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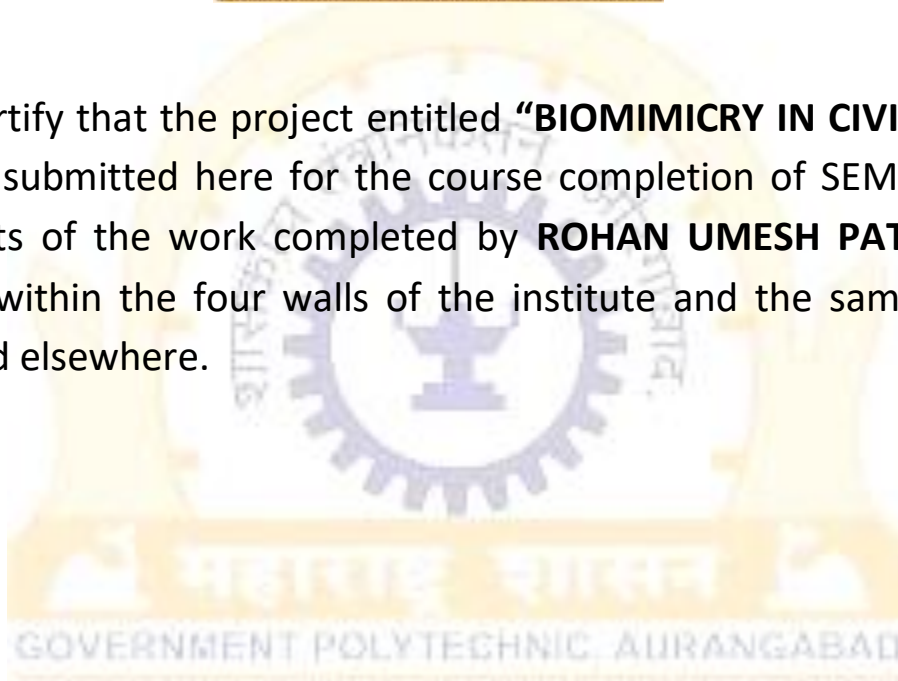
GOVERNMENT POLYTECHNIC AURANGABAD

Department of Applied Mechanics

CERTIFICATE



This is certify that the project entitled **“BIOMIMICRY IN CIVIL ENGINEERING WORKS”** submitted here for the course completion of SEMINAR (6C501) is the results of the work completed by **ROHAN UMESH PATHARE [EN.NO.-201041]** within the four walls of the institute and the same has been not submitted elsewhere.



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Abstract

The study of application of biomimicry on building envelope and its response to any building design challenge is the main structure of the research. It examines nature as one of the basis for resolving these challenges. It continues to discuss the application of possible strategies for establishment of an architectural configuration compatible to its structure. The incorporation of biomimicry idea in architectural design is believed to be more sustainable and efficient for reduction of energy usage and operating cost consumption along with design renewal in the future. The idea of inspiration from nature has developed the intention on this research to explore how the concept could be applied to overcome the challenges through design strategies. The paper concludes with the formulation of a design guideline with evident biomimetic principles that could be applied to any building design with reference to different contexts to achieve energy efficiency in building design.

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As it is rightly said by Boss well “The first and most important step towards success is the feeling that we can succeed”. This feeling has been imbibed in me by the seminar guide Prof. R.T.Aghao, I am thankful to him for rendered advices and guided me in every step of my work.

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YOUR'S FAITHFULL

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SIGN:-

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CHAPTER-1

1. INTRODUCTION

Biomimicry from bios, meaning life, and mimesis, meaning to imitate is a new discipline that studies nature's best ideas and then imitates these designs and processes to solve human problems. Studying a leaf to invent a better solar cell is an example, it as "innovation inspired by nature." The core idea is that nature, imaginative by necessity, has already solved many of the problems grappling with. Animals, plants, and microbes are the consummate engineers. They have found what works, what is appropriate, and most important, what lasts here on Earth. This is the real news of Biomimicry: After 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival. Biomimicry is a new science that studies nature's models and then emulates these forms, process, systems, and strategies to solve human problems – sustainably. Biomimicry uses an ecological standard to judge the sustainability of our innovations. After many years of evolution, nature has learned what works and what lasts. Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but what we can learn from it._There are several technological approaches and solutions to maximize building efficiency mostly which are termed as passive solutions to minimize the expense and impact of technologies by implementing more natural approaches of allowing nature to do the work. Biomimetic architecture represents a promising approach in this direction. Biomimicry is an ideology that combines biology with architecture to achieve a complete amalgamation of building and nature. It aims at studying the natural processes found in nature and uses it for the welfare of mankind.

CHAPTER-2

1. Relation between nature and Civil Engg.

The evolution of the concept of biomimicry appeared in early 1980s but was popularized by Janine Benyus, a scientist and an author, who brought forth an innovative way in design taking nature as key source of inspiration to solve any design challenge. In her book named “Biomimicry: Innovation inspired by nature” published in 1997, she defined Biomimicry idea as “a new science which studies nature as a model and an inspiration from which one can imitate its design and process to solve human problems”. The idea behind the concept is emphasizing sustainability as a major objective of biomimicry which when applied to building design in order to increase the strength of materials through self-healing and selfassembling properties, could offer better solutions to increase the performance of building, saving energy and cutting down material costs by eliminating wastes.



