Journal of Engineering and Applied Sciences

The Impact of the Type Urban Canyon in Solar Radiation into Open Spaces

[1]Rami Qaoud and [2]Alkama Djmal
[1]*Department of Architecture, University of Biskra, Biskra, Algeria*
[2]*Department of Architecture, University of Guelma, Guelma, Algeria*

Key words: The solar radiation, L/W, The city of Biskra, urban fabric, the coefficient of SVF, geometry

Corresponding Author:
Rami Qaoud
Department of Architecture, University of Biskra, Biskra, Algeria

Page No.: 2065-2069
Volume: 15, Issue 9, 2020
ISSN: 1816-949x
Journal of Engineering and Applied Sciences

Abstract: In this study, we present the impact of the type of urban canyon on solar radiation into open spaces. The study is based on the solarization periods in three types of urban canyons and comparisons are made between them to infer the impact of the geometry of the canyon in controlling the solarization periods. The most important parameter of canyon geometry is the relationship between L and W and we studied three types of relationships: $(L2\geq W\text{-}L = W\text{-}L\leq 0.5W)$, according to the Northeast/Southwest direction. This study is very important for determining the canyon with the shortest solarization period and least amount of solar energy. This study is useful for designing a small solarization period and very useful for desert towns. The methodology follows the comparison method where the comparison of the solarization period is the result for the solar plan for the city of Biskra. The difference in the values of the solarization period between the three types indicates that the urban canyon type $(L\geq 2W)$ is the least exposed to solar thermal radiation and experiences the lowest temperature. The conclusion is that the higher the L/W proportion is the smaller the solarization period and solar energy. In this framework, we can mention papers related to the subject. This belongs to the researcher's research team.

INTRODUCTION

The protection of open space from the physical environmental load is the responsibility of the urban fabric[1]. The large amount of solar radiation in desert regions requires an urban planning technique that allows little solar radiation to enter the open space. In this context, the type of urban canyon represents the most important tool in reducing the amount of solar radiation that enters the urban open space and it controls the size of the sky above the space and the amount of radiation that is transmitted. Therefore, canyons with a high ratio between length and width are best suited for use in cities that are located in desert regions because they allow a small amount of sky above the open space; this concept has been proven by scientific studies in this field. Therefore, typical studies on the distribution of solar thermal and

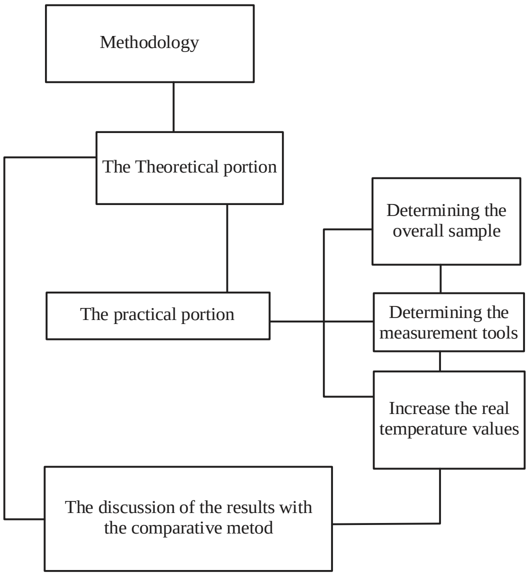

Fig. 1: The scheme of the methodology

lighting energy and the reduction of this energy are very important to guarantee the physical comfort of humans within open spaces, especially, in desert cities[2]. In this framework, we can mention papers related to the subject from the researchers research team[3]. The methodology is shown in the following Fig. 1.[4].

MATERIALS AND METHODS

The site measuring stations: The path of the sun above a city most commonly follows the direction of Northeast to Southwest, thus, this direction is the sunniest during the day. This was the reason for choosing the distribution of the three stations on the street from the fabrics according to this direction (Northeast/Southwest) which are the overall samples for the city[4] as presented in the following (Fig. 2-10).

