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# Journal of Vibration Engineering

ISSN:1004-4523

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# Energy ConservationinBuildingsusingBiomimicry

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**Abstract:**Thedesignandoperationofbuildingshaveasignificantimpactonenergyconsumptionandgreenhousegasemissions.Traditionalbuildingpracticesoftenrelyonenergy-intensivesystems,suchas HVAC and lighting, to provide thermal comfort and adequate illumination. However, there isgrowingrecognitionoftheneedforsustainablebuildingdesignthatreducesenergyconsumptionandminimizes the impact on the environment. Biomimicry is an emerging field that seeks to imitate nature'sdesign principles to solve human problems, including energy conservation in buildings. This reviewpaperprovidesanoverviewoftheapplicationofbiomimicryinenergyconservationindifferenttypes of buildings. The paper compares and discusses the results of various biomimicry-based approaches,including passive cooling, natural ventilation,and passivesolar heating. Thereviewfinds thatbiomimicry has the potential to significantly reduce energy consumption in buildings and offerssustainablesolutions tothechallengesofclimatechange.

**Keywords:** Sustainable Architecture, Biomimicry, Energy Conservation, Passive Cooling, Nature-baseddesign

## 1. Introduction

Energyconservationisacrucialaspectofsustainabledevelopment.Withtheworldpopulationgrowing at an unprecedented rate, the demand for energy is increasing every day. The use ofnon-renewableenergysourcessuchascoal,oil,andgasisnotsustainableinthelongrun,andtheirextractionandcombustionhaveasignificantimpactontheenvironment.Therefore,itisnecessary to look for alternative sources of energy and explore ways to conserve energy inbuildings.

The building industry consumes a significant amount of energy and has risen to become thethird greatest user of natural resources after the industrial and agricultural sectors (chel&kaushik, 2018). According to evidence, the building sector consumes roughly 31% of totalglobal final energy consumption and 54% of overall final electricity demand (Carnieletto&Emmi, 2019). Between 2005 and 2050, the former is projected to expand from 31% to 95%(Carnieletto&Emmi,2019).Recently,researchershaveconcentratedtheireffortsonloweringglobal energy usage (Ballarini, 2019).Heating, ventilation, and air conditioning system accountfor 48-57% of total energy usage depending upon location and this percentage jumps to over65percent whenlightingisincluded(yusek&karadayi,2017)

All these above manifestations have presented architects and designers with a plethora of issuesintermsofmakingtheirpracticesmoreenergy-efficientandenvironmentallysustainable.Theenergy-efficient strategy offers a great deal of potential for long-term development. Energyefficiencyimpliesusinglessenergytodothesamework-inotherwords,eliminatingenergywaste. It brings a lot of benefits in reducing greenhouse gas emissions, lowering our cost onhouseholdandeconomy-wideexpenditures,andreducingtheneedforenergyimports.

Moreover, climate zoning is vital for innovative, energy-efficient building design using optimalmethodologieswherethebuildingitselfcanfulfilallthedemandsofenergyfeatures.Tropicalclimatesarecharacterizedbyhightemperaturesbecauseofhighsolarheatgains,whichhaveanegativeimpactoninteriorareas,causingthermaldiscomfortforahealthyworking

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environment. The problems become more critical for cities like Dhaka in India, where theconsolation and environmental input parameters for office buildings are not favourable in termsof indoor air quality, thermal comfort, lighting for the employees working in a closed space.Officeworkersareincreasinglyawareoftherelevanceofsustainabilityinachievingahigherq uality of life.Here, the environmental considerations should be considered early designprocesstoensurethebuilding'slong-termviabilityforenergyusageandusers'comfort.

In pursuit of a solution for the above circumstances, the greatest destination to look foradvancesisnature,whereeveryorganismhasevolvedmanyadaptationstosurviveindiff icult environments and every form of life develops a responsive mechanism totolerate changing situations without wasting its resources or disrupting the ecosystem'sbalancethroughdevelopment.

**1.1. Biomimicry:**Biomimicryisthepracticeofusingnatureasamodeltosolvehumanproblems.Nature has evolved over millions of years to find sustainable solutions to problems. Biomimicryseekstolearnfromnatureandapplyitsprinciplestohuman-madesystems(OgochukwuOkeke&Okekeogbu, 2017). Biomimicry has been used in various fields, including architecture,engineering,andproductdesign.Itisanemergingfieldthathasthepotentialtotransfor mthewayweliveandwork.

**1.2. Energy Conservation in Buildings:** Buildings consume a significant amount of energy, andtheirenergyusehasasignificantimpactontheenvironment.Therefore,itisnecessarytofindway s to reduce energy consumption in buildings. Biomimicry offers innovative solutions toenergy conservation in buildings. Some of the ways in which biomimicry can be used toconserveenergyinbuildings are:

**1.3. Passive Cooling:** In hot and arid regions, buildings require cooling systems that consume asignificantamountofenergy.However,certainspeciesofdesertplantshaveevolvedmechanisms to cool themselves without using energy. For example, the saguaro cactus (figure)has a ribbed surface that allows it to expand and contract, reducing its surface area andminimizingheatgain.Thisprinciplecanbeappliedtobuildingdesignbyusingribbedfacadestha treduceheatgainandminimizetheneedforcoolingsystems.


*Figure1:Sugarocactus*

**1.4. Natural Ventilation:** Buildings require ventilation systems to maintain indoor air quality.However, these systems consume a significant amount of energy. Certain species of termiteshave evolved to build mounds that use natural ventilation to regulate temperature and humidity.Thesemoundshaveacomplexsystemoftunnelsandventsthatallowairtocirculate,creatin ganaturalventilationsystem.Thisprinciplecanbeappliedtobuildingdesignbyusingnaturalventila tionsystems thatmimicthetermitemounds.

