Urban Heat Island & Microclimate Report

Of

Proposed Project – "Acme - Ozone"

At

Gut No. 61/1/1, 61/1/2, 3, 4 & 61/2/1,2,3

Village Chitalsar –Manpada,

Taluka & District - Thane

Proposed by

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TABLE OF CONTENTS

No.	Topic	Page No.
1.0	About the project	03
2.0	Methodology	05
3.0	Floor plans	06
4.0	Findings	09
4.1	Heat released from Air Conditioners	09
4.2	Increase in temperature due to materials use	09
4.3	Mitigative options	09
4.4	Thermal Transmittance	14
4.5	Thermal Comfort Assessment – Simulation Method	14
5.0	Conclusion and Recommendations	16

LIST OF TABLES

No.	Topic	Page No.
1.1	Project buildings	04
1.2	Solar reflectance, infra-red emittance and solar reflectance index for different materials	10
1.3	Heat absorbed on plot area	11
1.4	Increase in temperature due to materials use	12
1.5	Estimation for Thermal Transmittance (U_{roof})	14

LIST OF FIGURES

No.	Topic	Page No.
1.1	Location of the proposed project	03
1.2	Layout plan of the proposed project	04
1.3	First floor plan of Eucalyptia building	06
1.4	Typical Floor Plan of Eucalypta building	07
1.5	Refuge floor plan of Eucalyptia building	07
1.6	First floor plan of Fenelia building	08
1.7	Typical floor plan of Fenelia building	08
1.8	Refuge floor plan of Fenelia building	08
1.9	Heat absorbance of different materials	12
1.10	Measures used to reduce urban heat island on proposed plot	13
1.11	Thermal comfort assessment for typical floor plan of Eucalyptia building	15
1.12	Thermal comfort assessment for typical floor Plan of Fennelia building	16

1.0 About the Project:-

The proposed project is a development of residential project at Gut. No. 61/1/1, Gut. No. 61/1/2, 3, 4, 61/2/1, 2, 3 village Chitalsar -Manpada, Taluka& District Thane. The detail location is shown in **Figure 1.1.**

