SHADING AND NATURAL LIGHTING DESIGN FOR COMMERCIAL BUILDINGS IN COMPOSITE CLIMATE (DEHRADUN)

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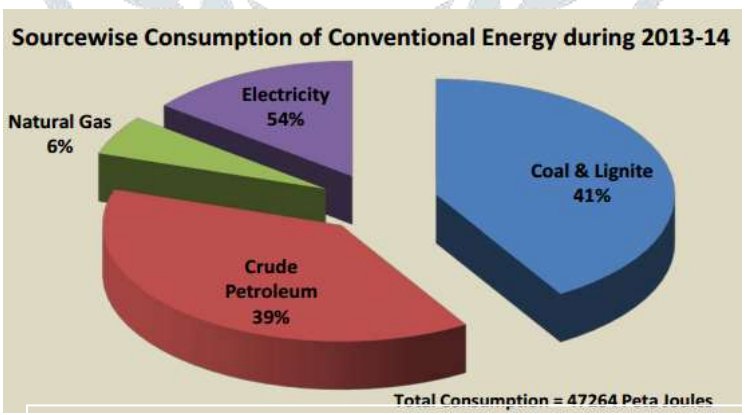
Abstract: In a building, if the spaces are well lit with the daylight, it features good designing skill in that building. Buildings with optimum daylight create a positive working ambience and also a healthy and relieving space to work in. Artificial lighting account for a large share of the total energy consumption which could be substantially reduced with the help of the provision of ambient day lighting in building. Visual comfort could be created with the help of proper day lighting along with avoiding glare and providing ambient lighting. Glare could be avoided in the buildings either by providing glare resistant glass, but that will result in reduced daylight too, thus another way of reducing glare is the proper designing of the sunshades in the openings. Sunshades could be fixed or movable, since the movable ones couldn't be installed everywhere therefore fixed shades are more common. While designing sunshades for a city like 'Dehradun' which experiences hot summers and chilled winters careful designing for sunshades is required such that it avoids the sun throughout the day in summers and allows the sun in winters without creating visual discomfort. Therefore, in this paper we will be designing the sunshades for 'Dehradun' in consideration with the climate and visual comfort.

Keywords: Daylight, Sunshades, Visual comfort, Glare

Introduction:

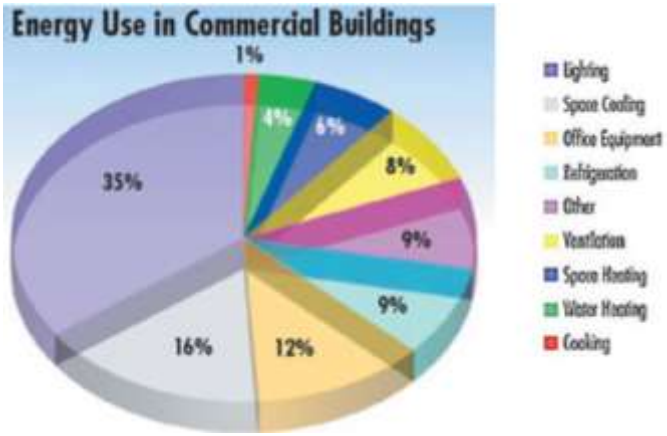
Conservation of energy is the matter of great concern among the users and the designers of a product or building. With the depleting resources and degrading environmental conditions, people are inclined towards using energy saving techniques and materials. Along with this there is also a demand of better environment quality within the buildings for the betterment of occupant's health thereby improving their working efficiency.

One of the projections of the International Energy Outlook 2013 also shows that India's commercial sector energy consumption growth is projected to increase at an average rate of 5.4 per cent per year, which is also the world's highest.



Energy statistics 2015 (central statistics office)

The Energy Statistics 2013 of India's National Statistical Organisation (NSO) shows electricity accounted for more than 57 per cent of the total energy consumption during 2011-12 in India, and building sector is already consuming close to 40 per cent of the electricity. This is expected to increase to 76 per cent by 2040. Out of the total electricity consumption a large share of the energy is used for the purpose of lighting followed by the cooling of the space.



The lighting and cooling load on the energy could be effectively reduced by proper designing of openings. Openings in the building cater both the demand if used effectively. As the opening in the buildings provide the required daylight for working as well as these serve a medium for connecting the users inside the building to the outer natural environment. In buildings which are used for commercial purposes like offices, provision of optimum natural light is necessary. In my report for the topic I will be providing the designs of shading devices and data regarding their contribution in providing optimum light in the working zone of the building. The study will aim at reducing the energy demand for the lighting load of the building along with providing visual and thermal comfort to the users by avoiding glare and direct sunlight from entering inside the building.

