



The Concept of Double Skin Facades of Office Building in Malaysia

Nur Athirah Ibrahim¹, Ruslinda Abdullah², Siti Rahayu Ab Razak^{3*}

^a Politeknik Port Dickson, Negeri Sembilan

¹athirah@polipd.edu.my, ²ruslinda@polipd.edu.my, ³sitirahayu.poli@1govuc.gov.my

Abstract

The issue of global warming was intensified said among of the researchers recently. It happens more so in the urban areas where most buildings were built too high and dense with structures, vehicles, goods, dwellers, visitors, wastes or any sources of pollutants. The price of the allocated land in urban areas was too expensive and very limited for designers to explore the green elements to implement and improve the ecological habitats as well as to beautify the urban landscape. The idea of the green wall system on façade is one of the most favourite solutions for designers to achieve the green building design which currently related to energy efficiency. This system can be placed during the design concept stages or later be installed to the existing building wall commonly known as a **Double Skin Façade (DSF)**. This particular system is not new in the market. However, there is growing tendency from the architects to put it into practice for certain buildings at certain places even the construction types can be differ from one location to another. This paper represents the findings of a team who have conducted an initial investigation into double skin cladding systems in Malaysia. The study focused on the flexibility approaches that improved indoor climate and reduced use of energy if it has been designed properly to meet the climate changes. It also discussed about the advantages and disadvantages of Double Skin Façade which found in different literature sources as described. Further discussion is about the implementation of the system in Malaysia based on the examples of office buildings.

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Key-word: - Double Skin Façade, green building, sustainable design

1.0 INTRODUCTION

Energy efficient building or sustainable building design is now a great concern among researchers as a global energy demand. *Natural Ventilation, Daylighting, Double Skin Façade, Orientation* and etc, were taken into consideration in their research for a better building design. An active façade function as a covering or enveloping the building interior which is made mostly of glass, thus serving also as a protective cover from the strong sun outside, filtering it into the building via small vents that can be air tighten or not. In this façade, the air cavity situated between the skins is naturally or mechanically ventilated. It is also known as DSF where originated from European Architectural trend driven mostly by the aesthetic desire for the usage of glass façade that leads to increase the image of transparency and openness convey to the public. The system also related to the practical need to improve indoor space and concerning the acoustics in buildings located in highly noise areas. The system usually applied in high-end commercial projects but it still can be developed to other projects to reduce the energy use for the occupant's purposes as they are aesthetically appealing. But foremost, it has been developed to increase human comfort and decreased energy consumption to the building. Eventhough the concept of DSF is new to the Malaysian market; there is a growing tendency by architects and engineers to use them currently in their design. Lots of project growing and using the system as part of the design approach.

* Nur Athirah. Tel.: +0123947946 ; fax: 066622026

E-mail address: ruslinda@polipd.edu.my

Previous research has been made focusing mostly in the architectural part where it emphasizes on architecture of the façade in general, fully glazed facades, office floor plan layout for a better utilization of perimeter area and the improvement of environmental profile of the building through the indoor climate in terms of thermal comfort, DSF also known in different ways include Double Envelope, Dynamic Façade, Double Layered Glass Façade, Double Skin Curtain Wall, and etc. It is also important to mention that in this first step it was considered important to present the function and the impacts of the mentioned system from different point of views.

2.0 SCOPE OF STUDY

The aim of the study is to describe the concept and effectiveness of the DSF based on the implementation in a few office buildings in tropical country such as Malaysia where temperature rises in daytime and goes beyond to comfortable limit. In addition to understand the system works, this paper also discussed about the types of the DSF which commonly used in the market with respect to the ventilation method and their ability to reduce overall energy consumption. The study also referred to the previous researches on the DSF system about the basic understandings, principles and application to the building design especially in sustainable construction in Malaysia. This paper focused only on recent case study which has implemented the DSF as a method of Green Building design. The case study also can determine the effectiveness of the DSF as an appropriate method to increased human comfort and reduce the energy consumption.

