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Research in Architecture (Building Facade Material)

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SYNOPSIS :

Aim :

To study how the material used for high rise building facades have changed in the due course of time.

Objectives :

- To study and understand the various aspects involved in facade design.
- To study the change in expression of a building over a period of time.
- To analyze the change with respect to changing materials and technology.
- To analyze how and what lead to a change in the use of façade materials and construction techniques.
- To carry out case studies of high rise building façades located in a same region/city.
- Doing a comparative analysis in order to arrive at the advantages and disadvantages of different façade materials.
- To find out the current trend in façade design and material selection for the same.

Scope:

Acting as a barrier between the inside and outside of a building and also creating climatic comforts for the users are some of the main purposes of a building façade. There has been a large amount of experimentation done in the façade materials. Various new materials have come up in the market which are more durable and strong as compared to those which were used earlier. The research would mainly focus on to the various new materials arrived in the market and the new construction techniques involved while constructing facades.

The data collected through research will help to build better facades which will act as an interface between the interiors and exteriors and also will respond to the surrounding climate. This data would act as a guideline while designing the skyline in terms of the material use and construction process.

Limitations :

- The study will include documentation of high rise buildings with respect to the façade materials used only.
- Structures constructed in various times need to be selected in order to show a timeline of the transformation in material use for the façade.
- Facades would be analyzed only in terms of the material use only.

Need

- In Architecture, the façade is one of the building exterior elements, which help achieve the goal of blending in with the surroundings or standing out from the crowd.
- It also helps to save building structure from various difficulties like weather changes, rain, air, sunrays, dust etc.
- It helps to keep suitable environment inside of the building.

ABSTRACT :

The building facade is the main visible element of a building, acting as a boundary between the interior and the exterior environment. The facade works as an interface between the living spaces and the external climate, influencing comfort and energy efficiency. The skins of these facades are important media between the interior and exterior of a building. They not only connect between users and environments, but also play an important functional and aesthetic role. The major advancements in facade technology gives the architects and specialists the opportunity to vary the appearance of the building envelope, create an integrate grid system with all of their ideas, such as, windows, ventilation elements, glazing, aluminum features, etc. while maintaining a high level weather proofing. The objective of this paper is to identify,

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investigate and understand the recent innovations in the material science which have been incorporated in facades, especially in high rise buildings.
In this paper, a qualitative evaluation research method is used. The research methodology comprises of case studies, visual observation and data collection. The various modern trends in the development of facade material employed in contemporary architecture around the world have been also been discussed through some examples in this paper.
Keywords: recent advances, materials, facade, contemporary architecture

I. INTRODUCTION :

The Facades are the first aesthetic feature of a building that distinguishes one building from another. A facade is generally one exterior side of a building, usually, but not always, the front. It comes from the French word facade which literally means 'frontage' or 'face'. The building facade is the main visible element of a building, acting as a boundary between the interior and the exterior, working as an interface between the living spaces and the external climate, influencing comfort and energy efficiency. Facade systems comprises of structural elements that provide lateral and vertical resistance to wind and other actions, and the building envelope elements that provide the weather resistance and thermal, acoustic and fire resisting properties. In current practice, in high rise buildings, the building envelope is being designed as a separation between exterior and interior environments, to provide an enclosure for comfortable indoor environment. Along with the innovation of ever-changing technologies the facade skins have been developing into an intricate but interesting multilayered system . The various modern trends in the development of facade material employed in contemporary architecture around the world have been also discussed through some examples in this paper.

II. METHODOLOGY :

In this paper qualitative research method has been used. The systematic literature review has been explored through internet and secondary data from relevant published academic literature from journals articles and research papers. The data collection in the qualitative research are the data that comes from a number of case study examples that are described descriptively and are supported by illustrations and photographs to reinforce the arguments put forward. The basic concepts and backgrounds are investigated through literature and on-line media, observations to work for qualitative analysis conducted for different types of materials which have been used in the facades of contemporary high buildings around the world.

III. TECHNOLOGICAL ADVANCES IN BUILDING FACADE MATERIALS :

A new paradigm of facades has emerged which interact with the external environment by the integration of new materials and technologies, some with intelligent controls. Some make use of long standing passive technologies such as solar shading and thermal mass.