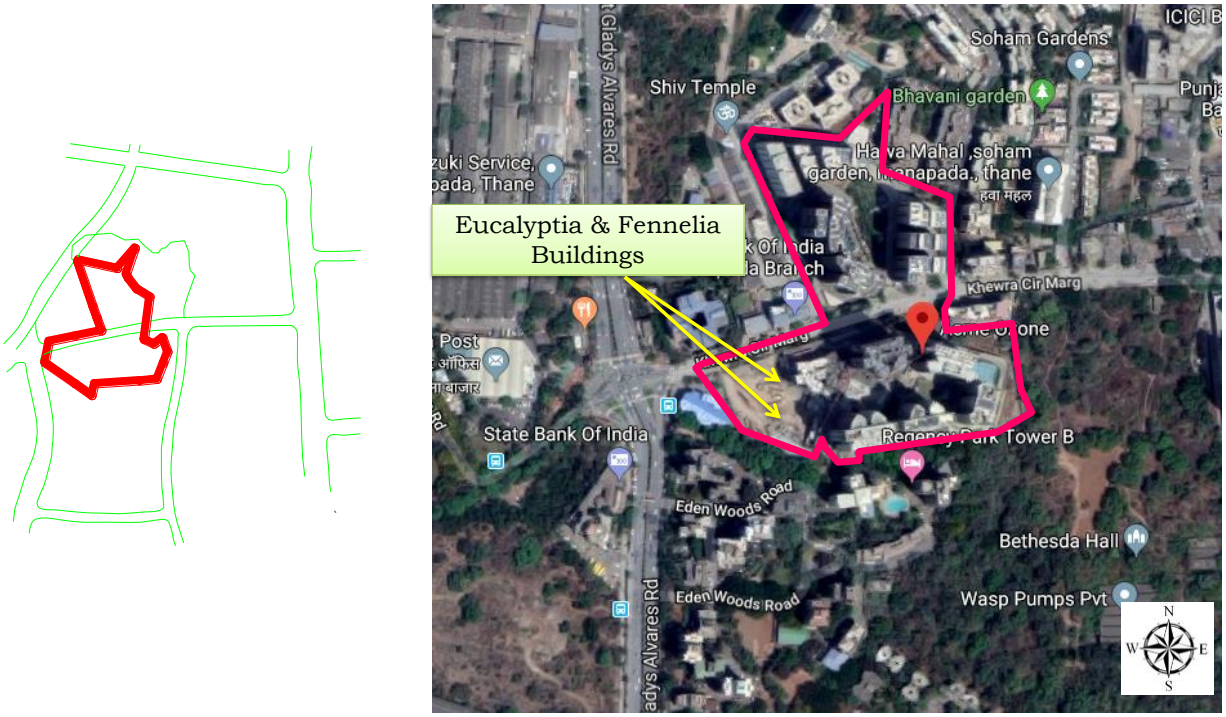


Figure 1.1: Location of the proposed project

Project layout shown in **Figure 1.2**

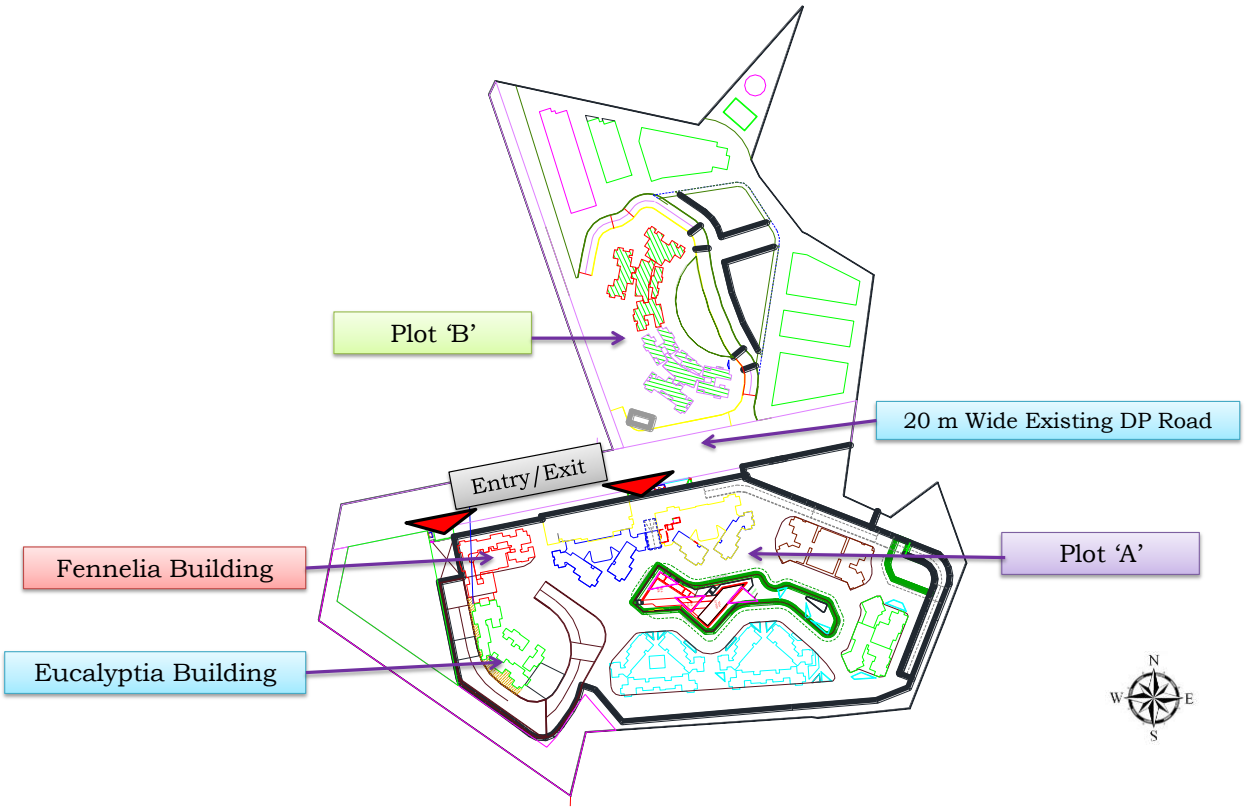


Figure 1.2: Layout plan of the proposed project

The project buildings details are given in **Table 1.1**.

