THE CORRELATION HIGHRISE BUILDING FASADE AND EFFICIENCY ENERGY OF AIR CONDITIONING

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ABSTRACT: A large number of energy crisis phenomena which directly related with the rising of global temperature had become a considerate issue to many people recently. But solving this issue is not an easy task especially for common people due to many factors that is related one another with different kind of subjects.

Building facade design also affects the amount of energy used both for general lighting and also the heat amount that enter through the facade itself. Based on several surveys on the used of energy, office building considered to be a large energy consumption building. Air conditioning system is the biggest consumption of energy in an office.

This is an interesting issue to be researched due to the positive benefit of energy saving by reducing Air Conditioning energy consumption in offices. One big opportunity to reduce the use of Air Conditioning energy is by designing the perfect building facade considering the use of the materials, percentage of the openings compare to the massive area and the orientation of the building.

KEYWORDS: saving energy of Air conditioning, office facade buiding, building material, Window to Wall Ratio (WWR), buiding direction

Indonesia have crisis in energy suppy. Total of energy needs has grow up 70% every year. The energy consumption grow up 9- 10% every year, but not equivalent with the energy suppy. So we will have a big problem with the energy supply and will give a impact to market world oil price. The researcher give warning to all people to saving energy since 1975, but not all architect in Indonesia care about it.

Energy specialy electrical energy crisis give big impact to Indonesia. In Jakarta, the goverment turn of the electrical supply on certain time with shift. If we not to energy efficient in Indonesia, energy supply in Indonesia will empty only in 7 year. The goverment for bit a building who use a big energy for operational. Many office buiding in Indonesia have *sick building sindrome*, because using Air conditioning with bad ventilation.

Building operational use a bigger energy than other energy using, so only a good design with energy efficiency will help us to increasing an energy consumption. Saving energy with buiding design will increasing the energy consumption 40-50% than no energy saving in building design. There is the example of highrise office building in Indonesia.

Figure 1. Rent High rise office building; Bandung, Jakarta, Surabaya

On this picture about office building, we can see the design have dominate with glass materioal on fasade. They do this to saving energy on lighting need, because office need a big energy on lighting. Daylighting from glass facade is one solution to increase lighting need. Building material, contruction, window to wall ratio with bad proportion will give a bad impat to energy using specialy energy for Air conditioning and *green house effect* to other buiding. The diagram beside this, give information about the bigger energy consumption in Office building.

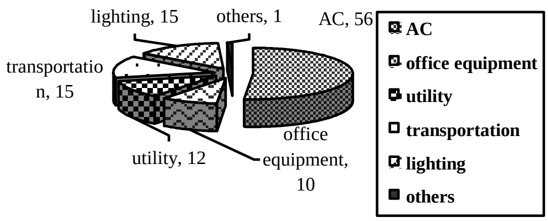


Figure 2. Energy consumption in office building in Indonesia
(research of DJLEB 1992**)**

The local climate in the big city at Indonesia[1], Air conditioning is nessecary to made a thermal comfort. So building will have a big energy consuption for Air Condirioning. The total energy consumption for AC in big city at Indonesia is 50- 60% and 30- 40% for lighting[2].

Rent office is the one bulding what have to made efficient, because this building have a big energy consuption[3]. The operational cost will give effect for the rent cost, but people need to rent office with lower cost and good place. So in first position office need to made efficient an energy use specially for Air conditioning to press an operational cost.

Office building need Air Conditioning to made people feel comfort and than will give a good condition for work and increase people productivity to work. Highrise office building cannot use a natural ventilation so Air Conditioning is a big part of office building. On the research of Prof. Tri Harso, people have more good adaption in home than adaption in office. So we need AC in office to give a people comfort.

Equipment, lighting, people and thermal transfer from wall and roof made the interior become hot and made a coolling load become more bigger. So we need to cut a thermal transfer from wall, roof and façade. Prof DR Suprapto say that we can make saving enegy from all aspect, internal and eksterior.