Note. The experiment was based on study two directions of Northeast to Southwest and Northwest to Southeest, these directions of the street are the sunniest during the day in the city, according to the path of the sun city of Biskra where the results were almost identical in both directions[4].

Description of measurement stations: Station N°01. The low ratio between the height-width (L2≤W). Open street station N°02. An average ratio between the height and Width (L = W). Dihedral street station N°03. A high ratio between the height and width (L≥2W). Canyon street.

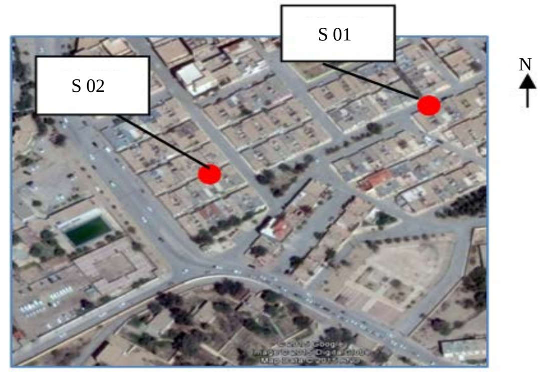

Fig. 2: The stations (01) and (02); Google Earth 2015

Fig. 3: Station (03); Google Earth 2015

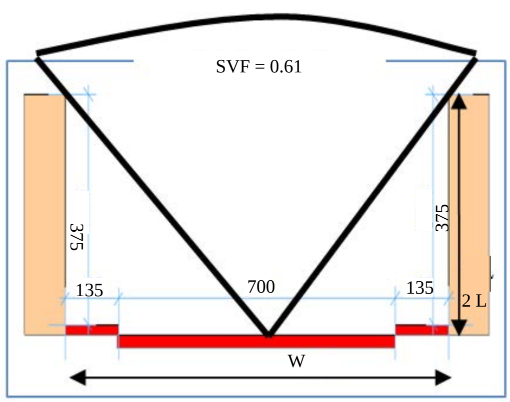

Fig. 4: Section of station (01)

Fig. 5: Fis-eye image of station N°01

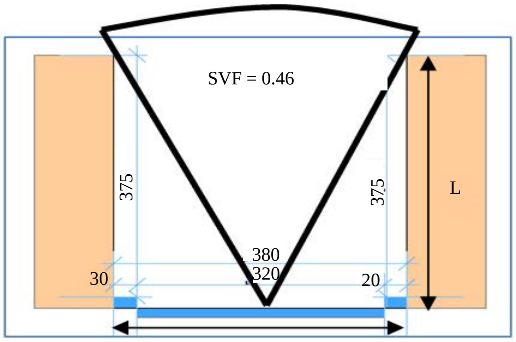

Fig. 6: Section of station (02)

Fig. 7: Fish eye image of station (02)

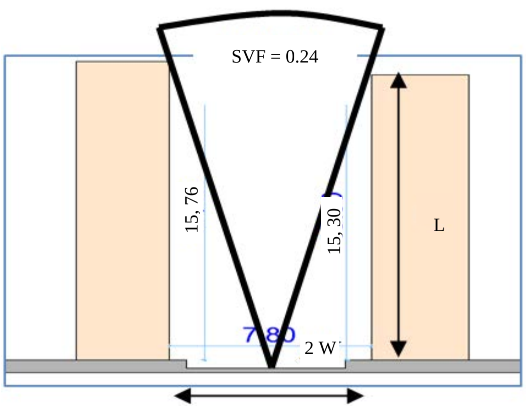

Fig. 8: Fish eye image of station N°03

Fig. 9: Fish eye image of station N°03

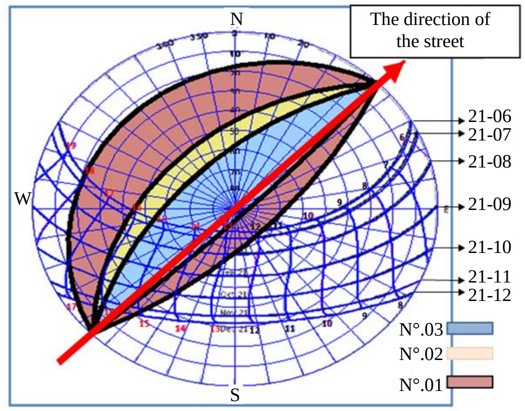

Fig. 10: Solar plan for Biskra city-street-North East/ South West. S@TEL-LIGHT /http://satel-light.com