Table 1.1 Project buildings

Name of Building	Previous Status		Current Status		Remarks
	Configuration	Height (m)	Configuration	Height (m	
Eucalyptia	Gr. + 2P + ST + 27 Floor	91.8	2 Basement + Ground + 2 Podium +Stilt +1st - 19th floor + Fire Check floor + 20th - 36th (Pt) floors	121.77	Basement is added and also increase in floor from 27th to 36 floor. Height increased from 91. 8 m to 121.77 m
Fenelia	Gr. + 2P + ST + 27 Floor	91.8	2 Basement + Gr (Pt.)/ 1st level. Podium	121.77	Basement is added and also increase in floor from 27th to 36 floor.

Name of Building	Previous Status		Current Status		Remarks
	Configuration	Height (m)	Configuration	Height (m	
			+ Mezzanine (Pt.)/2nd level Podium +3rd Podium + Stilt + 1st to 19th floor + fire Check Floor + 20th - 36th (Pt) floor		Height increased from 91. 8 m to 121.77 m

2.0 Methodology:-

The amount of heat directly emitted to the environment can artificially elevate the local temperature and is known as heat island. This depends on the number of air conditioners, DG sets and AC plants operational in and around the vicinity of the building or its impact zone. For the estimation of the heat island effect due to the proposed building in relation with the area, basic information was sought from Project Proponent. The number of flats and rooms were obtained from developers for estimating heat island effect. Other factors used and considered for the prediction included were:

- glass-to-surface area,
- total height-to-floor area ratio,
- surface albedo,
- local green area,
- width to height ratio,
- proximity to heat sink,
- sky view factor,
- surrounding built area ratio,
- altitude of the site,
- wind velocity and
- solar radiation

These parameters were chosen as these could be easily incorporated and moderated by the designers at the concept design stage of high density developments. The sky view factor is calculated based on a graphical method. The albedo levels for the surfaces are based on literature. In order to predict the impact of heat island, the surrounding length and breadth of the neighboring buildings were estimated. This was carried out through field survey as well as the information from the builders. The analysis was carried out on the basis of following:

- ***Situation analysis***: building type, material used, size, location, facing, wind, climate, surroundings etc.
- ***Scenario considered***: types of material being used, ACs being planned, DG outlet planned, usage percentage, etc.
- ***Results of analysis***: For each scenario, the level of heat generated, dissipated, accumulated
- Mitigation and Recommendations

3.0 Floor Plans:-

Eucalyptia Building

The First floor plan of the Eucalyptia building is shown in **Figure 1.3.** The Typical floor plan of the Eucalyptia building is shown in **Figure 1.4** & the Refuge floor plan of the Eucalyptia building is shown in **Figure 1.5**

Eucalyptia Building


Figure 1.3: First floor plan of Eucalyptia building

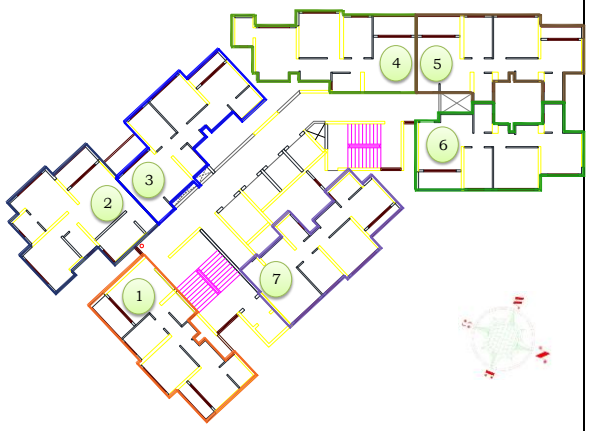


Figure 1.4: Typical floor plan of Eucalyptia building

(2nd to 4th floor; 6th to 9th and 11th to 14th and 16th to 19th and 21st to 24th and 26th to 29th and 31st to 34th floor)

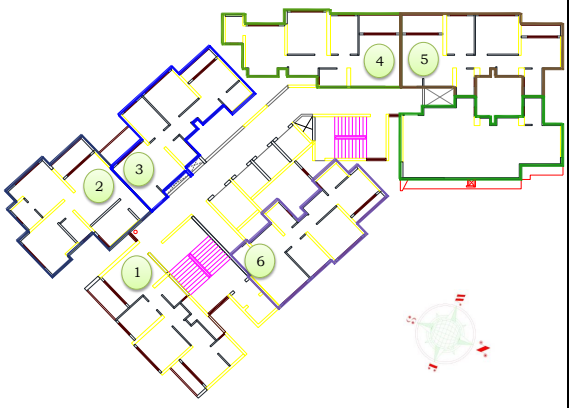


Figure 1.5: Refuge floor plan of Eucalyptia building

(5th; 10th; 15th; 25th; 30th, 35th & 36th floor)