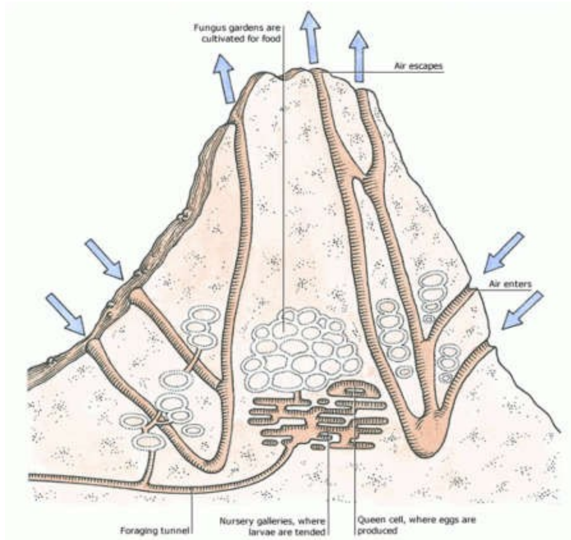


*Figure2:Termitemound(source:gettyimages)*

**1.5. PassiveSolarHeating:**Buildingsrequireheatingsystemstomaintainindoortemperaturesincoldr egions.However,thesesystemsconsumeasignificantamountofenergy.Certainspeciesofdesertliza rdshaveevolvedtoabsorbheatfromthesunduringthedayandreleaseitatnight,maintaining a constant body temperature. This principle can be applied to building design byusing passive solar heating systems that absorb heat during the day and release it at night,maintainingindoor temperatures.

**2. Methodology:** The methodology of the present research includes reviewing the presentliteratureonenergyefficiencyinbuildingsusingbiomimicry.Differenttypologyofbuilding sbasedontheutilityofthespaceisstudiestounderstandtheirenergyrequirementandpotentialtoredu cethesameusingbiomimicry.Thisisfurthervalidatedwiththehelpofanexampleofbuilding using biomimicry to reduce their energy consumption. Best available techniques ofbiomimicryisthencomparedfordifferenttypologyofbuildingssuitedfortheirpurpose.

## 3. Resultanddiscussion

Biomimicryoffersinnovativesolutionstoenergyconservationinbuildings.Theapplicationofbiomi micryprinciplesinresidential,commercial,andinstitutionalbuildingshasthepotentialto significantly reduce energy consumption and mitigate the impacts of climate change.However,theimplementationofbiomimicry-basedapproachesrequirescollaborationbetweenarchitects,engineers,andbiologists.Furthermore, theuseofbiomimicryprinciplesinbuildingdesign must be supported by policies and regulations that promote sustainable development.Overall,biomimicryoffersapromisingpathtowardsasustainablefuture.

### 3.1. ResidentialBuildings

Biomimicry offers several solutions to energy conservation in residential buildings. Forexample, passive cooling systems can be designed using ribbed facades that reduce heat gainandminimizetheneedforcoolingsystems.Naturalventilationsystemsthatmimicthetermitem ounds can also be used to regulate indoor air quality. Additionally, passive solar heatingsystems that absorb heat during the day and release it at night can maintain indoor temperatures.AstudybyMahmoudiandMahdavinejad(Javanroodi&nik,2018)foundthatusingbi omimicryprinciplesinresidentialbuildingscanreduceenergyconsumptionbyupto40%.

### 3.2. CommercialBuildings:

Commercial buildings, including offices and retail spaces, consume a significant amount ofenergy. Biomimicry can be used to reduce energy consumption in these buildings. For example,daylighting systems that mimic the structure of butterfly wings can be used to maximize naturallight and reduce the need for artificial lighting. Additionally, natural ventilation systems thatmimic the structure of termite mounds can be used to regulate indoor air quality. A study byHaghsheno et al. (Garcia &Murguia, 2021) found thatusing biomimicry principles incommercialbuildingscanreduceenergyconsumptionbyupto30%.

### 3.3. InstitutionalBuildings:

Institutional buildings, including schools and hospitals, consume a significant amount ofenergy. Biomimicry can be used to reduce energy consumption in these buildings. For example,passivecoolingsystemsthatmimicthestructureofdesertplantscanbeusedtoreducethenee dfor air conditioning systems. Using termite mound structure for internal ventilation could bethe other option as discussed above. A study by Sharifi and Osmond (Osmond &sharifi, 2014)foundthatusingbiomimicryprinciplesininstitutionalbuildingscanreduceenergyconsumpti onbyupto 50%.

## 4. Conclusion:

Biomimicry offers innovative solutions to energy conservation in buildings. By imitatingnature, we can find sustainable solutions to the problems we face. Passive cooling, naturalventilation,andpassivesolarheatingarejustafewexamplesofhowbiomimicrycanbeusedto conserve energy in buildings. As we continue to face the challenges of climate change andenergyconsumption,biomimicryoffersapromisingpathtowardsasustainablefuture.

The application of biomimicry in energy conservation in different types of buildings offerssustainable solutions to the challenges of climate change. The review finds that biomimicryprinciples can significantly reduce energy consumption in buildings. For example, passivecooling systems can reduce energy consumption by up to 40%, while natural ventilationsystems can reduce energy consumption by up to 50%. Additionally, the use of daylightingsystemscanreduceenergyconsumptionbyupto30%(Omar,2022).

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