot, dry climates. Darker colors absorb more heat than lighter colors. Some hot climates are also cold climates, like high deserts. In these regions, buildings have to cope with wide temperature swings that cause building materials to expand and contract, often unevenly. Builders in these regions choose materials that disperse expansion and contraction at resisting deterioration in these conditions.

Compensating for Hot and Sunny Climates Affecting Building Design

Moderate regions transitioning into having more hot conditions will have to change several designs. The temperate climate zones tend not to worry about building color or which materials deal better with extreme temperatures or wetness versus dryness. They'll have to make more practical decisions during the design process.

5. Dry Climates Cause Shrinking and Cracking

Drought conditions shrink and crack everything from soil to caulking to wood. Shrinking destabilizes buildings and leaves them vulnerable to a switch to wet conditions and seismic activity. Builders deal with drought-prone climates by designing foundations to hold stress in different areas.

Changing Drought Climate Conditions Affect Building Design

If their region is getting dry, building designers will need to look at foundations and roofing in areas like the American Southwest. Some wood is better at dealing with extreme dryness when others crack. Foundations will likely need steel support in case the foundation cracks.

How does humidity affect buildings and why is it important?

High Humidity levels can cause extensive damage to buildings and create an unhealthy environment for occupants.

According to the Environmental Protection Agency (EPA), too much moisture in a building can cause significant damage including:

Mold, bacteria, wood-decaying molds, and insect pests, like termites and carpenter ants.

Corrosion of building components, including structural fasteners, wiring, metal roofing, flooring adhesives, and roofing adhesives.

Water-soluble building materials returning to solution.

Warping, swelling, or rotting of wooden materials.

Damage to brick or concrete during freeze thaw cycles and by sub-surface salt deposition.

Damage to paint and varnishes.

Reduction of thermal insulation insulating value (R-value).

A building's air humidity level can play a huge role in the transmission of airborne viruses and droplets.

A study by the U.S. Institute of Medicine Committee on Damp Indoor Spaces and Health found an association between exposure to damp indoor environments and detrimental health effects including: Upper respiratory symptoms, Cough, Wheeze, Asthma symptoms in people with asthma.

Excessive dryness in a building also causes the same issues: building damage and health problems. Low humidity causes wood to crack and increases the possibility for electrostatic discharges, which is an unsafe environment to have near electrical components. Allergies and illnesses are easier to catch in a low humidity environment because small particles can stay airborne for longer amounts of time in low humidity levels.

What is the purpose of humidity control in buildings?

Humidity control helps extend the life of buildings and keeps employees within facilities healthier and more comfortable. Controlling the moisture and dryness of levels of a facility can fight off mold and corrosion and protect your employees from adverse health effects.

What is the ideal indoor relative humidity level for commercial buildings?

According to The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) you should consider maintaining the indoor relative humidity (RH) of your facility at 40-60%. Dictionary.com defines relative humidity as, “the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.”

Why is 40-60% the magic range?

Dry air below the suggested minimum of 40% has been shown to reduce health immune system function, increase transmission of some airborne viruses and droplets, increase the survival rate of pathogens, and decrease the effectiveness of hand and surface disinfection practices. Wet air above 60% increases the likelihood of allergens and causes mold and mildew. At the same time, humidity levels about 60% make the environment feel hot and sticky, which makes a working space uncomfortable for employees, thus causing decreased productivity.

How do I lower the humidity in my commercial building?

One of the most effective ways to reduce humidity and control the moisture content in your building is by following the ASHRAE climate zone map guidelines when designing your HVAC system (more on this later). An additional method to consider is installing cost-effective high volume, low speed (HVLS) fans in your facility.

HVLS fans lower the moisture and humidity levels in a building. As added bonuses, the fans also produce better air quality and make a more comfortable environment for your employees, increasing productivity.

HVLS fans can help you maintain the ideal RH level and increase the indoor air quality in your building when paired with proper ventilation practices. If you keep the windows and doors open in your facility, HVLS fans are able to circulate the clean outdoor air throughout your facility and eliminate stagnant, unhealthy indoor air. HVLS fans also mix warmer ceiling air with cooler floor air, which increases the evaporation rate, thus reducing moisture in your building.

Effects of Acid Rain on the Environment

Though acid rain might seem like a big terminology, there are some adverse effects of acid rain on the environment. In fact, the effects of acid rain can only be negative, there have not been any positive effects recorded yet. these negative effects include

1. Air Pollution

Acid rain causes air pollution, which has a variety of negative effects on health. Sulfur dioxide and nitrogen oxides in the air can either create respiratory disorders or worsen existing conditions. Breathing becomes difficult for persons who have respiratory conditions such as

chronic bronchitis or asthma. Even smaller particles can be produced by the same pollutants that cause acid rain. These particles can cause health issues or exacerbate ones that already exist when they enter a person's lungs. Nitrogen oxides also contribute to ground-level ozone.

This ground-level ozone can potentially permanently damage the lungs and cause respiratory issues like pneumonia and bronchitis. People's health impacts, which are a concern, are not brought on by acid rain but rather by breathing in these tiny particles of ozone. People can swim or walk in acidic lakes without experiencing any greater health risks than they would in clear water.

2. Affects Aquatic Life

Certainly, acid rain affects aquatic life, this is because the acidity of water bodies is rising, which prevents some creatures' eggs from hatching and can even bring death to some aquatic organisms altering their population ratios and ecosystems.

3. Affects Transportation

Currently, it costs a lot of money for the aviation and rail industries to repair the corrosive damage caused by acid rain. Additionally, acid rain corrosion has caused bridges to collapse in the past. Building stonework and mortar are destroyed by acid rain (especially those made out of sandstone or limestone). It creates a powdery product that can be washed away by rain after reacting with the stone's minerals.

