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HOT & HUMID CLIMATE AIR FLOW STUDY AND AFFECT OF STACK VENTILATION IN RESIDENTIAL BUILDING

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Abstract. Natural ventilation is the process of supplying and removing air through an indoor space by natural passive means. For comfort and saving energy, there are two major types of natural ventilation occurring in buildings: wind driven ventilation and stack ventilation. The majority of buildings employing natural ventilation rely primarily on wind driven ventilation, but stack ventilation has several benefits and doesn't need wind pressure for removing hot air. The most efficient design for a natural ventilation building should implement both types of ventilation but there is not enough wind pressure in Malaysia that's why in this project just relies on a stack effect. Three time measurements accomplished on this project in three different conditions which includes stack effect and interference fan on the stack for harnessing more results and accelerating ventilation.

Keywords: passive ventilation, cooling, stack ventilation and fan.

1. Introduction

Almost all historic buildings were ventilated naturally, although many of these have been compromised by the addition of partition walls and mechanical systems. With an increased awareness of the cost and environmental impacts of energy use, natural ventilation has become an increasingly attractive method for reducing lost of energy use and cost it also for providing acceptable indoor environmental quality. It will more help in maintaining a healthy, comfortable, and productive indoor climate. In favorable climates and building types, natural ventilation can be used as an alternative to air-conditioning with saving up to 30% of total energy consumption.

In the project decided to evaluate three different position and measure temperature and humidity on an existing building in Malaysia and obtained the best ventilation system for building also improving sustainable movement and eliminate of electricity west on building.

Therefore, there are three positions to measurement,

1-Measurment on the existing building without any changes.

2-Measurment the use building when set up stack ventilation.

3-Measurment when a use fan on top of the stack ventilation to use better air movement.

The figure below shows the case study which done a measurement on it.

