UNSUSTAINABLE BUILDING FAÇADES AND FASHIONS IN SURABAYA

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ABSTRACT

In the past ten years, there have been intense developments in the application of energy savings in buildings and high technology glass invented in all over the regions of the world. The complexity of curtain-glass used in buildings is always crucial related to energy savings and climatic nature in every region of the world. More specifically this paper will observe the direct and global solar radiation behaviours that have impacts on building envelopes in every orientation, horizontal and slope surfaces. Because of the limited data of the solar radiation behaviours in every region in Indonesia, public (building or residence owners) and solar hot water supplier actually do not know the accurate orientations and tilt angles for gaining maximum solar heat radiation. Moreover, the local or foreign building consultants often act in different ways for designing building façades—mostly by applying curtain-glasses instead of curtain-walls on the building without concerning the tropical hot humid climate of Surabaya. This paper will try to give an outline of the failures of the curtain-glass building facades built and some post-modern buildings outlook in fashions which cause energy wasting. Obviously, the sustainability of the curtain-glass building is wasting energy in term of applying air condition buildings in Surabaya.

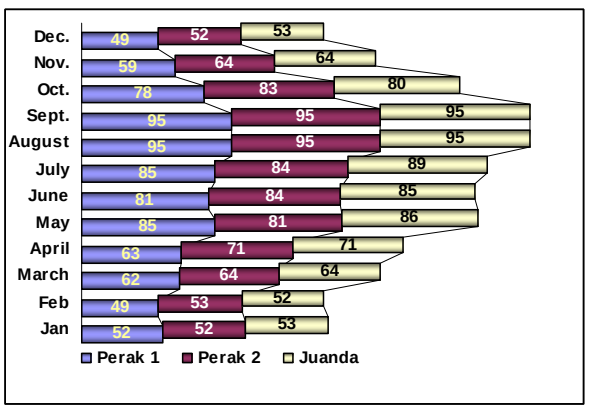
Keywords: Sustainability, Building Facades, Fashions

INTRODUCTION

Today, people of Indonesia have changed dramatically in their ways of life, tastes, and spirits. They are concerned about styles, performances, and fashions of a building existing in an urban environment. The sustainable buildings are very little existed in harmony with the nature. The atmosphere of Indonesia climate is tropical hot humid weather. The high intensity of the solar radiation often gives impacts from all directions of the sky to every building in town each time, each day, and throughout the years. Derived from Szokolay (1992), 24% of the solar radiation reaches the ground level as direct beam radiation, 22% is diffuse radiation, and 23% is absorbed in the atmosphere.

Indonesia, along with its thousand islands, located at the latitude ranging from 6°8' North to latitude 11°15' South and the longitude ranging from 94°45' East to 141°5' East, mostly has tropical humid climate. The hot humid climate is almost throughout the year. While, the wet or rainy season will be approximately from mid December to mid May. The dry or hot humid season starts from mid May to mid December. The Surabaya city is located at the latitude 7°17' to the South and at the longitude 112°47' to the East. This city has experienced quite a high percentage of sunshine—above 50%--condition throughout the day and the year even during the rainy season since 7 years.

Figure 1 shows the monthly average sunshine duration for the years of 1996 to 2002. The data has been taken from the Surabaya Bureau of Meteorology at three stations, such as Perak 1, Perak 2 (harbour location), and Juanda (airport location). During the dry season from May to October, the monthly average sunshine duration percentage is extraordinarily high. The sunshine duration can range from above 80% to 95% throughout the days and months.



(Source: The Bureau of Meteorology of Surabaya)

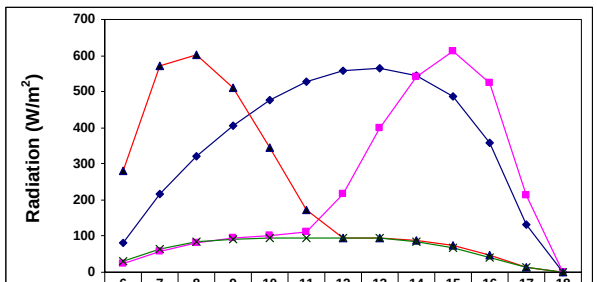
Figure 1. The Surabaya's Monthly Average Sunshine Duration Percentage Annually 1996-2002