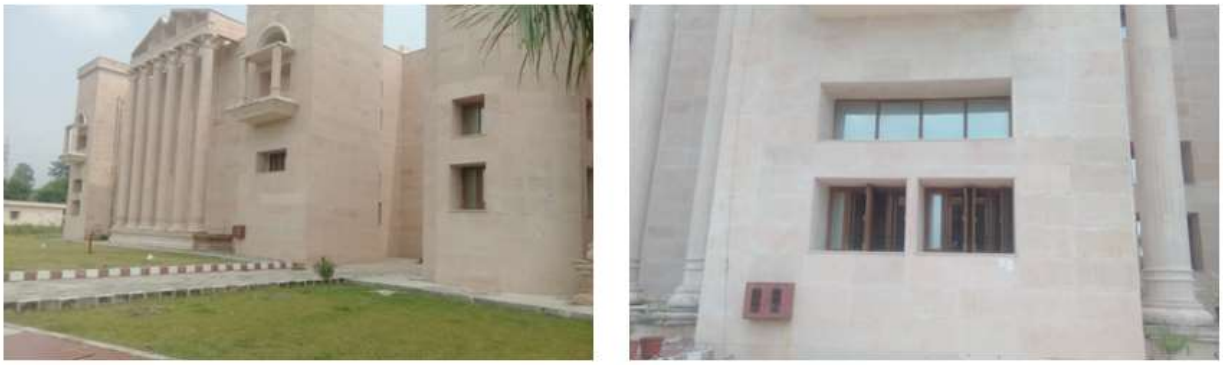
Case Studies:

Various case studies of office buildings and commercial buildings are done to understand the frequently used design in the existing buildings.

1. Forest Research Institute:

2. Wadia institute of Technology

3. Uttarakhand Technical University



4. Graphic Era University.

Inference drawn from the above mentioned case studies is that mostly used sunshades in the office buildings are the recessed inside the wall and generally have a recess of about 2’ 3” to 2’ 6”.

Methodology:

A theoretical modeling approach is adopted in order to find out the potential of energy savings by the proposed designing of sunshades in the openings in the specified city. Three stage method is adopted for research:

1. Base Model: Preparation of base model which would be a room of an office of a common size considering- The material frequently used in Deahradun, direction for which sunshade is to be designed and the opening is left unshaded such that it allows maximum sunlight and glare to enter inside the room.
2. Analyzing the commonly practiced sunshades: The common sunshades designs are taken from the case studies done at various office buildings and are further analyzed.
3. Proposed design: A design of sunshades is then proposed which will be able to avoid glare, direct sunlight and provide optimum daylight inside the building.

The Simulation tool: The simulation tool used for designing and analyzing the design is ECOTECT. The weather files will be taken from energy plus and the graphical interpretation of the weather file will be done in CLIMATE CONSULTANT and the generated graphs will be used in the study.

Modeled climatic condition:

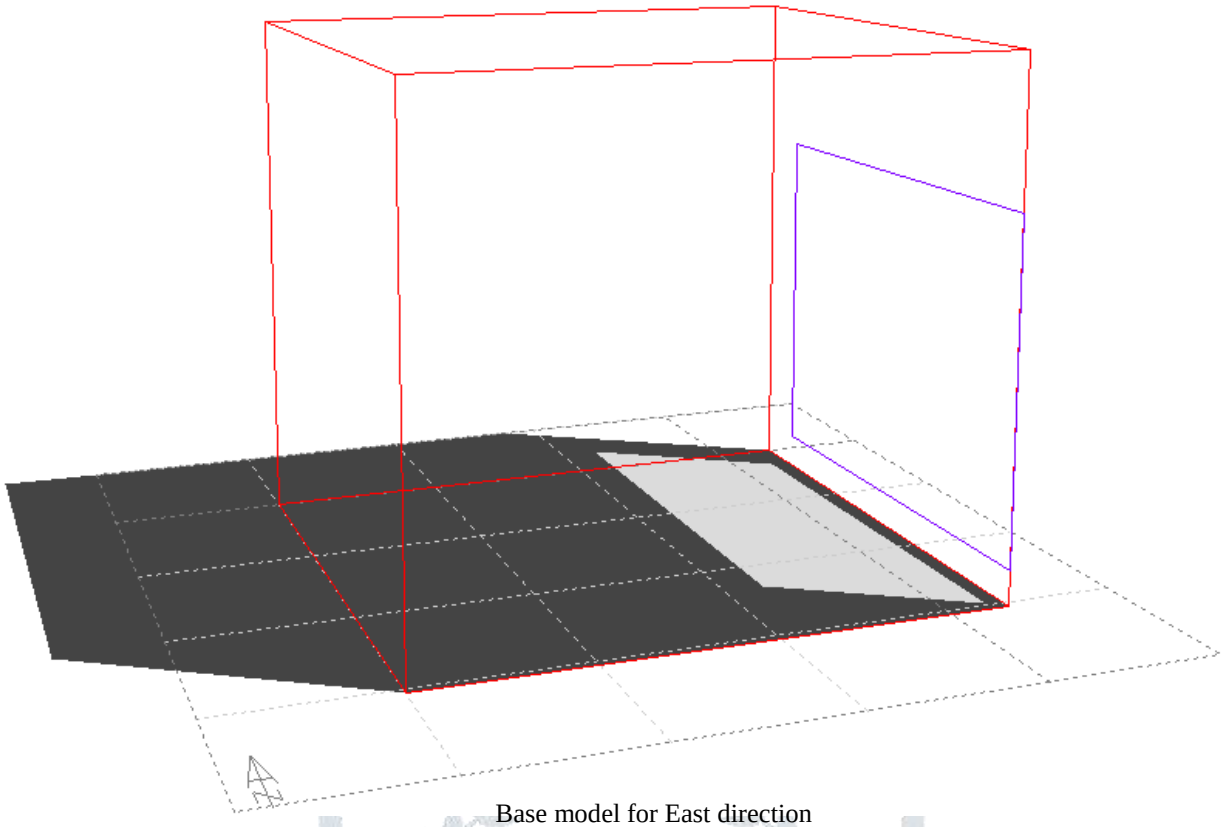
The modeled climatic conditions are of Dehradun (Lat. 30°3'N, Long. 78°0'E, 682mtrs. above sea level). Its climate is characterized by hot and humid in summers and cold in winters with an average rainfall of 2073.3mm. in summers temperature could rise upto 40°C.