The bigger cooling load in Indonesia is 10.00- 16.00 a clock with the consumption 80-100%. Thermal transfer from facade is a bigger cooling load 45%, and infitration 20%, user 18%, heat from wall 9%, lighting 8% and heat from room 3%. So office have a big cooling load on office operational time and the bigger heat come from glass facade.

Facade design, WWR, facade material and glass with low transmitas, and building orientation will give affect to energy consuption especially for AC.

Saving energy for AC and human comfort zone

We need an energy efficient with not decreasing a human comfort. There is asaving energy principal:

PRINCIPAL

1) Not decreasing a **human comfort**
2) Not decreasing **people productivity**
3) Energy **efficient**
4) Implementasi dari **konservasi energi**
5) Making **sustainable** building

Total energy in building :

- **Office = 246 kWh/m2.year**
- mall = 332 kWh/m2.year
- hotel = 307 kWh/m2.year
- hospital = 382 kWh/m2.year

[1] temperature (> 25^0C), high humidity and pollution.
[2] Menurut Jimmy Priatman dalam News and Headline of PCU
[3] More than 200 kwh/ m2/year , on Asean Save Energy Award- Ir. Ratna Aryati

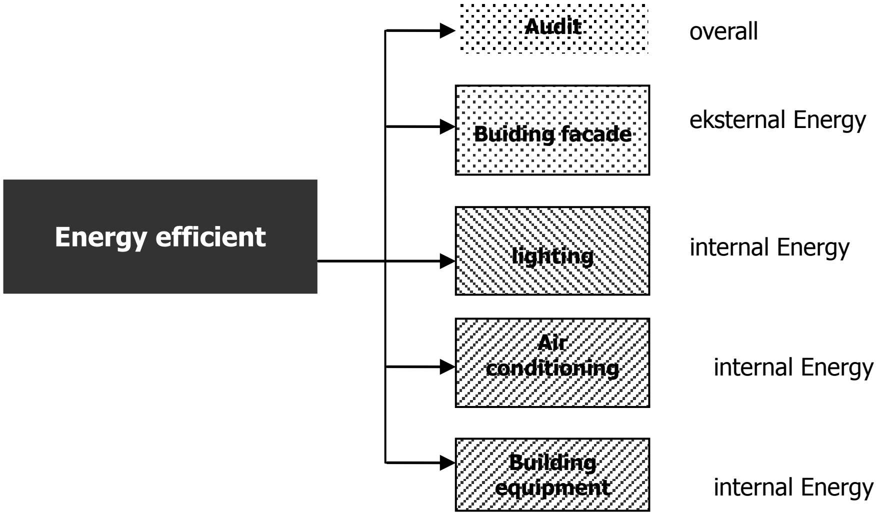


Figure 3. saving energy in building (Suprapto)

Saving Energy Criteria
Human comfort criteria to make a saving energy:
Termal comfort:
temperature : DBT = 24- 26^{0}C
humidity: RH = 50- 60%

Visual Comfort:
Iluminasi : E = 200- 300 lux
Building fasade:
OTTV wall ≤ 45 W/m^2
RTTV roof ≤ 45 W/ m^2
Energy Efficienty Index:
EEI office building ≤ 189 Kwh/ m^2/ year

Figure 4. Wisma Lippo

Wisma Lippo is a one office building at building since 1992. the architect of Wisma Lippo is DENTON CORKER MARSHALL HONGKONG and joint with PT. DUTA CERMAT MANDIRI, Jakarta. This building is the first high rise building in Bandung, who is very modern. So this building is very popular for business man.

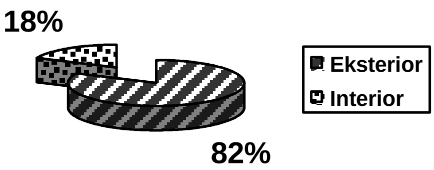
The building façade material of Wisma Lippo:

Material	Spesification
glass	Stopsol glass, tipe **supersilver blue**, thick 6mm, α=0,45, transmitan= 0,42, refleksi 0,13, SF=0.54, SC=0.62, Uf= 1.08 (W2 and W4)
	Stopsol **supersilver dark grey** , 6mm α= 0.64 Transmitan=0,28 , SF= 0,46, refleksion 0,08, SC= 0.51, and Uf= 1.10 (W3 dan W5)
WWR= 78%	
Cladding granite	dark grey α=0.88 (W1)