Even during the rainy season from the month of November to the month of April, the average sunshine duration is still above 50%. Obviously, these phenomena indicate that Surabaya city has experienced a lot of solar radiation during the daytime. The positive aspects are that it could install passive systems—photovoltaic panels, solar hot water panels, and even applying day-lighting all the time to either commercial, offices, institutional

buildings or dwellings for saving energies, reducing electric lights during the working hours. Meanwhile, the negative sides are that all buildings have impacted solar radiation on all vertical curtain-glass or wall facades as well as horizontal and inclined daylight features installed to make up for energy savings. The higher the sunshine duration percentages are, the longer the solar heat radiation impacts on all horizontal, vertical and inclined outside surfaces of building.

Figure 2 shows four directions of daily average vertical global solar radiation per hour on May 2005. The highest vertical solar radiation is 603 W/m^2 at 08.00 a clock on Eastern side and, has an average of 247 W/m^2. But the average radiation on the Northern vertical surface during 12 hours—6 am to 6 pm—is 389 W/m^2 which is the highest among 3 directions, and has the total amount of radiation 4,675 W/m^2. The Western and Southern hemisphere receiving total global vertical solar radiation for 12 hours is 2,969 W/m^2 and 845 W/m^2 in a day. The Southern hemisphere is the least receiving vertical global solar radiation from May to October. Nevertheless, the Northern hemisphere will get more amount of vertical global solar radiation than Western hemisphere.

With respect to figure 1 and figure 2, it is obvious that vertical façades on buildings during the dry season will get a lot of global solar radiation. Therefore, many buildings and dwellings which install curtain-glass or huge windows without any shading devices will experience huge amount of solar heat radiation throughout the days and years.



	6	7	8	9	10	11	12	13	14	15	16	17	18
North	81	218	320	405	478	528	558	565	544	488	359	132	0
West	23	58	81	94	102	110	218	398	540	611	525	212	0
East	280	571	603	509	346	173	95	94	89	74	46	14	0
South	31	65	83	91	94	95	95	93	83	66	39	12	0

(Source: author)

Figure 2. The Surabaya's Daily Average Vertical Solar Radiation on May 2005

The Objective

By looking at most condition of the Indonesia buildings and dwellings built to day, two issues to be addressed. First, it attends to the design professionals, the consultants and the product manufacturers. The three types of professionals above have to be selective in using proper building materials—glasses, bricks and stones for tropical hot humid climate and certain latitude in Indonesia. Secondly, it is the building occupants. Commonly, the occupants of public facilities, commercials buildings, and private residences are the public who do not really familiar with all technical aspects of buildings and houses. They are the ones who are directly and indirectly affected by design choices made in the building. They are willing to have energy savings in buildings and dwellings, but the question is, could the buildings be designed to really save lots of energy? Or will the buildings waste energy?

The Goals

The designers and local architects or foreign consultants could really understand the behaviour of the Surabaya-Indonesia's solar heat radiations—horizontal and vertical—in order to save energy but not waste energy due to improper use of curtain glass and uninstall of all shading devices—horizontal and vertical.

The Piece of Equipment of the Research

The equipment used to measure the solar heat radiation is 5 series of silicon pyranometer smart sensors from "HOBO" and Weather Station Data Logger with the specification of the measurement ranging from 0 to 1280 W/m^2. Three pieces of SUNERGY glasses are used for measuring the radiation performances if it were installed on façade buildings. BoxCar Pro4 software is needed.

BUILDINGS IN FASHION

There are different definition between building and human beings. Humans—men and women need cloths for showing their performances at a certain time, and will change according to places, events and time. First thing about clothing is to be used to identify a nation culture existed in the world. Hungarian men wear shirt and skirt while dancing; Japanese girls wear "Kimono" as a national identity at several important events. Indonesian wedding couples will have "Java Look—Kebaya" on their wedding party. All these examples are part of the evolution of the world fashion now. But we will think twice and very selective to what we are going to wear as "fashion". We are not going to wear cloths which are not suitable for our cultures.

