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Massing Multi-Functional Facade

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Abstract: A Building is affected by many things (weather, function, human needs, etc.), and also it is affected by the static and dynamic forces so that the building can adjust the complex system of the building.
A multifunctional façade module system can adapt to various climates and monitor the real-time energy combustion and different kinds of things (weather, function, human needs, etc.) and control it through multiple sensors. The façade components not to save energy consumption but also improve the building façade aesthetics. The system monitors the sunlight orientation and the winds, rain penetration, and photovoltaic units.
So the architect can change the techniques of design of building and design multifunctional façade.
Keywords: Massing, Adaptive Façade, Responsive, Shading Devices, Energy consumption.

I. INTRODUCTION

A. Massing Means

A Unified composition of two-dimensional shapes or three-dimensional.
In historic architecture, façade systems have a long tradition where doors and windows are the most common movable historic architectural elements.
A building's most intelligent part is façade that could increase internal comfort and at the same time decrease energy consumption. The Residential unit is the most comfortable space or zone for the people.
There has been a residential area trend to use more glass in the façade to provide enough natural light in the interior space and decrease energy consumption.

Fig.1: carved façade of Haveli in Rajasthan

Fig.2: Simple Façade's door and windows

Fig.3: internal Door and windows

However, economic justification in terms of sustainability and energy saving using these transparent skin (glass) is critical to use the wide Window to mitigate the negative impact.
High rise building envelopes are generally applied multifunctional façade. Architects and engineers design and apply intelligent façade to improve the building energy combustion and performance and the aesthetic value in present time practices.
This Dissertation proposes a guideline for the double-skin façade in public or hotel buildings.
The new construction and techniques provide a set so that all the future buildings reach zero energy level. This type of energy-efficient façade, when applied to the building façade then the building has a low energy efficiency of HVAC and lighting system use. So in this paper, research on whom to use the massing multifunctional façade so that building is energy-efficient and adaptive façade.

Fig.4: Al- Bahr Towers, Abu Dhabi, United Arab Emirates
By; Aedas Architect

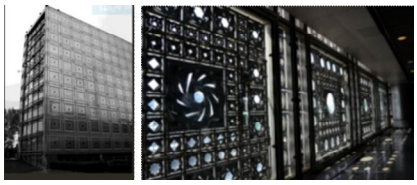


Fig.5: Institute du Monde Arabe, Paris, France
By; Enrique jan, jean Mouvel, Architecture- Studi

II. FAÇADE FUNCTION

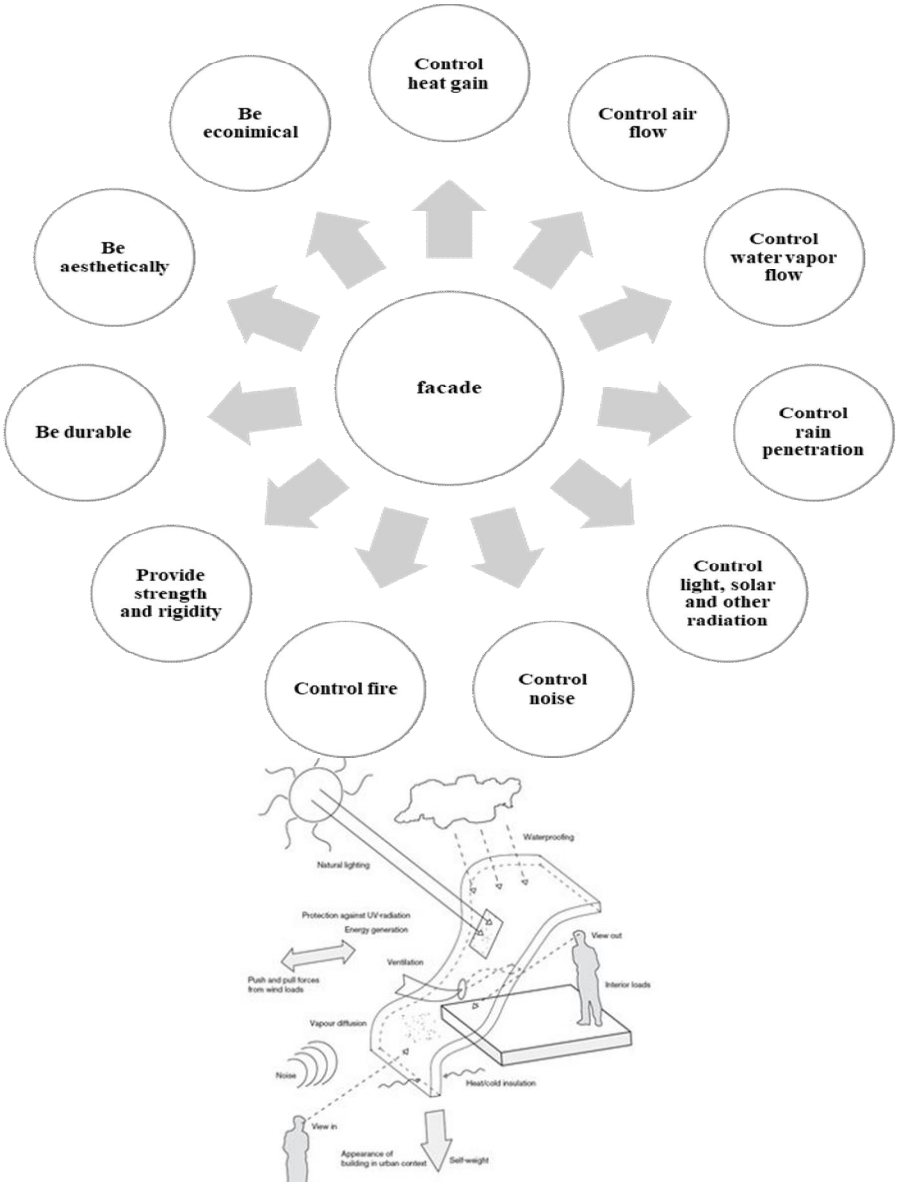


Fig.:6 Façade functions

Facades are transformed as technology has progressed. Massing Multifunctional façade use for aesthetic purpose or energy-efficient means the façade balances the building's internal and external area temperature.

III.ROLE

The sunlight is exposed throughout the year and other environmental events in every typical building façade.
In massing multifunctional and responsive facade system, the building facade changes its character according to the need of the building, and its result is minimizing energy.

IV.DATA

A. *Aim*

This Dissertation aims to develop the Guideline for public or hotel building facades to make building adaptive in composite climate.