A detailed study of these new materials and technologies of different facade systems along with case studies has been carried out to learn how these approaches can be implemented in today's contemporary architecture. These materials have been summarized as follows :

3.1. Self-Cleaning Glass

The self-cleaning coating on glass is divided into two categories i.e. hydrophobic and hydrophilic. These two types of coating both clean themselves through the action of water, the former by rolling droplets and the latter by sheeting water that carries away dirt. Hydrophilic coatings based on titanium dioxide can chemically break down absorbed dirt in sunlight. Self-cleaning glass consist of a thin layer of photo-catalysts on its surface, which are compounds that accelerate a chemical reaction using the UV bands of sunlight.

The Elbphilharmonie Concert Hall with self-cleaning glass, Hamburg, Germany.

3.2. LED Facades

LED facades help create a vibrant and beautiful visual quality to both the building as well as the city. LED's are becoming famous as media facades, where hundreds of LED's can be linked together to form large screens but yet can be all controlled individually, letting images and messages come to life making shopping malls and office buildings crowd pullers. LED's are perfect for outdoor application as they are weather resistant. With a life of 50,000 hours, they can reduce energy and maintenance costs. The compact design allows them to be installed very close to the

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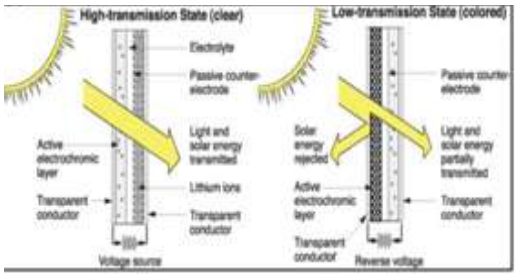
facade, saving energy and light emissions. The Agbar Tower by Jean Nouvel in Barcelona has 4,500 LED'S that can be operated as computer controlled pixels, that creates moving images on the tower envelope, with as much control as the LED screen on the laptop. With RGB (Red Green Blue) management, the LED's can generate 16 million colours.

The LED facade of The Agbar Tower by Jean Nouvel in Barcelona, Spain

3.3. Electro-Chromatic Glass

They consist of an extra layer of film, which changes its opacity when applied with an electrical voltage. The transparent electro-chromatic glass can change into a tinted glass when applied with electricity and vice versa, with the ability to remain in that state unless applied with electricity again. The solar heat gain reduces when the glass is tinted and it increases when it becomes clear. Therefore, it can be used according to the changing climate. It provides good shading to the building and can reduce the overall energy consumption of the building. The activation time of the system is around 30 minutes, while the deactivation is around 45 minutes.



Details of functioning of Electro-chromatic glass

3.4. Fritted Glass

Fritted glass has computer controlled patterns printed on the surface. Fritted glass has application ranging from reducing solar gain; avoid glare; or simply creating a pattern, also, giving better safety and privacy. The Ryerson University student Centre at Toronto, Canada is a light, transparent designed to be energy- efficient and is an excellent example for its use of fritted glass making it resemble an ice crystal. It has a high performance facade which is triple glazed, low e-coated, fritted, and shingled.

Fritted glass on the facade of Ryerson University student Centre, Toronto, Canada

3.5. Composite Metal

Aluminum Composite Material (ACM) is widely known as the exterior cladding of choice on multi-storey buildings because of its ability to provide complex architectural features and superior weatherproofing. It is also used for column covers, entrances, canopies and other critical design elements. ACM panels can be used in both Rain screen and barrier wall systems and also provide LEED certification value as a sustainable material. ACM panels are used widely for both new and retrofit construction, and can be field installed or as a component in prefabricated panels to provide a clean high tech look. The extra sunshade of lightweight stainless steel (with sun reflecting surface) forms a protective girth around the north and south perimeter of the office complex. In other words there is an 'eyebrow' of lightweight metal on every floor providing sun protection. It will be noted that this would counter heat when the sun is at the highest altitude between 11 am to 3 pm.

