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Micro Climatic Analysis - Report

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Micro Climatic Analysis – Structure, Market Square Roscommon, GKMP Architects.

1 Introduction

The purpose of this analysis, preformed for the client GKMP Architects, was to investigate and analyze both the location and design variations of a proposed structure in order to optimize the design for outdoor thermal comfort. Outdoor thermal comfort (OTC) was selected as it is one of the most influential factors impacting the perceived quality of urban open spaces and thus the participation in outdoor activities. Outdoor thermal comfort analysis measures the degree to which an individual is satisfied or comfortable with the ambient temperature. An optimal thermal comfort is defined as the as the air temperature at which the heat balance of the human body is maintained with core and skin temperature equal to those under the conditions being assessed.

The measurement and assessment of outdoor thermal comfort includes the measurement and assessment of a number of factors at a site location, for example air temperature, relative humidity, wind speed and direction, clothing & activity (*Figure 1*). The most significant of which are the solar conditions which influence air temperatures, direct and diffuse radiation. Typical strategies to optimize outdoor solar comfort include shading (trees, buildings), the orientation and geometry of urban forms, vegetation, solar-reflective materials, and water bodies. Shading and the benefit derived from it form a central part of any outdoor thermal comfort strategy.

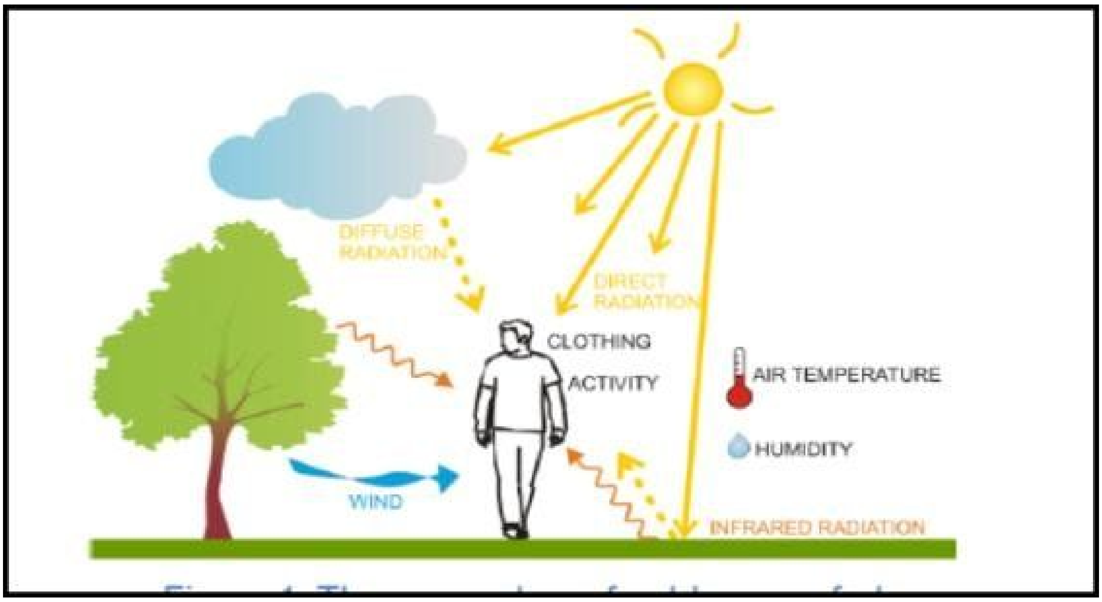

Figure 1- Factors Affecting Outdoor Thermal Comfort

2 Analysis Types & Structure

In order to investigate the potential of the proposed structure to maximize outdoor thermal comfort the following types of analysis were performed on the site and variants of the proposed design at the site (*Table 1*).

Analysis Types	Analysis Content	Time period
Solar Radiation , Daylight Hours	Site	Annual, Dec 21st, June 21st
Daylight Hours & Shading	Structure & Site *7	Annual, Dec 21st, June 21st
Shading Benefit Analysis	Site	Annual
Outdoor Thermal comfort	Structure & Site *7	Annual, Dec 21st, June 21st

Table 1- Analysis type, Analysis Content & Time Periods

2.1 Site Analysis

An initial site analysis was performed on the urban context, without the proposed structure, in order to identify the location that would provide maximum shading benefit for outdoor thermal comfort. To identify that location both radiation and shading analysis were performed. The results from both confirmed that proposed location of the structure would provide the maximum shading benefit for outdoor thermal comfort in that environment.