Fenelia Building

The First floor plan of the Fenelia Building is shown in **Figure 1.6.** The Typical floor plan of the Fenelia building is shown in **Figure 1.7** & the Refuge floor plan of the Fenelia building is shown in **Figure 1.8**

Fenelia Building



Figure 1.6: First floor plan of Fenelia building

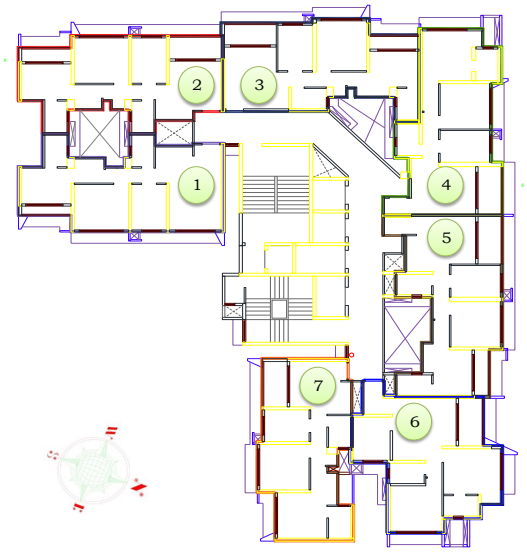


Figure 1.7: Typical floor plan of Fenelia building

(2^{nd} to 4^{th} floor; 6^{th} to 9^{th} and 11^{th} to 14^{th} and 16^{th} to 19^{th} and 21^{st} to 24^{th} and 26^{th} to 29^{th} and 31^{st} to 34^{th} floor)

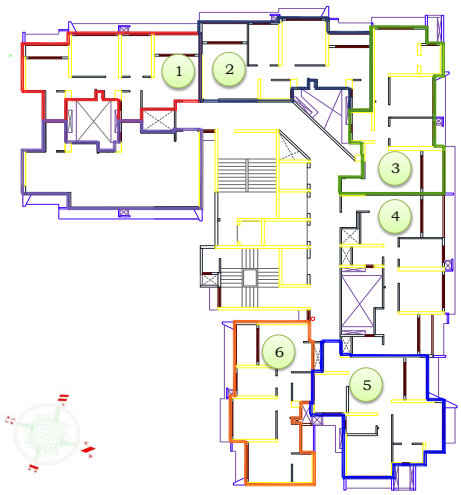


Figure 1.8: Refuge floor plan of Fenelia building

(5^{th}; 10^{th}; 15^{th}; 25^{th}; 30^{th}, 35^{th} & 36^{th} floor)

4.0 Findings:-

4.1 Heat Released from Air Conditioners:-

The proposed project consists of 16 buildings out of which 2 buildings Eucalyptia & Fenelia building are for amendment. AC points would be given in the bedrooms and living rooms. Heat released would be dependent on AC usage. These assumptions were made on the basis of the literature available. The cooling demand was estimated based on probabilistic behavior of the occupants.

4.2 Building Materials and Heat Dispersions:-

Building material also plays the crucial role in heat dispersion. An increase in glass to surface area ratio by 1% increases the UHI by 22%. Heat generated from buildings could get dispersed under the influence of wind. It would depend on wind direction, wind velocity, relative humidity and temperature. Materials used in the envelope of buildings and the urban structures play a very important role in the urban thermal balance. They absorb solar and infrared radiation and dissipate part of the accumulated heat through convective and radioactive processes to the atmosphere increasing ambient temperature. Thus, the technical characteristics of the used materials determine to a high degree the energy consumption and comfort conditions of individual buildings as well as of open spaces.

4.3 Mitigative Options:-

A- Material Use

The use of materials presenting high reflectivity to the solar radiation and high spectral emissivity, cool materials, contribute to increasing the urban albedo and it is considered to be one of the more promising and powerful techniques to mitigate the heat island phenomenon. Cool materials have gained an increasing acceptance and are widely used in buildings and urban applications presenting a high potential for surface and ambient temperatures decrease. The representative values for solar reflectance, infra-red emittance and solar reflectance index for different materials are given in **Table 1.2**.

