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Sustainable Building Envelope by Dynamic Facade

A. Mohamed Mansoor[1], M. Rajiv[2], M. P. Salaimanimagudam[3]
[1]Asst. Professor, Department of Civil Engineering, Kings College of Engineering
[2]Asst. Professor, Department of Civil Engineering, Saranathan College of Engineering
[3]Autodesk Student Ambassador & Expert, B.E., Student, Department of Civil Engineering

Abstract*—The principle concern of this paper is to develop the sustainable design of building envelope by using dynamic facade to provide thermal and visual comfort to the occupant , the dynamic facade used to maximize the primary ventilation and passive facade used in south facade side of the building, the thermal analysis and building performance analysis are pre-estimated for the kings college of engineering campus and the thermal and visual uncomforted building is find at last research work.*

The combination of active and passive facade is used to provide optimum ventilation and air flow, green facade used as an passive facade to reduce the direct sun radiation on the south facing external wall, the solar cladding and the Dynamic facade is used an active facade to increase the ventilation and to generate the solar energy, the Dynamic facade reduce the wind load over a building

The Dynamic facade have the kinetic movement depending on the sun path and its maximize the Air flow and ventilation and power supply for the Dynamic facade is taken from the solar cladding and this design made the building as an sustainable building.

***Keywords*—** *Dynamic facade; solar cladding; sustainable design; Green Facade; Thermal Comfort; Building Integrated Green Facade; Autodesk Formit 360; Autodesk Insight; Autodesk Flow design*.

I. INTRODUCTION

Shelters created by humans first to provide thermal comfort and protection from natural elements, and this still remains a primary objective of buildings. The building envelope act as the physical separator between the exterior and interior of a building.

Components of the envelope are typically: fenestrations and doors walls, floors, roofs, opening in the structure is named as Fenestrations: Clerestories, windows, skylights, etc. When designing the building envelope, building materials are important for knowing some fundamentals of and heat transfer will help you make the right trade-off decisions.

A. Envelopes For Climate Types

A envelope well-designed to responds the local climate. there are many climate around the globe are classified into four types, but the following four common extremes shows that people design for. These strategies, or mix and match used for milder climates for milder versions.

B. Arid Climate Envelope

Arid climates are hot, and usually very dry, but large swings of temperature often from day to night. Thus thermal is most crucial design strategy mass on the outside of the building is the to even out such temperature swings. For consistently hot and very dry locations, it also helps to have shaded breezeways, high ceilings, daylighting, and light colors via reflected light (not direct sun), Courtyards with natural ventilation and fountains or pools can provide evaporative cooling as well.

C. Tropical Climate Envelope

Tropical climates are humid and hot. Therefore, keeping the maximizing ventilation, as well as heat of the sun off is the top priority—essentially a reflective insulated roof with walls that pass breeze but not rain is ideal. This traditional housing thicken light colour thatch roof reduced the solar radiations, while porous bamboo and open eaves slats for floor maximize natural ventilation and walls. The materials are all low-mass to avoid condensation and mould growth, High-mass materials in humid climates can happen. (Note: Jalousie windows are found in the tropics, but are not as common, because they are so porous to the breezes.)

D. Cold Climate Envelope

Cold climates have many less cooling degree days than heating degree days. Thus windows for solar gain on thermal mass inside the building envelope, as well as maximizing insulation is the key to keeping warm using (not outside as in arid climates). Part of having effective insulation in cold climates is an avoiding infiltration, air-tight envelope. This Finnish cabin has very small and very few windows except on the south side, to maximize solar gain while minimizing losses elsewhere. Before modern insulation, better insulation provide by thick solid log walls such as they board walls could.