2.2 Design Analysis

In order to identify the how the proposed structure could be optimized for outdoor thermal comfort, 7 variants of the proposed design were analyzed for their impact on shading, daylight and outdoor thermal comfort. The analysis used a range of parameters from the design concept which had the greatest potential to influence shading and solar factors to higher outdoor thermal comfort (glazing distribution & structure, heights, roof angles/pitch) (*Figure 2*). Subsequently, different configurations of those parameters (design variants) were simulated and analysed in order to identify which configuration maximized the potential for outdoor thermal comfort (*Table 1*).

Design variant	Glazing Distribution & Structure	Section Height/Roof Angle
1	10 Bays	3500mm
2	3 Bays	3500mm
3	10 Bays	4250mm
4	3 Bays	4250mm
5	5 Bays	3500mm
6	5 Bays	4250mm
7	8 Bays	4250mm

Table 2- Design variants- Parameters Analysed

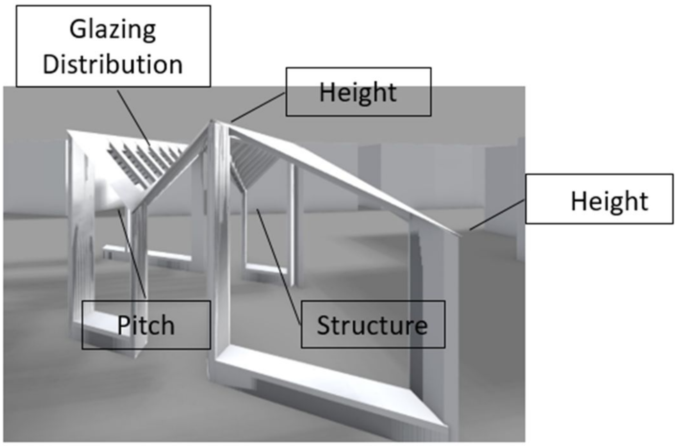

Figure 2- Parameters for Analysis

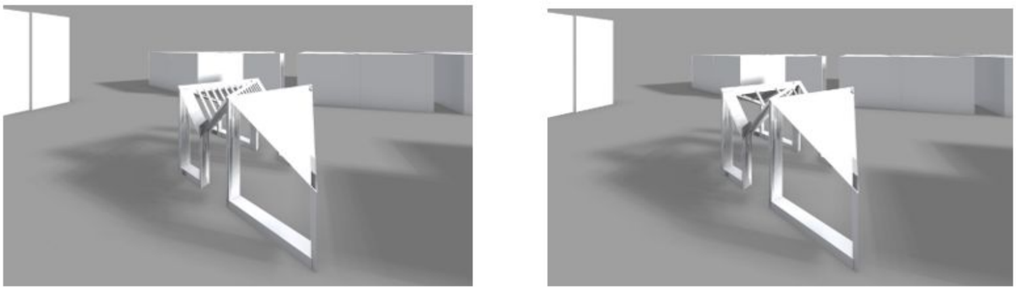

Figure 3- Sample of Design Variants Used for Analysis

2.3 Solar Analysis

An initial shading and daylight analysis was undertaken to examine the influence of each of the design variants on shading and daylight in order to establish which of the variants were most likely to contribute effectively to outdoor thermal comfort through shading whilst still providing the adequate daylight levels. *Table 2* outlines the performance of the design variants (poor, average, good) in relation to the outdoor thermal comfort potential and adequate daylight levels.

Design variant	Performance
1	Poor
2	Average
3	Poor
4	Average
5	Poor
6	Good
7	Good