RESULTS AND DISCUSSION

Comparing the periods of solarization: The solar plan for the city of Biskra was established according to the time period of the experiment. The results are as follows. For station N°01, open street 7 h of direct solar radiation from 14.3 solar hours when the range of the elevation angle of the sun extends from 73.5° to 23.5°. This area runs from 12.00-8.00 h. Station N°02, dihedral street 05 h a day, within this range, the angle of the sun rises from (73.5-44°); this area runs from 12.00 -16.00. Station N° 03 canyon street which is exposed to more than 2 h within the range of the angle of the sun which rises from 86-67.5°. This area extends from 13:30-15:30. The relationship between L and W led to a difference in the solar angle ratios for the three types of streets and the time of period solarization; thus, different solar radiation values were received by the streets during the day (Fig. 11).

Comparison (SVF) for the Three Models of Streets, Northeast/Southwest: Through Fig. 12, we can observe the amount of the opening of the canyon towards the sky where the S.F. V for the type canyon (L2≤W is = 0.61, L W is = 0.46 and L≥2W is 0.24) Thus, the tendency of the geometric canyon to reduce the space towards the sky greatly helps to reduce the amount of falling down solar radiation inside the canyon and therefore less solar energy.

Comparison of the relative humidity on the streets from Northeast to Southwest: As shown in Fig. 13, we can observe the influence of the solarization direction in urban canyons on the level of relative humidity; the canyon L≥2W which has the lowest period of solarization has the highest humidity which can improve the air temperature.