Table 1.2: Solar reflectance, infra-red emittance and solar reflectance index for different materials

Materials	Solar Reflectance (SR)	Infra-red emittance (IRE)	Solar reflective index (SRI)
Asphalt shingles			
White asphalt shingle	0.20-0.30	0.80-0.90	15-28
Black	0.04	0.80-0.90	-7 to -1
Tiles			
Terracotta ceramic tile	0.25-0.40	0.85-0.90	23-45
White clay tile	0.60-0.75	0.85-0.90	71-93
White concrete tile	0.60-0.75	0.85-0.90	71-93
Grey concrete tile	0.18-0.25	0.85-0.90	14-25
Cool dark colored concrete tile	0.40-0.60	0.85-0.90	43-72
Build up roof			
With asphalt	0.04	0.85-0.90	-4 to -1
With white gravel	0.30-0.75	0.80-0.90	27-58
With white coating	0.75-0.85	0.80-0.90	93-113

Where; solar reflectance and infra-red emittance of a material was calculated by using ASTM methodologies. An increase in albedo level, height-to-floor area ratio, glass-to-surface area ratio and proximity to heat sink by 1% will lead to decrease in nocturnal UHI by 1.3, 8.7, 2.2, and 4.3%, respectively. Increase in local green area by 1% will increase nocturnal UHI by 0.15%.

B: Use of Green Cover

Probable Heat emissions from proposed project

Total Plot area of the proposed site is 44133.20 m^2 would have green cover area i.e. 6138.74 m^2 on ground. Hence, amount of heat absorbed was predicted for the entire plot area with emissivity of concrete which is 0.95. Out of the total developed area, 20-25% of concrete area would be reserved for pedestrian walking and footpath. This pedestrian walking or footpath would be developed with cool pavement ideas like use of grey concrete tile or cool dark colored concrete tile. Both of them have emissivity of 0.90. This emissivity factor was considered for predicting the heat absorbed. Thus comparison of heat absorbed by the plot area with current situation, with concrete and with cool pavement idea is given in **Table 1.3**.

Table 1.3: Heat absorbed on plot area

Options	Heat absorbed (w/m2)
Full concrete	21721.38
20% of cool pavement ideas	17377.10
30% of cool pavement ideas	15204.96
40% of cool pavement ideas	13032.83

If the entire plot is developed with concrete then it would have heat absorbing capacity of 21721.38 w/m^2. In this estimate the green cover area was considered as soil covered area. Proposed buildings would attempt for maximum of cool pavement ideas. These cool pavement ideas would be implemented for pedestrian and footpaths. Thus three scenario predictions were made for using cool pavement ideas. In this estimate, cool pavement areas along with concrete and green cover were taken into consideration.

In order to predict the heat absorbed from the building surfaces, it is important to estimate the area of the cross sections. Height, width, breadth were used to predict the amount of heat absorbed on the surface of buildings. Predictive study was made with different colors that could be used for the painting. Use of white color showed a variation of 12% from concrete walls white using cadmium yellow color and Chromatone with silver coated color showed a very high decrease in heat absorbing character from buildings. All this are given in **Figure 1.9.**