Tabel 1. Fasade Material Wisma Lippo

Cooling load in Wisma Lippo

the cooling load in this building came from



:

1. Lighting
2. Human accumulation
3. Office equipment, like:
   - computer
   - UPS
   - foto copy

4. heat from another room who is not using AC

Simulation

DESIGN ALTERNATIFE WITH CHANGE WWR PRESENTATION

The simulation using the same material and condition like Wisma Lippo:

- concrete wall with grey finishing= 0.88
- Stopsol glass, tipe **supersilver blue**, 6mm, α=0,45, transmitan= 0,42, refleksi 0,13, SF=0.54, SC=0.62, Uf= 1.08

Information:

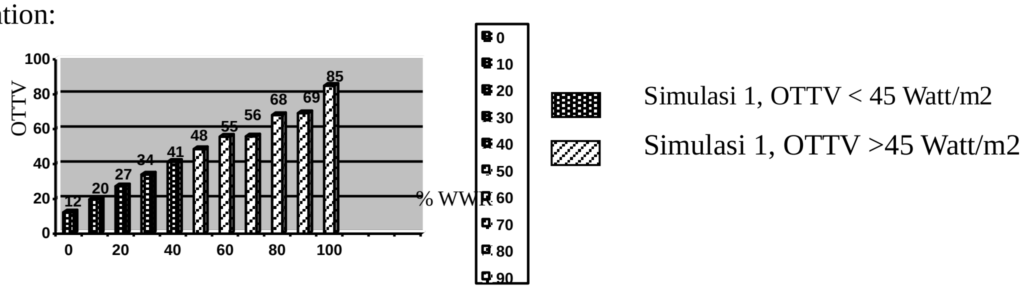


Figure 6. Diagram %WWR and OTTV

DESIGN ALTERNATIVE WITH CHANGE THE BUILDING FAÇADE MATERIAL

WWR	building material	OTTV
90%	Material W8 and K6	48.6
	Material W9 and K6	48.7
	Material W7 and K6	49.2
80%	Material W1 and K8	46.6

	Material W3 and K8	45.2
	Material W7 and K8	45
	Material W9 and K8	43.9
	Material W10 and K8	42.5
70%	Material W3 and K2	45.7
	Material W3 and K7	45.1
	Material W10 and K8	38.5
60%	Material W10 and K8	33.6
50%	Material W3 and K2	36.1
	Material W3 and K8	32.8
	Material W10 and K8	28.6

Tabel 2. The equal of WWR, Material, OTTV and Cooling Load

No	**Simulation**			**Eksisting**	
	WWR	**Material**	**OTTV**	**WWR**	**OTTV**
1.	80 %	Material W10 and K8	43.5	78 %	58.30
2.	70 %		38.5		
3.	60 %		33.6		
4.	50 %		28.6		

Tabel 3. The Equivalent of simulation and eksisting condition

Information:

K1	Panasap Dark Grey
K2	Stopsol Classic Dark Grey
K3	Stopsol Classic Green
K4	Stopsol supersilver blue
K5	Indoflot
K6	Low emisity glass
K7	increase a glass thickness
K8	double low emisity glass

W1	brick wall with granite
W2	brick wall and supersilver blue glass
W3	brick wall supersilver dark grey glass
W4	supersilver blue glass
W5	supersilver dark grey glass
W6	Tempered glass
W7	Alucobond and gypsum
W8	clear glass, rock wool and gypsum
W9	Rock wool and gypsum
W10	B- pannel