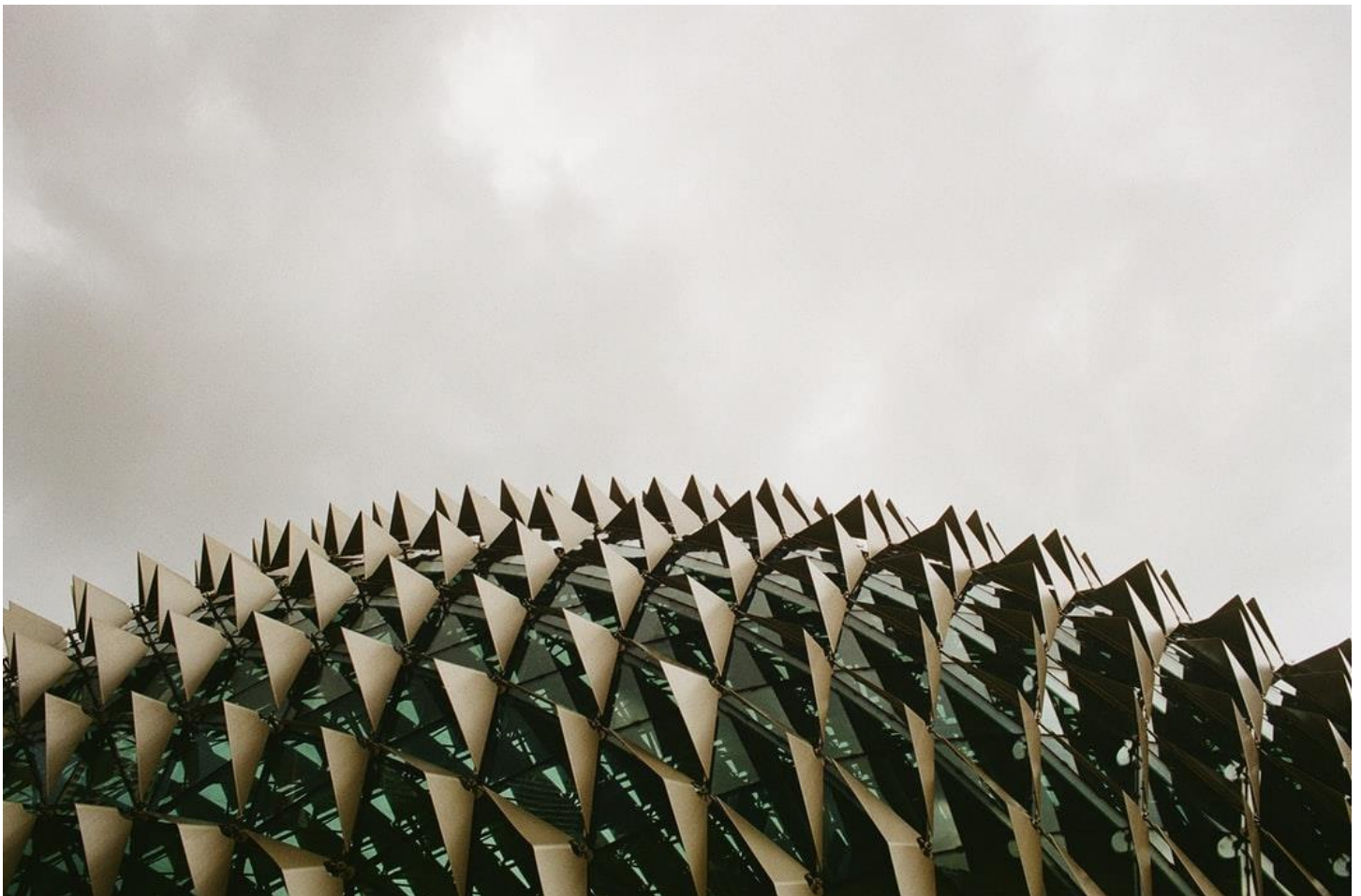
Biomimicry is often termed as an evolutionary process taking inspiration from nature to generate systems and processes infinitely seeking a close fit to the ever changing environment. The representation of the concept can be depicted as a spiral feedback process with organ as the individual product and organisms as systems and processes which undergoes a continuous refinement with an ultimate goal to achieve sustainability. From the understanding of process of Biomimicry, it can be presumed that any problem created by human with respect to build environment can find its solution from nature and the process can be imitated successfully aligned in response to the context.

One of the earliest examples of Biomimicry was the study of birds which enabled humans to gain the technology of flight. Though, it could be argued that our ancestors mimicked the techniques of the animals around them to become more successful hunters or gatherers, or to create better shelter. Sustainable development is moving to a new level where buildings are integral to nature, supporting nature's work rather than interfering with life-sustaining ecosystems. Nature has been offering immense ideas and inspirations to designers for creating architecture. Venus flower Basket sponge (Fig, 1) sits in an underwater environment with strong water currents and its lattice like exoskeleton and round shape help disperse those stresses on the organism. Architect Norman Foster inspired by this Venus flower designed Gherkin tower, (Fig.2) which has hexagonal skin.

