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PERFORMANCE EVALUATION OF BUILDING HAVING DIFFERENTTYPES OF SOLAR SHADES

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Abstract: Numerical investigations have been performed to study the cooling load reduction of office buildings by using different types of solar shades and find out the most efficient type of shade. In this paper simple indices were proposed to compare the thermal efficacy of different types of solar shadings in non-residential buildings. The building cooling load influenced by sunlight and outside weather. An auditorium in the campus is analyzed and recommend an optimized length of shade using Google sketch and Energy Plus software.

Keywords:- Shades, simulation, building energy, width o f shades, weather data, Green building.

NOMENCLATURE

Symbols

d	Width of shade ,m
h	Height of window, m
ºC	Degree celsius
GJ	Giga Joule
KW	Kilo Watts

Abbreviations

wmo	World Metrological organization
idf	Input data file
ISHRAE	Indian Society of Heating Refrigeration and air conditioning Engineers
Ind	India
HVAC	Heating ventilation and air conditioning
GenOpt	Generic Optimizer
EPlus	Energy Plus

1. INTRODUCTION

The design of low energy buildings in tropical climates and in warm climates normally focuses first on the quality of solar shading. Solar shading is the over-riding design feature needed to avoid overheating inside the building and thus decrease the cooling capacity of air conditioning. The capital cost of installation and the operating time of air conditioning systems can be reduced or avoided if solar shading is combined with architectural design features such as cross natural ventilation. As reduction of the energy consumption of the building sector constitutes now a priority objective, consideration of natural lighting also is essential. Finding building energy performance problems is a critical step in improving energy efficiency in buildings and in reaching a building's performance goals established during design

As buildings become more energy efficient, not only does their total energy use decrease, but there is also a shift in the distribution of energy end uses, such that occupant behavior plays an increasing role. These actions also add considerable uncertainty in predicting how a building will perform, during design. Window shading devices, which include roller shades, venetian blinds, vertical blinds or louvers, and which can be interior, exterior, or between window panes, provide significant control over day lighting, thermal and visual comfort, views and privacy, while also affecting heating and cooling loads.

1.1 Energy plus

Using Energy Plus software, one can predict type of shading having least total energy consumption. Since the simulation is fast one can optimize the dimensions of solar shade. Simulations can done for existing as well as future buildings EPlus is a new building energy simulation program that combines the best features of the BLAST and DOE–2 programs along with many new capabilities. Connectivity and extensibility were overriding objectives in the design and development process to facilitate third party interface and module development. Energy Plus not only combines the best features of the BLAST and DOE–2 programs, but also represents a significant step forward in terms of computational techniques and program structures. As load calculation and energy simulation methods become more accurate, more detailed models must be created to include the effects of different architectural components and systems in the calculations. Energy Plus software is mainly developed to simulate the performance of the buildings. It is a thermal load and energy analysis simulation software. Based on user inputs for building itself and operational properties, it calculates heating and cooling loads to maintain temperature set points year round. The design of a building or the analysis of an existing building with the software will show how efficient the building is or will be, and also helps finding the best efficient choice of the whole building system. For building drawings and envelope details as windows, doors or shading, Google Sketch-up tools are used .Building Parameters such as location (latitude, longitude), orientation are entered at the very beginning. Internal loads (occupancy, lighting, equipment etc.) that differ as per building shall be inputted by the user; although solar loads and conduction loads are calculated by the program itself regarding the location, orientation and time of day, also outdoor weather properties. Loads and schedules are to be defined in order to simulate building's behavior throughout the desired time period.

M. David et al[1] were proposed to compare the thermal and visual efficacy of different types of solar shadings in non-residential buildings. These indices can be derived from the results of numerical simulations that include thermal and day lighting analysis such as the Energy Plus software.

William O'Brien et al[2]This paper provides a comprehensive and critical review of experimental and study methodologies for manual shade operation in office buildings.

F.A. Ansari, et al[3] The cooling load calculation described in the present paper is simply based on the rule of thumb. It may be called a computer version of cooling load estimation form.

Hema Sree Rallapalli [4] A Comparison of EnergyPlus and eQUEST Whole Building Energy Simulation Results for a Medium Sized Office Building. Author explained the capabilities of Energy Plus in comparison with other simulation software. From the above literature survey, it can be seen that many of the previous investigators have focused their attention on experimentally determine the cooling load from real building data and also there are some limitations in the predecessor simulation software of Energy plus.

Natasa Djuric[5] on his doctoral thesis Real-time supervision of building HVAC system performance. This thesis presents techniques for improving building HVAC system performance in existing buildings generated using simulation-based tools and real data.

Kemal Ozgen Birol[6] in his master thesis aims to present efficient technologies providing energy savings in buildings, to present green building concept and alternative energy simulation software.