Base Model:

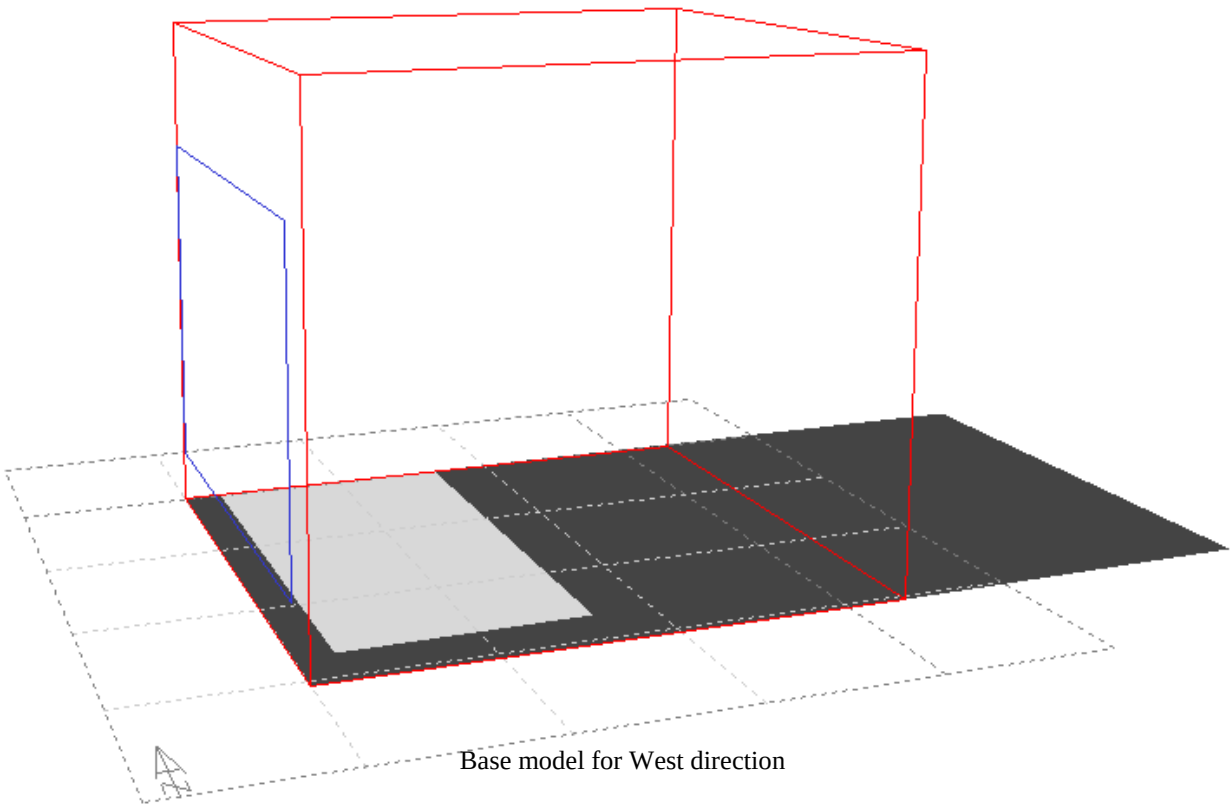
The base model is formulated to simulate the intended building type i.e. the office building. The model taken for simulation is a room of general size 3.35 mtrs long and 3.05 mtrs wide. The shading is designed for east and west face of a building. The time of simulation is concluded keeping in mind the penetration of direct radiation inside the room from the data generated from Energy Plus for Dehradun city.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0:01- 1:00	0	0	0	0	0	0	0	0	0	0	0	0
1:01- 2:00	0	0	0	0	0	0	0	0	0	0	0	0
2:01- 3:00	0	0	0	0	0	0	0	0	0	0	0	0
3:01- 4:00	0	0	0	0	0	0	0	0	0	0	0	0
4:01- 5:00	0	0	0	0	0	0	0	0	0	0	0	0
5:01- 6:00	0	0	0	0	0	0	0	0	0	0	0	0
6:01- 7:00	0	0	0	1	65	81	3	0	0	0	0	0
7:01- 8:00	0	0	54	326	458	354	83	97	79	18	2	0
8:01- 9:00	90	201	458	618	670	487	161	168	252	228	321	162
9:01-10:00	462	490	667	727	689	579	167	189	343	402	638	603
10:01-11:00	785	653	760	709	596	547	174	153	330	530	931	888
11:01-12:00	844	668	715	580	496	439	132	152	320	509	867	916
12:01-13:00	757	615	596	505	379	401	136	119	265	371	729	804
13:01-14:00	553	436	520	357	354	327	103	105	178	270	398	520
14:01-15:00	314	351	417	297	283	329	112	91	199	170	247	269
15:01-16:00	159	192	258	226	268	207	111	75	164	118	114	86
16:01-17:00	65	104	215	209	212	202	94	66	121	73	34	22
17:01-18:00	1	17	90	98	125	105	58	68	49	7	0	0
18:01-19:00	0	0	1	6	29	40	25	22	0	0	0	0
19:01-20:00	0	0	0	0	0	0	0	0	0	0	0	0
20:01-21:00	0	0	0	0	0	0	0	0	0	0	0	0
21:01-22:00	0	0	0	0	0	0	0	0	0	0	0	0
22:01-23:00	0	0	0	0	0	0	0	0	0	0	0	0
23:01-24:00	0	0	0	0	0	0	0	0	0	0	0	0