B. *Objective*

1) To identify and analyse the façade techniques.
2) To do a comparative analysis of multifunctional adaptive façade guidelines.

C. *Methodology*

1) To explore the different type of shading devices.
2) Façade literature study or case study
3) Make comparative study chart.

D. *Scope*

1) Protect building rain, wind, sun, etc.
2) Increase energy comfort and decrease energy consumption
3) Guideline help developing local authorities to make building adaptive in future
4) Control the harmful effect on the climate.

E. *Limitation*

1) The study based only external façade of the building
2) Dissertation, the focus is on composite climate

F. *Needs*

The Dissertation need is for the user who wants their comfort zone in a building and the adaptive façade balances the building's internal and external temperature. In term of human comfort, the following point need to consider-

1) Visual comfort- good view and sufficient lighting.
2) Thermal comfort - air movement, temperature.
3) Sound regulation- loud, distracting and, traffic sounds reduced to the minimum.
4) Good air quality- air at low levels.
5) Security- is the building safe in the event of a bomb blast or earthquake or other?

G. *Hypothesis*

Adaptive façade would be an approach to words providing a layer that will protect the building from weathering, be energy efficient, and add aesthetical value to the structure.

H. *Research Question*

1) How can the multifunctional façade as an adaptive façade be designed, and the different layers of the façade can work in the climate?
2) How get a responsive, energy-efficient facade and reduce the energy demand in a public building?

V. CLIMATE STUDY

A. *Composite climate*

Code	Description	Group	Precipitation	Level of heat
Cwa	Monsoon- influenced humid subtropical climate	Temperate	Dry winter	Hot summer

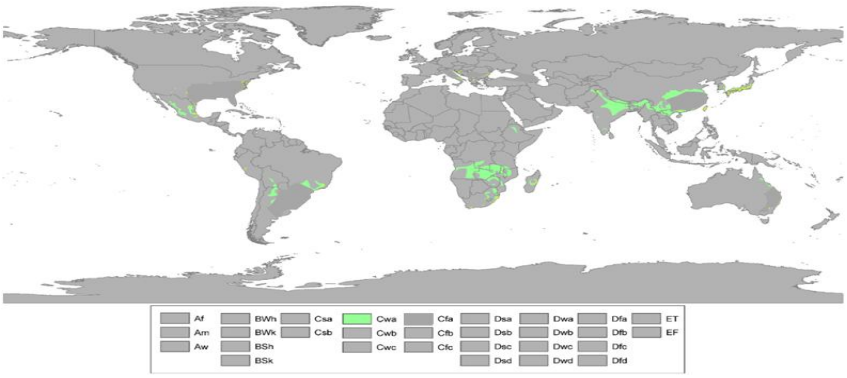


Fig.:7 composite climate areas in world map

1) The high temperature in summer and cold in winter
2) Low humidity in summer and high in monsoon
3) High direct solar radiations in all the seasons except monsoon high diffused radiation
4) Occasionally hazy sky hot winds in summer, cold winds in winter and healthy.
5) Large projecting to reduce sly glare, keep out the rain and provide shades
6) Shading devices have a low thermal capacity.

B. Orientation

1) The solar path of an area is one of the critical factors in orienting a building on the site.
2) Extreme heat falls on the west facade while east, southeast, northwest faces the moderate sun, and most minor rays fall on south/north.

C. Building Orientation

1) The longer axis of the building is advised to face south and north
2) To reduce heat gain but promote ventilation, fenestrations are given on the north and south facade.
3) To knowingly invite sun east is best for opening.
4) West should be kept as the last option for opening even though the temperature is low.
Such a combination of opening will reduce the heat gain inside the building, reducing the energy by making the building more excellent than usual by strategically placing fenestrations with the consciousness of directions.

VI. COMPARATIVE TABLE

A. Comparative Table of Literature Studies

	THE ENERGY COMMISSION DIAMOND BUILDING	HSBC BUILDING	V ON SHENTON	OASIA HOTEL DOWNTOWN
Building type	Office	Commercial offices	Mixed Land use	Hotel
Climate	Composite	Composite	Composite	Composite
Area of project	4,928 m^2	99,000 m^2	6,778 m^2	2311.4 m^2
Height	---------	180mt	Residential tower 237 m and Office tower 123 m	199.080 mt
Material	glass	glass	glass	red aluminium mesh
Architect	created under the Energy Commission Act 2001	Foster and Partners	Architects 61 Pte Ltd	WOHA

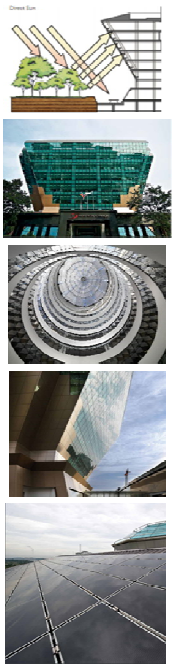
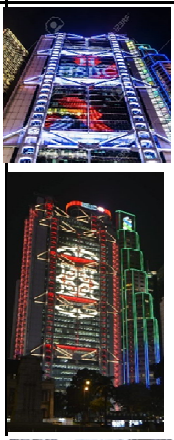
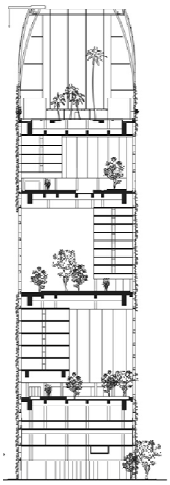
	GRAN RUBINA	ONE TAT SENG	THE ILHAM TOWER	TAI KWUN CENTRE FOR HERITAGE AND ART
Building type	Commercial Office	Commercial	Mixed Land use	Heritage and art centre
Climate	Composite	Composite	Composite	Composite
Area of project	150.000m2	729.5 sq.mt.	92,000m²	27000 m²
Height	104.1 m	---------	298mt	50 mt
Material	glass	single sheet aluminium expanded metal mesh	glass	Metallic facade
Architect	AG5	Goy Architects	SAA Architects	Herzog & de Meuron

	THE ENERGY COMMISSION DIAMOND BUILDING	HSBC BUILDING	V ON SHENTON	OASIA HOTEL DOWNTOWN
Place	Malaysia	Hong Kong	Singapore	Singapore
Façade works	• The north and south facades enjoy full self-shading, particularly from the hottest midday hours, protected from the sunlight's penetration in the building's east and west facades.	• The feature is, natural sunlight i s the primary source of lighting inside the building. • this design helps to conserve energy • Reduce the sun glair.	• create patterns, the basic shape of the hexagon is used to that increase the performance of the facades • Vegetation naturally provides fresher, cleaner air. • Series of sky gardens play an integral part in developing a sustainable lifestyle.	• Facades were to the tolerance of direct sunlight and the rate of growth of each climbing species.