3.0 METHODOLOGY

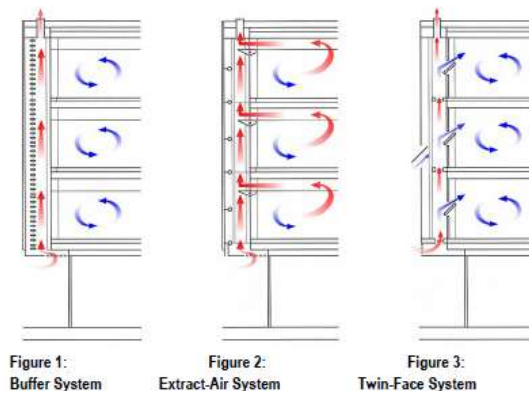
The following methodology was used during the case study process for example; identifying the field of study that need to be conducted, interview session, photograph analysis, and searching for information from the books and internet.

- a) Interview session of 20 random people from workers and visitor at Port Dickson especially in office buildings and shophouses; seeking information and their knowledge on the DSF.
- b) Comparative building analysis within country to identify the advantages and disadvantages of the effectiveness of DFS.
- c) Data collection based on the interview session related to the previous case studies and researches where the problem of the internal buildings was identified based on the objective and scope of study as a guideline during the investigation process.

4.0 CLASSIFICATION OF DOUBLE SKIN FAÇADE

i) Buffer System

They predate insulating glass and were invented to maintain daylight into buildings while increasing insulating and sound properties of the wall system. They use two layers of single glazing spaced 250 to 900 mm apart, sealed and allowing fresh air into the building through additional controlled means. Shading devices can be included in the cavity. (Refer to Figure 1)



Clipped from Understanding the General Principles of the Double Skin Façade System by T.M. Boake, 2003

ii) Extract Air System

These are comprised of a second single layer of glazing placed on the interior of a main façade of double-glazing. The air space between the two layers of glazing becomes part of the HVAC system. The heated "used" air between the glazing layers is extracted through the cavity with the use of fans and thereby tempers the inner layer of glazing while the outer layer of insulating glass minimizes heat-transmission loss.

These systems tend not to reduce energy requirements as fresh air changes must be supplied mechanically. Occupants are prevented from adjusting the temperature of their individual spaces. Shading devices are often mounted in the cavity. Again the space between the layers of glass ranges from around 150 mm to 900 mm and is a function of the space needed to access the cavity for cleaning as well as the dimension of the shading devices. This system is used where natural ventilation is not possible (for example in locations with high noise, wind or fumes). (Refer to Figure 2)

iii) Twin Face System

This system consists of a conventional curtain wall inside a single glazed building skin. This outer glazing may be safety or laminated glass or insulating glass. Shading devices may be included. These systems must have an interior space of at least 500 to 600 mm to permit cleaning. These systems may be distinguished from both Buffer and Extract Air systems by their inclusion of openings in the skin to allow for natural ventilation. The outer glass skin is used to block/slow the wind in high-rise situations and allow interior openings and access to fresh air without the associated noise or turbulence. Windows on the interior façade can be opened, while ventilation openings in the outer skin moderate temperature extremes within the façade. For sound control, the openings in the outer skin can be staggered or placed remotely from the windows on the interior façade. (Refer to Figure 3)

iv) Hybrid System

The hybrid system combines various aspects of the above systems and is used to classify building systems that do not “fit” into a precise category. Such buildings may use a layer of screens or non-glazed materials on either the inside or outside of the primary environmental barrier. The Tjibau Center in New Caledonia by Renzo Piano may be used to characterize this type of Hybrid system. (Refer to Figure 4)