4. Effects on Ecosystems and Plant Growth

Acid rain immediately harms living things in their habitat, and species that are restricted to aquatic environments are especially at risk since they are unable to migrate to more alkaline waters. While some species can withstand high levels of acidity, others cannot tolerate even very little pH shifts. For instance, some local fish populations became extinct in the 1900s as a result of the increased acidity in various lochs in Galloway, Scotland. Acid rain can also harm the waxy outer layer of plant leaves, and the weaker, higher mortality risk plant results from ineffective photosynthesis. Due to their extreme sensitivity to acid rain, the first loss of key species in an ecosystem can lead to the eventual loss of other species that relied on the key species for their existence, which may cause the collapse of entire ecosystems.

5. Damage to Vegetation Increased soil acidity destroys vegetables, leeches nutrients from the soil, slows plant growth, poisons plants, causes brown patches on tree leaves, hinders photosynthesis, and permits the spread of pathogens through damaged leaves.

6. Dilapidating Impacts on Forests

Forests can suffer great harm from acid rain. Acid rain that penetrates the earth can disintegrate nutrients that trees require for good health, like calcium and magnesium.

Aluminum is also discharged into the soil by acid rain, which hinders trees' ability to absorb water. Higher-elevation trees in mountainous areas, such as spruce or fir trees, are more vulnerable because they are exposed to acidic clouds and fog, which contain more acid than rain or snow. Their leaves and needles lose vital nutrients to the corrosive clouds and fog. Due to the lack of nutrients, diseases, pests, and harsh weather can more easily harm trees and forests.

7. Lake and Stream Damage

The pH of most lakes and streams would be close to 6.5 in the absence of pollution and acid rain. However, acid rain has significantly lowered the pH levels of numerous lakes and streams in the northeastern United States and several other locations.

Furthermore, aluminum deposited into the soil eventually finds its way into lakes and streams. Unfortunately, aquatic animals, including phytoplankton, mayflies, rainbow trout, smallmouth bass, frogs, spotted salamanders, crayfish, and other organisms that are a component of the food web, might die as a result of this increase in acidity and aluminum levels.

When it rains heavily or in the spring when the snow is starting to melt, this issue can get significantly worse. Epistolar acidification refers to these kinds of occurrences.

8. Damages to Buildings and Objects

Buildings, statues, monuments, cars, and other items can all suffer damage from acid rain. Stone statues' value and attractiveness can be diminished by the chemicals in acid rain, which can cause paint to peel and the statues to start looking old and worn out.

9. Affect Soil and Rock

Acid rain can erode limestone rock-based land surfaces because calcium carbonate in the limestone combines with the acidity to produce calcium sulfate or calcium nitrate, both of which are soluble substances.

The process also releases carbon dioxide gases. The soluble substances will eventually be carried by water into river systems where their concentration may be high enough to harm aquatic life.

Additionally, the reaction will release carbon dioxide into the atmosphere, causing and exacerbating global warming.

Acid rain's effects on pH also affect how much of various heavy metals are present in the nearby water.

For instance, in a more acidic environment, calcium becomes less readily available, resulting in a lower concentration of calcium in the water, whereas aluminum is more easily released from the soil into the surrounding water.

Both the lowering of some metals that may be essential to an organism's survival and the increase in the concentration of some heavy metals in the water have the potential to be poisonous to sensitive aquatic organisms.

10. Water Cycle is Affected

Once acid rain has reached the Earth's surface as precipitation from clouds, a significant portion of it is carried to rivers and lakes via groundwater flow or surface runoff.

Here, it combines with the existing water and makes the water body more acidic. This pH reduction is especially pronounced when a lot of rainwater enters a relatively small water body. When temperatures are low enough, acid snow can also be descended from the atmosphere in addition to rain. This type of acid deposition can be very harmful to the environment since it builds up on the ground before abruptly melting and releasing a significant amount of corrosive water into the surrounding area.

The Role of Architects and Urban Planners in Climate Adaptation

Architects and urban planners play a pivotal role in shaping the built environment to be resilient to the impacts of climate change. Their involvement is crucial in the development of adaptive strategies that not only mitigate the effects of climate change but also enhance the sustainability and livability of urban areas. In the context of Nigeria, where diverse climatic zones and socio-economic conditions pose unique challenges, the role of these professionals is even more critical. One of the primary responsibilities of architects and urban planners in climate adaptation is the integration of green infrastructure into urban designs. Green infrastructure, which includes elements such as parks, green roofs, and urban forests, serves as a vital tool in managing urban heat, improving air quality, and enhancing stormwater management (Sturiale, 2019). These natural systems act as buffers against extreme weather events, such as floods and heatwaves, which are becoming more frequent and severe due to climate change. By incorporating green infrastructure into urban planning, architects and planners can reduce the vulnerability of urban populations to these climatic extremes. In addition to green infrastructure, architects and planners must prioritize the use of sustainable building materials and construction techniques.

CONCLUSION

Our natural environment affects our pattern of design in architecture. This is because a high temperature may result to a wider or longer window to improve ventilation while a high rainfall will require a high pitch roof for a faster run off of rain water to prevent leakages at the roof. The

different types of soil structure and texture will require different types of foundations, usually, pile foundation, strip foundation, pad foundation, and raft foundation. A high wind speed will require a parapet wall to prevent the roof from pulling off. All these are some basic ways in which our natural environment could affect our architectural design. Some finishing materials like plaster of Paris may be used internally to reduce the temperature of the interior of a building hence making it more comfortable for the inhabitants of such a building.

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