Scope of Kinetic Architecture in india

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Abstract –*Kinetic Architecture is a branch of architecture that involves the use of mobile or dynamic components in a building or structure, such as movable roofs, walls, and façades. The use of kinetic architecture is highly popular in countries with changing climates, where buildings need to adapt to various weather patterns throughout the year. India is a country with a tropical climate, which makes it an ideal location for the exploration of kinetic architecture. Kinetic façades offer both aesthetic and functional appeal in modern architecture. This paper will explore the working mechanism of kinetic façades, the technology behind the façade's movement, and the various applications of the kinetic facade in modern architectural design. Some case studies has also been included for better understanding of the knetic mechanism. This research paper explores the use of kinetic architecture in India's tropical climate, analyzing case studies of buildings that have incorporated dynamic components into their designs to create more sustainable, energy-efficient, and comfortable spaces.*

Key words: *climate, Indian, kinetic, façade, computational design, cladding system, panels.*

1.INTRODUCTION

The use of kinetic facades in architectural design is rapidly becoming popular. Kinetic facades are a type of façade that responds to environmental changes or human interaction, such as wind or light, through controlled motions. Kinetic facades not only offer visually fascinating patterns and shapes, but they also help regulate the interior spaces they cover by providing shading or ventilation, among other benefits. This essay will explore the working mechanism of kinetic facades, the technology behind the façade's movement, and the various applications of the kinetic façade in modern architecture.

Working Mechanism of Kinetic Facade

Kinetic facades operate by responding to external forces or stimuli, which trigger programmed movements. The motion of kinetic facades can be classified as either responsive or generative. Responsive kinetics refers to the façade's reaction to an external stimulus such as the wind, the sun, or the user's proximity. In contrast, generative kinetics refers to the façade's programmed motion generated by an algorithm. In either case, a kinetic façade is composed of the following essential components:

1. Actuators

Actuators are the main components that produce the motion in a kinetic facade. These are devices or mechanisms that convert energy into motion. There are four types of actuators commonly used in kinetic facades: pneumatic, hydraulic, electromagnetic, and mechanical. Pneumatic and hydraulic actuators use fluids to create motion, while mechanical actuators use gears or cams to convert energy into motion. Electromagnetic actuators use magnetic fields to produce motion.

2. Control System

The control system is a computerized system that manages the movement of the kinetic façade. It comprises a central processing unit (CPU), sensors, and software. The sensors detect environmental changes or user interactions, while the software executes the actuator's movement based on the sensor's input. The CPU manages the communication between the sensors, the software, and the actuators.

3. Cladding System

The cladding system is the facade's external layer, consisting of various materials such as glass, metal, wood, or fabric. The kinetic actuator or mechanism is attached to this cladding system, which moves the facade. With the kinetic facade system, the cladding system can transform and reconfigure, creating various patterns and shapes within its design.

Technology behind Kinetic Facade Movement

The technology behind kinetic façade movement is rapidly evolving, with new innovations emerging around the world. Generally, the technology behind the mechanism of kinetic facade systems has been influenced by the need to make them energy-efficient, safe, and adaptable for various environments.

A. Energy Efficiency

The energy efficiency of kinetic facades has been improved through the use of photovoltaic (PV) cells. By covering the kinetic façade with PV cells, the energy generated can power the control system and actuators. This system not only improves energy efficiency but also makes the façade more sustainable.

B. Safety

The safety of kinetic facades has been improved through the use of fault-tolerant systems. These are systems designed to function even if part of the system fails. They are an essential safety measure, as a fault in the system could cause the façade to fail.

C. Adaptability

The adaptability of kinetic facades has been improved through the use of machine learning and artificial intelligence (AI) algorithms. These algorithms enable the kinetic façade to adapt and learn the environment and user interactions and make adjustments accordingly. This adaptability allows the façade to anticipate and respond to environmental conditions, thus improving energy efficiency and user comfort.

Applications of Kinetic Facades

Kinetic facades have a wide range of applications in modern architecture, from commercial to residential and educational spaces. The following are some of the most common applications of kinetic facades.

A. Commercial Buildings

Kinetic facades are mostly used in commercial buildings, such as shopping malls, office buildings, and institutions. The façades can be used to regulate temperature and airflow, providing energy saving solutions for these spaces. The kinetic facades also offer a visually appealing element to the commercial buildings, thereby attracting more traffic to the premises.

B. Residential Buildings

Kinetic facades are also commonly used in residential buildings. They can be used for energy savings, architectural design, and privacy. By using kinetic façades, residents can have greater control over the lighting and ventilation in their homes. The kinetic facades provide energy savings by minimizing the amount of heating and cooling needed in the spaces, and reducing glare from the sun.