ALTERNATIVE TO ROTATING BUILDING

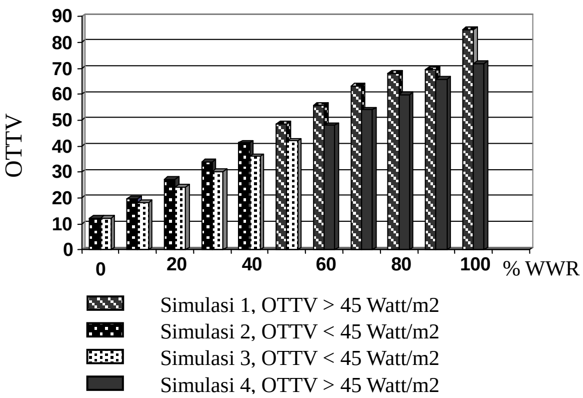


figure7. OTTV for simulation and eksisting

This simulation by rotating a building 45 degree. (North East, North West, South East and Sorth West)

CONCLUTION

The optimal WWR to saving energy an Air Conditioning is:

1. WWR more smale than 40%, with the same condition with Wisma Lippo like:
    a. In Bandung City, because every city have difference climate condition
    b. Building direction to South, west, East, and North.
    c. Use a same facade material like Wisma Lippo, specially same U value. Because the façade material will give impact a termal transmision.
    d. Have a same function like Wisma Lippo, because every activity have difference comfort standart to establish a temperature difference for interior and eksterior.
    e. Using a same equipment, because every equipment will give a heat to the air.
    f. Have same an equal of people accumulation with the same activity
    g. Have same space volume, to calculate the AC capacity

    If we use wwr ≤ 40% we need to increase *lighting load*, because the opening become smaller.

2. WWR more smaler than 50%, with same condition like Wisma Lippo and rotating a building to North west, sorth east, north east, sorth west. WWR ≤ 50% have same weakness that we will have to increase *lighting load* because we have a smaller opening.

WWR more smaler than 90%, with prerequirement a facade material[4] like this:

Wall	WI	W3			W7		W8	W9		W10			
glass / WWR	K8	K2	K7	K8	K8	K6	K6	K8	K6	K1	K2	K7	K8
90 %	50	55.2	54.5	49.3	49.2	49.2	48.6	48.7	48.7	77.3	54.4	53.7	48.5
80 %	46.6	50.4	49.8	45.2	45.0	45	43.8	43.9	43.9	69.1	48.8	48.1	43.5
78%	45.9	49.5	48.8	**44.3**	**44.2**	**44.2**	**42.9**	**43**	**43**	67	47.6	47	**42.5**
70 %	43.2	45.7	45.1	41	40.8	40.8	39	39.2	39.2	61	43.2	42.6	38.5
60 %	39.8	40.9	40.4	36.9	36.6	36.6	34.2	34.4	34.5	52.8	37.5	37.1	33.6
50 %	36.4	36.1	35.7	32.8	32.4	32.4	29.5	29.7	29.8	44.7	32	31.5	28.6

(grey) OTTV < 45 Watt/m2

(black) Wisma Lippo’s façade material, OTTV < 45 Watt/m2

Tabel 4. Facade material and percentage of wwr

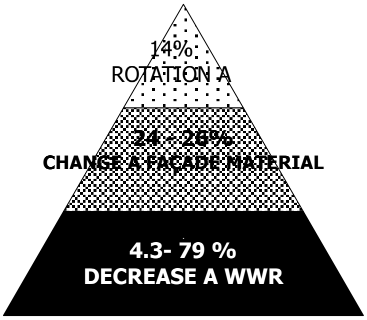
Material Information:

K1	Panasap Dark Grey	W1	brick with granite
K2	Stopsol Classic Dark Grey	W2	brick and supersilver blue glass
K3	Stopsol Classic Green	W3	brick and supersilver dark grey glass
K4	Stopsol supersilver blue	W4	supersilver blue glass
K5	Indoflot	W5	supersilver dark grey glass
K6	Low emisity glass	W6	Tempered glass
K7	Glass (cool –lite Blue), 8mm	W7	Alucobond and gypsum
K8	glass low emisity (double glass)	W8	glass, rock wool and gypsum
	W9	Rock wool and gypsum	
	W10	B- pannel	

B. If we have a building direction to North East, North West, South East and Sorth West we will have more efficient energy use. The prerequirement are:

– Single buiding
– No shadow from another building

C. Percentage of energy efficient with facade design is:



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