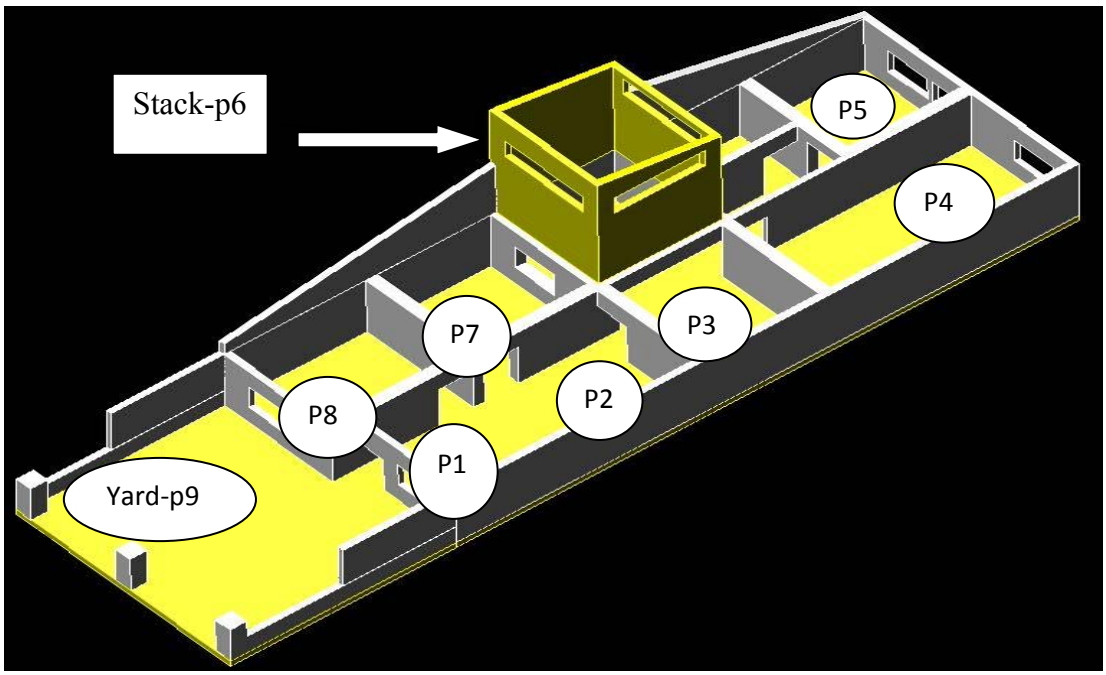


Figure 1

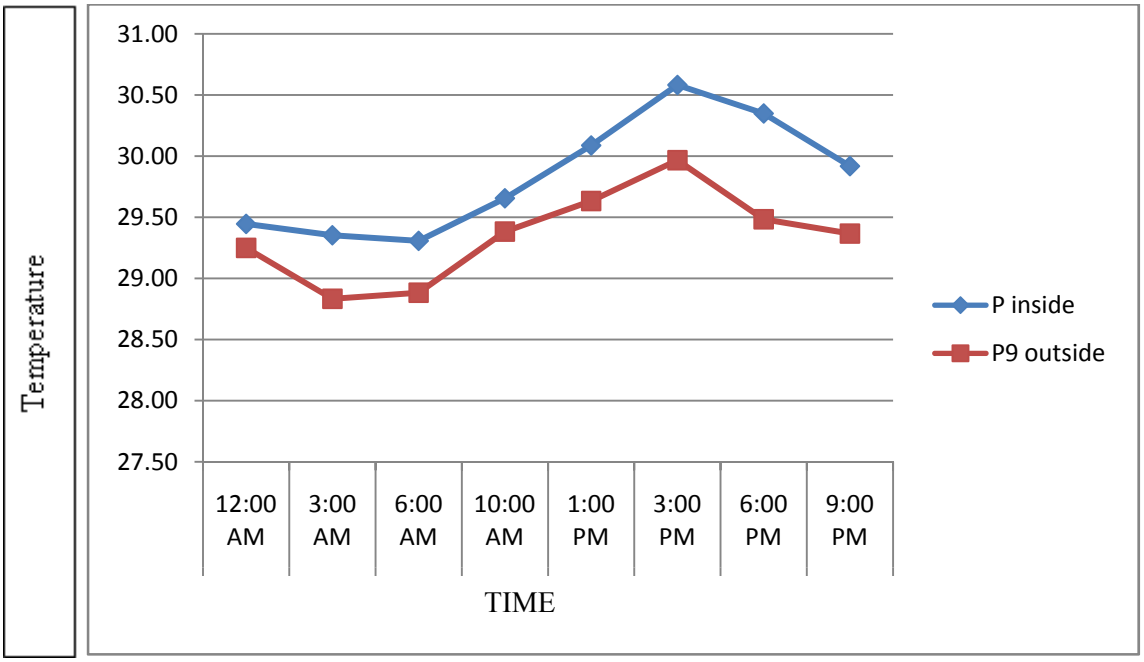
The 9 points determined from above figure show the points measured, p1, p2, p3, p4, p5, p6, p7, p8 are related to inside the building and p9 is related to outside the building for comparing temperature. This measurement continued for 25 days and bellow tables just extract of those days.

2. Result comparison between three different terms

2.1 The Building without stack ventilation

Table 1-1 the average of temperature while not using of stack ventilation

	The average of temperature while not using of stack ventilation							
	12:0-AM	3:00 AM	6:00 AM	10:00 AM	1:00 AM	3:00 AM	6:00 AM	9:00 AM
p	29.45	29.35	29.31	29.66	30.09	30.58	30.35	29.92
p9	29.25	28.83	28.88	29.38	29.63	29.97	29.48	29.37