C. Educational Buildings

Kinetic facades are also becoming increasingly popular in educational buildings. These facades can regulate temperature and lighting, thereby providing a comfortable and stimulating environment for learning. The kinetic façades also provide shading and ventilation, reducing energy consumption and keeping the spaces attractive and engaging.

2.1 Literature study: Analyzing the concepts of kinetic facades

Buildings have traditionally been constructed based on the external environment and the available natural resources to create comfortable climate-related spaces. The term "house skin" refers to the exterior shell of the structure. By employing the façade in this manner, we may provide a building the capacity to respond to or benefit from outside climates, which is to say, the capacity to absorb or reject free energy from the environment, hence lowering the quantity of artificial energy required to attain internal comfort. Making efficient buildings is a problem for architects nowadays. However, recent advancements in computer-aided design software and digital fabrication have enabled architects to find new design modes and envelope strategies in an effort to correct architectural design.

2.2 Literature study: key features

1. The objects rotate along an axis.
2. Scaling is the process of making gadgets and items smaller and larger.
3. Translation: The movement occurs in a vector's direction.
4. Movement caused by material deformity: this type of movement is dependent on the materials' fluctuating weight and elasticity.

2.3 Literature study: Indian climate

India's tropical climate is characterized by hot summers, high humidity levels, and monsoons. This climate poses various challenges to architects, engineers, and designers when it comes to building construction, maintenance, and energy consumption. The weather patterns in India require buildings to be designed with consideration of factors such as air flow, shading, and insulation to ensure occupant comfort and energy efficiency. Buildings located in urban areas face additional challenges brought about by the urban heat island effect, which increases the temperature in cities, making them insufferable during the summer months.

Kinetic Architecture involves the use of dynamic elements in building construction, including moveable parts and facade systems, to adapt to the changing weather and reduce the energy footprint of a building. The concept of Kinetic Architecture was first introduced in the 1960s and has since evolved to incorporate technology-driven components such as sensors, actuators, and motor systems. When it comes to building in a tropical climate like India's, Kinetic Architecture has the potential to mitigate issues such as solar heat gain and glare, rain, and wind impact, and reduce the energy consumption of a building. However, the technology involved comes with its trade-offs in terms of cost, maintenance, and durability.

3. Case Studies

Case studies of buildings that use kinetic architecture in provide practical examples of the potential of dynamic components in architecture designed for tropical climates. This section of the paper explores various buildings from different parts of the world that use kinetic architecture in their designs.

3.1.Foster and Heatherwick Fosun Art Centre, Shanghai, China.

Inspired by traditional Chinese theatres, the three-storey building features a curtain-like facade of bronze tubes. These tubes hang in three layers, creating semi-transparent screens in front of windows and balconies.

When the design was first announced, the architects described this facade as "a moving veil, which adapts to the changing use of the building, and reveals the stage on the balcony and views towards Pudong".

Developed in collaboration with local engineers Tongji University, the facade is organized along three tracks and made of layers of 'tassels' – a headdress. Each tassel length is between two and sixteen meters. reference to the traditional Chinese bridal. headdress. Each tassel length is between two and sixteen meters.