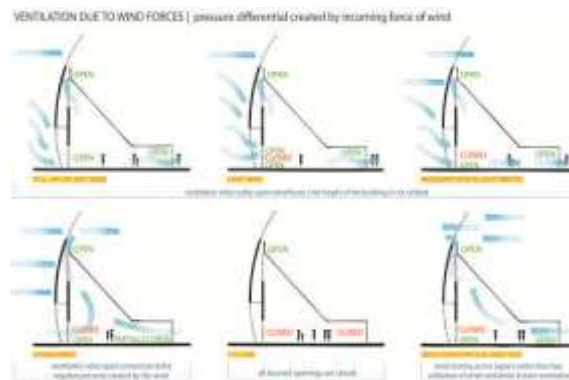


Figure 4

5.0 DSF AS A SUSTAINABLE STRATEGY FOR OFFICE BUILDINGS

DSF technology is a starting point to develop a strategy to integrate high-rise office or commercial buildings into the realm of sustainable architecture. Not as a comprehensive solution but as a component of integrated system of building design. At the first place, it is not acceptable when the premise that fully glazed office tower is an effective design in terms of energy efficiency. The uses of DSF increase the potential of this building design to come more in line with the sustainable architecture. The advantages of this system are improved occupant control over local environment with operatable windows and shading devices for natural ventilation behind the exterior glazing, as well as the lighting requirements. The twin face façade offers strategies for use and control of solar heat gain, increased daylight and moderation of temperature differences. It is only system at present that offers a range of natural ventilation strategies to the occupants. The width of the intermediate cavity of a DSF can vary from 20cm to several meters. This results to the loss of useful space and this idea is not acceptable to the developers who just think over the full construction parameter. DSF has higher cost regarding to the construction, cleaning, operating, servicing and maintenance compared to single skin façade. In certain reason, the daylight and the visual comfort is not extensively discussed because once we applied the DSF to the building, it might not give 100% satisfaction in terms of visual comfort.

Advantages mentioned by author	Oeserle et al., (2001)	Compagno, (2002)	Claessens et al.	Lee et al., (2002)	B.B.R.I., (2002)	Aronx, (2000)	Faist, (1998)	Knigh, (2000)	Jager, (2003)
Lower construction cost (comparing to electrochromic, thermochromic photo-chromic panes)	√								
Acoustic insulation	√		√	√	√	√	√	√	√
Thermal insulation during the winter	√	√	√	√	√	√	√	√	√
Thermal insulation during the summer	√	√	√	√	√	√	√	√	√
Night time ventilation	√	√	√	√	√	√			
Energy savings and reduced environmental impacts						√			
Better protection of the shading or lighting devices	√	√	√						√
Reduction of the wind pressure effects	√	√	√						√
Transparency – Architectural design				√	√	√		√	
Natural ventilation	√	√	√	√	√	√	√	√	√
Thermal comfort – temperatures of the internal wall	√	√	√	√	√	√	√	√	√
Fire escape	√								
Low U-Value and g-value		√				√		√	

Table 1: Advantages of Double Skin Façade (Poirazis H. 2004)

Disadvantages mentioned by author	Oeserle et al. (2001)	Compagno (2002)	Claessens et al.	Lee et al. (2002)	B.B.R.I. (2002)	Aronx (2000)	Faist (1998)	Knigh, (2000)	Jager (2003)
Higher construction costs	√				√	√			√
Fire protection	√				√				√
Reduction of rentable office space	√								√
Additional maintenance and operational costs	√		√		√				√
Overheating problem	√	√			√		√		√
Increased air flow speed					√				
Increased weight of the structure			√						√
Daylight	√								
Acoustic insulation	√				√				√

Table 2: Disadvantages of Double Skin Façade (Poirazis H. 2004)

Appropriate design of the air space is crucial to the double façade. The air cavity can be continuous vertically across the entire façade to draw air upward using natural physics principles, divided by floor which is best for live protection, heat and sound transmission or be divided vertically into bays to optimize the stack effect. The DSF incorporates the passive design strategies of natural ventilation, daylighting and solar heat gain into the fabric of the high-rise building. These are the key components of the DSF in respect to energy efficiency and comfort that are controlled by the occupants of certain types of DSFs.