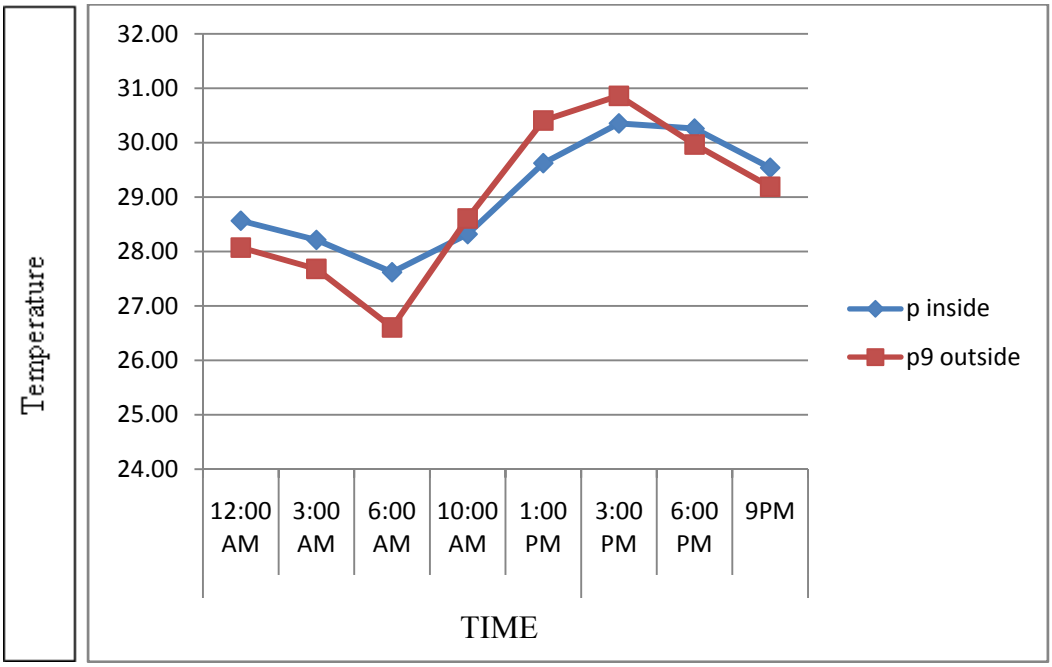
Graph 1-1 the average of temperature while not using of stack ventilation

This is regular building in Malaysia which people living on it or using that as office, measurement accomplished inside and outside of the house within ten days (raining days and sunny days) to obtain accurate average and any twenty four hours accomplished eight steps measurements in nine different points which can see in the figure 1. Blue arrow (p inside) an above diagram has shown that average of temperature on inside the building is higher than outside (without stack ventilation). The temperature start rising from 6 AM till 3 PM from this time density of air went down slowly till midnight.

2.2 The Building with stack ventilation

Table 2-1 Average temperature by stack ventilation

Average temperature by stack ventilation								
	12:00 AM	3:00 AM	6:00 AM	10:00 AM	1:00 PM	3:00 PM	6:00 PM	9:00 PM
p	28.57	28.21	27.62	28.32	29.62	30.35	30.26	29.54
p9	28.07	27.68	26.60	28.61	30.41	30.86	29.97	29.19



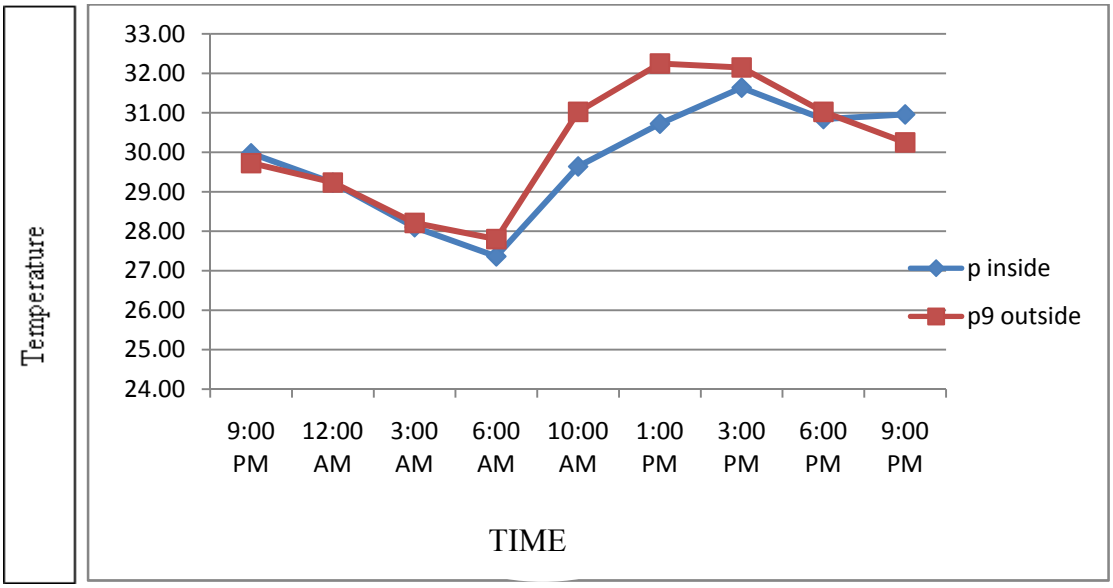
Graph 2-1 Average of temperature by stack ventilation