E. Mixed Cold / Hot Climate Envelope

Many “temperate” inland climates have two extremes--Hot and humid, cold in winter in summer. Flexibility is created for design of these climates. The Aldo Leopold Center in Wisconsin, the first building to be LEED certified as carbon-neutral, deep overhangs is used to allow low winter sun in through the windows raise the temperature of high mass inside the concrete slab, while blocking high summer sun with more radiation . It also uses a darker walls and light roof to repel summer sun but it absorb winter sun. Extra insulation retains, operable windows passively cool it in summer, but heat in winter.

II. ENVELOPE ENERGY FLOWS

From an energy flow perspective, the envelope is a composition of layers with varying permeability and thermal properties. The envelope may be composed of membranes, blocks, sheets, and preassembled components. The choice of envelope is governed by the culture, climate, and available materials. The range of choices in envelope design can be

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illustrated by two opposite design concepts; the closed shell and the open frame.

In heavy climates, the engineers and designer frequently conceives and made chance in the building envelope as an closed shell or partially closed shell and to proceeds the selectively punch holes in it to make special and limited contact with the outdoors. This may also be true where there are unwanted external influences the as visual clutter or noise.

When external conditions are very closer to the required internal condition, in this condition the open envelope is used, with pieces of a building skin which are selectively added to resist the few external forces.

The flow of heat through a building envelope varies by both season (heat always flows from a hot region to cold region and generally flows **from** a building in winter and in summer) and by the path of the heat (through the materials of a outdoor air entering or building's skin). These complexities must be considered by a architecture and designer who intends to deliver thermal comfort and energy efficiency.

III. Building Energy Loads

Energy loads defined as the how much energy your building needs. These demands can be provided by fuel, electricity, or by passive means such as solar power. Understanding building loads can be a complex topic because there are so many interrelated terms to navigate and its sometimes difficult.

The info-graphic analysis below can used to determine the nature of building performance analysis results.

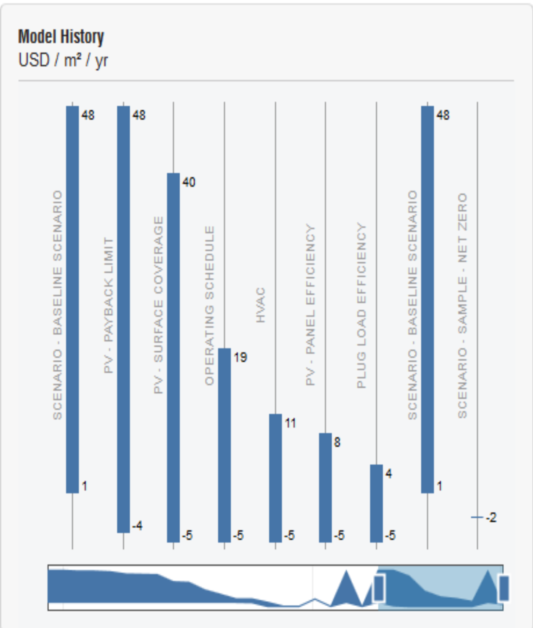

Fig. 1. Building performance analysis infograph.

Thermal loads are the quantity of cooling energy and heating energy that must be removed or added from the building to keep occupant comfortable. Thermal loads come from heat transfer during the thermal operations and between the building and the external environment (envelope, external, or fabric loads).

These thermal loads can be translated to cooling loads (when the building is too hot) and heating loads (when the building is too cold). These cooling and heating loads aren't just about temperature (sensible heat), they also include moisture control and humidity (latent heat).

Cooling and Heating loads are met by the building's and Engineer's HVAC system, which uses energy to remove or add the heat and condition the space. This energy use transfer to the HVAC component of a building's equipment loads (met by fuel or electricity). Other building loads include lighting loads (electricity used for lights) and plug loads (electricity used for computers and appliances).