	GRAN RUBINA	ONE TAT SENG	THE ILHAM TOWER	TAI KWUN CENTRE FOR HERITAGE AND ART
Place	Indonesia	Singapore	Malaysia	Hong Kong
Façade works	• A series of deep horizontal bands and vertical glass fins ensure the shading of the façade. • They are creating privacy but ensuring natural ventilation.	• Adding a second skin of sun shading devices to shade the building from the western sun.	• The façade is rich and finely tuned to shade the interiors	• Roughness and texture break down the façade surface, which reduces the reflectivity and glare during the daytime.

	THE ENERGY COMMISSION DIAMOND BUILDING	HSBC BUILDING	V ON SHENTON	OASIA HOTEL DOWNTOWN
Benefit	• Reducing solar impact by 41%. • .capacity produced 10% of the building's energy needs. • 63,000 kg annual carbon dioxide (CO_2) emission. • They are minimizing heat from the sun.	• Sunshades are provided on the external facades to block direct sunlight going into the building and reduce heat gain.	• Series of sky gardens part developing the sustainable lifestyle.	• The benefits of Nature leading the way is a sustainable energy saving • To the maintenance of the "living cloak." This "living breathing" façade.

	GRAN RUBINA	ONE TAT SENG	THE ILHAM TOWER	TAI KWUN CENTRE FOR HERITAGE AND ART
Benefit	• Social sustainability and low energy usage.	• The curvature at the edge of the building allows for a continuous flow of the sun-shading fins, which creates a subtle visual interest.	• To provide high-quality living spaces. • reduce solar gain	• Reduce the reflectivity and glare during the daytime.

	THE ENERGY COMMISSION DIAMOND BUILDING	HSBC BUILDING	V ON SHENTON	OASIA HOTEL DOWNTOWN
Benefit				

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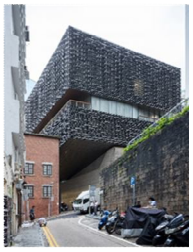
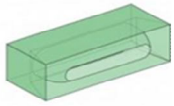
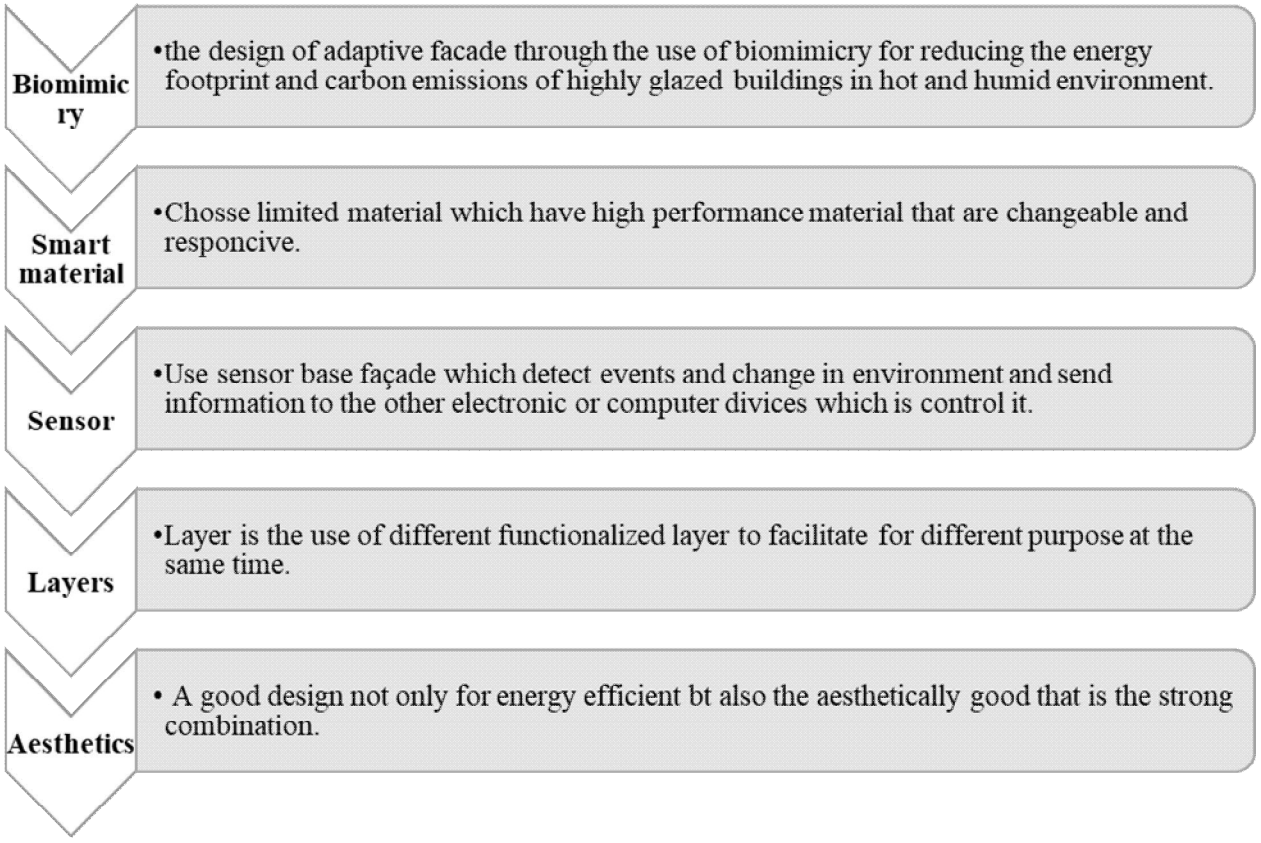
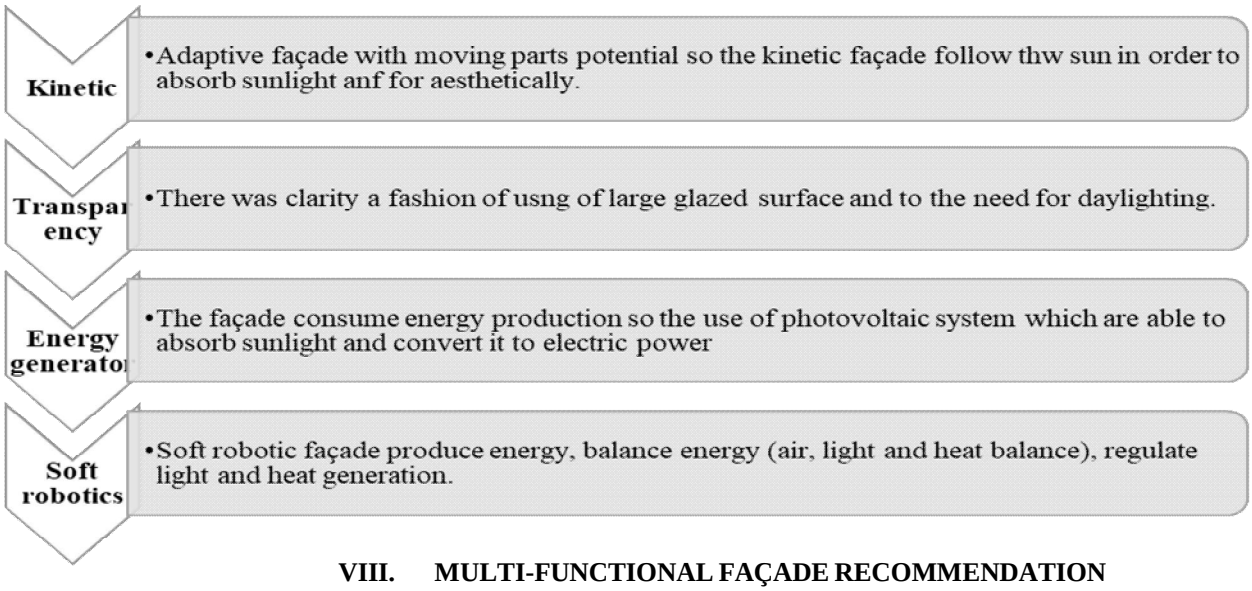
Benefit			 	  