Natural Ventilation

Natural ventilation allows the inhabitant access to air-flow that can be used to cool and ventilate the space. This passive use of air currents over mechanical means of air conditioning reduces the energy consumption of the building and in turn reduces the CO2 output of the building in the operational phase of the building. The exterior glazing of the double skin creates a layer of air next to the exterior wall of the building that is not affected by high velocity wind. This buffer zone, a key component to the DSF, is typically the region accessible by the inhabitants for natural ventilation. In some instances the use of operable windows in the exterior glazing skin is also used for natural ventilation. A typical strategy of the DSF is to compartmentalize the buffer zone into separate regions with air supplied by vents at each level. This compartmentalization eliminates the impact of noise, sound, smoke and heat transfer from one section to incoming air by reducing our velocity, protecting from rain and reducing noise transmission from the exterior.

Solar Heat Gain

The control of solar heat gain with the DSF is obtained through the use of shading devices contained in the air cavity, typically horizontal blinds called shading devices. They can either be fixed elements or operable units that are controlled by the occupant or by sensors within the building. On multistory buildings unprotected external devices are expensive because of the installation cost and safety concerns. They are typically fixed and not usually effective for all sun angle conditions especially with low sun angles in the morning or late afternoon (e.g. Roof-Roof House by Ken Yeang) the double Skin is important because it offers protection from the elements for the shading devices which prevent heat from entering the space. It also allows the use of daylighting and maintains some of the view to the exteriors. Possible to be used at the hotels in Port Dickson since the direct sun path could enter the space and will gain some heat.

Daylighting

Daylighting is important in two ways; first it reduces the amount of electrical lighting required and second is that the quality of light from daylight is preferential to electrical lighting. The DSF with its increased glazing coverage improves the access to daylighting in the space.

6.0 DOUBLE SKIN FAÇADE IN MALAYSIA

The building façade is the interface between the external and internal space of a building. Due to the multiple important roles – i.e., aesthetics, thermal comfort, day lighting quality, visual connection to the outdoor environment – building facades, especially glazing systems, have received high attention in research and development. More projects today are integrating green sustainable designs to meet the increasing demands for environmentally friendly developments example Wisma Rehda, the Rehda headquarters. It stands proud as a green building that has passive ventilation, efficient energy consumption and an effective water conservation system in the heart of Kelana Jaya in Petaling Jaya, Selangor.



Figure 5: The exterior view of Wisma Rehda



Figure 6: West-facing “double-skin” facade minimises heat gain into the building.



Figure 7 Pot-holed block walls provide natural ventilation throughout the building while water features and greenery complement the entrance

Double-skin facade

The building also features “block walls” which function as a second skin to the building’s envelope. Not only does this double-skin feature prevent heat from entering the building but it also acts as natural ventilation. As heat is filtered through the “block walls”, the interiors of the building will be kept cool. Heat gain into the building was minimised during the construction stage of the building. “The double-skin façade on the east and west sides of the building help to prevent heat from coming in without sacrificing daylight. During the day, we receive a sufficient amount of daylight into the building so we don’t have to switch on any lights.” According to Chua, the building is so well shaded from the sun’s heat, that Rehda only requires a minimal usage of air-conditioning.

Integrated of Sun Shading Devices

Sun shading devices, such as operable blinds, can be installed within the ventilated cavity. The insulated glazing is used as the internal skin. It keeps the direct sunlight from shining co-efficiency of facades, and result in less thermal transmission through the facade system.



