ENERGY MODELLING OF A MULTI-STOREYED BUILDING FOR GREEN BUILDING DESIGN

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(09/8654)

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa
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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree

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DECLARATION

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The above candidate has carried out research for the Masters Dissertation under my supervision.

……………………………

Signature of the supervisor Date:

(Dr. Asanka S Rodrigo)

Abstract

On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy. The Air Force Headquarters (AFHQ) building has been constructed 12 years before and minimal concern has been made for the application of green building concepts. In order to apply these key steps into the AFHQ building there are restrictions and limited steps could be accommodated. Reduce the load, optimize the systems and save energy are the most important key steps which can be applied for this building.

At present the systems are being operated catering only for the basic requirements of occupants. Whole building is used for offices and there are few elements operated in the night time also due to the operational and security commitments in the country. Observations have been made on general lighting and air conditioning systems which can be improved in order to reduce the load, optimize the system and finally to save the energy. Minimise the energy waste is one of the main concerns of the green building design and such avenues have been explored and evaluated the total energy saving has been estimated.

AFHQ building's light system and air conditioning system have been modelled using DIALux 4.11 and Loadsoft 6.0 software respectively. Basically a typical floor is modelled for the existing system parameters and calculated the energy consumption. The lighting system has been designed based on general requirement of offices and not integrated with the partitions and natural lights. The power consumption of a typical floor is nearly 10KW where fluorescent lamps with magnetic ballasts used. With the new design electronic ballast are used and luminaries were selected to maintain 300-500 lux level at the working plane. The total power consumption is reduced by 4KW and further reduced with the day light integration. The total load averagely reduced to 3.2-4.1KW at the day time where total energy reduction is 46-52kWh per day per floor.

Chilled water central air conditioning system has designed for two chillers of capacity 200 tonnes and each chiller serve 7 floors of the building. There are 14 AHUs serving each floor having fixed drive motors. The temperature of each floor varies significantly within the floor as well as during the working time. In side temperature is directly responded to the outside environmental conditions. Only one thermostat is available in one floor and not sufficient to cater the whole area where there are different types of partitions. Present cooling load of a typical floor is approximately 25-28 tonnes with constant air flow and uncontrolled fresh air. At present the inside temperature is not controllable and some instances drops to 22-23ºC creating uncomfortable working environment. While proposing variable air flow and regulating the inside temperature to 24ºC the cooling load could be reduced by 14-17% of the total existing load where total energy saving per day per floor is 197.1 kWh.

Then a new system was proposed with day light integration and simulated with software and optimum quality of the window is defined. The total energy saving is calculated as LKR 16.7 M against the total cost of the proposal LKR 56.6 M. The return on the investment has been calculated as 3 years.

Key words: Green Building, Optimize, model, Simulation, Day Light Integration

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LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Air Conditioning
AFHQ	Air Force Head Quarters
AHRI	Air Conditioning Heating and Refrigerating Institute
AHU	Air Handling Unit
ANSI	American National Standard Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
CAV	Constant Air Volume
CEB	Ceylon Electricity Board
CFL	Compact Fluorescent Lamps
CIBS	Charted Institution of Building Services
DF	Daylight Factor
EEBC	Energy Efficient Building Code
ERC	Externally Reflection Component
FCU	Fan Coil Unit
FL	Fluorescent Lamps
HVAC	Heat Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IRC	Internally Reflection Component
IRR	Internal Rate of Return
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LPD	Lighting Power Density
RA	Return Air
ROI	Return On Investment
SA	Supply Air
SC	Shading Coefficient/ Sky Component
SHGC	Solar Heat Gain Coefficient

SLGBC	Green Building Council Sri Lanka
SLSEA	Sri Lanka Sustainable Energy authority
TFA	Treated Fresh Air
USGBC	United State Green Building Council
VAV	Variable Air Volume
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
VOC	Volatile Organic Compounds
WCP	Water Cooled Package

LIST OF APPENDICES