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Double Skin Facade & Its Impact on Energy Reduction

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ABSTRACT: Society and the infrastructure are significantly dependent on energy and due to rise in the energy demands for the proper functioning of the building, there is a huge load on the available limited resources around. Therefore, the concept of sustainability is introduced to promote the use of natural renewable resources by applying the various techniques and practices. So, various solutions have come up to reduce the energy consumption of building in order to step towards sustainability approach. By using the double skin facade (DSF) in buildings external facade, the available energy resources can be used in more efficient way. The external facade of building has a major role to play in the energy consumption, performance and interior environment of the building. In buildings where exterior glazing is used on large scale the Double skin facade is the appropriate solution that can control solar heat gain, can reduce the cooling and heating demand by reducing the heat loss and also can minimize the wind and acoustic effects. Therefore, the aim of this paper would be to understand the basic functionality of double skin facade, its impact on interior environment of the building and the level of energy reduction achieved by double skin facade.

KEYWORDS: Double Skin, Facade, Energy Consumption, Solar Heat, Natural Ventilation.

INTRODUCTION

The ever-increasing population and the consequent growth in demand for newer buildings, construction projects, materials and construction methods has led to an increase in production and inventory of materials in construction sites. A significant gap was observed between the supply and demand of various materials, in a study conducted by the Material Consumption Patterns of India (2016) (Rastogi & Paul, 2020). Projects and buildings are planned and developed to fulfil the needs of clients, users, community and professionals involved. These buildings are also expected to support daily activities and quality of the occupant space, for which the quality and type of materials and technologies used are important (Seshadhri & Paul, 2017).

Materials, designs and construction techniques that have standardized production and installation processes are helpful in maximizing benefit and value from a project. Constraints and peculiarities on site can also motivate the project managers and designers to modify and improvise as per requirements. (Paul, Khursheed, & Singh, 2017) Inadequacies in existing materials and construction techniques and the need to improve quality and speed of construction can provide opportunities for growth in development and research of newer, detailed and appropriate processes and methodologies. (Paul & Seth, 2017) It can also prove to be beneficial for the decision makers and building professionals to prioritize the maintenance and management processes according to availability of funds, importance, etc. (Seshadhri & Paul, 2018).

Double Skin Facade

Solar heat gain from the radiations of the sun results in major demand of the mechanical load on a building. External facade of building is main factor for solar heat gain. Therefore, the type of facade used for a building exteriors work has major contribution to the mechanical load inside the building. More the value of solar heat gain less will be the comfort level inside the building which results increasing demand of mechanical load. Buildings with high mechanical load require high energy consumption which majorly comes from the non-renewable energy sources and upcoming future generations may face the scarcity of natural renewable resources. Therefore, to accelerate and improve the sustainability approach, the concept of Double Skin facade is adopted globally which minimizes the solar heat gain through various techniques which helps to reduce the energy requirement of the building. (Mostafa M. S. Ahmed, 2016)

Double skin facade is a system consists of two glaze shells having intermediate cavity between shells and these shells are commonly known as skins. A ventilated cavity is located between these two skins having a variable width ranging from several centimeters to several meters. Thermal buffer zone is formed between these skins which reduces the heat losses and enables passive solar gains (Alibaba, 2015). Outer facade plays an important role to prevent the waste of the generated heat and cold which subsequently saves a considerable amount of energy consumption. The surrounding characteristics have a considerable impact on the performance of DSF and internal energy requirement. For same type of building, ventilated cavity keep changes as per the surrounding & climatic conditions. Cavity depth ranges from 200mm to more than 2m is observed from major studies on DSF which is majorly depend on the characters like Maintenance, natural ventilation through cavity and greenhouse effect and thermal comfort. It has direct impact on directly influences the cooling and heating load of the adjacent built form. So, it is necessary to consider a proper cavity depth depending on climatic environment in the area of building location. (Alibaba, 2015)

Objectives

- To understand the various components & functional characters of double skin facade
- To study its impact on interior environment and reduction in energy consumption of building.

