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GREEN POTENTIAL OF TALL BUILDINGS IN VIETNAM CASE STUDY: INSTITUTE OF AGRICULTURE

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Abstract
The construction industry in Vietnam is developing and there are more and more high-rise buildings built with different types such as: residential buildings, commercial buildings and more complicated high-rise buildings. However, most of these new and under-construction buildings were not designed with respect to the local climate nor were they environmental friendly. This paper presents a case study of energy efficient design for the Institute of Agriculture in Vietnam as an underlying research to evaluate potential energy savings and LEED green building rating points. First, the study analyses local weather data to find the potential for efficient design improvement. Then, two widely used and accepted Ecotect and Equest building simulation software were run with typical meteorological year (TMY) weather input data. The results of integrated design show that the building can utilize up to 50% of recycled construction materials in the local regions reduce water use up to 65% and produce 63% on-site renewable energy. The integrated design focuses on optimum orientation, glazing, green roof, insulation, shading design, daylight dimming control, on-site renewable energy and water reduction.

Keyword: Green Building Design, Equest , Ecotect Building Simulation Program, Simulation Results

1. Introduction

This research uses local weather data and all available general designed data of current building as an input data for Equest and Ecotect building simulation program. Alternative design strategies are run and evaluated to find the optimum condition which will be compared with LEED green building credits and terms [1] to determine achieved points. The integrated design of all strategies is also considered to find overall efficiency and is suggested for better design of the building.

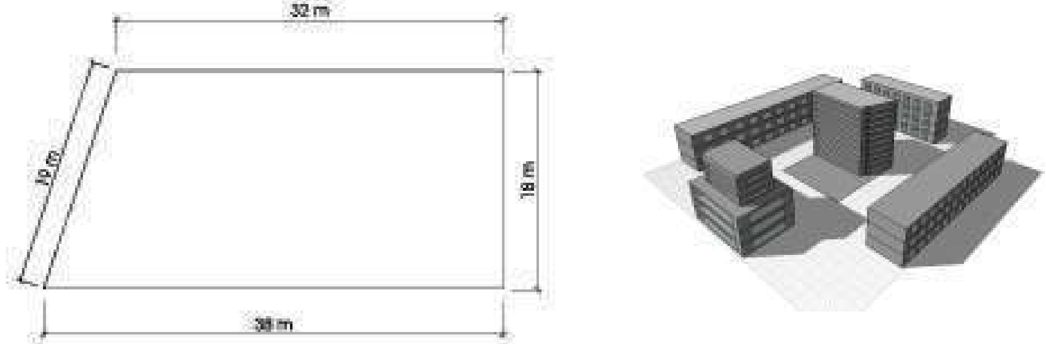
2. Objectives

The specific objectives of this study were:

- Analysis Vietnam weather data to find potential improvement for green design
- Analysis heat gain and heat loss through envelope by using Ecotect building simulation program
- Analysis alternative design options and find optimum choice by using E-Quest energy consumption simulation program

3. Description of building

The planning building is intentionally design with some basic data such as: 10 floors, 4m height from floor to floor, 2.8m height from floor to ceiling. Figure 1 shows plan view and perspective view of this building.



(a) Plan view (b) Perspective view

Fig. 1. View of building ((a) Plan view; (b) Perspective view)

4. Description of EQuest and Ecotect program

Ecotect and Equest are two widely used and accepted simulation program and this research use these programs to evaluate potential of energy saving from local weather data and find optimum green design [2],[3].

5. Weather data

Typical meteorological weather data is generated from a period of record of 30 years to be representative of this location. Tested building located in Hanoi - Northern of Vietnam which has a humid tropical climate, characterized by monsoons [4]. Summers last from June to August are very hot with plenty of rain and winters last from December to February are cold and relatively dry. It can be seen that the best orientation is 45^{o} around due south (Fig. 2). We need to do more simulation to find optimum orientation for tested building because it can do nothing with a quite wide range of orientation like that.