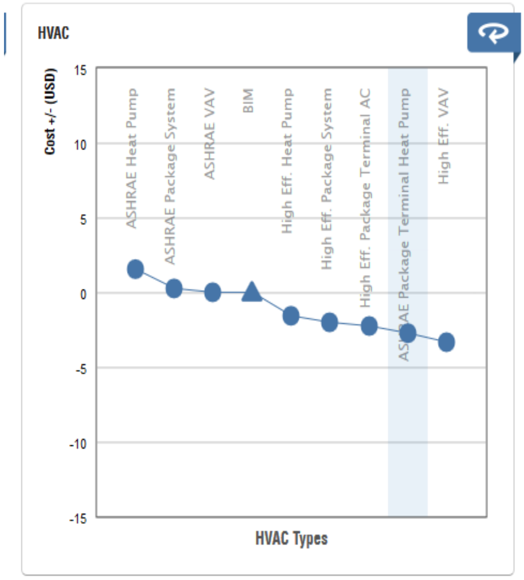

Fig. 2. HVAC infograph.

IV. Heat Energy Flows in Buildings

There are of two forms of heat flows: latent heat and sensible heat. Latent heat flow results in a change in humidity and moisture content. Sensible heat flow results in a change in surrounding temperature. Total heat flow is the sum of latent and sensible flows. Human comfort depends on providing comfortable latent and sensible heat.

A. Sensible heat:

The heat associated with change in temperature of a material/substance/ space.

B. Latent heat:

The release or storage of heat associated with change in phase of a substance, without a change in the substance's temperature. In building design and structural design, this is often heat required to remove/add the moisture content (humidity) from the air and surrounding. Whenever an object is at a temperature different from its surroundings,. moisture flows from areas of greater concentration to areas of lower concentration Likewise, heat flows from hot to cold.

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C. *Conduction, Convection, and Radiation*

Buildings lose sensible heat to the environment (or gain sensible heat from it) in three principal ways:
1) Conduction: The transfer of a heat between substances or a element which are in direct physical contact with each other. Conduction occurs when heat flows through a solid materials.
2) Convection: The movement of liquids and gasses caused by heat transfer. As a liquid or gas is heated, it warms, rises and expands because it is less dense resulting in natural of convection.
3) Radiation: When electromagnetic waves travel through surrounding, it is known as radiation. When these waves transmitted from the sun, (for example) if they hit an object, it will transfer their heat to that object.

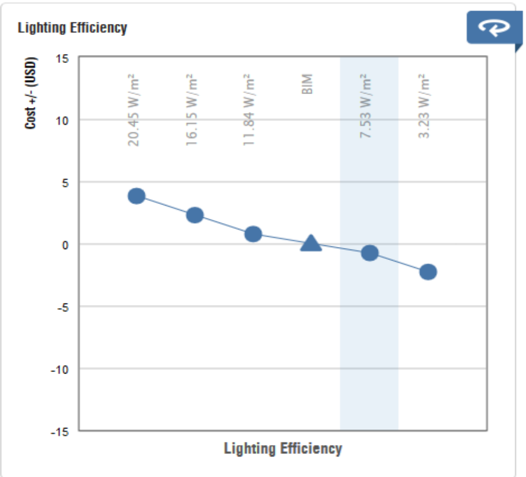

Fig. 3. Light efficiency infograph.

V. Dynamic Thermal Effects

Although the general principles remain the same, analysis of heat flow under dynamic (rapidly changing) conditions is more complex than "steady-state" or under static

The effects of heat storage within materials become a larger concern under dynamic motion conditions. Under static conditions, heat flow is primarily a function of thermal resistance (the resisting force) and temperature difference (the driving force). Under dynamic conditions, these two factors are more important, but heat storage in the building skins assembly moderates the temperature flow that would otherwise occur if the assembly could give off heat or not absorb the heat.

Heat storage is a function of the density of a element or a material and its specific heat; the product of these two properties is called as Thermal Mass or thermal capacity.

Building materials or elements lose or gain heat energy over time as surrounding temperature change and these heat absorbing properties are determine how much energy can be stored within a given element or material, and how quickly that energy will be released or gained.