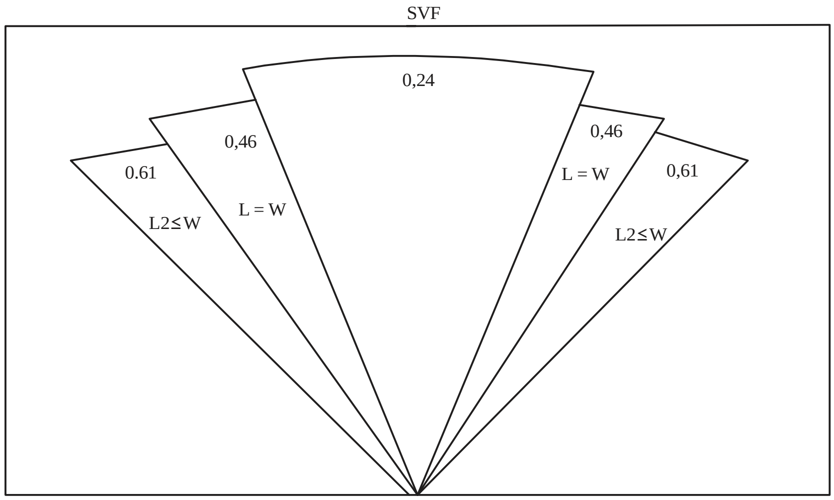

Fig. 11: The comparison (SVF) for the three models of streets

Fig. 12: A compilation fish eye images for stations No.01 02 and 03

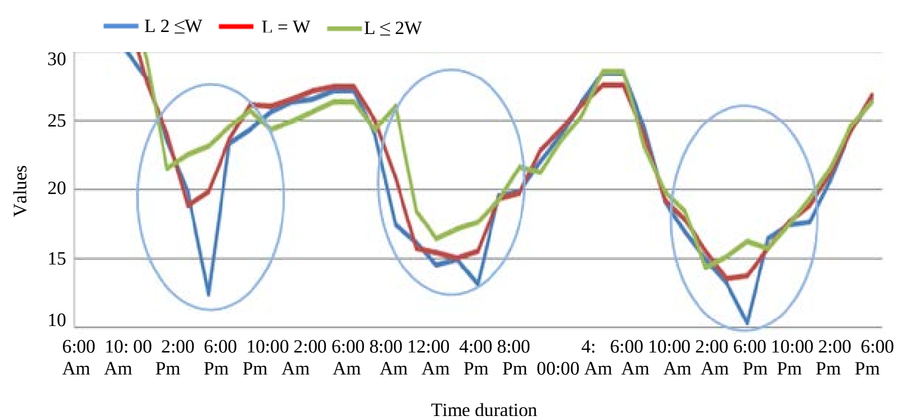

Fig. 13: Graph of relative humidity for station n°01, 02 and 03

As shown in Table 1, we can observe the relationship between the (SFV) and the periods of solarization where the (L2≤W) canyon type has the longest solarization time (SFV = 0.61 and time of solarization = 7 h), followed by the (L W) canyon type (SFV = 0.46 and time of solarization = 5 h) and the (L≥2W) canyon type (SFV = 0.24 and time of solarization = 2.1 h). This result indicates that there is a positive relationship between the two indicators (SFV and period of solarization when the SFV is high, the period solarization will be long.

The difference in (SFV) resulting from the difference in the L/W ratio leads to differences in the periods of

Table 1: Table of the compilation of results

The relationship between H/W	L≤2W	L = W	L2≥W
SVF	0, 61	0,46	0, 24
Hours of direct solarization	7 h	5 h	2.1 h
Total thermal energy gusset during the hours of direct insolation	5218 $_{W/m2/d}$	4600 $_{W/m2/d}$	3288$_{W/m2/d}$
Max a temperature	°45.4°C	42.7°C	41.3°C
Total lighting energy in direct lighting	293$_{3k/lux/d}$	229.1$_{k/lux/d}$	76$_{k/lux/d}$

direct solarization and the amount of solar thermal radiation and lighting energy for the three models of the street. The coefficient of the sky view factor is considered a door for solar radiation to enter the street. Scientifically, the coefficient of the sky view factor must be low in free urban spaces in desert areas to ensure more shade, a low amount of solar energy, a low air temperature and a low natural lighting value; thus, the main controller of the coefficient of the sky view factor is the relationship between L and W, so, the greater the proportion between L and W, the lower the coefficient of the sky view factor and the lower the amount of solar energy.

CONCLUSION

The reduction in the exposure of a street to direct solar radiation by the reduction in the coefficient of the sky view factor helps to reduce the natural loads on humans on streets by reducing the amount of solar energy that reaches the street. Thus, this reduction helps to accelerate the process of thermal equilibrium between the human body temperature and the physical envelope temperature, therefore, when humans are in a state of thermal equilibrium with their physical environment, they are in a state of thermal comfort. Thus, the reduction in physical loads on the street helps to provide the conditions for thermal equilibrium in humans with their environment and achieve thermal comfort.

This research is classified under the research axis (the studies of external spaces in the urban environment according to the bioclimatic approach and geographic approach). However, this research focuses on the tracking and study of the distribution of solar radiation-thermal radiation and lighting radiation-in different types of street canyons by comparing the study of the direct solarization periods of each type and the quantity of solar energy collected during the solarization periods.

REFERENCES

01. Marc, C., 2005. [The City and the Desert: The Algerian lower Sahara]. Karthala Editions, Paris, France, Pages: 305 (In French).
02. Allain, R., 2004. [Urban Morphology: Geography, Planning and Architecture of the City. Armand Colin Publisher, France, ISBN: 9782200262624, Pages: 254 (In French).
03. Boukhabla, M., D. Alkama and A. Bouchair, 2013. The effect of urban morphology on urban heat island in the city of Biskra in Algeria. Int. J. Ambient Energy, 34: 100-110.
04. Qaoud, R. and A. Djamal, 2017. The impact of constructivism density of the urban tissue in improving the urban ambience-thermal, visual-of the street. Casa Study City Biskra: Proc. Plea, 1: 820-826.