Source: Energy Plus- Dehradun Weather Analysis



Base model for East direction



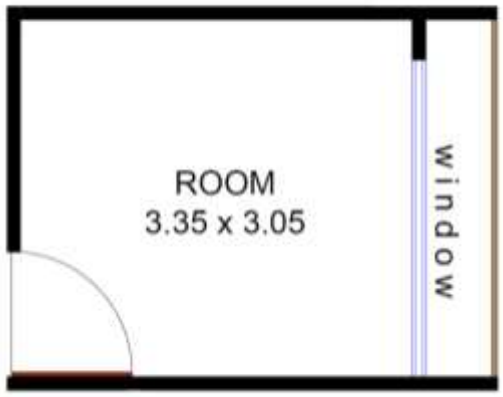
Base model for West direction

Source: Ecotect

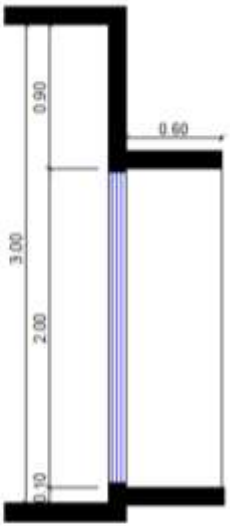
Simulations:

A process of simulation is adopted for designing such a sunshade which provides the required shading and protection from the direct solar radiation from penetrating inside the building during the months of summer and reduce the cooling load as well as avoids glare inside the building thereby reducing the lighting load of the building in the east and west direction.

Simulations for east direction:

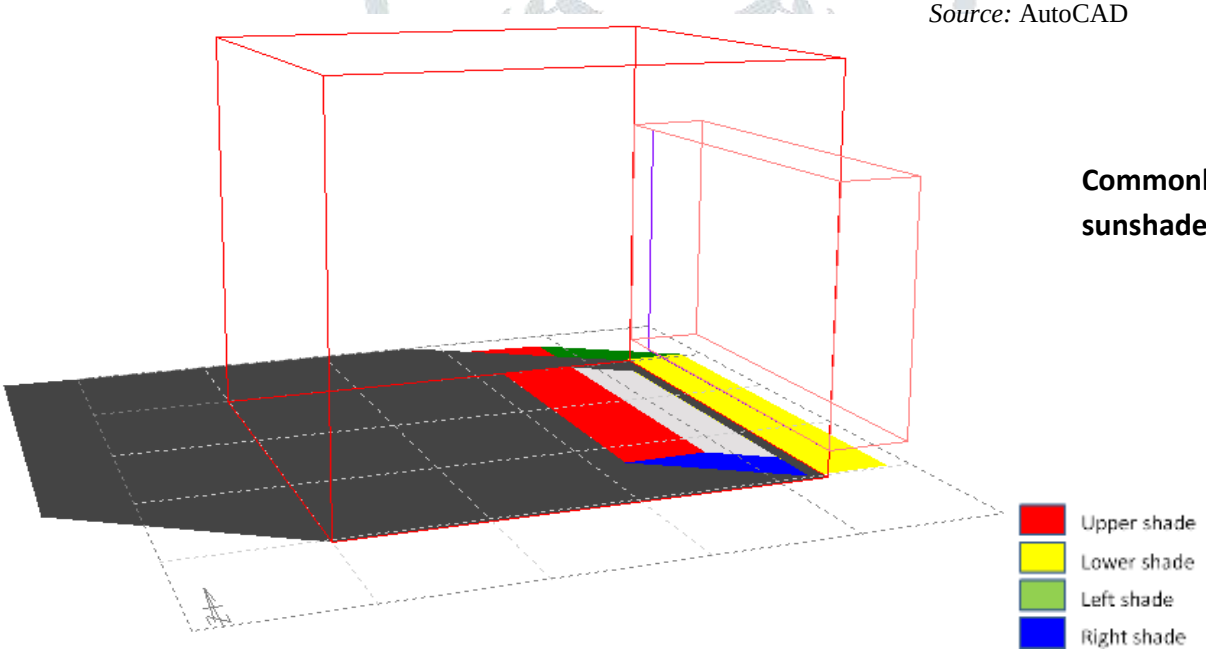


Plan



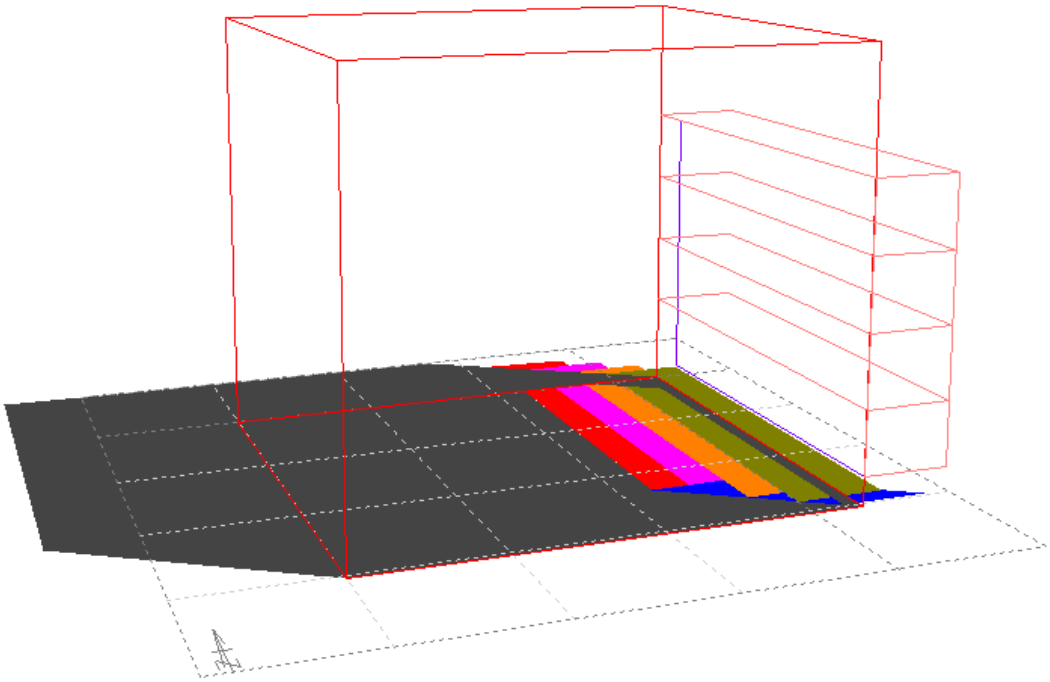
Section of wall

Source: AutoCAD

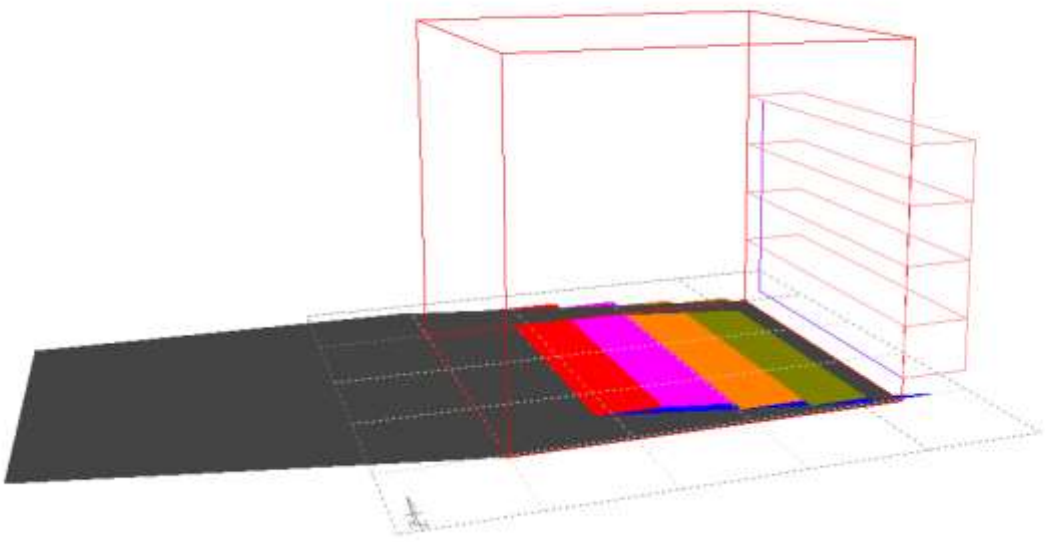


Commonly used sunshades