VI. Dynamic Facade

The Dynamic is the type of active facade and it have dynamic movement coordinated with the solar path, air flow analysis is done in wind tunnel

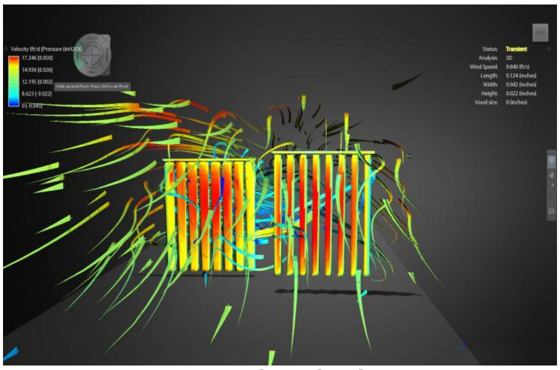

Fig. 4. Wind tunnel analysis.

Two model kept in wind tunnel the first model in closed condition and second model in 45 degree open and the movement of air the path were determined and the wind load is reduce maximum

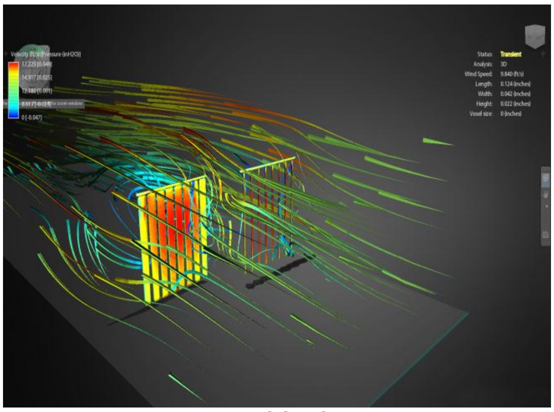

Fig. 5. Wind distributions.

VII. Result

The optimum and sustainable design of Dynamic facade is designed by referring the building performance analysis, thermal analysis wind flow analysis

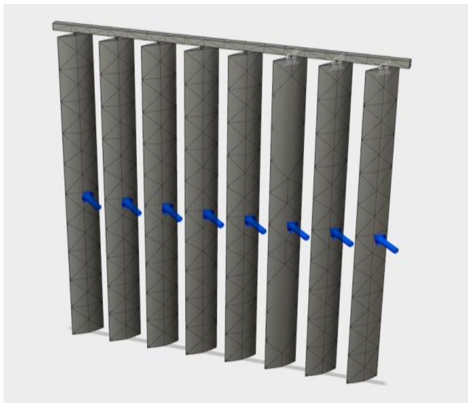

Fig. 6. Sustainable dynamic façade.

The building integrated green facade BIGF & Dynamic Facade in recent years has evolved conceptually from a primarily aesthetic design, gardening, or of artistic expression by the designer or the manifestation of economic power by the promoter, no a "vegetated architecture" in which the vegetation is another element of the building, with specific functions to develop the building as well as its relationship with the environment (energy aspects, acoustic protection material, support of biodiversity, provide thermal comfort).

the green facade reduce the HAVC load and give the oxygen by the process of photosynthesis a vertical vegetation cover could lower the temperature of a facade wall and buffered its fluctuation with time, leading to reduced power loading air-conditioning. Time lag in temperature increase reflected that a vegetated cladding could mitigate the potential impact of solar heat that continued to affect the indoor space after sunset.

With a green plant cover on a facade over south elevation wall, student could be benefited by a physical and mentally and get good result in exams. The management can have cheaper electricity bill in addition to the ecological merits of the vertical green panels and solar cladding, Dynamic facade.

In general, the use of vegetation and Dynamic Facade, so well designed and managed, can be a useful tool for passive and active thermal control of buildings with the consequent energy saving. This can occur in four ways, often related, thermal insulation, and the interaction with solar radiation, ie shade, evaporative cooling, and the variation of the wind on the building.

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