Fig 1: exploded view of the kinetic element

Fig 2: view of tassels from insides

Fig 3: view of the building

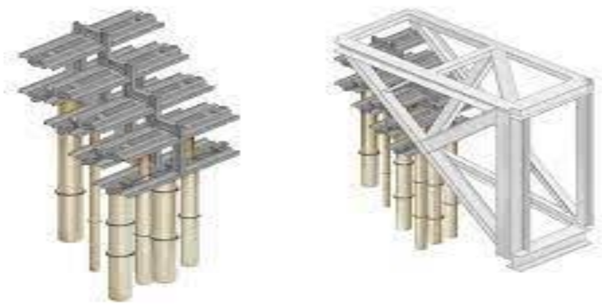

Fig 4 : details of the tassels

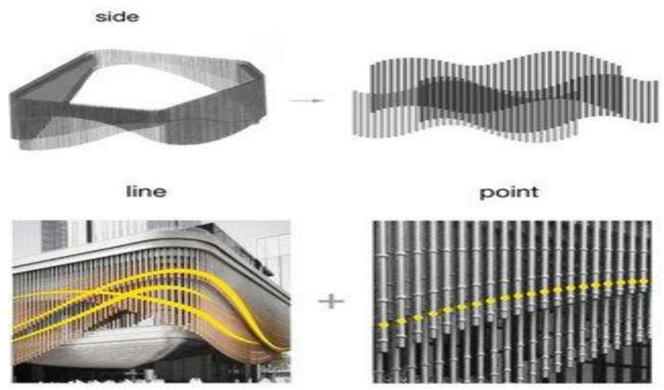

Fig 5: façade details

3.2. Al Bahar Tower, Dubai

The envelope The two circular towers are clad in a weathertight glass curtain wall. The curtain wall consists of unitized panels with a floor to ceiling height of 4200 mm, which are variable in width between 900 and 120 mm. The vision area of the curtain wall shall be 3100 mm, between floor and ceiling. The curtain wall is separated from the kinetic shading system through a substructure by means of movement joints. The fixation of the substructure movement joints (cantilever struts) is at the first basement, ground floor, and podium levels, thereby allowing them to respond independently from the substructure. A screen composed of triangular units, e.g. origami umbrellas, is a dynamic shade system. In order to prevent direct solar radiation, triangular units function as individual shields that unfold on their own axis in response to movement of the sun. Each Mashrabiya was designed as a unitized system and spanned 2.8 m from the primary structure. Stainless steel supporting frames, aluminium dynamic frames and fibreglass mesh infill are included in the shading device system. In order to provide shade or light, the folding system changes the shade screen from a smooth veil into a latticelike pattern. Each shading device comprises a series of stretched polytetrafluoroethylene (PTFE) panels. When a shade lamp is shut, the person can see from inside to outside. Each tower has a total of 1049 mashrabiya shade devices, each about 1.5 tonnes in weight. The design of the house in shape and height resulted in a series of 22 distinct mashrabiya geometry variations which, individually, posed an insurmountable challenge for their production and assembly.

Fig 6: view of the towers

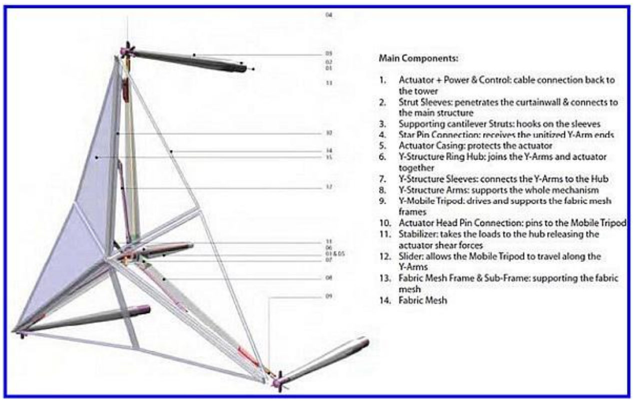

Fig 7: details of the façade component

Fig 8: view the kinetic element

Fig 9: mechanism of the kinetic element

3.3 M9-C b Building, Paris

The M9-C building is a cutting-edge urban multi-use structure in Paris. The whole facade consists of distinctive dynamic shutters that deliver the much-needed insulation and heat. The perforated aluminum shutters serve as the main feature of the building, opening and folding back depending on the time of day or the intensity of sunlight, giving inhabitants the option of solitude or exposure to the city's noises and views. While these shutters provide inhabitants with an external extension of their apartment, they look impressive from the outside. The whole building comprises residential areas, a school, and a theater, making it a one-stop destination where culture and everyday life intersect.