Source: Ecotect

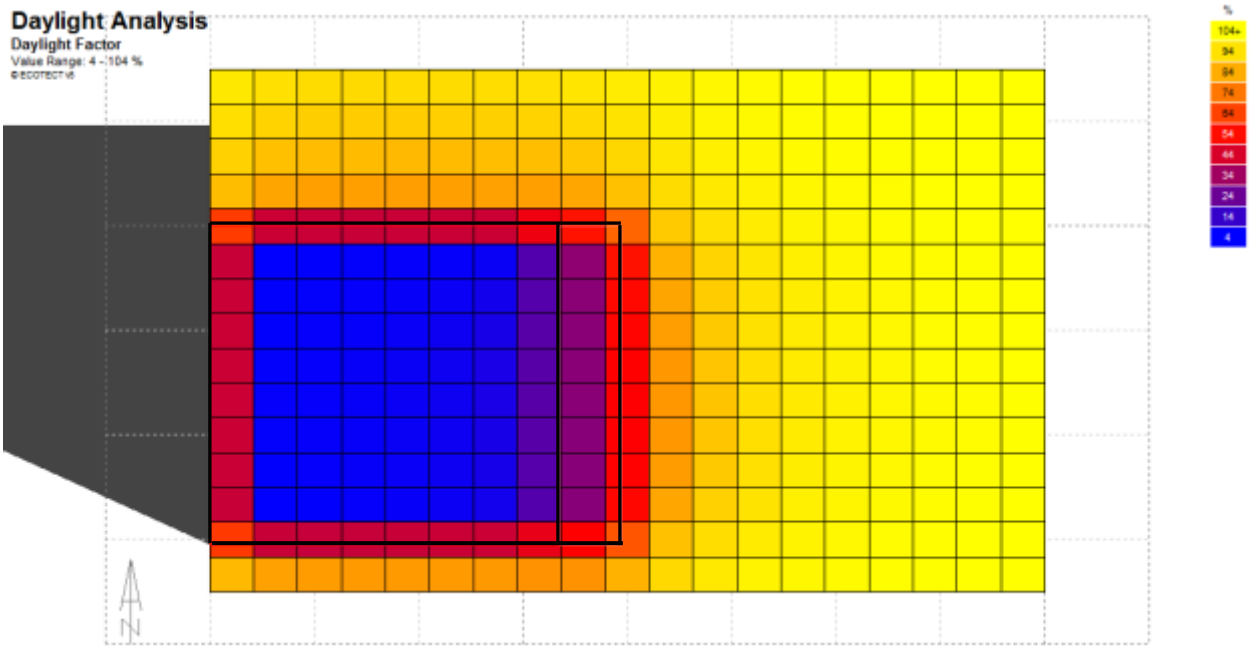


Simulated model for 18th April, 10:30AM



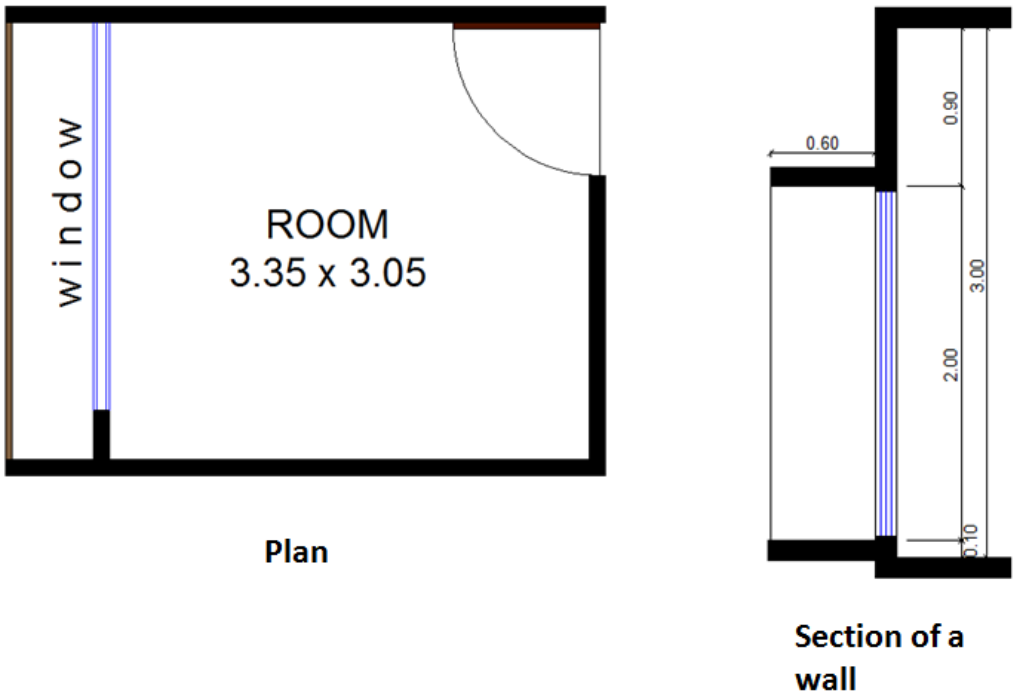
Simulated model for 18th April, 9:00AM

