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RESEARCH ARTICLE

BREATHING BUILDING SKINS SYSTEMS FOR OFFICE BUILDING

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Abstract

The Breathing building skin is a way of Natural ventilation which should always be the first option when attempting to deliver fresh air due to its low energy requirements. However, its implementation depends on the presence of certain atmospheric, environmental, and programmatic conditions. The breathing building skin is needed to be used and applied in Egypt to save energy which we now face a huge problem with it whether it was renewable or not.

In the absence of the atmospheric, environmental and programmatic conditions the building can become over concentrated with CO2, creating an environment which negatively affects occupant comfort and respiratory health and far away from the comfort zone and the sufficient use for the building also now all the world have the direction of saving energy and environment by using more environmental methods for living. Buildings in Egypt take a huge percentage of the whole percentage of energy used in Egypt. The main objective is to present methods for breathing building skins and its uses as a series of diagrams for moving air, functioning in the same way as our lungs where a volume of air is displaced through the expansion and contraction of a flexible form. That by using breathing building skins and applying it in Egypt can save a huge percentage of our consumed energy .The expected outcome is to present Guidelines for breathing building system to save energy, reach the comfort zone. The breathing building system makes the building sustainable and environmentally friendly.

Outline

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1.2 Breathing Building Skin Types
1.3 Breathing Building Skin Techniques
Parametric Model - The DNA of the Diaphragm
1.4 Material Systems
1.5 Designing Based Criteria of Different ventilation styles (systems)
1.6 Conclusion of Theoretical Part

PART 1: OVERVIEW OF THE VENTILATION SYSTEM

This part will show the definition and the techniques and the usages of the breathing building system which is a way of system that ventilate the whole building using less energy and power and save the environment it acts as small fans that exhale and inhale (fig.1, 2)

1.1DEFINITION

The primary function behind this project was to move air for the purpose of ventilation. Fans and compressors are capable of moving large volumes of air at high flow rates, but this comes at the cost of noise and potential discomfort from sensible air movement. A fan will typically use 1 Watt of energy for every 10-20 cubic feet of air that it moves every minute (10-20cfm/W) 2. The high fl ow rates of a fan based system are distributed through a series of ducts which can represent a large amount of embodied energy both in terms of the materials they are made of and the space they occupy within a building. (Scott Crawford,2010)

1.2BREATHING BUILDING SKIN TYPES

A comparison between 2 different types of building skins that shows the differences between photo Photosynthesis Breathing Skin and Ventilation Breathing Building Skin in air movement and usage as shown in the following table (1) . (Scott Crawford -2010-05)

Table (1): Photosynthesis Breathing Skin vs Ventilation Breathing Building Skin

Photosynthesis Breathing Skin	Ventilation Breathing Building Skin
using the sun and light to figure the amount of air needed	using pure mechanical and information system saved to the building system
Allow light and air	act as a fan moves air allow air only

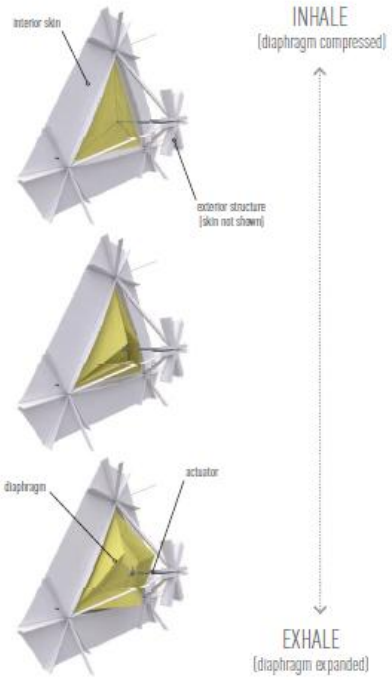

Figure 1: The Inhale and Exhale of The Ventilation System
Source (Scott Crawford,2010)

1.3 BREATHING BUILDING SKIN TECHNIQUES

PARAMETRIC MODEL - THE DNA OF THE DIAPHRAGM The use of parametric modeling software allows for a significant increase in the number of iterations that can be explored during the design process, leading to a potential increase in the complexity of relationships that can be created between building systems. Complexity here is not synonymous with complicated but instead is defined as the occurrence of a large number of