VII. TECHNOLOGY

A. Different Technology Concept of Adaptive Façade





VIII. MULTI-FUNCTIONAL FAÇADE RECOMMENDATION

In the composite climate, the maximum use of façade is double-skin façade The first skin is building concrete skin, which is constructed, and the other skin is made with a different material in which glass is maximally used. In the double-skin façade between the two façade, there is space only for the airflow. In double-skin façade study, their different type of things makes building adaptive.

A. Shelf Shading

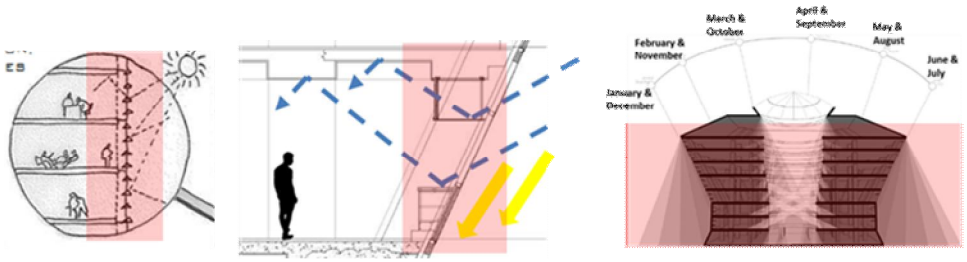


Fig.8: shelf shading in building

The shelf-shading use in sunlight is resected maximum in the daytime (south and west) and used resected surface resected daylight outside in summers and resected inside winters. Moreover, use vertical and horizontal louvers.

B. Buffer Spaces

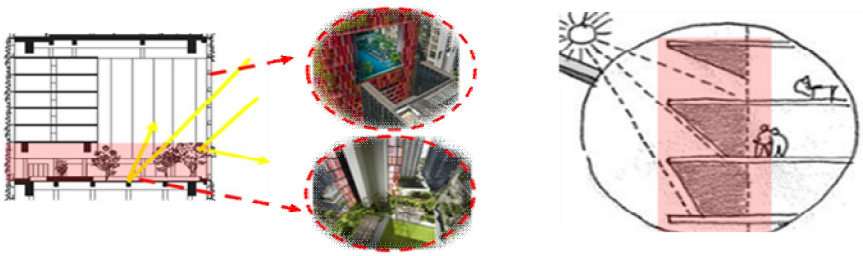


Fig.9: buffer spaces in the building

In building, façade creates buffer spaces like horizontal louvers, creates green spaces or terraces, garden floors etc., so that creates shadow and airflow in the floor.

C. Create Boxes

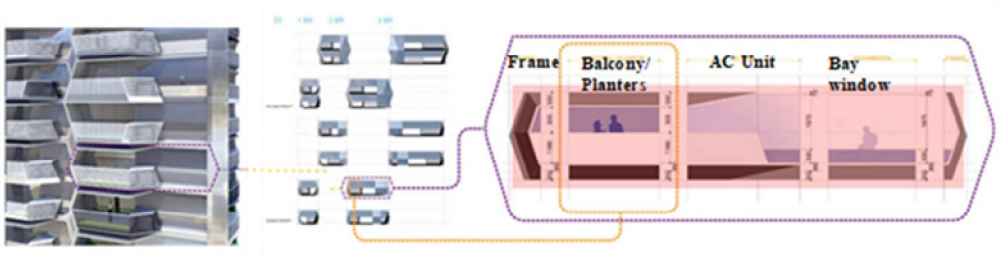


Fig.10: boxes in building facade

In façade create boxes for the various activities in a single unite on every floor for multiple purposes.

D. Use Different Materials

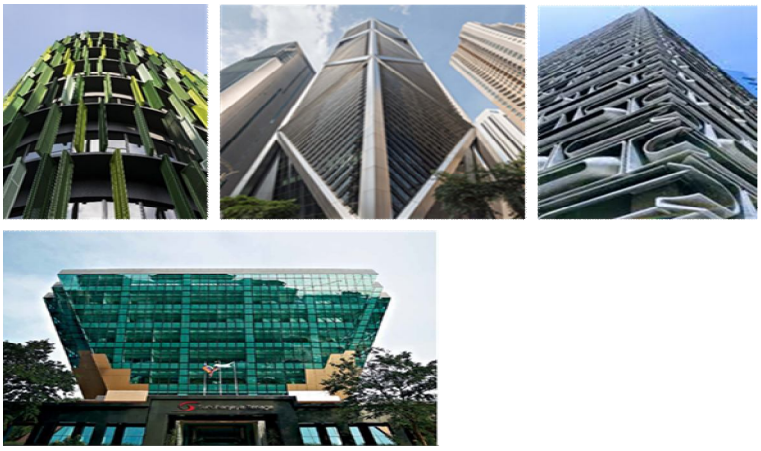
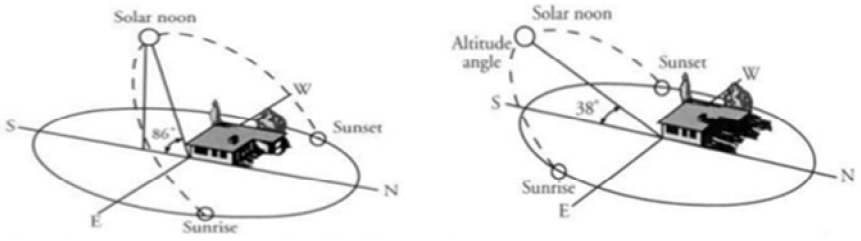


Fig.11: different materials used in building facade

In building, façade use different materials in a different ways. Composite climate maximum use of façade is glass façade in double skin façade.