The Buildings are just like human beings; the facades are similar to clothing. We, as modern

designers or architects, like to act as fashion designers; designing facades with many materials some of them are not suitable to certain places based upon the local weather, latitude and culture. In some places or cities of a nation which have four seasons weather—fall-winter-spring-summer, curtain-glasses are the favourite one to be used for several or full facades buildings. Summer—high solar radiation—persists only for 2 to 3 months; likewise there are lots of "green or blue glasses" buildings exist in Indonesia now. There are several aspects show that Indonesia is not suitable for using curtain-glasses fashion on building; first, the latitudes are very close to equator which causes high intensity of solar heat radiation to all surfaces buildings. Secondly, the dry seasons often last for 6 to 7 months which will have high percentage of sunshine duration that brings direct sun beam and radiation. Lastly, the glass building cleaning will cost twice due to dry dusty environment on long summer seasons.

Looking at figure 3, lots of glasses fashion buildings in Surabaya have become major city-skyline in urban areas and central business district now. It is hard to find local traditional fashion buildings—architectural tropical Surabaya or Indonesia--existing among those modern styles building. So, what are the differences made if those curtain-glasses building built in Surabaya have been moved and placed to Japan or United States or Dubai? Will those buildings achieve better in saving energy or wasting energy. Will the tropical Indonesia hot humid climate with two seasons of the weather remain to same with the subtropical 4 seasons of the weather in Japan or United States in term of energy savings on buildings?

Figure 3. The Surabaya's Curtain-glass Buildings Fashion (Photograph: author)

Compare with figure 3, figure 4 has some interesting points. First, although the buildings have been built based on post-modern architectural concepts, they have encountered consideration local aspects for maximum operational building costs in terms of cooling loads and having Surabaya culture identity (Javanese buildings like to have "Joglo" roof, local ornaments and country style shading devices). Secondly, the buildings best respond to local climate encounter (the buildings are inclined to have small to middle windows, opaque brick walls as dominant and having vertical and horizontal shading devices to block direct sun light and heavy rains). Lastly, the buildings have been adopting Javanese fashion styles—curve and ornamental roof, base and local stone or brick and concrete block walls.

Figure 4. The Surabaya's Modern Buildings Fashion (Photograph: author)

SUSTAINABILITY ASPECTS

Sustainability is commonly interpreted to mean living in such a way as to meet the needs of the present without compromising the ability of future generations to meet the needs of the future. Sustainable building is a science concept oriented that it considers the needs of energy savings without depleting the energy resource management on Earth's ecological systems. It is also an economic concept that it seeks to quantify the tolerable limits for energy consumption in building and to seek other energy resources which are less harmful to the mother Earth, such as solar energy in photovoltaic and hot water, or wind energy in obtaining electricity. According to the department of energy of United States, improvements in energy efficiency of buildings, utilizing existing and readily available solar energy technologies, could save $20 billion annually.

Two approaches focus on the sustainable buildings are, where the building energy come from? And how well the building is compensating the energy? Let us look at two aspects reality in Surabaya.

Fully Curtain-glass Façade Buildings

Facades buildings deal directly with solar radiation which affects the use of energy consumption on air conditionings. Tropical solar sun will have higher and longer intensity of radiation from morning to evening than the subtropical zones. The intensity of solar radiation that impacts facades is varying by hemisphere orientations and months of the year. Meanwhile, the concentration of radiation received in a room will also deal with the façade materials; the glass façades will have more radiation received than wall façades. But the facts are that (figure 3) lots of curtain-glass buildings have been built with energy savings concept without further investigation on the radiation behaviours in Surabaya.

Table 1 shows the average vertical solar radiation annually from the year of 2005. The Southern vertical facade will have the lowest concentration radiation impacts. By far, the Eastern façade has the highest concentration radiation throughout the year. The Northern façade ranks the second and Western façade ranks the third to receive global solar radiation. Interestingly, most people are considering blocking western sun-rays from noon to evening.