Figure 4- Design Variants - Shading & Daylight Performance

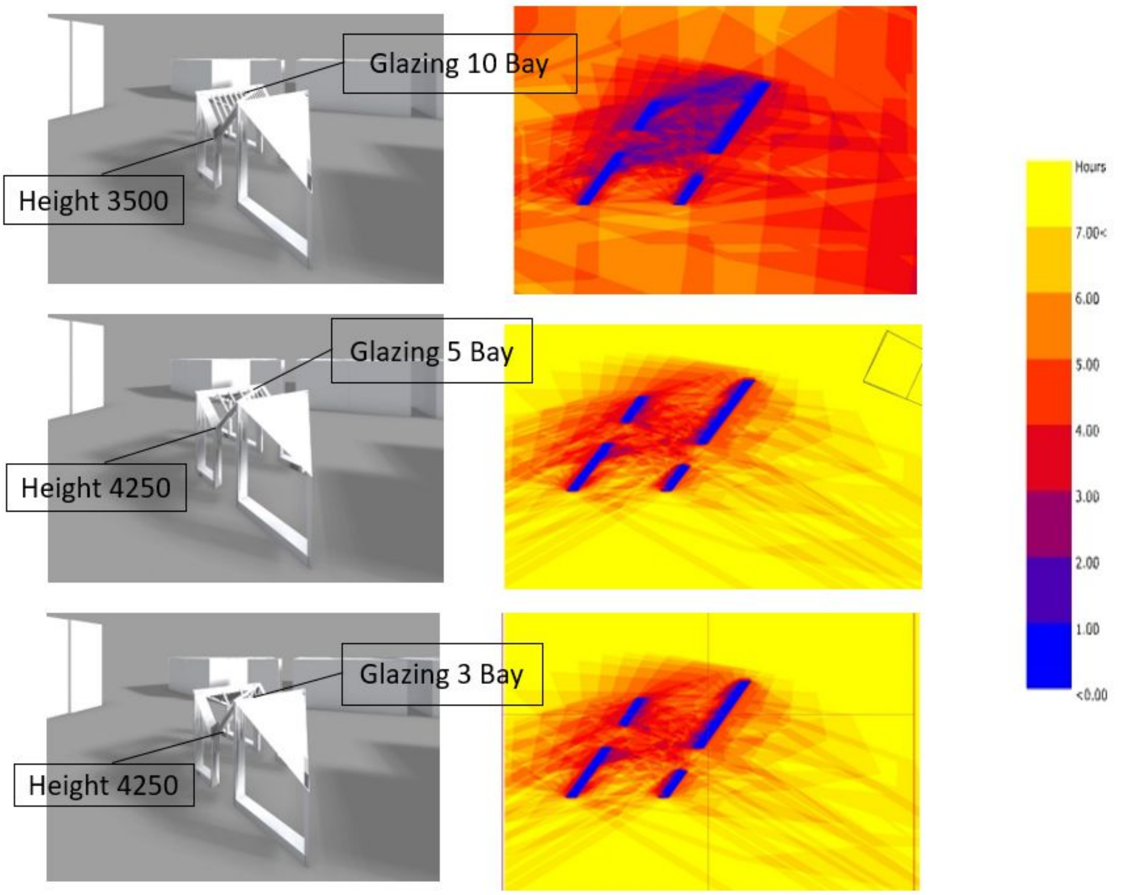

Figure 5- Design Variants Daylight Hours 21st December

Blue = Low, Red = Average, Yellow = High

2.4 Outdoor Thermal Comfort Analysis

The site alone and the seven variants (on the site) were simulated and analyzed for outdoor thermal performance. The Outdoor thermal comfort analysis model used for this analysis assumed the following:

- Standard urban wind conditions (low rise surrounding).
- Appropriate clothing for each time of year.
- Climate, Midlands Region, Ireland.

Table 5 indicates the performance (poor, average, high) of each of the variants in terms of their outdoor thermal performance. The rating indicates the average annual condition for outdoor thermal comfort.

Design variant	Performance	Average Condition
1	Poor	Cold
2	Average	Warm / Cold
3	Poor	Cold
4	Average	Warm/Cold
5	Average	Warm/Cold
6	Good	Comfortable
7	Good	Comfortable