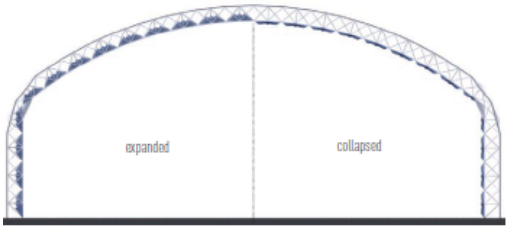

Figure 2: The Inhale and Exhale of The Ventilation System
Source (Scott Crawford,2010)

interdependent relationships whose connections are not immediately apparent. The parametric model allowed for the design to be iteratively developed to maximize the amount of daylight within the enclosed space. As the parameters of the structure were changed so did the form or phenotype of the roof, creating a new configuration. (Scott Crawford -2010-05)

1.4 MATERIAL SYSTEMS

Two material types were chosen with these constraints in mind; plastics and fabric composites. Both materials have the advantage of being able to act as a living hinge which is when a portion of the material is treated in a way that allows it to continuously bend without failing.4 Polypropylene does this through a reduction in the material thickness at the location of the folds. In a composite system, using a material like carbon fiber, fiberglass or kevlar, the fold lines are coated with a flexible material, like silicone, before the entire piece is set with epoxy resin (Scott Crawford -2010-05).

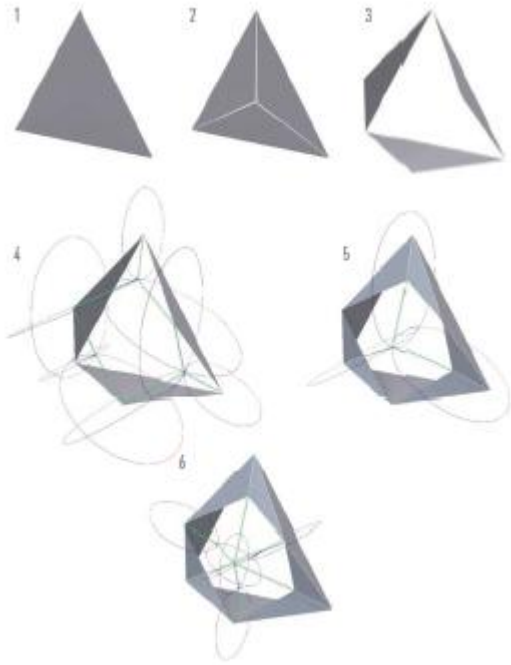

Figure 3' : Parametric modeling
Source (Scott Crawford,2010)

It is possible to make one of the proposed diaphragms from a single sheet of material, but when this is done 51% of the material is waste. The form nests more efficiently by breaking the diaphragm at the seam between each petal, wasting only 24% of the material. Assembling the diaphragm from multiple petals opens the opportunity for better control of how the outer seam between petals comes together. There is also the ability to repair a diaphragm without replacing the entire thing while still limiting the total number of parts that go into each diaphragm. Each of the decisions related to material choice were concerned with flexibility, lightness, and waste because these three criteria have a large impact on the cost of the system both in terms of inital investment and the energy needed to actuate the system (Scott Crawford -2010-05).

1.5 DESIGNING BASED CRITERIA OF DIFFERENT VENTILATION STYLES (SYSTEM)

A comparison between different ventilation styles and the effect of energy usage ,place, environment and efficiency on it as shown in table (2).

Table (2): Different ventilation styles comparison (breathing building skin , natural ventilation ,HVAC system (Scott Crawford -2010-05)

	Energy usage	Place	Environment	Efficiency
Breathing building skin	Medium	Building skin	Safe	High
Natural ventilation	Low	Building skin	Safe	Medium
HVAC system	High	Inside building	Harmful	High

1.6 Conclusion

After studying the breathing building skin and the comparison between it and other systems it was found that it is one of the optimum suggestions to reach the comfort zone mainly in offices building using the lowest energy use and the highest efficiency.

