

Thermal Comfort Survey for Different Street Configurations in Summer in Japan

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ABSTRACT: To evaluate urban street thermal environments for pedestrians in summer, we conducted thermal comfort surveys and thermal environmental measurements on three streets that have different configurations: a narrow alley (Narrow), an intermediate street (Middle), and a wide street (Wide). Narrow or Middle were evaluated more thermally comfortable than Wide by subjective thermal sensation voting (TSV). Although the mean Standard Effective Temperature SET*, which considered solar radiation in each street did not differ significantly, the relationships between SET* and thermal sensation were different by street. Comparing the TSV within the same SET* ranges, the subjects on Narrow voted cooler than on Middle and Wide. The percentage of subjects feeling 'uncomfortably hot' within each SET* range was smaller, and the thermally comfortable SET* range was broad on Narrow. We conclude that the street thermal environment in summer for pedestrians is more comfortable on Narrow than that on Middle or Wide.

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Keywords: thermal comfort, thermal sensation survey, SET*, pedestrians

1. INTRODUCTION

Due to the heat island effect, the urban street thermal environment in summer is getting worse. It is important to offer an appropriate thermal environment for pedestrians in future urban planning. There are various street configurations, and each type of street, with varying surface materials has different thermal environments due to differing heat balances or wind environments [1]. Some studies have analyzed street thermal environments using a coupled simulation based on their configurations [2][3]. Other studies have used field research to determine pedestrians' subjective comfort [4], but have not studied street configurations and their thermal environments. In the current research, we assessed pedestrians' subjective comfort in summer and linked it with the measured thermal environments of different street configurations.

Surveys were carried out in the Nishijin district, the central part of Kyoto City, Japan. This district, has traditional narrow alleys called 'roji', which have street widths of less than 2 meters, wide enough only for pedestrians to pass each other. Local residents commonly use this space not only for the passage but also as a communication space. There are many traditional timber houses along a 'roji,' and it has unique streetscape aesthetics.

The selected three streets, including this narrow alley, have different configurations: a narrow alley (Narrow); an intermediate street (Middle); and, a wide street (Wide), which are described in Table I. A map of survey locations is shown in Fig. 1, and photographs of the survey scenes are shown in Fig. 2.

We conducted thermal environmental measurements and thermal sensation voting (TSV) surveys along these three streets. Generally, each pedestrian has a different metabolic rate, depending on their action level. To assess pedestrians' comfort on the three streets, we conducted surveys on subjects in a seated condition to keep their metabolic rates constant. Using the Standard Effective Temperature (SET*), a thermal index that considers solar radiation, we compared: 1) subjects' thermal comfort on the three streets; and, 2) relationships between SET* and TSV on each street.

Table I: Survey locations

Streets	Date	SVF [-]	Street width [m]
Narrow	Sep. 16	0.36	1.6
Middle	Sep. 17	0.49	4.0
Wide	Sep. 14	0.58	20.0

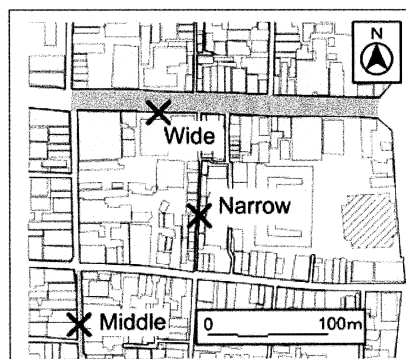


Figure 1: Map of survey locations. Three streets (Narrow, Middle, and Wide) are shown.