IX. DESIGN PROPOSAL

A. Sun-path

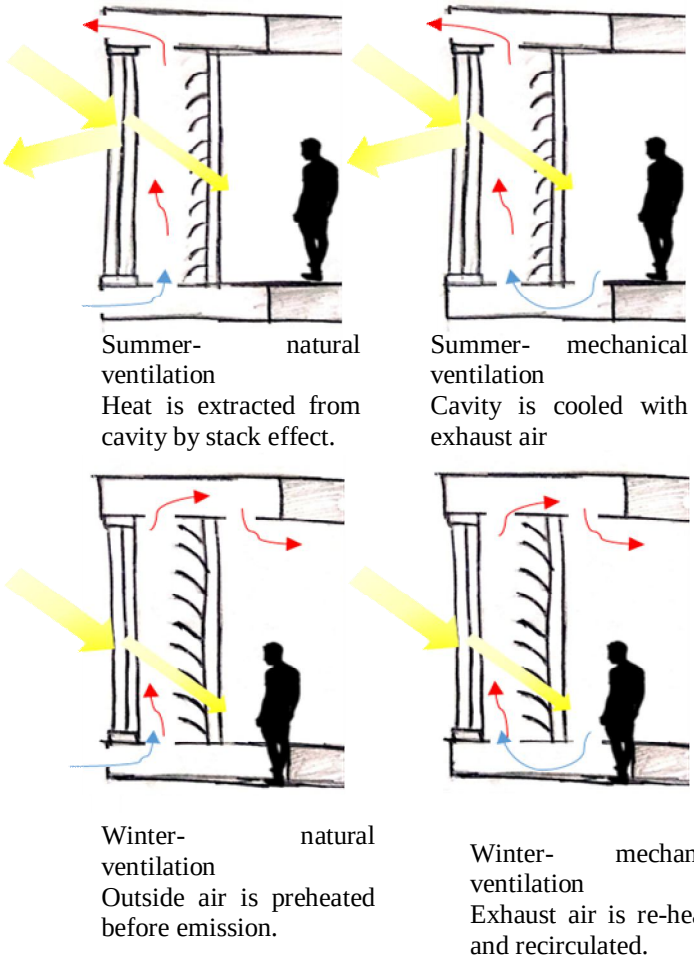


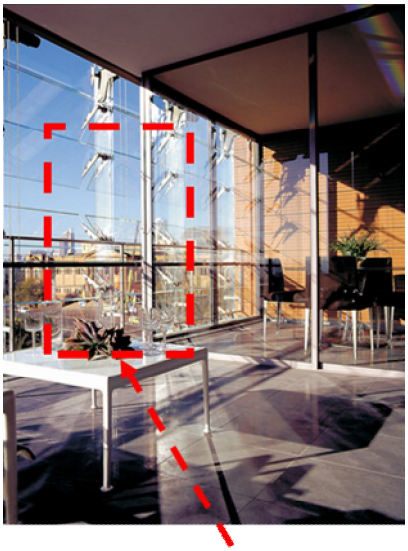
Sun path on summer Sun path on winter

Fig.12: sun path

Sun moves in different angles in different seasons from east to west via the south. In summers sun move at 86'c, and in winters move at a 38'c altitude angle so that maximum sunlight is in the south. The Southside façade is resected a maximum 50% of daylight and maximum energy consumption from this side. The east and west side façade also reflect sunlight and even energy consumption. The building's internal area gains defuse light from the north side of the façade, so in this side glazed, or glass façade provides. So two types of design proposals for the HOTEL and OFFICE building façade. These proposals for the SOUTH and WEST side of the building where maximum time is day/sunlight is present.

1) *First Techniques for Façade:* In this façade, the glazing surface in the outer façade and inner façade is covered with movable louvers open in winters for internal sunlight and summers closed to reflect the sunlight shafts for the airflow. These façade in two different ventilation one is natural, and the other is mechanical.