Figure 8: Sun shading devices integrated with traditional motif as architectural design expression for the Malaysian Ministry of Finance building in Putrajaya, Malaysia

Building Envelope Commissioning

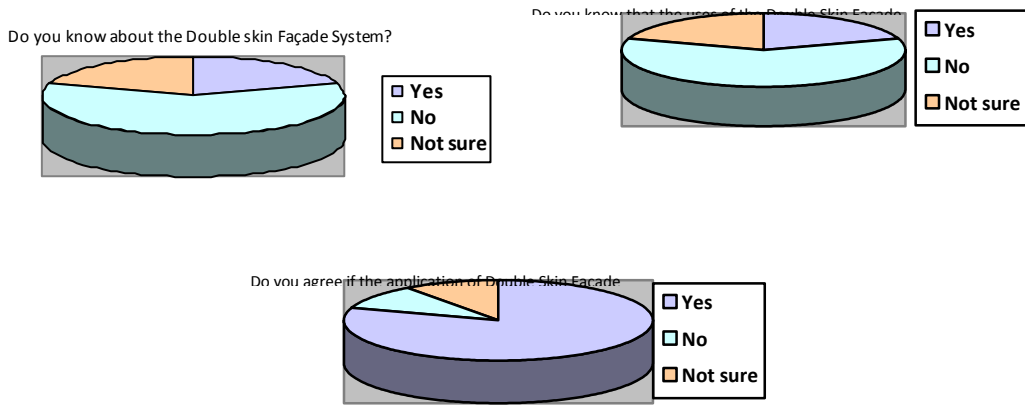
Since the building envelope is one of the most crucial components determining a building’s thermal and energy performance, it is worthwhile for larger-scale buildings and building with complex façade systems to have building envelope commissioning, to safeguard its workmanship, durability and environmental performance. For example Paradigm Mall in Kelana Jaya, Malaysia.



Figure 9 (a) and (b) : Complex Façade system in Paradigm Mall, covering and filtering the direct sunpath to the carpark and part of the offices.

7.0 DISCUSSION

A survey of 20 respondents took place in Port Dickson Town Centre. Most of them did not know about DSF since none of them involved in the construction field. To support the statements, Port Dickson has no building that implemented the DSF. There are few tall buildings located in PD and most of them are hotels and resorts which are not a part of the system. Based on the investigation of the previous case studies, the systems are not cooperating with the visual comfort. Most of them did not know how the system operates and how the DSF function as a method to reduce heat in the building. Almost all respondents agreed if the application of DSF can be implemented to the building in Port Dickson if it certainly could reduce heat and increase the human comfort. Few of them not really sure about the implementation of DSF that will cover the wall and definitely will block the view to the sea. This circumstances will come to exceptional of building function where most of the DSF are suitable to the office building when most people or occupant will spend most time from 8 to 5 or more in the space.



8.0 CONCLUSION

Referred to the study that has been done, DSF system is particularly suitable for the application on the part of the Hotel and most suitable for the usage of office buildings which is currently not implemented in Port Dickson. This is also because the system is effective to deflect and reduce the heat from entering directly into the building. Other than that, it is able to absorb noise and thus can help to reduce global warming. Based on the site study and research findings, issues raised from the problem of heat from direct sunlight to the building wall. Air polluted occurred from the road from vehicle's smoke. The building façade are obviously looks like a simple façade which not attractive to some of people. The building using vertical landscape as a shading device but it is not covers in the whole part of the building which are not focusing on reducing the heat for the building. It is only to fulfill the concept of the landscape.

The system can be used to most of the hotel buildings here in Port Dickson since the high rise building can easily receive sunlight without any interference of other buildings surroundings, even more it is close to the coast. The system can be used to the hotel building but in some areas it might be block the views to the sea and people won't be enjoying the wind flows. Anyway, well designed and good arrangement on site result in good daylight penetration to a building's internal spaces without creating a glaze effect or any blocking views. Installation of the systems might involve a high costs but it can save cost in term of maintenance and also during the occupational stage. This will also contribute to electricity saving by reducing the use of artificial lighting. Besides, it offer occupants external views, and enhance the quality of the living or working environment if they fits the system well in the design stage to avoid any circumstances. The depth of this initial study was limited by timeframe, access to property information, access to the site location where the study area hasn't implemented the DSF. To continue the study need to be in more specific areas which have the implementation of DSF system constructed in the building with a different building function that could become the comparative study for other researchers.

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