LITERATURE REVIEW

Components of Double Skin Facade

Ventilated Cavity: The intermediate gap between the inner and the outer skins that can be totally natural, fan supported or mechanically ventilated. This cavity width varies from 200mm to more than 2m. These cavities are provided with metal walkways or grills at each floor for many purposes like maintenance, cleaning and sometimes also for fire escape. The cavity provides resistance against winds, noise and temperature. In winters the same cavity creates the thermal buffer zone which minimizes the heat losses and activates the passive thermal gain from solar radiation. (civilenggseminar, 2016)

Exterior & Internal glazed facade: The exterior wall provides the protection against weather and sound. It is basically a single layered heat-strengthened safety glass or laminated safety glass. Spectrally-selective glazing is used sometimes as it allows daylight but prevents the transmission of solar heat inside the building. Usually, this layer is a hardened single glazing. In internal facade there is a thermal insulating single or double glass panel with solar control

or low Emissive coating to reduce heat gain which may allow natural ventilation to the offices. This layer has operable casement or window and somewhere a sliding glass door. Usually, this layer is not completely glazed. (civilenggseminar, 2016).

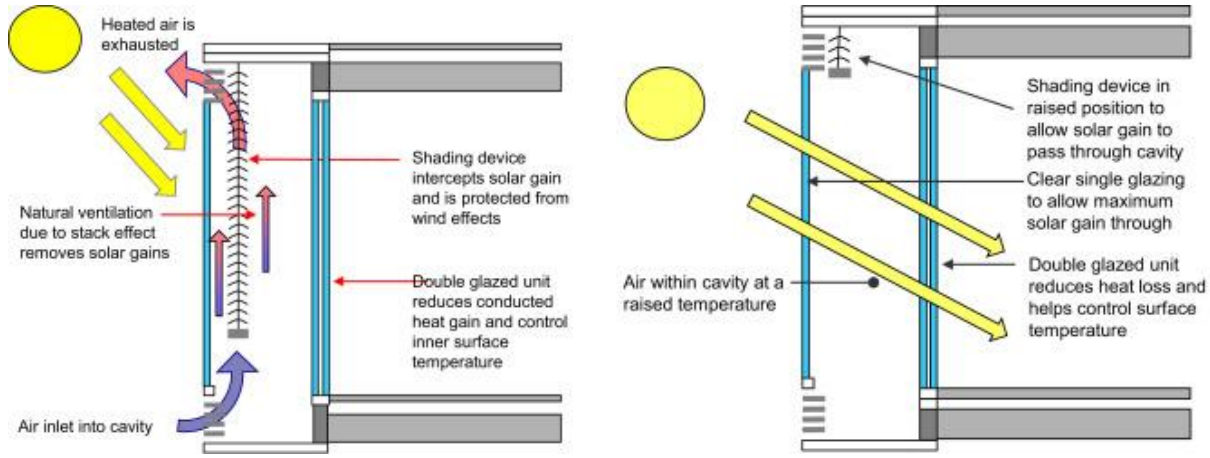

Figure 1: Summer & Winter Day operation of DSF (Google Image- Science direct.com)

Shading devices: Shading devices like Blinds, roller shades, louvers, motorized openings, or fans, are placed in the cavity to provide a complete screening or a cut-off, to allow diffused daylight and minimizing the solar heat gain. (civilenggseminar, 2016)

Classifications of Double Skin Facade

Double skins are classified into following types as mentioned below.

Box window type: It is the earliest form of a DSF and in box window types the horizontal and vertical partitions splits the facade into smaller and independent parts which allows air exchanges (Poirazis, 2006).

