

Proposals to improve the conditions of outer space. The environmental comfort of the pedestrian circulation in the coastal line.

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Abstract

With the climatic change, the conditions of outer spaces have had a major change, therefore developing new research needed to make it more habitable. The study of coastline comfort gives special interest for its possible marine relationship and its differences with the inner area, for which we have classified the pedestrian circulation defining the influence of its limits both vertical (facades, walls and vegetation) and horizontal(deck, vegetation and floor). It is important to determine how the cover of the pedestrian circulation influences the comfort of the pedestrian as well as the various materials with which they are formed, the distance to the coast, the shape of the first front, speed and wind direction. To have a deeper understanding of the possibilities of comfort and design, this will implement other developments that may arise in similar climatic and cultural areas to the Mediterranean climate.

Keywords: thermal comfort; pedestrian circulation; urban areas.

1. Presentation

The sustained growth of traffic in European cities resulted in circulatory congestion, a high rate of accidents, and a lack of parking, which has transformed the urban environment, creating environmental conditions different from the originals in profoundly altering the physical environment of its territory. Thus, the heat produced by the increase in the vehicle fleet and consequent burning of fossil fuels in cities has reached significant levels, giving rise to local climate changes.

As a result of the above, the morphological characteristics typical of a city, and the plot and the different characteristics within cities where it is located, determine the thermal comfort of a town, reacting differently to the wind and solar radiation.

The study of the typology of elements that relate to passive cooling in outdoor spaces, such as boulevards, arcades, awnings, porches, gardens, pergolas, create a deep and thorough knowledge of the possibilities of control and design of urban spaces, in this case, analyzing the pedestrian circulation in the coastal belt.

To perform this research work the following questions were made: What happens in outdoor spaces in front of the coastline? To achieve a comfortable place for pedestrians, how does the breeze influence on comfort? Is there a difference in the spaces with or without vegetation? In summer, are shadowless spaces comfortable? Do they depend on the materials? The answer to all these questions was found in a study of Villa Icaria located in Barcelona, Spain.

2. Methodology

Studying the behavior of the urban environment requires measuring the effect of key variables involved in the energy balance of the outdoor spaces, being these variables, the climate, the context and the user.

- The microclimate of the place is where we get the parameters of air temperature, radiation, humidity and air movement.
- The context refers to physical and space characteristics, which are the location, shape, and boundaries, they contain.
- The user is the person who carries out its activities in outer space, such as slow or hurried walking, jogging, biking, skating and sitting, among others. As a result of these activities there

is an exchange of energy, being its metabolic activity one of the factors affecting the comfort of the person in outer space.

For this study the pedestrian circulation in the district of Icaria in the Olympic Village, Sant Martí district was chosen. Formerly, it was an industrial zone, which had little relationship with the city. With the approval of the Olympic project, this zone disappeared and was renovated and fitted out as the athletes' residences during the Olympic Games in Barcelona in 1992. It is now a residential neighborhood, its urban structure consists of five successive strips parallel to the sea and integrated park system:

- First strip: beaches and piers with a length of over 1 km of the waterfront.
- Second strip: a broad walk was drawn 30 feet wide.
- Third strip: formed by the towers that make up the waterfront on a large scale, concentrating many activities (hotels, offices and recreational spaces clustered on the ground floor around the towers).
- Fourth strip: Ronda del Litoral, is a segment of the circulatory system of the city belts.
- Fifth row the urban strip: integrates the traditional morphology of the new residential typologies.

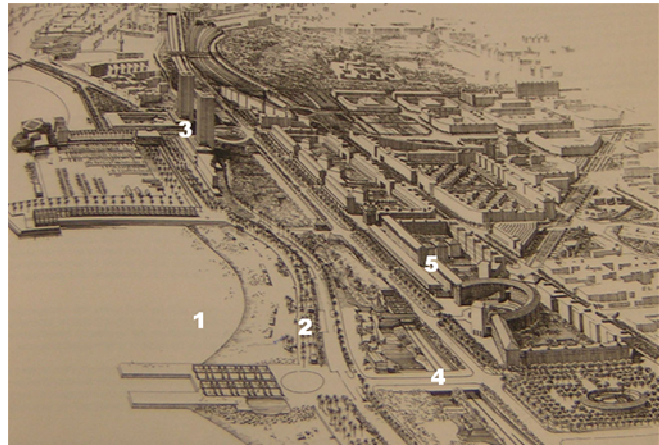


Figure 1. Olympic Village District of San Martí

The study is divided in two tracks, which are in front of the first marine facade. These tracks are named Track One Port Olímpic and Track Two Nova Icaria. Both tracks reach the beach. Track One is opposite to a closed block and Track Two is opposite to a concave shape block. This study was conducted in the spring and fall equinoxes, and in the summer and winter solstices.