From an architectural point of view it is an exciting to watch the construction of amazing new stadium like the Bird's Nest (Fig.4) and water cube. These buildings are not only energy efficient and eco-friendly but also inspired by the nature. The Watercube's (Fig. 3) architectural design is based on water bubbles in foam, this structure is derived from principles of geometry and crystalline systems. The building's structure is framed in steel, while the bubbles themselves are made from Ethylene tetrafluoroethylene pillows. The membrane lets in more light and

heat than traditional glass does, which keeps all 5 pools warmer, thus reducing energy costs by 30%. Rainwater from the roof is collected and recycled with efficient filtration and backwash systems.

Biomimicry design is not only adapting the design from the nature but also considering how to use nature's effective functions such as heating and cooling system, protecting natural light and ventilation. One of the most effective ways to cut down the ecological footprint of buildings is to follow the lead of nature through biomimicry. The Habitat 2020 building envisioned for china (Fig.3) is a future forward example of biomimetic architecture that fuses high-tech ideas with basic cellular functions to create 'living' structures that operate like natural organisms



CHAPTER-3

3. USES OF BIOMIMICRY

3.1 BIOMIMICRY IN ARCHITECTURE

In the field of architecture, the application of biomimicry mainly emphasizes on improving the built environment through development of site work, construction and operation and reduction in the environmental impacts like carbon emissions, wastes etc. Historic Evolution of Bio-Mimic Concept Examples of biomimicry in architecture can be seen through ages in different forms .The concept was prior adopted as an ornamented elements which subsequently transformed to functional, structural as well as aesthetic part of design. There are extensive sources of knowledge and ideas from the history to refer and apply in architectural design to allow the design to be more sustainable. Even if there are numerous examples in past, but their applications differ based on the context and needs. Some solutions offer flexibility in design whereas others give structural stability by integrating the ideas of biomimicry in architectural components . Application of Biomimicry in Building Design.

. 3.2 BIOMIMICRY IN INDUSTRIAL DESIGN

This section presents a number of case studies to show existing cases of biomimicry that can be regarded as industrial design. None of the examples are regarded as purely engineering or art, emphasizing that industrial design often lies in the middle of the two. The cases are chosen to give an idea of the scope of projects that can be achieved with biomimicry. Figure 6 shows how the cases relate individually to the applications as summarized in Figure 5. In the figure, A1, A2 and A3 represent applications 1 – 3.

CHAPTER-4

4. CASE STUDY

Case: Gecko tape

Several institutions worldwide have been involved in projects to mimic the mechanism employed by for example the gecko lizard to walk on surfaces, including glass. Research shows that gecko feet are covered with fine hairs (setae) or bristles which increase the contact area with the surface. Each of the bristles adheres to the surface using positive and negative molecular charges that create Van der Waals forces. These are the smallest existing attractive forces, but when combined by the billions they form the strongest adhesives known to man. Based on these discoveries scientists have developed a new adhesive, “gecko tape”, containing billions of tiny plastic fibers, less than a micrometer in diameter, which are similar to the natural hairs covering the soles of geckos’ feet. One square centimeter of gecko tape could support a weight of one kilogram. In addition, the feet of a gecko are selfcleansing, and the adhesion does not diminish in liquids or vacuum. Another interesting characteristic is that gecko tape can be reapplied and reused as it is easy to remove from the surface it is stuck to simply by levering the hair upward at a 30-degree angle [11]. Other animals that use the same principle as the gecko include beetles, spiders and flies. Figure 9 shows the principle of contact division in biological contact systems: heavier body weight requires finer surface structures (setae) in order to stick better to surfaces [12]



CHAPTER-5

5. CONCLUSION

This paper has attempted to provide an overview of biomimicry for industrial design, and to provide a starting point for industrial designers to work with the subject. Through the exploration and case studies in the paper, examples have shown that biomimicry can be very useful to the industrial designer. The main challenge seems to be how to access the information needed to use biomimicry in an effective and successful way. In response to these findings, an alternative, introductory tool has been introduced. The important aspect to remember is that design is about arriving at the most satisfactory solution regardless of origin. This may sometimes imply using biomimicry, and sometimes not. To get the most out of biomimicry, it should be regarded as a way to enlarge the designer's solution-space; as an extra arena in which to search for solutions. When used reductively - that is saying with the goal to find a solution, not to necessarily create an ecologically sound product – biomimicry can be seen as a supplement to the designer's existing toolkit. However, it should not be used bombastically and without consideration as to if it is actually nature which holds the most suitable solution for the problem in hand. Other aspects to remember when considering using biomimicry, is that design projects tend to have time- and fund constraints, and a demand to get products into production and commercialized. This implies that the designer in every project must contemplate whether biomimicry is the right way to go about finding the solution to her specific problem.



CHAPTER-6

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