Composite Aluminium Panels on DMRC Metro Bhawan, New Delhi, India

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3.6. FRP Composites

Fiber Reinforced Polymer (FRP) composites represents a family of materials combining fibers and polymers to offer excellent mechanical, thermal and insulation properties. Within the frame of engineering applications in buildings and infrastructures. FRP composites represent a relatively novel construction solution with several intrinsic advantageous properties, such as high strength and stiffness, reduced mass, low thermal conductivity, high corrosion and weather resistance, durability, but also the implicit feature of offsite fabrication, modular construction capacity and possibility to mould complex forms with special finishes and effects.

FRP panels on the facade of Ravel Residence, Student housing

3.7. Stainless Steel Panels

Stainless steel is used in all aspects of architecture, building and construction. the use of stainless steel use and range of applications has been growing. Stainless steel is both aesthetic and functional, such as curtain wall and roofing. This material has been garnering plenty of attention for both aesthetic and functional for architectural curtain wall and fabric made of stainless steel. The number of different stainless steel alloys used in building and construction has expanded. The more highly alloyed molybdenum containing stainless steels are preferred because of their enhanced corrosion resistance. One of the best examples of stainless steel facade is Walt Disney Concert Hall, California, Los Angeles, USA where the most of the building's exterior was designed with stainless steel with a matte finish.

Stainless Steel cladding on the facade of Walt Disney Concert Hall, Los Angeles, USA

3.8. Rain-Screen Cladding

Rainscreen cladding is a system designed to work with the elements of nature to protect the structure of a building from the wind and rain. It is an extra element attached to the wall to keep water from entering in as well as to prevent leakage of air, carry wind load and to offer thermal insulation. The rain-screen concept makes use of the outer layer to act a protective layer against the rain and the weatherproof inner layer blocks moisture and air from penetrating inside. They can be made of different materials such as terracotta, precast concrete, cement composite, stone, glass, metal, etc.

Rain-screen cladding façade in Rutgers University Camden Graduate Student Housing, USA

3.9. Vacuum Insulated Panels

Vacuum Insulated layers are 5-10 times thermally more effective than layers of conventionally available insulation They make use of new technology and have room for further developments, for example, incorporating them into unitary curtain walling systems. Vacuum insulated layers have good insulating properties and can be made very thin, hence they can be easily used in small tight spaces such as below the window sill or floor connections to prevent heat bridges, or by enabling thinner panels, to improve the net let table space in the gross floor plate area of a framed building.

Section of a thin Vacuum Insulation Panel

3.10. Terracotta

The terracotta has been used in building construction, mostly as roof and floor tiles, since centuries. Terracotta now provides a premier architectural option used in Rain screen and

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ventilated exterior wall construction.Terracotta is available in varied profile shapes and earth tone colours, glazed or unglazed, to provide an architecturally appealing, energy-efficient building. Terracotta is a 100% natural material, made from clay and sand, is non-combustible and provides LEED certification value as a sustainable material. Terracotta, with its colours stabilized under a glazed finish, has an eternal durability. Terracotta is not only natural, but it also possesses incredible insulant properties that seal warmth or coolness inside buildings for longer.

Terracotta tiles on the facade of Bund House office complex, Shanghai, China

This reduces overall energy consumption, which is more than desirable nowadays. The most iconic building that comes to mind is The New York Times' headquarters, designed by the renowned Renzo Piano. Nevertheless, there are plenty of other successful instances of terracotta usage at a global level. There is also another example of Bund House, an office complex in Shanghai, China is a terracotta walling solution.

IV. CONCLUSIONS:

- The facade makes up the majority of the building's envelope separating the interior and exterior environments.
- Building facades are directly exposed to the external environment. Different building facades are related to varying indoor comfort and energy consumption levels.
- It is the single most important factor in the energy efficiency of the structure.
- A reasonable facade design helps reduce energy consumption and improve indoor thermal comfort.
- A new paradigm of facades has emerged due to technological advancement in the material science and prefabrication which interact with the external environment by the integration of new technologies.
- Some of these facades have intelligent control system, while some use passive technologies such as solar shading, ventilation and thermal mass.
- Some of these materials and design strategies for facade can help in reducing the cooling and heating load on HVAC systems there by reducing the energy consumption of the structure.
- Future advanced facade design research is needed in order to understand sustainable design in a more comprehensive way and apply its principles to tall buildings.

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