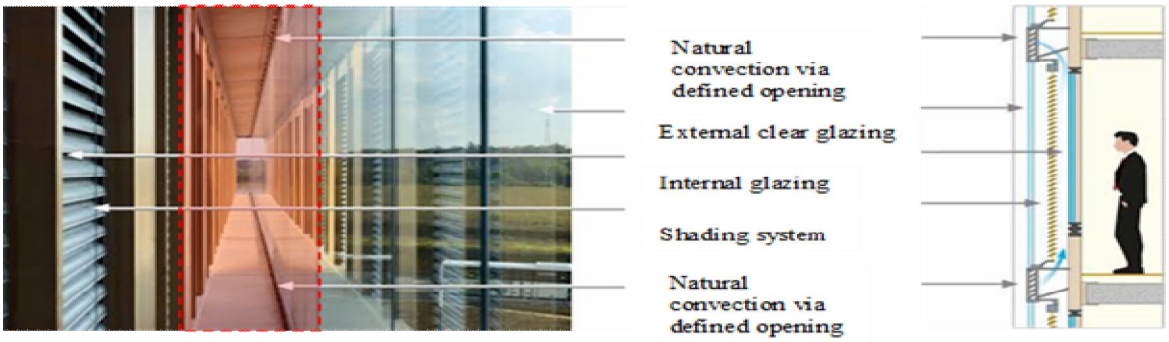


Fig. 13: façade working first technique

2) Second Techniques for facade

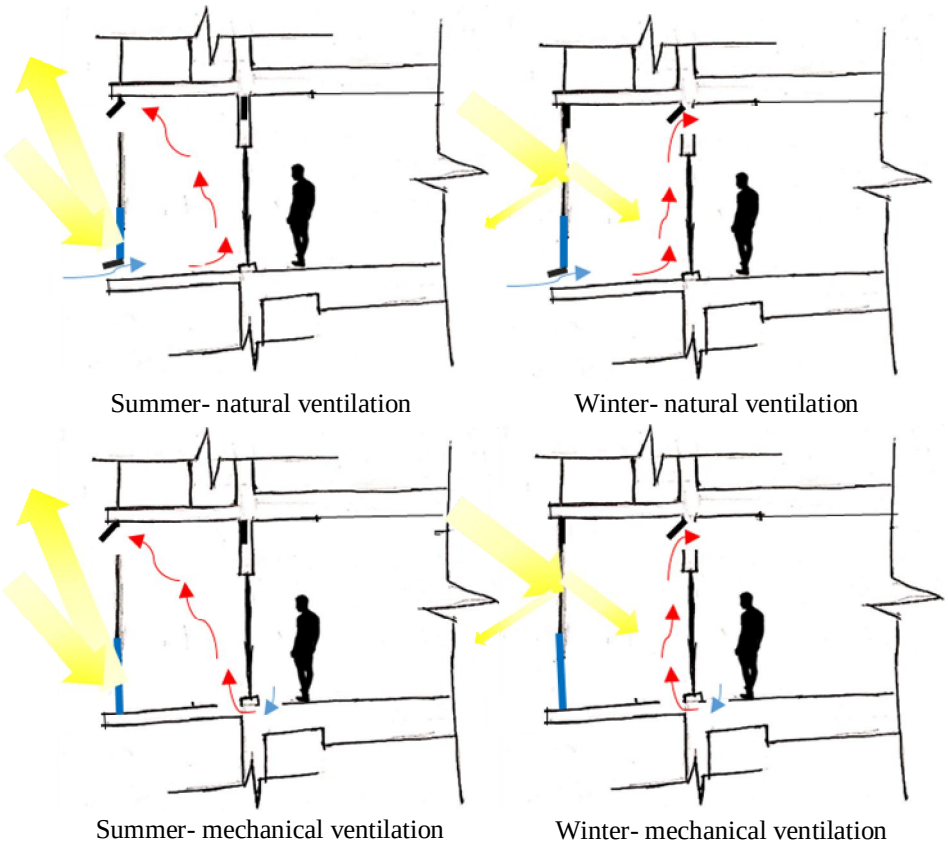
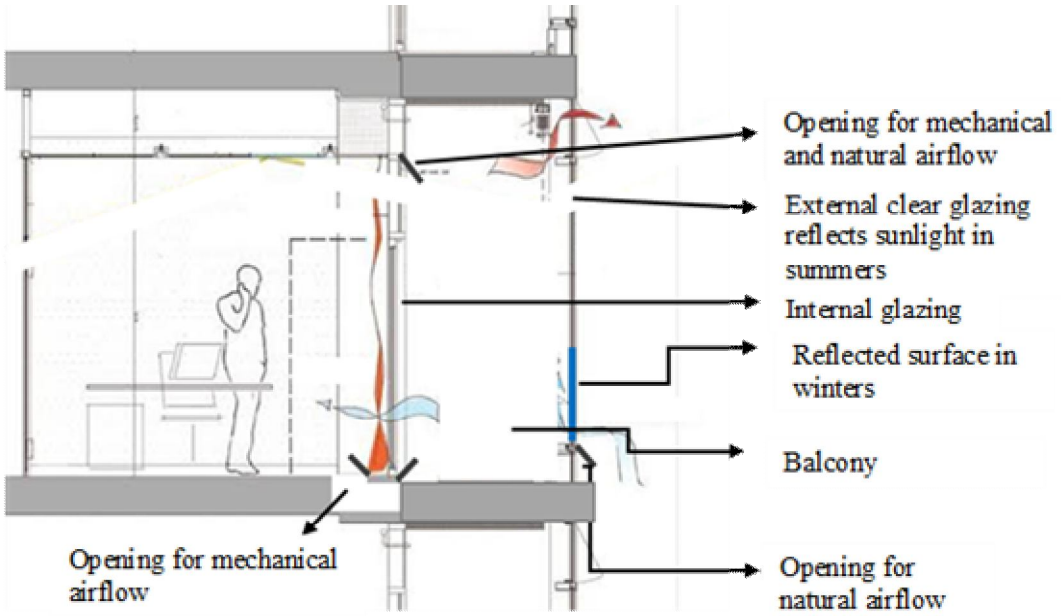


Fig. 14: façade working second technique

In this façade, there is a reflected surface in different areas and the opening for the airflow. Moreover, in this also the balcony area and there is external glazing.



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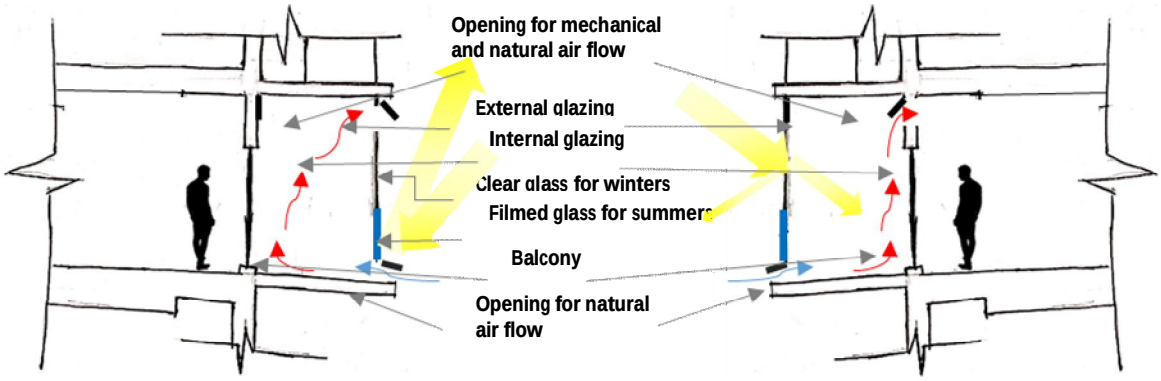
X. GUIDELINE FOR MASSING MULTI-FUNCTIONAL FACADE

Sun is moving from east to west via south so in the day time sunlight is maximum in east, south, and west and the north side is only diffused light is present so these are the Guideline for the different side of the façade that is-

A. Different Techniques for east, South and west Side of Façade

In this direction of façade use different glass (clear glass for winters and filmed glass for summers), and airflow shafts, and movable louvers. These double-skin façade spaces use different uses in first use as balcony shown in fig. 13 and the other one is used for the wind flow shown in fig. 14 which is used for the office building, hotel, and other buildings.