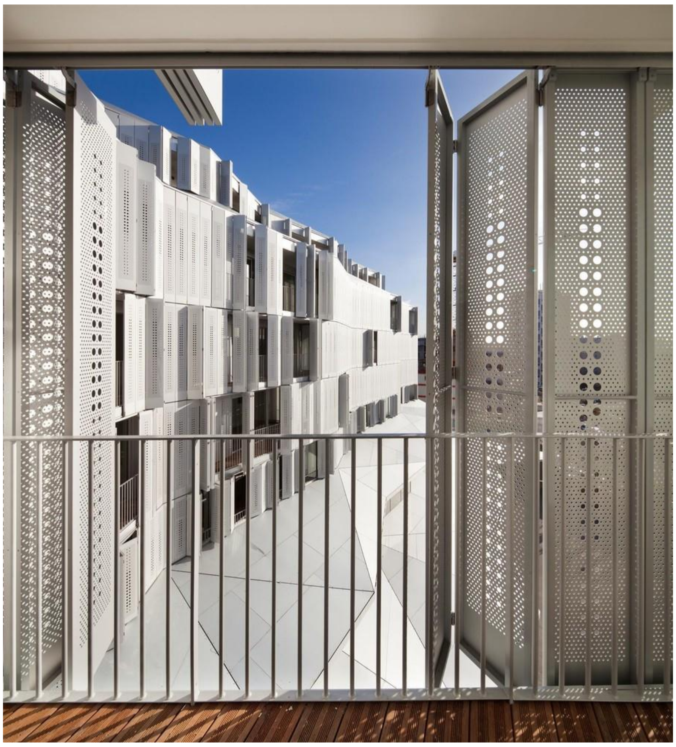

Fig 9:building view showing aluminium panels

Fig 10: building view

Fig 11: window view

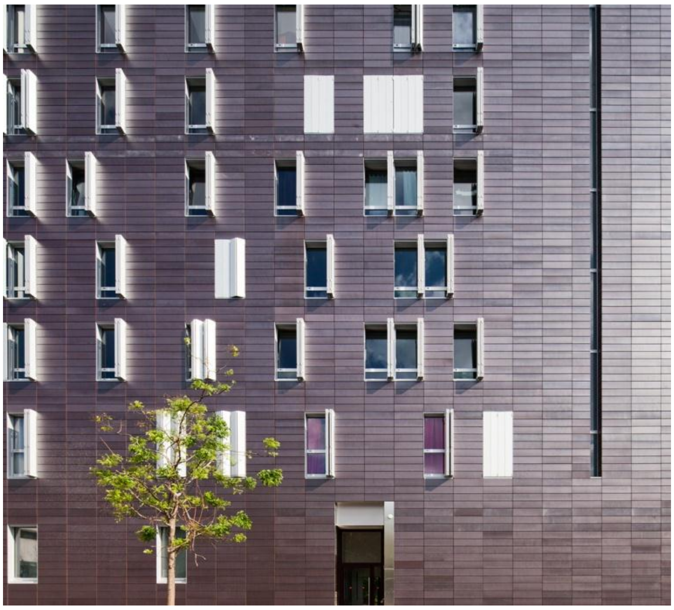

Fig 12: aluminium panels around windows

Fig 13: interior view

Fig 14: corridor view showing folded panels

3.4 Samundra institute of maritime studies – lonavala, india

The Samundra Institute of Maritime Studies (SIMS) is a premier maritime training institute established in 2005. The institute's building is an excellent example of kinetic architecture, featuring several unique kinetic elements that make it stand out.

One of the most prominent kinetic features of the SIMS building is its facade, which consists of a series of overlapping metal panels that move in response to wind and light. The panels are designed to mimic the motion of waves, creating a dynamic and ever-changing appearance that reflects the institute's maritime focus.

Another notable kinetic feature of the building is its sunshade system. The sunshade is made up of a series of vertical louvers that can be adjusted to control the amount of sunlight that enters the building. The louvers are controlled by a computerized system that adjusts them according to the time of day and the position of the sun, ensuring that the building remains cool and comfortable throughout the day.

Overall, the kinetic features of the Samundra Institute of Maritime Studies are an excellent example of how kinetic architecture can be used to create buildings that are not only aesthetically pleasing but also functional and sustainable.

Fig 15: SIMS façade showing kinetic panels

fig 16: kinetic façade detail

3.5 The Hive, Bangalore

The Hive Building is a unique structure that incorporates kinetic architecture features, making it an exceptional example of kinetic architecture in India. The building's facade is designed to act like a curtain, which can be opened or closed to regulate the amount of sunlight and air entering the building.

The facade of the building is made up of hexagonal aluminum panels that are hinged to allow them to move independently. Each panel is connected to a motor that can be controlled to adjust the opening and closing of the panels. This movement creates a dynamic aesthetic and helps regulate the temperature inside the building.

In addition to the facade, the building also has a kinetic roof that can be opened or closed depending on the weather conditions. The roof is made up of a series of triangular panels that can be raised or lowered to control the amount of sunlight and ventilation in the space.

The Hive Building's kinetic features not only provide functional benefits but also add to the building's visual appeal. The building's unique design has won several awards, including the World Architecture Festival Award in 2014.

Fig 17: The Hive

4. CONCLUSION

In conclusion, kinetic facades are a unique type of façade that responds to external stimuli or user interactions through controlled motions. The working mechanism of the kinetic façade comprises of actuator systems, control systems, and cladding systems. The challenges of improving energy efficiency, security and adaptability have had an influence on the Kinetics facade movement technology. Finally, the applications of kinetic facades are diverse, including commercial, residential, and educational buildings. Kinetic facades offer both aesthetic and functional appeal in modern architecture.

Kinetic Architecture has the potential to revolutionize building construction in tropical climates such as India's. By incorporating dynamic components into building designs, architects and engineers can create sustainable, energy-efficient, and comfortable spaces that respond to the changing climate. The case studies presented in this paper demonstrate the potential of kinetic architecture to mitigate issues such as solar heat gain, glare, and rain, while providing occupants with a healthier and more enjoyable working and living environment. While there are trade-offs involved in using kinetic architecture, such as cost and maintenance, the benefits can outweigh the disadvantages when implemented correctly. As tropical climate regions around the world face the challenges of climate change, the potential of kinetic architecture in building design is becoming increasingly significant.

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