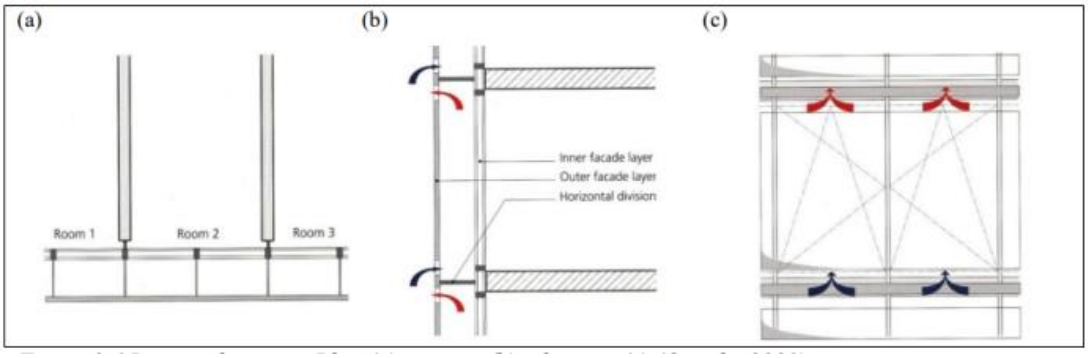

Figure 2: Box Window Type: (a) plan, (b) section, (c) elevation (Azarbayjani, 2010)

Shaft box type: A group of box window elements are put in the facade. These elements are connected through vertical shafts and these shafts establish an increased stack effect (Poirazis, 2006).

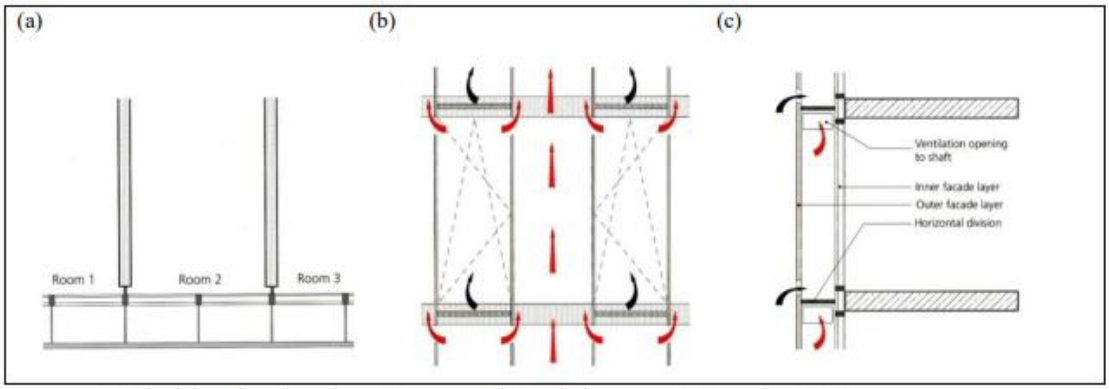

Figure 3: Shaft Box Type: (a) plan, (b) section, (c) elevation (Azarbayjani, 2010)

Corridor Facade: In corridor facade the floor wise horizontal partitioning is done for acoustical, fire security or ventilation purposes. Air can freely flow within the cavity on each floor. (Poirazis, 2006)

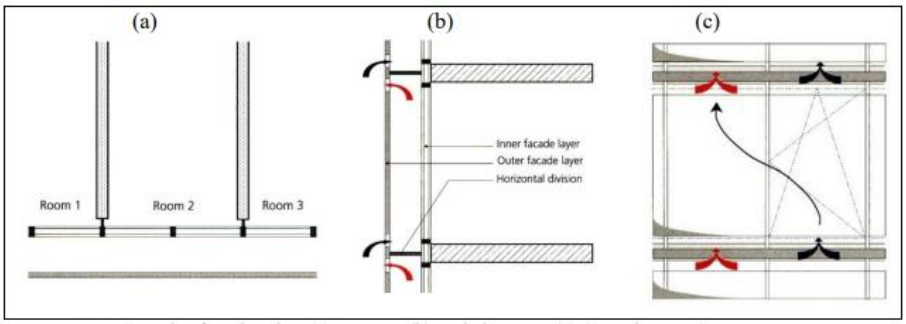

Figure 4: Corridor facade type: (a) plan, (b) section, (c) elevation (Azarbayjani, 2010)

Multi story double skin facade: In Multi story DSF the two skins are free from horizontal or vertical partitioning. The ventilation in cavity is bringing out through large openings near the floor and the roof of the building. (Poirazis, 2006)