Summer- natural ventilation Winter- natural ventilation

Fig. 15: use for hotel building facade

In this technology use half is filmed glass which is reflected up to 15% sunlight and transmitted up to 50% at 86' in summers and save 40-60% energy in summers and half is clear double or single glazed glass which is reflected up to 50% sunlight and transmitted up to 10% at 38' in summers and save 20-40% energy in winters.

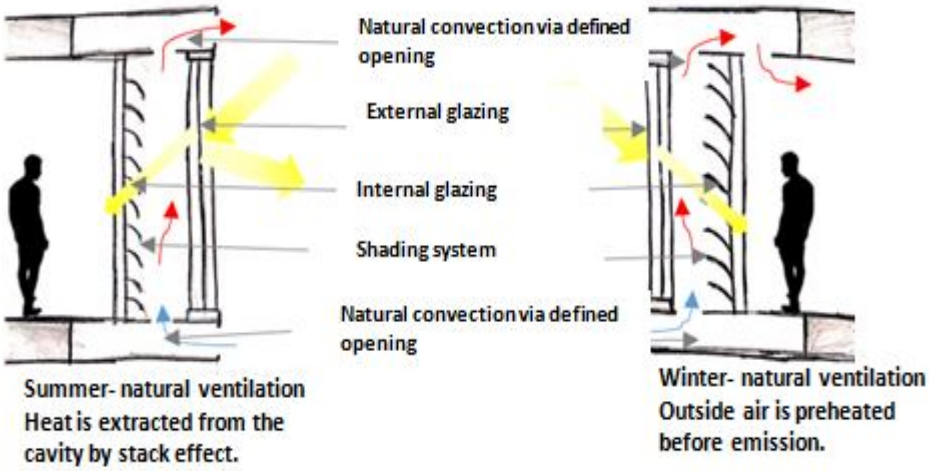


Fig. 16: use for office building facade

This technology uses clear double or single glazed glass, which is reflected up to 50% sunlight and transmitted up to 10% at 38' in summers and also use movable shading, which is control manually, so that it is opened in winter for light and heat and closed in winters and save up to 30-40% energy.

B. Glass Façade for north side of facade

In this direction, use of glass façade glazing for the defuse sunlight for the internal areas. This façade is fixed and operable for both uses.

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C. Table of different glasses

In this table, various glass types reflect, absorb, and transmit heat, light, and U.V. rays in interior spaces so that which kind of glass is suitable for a different type of buildings. This glass use in future construction to that save maximum energy per day.

S.No	Glass	Heat transmitted	Absorbed heat by glass	Entered light	Entered U.V. rays	Reflected light	Reflected U.V. rays	Reflected heat	Heat loss reflection	Energy save (/day)
1.	Clear glass									
a.	Clear glass, glazed glass	77%	8%	81%	58%	19%	42%	10-15%	50%	10-20%
b.	Tinted grey, double glass, and clear glass	50%	10-20%	45%	21%	55%	79%	15-30%	54%	20-40%
c.	Double glazed with standard low-E	56%	9-12%	69%	49%	31%	51%	10-30%	72%	25-35%
d.	Double glazed with high-performance low-E	62%	5-9%	80%	48%	20%	52%	9-29%%	78%	25-30%
2.	Filmed glass	6%	38%	20%	10%	56%	15%	40-56%	---------	40-60%

XI. CONCLUSIONS

In the above table, these two glasses save maximum energy in winters and summers.

1) Tinted grey double glass and clear glass use in winter, which is
a) reflect 55% sunlight,
b) Transmitted 45% sunlight
c) transmitted 50% heat,
d) Reflect 15-30% heat
e) Reflect 79% U.V. rays
f) And save 20-40% energy in winters.

2) Filmed glass use in summers which is
a) reflect 56% sunlight,
b) Transmitted 20% sunlight
c) transmitted 6% heat,
d) Reflect 40-56% heat
e) And save 40-60% energy in summers.

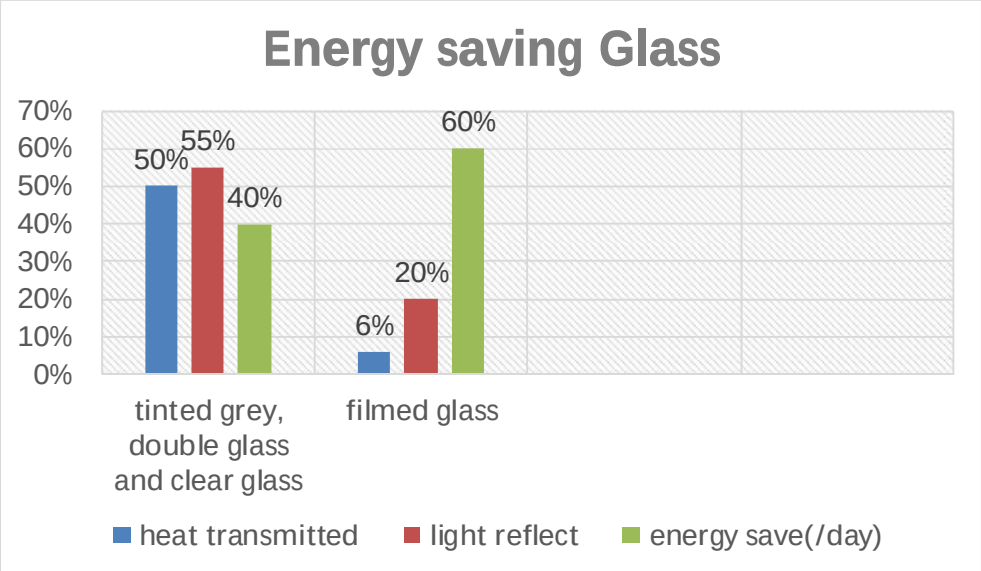

Fig. 17: Energy save by the buildings

XII. ACKNOWLEDGMENT

The study has followed a long and winding path along which I meet many people, this formal space to acknowledge their contributions is too less. Yet, I would say that the distribution of my gratitude to all these supporters from different places is proportionate and equitable. I would like to thanks all my teachers, friends, and colleagues at the Faculty of Architecture, Lucknow, for their help to make this endeavor possible, and special thanks to my friend Ansh Mishra, Saloni, Shivani, Aashna, and Ritika for appreciating and helping me in this research work. Firstly I would like to thank my guides and advisors, Pro. M. Sabahat Sir, Pro. Salman Nasir Khalil Sir, Pro. ICVS Sir, and Pro. Tauseef Rahi Sir guided me in selecting the final topic and giving me information about my dissertation topic. I would not have been able to do the research and achieve learning in the same manner without their support and instructions to assemble and finish the Dissertation effectively.