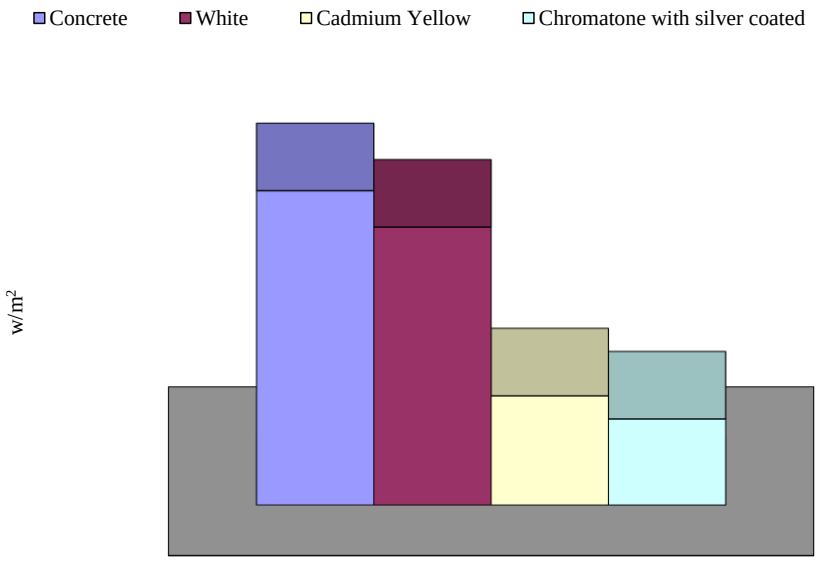


Figure 1.9: Heat absorbance of different materials

Hence, proposed towers would be painted with cadmium yellow paint. This would reduce UHI effect to certain extent. Similarly the amount of heat radiated inside the room and amount of heat emitted from the surface of the towers were also predicted. The increase in temperature from the proposed project is given in **Table 1.4.**

Table 1.4: Increase in temperature due to materials use

Types of Materials	Increase in Temperature (^{0}C)
Concrete	2.66 – 2.92
Eco friendly ideas	1.73 – 1.90

All these are predicted value

Hence, developers would choose the appropriate materials for construction of proposed towers. This would be dependent on availability of materials. They could select a material has higher solar reflective index. This would aid in mitigating the impact of heat island on surrounding. Also AC outlets are kept as per wind direction of Mumbai. **Figure 1.10** shows an overall gist of measures used to reduce urban heat island on proposed plot and the increase in temperature due to material used



Types of Materials	Increase in Temperature (^{o}C)
Concrete	**2.66 – 2.92**
Eco friendly ideas	**1.73 – 1.90**

Eco Friendly methods to reduce urban heat island effect

- **Landscape Area:** Landscape area is proposed on Ground
- **Colour** : Use of Cadmium yellow paint for building to decrease heat absorption
- **Roof**: Use of White asphalt will aid in reflection of heat
- **Tiles for Ground Flooring**: Use of cool pavements like grey concrete tile or cool dark coloured tile to reduce urban heat island
- **Driveways & Podium**: Use of Black asphalt shingles

Figure 1.10: Measures used to reduce urban heat island on proposed plot

4.4 Thermal Transmittance (Uroof):-

Characterizes the thermal performance of the roof of a building. Limiting the Uroof helps in reducing heat gains or losses from the roof, thereby improving the thermal comfort and reducing the energy required for cooling or heating.

Formula: Uroof = 1 ∑(Ui × Ai)/ Aroof i=1

Where,

Uroof: Thermal transmittance of roof (W/m^2.K)

$\mathbf{A_{Roof:}}$ Total area of the roof (m^2)

$\mathbf{U_{i:}}$ Thermal transmittance values of different roof constructions (W/m2.K)

$\mathbf{A_i}$: Areas of different roof constructions (m^2)

Table 1.5: Estimation for Thermal Transmittance (U_{roof})

Buildings	Thermal Transmittance Estimated	As per guidance value
Eucalyptia Building	0.059	Max limit of 1.2 W/m^2.K
Fenelia Building	0.058	

The thermal transmittance values of different roof constructions i.e U value is 0.409 Watts/hr/m^2/°C

The thermal transmittance values for our proposed project ranges from 0.059 - 0.058 Watts/hr/m^2/℃

4.5 Thermal Comfort Assessment –Simulation Method

The main urban climatic factors in high density cities that affect thermal comfort are lower urban wind speed, higher temperatures and restricted access to solar energy compared with climatic conditions in low density cities placed in a similar natural climate. Thermal comfort is estimated using the software Ecotect. Thermal comfort assessment for Typical Floor Plans is shown in **Figure 1.11**

