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## Climate-Sensitive Pavement Modelling for Pedestrian Ways

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### Abstract

It is very obvious that urban areas should be more liveable and well equipped for different seasons to provide sustainable urban environment for the inhabitants. SVF and RayMan Pro 2.1 model are used for the determination of comfortable conditions. Measurements were also taken from north and south side and from the middle of the pedestrian ways. Time of the measurements was decided as September 2015 and January 2016 between 12:00 and 14:00. When the measurements were made, Fish-eye photos were also taken for the calculation of SVF. This study found that the relationship between temperature and SVF is more important during the winter.

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### 1. Introduction

Public places are the most important feature that put the cities into action. Public places, such as streets, squares, and sidewalks, carry the soul and the characteristics of a city [1]. Sidewalks are the physical symbol and the first indication of a new city; they are less functional, but provide more living areas for people. Sidewalks in the city results in more interest from the public spiritually and emotionally [2]. In this paper, alternative pavement proposals have been studied for sidewalks in the city of Erzurum. In the modelling process in which thermal comfort is considered, solar radiation, forestations are tested. It is well known fact that accessibility and thermal comfort based studies and modelling increase the visual quality of city and safe mobility of urban population. With this study, it is aimed to contribute to the decision making process of urbanization practices and the determination of urban transformation

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areas. Presentation of how different models affect urban microclimate is very crucial for healthy and comfortable urbanization. Pavement models proposed in the context of this study will make a big contribution to urban aesthetic and will be an important input for urban transformation projects, development plans and new settlement areas in the city Erzurum.

Public places had been heavily used by pedestrians until the 20th century, but with the increase of motor vehicles, the priority of pedestrians on streets and roads ended. Although the transportation technology has improved, pedestrian traffic in cities still exists in order to meet some essential needs, such as shopping, being socialized, doing exercise, and walking a short distance [3].

Pedestrian sidewalks which are described as the public area that is between where the curb ends and private property starts, consist of “three main stripes” which are ideally separated from each other and have different functions. This stripe has an important role on sidewalk’s quality, comfort, and security. Pedestrian crossing is completely dedicated for pedestrians. The stripe attached to the buildings are generally found on streets/roads with commercial and mix uses, and this stripe aims at window-shoppers and people going in and out of stores [4]. In this sense, the main factors that affect the arrangement of sidewalks can be listed as technical, climatic and physical factors. Technical factors are effective on measuring sidewalks; climatic factors are effective on design (direction, shadow, windbreak etc. arrangements); physical factors (natural and man-made environmental aspects) are effective on modelling the sidewalks [5]. Research has been done on sidewalk humidity, flooring, birds eye view affect, and direction Reduction of cold and heat stress on sidewalks can be provided by planting native plant species [6,7,8].

Climate factors are important on providing human comfort. Design features should be determined locally in order to provide thermal comfort on cities with distinct climate conditions. These features should be climate sensitive, that is to focus on protecting cities from severe cold and hot air and surface temperature that has a negative impact on thermal comfort; from humidity; and from wind movements. Especially in cold climate regions, icing of sidewalks and icicles on the roof negatively affect the quality and comfort of life. Pedestrian safety, accessibility, floor coverings and human comfort on sidewalks are the needs for the quality of life and sustainable cities. Also these arrangements make a big contribution to the cities’ legibility and design qualities. Sidewalks as one of the important parts of the urban environment positively affect urban identity, accessibility and livability and their design and used materials become crucial for the residents in urban areas. It is very well known that pavement models, which have thermally comfortable, useful, increase the safety of the mobility of habitants and increase the visual quality of the city.

This study investigates the changes on thermal comfort based on the measurements that are made on different locations and on different pedestrian axes both in the winter and summer time. This study examined how much sidewalks can benefit from sunlight in a city with cold climate or examined the impact of plantation in order to prevent to be subject to direct sun light during summer time. For this purpose, Erzurum city center which has a high density residential development and green places are investigated.

## 2. Materials and Methods

### 2.1. The features of the working area

Erzurum is located on the eastern part of Turkey with a population of 776.729 (numbers from 2014). The elevation of Erzurum is 1890 meters and it is one of the coldest settlements in Turkey. Winter conditions take more than six months in a year. The average minimum daily temperature during January is  $-16^{\circ}\text{C}$  and the temperature goes below  $-30^{\circ}\text{C}$  every year. The average number of snow-covered days is 30 and the temperature difference between the day and night is very high.

In sum, “the length of the longest and shortest daytime” in Erzurum or the changes of nighttime length in the year negatively impact the heating and lighting of residential places or the overall energy consumption in a year. Daytimes being shorter than night times in majority of the year, and being above the sea level are the negative climatic impacts.

Along with these negative conditions, the formed environment conflicts with the cold climate and the living standards on the city become lower. For this reason, urban area is researched closed lath, semi open, open, surround building and two edge tree. The measurements are made in September 2015 and January 2016 in 10 points in 5 different locations. Research assistants were told how to take pictures with fish-eye lens (Nikon D5100 digital camera

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