Waters [7] have demonstrated the importance of selecting a proper model for indoor convection in accurately performing load calculations.

In this work, Numerical investigations have been performed to study the cooling load reduction of office buildings by using different types of solar shades and find out the most efficient type of shade. By varying the width of shades for different types of solar shades an optimal value of width of shade is obtained.

2. NUMERICAL MODELING AND ANALYSIS

The modeling the office and simulation is done by Google sketch and Energy Plus version 7.2.0. Geometry of the case study is shown in fig.1

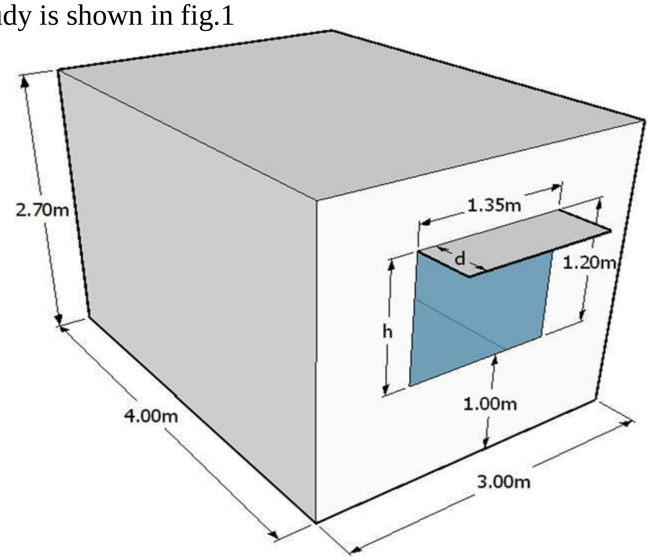

Fig 1: Geometry of study

2.1 Geometry

Building size: 3m x 4m x 2.7m
Window size: 1.35m x 1.2m
Shade Thickness: 3.5cm

2.2 The weather conditions

For my study the weather data of Trivandrum is used. The weather data are arranged by world metrological organization. The weather file .epw is obtained from Asian wmo region 2-Ind-Trivandrum 433710 (ISHRAE).

2.3. Materials of wall, floor, roof

M15200mm heavy weight concrete,G01a19mm gypsum board, F16 Acoustic tile.

2.4 Heating and cooling set point Heating set point 20°C and cooling set point 25°C.Constant set point thermostat.

2.5. Methodology

In this thesis simple indices were proposed to compare the thermal load and shading efficacy of different types of shades types of solar shadings in non-residential buildings Numerical procedure was done using, Google sketch coupled with EnergyPlus software. The physical geometry consists of an office building with dimensions 3m x 4m x 2.7m and a window on north side building having dimensions 1.35m x 1.2m.The building geometry was created in Google sketch is simulated in Energy Plus software. The required weather file of Trivandrum city is obtained from Energy Plus weather data file. The input file used for simulation is idf. By using Energy Plus different cooling loads obtained for each type of shades also simulate by varying the shade length and finds the optimum length where the load is minimum.

2.6. Simulation

Energy Plus software allows study of the solar efficiency of the solar shading as well as thermal loads of room The sky radiance distribution is based on an empirical model based on radiance measurements of real skies. Even if Energy Plus uses a zonal model to solve the thermal balance, the solar radiation distribution on the building is spatially defined. The shadow of a solar protection is accurately taken into account for evaluating the solar gains through windows. An ideal load air system is set up in order to evaluate the cooling load. This object of the Energy Plus program permits to assess the theoretical thermal loads needed to achieve the thermal balance at any time step of the simulation

The case study (Fig.1) is a typical office of 12 m2.The window-to-wall ratio is 20%.This ratio corresponds to the recommend opening area for office buildings in Trivandrum, Kerala. Here we obtain the result of annual energy consumption of building for different types of solar shades Solar shading is the over-riding design feature needed to avoid overheating inside the building and thus decrease the cooling capacity of air conditioning. The present work is aimed to conduct a numerical and experimental study on different types of solar shadings and its efficacy and to obtain a building with less energy consumption

3. RESULTS AND DISCUSSIONS

3.1 Validation

The results from Energy plus software is compared with the results in F.A Ansari et al[3] Here the author used Window with shading carrier software to obtain the Gross cooling load with no shading and the value is 16.91KW.Building dimension for our validation is 15m x 7m x 3m In our numerical simulation of same building using Energy plus obtained a value of 20.5KW. The error may be due to Ideal air system used in energy plus for easiness of HVAC design load. The closeness of the values indicates the trustworthiness of Energyplus software.