PART2: ANALYSIS OF CASE STUDIES

This part will discuss the case studies (the KAFD spa in Riyadh , Bahar Towers) using different breathing system for ventilation and lighting and the comparison between them in use and efficiency .

2.1THE KAFD SPAS IN RIYADH

2.1.1 INTRODUCTION

The facades of the Men's and Women's Portal Spas is the first major building to implement Tessellate technology – a dynamic perforated screen system that regulates light and solar gain – developed by Adaptive Building Initiative). The buildings will be enveloped in a titanium rain screen that incorporates the kinetic Tessellate system (Alison Furuto,2013 **)**. look fig(4)

Figure 4 A View to The Building
Source (20 Jan 2013, Alison Furuto)

2.1.2 The skin of the façade

Always adjusting its opacity to respond to the environment within and outside of the spas, the skin controls light levels choreographing the guest's experience. The A. Zahner Company helped develop its performance specifications and production plan, and fabricated a full-scale working mockup out of the color-interference titanium (Alison Furuto**,** 2013). Look fig(4).

Figure 5 Inside Illumination
Source (20 Jan 2013, Alison Furuto)

2.1.3Technique

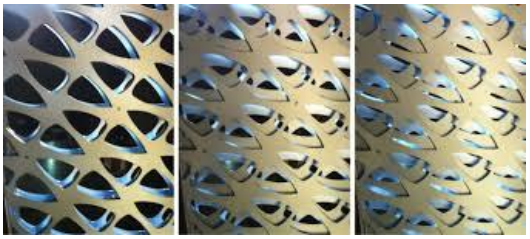

Figure 6 different stages shows the motion
Source (20 jan 2013 , Alison Furuto)

The building is composed of Tessellate surface modules composed from three layers of perforated titanium, two of which are motorized check fig (5,6) . Responding to the sun's intensity, the way heliotrope plants such as sunflowers do, the screens move so that their perforated patterns overlap to regulate light and heat, ventilate and create privacy in a continual Reaction to external conditions. Manufactured bythe metal panel experts at Zanier, they can reduce the cost of cooling a building by 15 to 20 per cent (Alison Furuto 2013).

The following table shows the needed criteria in the breathing system and its application in KAFD spa in Riyadh**.**

Table (3): criteria needed and its application in KAFD spa

Criteria	
Power saving	Reduce 15to 20 %
Ventilation	Exist
Illumination	Exist
Façade	It is the main façade
Photovoltaic cells	Doesn't contain
Technique	Responding to the sun intensity

(Source: researcher, 10/12/2013)

2.2Al Bahar Towers Abu Dhabi

2.2.1 Introduction

Figure 7 The Albahar towers
Source (By Miguel Rus | January 1, 2013)

The design concept for Aedas' innovative competition winning design is derived from an algorithmic composition, informed by islamic principles of design, that has been supplemented by the application of a dynamic translucent 'mashrabiya' which opens and closes in response to the movement of the sun, reducing solar gain on the building facade by up to 50%. the resulting composition seeks to create a building which is both culturally and environmentally responsive, reflecting the aspirations of the brief while also respecting the emergent Abu Dhabi 2030 plan (Miguel Rus,2013) . Check fig (6, 7)

2.2.2The façade

The façade system defies the typical typology of Skyscrapers in the area, suggesting a more agile and dynamic solutions to the climate. Towers Al Bahar seek to provide a contextual and culturally sensitive design while utilizing modern technology to meet the highest standards of efficiency.

Figure 8 The breathing system units
Source (By Miguel Rus | January 1, 2013)

Masharabiya shading system based on traditional Arab latticework is one of the main concepts that led to the firm Aedas to win the tender for the construction of the towers that would ADIC headquarters in Abu Dhabi. Powered by computational design team, the work of architects and engineers was to find a parametric description for the geometry of the movable panels on the facade and simulate its operation in response to sun exposure and the consequent change of incidence angles during different days of the year (Miguel Rus 2013).