Table 3- Design Variants - Outdoor Thermal Performance

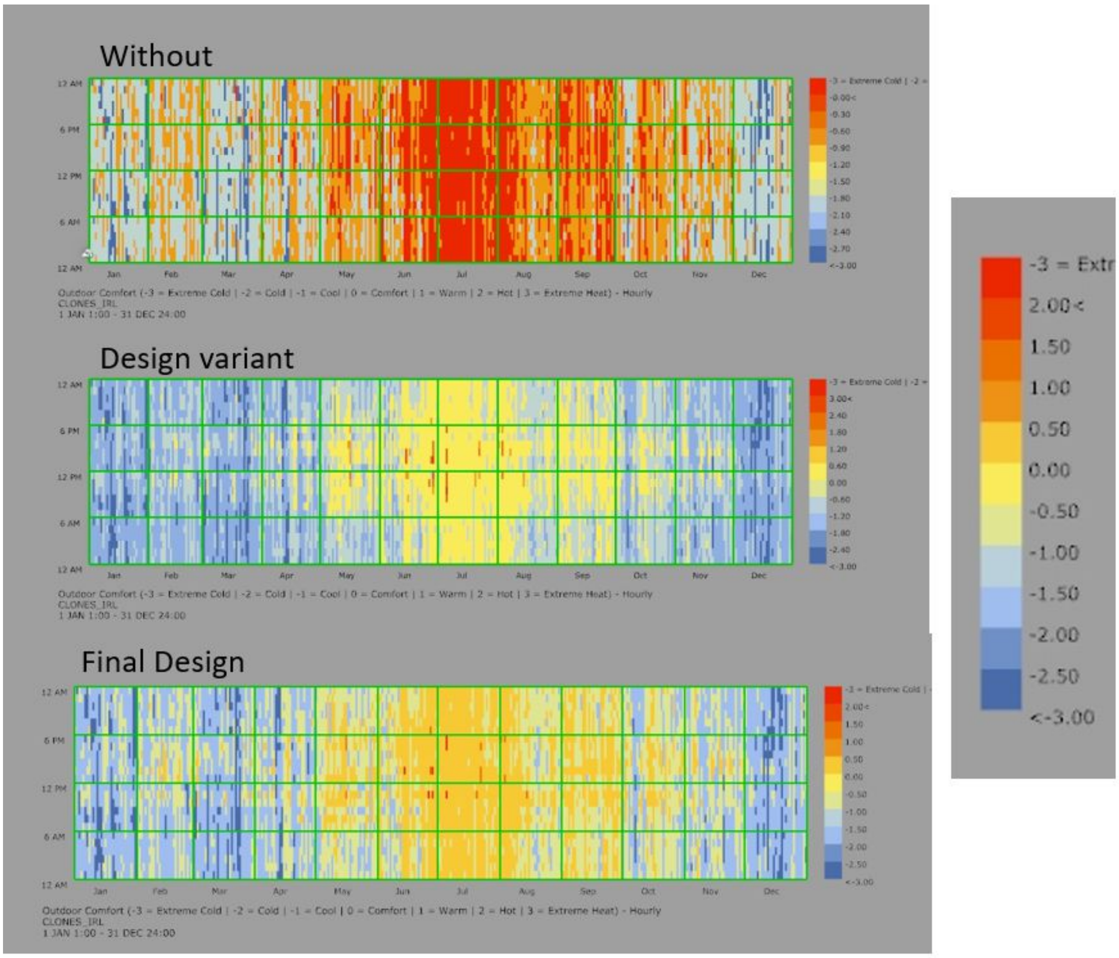

Figure 6- Outdoor Thermal Comfort, Without, Design variant 4, Final Proposal

Outdoor Comfort (-3 + extreme cold, -2 = cool, 0= comfort, 1= Warm, 2 = Hot, 3 Extremely hot)

3. Conclusions

3.1 Site

The initial site analysis indicates that the proposed location for the structure is the area in the urban context receiving the highest amount of solar radiation and therefore the most in need of shading. The Outdoor thermal comfort analysis also indicates high levels of thermal discomfort at that location during the summer months (*Figure 6*), concurring with the initial site analysis. The proposed structure is located in the part of the urban context most likely to need and benefit from shading.

3.2 Structure

The steeper angle/pitch of roofs, decreased the potential for daylight penetration at ground level, impacting negatively on the daylight levels and the ability of solar radiation to positively affect outdoor thermal comfort. The steeper angles caused over shading from both the roofs and the internal structure which negatively affected the air temperatures at ground level in terms of outdoor thermal comfort.

Increasing the surface area of the glazing (larger bays), does not correspond to increased levels of outdoor thermal comfort. The increased surface areas of the glazing lead to higher air temperatures at ground level as a consequence of increased solar radiation. A higher level of structural bays (5-9 bays) which lowers the surface area of the glazing, and increases shading from their structure promotes increased outdoor thermal comfort while providing adequate daylight levels at ground level.

3.3 Final Proposal

The final proposal from the designers which incorporates the above suggestion represents a significant improvement on the existing outdoor thermal comfort conditions and offers high levels of outdoor thermal comfort for a majority of the year including from April to November, those months of the year where the structure is most likely to used.

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