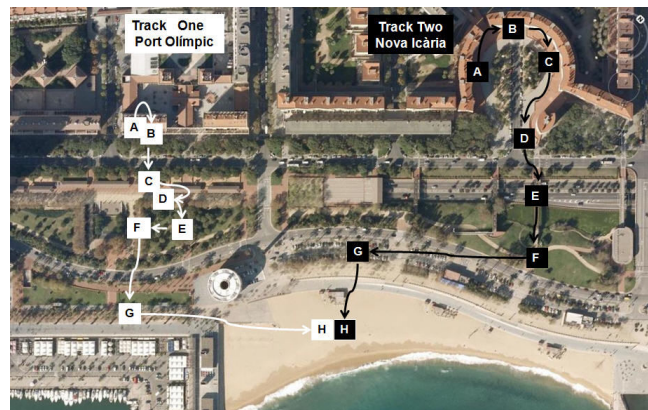


Figure 2. Track One Port Olímpic and Track Two Nova Icaria.

Track One is formed for the following pedestrian circulations:

- A. The front porch circulation is SW
- B. Pedestrian and cyclist circulation along groups of trees is SW
- C. Circulation under a tiled roof, open laterally is NE - SW
- D. Circulation on sandy soil, along a row of trees is NE - SW
- E. Circulation between two rows of trees is SE - NW
- F. Circulation along a row of trees is SE - NW
- G. Circulation between two rows of palm trees is NE - SW

For Track Two, points D, E, F and H, were omitted because they lack vertical boundaries.

Track Two is formed by the following pedestrian circulations:

- A. Circulation in front of the NE facade is NW - SE
- B. Circulation in front of the SW facade is NW - SE
- C. Circulation in front of the SE facade is NE - SW
- G. Circulation between two rows of streets is NE - SW

The program called *COMFORT-EX* was used for the calculation of comfort in outdoor spaces, which was designed by Dr. Jose Manuel Ochoa in 1999.

The process for analysis of comfort of the pedestrian circulation was performed as follows:

- Each track was grouped and analyzed according to the season, giving the result of the energy balance of a person in each pedestrian circulation per hour.
- To determine the pedestrian circulation of comfort or discomfort, we used the following criteria:
 - It was conducted by adding each gain or loss of a person's energy during the day.
 - The total value of gains or losses of energy of pedestrians in pedestrian traffic was conclusive to determine the most comfort or discomfort on each track.

Analyzing generally and particularly the variables:

- a) Air temperature and radiation temperature
 - The movement of shadows, according to the horizontal and vertical boundaries.
 - Determining how different materials behave on pavements in terms of radiation making an analysis of their albedo and emittance.
 - According to the type of vegetation its transmissivity was determined.
- b) Wind
 - The site plan drawn in the direction of winds at different times of day, given the dominant direction.
 - We analyzed the speed and the direction of the wind according to the urban obstacles and vegetation.
- c) Humidity
 - We analyzed the percentage of moisture, in relation to the proximity of green areas, trees, and walls without vegetation, and how the change of materials influence the percentage of humidity.

3. Results

Track One Port Olympics

The following table shows the most comfort and discomfort during the seasons of the year.








Track One, in Port Olímpic	Comfort	Warm Discomfort
Spring	 B	
Summer	 C	 G
Autumn	 E	 G
Winter	 B	 G

Table 1. Comfort - discomfort in Track One, Port Olímpic.

From Nova Icaria's Track Two:

On table 2, we can see that the pedestrian circulation "G" has the greatest comfort in summer, autumn

and winter. The features that make this circulation most comfortable are:

- Its vegetation filtering the solar radiation,
- The constant sea breeze,
- Clay soil, being a porous material allowing water permeability.

Pedestrian circulation “A”, in front of the northeast facade presents discomfort in two seasons: summer and fall.

In spring all circulations were found in heat discomfort, the most critical of pedestrian circulation is letter “B”, in front of the southeast facade. In winter, the pedestrian circulation in front of the southern facade was found with the highest heat discomfort.






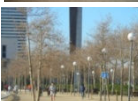

Track Two, in Nova Icaria	Comfort	Warm Discomfort
Spring		 B
Summer	 G	 A
Autumn	 G	 A
Winter	 G	 C

Table 2. Comfort – discomfort in Track Two, Nova Icaria.

4. Conclusions

All this research work answers in a timely manner the questions posed at the beginning, and serves as framework for the election of the study in Villa Icaria Barcelona, Spain.

What happens in outdoor spaces in front of the coastline to achieve a comfortable place for pedestrians?