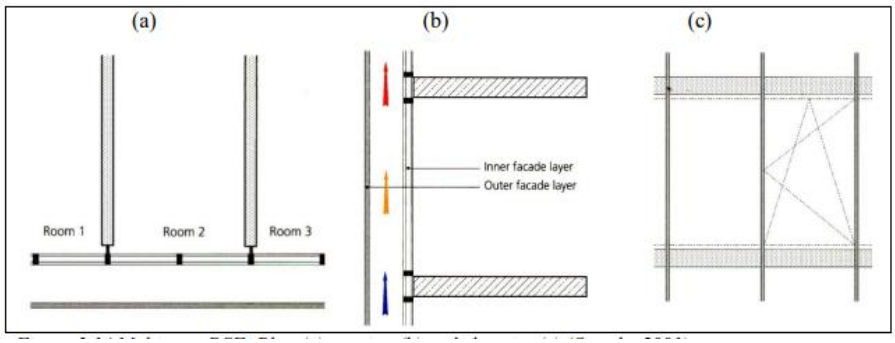

Figure 5: Multi story DSF: (a) plan, (b) section, (c) elevation (Azarbayjani, 2010)

Types of Ventilations

The ventilation of cavity between the two layers of facades can be achieved through different features :

Natural Ventilation: In natural ventilation the hot air present in the cavity moves upward and the fresh air flows inside the cavity. Hence the occupants have access to the air flow. The

natural ventilation results in notable reduction in energy consumption of the building. (Faod Faizi, 2014)

Mechanical Ventilation: In mechanical ventilation, air flows with the help of powered air movement component through mechanical means operated by power and hence requires some amount of energy which increase the energy consumption of the building. (Faod Faizi, 2014)

Hybrid Ventilation: Combination of both natural and mechanical ventilation in which the mechanical ventilation is bring in use when the natural ventilation is not enough to fulfill the thermal comfort inside the building. (Faod Faizi, 2014)

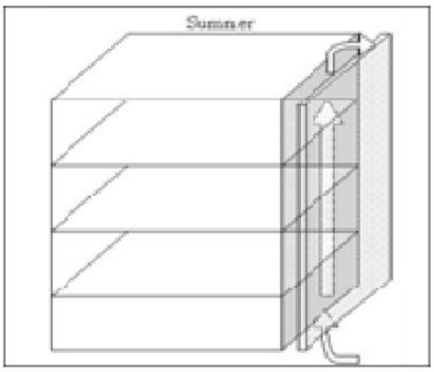

Figure 6: Natural Ventilation (Faod Faizi, 2014)

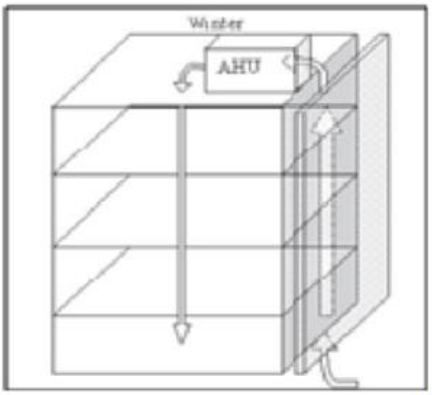

Figure 7: Mechanical Ventilation. (Faod Faizi, 2014)

Merits & Demerits of Double Skin Facade

Double skin facade has various merits over the single facade system and due to some demerits, it is not commonly used. Some of Merits and Demerits of DSF are listed below:

Merits	Demerits
Energy savings & Thermal comfort	High cost of construction
Aesthetics & Transparency	Overheating issues
Protection to the shading devices	Increase air flow velocity
Low U-value & g-value	More construction weight
Reduced Energy consumption & wind pressure effects	Additional maintenance & operational costs

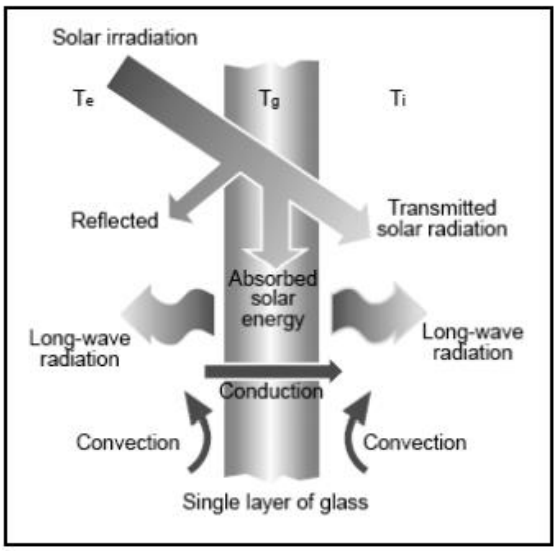

Figure 8: Heat transfer through a single pane of glass (Yellamraju, 2004)