P in the above tables obtained from got an average of p1, p2, p3, p4, p5, p6, p7, p8 and p9 just shows the average of outside temperature. Above graphs shown that the temperatures of inside building are really cooler than outside during night time. By comparing Graph 2-1 with Graph 1-1 can understand the variation of temperature and effect of stack ventilation in residential building because stack extract temperature from building very smart. The air trapped in the first measurement (without a stack) and couldn't remove from building to outside.

2.3 The Building with stack ventilation and ceiling fan

Table 3-1 Average of temperature while using of fan and stack

The average of temperature while using of fan and stack									
	9:00 PM	12:00 AM	3:00 AM	6:00 AM	10:00 AM	1:00 PM	3:00 PM	6:00 PM	9:00 PM
p	29.98	29.23	28.10	27.36	29.64	30.72	31.64	30.84	30.96
p9	29.73	29.24	28.21	27.80	31.03	32.25	32.15	31.03	30.25



Graph 3-1Average of temperature while using of fan and stack

The red diagram (p9) shows a variation of temperature outside the buildings, and blue one (p) shows a variation of temperature inside the building. This measurement contained within 25 days and results from shows in the above diagrams. By comparing three conditions, without stack ventilation, just stack ventilation and stack ventilation by a fan, the graphs above illustrated differences between these conditions, in the first step it is going to survey term without stack ventilation, there are big differences between trends inside and outside. This is showing that stack ventilation that how can effect on the temperature inside the building. In the first graph temperature of inside the building is totally higher than outside, this is because the temperature trapped inside the building, and it doesn't skip. The best condition is when using of a fan. It could bring the better cool air inside the building and remove warm air by stack and pressure of a fan, in this term fan works in two different ways, which start to bring air from outside to inside during a night and remove air from inside to outside during a day (6 am to 9 pm). Fan could accelerate air movement when using on the top level of stack ventilation and provide pleasant air temperature for residential however it would be better if can increased the high of the stack ventilation to nine meters. The side of stack which faces to sun radiation should be black for extract sun radiation because stack effect rely of sun warming. When the temperature of inside the stack goes higher air can remove of it better and better.

1-In the term without using of stack ventilation:

$$y = 0.4998lnx + 29.175$$

$$y = 0.2975lnx + 28.956$$

2-In the term by using of stack ventilation:

$$y = 1.3271lnx + 27.164$$

$$y = 0.9614lnx + 27.78$$

3-Using of stack ventilation combine with fan:

$$y = 1.1171lnx + 28.597$$

$$y = 0.8845lnx + 28.572$$

3. Acknowledgements

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4. References

[1] Maatouk Khoukhi 2009, Investigation of Airflow Patterns Inside Tall Building.

[2] Stephen A. Gage., G.R. Hunt., P.F. Linden., (winter, 2001) Top Down Ventilation And

[3] Cooling.Fred Tepfer., (2007). Sustainable Design Strategies at Lillis Hall: a Selected Sample.