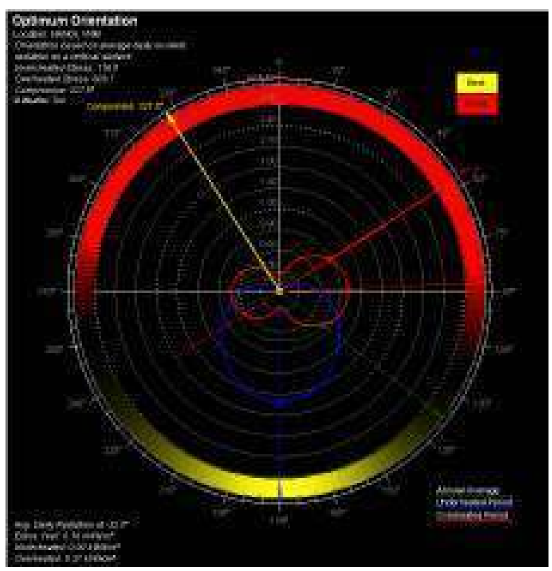


Fig. 2. Optimum orientation

Although wind speed and wind direction play an important role for building construction, especially in tropical climate, but this problem is not concerned in this research due to restriction ability of simulation program. Anyhow, we know that the velocity and frequency of the South-East wind direction is quite high so that we need to take into account of insulation to prevent wind chill in winter seasons. It can be read that building need more heating for months from November to February and need more cooling from June to August (Fig. 3).

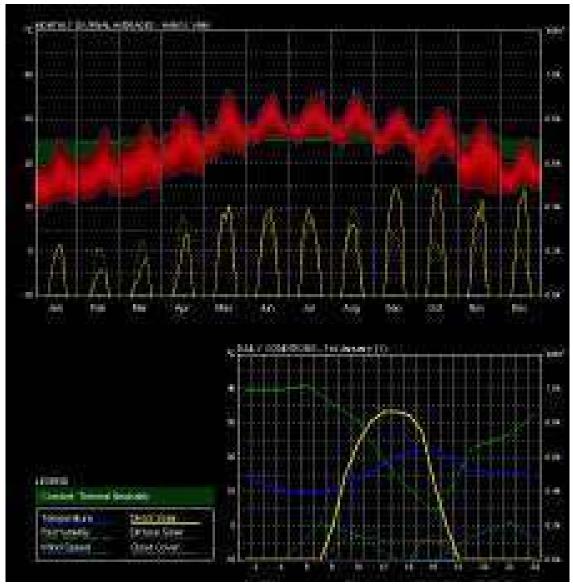


Fig. 3. Optimum orientation

Solar radiation can penetrate through window in summer and this may cause discomfort due to heat gain and green house effect. We can get advantage of the low altitude of solar position to let more sunlight come into room in winter and the high altitude of solar position to design shading devices to prevent heat gain.

6. Simulation results for alternative design options

6.1 Orientation

The building is simulated with respect to 16 orientations. The results show that the façade of building facing South orientation will have least energy consumption (Table 1). For other green design options, the south orientation will be assumed for simulation. Window to wall area are as follow: 20% for main wall of 32m length, 15% for other walls.

Table 1. Energy consumption with respect to 16 orientations

Electric consumption [kWh x 000] *kWh/sq.ft*															
N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE
1050 *15.3*	1059 *15.5*	1078 *15.8*	1080 *15.8*	1076 *15.7*	1065 *15.6*	1060 *15.5*	1048 *15.3*	1016 *14.8*	1065 *15.6*	1083 *15.8*	1087 *15.9*	1080 *15.8*	1077 *15.7*	1070 *15.6*	1041 *15.2*

(Note: *kWh/sq.ft* is kWh of energy consumption per square foot of floor area)

6.2 Glazing type

Different type of glazing is considered in this research such as single, double, triple and Viracon glazing brand and the result comparing with ASHRAE baseline design is shown on Table 2. It can save 30% energy by using Viracon Super VWY15-08 for glazing design.