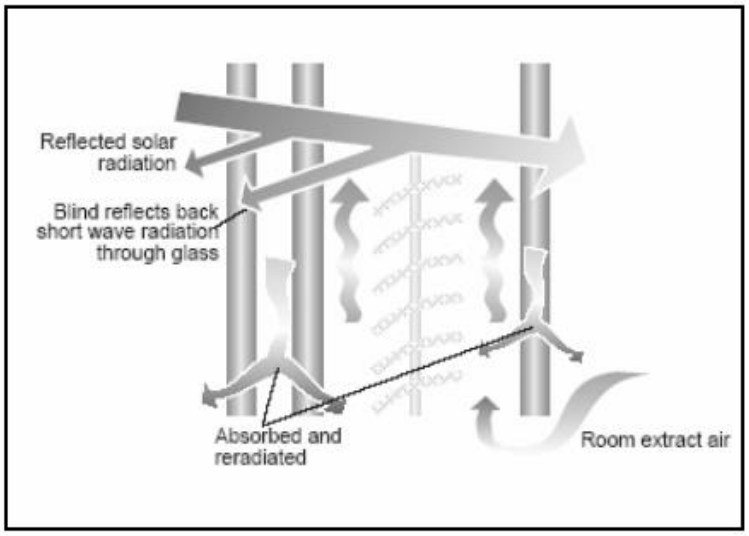

Figure 9: Heat transfer through a double skin facade (Yellamraju, 2004)

Reduction of Energy consumption in Double Skin Facade

By using the double skin facade system in a building the heating which is received through the cavity can be reduced by exhausting the heat to the outside environment. By virtue of this, the HVAC systems can be partillay shut out. (Mostafa M. S. Ahmed, 2016) Sunscreen louvers or special daylight systems can be integrated in the cavity between external and internal layers to protect the building from overheating in summer and save energy. Special daylight systems direct natural daylight deep into the rooms and save energy for artificial lighting. Therefore, the double skin facade is helpful to reduce energy consumption in both summer and winter. DSF also improve the access to day lighting in the space with their increased glazing coverage which causes to reduce the amount of electrical lighting and hence increase a sustainable factor to the building. DSF system helps in minimizing the enrgy demand and it contributes towards the sustainablilty.

Thermal action of Double Skin Facade in different weather conditions

In summer, when solar radiation passes into the building, it gets absorbed by the building and re-radiated as long-wave infrared energy that does not pass back through the glass. Hence, the air present in the cavity gets heated via convection and the hot air flow in the cavity can pass through the glazing outside and inside the space via conduction. As the cavity heat up, the stack effect is raised respectively, as well as the blinds present between the two skins of glass minimize the solar heat gain (Faggal, 2014). In winter, when the intermediate gap is partially or completely closed during the heating period. The external additional shell helps to improve insulation to the building. Inside the cavity due to the decreased air flow speed and increased temperature which lowers the heat transfering rate on the surface of the glass which helps to reduce heat loss. Hence high temperature on the inside part of the interior pane can be maintained (Faggal, 2014).

CONCLUSION

Nowadays, buildings having DSF are helpful to minimize the total energy requirement by 65% and running costs of building by 60 % and 50 % less carbon dioxide emission in comparison to single skin facade system. Therefore, buildings with DSF are exceptionally useful & significant in enhancing the sustainability & development. DSF reduces heat loss, external noises and save energy. DSF system is helpful to minimize the energy consumption & provides the thermal comfort to the interior environment of the building. In summer, DSF reduces the thermal energy with the help of natural & mechanical ventilation through the intermediate gap between the inner & outer facade. On the other hand, DSF allow heat through solar heat recovery in winters. It also improves the day light and provides better view to the outside of the building. However, high cost is one of the demerits of double skin facade but DSF is cost effective in long term as it is more durable and long lasting when compared to the single glass facade system. Hence it helps to achieve the sustainability goals.

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