Table 1. The Average Vertical Solar Radiation Annually 2005 (Tested: author)

	South	East	West	North
January	2,283	2,159	2,028	1,650
February	1,922	2,628	1,723	1,228
March	1,172	1,702	1,813	1,496
April	1,057	1,747	2,277	3,516
May	845	2,893	2,969	4,675
June	815	3,247	1,968	3,431
July	895	3,010	2,752	4,004
August	975	3,122	2,450	3,422
September	1,574	3,114	2,954	2,428
October	1,783	3,279	4,106	2,020
November	2,981	3,357	4,108	1,799
December	2,432	2,109	2,059	1,594
Total	**18,734**	**32,367**	**31,207**	**31,263**

Table 2 demonstrates the radiation daily in a room by using the high technology invented glass. It is said to be the advanced architectural glasses to put on facades building. The smallest intensive solar radiation after passing thru is the "SUNERGY GREEN"; total radiation received per-day—12 hours—is 301.8 W/m^{2}K. The Sunergy clear glass radiation received would almost 2 ½ times bigger then Sunergy Green; it is 881.9 W/m^{2}K.

Table 2. The Average Southern Vertical Solar Radiation annually 2005-2006

Date/Time	Sunergy Clear	Sunergy Green	Sunergy Azur	Vertical Outside
02/03/06 06:00:00.0	11.9	3.1	5.6	21.9
02/03/06 07:00:00.0	98.1	18.1	48.1	239.4
02/03/06 08:00:00.0	***124.4***	28.1	59.4	288.1
02/03/06 09:00:00.0	125.6	28.1	***68.1***	***394.4***
02/03/06 10:00:00.0	73.1	31.9	59.4	370.6
02/03/06 11:00:00.0	99.4	***41.9***	51.9	336.9
02/03/06 12:00:00.0	68.1	30.6	36.9	119.4
02/03/06 13:00:00.0	69.4	29.4	36.9	244.4
02/03/06 14:00:00.0	91.9	38.1	48.1	268.1
02/03/06 15:00:00.0	66.9	29.4	35.6	179.4
02/03/06 16:00:00.0	41.9	18.1	23.1	113.1
02/03/06 17:00:00.0	10.6	4.4	4.4	20.6
02/03/06 18:00:00.0	0.6	0.6	0.6	0.6
Average	**67.8**	**23.2**	**36.8**	**199.8**
Total Radiation	**881.9**	**301.8**	**478.1**	**2,596.9**

Supposing, a building glass-façade is 10 meter x 15 meter = 150 m^2.

a. the curtain sunergy green glass is 150m^2; so the radiation occurs in a room will be 150 m^2 x 301.8 W/m^{2}K = **45,270 W/m^{2}K**. If it uses clear glass (for automotive showroom), the total radiation received is 150 x 881.9 W/m^{2}K = 132,285 W/m^{2}K.
b. the non curtain-glass façade buildings—see figure 4—are supposed to have around 15% of glass windows; so the radiation will be (15% x 150m^2)x 301.8 W/m^{2}K = **6,790 W/m^{2}K**.
c. the energy loss (energy wasting): type A – type B = 45,270 W/m^{2}K – 6,790 W/m^{2}K = **38,480 W/m^{2}K**. By taking the conversion factor from W/m^{2}K to Btu/h, the average radiations are then multiplied by 3.412. → 38,480 x 3.412 = **131,294 Btu/h**. So, the cooling loads are needed approximately **131,294 Btu/h.** It wastes huge energy in air conditioning systems to spend extra electricity per hour to cool down the radiation passing through all curtain-glass facades.

CONCLUSION

It is clear that energy has been wasted by purpose or in purposely. The society, professionals and building owners don't know and appreciate the high intensity of solar radiation throughout the year in Surabaya. Due to the hot humid tropical weather, the Southern latitude of 7^o 17' (close to equator) and high percentages of sunshine duration throughout the year in Surabaya, every building has to be carefully designed and placed shading devices horizontally or fins vertically on Northern, Eastern and Western side. Southern side has the least solar radiation that could be used for getting natural daylight and placed little

shading devices. Some suggestions to minimize the energy wasting:

a. Careful redesign on the curtain-glass facades; it could have double layers of ventilated curtain-glasses façade on building if it is not provided with shading devices.
b. Equipped with horizontal and vertical shading devices on curtain-glass façade is very crucial to reduce the impact of highly solar radiation intensity on East, North, and West side.
c. Publish a solar radiation behaviours book for Surabaya.

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