Source: Ecotect

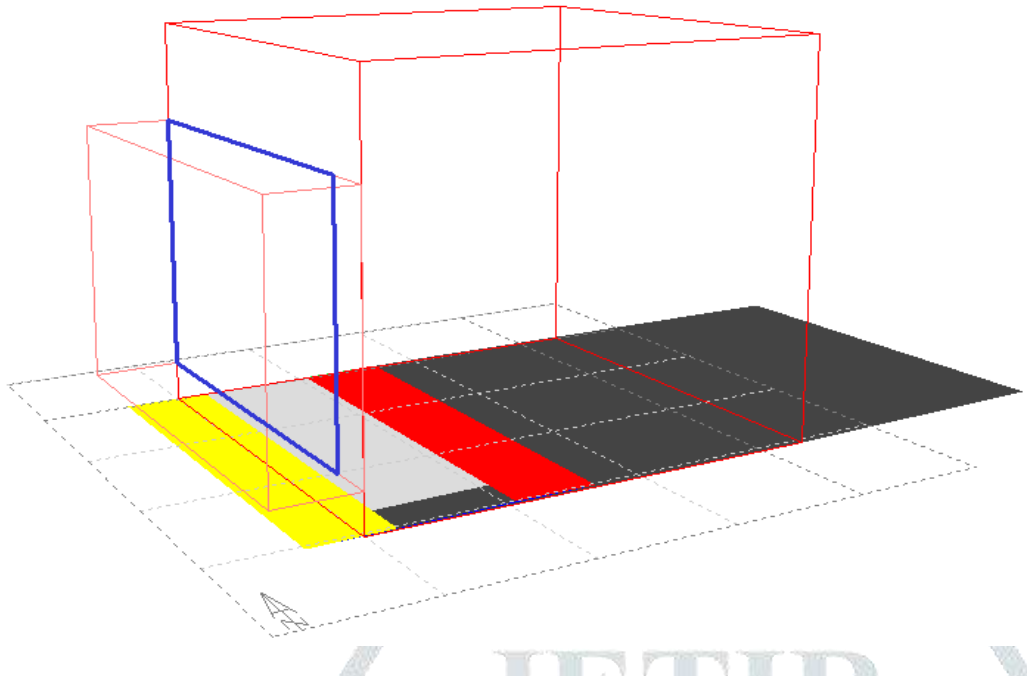


Source: Ecotect- daylight analysis

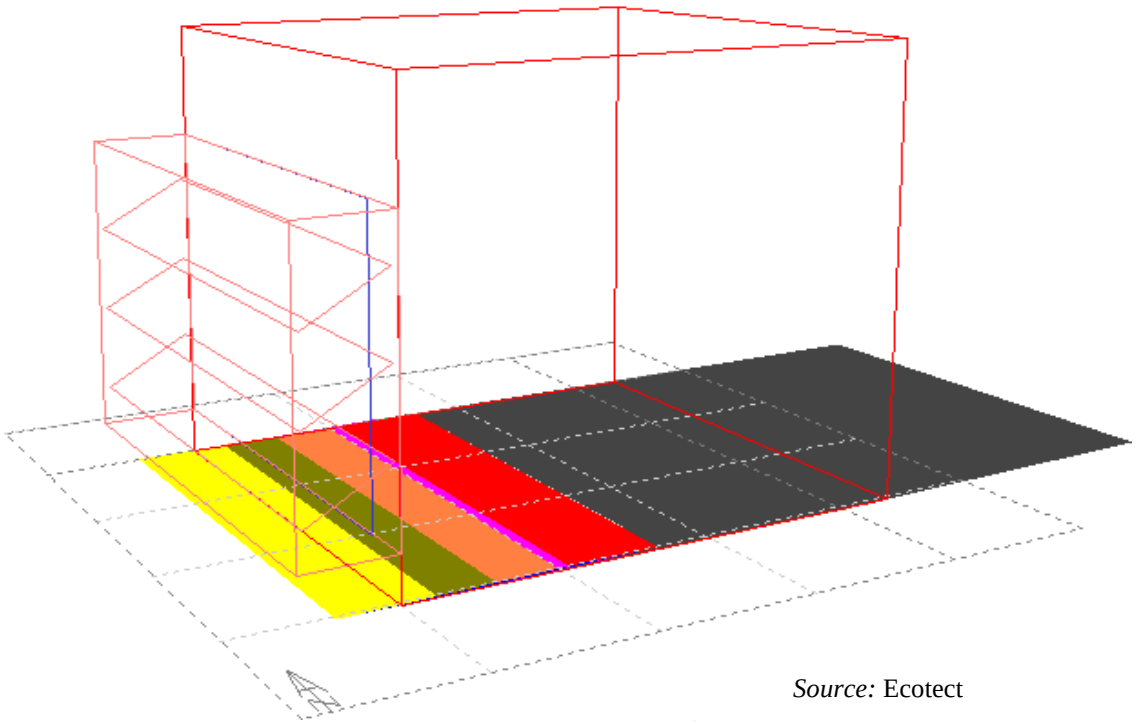
Simulations for west direction:



Source: AutoCAD`

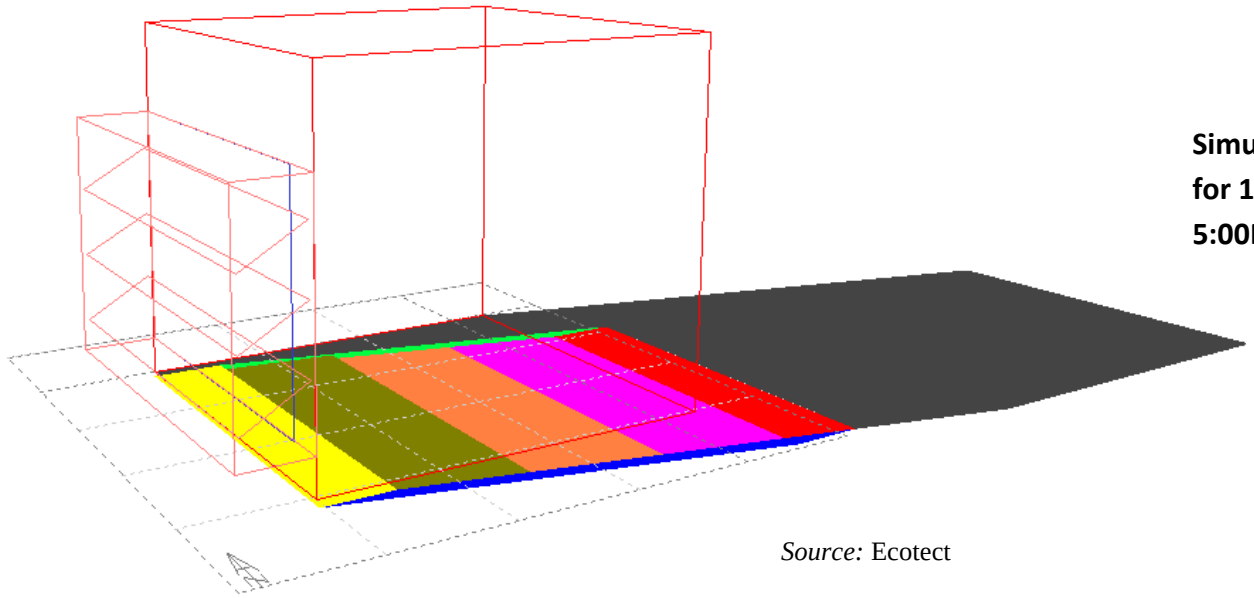


Commonly used sunshades



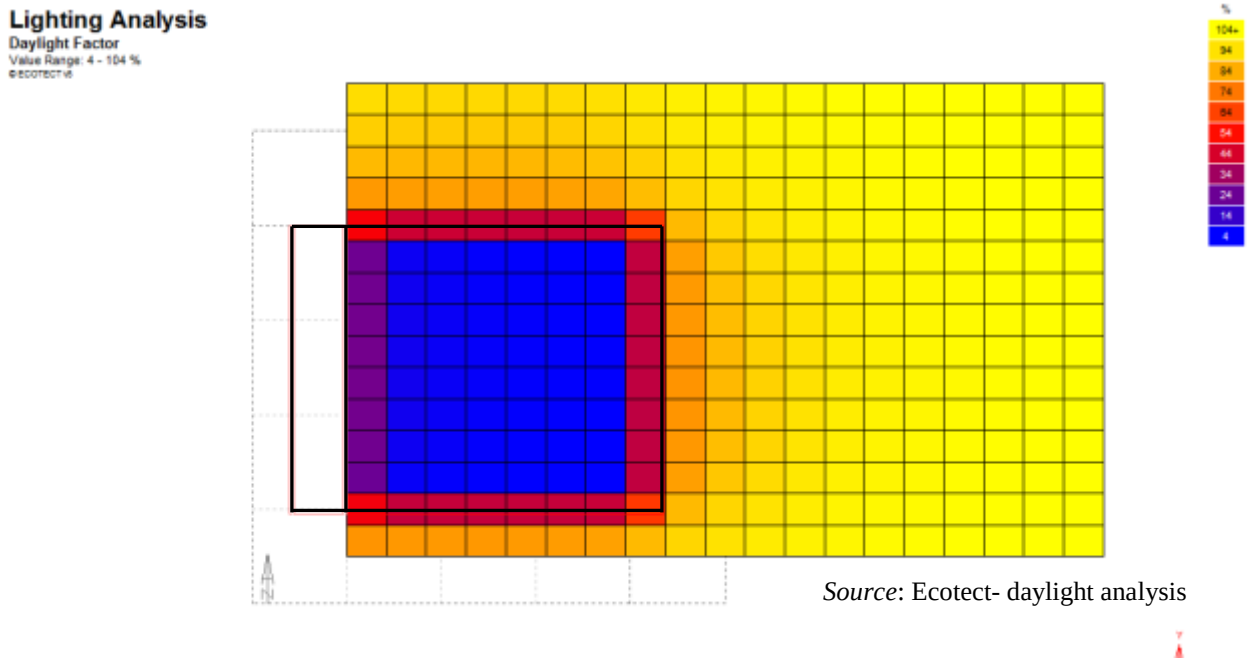
Simulated model for 18th June, 3:00PM

Source: Ecotect



Simulated model for 18th June, 5:00PM

Source: Ecotect



Source: Ecotect- daylight analysis

Conclusions:

Commercial buildings accounting for large amount of energy consumption, electrical load being the highest in the share of the consumption. The electrical load can be efficiently reduced by properly designing of the buildings openings and sunshades thereby allowing optimum daylight and avoiding glare. Therefore the research concludes the sunshades design avoiding direct sunlight which is the major source of glare inside the buildings.

It can be concluded from above simulations that additional sunshades could be added in the openings in the form of thin slabs to avoid entering of direct sunlight inside the building. The slabs cut the unwanted direct rays from the sun during summers and provide visual comfort to the users.

Acknowledgement:

The author would like to express her gratitude and thanks to the Dissertation Coordinator Ar. Shailja Sikarwar for her continuous support and guidance. The author is also thankful to her family for their valuable support.

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