3.2 Types of shades

1. Simple Overhang
2. Simple Overhang with 45 Degree inclination
3. Vertical side fin
4. Rectangular side fin
5. Arc+ Triangular side fin
6. Triangular.

NORTH=3.53GJ
SOUTH=3.54GJ
EAST=3.58GJ
WEST3.63GJ

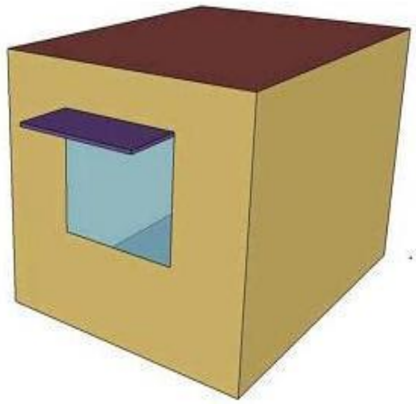

Fig 2: Simple overhang

Table 1: Annual Total Energy of building of Simple overhang

Width of shade	Total building energy (GJ)
d=0.3m	7.06
d=0.6m	6.99
d=0.9m	6.97
d=1.2m	6.95
d=1.5m	6.93
d=1.8m	6.925
d=2.1m	6.924
d=2.4m	6.921

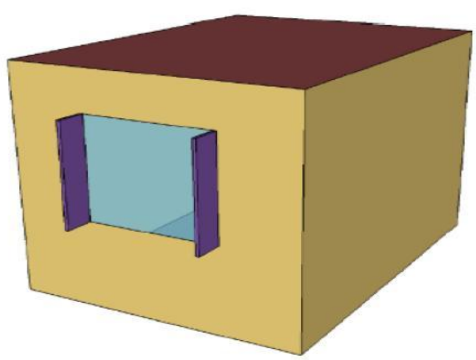

Fig 3: Vertical side fin

Table 2: Annual Total Energy of building of Vertical side fin

Width of shade	Total Building energy (GJ)
d=0.3m	7.14
d=0.6m	7.09
d=0.9m	7.01
d=1.2m	6.98
d=1.5m	6.97

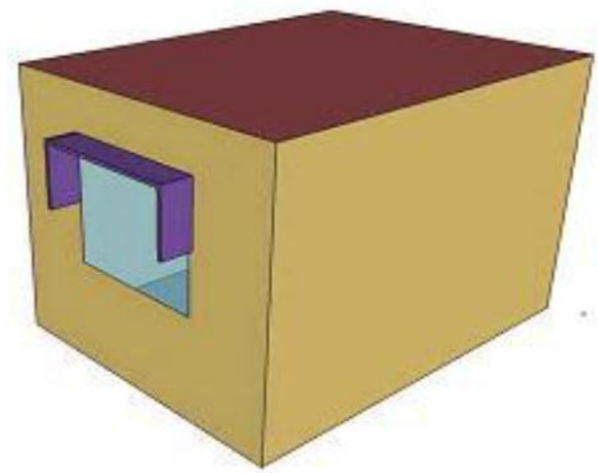

Fig 4: Rectangular side half fin

Table 3: Annual Total Energy of building of Rectangular side half fin

Width of shade	Total Building energy (GJ)
d=0.3m	6.93
d=0.6m	6.87
d=0.9m	6.8
d=1.2m	6.72
d=1.5m	6.68
d=1.8m	6.678
d=2.1m	6.68

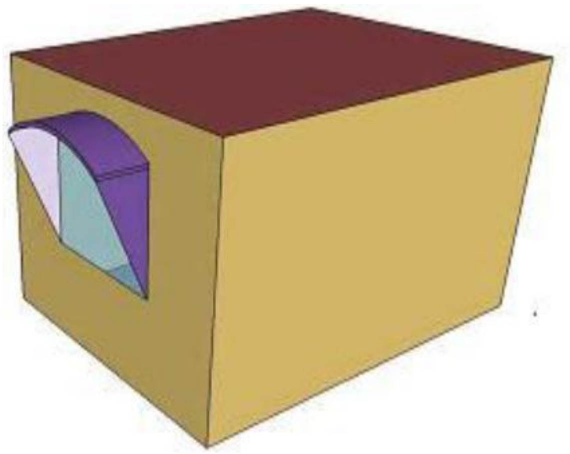

Fig 5: Arc + Triangular side fin

Table 4: Annual Total Energy of building of Arc +Triangular side fin

Width of shade	Total Building energy (GJ)
d=0.3m	6.93
d=0.6m	6.76
d=0.9m	6.682
d=1.2m	6.68
d=1.5m	6.68