Pedestrian circulation on Track One Port Olímpic has as vertical limits, groups and lines of deciduous and evergreen trees, which leaves change depending on the time of the year. In summer time when solar radiation is higher, the trees protect the pedestrian, generating shadows throughout the day. The porch is the circulation of most comfort next to a building with six levels, which makes the energy balance of a person, more homogeneous.

How does the breeze influence in comfort?

Breeze is constant during the day; at a distance of 150 mt from the coastline its speed is 1 m/s, and increases as we approach the beach, reaching speeds of up to seven m/s. This speed is annoying sometimes. This speed of the wind decreases as we move away front the coast. In summer this breeze is normally appropriate, due to the temperatures recorded in summer between 22 °C and 25 °C. In the fall, the pedestrian circulation where the roof is solid, it presents cooler comfort.

The breeze decreases as we move away from the coast, and is modified by the existing vegetation, topography, and shape of the facade, as in the case of the Track Two Nova Icaria’s concave block. Wind speed on this route has decreased up to 70% compared to the coastal breeze. Red brick is the dominant building material used on floors and walls. It loses moisture quickly and the breeze evaporates.

Is there a difference in the spaces with or without vegetation?

There is a big difference of discomfort, where there is no vegetation on the three front facades of Track Two Nova Icaria especially from 10 in the morning during all the seasons of the year.

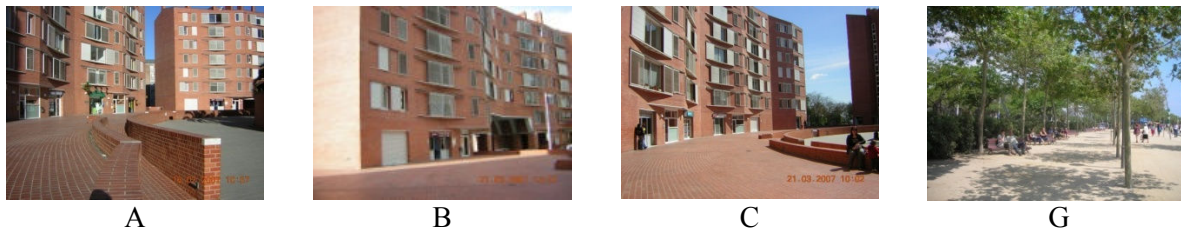


Figure 3. Pedestrians circulations. Track Two Nova Icaria.

On Track One Port Olímpic, in the spring as it can be seen on figure 4, it was observed that all circulations have comfort because pedestrian circulations “B”, “D”, “E” and “F” have rows or groups of different kinds of deciduous and evergreen trees.



Figure 4. Pedestrians circulations in spring, Track One Port Olímpic.

In the summer, when trees have the highest density of their foliage, as shown on image 4, all pedestrian circulation covered with vegetation presented comfort during the day. However, pedestrian circulation “C” under a tiled roof presented the most comfort of all during the day.



Figure 5. Pedestrian circulation in the summer, Port Olímpic's Track One.

During the day, because of the high solar radiation and high temperatures, people usually look for shady places, depending on the activity being performed, they prefer areas where solar radiation is direct, as in the case of the beach area.



Figure 6. Sunny and shadow areas, facing the costal line.

In winter, people look for sunny areas, as shown on figure 7.



Figure 7. Pedestrian circulations in winter.

Are the materials affecting the comfort of the pedestrian?

Designing exterior spaces, the choice of materials is of great importance. The ones with low albedo like red brick, stone and concrete are a great heat storage. Asphalt street pavement has the greatest effect on air temperature. These facts increase the air temperature in outdoor spaces, as a result of radiation from the irradiated surface that heats the air by convection. The colors of the facades, walls and floors, should be usually clear as they reflect solar radiation. For cold climates it is advisable to use dark pavement.

Recommendations

For a coastal temperate climate, it's recommended to leave at least a distance of 150 meters from the construction area to the coastline; this will allow the pedestrians to enjoy the breeze, the alternation of the landscape and climate in all seasons. It is very important to seek appropriate vegetation cover for the best protection outdoors, considering the physiological and structural changes of the season.

Textile covers are another option to manipulate the projection of shadows and transmissivity. Solid covers allow protection from the rain. In summer, they also provide comfort.

Finally, these recommendations, give an opportunity to continue doing more research on:

- a. Studying the urban mobility of pedestrians in accordance with local customs, housing, restaurants, bars, shops, as well as time spent in outdoor locations.
- b. To determinate the influence of the coastal climate in interior spaces.
- c. Analyzing the urban furniture: such as benches, lampposts, and recreation areas.
- d. Analyzing the pedestrian coastal comfort in other latitudes.

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