2.2.3 TECHNIQUE

A dynamic and sensitive shading screen further reduces solar gain, acting as' Mashrabiya "secondary skin filters the light and reduces glare. The system is powered by renewable energy derived from photovoltaic panels. Wraps giant Lattice almost two towers completely except for the area north-facing facades (Miguel Rus 2013).

"At night all screens fold, allowing more of the facade." "As the sun rises in the morning in the east, the mashrabiya along this side of the building will begin to close, and when the sun moves around the building, all vertical strip mashrabiya move with the sun, "says Ether Oborn, VP of Aedas, and one of the project architects (Miguel Rus 2013).

The following table shows the needed criteria in the breathing system and its application in KAFD spa in Riyadh**.**

Table (4): criteria needed and its application in KAFD spa

Criteria	
Power saving	Reduce solar gain up tp 50 %
Ventilation	Doesn’t exist
Illumination	Exist
Façade	It is covering the façade façade
Photovoltaic cells	contain
Technique	Responding to the sun intensity

2.3 COMPARISON BETWEEN TWO BUILDINGS

There is many differences between the application of the breathing system in the KAFD spa Riyadh and the Bahari tower and there is similarities too as shown in the table below.

Table (5) Differences and Similarities between the Albahar tower and KAFD spa in the usage of breathing building skin.

APPLICATION CRITERIA		KAFD SPA	**ALBAHAR TOWERS**	**COMMENTS**
POWER SAVING	REDUCE MORE THAN >15 % OF ENERGY USAGE ONLY	✓		-THE BUILDINGS USING THE BREATHING BUILDING SKIN CAN REDUCE ENERGY USAGE UP TO 20 % SOMETIMES MORE
	REDUCE MORE THAN 15% AND GENERATE ENERGY		✓	- SOME BREATHING BUILDING SKINS CONTAINS PHOTOVOLTAIC CELLS WHICH CAN ALSO GENERATE ENERGY FOR THE BUILDING
	HIGH ENERGY USAGE			
VENTILATION	NATURAL	✓		USING NATURAL VENTILATION SAVES MORE ENERGY
	HVAC		✓	
ILLUMINATION	NATURAL	✓	✓	- USING OF NATURAL LIGHTING WITH THE ARTIFICIAL LIGHTING AWAY FROM ONLY DEPENDING ON THE ARTIFICIAL LIGHTING SAVES MORE THAN 50 %FROM THE ENERGY USAGE
	ARTIFICIAL	✓	✓	
FAÇADE BREATHING SKIN	MAIN	✓		FACADES ARE USED EITHER AS A MIN FACADES OR AS A SECONDARY OVER THE MAIN
	SECONDARY		✓	
PHOTOVOLTAIC CELLS	EXIST		✓	-SOME OF THE BREATHING SKIN FACADES CAN BE PROVIDED BY PHOTOVOLTAIC CELLS
	DOESN'T EXIST	✓		
TECHNIQUE	SENSORS TO LIGHT	✓	✓	- IT IS A PARAMETRIC MODEL WHICH SEND TO THE SYSTEM ALL THE SIGNIFICANT POINTS OF WEATHER SUN INTENSITY (ETC)
	PROGRAMMED DATA			A PROGRAMMED SYSTEM WITH ALL DATA NEEDED FOR THE FUNCTION OF THE SYSTEM .

Source (researcher, 10/12/2013)

2.4 EGYPT SUGGESTION FOR GUIDELINES

- Cost : material affordable (fiber glass, plastic)
- Human skills (well trained , precast)
- Durability & maintenance (high)
- The importance of applying this in Egypt

1- Temperature control inside buildings (office buildings total glass facades use a huge amount of energy which can be saved

2- Illumination control and the needed amount of illumination inside the building

3-ventillation act as a air ventilation system all the time by its small fans

2.5 CONCLUSION

After studying these 2 cases, the researcher came out of some main criteria needed for applying this system in Egypt including the context and surrounding environment of the country, for sun path, wind and humidity and the use and the energy consumed these criteria are (power saving, can be used for ventilation and also for sun protection and illumination using it for also electricity (power) generation by using photovoltaic cells.

PART 3: REFERENCES

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