Thermal Comfort Assessment – Eucalyptia Building

Typical floor plan thermal comfort assessment are shown in **Figure 1.11**

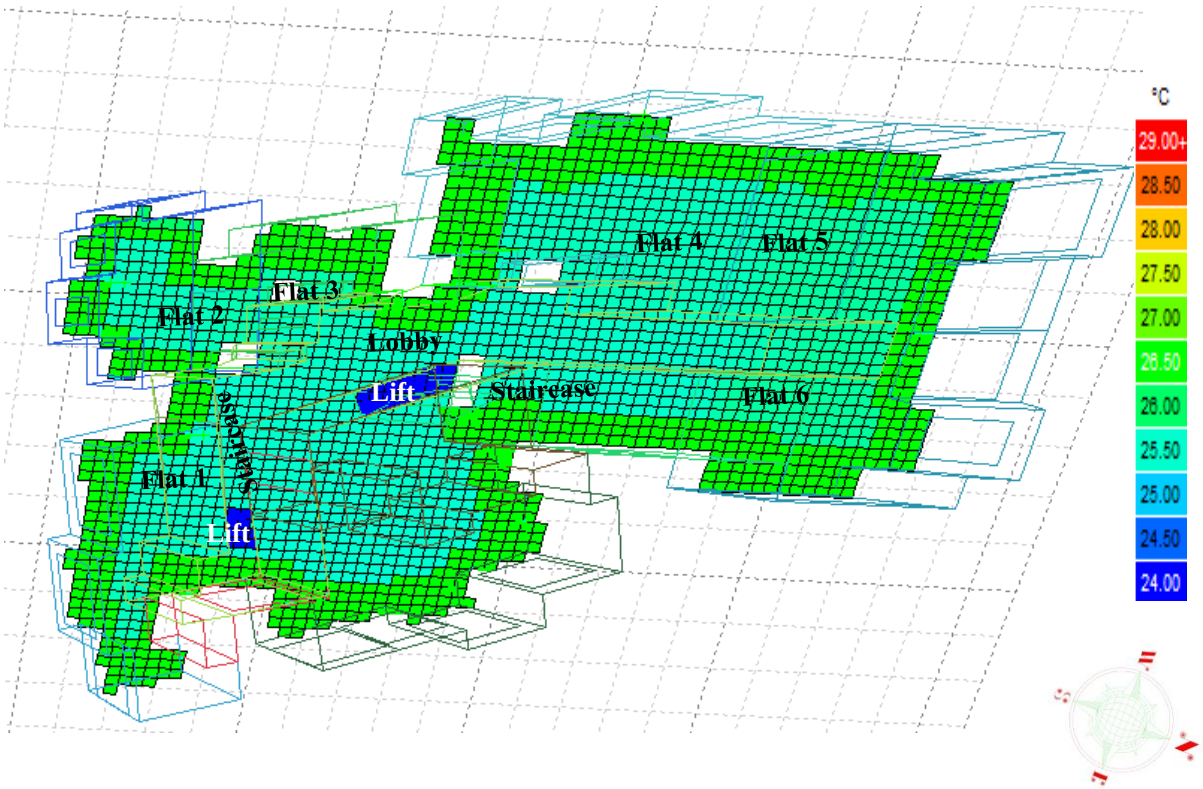


Figure 1.11: Thermal comfort assessment for typical floor plan of Eucalyptia building

Thermal comfort zone observed in Eucalyptia building are in the range 25° C – 27° C