Table 2. Energy saving of different glazing type vs. ASHRAE baseline design

	Annual energy consumption (kWh x 000)	Single energy saving (%)	Energy saving (%)
Single	1020	None	-24
Double	1000	2	-22

Triple	930	9	-13
ASHRAE	820	20	None
Viracon VS1-20	770	25	6
Viracon VRE11-38	750	26	9
Viracon Super VWY15-08	710	30	13

6.3 Green roof and wall insulation

The building is simulated according to green roof and insulation wall such as R10, R13, R19 and the result comparing with ASHRAE baseline design is shown on Table 3. This method of green design does not impact much into energy saving compared with ASHRAE case.

Table 3. Energy saving with green roof and wall insulation design vs. ASHRAE baseline design

		U-factor	Annual energy consumption (kWh x 000)	Saving (%)
ASHRAE	ROOF	0.065	820	None
	WALL	0.113		
Alternative	Green Roof	0.03	807	2
	R-10 + R-13	0.061	791	4
	R-19 + R-13	0.048	780	5

6.4 Shading

The result show that there is not much different energy saving between alternative 5 and alternative 6. It can be seen that 6ft overhang is quite suitable with regard to solar altitude. Alternative designs and its results are shown on Table 4.

Table 4. Energy saving by using shading compared with ASHRAE baseline design

		Energy Consumption (kWh x 000)	Saving (%)
Base Model ASHRAE	No Shading	820	None
Alt 1	3 ft overhang	778	5
Alt 2	6 ft overhang	768	6
Alt 3	9 ft overhang	757	8
Alt 4	3 ft overhang and fin	760	7
Alt 5	6 ft overhang and fin	748	9
Alt 6	9 ft overhang and fin	745	9

6.5 Daylight dimming control

It is quite popular to see modern building use daylight dimming control to save energy and this method is applied for this tested building. The results show that lighting reduction is 24% and it can save about 9% compared with ASHRAE baseline design (Table 5).

Table 5. Energy saving by daylight dimming control vs. ASHRAE baseline design

		Energy Consumption (kWh x 000)	Saving (%)
ASHRAE	No Shading	820	
	Daylight Dimming Control	747	9

6.6 On-Site renewable energy

Wind Turbine:
It is found that there is a great potential in wind energy. With mean wind speed is 6 m/s of local weather, this building can apply horizontal shaft wind turbine to create about 1,185 kWh of green energy per year. Wind energy produce from 30 wind turbine is 35,550 kWh per year.
Solar energy calculation is shown on Table 6 which considers these designs: photovoltaic (PV) grid at roof of building and parking lot, horizontal shading grid for window walls and building integrated photovoltaic (BIPV) grid for walls. The optimum angular of PV is about 25^o which produce most energy from PV systems with respect to local weather data, likewise, other factors impact the efficiency of PV system is prepared as mentioned by Yoo [5].
Total electric output from wind and PV system is about 293,000 kWh/year which supplements for 36% of total building energy consumption in baseline case. According to LEED 2009 (EA credit 2), this design strategy will got 7 points.

Table 6. Solar energy calculation

		Incident solar radiation (kWh/sq.m)	PV efficiency (%)	Area (m^2)	Annual electric output (kWh x 000/year)
PV	ROOF	720	10	550	39
	Shading	600	10	1000	60
	BIPV	420	10	3000	126
	Parking	650	10	500	33
Wind energy					35
				Total	293

6.7 Water Reduction

To help reduce potable water demand by 65% overall, it is possible to collects rainwater to use for other purposes, recycle 50% domestic wastewater by available advanced treatment systems, use low-flow water closet and water-saving irrigating landscaping accessories [6].

6.8 Integrated design

The integrated design combines of wall insulation R-19 + R-13, green roof, Viracon Super window VWY15-08, Overhang +Fin and Daylight dimming control together. This combination in design can reduce annual energy consumption to 420,000 kWh and increase on-site renewable energy generated for building up to 63%.

7. Results and discussion

Although this report does not mention of economic consideration, it is preliminarily calculated that the total cost of this green design is about 6 millions, then 1.5 times as much as the cost of normal building design. However, the payback of this green design is hopefully about 10 years because of energy and water saving.
The research shows us a potential of green building design in term of Vietnam weather data and conditions. Because there are many other credits needed to consider how many points this green building design can get, this research focus only on major designs and innovation techniques that are specifically presented above.

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