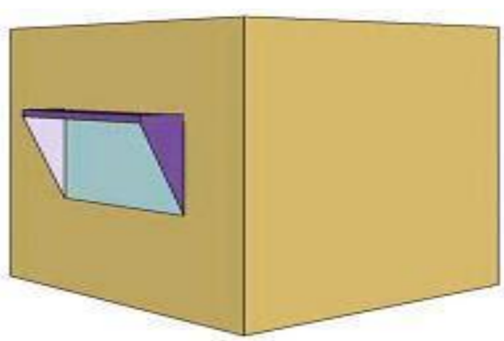

Fig 6: Triangular shade

Table 5: Annual Total Energy of building of Triangular shade

Width of shade	Total Building energy (GJ)
d=0.3m	6.77
d=0.6m	6.682
d=0.9m	6.68
d=1.2m	6.75
d=1.5m	6.674

3.3DIAMOND JUBILEE HALL COLLEGE OF ENGINEERING TRIVANDRUM - case study 2

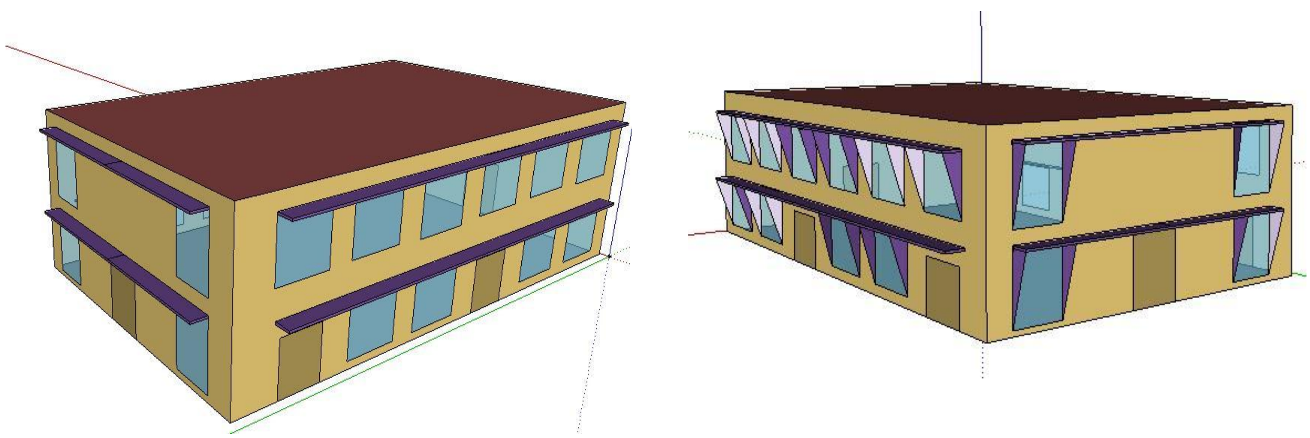

Fig 7: Diamond Jubilee Hall at College of Engineering

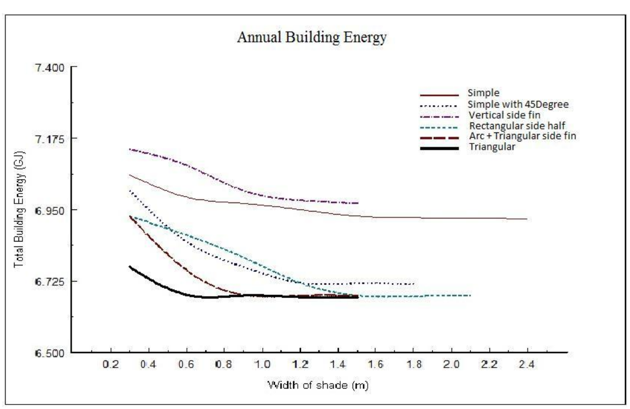

Fig 8: Diamond Jubilee Hall at College of Engineering Trivandrum-case study 2(with Triangular shade)

Table 6: Compare the effect of triangular shade

Without any shade	Simple overhang type (presently used)	Triangular Type (Recommended)
239.23 GJ	194.24 GJ	189.26 GJ

4. CONCLUSION

Trivandrum-case study 2(with simple shade)

<u>From case study 1</u>

From case study 1

1. North side window gives least energy consumption of building.

2. In the present numerical study it can be concluded that solar shade of simple overhang with triangular finsgives least energy consumption.

3. A Triangular shade with width of shade d= 0.6m is the optimal shade width at which minimum energy of 6.68 GJ.
4. Arc + Triangular and Rectangular shade also gives minimum energy to building at shade width of 0.9m and 1.5m respectively. But extension of shade cannot be taken as long so triangular shade is apt one.

<u>From Case study 2</u>

1. Simulation using Energy plus at Diamond Jubilee Hall at College of engineering Trivandrum; triangular shade reduces building heat gain by 2.56% than currently used simple shade.

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