Thermal Comfort Assessment – Fenelia Building

Typical floor plan thermal comfort assessment are shown in **Figure 1.12**

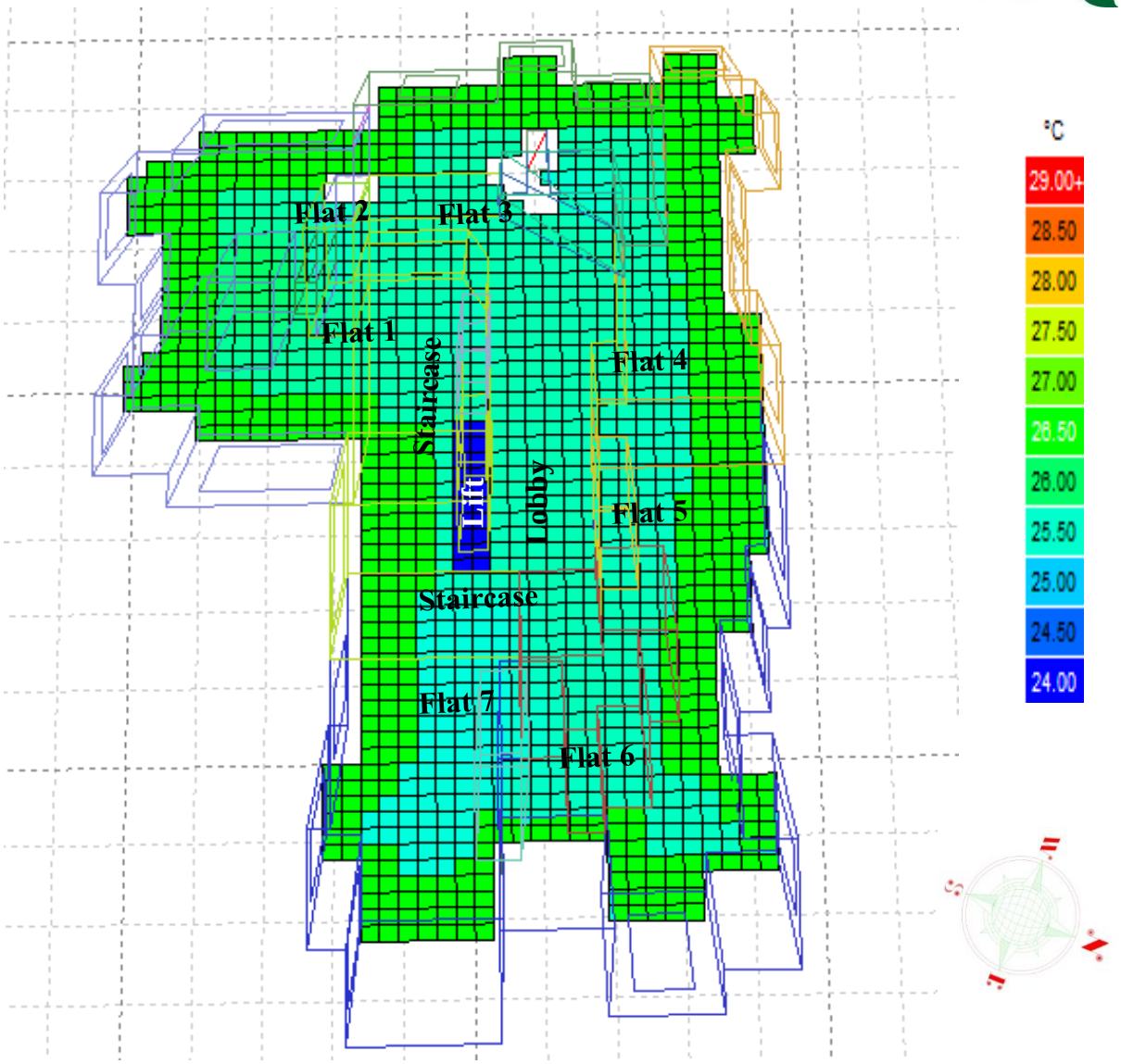


Figure 1.12: Thermal comfort assessment for typical floor plan of Fenelia building

Thermal comfort zone observed in Rehab Building 2 are in the range 25° C – 27° C

5.0 Conclusion and Recommendations:-

- The heat released from ACs would be dependent on occupant habit and their usage.
- Different materials used for construction also play a crucial role in heat released and thereby increases the surrounding temperature. A list of materials has been provided in **Table 1.2**. Developer would select the materials that would aid in reducing UHI. This would be dependent on availability of materials. A decision would be taken during construction phase

- Cool pavement ideas can be implemented for footpaths and pedestrian pathways. This would also aid in reducing UHI impact on the environment. Reduction in heat absorbed is given in **Table 1.3.**

- The heat outlet locations need to be kept as per prominent wind movement of the location

- Cool roofing and cool pavement idea should be implemented to reduce heat island effect as it enhances the surface heat flux. Such designs should be implemented for all the open areas, pedestrian pathways and outside the building

- All the residents would be provided with a booklet. This booklet would have information about energy and money saving from less usage of ACs and other appliances. This would also include importance of maintenance of particular instrument towards saving heat load and energy. This would also include option of use of renewable resource

- Open spaces would be developed as per the landscape plan which would reduce the heat load. The landscape would have a mix of tree shrubs and grass

- An increase in albedo level, height-to-floor area ratio, glass-to-surface area ratio and proximity to heat sink by 1% will lead to decrease in nocturnal UHI by 1.3, 8.7, 2.2, and 4.3%, respectively. Increase in local green area by 1% will increase nocturnal UHI by 0.15%

- The design aspects of the proposed project have incorporated required thermal comfort of 26 ± 2° C as per NBC, 2016.