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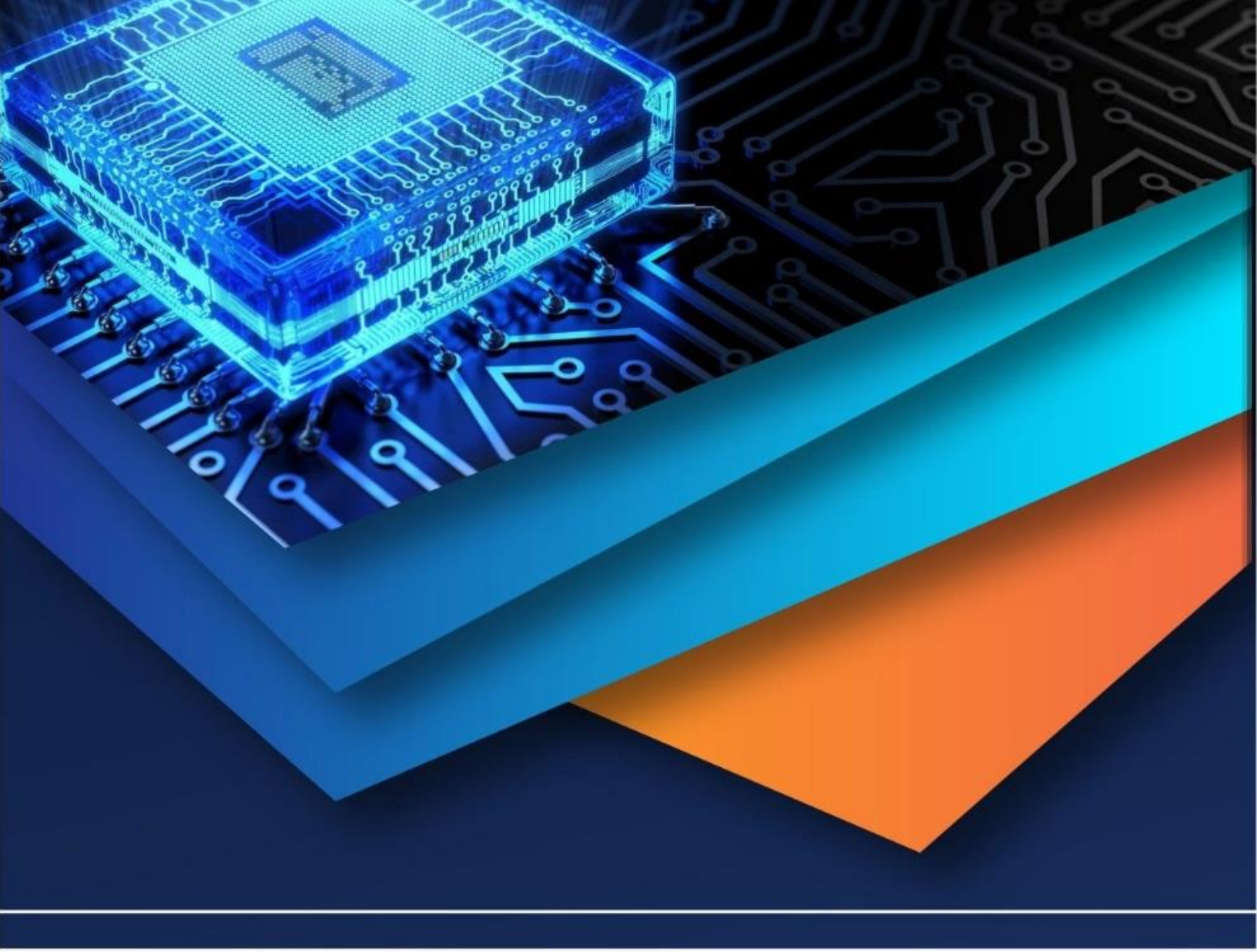
REFERENCES

[1] Xin, Hew Zhi, and Rao, S.P., 2012-13, Active energy-conserving strategies of the Malaysia Energy Commission diamond Building, Malaysia, ELSEVIER
[2] Wong, Mun Summ and Hassell, Richard and Phua, Hong Wei, 2018, Active energy Conservingg strategies of the Malaysia Energy Commission diamond the building, Singapore, Active energy-conserving strategies of Malaysia Energy Commission Diamond building
[3] Wilson, Marc, 2014, CSR & The global compact, Indonesia, AG5,
[4] Lumpur, Kuala, 2017, Architecture Malaysia, Malaysia, RM18.50, ISSUE 5 2017, BI- MONTHLY
[5] Reimann, Gregers, 2 june 2016, Application of Innovative Daylighting in High-rise Buildings (Malaysia),Malaysia,I|E|N,Consultant
[6] Semy, Gwahyulo and Colney, R.Saizampiua, Climatology (AR-307),
[7] Souza, Eduardo , Sep 17, 2019, How Do DoubleSkin Façades Work? https://lopesdias.com.br/en/howdodoubleskinfacadeswork/
[8] Sheikh, wajiha Tariq and Asghar, quatrain, September 2019, Adaptive biomimetic facades: Enhancing energy efficiency of highly glazed buildings, Lahore, Pakistan, volume 8,issue3,KeAi
[9] Meuron de, and Herzog, 2018, Tai Kwun, Centre for Heritage & Arts, Hong Kong, China,2016-18,weArch,Progetti
[10] Herzog & de Meuron, Tai Kwun, Centre for Heritage & Arts, Hong Kong, China, 2006- 18, Photo: © Iwan Baan.
[11] One tat seng (world-architects.com), Goy Architects, Fabian Ong
[12] Gran Rubina AG5 (swiss-architects.com), AG5
[13] Oasia Hotel Downtown STX Landscape Architects (world-architects.com), STX Landscape Architects, Patrick Bingham- Hall
[14] 6.1 Hongkong and Shanghai Bank | Sigit Kusumawijaya's Course [: Sun wind water earth life living; legends for design] (wordpress.com)
[15] Multi-functional Facade Module (MFM) for different climate conditions (https://issuu.com/) https://www.reading.ac.uk/
[16] https://www.mindat.org/climate.php (**The Köppen Climate)**
[17] https://cordis.europa.eu/
[18] https://www.unstudio.com/en/projects
[19] https://www.archdaily.com//
[20] https://www.designbuild-network.com/projects/media-tic/



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